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# City Introduction & Context

Europe is an urban society, with many environmental challenges to face. The European Commission has long recognised the important role that local authorities play in improving the environment, and their high level of commitment to genuine progress.

The European Green Capital Award has been conceived as an initiative to promote and reward these efforts.

Starting in 2010, one European city is selected each year as the European Green Capital of the year. The award is given to a city that:

- Has a consistent record of achieving high environmental standards;
- Is committed to ongoing and ambitious goals for further environmental improvement and sustainable development;
- Can act as a role model to inspire other cities and promote best practices to all other European cities.

## European Green Capitals

The first European Green Capital was awarded in 2010 and nine cities have been awarded the title thus far. The European Green Capitals to date are:

2010 Stockholm, 2011 Hamburg, 2012 Vitoria-Gasteiz, 2013 Nantes, 2014 Copenhagen  
2015 Bristol, 2016 Ljubljana, 2017 Essen, 2018 Nijmegen, 2019 Oslo and 2020 Lisbon.

Source: European Commission

## Application Lahti 2021

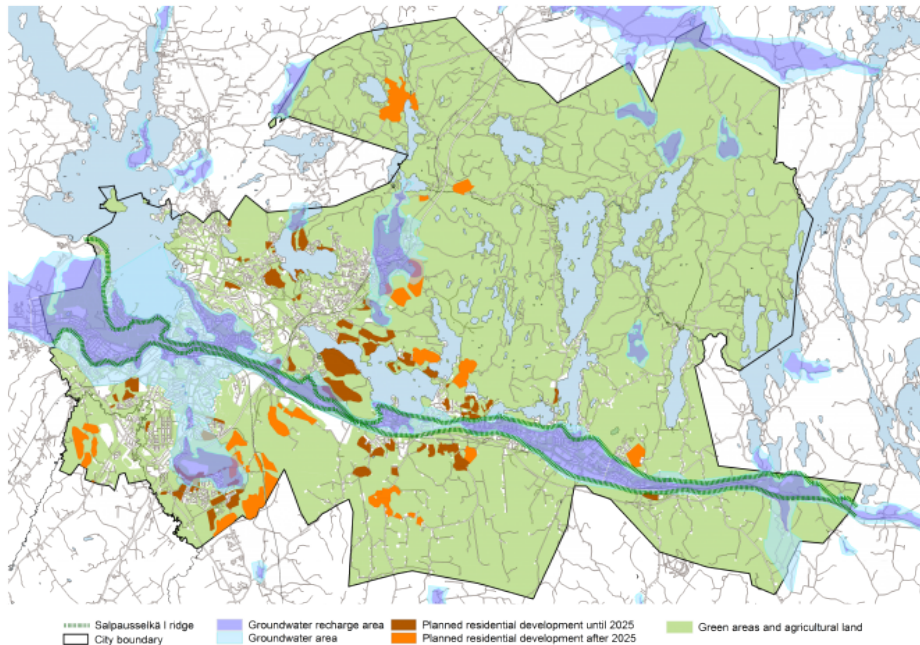
Indicator		Units	Year of Data
Population	119 573	Number of inhabitants	2017
Area	517.63	km <sup>2</sup>	2017
Population Density	267	gseg	2017
GDP	30 783.10	lnh/km <sup>2</sup>	2014
Köppen climate classification	Dfc: Subarctic climate Cold winters and short, cool-to-mild summers. Precipitation all year round.	€/capita	

Lahti is a city of 120 000 inhabitants in Southern Finland. Lahti and the neighboring municipality of Nastola merged in 2016. Lahti's area increased over three fold and the population by 15 417 residents. Now, forests cover over 70% of Lahti (Fig. 1).

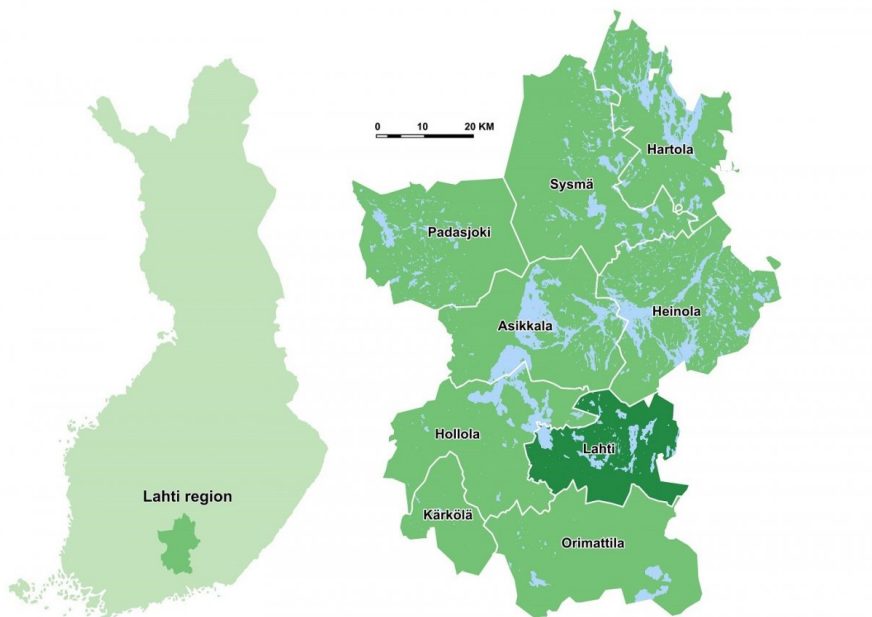


Figure 1. Lahti's city centre is densely built but, most of the city surface is covered by green and blue areas.

Located in between two capitals, Helsinki and St Petersburg, the City of Lahti has always been an important logistical route and marketplace (Map 2). Lahti has a special geographical environment and history. The Salpausselkä ice age formation, runs through the city from east to west, which is why some of the oldest human settlement remains, in all of Finland, are found there. The Salpausselkä Ridge provides numerous ecosystem services: large groundwater reservoirs (one of the most valuable in Northern Europe), recreational values for citizens and visitors, and a diversity of biotopes (Map 1).



Map 1. The Salpausselkä Ridge ice age formation, the Salpausselkä Ridge, brings unique characteristics and ample nature opportunities and value to the city.



Map 2. Lahti is a regional centre with 200 000 inhabitants and easy connections to the airport, Helsinki and St Petersburg

For a long time, Lahti was only a small village linked to the wealthy agricultural municipality of Hollola. The last 50 years have proven to be a remarkable growth period for the city. After the

Second World War, Lahti was growing faster than any other city in Finland. The rapid growth of Lahti City was a consequence of the industrialization and urbanization of Finland, during the 1960s and 1970s (Fig. 2), and it created numerous working opportunities, new industries and an economic boom for the area. Lahti was known as the “City of Carpenters” in the early 19th century.

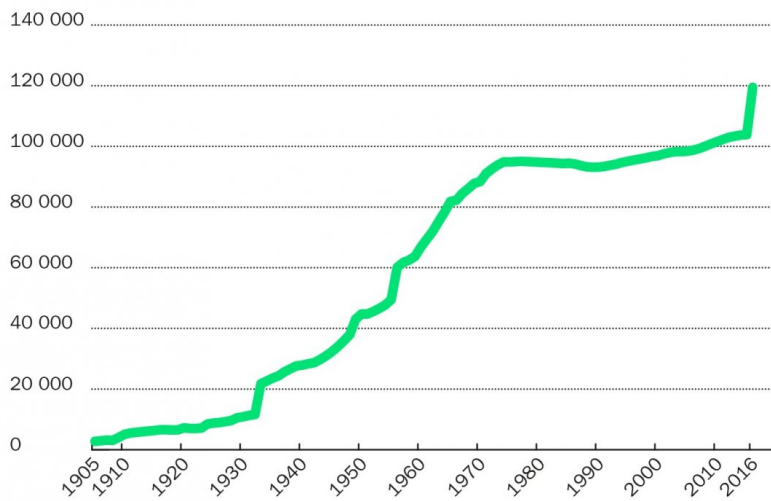


Figure 2. The population growth and urbanisation of Lahti was very rapid after WWII, but plateaued by the mid-70s.

The rapid industrialization and population growth also caused some unpleasant environmental problems. Nearby Lake Vesijärvi was badly eutrophicated during 1970-1980, although, the first sewage water treatment plant started functioning in the 1960s.

# 1. Climate Change: Mitigation

## 1A. Present Situation

City reduction targets (add rows if needed for further commitments) Where possible please use 2005 as the base year for listing city reduction targets	Base Year	Target Year	% Reduction
	1990	2030	70%
	1990	2050	carbon-free

CO <sub>2</sub> emissions	Units		Year of Data
Total CO <sub>2</sub> emissions/capita	5.77	t CO <sub>2</sub> /capita	2017
Total transport CO <sub>2</sub> emissions/capita	1.55	t CO <sub>2</sub> /capita	2017
Total (less transport) CO <sub>2</sub> emissions/capita	4.22	t CO <sub>2</sub> /capita	2017
Total CO <sub>2</sub> emissions per year	690 300	t CO <sub>2</sub>	2017
Total CO <sub>2</sub> emissions per MWh electricity consumed	0.63	t CO <sub>2</sub>	2017

Lahti is located in a boreal climate zone. Building heating is the largest emission source. Over 80% of the buildings have district heating, of which most is produced in CHP plants [Fig.A1]. The energy source of these plants has the greatest impact on Lahti's GHG-emissions. The second biggest challenge is the transport emissions, which the city is tackling by developing a personal carbon trading scheme. The first baseline emission inventory was made by the Helsinki University of Technology, in 2000, using the national calculation model, Kasvener. This production-based calculation covers all scope 1 and 2 emissions produced in the Lahti geographical area.



Lahti is committed to cutting CO<sub>2</sub> emissions by 70% by 2030 of the 1990 level. We are currently designing a new SECAP for 2030, which will likely tighten the climate change mitigation targets significantly, with a new short-term goal for year 2021 (suggestion: -70% from 1990 level) and carbon-neutrality by 2030, at the latest.

In 2017, 690 300 tonnes of CO<sub>2</sub>e were produced altogether. By now, the CO<sub>2</sub>e reduction is 41.33% from the 1990 level (Fig.A1) and if calculated per capita, 46.9%. (Fig. A2). Emissions have decreased even though the population has increased from 100 080 (1990) to 119 573 (2017). In order to make the last few years progress visible, Lahti will organize a city-wide pilot on living in a carbon-neutral society for the EGCA year 2021.

**Production-based CO<sub>2</sub>e Emissions of Lahti, 1990 and 2017 (1000 tons)**

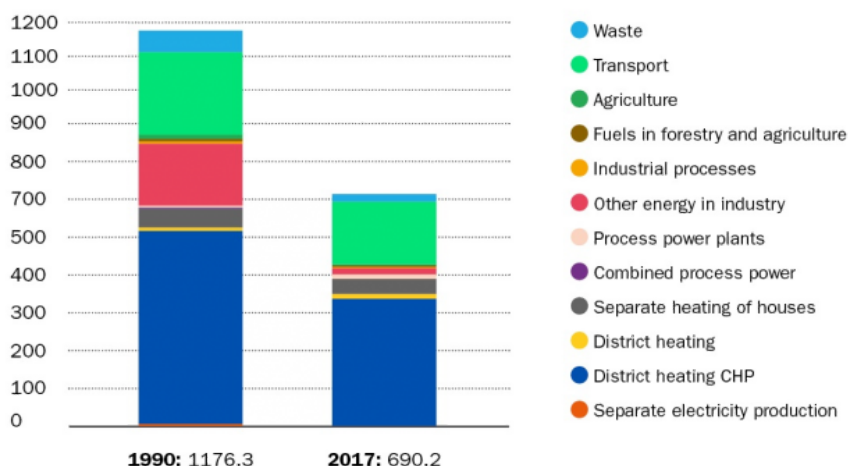


Figure A1. Lahti greenhouse gas emissions in 2017 compared to 1990 level.

**CO<sub>2</sub>e emissions tons per capita in Lahti, 1990, 2008\* and 2017**  
production-based \*old Lahti

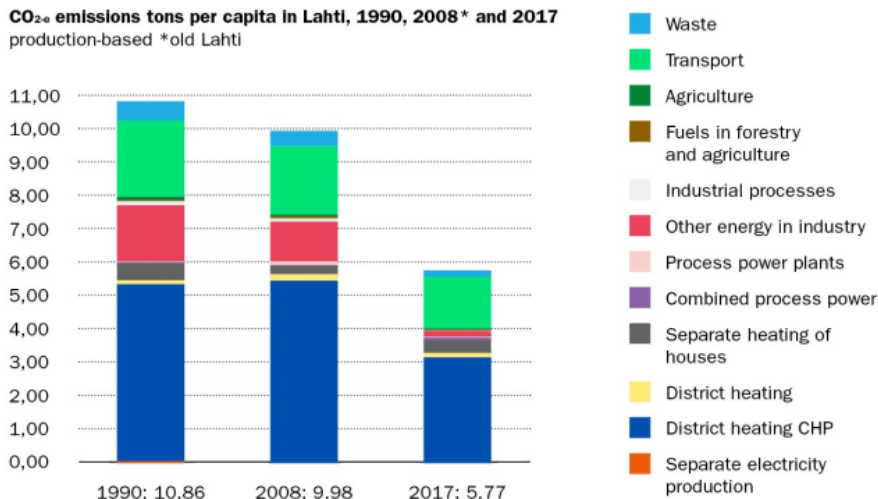


Figure A2. CO<sub>2</sub>-e emissions per capita. The 2008 figure is from old Lahti municipality, before the merging of the municipalities. 1990 and 2017 are from same geographical area.

City of Lahti has its own energy, climate and sustainability targets. Other own targets are sustainable food in all activities, by 2030 and the use of biogas or e-cars in municipal operations by 2030. The WWF Green office EMS is in use in 11 city departments. EMS increases environmental knowledge of employees, energy efficiency of premises and the reporting quality. Results show that the long-term perseverance is bearing fruit. The municipality's own emissions have decreased from 26,080.7 tons of CO<sub>2</sub>-e in 2009, to 21,277.2 tons in 2017 (Figure A3).

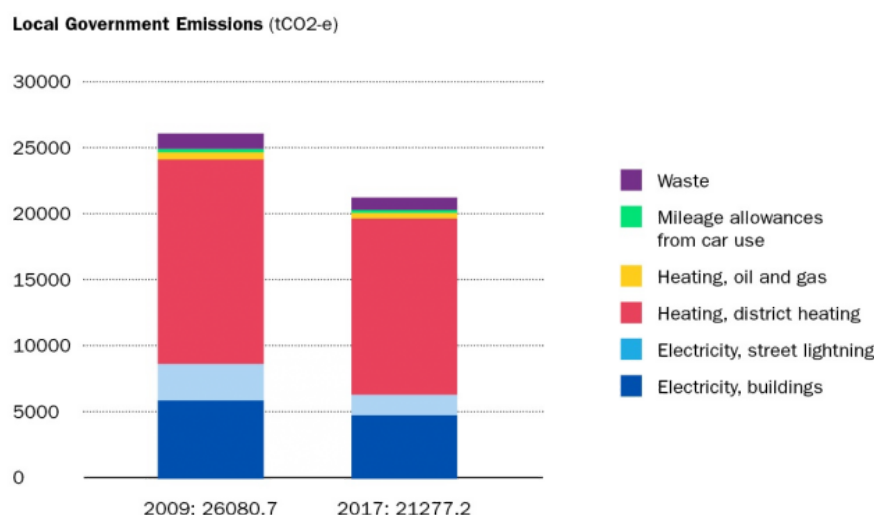


Figure A3. Greenhouse gas emissions from city and city owned companies' activities 2009 and 2017. Waste emissions were 909.95 tons of CO<sub>2</sub>-e in 2017. Consumption-separated waste fractions are presented in Figure A4.

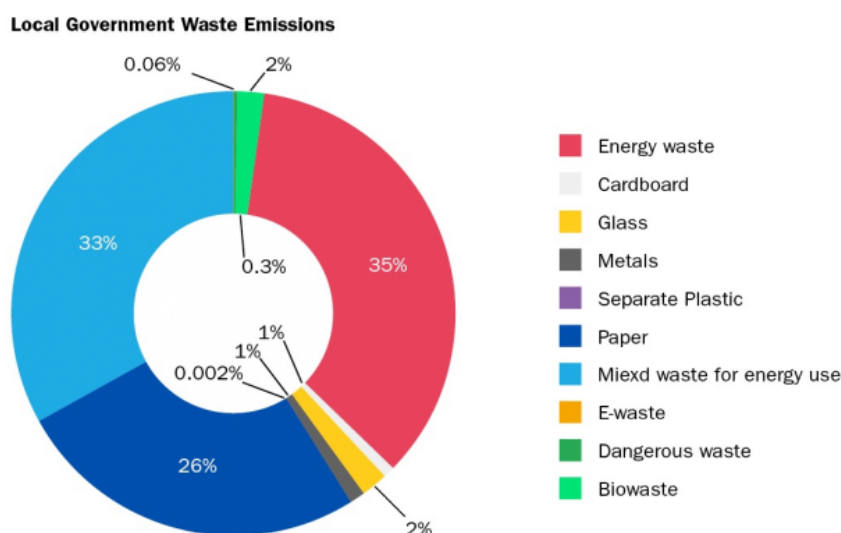


Figure A4. Closer look at Lahti's annually reported emissions from waste in 2017 most resulting from energy waste, mixed waste and paper.

In 2008, the City of Lahti signed the Ministry of Economic Affairs and Employment's National Energy Efficiency Agreement 2008-2016 (KETS), which was drafted to implement the Energy Efficiency Directive. The aim was to achieve 9% of energy savings, over the 2008-2016 period (15.99 GWh) by increasing the energy efficiency of water and wastewater treatment of the city's premises and street lightning. This goal was met and even exceeded and Lahti managed to save 18.87 GWh of energy. The City of Lahti signed a new Energy Efficiency Agreement 2017-2025, targeting a further 7.5% energy saving (10.57 GWh). Lahti has been a member of the EU Covenant of Mayors since 2012.

Progress in climate change mitigation is reported annually in the Environmental Reviews, Environmental Balance Sheet, and every 2nd year in the CoM SEAP report and City Strategy Follow-up.

## 1B. Past Performance

### Strategy for Climate Change

For the the EGCA2021 we will build a model and demonstrate carbon-neutral living, on a city-

wide scale, in Lahti. Our strategic target is to cut 70% of GHG emissions (from year 1990 level) by 2030. Environmental Programme was accepted in 2018 with a shorter term target to reach 70% sustainable fuels in energy used in Lahti area by 2021 (excluding transport). Long-term target is to be a carbon-negative city by 2050. However, we are currently designing the SECAP for 2030, which will likely result in increasingly ambitious mitigation targets.

Climate work has a long history in Lahti. Local commitment to climate work was established right after the Rio Summit 1992, when a Citizen Forum on Environment was established. An Aalborg Commitment baseline review was performed in 2009 and the city's sustainability programme was established in 2011. Lahti joined the EU Covenant of Mayors in 2012. The CoM Sustainable Energy Action Plan was launched 2013, with more ambitious strategic goals required by the EU. Lahti SEAP is an ongoing process with 44 actions (Fig. B1), monitored every other year. In the SEAP 2013-2020 the estimated energy savings are 141736.2 MWh. Renewable energy production (without the bio thermal plant Kyvo3) will be 360871 MWh and CO2 reduction 94456.53 tons of CO2. Lahti will give up on coal after opening the Kyvo3 in 2020. Currently, the most effective actions are the Energy Efficiency Agreements, the biogas plant and the collecting of landfill gas. It is challenging to calculate the CO2 reduction of many of the SEAP actions, such as land-use planning and the energy advisory. The shares of different actions are shown Fig.B1 and their status in Fig.B2.

**Lahti Sustainable Energy Action Plan 2013–2020** (Actions by sector)

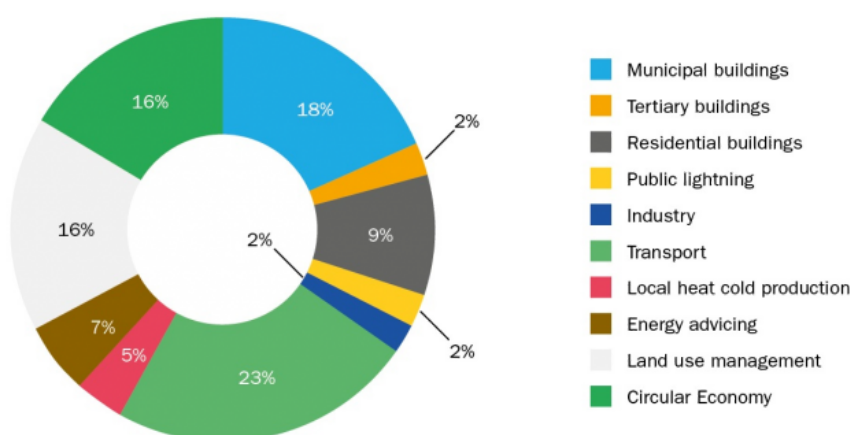


Figure B1. Sustainable Energy Action Plan 2013-2020: shares of different actions (total of 44).

**Lahti Sustainable Energy Action Plan 2013–2020** (44 actions)

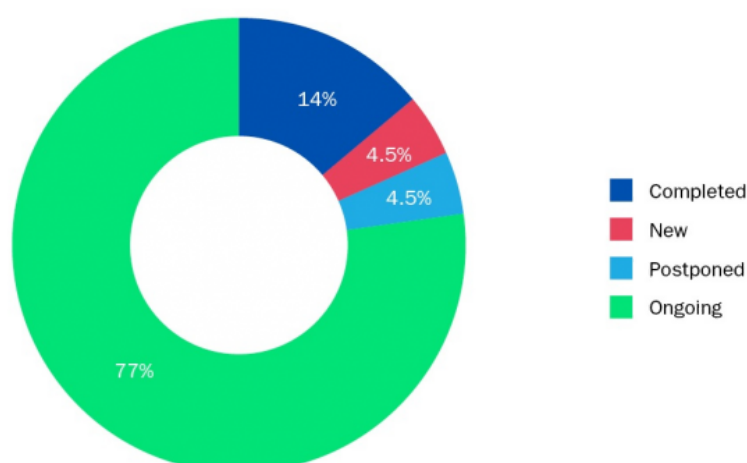


Figure B2. Current status of SEAP 2013-2020 actions (in total 44).

City-owned Lahti Energy Ltd. set an ambitious strategic goal, to reduce CO<sub>2</sub> emissions with 80% by 2020 from the 1990 levels, in all its activities. Lahti Energy has invested in sustainable district heating, which is the heating source for over 90% of the population. Over 95% is produced energy efficiently at the Kymijärvi I-II CHP plants. Kymijärvi power plant II started operating in 2012. It is a unique gasification power plant that uses solid recovered fuel (SRF). Share of renewables in the district heating production accounted 40.53% in 2017. Specific emission coefficient for district heating in Lahti is 180 gCO<sub>2</sub>/kWh. In terms of electricity sales based on energy source distribution, renewables accounted for 40.22% (2017) and the specific emission coefficient for electricity sales was 150.58 gCO<sub>2</sub>/kWh. Lahti Energy is also purchasing shares of wind power plants in Western Finland.

#### **Mainstreaming of Climate Protection Measures**

Climate protection measures have been mainstreamed across municipal services. CO<sub>2</sub> reduction is a strategic goal for Lahti Energy company, Lahden Talot housing company and Lahti City Strategy, including the Lahti Premises Centre. Reduction is reported in the Environmental Review reports and company balances. In other Lahti Group companies, such as the Lahti Aqua Ltd. and Päijät-Häme Waste Management Ltd., the climate protection is integrated into the processes and monitored annually. For example, the Regional kitchen of Southern Lahti was designed energy-efficient with district heating, heat pumps and energy recovery and solar panels. The kitchen prepares 10 000 meals a day for schools and kindergartens.

Lahti is also part of the Finnish CO<sub>2</sub> reporting initiative, calculated by Benviroc Ltd. for many Finnish municipalities. This allows comparison with other cities (Fig.B3).

Participation in the Energy Efficiency Agreement of the Ministry of Employment and the Economy of Finland (KETS) has shown its effectiveness. Agreements are an important part of Finland's energy and climate strategy and the main method to promote the efficient use of energy and to implement EC Energy Efficiency Directive. The consumption of electricity and heating energy are illustrated in Figures C4 and C5. The amount of municipality owned premises has changed during the years, but the relative figures of energy use per m<sup>3</sup> can be monitored (Fig. B3). Swimming halls of Lahti have significantly improved the energy efficiency (Fig. B4). Lahti Aqua and Premises Centre also participate in the Energy Efficiency Agreement (KETS) and are monitored annually.

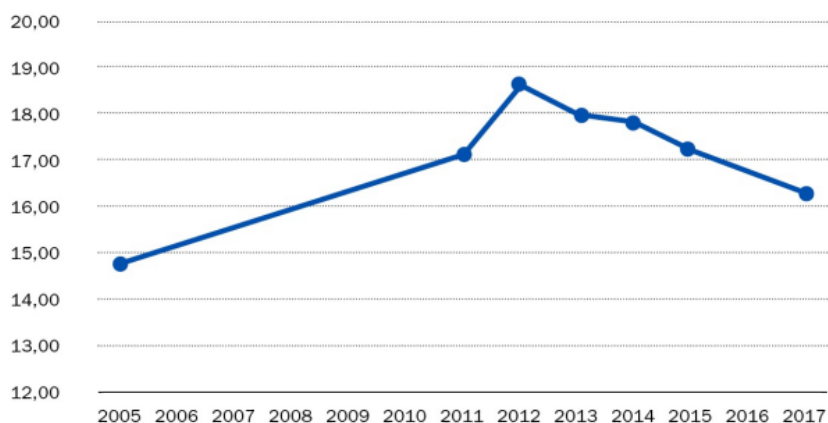
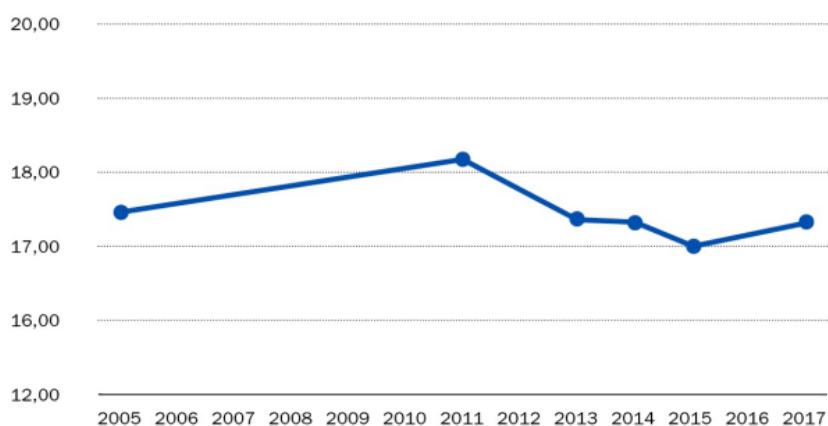
**Lahti Municipal Premises Electricity Consumption 2005–2017 (kWh/m<sup>3</sup>)****Lahti Municipal Premises Heating Energy Consumption 2005–2017 (kWh/m<sup>3</sup>, Weather corrected)**

Figure B3. Electricity consumption of Lahti premises 2005–2017 (kWh/m<sup>3</sup>) and heating energy consumption 2005–2017 (kWh/m<sup>3</sup>).

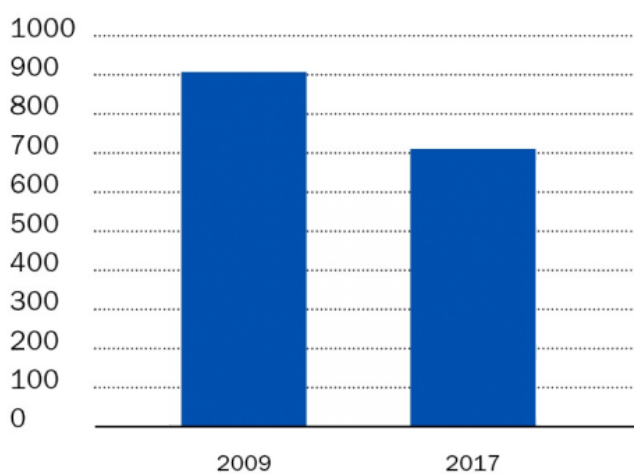
**Water Use in Lahti Swimming Halls (3 halls, m<sup>3</sup>)**

Figure B4. Use of water in municipal swimming hall 2009 and 2017. Reduction over 20%. Less water, less chemicals and heating energy are needed.

Climate change mitigation and adaptation are mainstreamed in land-use planning. Green



Ratio -calculator and KEKO tool are in use since 2016. Stormwater Management Programme was accepted in 2011 and is used in land-use planning and construction. Climate change risks and vulnerabilities assessment is currently in progress and it will be part of Sustainable Energy and Climate Action Plan of Lahti in 2019. Comprehensive project Hybrid solutions in Stormwater Management will tackle stormwater in the city centre using nature based solutions.

The City of Lahti has developed a practice of continuous master planning. Under this model, the planning work proceeds in four-year cycles. In 2017 Lahti started a process that integrates Master Plan and Sustainable Urban Mobility Plan (SUMP), the latter being drafted for the first time. Sustainable urban transport is a strategic goal and the largest city transformation process. Sustainable urban mobility supports citizens' health and wellbeing. The process is participatory and utilizes different participation tools. New Master Plan draft will be ready in the beginning of 2019. Ecosystem impact assessment and climate impact assessment will be performed before the City Council decides on it in 2020.

#### **Mechanisms Used to Reduce Emissions**

Lahti Group companies are important climate strategy partners for the city. Main reductions in city area GHG emissions are currently achieved by Lahti Energy in their shift to renewables in the district heating production. Lahti Energy waste gasification CHP plant Kymijärvi II (2012) and biomass thermal power plant Kymijärvi III (2020) will enable the transition. The City Council supports these investments.

Citizen and company participation has been recognized essential if Lahti will achieve its climate goals. Citizens have been engaged in several projects, such as Consumers' Energy Advising in Päijät-Häme region and Eco-Efficient Energy Solutions (EU funded project 2015-2016) for building-owners. In the CitiCAP-project citizens become the actors in climate change mitigation. With Climate Partnerships the city challenges companies to lower their emissions. This is done in cooperation with Lahti University of Applied Sciences. The students assess the company and suggest how they could reduce emissions. Monitoring takes place after two years and successful companies receive a diploma from the Mayor.

Lahti employs professional environmental educators that work with schools and kindergarten and has established a network of environmental educators in Tavastia region. The environmental educators support the climate work providing material and training for the children.

Lahti was involved in the planning of national climate change medium-term policy plan (KAISU) in 2015-16. Policy plan will be implemented to reduce GHG and F-gas emissions in different sectors and to develop the monitoring.

## **1 Future Plans**

Lahti is committed to cut at least 70% of CO<sub>2</sub> emissions by 2030 from 1990. However, we are also currently preparing a new SECAP with even stricter CO<sub>2</sub> reduction targets (suggestion: -70% by 2021, climate-neutral by 2030). We are already willing to introduce a concept for carbon-neutral living in the city already for EGCA2021 and to involve all the stakeholders in the planning and execution of the demonstration.

Lahti signed a strategical EU commitment, the Covenant of Mayors 2030 on Dec 2017, as continuation for SEAP 2020. Before that Lahti joined the Finnish Sustainable Cities Network (FISU) with the following long-term goals of: no emissions, no waste, sustainable consumption. Lahti's Environmental Programme that also constitutes Lahti's roadmap for the FISU Network, was accepted by city council in 2018.

Targets include:

- Carbon negative by 2050
- Sustainable food supply by 2030

- Sustainable consumption level of residents by 2050
- Zero-waste 2050

Communication plan has been made and implementation has started in i.e. land-use planning. Long term implementation and monitoring plans are under development.

The 2015 future scenario work, mentioned in part B, showed that Lahti will be able to lower its GHG emissions even under different economic and social conditions. The tools may differ between the scenarios (Figs. C1, C2 and C3). The first scenario is based on the assumption that the current development will continue on European and Finnish average path. The second scenario is based on the assumption that Lahti region will regress, with an ageing and decreasing population, the car fleet doesn't renew and coal cannot be replaced with renewables in district heating. The third scenario is based on the assumption that Lahti will be a technological forerunner running fully on renewables in district and separate heating and in transport, while the development is faster than in average. By now we already know that the district heating will be produced coal free by 2020. What is more, the population of Lahti is currently promisingly growing.

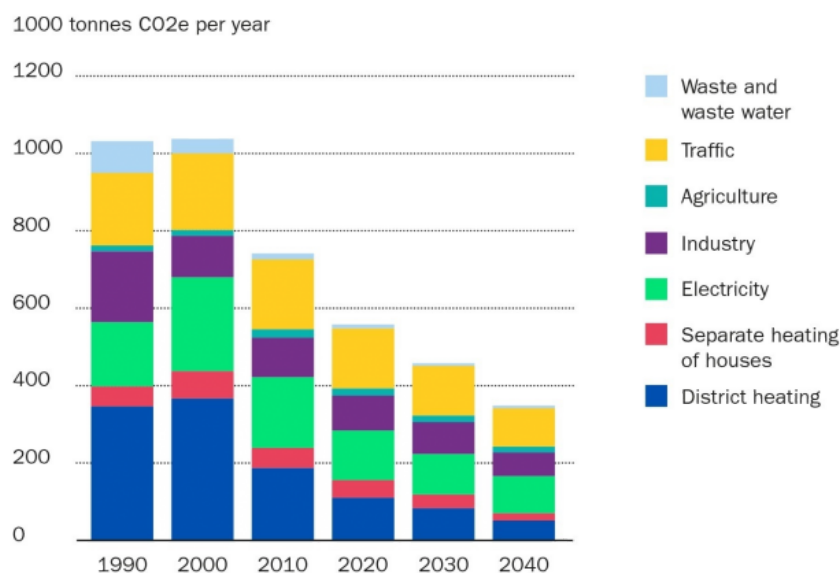


Figure C1. Emission scenario 2040: Lahti business as usual. Development is European and Finnish average.

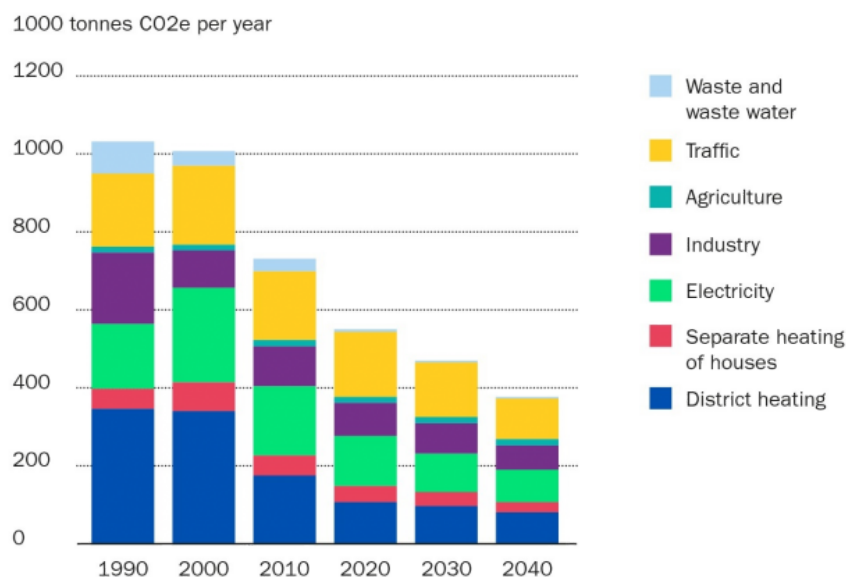


Figure C2. Emission scenario 2040: A regressive Lahti.

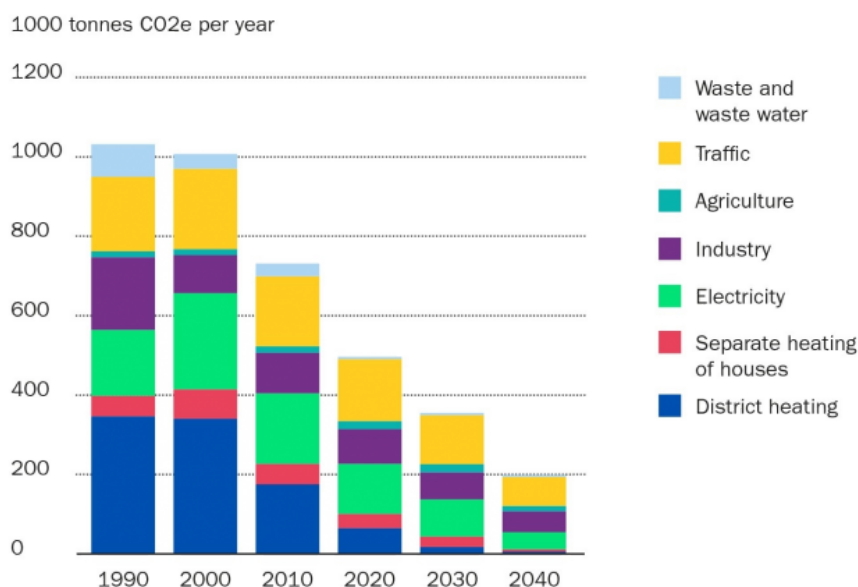


Figure C3. Emission scenario 2040: Lahti as a technological forerunner.

Lahti is committed to the new period, 2017–2025, of the Energy Efficiency Agreement of the Ministry of Employment and Economy of Finland. The agreement is the Finland's main contribution on the EU climate and energy package, which aims for a 27% improvement in energy efficiency. Lahti's activities energy use, covered by the agreement, was 140 900 MWh / year in 2017. The reduction target for 2025 corresponds to 7.5% of the city's energy use. Public buildings are included in the calculation and the buildings of Lahti Premises Centre, Osaamiskiinteistöt Ltd. (university premises) and Spatium Toimitilat Ltd. (offices). In addition, street lighting, heating for pedestrian streets and football fields, and the energy use of Lahti Aqua water and wastewater treatment are included.

#### Electricity Used in the Lahti Energy Efficiency Agreement 2017 (MWh)

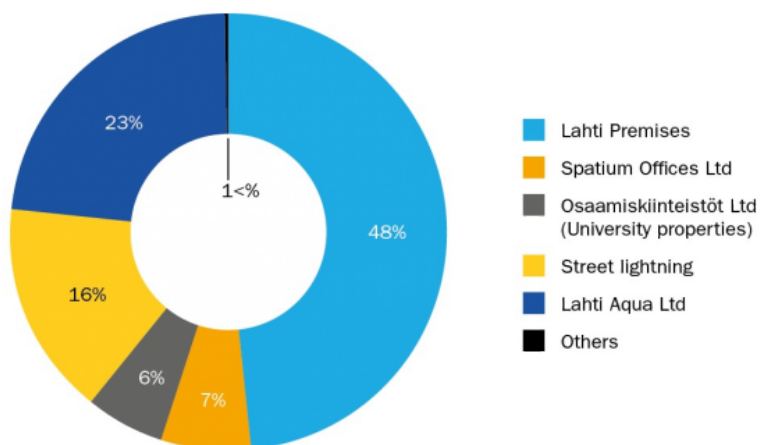
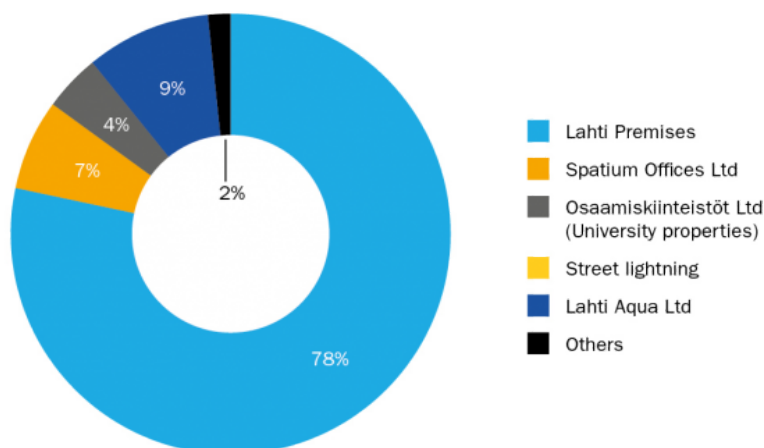


Figure C4. Used electricity in the Lahti Energy Efficiency Agreement in 2017.

**Heating Energy Used in the Lahti Energy Efficiency Agreement 2017 (MWh)***Figure C5. Use of heating energy in the Lahti Energy Efficiency Agreement in 2017.*

Lahti Energy is investing 165 million euros in a new biomass power plant, which will be completed in 2019. This means Lahti will give up on coal by 2020. The biomass will be local (~100 km radius) certified sustainable wood and biomass. The plant, itself, will be energy efficient with a BAT in energy recovery and drinking quality waste water.

The actions of the city can however only reduce emissions up to a certain level and therefore further actions from municipal companies, citizens, organisations and businesses are needed. Lahti is implementing various actions and projects to tackle this dilemma: for instance, the EU-funded UIA project CitiCAP, a project involving citizens in the climate change mitigation with the aim to reduce 25% of each participant's transport emissions.

One strategical action in the SECAP 2030 will be carbon storages and carbon sinks. Lahti will have its carbon storages and sinks mapped in GIS in 2018-2019. The work was already started in the ILKKA adaptation project in 2014.

## 2. Climate Change: Adaptation

### 2A. Present Situation

Climate adaptation risks, vulnerabilities and main targets were identified in 2018. Adaptation work is part of the Covenant of Mayors 2030 Energy and Climate Action Plan (SECAP) that will be ready in 2019. SECAP is a continuation of SEAP2020, in which Lahti has 44 actions to mitigate climate change. Now, adaptation is also a part of the strategical action plan. Assessment of vulnerability indicators, and prioritizing the most important coping capacities will be done in autumn 2018.

#### Awareness and Commitment

These are the key areas for the success of the adaptation work. Lahti's values are Openly, Responsibly, Together. These values have been concretely embedded in all actions. Vulnerabilities have been discussed with the citizens at five 'My Lahti' participation events 2018. As part of the Resin (EU Horizon2020) project Resilient Cities and Infrastructures, a cross-sectoral adaptation working group has had so far six meetings in 2018. The working group coordinates the Climate Change Risks and Vulnerabilities Assessment. A stakeholders'

workshop was held in summer 2018. Fifty people, presenting different stakeholders and departments, gathered together for a Lahti Adapts workshop, where the main impacts, risks and vulnerabilities as well as coping capacities were identified and listed in IVAVIA tables (Fig.A1). After the workshop, the results were published on Lahti website and also sent to an iteration round for a wide range of stakeholders. Further on it will go to the Lahti Executive Committee and the Mayor to prioritize the actions during autumn 2018. The Environmental Development Unit, which is under the City Group Administration, is responsible for the adaptation work.



Figure A1. The IVAVIA tool, developed in the Resin project, was used at the Lahti Adapt stakeholders’ workshop in 2018

Increasing precipitation (+5–36%, depending on scenario and month) and increasing temperatures (+2.9–8.2 degrees C, depending on scenario and month) were the two phenomenas recognized as the most threatening at the stakeholders’ workshop. Other hazards that Lahti will have to adapt to are heavy rains, heat waves and storm winds. Exposed sectors are 1) land-use planning and construction, 2) infrastructure, 3) biodiversity and urban green and blue spaces, 4) social and healthcare, 5) water and wastewater management and 6) rescue management. There is a variety of specific challenges identified for Lahti, i.e. stormwater management and ageing people. Area of Lahti was laserscanned in summer 2017 and a new spatial model is being constructed. Urban flood risk map will be finalized in autumn 2018. It can be layered with other maps, such as elderly population and ecosystem service hot spots. Stormwater management is increasing its importance in land-use planning and special flood conveyance routes are being planned in every new urban plan. Stormwater detention quotas for every city block (mm per rain event) will be implemented in the master planning process in 2018. A Climate-Proof City – The Planner’s Workbook at [ilmastotyokalut.fi](http://ilmastotyokalut.fi) database, is in use. Many ongoing actions are presented in Table A2.

Table C2. Current and future adaptation measures of Lahti City.



Main Identified [1] Climate Change Hazards and Challenges in Lahti	Action, Project Name	Partners	Lahti City Consortium Staff Allocation	Year	Estimated Cost (€) and Funding Source	Monitoring and Performance Evaluation Scheme
City Floods	City centre vulnerability assessment	Lahti School of Applied Sciences (LUAS), City of Lahti	1	2014	10 000 LUAS, student thesis	Assessment, did not contain monitoring
Eutrophication	Large-scale investment and R&D project <i>Hybrid Solutions for Urban Storm Water</i>	City of Lahti, University of Helsinki, Smart & Clean Foundation, LADEC, City of Helsinki, Espoo and Vantaa	2	2017-2020	Circa 2 M€ Finnish Government 2017-2018. Applications will be sent to several other funding sources	Monitoring (quantity and quality of storm water) is part of the project
Heat Waves and Health Risks	District cooling system analysed for new residential areas	City of Lahti, Lahti Energy, private companies	1	2012-	Planning costs, 10 000 €	No investments made.
	Good network of street trees ( <i>Tilia vulgaris</i> ) Circa 3 000 trees in the centre of Lahti and 10 000 overall (Fig. B4)	City of Lahti, private companies	1	1900-	Maintenance 150 000 €/a.	Maintenance is monitored
Effects on Green Spaces and Biodiversity	Prevention of invasive plant species <i>Voluntary work programme</i> (Fig. A3)	Luontoturva Ky, City of Lahti, volunteers	1 + volunteers	2017	50 000 €	Treated areas are monitored by Luontoturva Ky
Storms and Strong Winds	Storm-proof electricity network	Lahti Energy Company Ltd	2	2010-2030	Several M€ Lahti Energy Company Ltd	Monitored by Lahti Energy Ltd.
Impacts on Ground Water Reservoirs	Groundwater Risk Assessment and Modelling (Fig. A4), RAINMAN	Finnish Geological Survey, City of Lahti, Mikkeli and Helsinki (FI), St. Petersburg water company Vodokanal (RUS), Voeikov Main Geophysical Observatory (RUS), Federal State Budgetary Institution "State Hydrological Institute" (RUS)	2	2018-2020	120 000, City budget share 30 000 € ENI-CBC (EU)	Quality and quantity of groundwater is monitored continuously by the City of Lahti
	Ice prevention of city centre streets: change from NaCl use to EcoMelter product	City of Lahti	1	2017-2018 test period	300 000 € annual extra cost	Monitored continuously by the City of Lahti



Figure A3. A joint volunteer work campaign by Luontoturva and the City was launched in summer 2017 to prevent the invasive species.

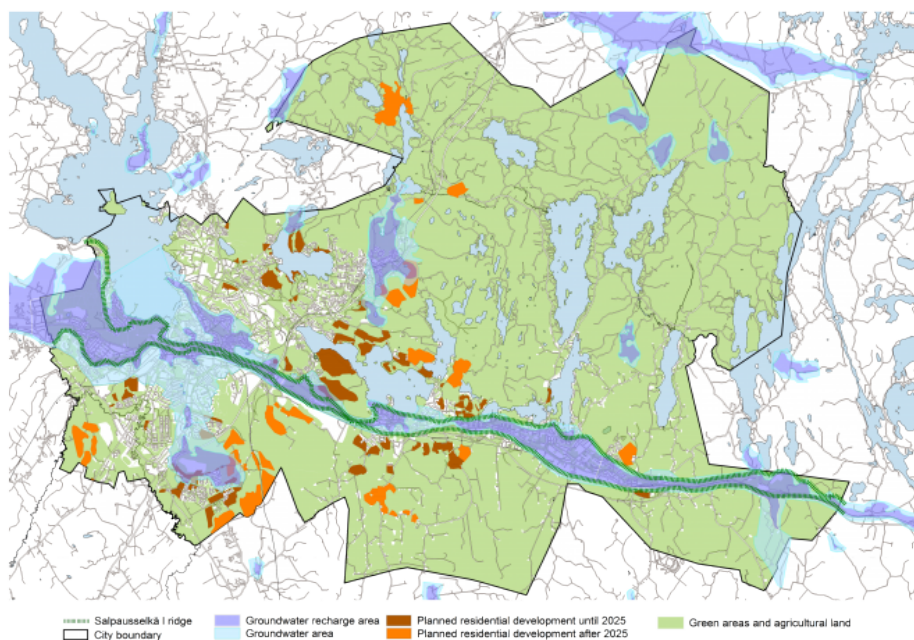


Figure A4. A large part of Lahti urban structures lie above one of the most valuable drinking water resources in Northern Europe.

#### Creating an Innovation Platform: Hybrid Solutions for Treating Urban Stormwater

Finding the best solutions to treat urban storm water is currently high on priority on the city's agenda, as the city is implementing a large-scale investment project called "Hybrid Solutions for Urban Stormwater Management". This improves the 1) climate resiliency of Lahti City and 2) water quality of nearby Lake Vesijärvi. The project received a Finnish Government Programme Key Pilot Project status and funding for 2017-2018. The idea is to create both large and small-scale solutions for treating urban stormwaters and to combine them into two urban development areas in Lahti (Fig. A5).



Figure A5. Project “Hybrid Solutions for Urban Stormwater”.

2B. Past Performance

In 2012, PACT was produced by project consultant Alexander Ballard Ltd. to assess the organizational capacity of Lahti to respond to climate change effects. The results were as shown in Figure B1.

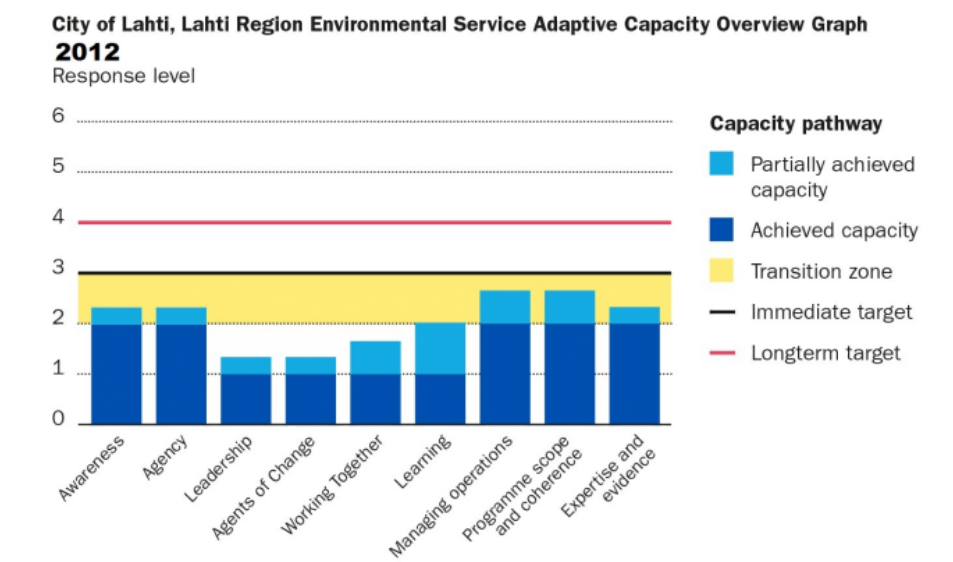


Figure B1. PACT assessment result: the state of Lahti’s adaptation programme on climate change, in September 2012.

Lahti participated in a project called Adaption Strategies for European Cities (EU Cities Adapt) during 2012-2013. The project surveyed municipalities’ adaptive actions and the overall ‘adaptive capacity’ of individual cities, and created a base for adaptation programme planning. Together with specialists, key climate change risks were identified. A working group was established for adaption planning within the consortium.

An impact and risk assessment was performed during the EU Cities Adapt project. Ongoing actions (Table A2) have been chosen on the basis of the analysis. After the EU Cities Adapt, Lahti continued working with climate change adaptation within the ERDF funded national



ILKKA project (2012-2014). At that time, Lahti started to draft a climate change adaption programme focusing on areas described in Section 2A. The ILKKA project provided a large number of planning tools, such as the Green ratio calculator for climate change adaptation, which are currently in use in the urban planning of many cities in Finland, including Lahti. A database, the Climate-Proof City – The Planner’s Workbook ([ilmastotyokalut.fi](http://ilmastotyokalut.fi)) was created in the project. Also, the first carbon storage and carbon sink maps about the municipal area were created.

#### **Urban Ecosystem Approach in the Lahti Adaptation Work**

Since early 2000, the City of Lahti has coupled city development work with university research. Department of Environmental Sciences (UH-DES) of the University of Helsinki is mainly located in Lahti and receives strategic funding from the city. The aim of this co-operation is to increase city resiliency. The department has a strong focus on urban ecology and climate change research questions.

Increasing precipitation that causes, i.e. urban and river flooding, is expected to be one of the most problematic climate change impacts in Northern Europe. The City of Lahti has built and studied stormwater structures in new residential areas (Fig. B2) during 2008-2018, using scientific knowledge from UH-DES (Fig. A5). According to the research results from these study sites, stormwater systems reduce the speed of water flow from retention area to the water body, and diminish the leaching of nutrients and heavy metals.



Figure B2. Stormwater management structures in the Karisto residential area, Lahti 2017.

Cities can greatly benefit from and create a more adaptable infrastructure by utilising ecosystem ecology research results. The University of Helsinki has studied green roofs and their impacts on nutrient leaching loss in northern climates, proving that these are important structures for balancing urban hydrology.

Forestry adaptation questions are highly relevant throughout Finland, including Lahti, as the city owns roughly 7 000 hectares of forest. A large part, circa 60%, of the forest consists of approximately 80-year-old spruce, which makes it prone to, e.g. mass colonization by certain damaging insects, such as *Ips typographus*, which additionally benefits from climate change induced warmer summers and increased wind damage. These threats are considered in the new forest management practices of Lahti.

#### **Mitigating the Health Risks of Climate Change**

As in the Southern Latitudes, climate change poses risks to human health in Northern Europe, although the effects occurring may not be that severe or sudden. Some preliminary actions are described in Table B3, but further analysis and attention is needed.

Table B3. Climate change induced risks for human health and their mitigation in Lahti.

Possible Risks that Changing Climate Poses to Human Health in Lahti	Actions Taken to Mitigate the Risk	Partners	Year	Estimated Cost (€) and Funding Source
Milder Winter with Increasing Amount of Freeze-thaw Cycles + Aging Population = Increasing Amount of Slip and Fall Accidents	Text-message warning system of slippery weather conditions, free for users [11]	City of Lahti, other cities, YIT service centre PANU	2014-	Part of service cost
Heat Waves and Health Risks	District cooling system	City of Lahti, energy companies, property owners	2012-	So far, only planning costs of several thousand euros, but investment is on several M€ scale. No decisions made.
	Lahti has a good network of street trees ( <i>Tilia × vulgaris</i> ) that shade the buildings in the city centre. Circa 3 000 trees in the centre of Lahti and 10 000 trees overall (Fig. B4).	City of Lahti	1900-	Street tree network maintenance 150 000 €/yr.
Storms and Strong Winds	Storm-proof electricity network	Lahti Energy Company Ltd	2010-2030	Several M€ Lahti Energy Company Ltd
	Forest and street tree management practices	City of Lahti, forest harvesting companies	2011-	Part of forest management budget

Figure B4. Lahti has a good network of street trees (*Tilia × vulgaris*).

## 2C. Future Plans

Lahti is aiming at becoming a climate-resilient city by 2030 by cutting the majority of our CO<sub>2</sub> emissions (-70% from 1990 level by 2030) and building a society able to cope with the changes. We are currently designing a new SECAP for 2030 with even more ambitious CO<sub>2</sub> reduction targets: by 2021 -70 % from 1990 level and carbon-neutrality by 2030 at the latest.

In Northern Europe the expected temperature rise is much higher than the global average: there will be a decrease in snow coverage, an increase in river flows and storm water, a northward movement of species and an increase in crop yields. The majority of climate



change effects pose serious threats to ecosystems and risks to building infrastructure and human health. One positive impact may be the decrease in the need for energy in heating. The Forests and Green Areas Master Plan and Biodiversity Master Plan are under development. These strategical programmes will provide a strong adaptation basis. The more green areas and biodiversity Lahti has, the better the coping capacity is. The mapping of Lahti carbon storages started in 2012 and will be updated in 2018. Adaptation measures are included in the Lahti Environmental Programme that was accepted 2018. These will be revised in 2021 and 2030. Adaptation measures will be followed up also in SECAP 2030. Nature conservation actions will be made in order to protect and increase carbon sinks (Fig. C1). A compensation programme will be established before 2021.



Figure C1. Nature conservation areas are important for providing carbon sinks and biodiversity hot-spots in changing climate conditions.

Although the SECAP of Lahti City is as yet under preparation, we are implementing several climate change adaptation measures with a future perspective (Table C2).

Table C2. Current and future adaptation measures of Lahti City.

Main Identified [1] Climate Change Hazards and Challenges in Lahti	Action, Project Name	Partners	Lahti City Consortium Staff Allocation (persons)	Year of Planned/ Conducted Measures	Estimated Cost (EUR) and Funding Source	Monitoring and Performance Evaluation Scheme
City Floods	City centre vulnerability assessment	Lahti School of Applied Sciences (LUAS), City of Lahti	1	2014 assessment	10 000 € LUAS, student thesis	Assessment, did not contain monitoring
	Further research and possible investments in warning system	LUAS and other universities, property owners	1-2	2017-2020	Unknown	Unknown
Eutrophication	Large-scale investment and R&D project <i>Hybrid Solutions for Urban Storm Water</i>	City of Lahti, University of Helsinki, Smart & Clean Foundation, Lahti Development Company LADEC, City of Helsinki, Espoo and Vantaa	2	2017-2020 R&D, investments	circa 2 M€: 0,6 M€ Finnish Government 2017-2018; 0,3 M€ Smart & Clean Foundation Applications will be sent to several other funding sources	Monitoring (quantity and quality of storm water) is part of the project
Heat Waves and Health Risks	District cooling system analysed for new residential areas and for Lahti city centre	City of Lahti, Lahti Energy Company, private companies	1	Planning started in 2012, no decisions made on investments	So far, only planning costs of several thousand euros, but investment is on several M€ scale. No decisions made.	No decision made.

	Lahti has a good network of street trees ( <i>Tilia x vulgaris</i> ) that shade the buildings in the city centre. Circa 3 000 trees in the centre of Lahti and 10 000 trees overall.	City of Lahti, private gardening service companies	2 (maintenance work is performed by companies)	1900-	Street tree network is maintained with annual city budget of 150 000 €.	Maintenance is monitored
Effects on Green Spaces and Biodiversity	Prevention of invasive plant species, especially <i>Impatiens glandulifera</i> and <i>Heracleum persicum</i> -group  Voluntary work programme probably continues in 2018	Luontoturva Ky, City of Lahti, volunteers	1 (project uses large amount of volunteer work)	2017 pilot, probably continues in 2018	50 000 €	Treated areas are monitored by Luontoturva Ky
Storms and Strong Winds	Storm-proof electricity network, investments are performed as part of the city electricity network investments	Lahti Energy Company Ltd	2	2010-2025	Several M€ Lahti Energy Company Ltd	Monitored by Lahti Energy Ltd.

Impacts on Ground Water Reservoirs	Groundwater Risk Assessment and Modelling, <i>RAINMAN</i>	Finnish Geological Survey, City of Lahti, Mikkeli and Helsinki (FI), St. Petersburg water company Vodokanal (RUS), Voeikov Main Geophysical Observatory (RUS), Federal State Budgetary Institution "State Hydrological Institute" (RUS)	2	2018-2020	120 000, City budget share 30 000 € ENI-CBC (EU)	Quality and quantity of groundwater is monitored continuously by City of Lahti, Environmental Services and effects of climate change on groundwater will be modelled by the Finnish Geological Survey
	Ice prevention of City centre streets: change from NaCl use to EcoMelter product	City of Lahti	1	2017-2018 test period	300 000 € annual extra cost City of Lahti	Monitored continuously by the City of Lahti

Selection was based on projects [1-2] and our impact and risk assessment analysis (Table B3).

## 3. Sustainable Urban Mobility

### 3A. Present Situation

Indicator	Data		Units	Year of Data Provided
Proportion of population living within 300 metres of an hourly (or more frequent) public transport service	81,3% * *Public transportation at least every 30 minutes and max 250 metres to a bus stop		%	2018
For all journeys under 5 km, proportion of these journeys undertaken by:  i) Car; ii) Public transport; iii) Bicycle; iv) Foot; v) Mixed/multimodal (with a car); vi) Mixed/multimodal (without a car); vii) Other.	Car	59	%	2016
	Public Transport	5		
	Cycling	9		
	Foot	26		
	Mixed/multimodal (with a car)	1* (aviation/shipping)		
	Mixed/multimodal (without a car);			
	Other			
Proportion of buses operating in the city that are:				
▪ Low emission (at least Euro VI); and ▪ Alternatively fuelled (electric, hydrogen, LNG etc.)	Low emission	87	%	2016

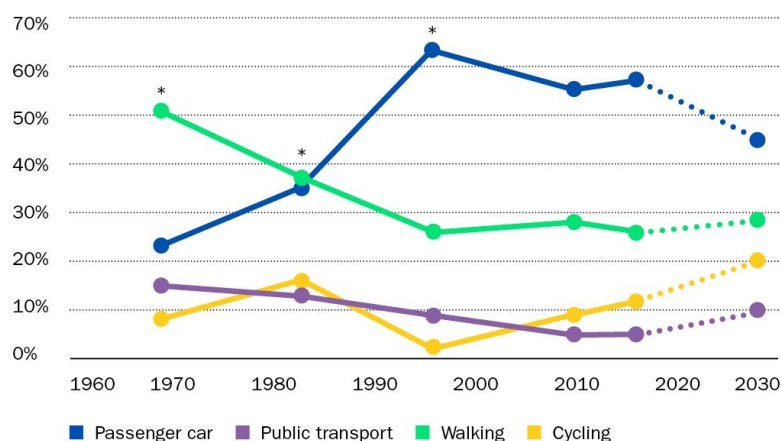
#### Infrastructure, Modal Share and Governance

The current urban structure is primarily inherited from the 1950s-1970s. The population has grown since 1975. The road network was developed for cars. Major car transportation routes

cut almost through the city centre. There are 468 cars per 1 000 residents in Lahti. The cold climate and hilly landscape favour motorization. Nevertheless the city has an ambitious aim to reduce the car mode share with 17% by 2030. (Fig. A1).

Before 2014 public transportation was operated by private companies subsidized by the city. Transferring responsibility to the city allows flexibility in the public transportation system reformation and redesign. In 2015, 81,3% of residents lived in a pedestrian/public transportation zone (Tab.1). The goal is to double the public transit ridership by 2030 (Fig. A1). During winter weekdays, 98 buses are in service of which 77 are two-axle, 18 multi-axle and 3 minibuses. We are currently piloting a real-time information system for public transportation. Later, this will be combined with traffic signals to prioritize public transportation at junctions. VR, a state-owned railway company, serves multiple destinations to and from Lahti. In 2016, about 2.15 million travels from and to Lahti were made on rail.

Lahti has a large cycling network (Fig. C1) with 532 km of combined pedestrian and cycling paths (2016) that are of good quality (i.e. wide, separated from cars, quality asphalt). The share of pedestrians is high (Fig. A1) which is due to the compact urban structure, with 75 % of the population living within 5 km from the city centre. The city is currently planning the construction of a smart bicycle highway as part of the UIA-funded CitiCAP project. Current mode split of cycling is 9%. The goal is to achieve 20% by 2030 (Fig. A1).



\* These are not comparable to 2010 & 2016 numbers due to differences in the research methods and period.

Figure A1. The modal split has varied over the decades. City of Lahti is currently developing an ambitious SUMP to increase the sustainable mobility mode share.

### Mobility Flows

The greatest share of journeys is made within Lahti and its neighbouring municipalities Hollola, Orimattila and Asikkala. (Figs. A2, A3). Daily over 2 000 cars enter Lahti from nearby areas and over 4 000 cars leave Lahti. The most common destination from the Lahti Region is Helsinki (Fig. A2), and 2nd the Capital Region (over 11 000 trips). Lahti has excellent train connections: Helsinki (1 h), Helsinki-Vantaa Airport (1 h) and St Petersburg (2.5 h).

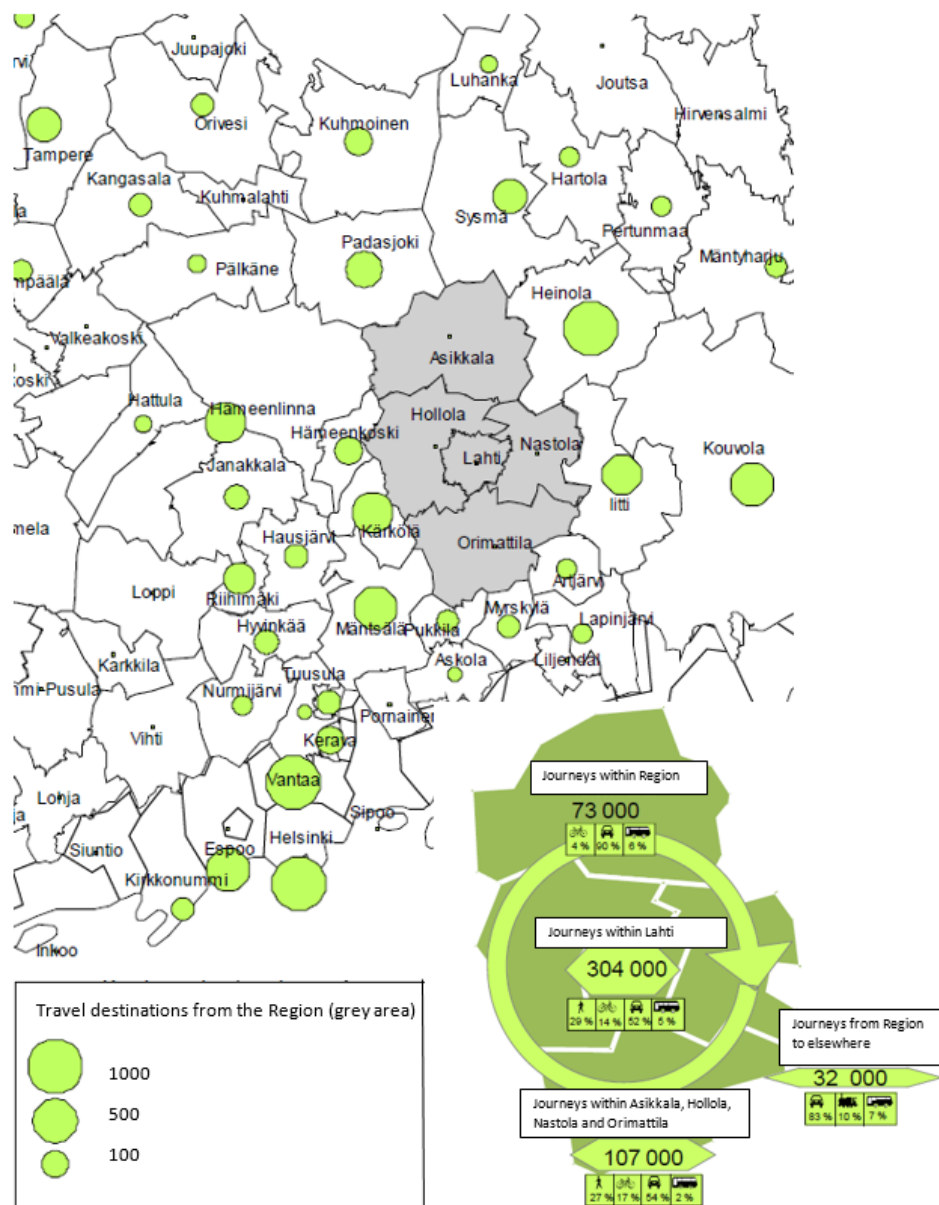


Figure A2. Mobility flows within Lahti and nearby areas. Data 2010.



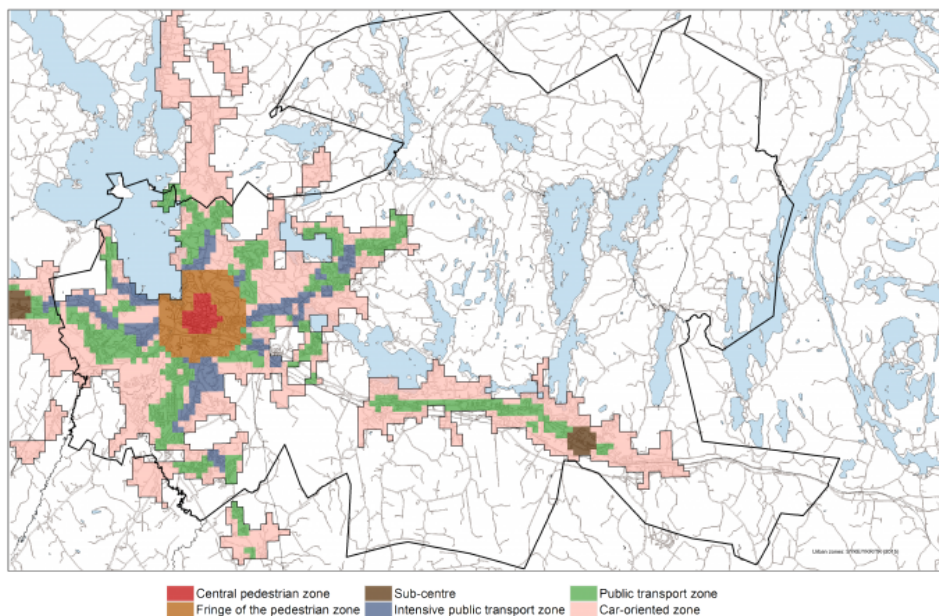


Figure A3. Mobility zones of the Lahti urban area. Click to enlarge map.

### Alternative Fuels

Most of the passenger cars use petrol or diesel, but the share of alternative-fuel vehicles is increasing. Currently there are 23 electric, 35 biogas and 121 hybrid cars in Lahti. The Lahti Group owns 8 electric cars, 35 biogas cars and electric bicycles. Lahti has 10 public charging stations for electric cars, with some free of charge. Lahti Aqua Ltd and Päijät-Häme Waste Management Ltd produce biogas, with 1 public gas station.

In 2014, Lahti replaced almost the entire public transportation fleet (Fig. A4). Now 87% of the city's buses are low emission buses (86% Euro VI, 1% Euro V).



Figure A4. 87% of the bus fleet has low emissions (86% Euro VI) and nearly all have low floors.

## 3B. Past Performance

Strategic Key Documents for Smart Mobility

- Transport Policy (2011)\*
- Development Plan for Walking and Cycling 2025 (2012)\*
- Transport System Plan for Päijät-Häme Region (2013)
- Parking Policy of the City Centre (2014)
- Master Plan (2016)\*
- Traffic Safety Plan (2017)

\*Policies and plans consider issues on sustainable urban mobility before SUMP process was initiated..

#### Transport policy 2011

The Transport Policy was drafted to reduce the number of cars, improve pedestrian and cycling path networks and reduce greenhouse gases.

#### Development Plan for Walking and Cycling 2025

In 2012, the City of Lahti drafted a plan to promote walking and cycling. By 2030, 45% of the journeys will be made by walking or cycling.

Examples of actions completed or in action:

- Lower speed limits in the city centre.
- Separate and clearly marked cycling paths in the city centre.
- High maintenance of the main cycling network during winter.
- Walkable city centre.
- Additional bicycle racks. Lahti has by now over 1 100 racks in the city centre.
- High quality parking facility for 200 bicycles at the Travel Centre.
- New cycling map every four years, logo (Fig. B1) and Cycling Review.
- Events during European Mobility Week annually.



Figure B1. Cycling logo since 2016.

We use the Eco-counter tool to count and display the amount of cyclists on an interactive map.

Lahti belongs to the Network of Bicycle Municipalities, which offers a tool to evaluate the state of bicycling circumstances and development. The Bicycle Compass considers nine indicators: policy, monitoring, amount of bicycle traffic, competitiveness, infrastructure, parking, safety, satisfaction as well as communications. The evaluation informs the city how to promote cycling. The first evaluation was done in 2017 and the results are represented in the figure B2. There is a need for clear policy and strategies, including communication, to improve cycling conditions in the city.

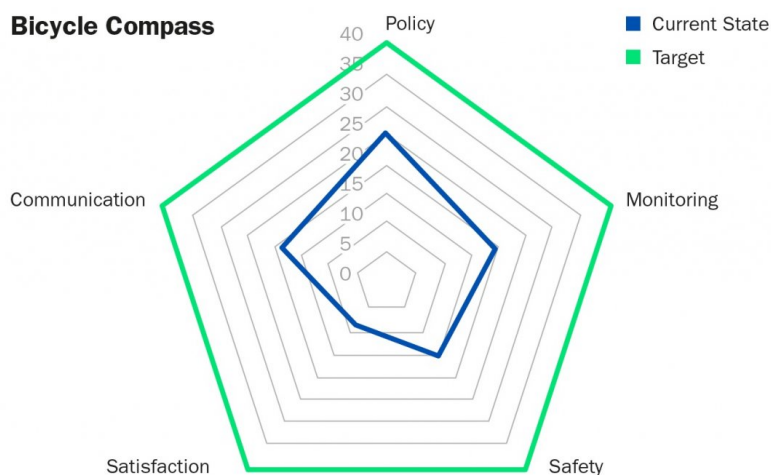


Figure B2. The Bicycle Compass is a tool for evaluating bicycling circumstances and development work.

### Public Transportation Reform

The city has organized public transportation since 2014. Reforms include:

- Replacing nearly the entire fleet with low-emission buses.
- Increased frequency of public transportation service (on main rural routes, buses at least every 30 minutes).
- New routes added (40% increase in kilometres).
- Nearly all routes go to the market square and Travel Centre.
- Nearly all buses are low-floor.
- Free of charge for people with a wheelchair or a walker and their escorts and parents with a pram.
- Transportation on demand for people with disabilities.

The transportation route updates were partially based on a questionnaire inquiring about the citizen's "Dream Bus Routes". The Lahti Region Public Transport Committee was awarded by the City's Elderly Council, in October 2017, for its senior citizens discounted bus ticket arrangements.

Lahti's Travel Centre opened in 2015 (Fig. B3), combining railway and bus transportation, enabling smooth transition between the different modes and offering parking garages for bicycles and cars (investment 18 M€).

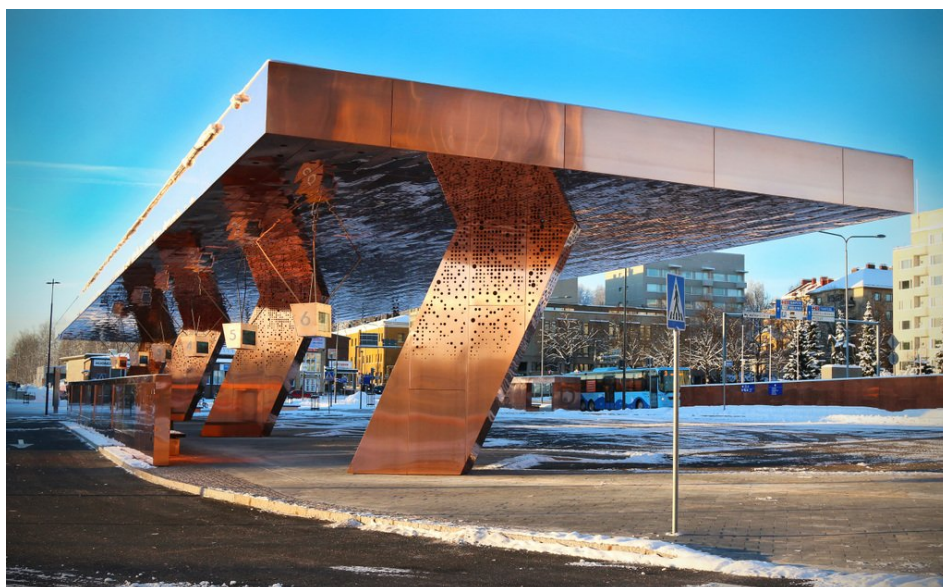


Figure B3. Lahti's Travel Centre enables local transportation, walking, cycling or cars to be combined with long-distance buses and trains.

### City Centre for Sustainable Urban Mobility

The aim is to create a high-quality space that will spur walking, cycling and the use of public transportation. Actions taken:

- Car-free zones (e.g. Lanunaukio in 2007).
- In 2015, a parking garage, underneath the market square, for 600 cars (investment 20 M€).
- Pedestrian paths widened by taking space from cars.
- Widened pavements will be used as shared space for pop-up cafeterias, sale points and exhibitions.
- Separate cycling paths with red asphalt.
- Aleksanterinkatu Street, transformation into a primarily pedestrian area, was completed in November 2016 (Fig B4.). Car lanes were reduced from 4 to 1. Investment 3.1 M€. [10]. The transformation was successful, today the share of pedestrians is over 60%.
- Reduced speed in the city centre (30 km/h).

Lahti is piloting widening a pedestrian path to 5.5 m (length 200 m) on one side of Rautatiekatu Street by utilising the car parking space. According to questionnaires directed to residents and businesses the widening could be made permanent. The current decision allows keeping the widening until the end of 2019. According to the latest City traffic counts the share of pedestrians is 6 times higher than cars. Popular street events are arranged on Rautatiekatu and in Lanunaukio.

#### Lahti Awarded for Its Cycling and Pedestrian Facilities

Lahti's Transport Planning Unit received recognition for its work in promoting walking and cycling, when it was granted an award by the national Fit for Life Programme. The jury appreciated the significant and diverse measures Lahti has taken to make cycling and walking an easier and more attractive transport choice.

### Sustainable Land Use

Lahti's landscape sets its own limitations and challenges for transportation infrastructure. The large amount of lakes creates a barrier effect, which hampers offering good public transportation service. However, the urban core is dense which enables increasing the modal split for cycling.

The City of Lahti has developed a continuous master plan process with four-year cycles. This enables a strategic long-term view of urban development, simultaneously allowing adjustments for pressing short-term development needs and challenges. During each Master Plan cycle, various impacts of the proposed plan are assessed by city officials as well as qualified academic experts (e.g. walking and cycling, children, climate change and ecological networks).

Lahti focuses on consolidating land use in the city centre and along public transportation routes. Emphasis is on building on brownfields along the railway route and on developing areas for mixed land use. Population density needs to be at least 15 inhab./ha to ensure good public transportation. For instance, the Niemi industrial area and the harbour areas have been renewed as mixed-use areas with good public transportation and pedestrian/cycling paths. The population density in Ankkuri (harbour area) is 86-126 inhab./ha.

Lahti is using an eco-efficiency tool, KEKO. This tool estimates the impact of the urban plans on greenhouse gas emissions, use of natural resources, biodiversity and ecosystem services.

### Reducing Cars

Lahti has no traffic congestion. To promote walking, cycling and the use of public transportation, we:

- Annually celebrate World Car Free Day and offer discounts for bus tickets on that day, since 2014.
- In 2006, a new railway route was built between Lahti and Helsinki.



- In 2016, electric bicycle test-riding was implemented for local residents and workers, e.g. Mayor Timonen had good experiences with an e-bike.
- To encourage the use of buses for commuting, the city gave free bus rides to 144 commuters from the Department of Technical and Environmental Services for a period of four months.
- In 2018 the city was awarded for the first time an employer for being “The frontrunner in commuting in the Lahti region”. The commencement is part of the “Wise Commuter” project initiated by the Finnish Transportation Agency.

We acknowledge the challenges of urban freight, but currently have no plans in place to improve its environmental performance.

## 3C. Future Plans

### Objectives and Policies

Lahti adopted its new City Strategy in 2018. The strategy highlights the need for mobility transformation. One of the accepted key projects is “naturally mobile” to additionally support the sustainable urban mobility development of the city center (Budget €500k). See Figs. C2 and C3.

The Master Plan aims to reduce the need for transportation and promotes walking, cycling and public transport:

1. Improved accessibility of workplaces and services.
2. Improved safety and comfortability of the urban environment.
3. Developing planning instructions for the main road network.
4. Updating the main cycling network according to the Development Plan for Walking and Cycling 2025 (Fig. C1).

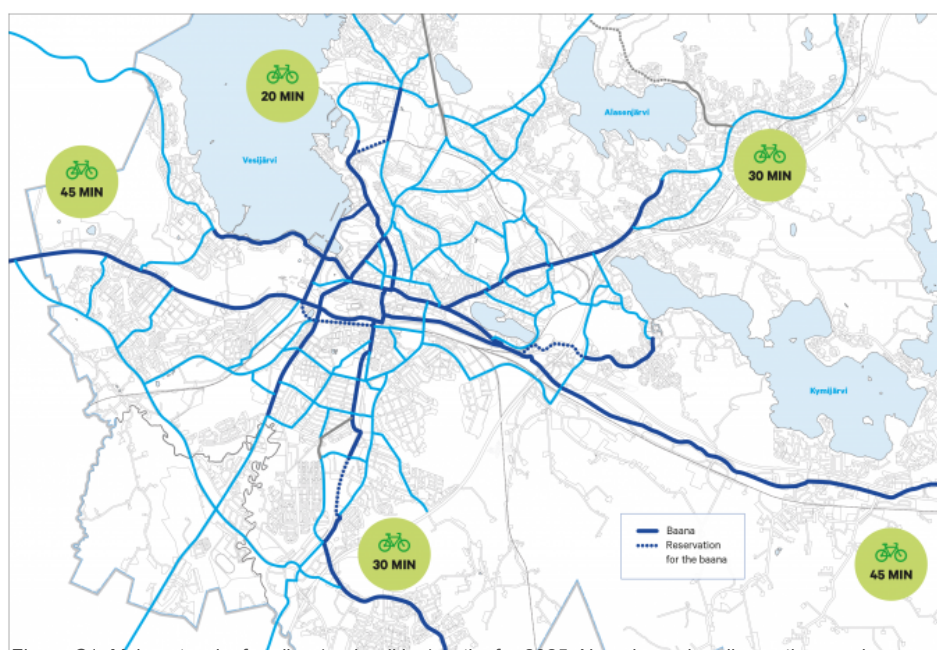


Figure C1. Main network of cycling (and walking) paths for 2025. New planned cycling paths are shown with a dotted line. Click to enlarge map.

### Special Focus on Traffic Emissions and Sustainable Urban Mobility

First Sustainable urban mobility plan (SUMP) is currently under development. Strategic aim is to increase the share of sustainable transportation to 55% by 2030.

Our future challenge is to prevent the increase in traffic emissions. Special emphasis is now placed on integrating a Sustainable Urban Mobility Plan (SUMP) into the spatial master plan. This creates a city-wide framework for cutting CO<sub>2</sub> emissions, e.g. by 1) improving the bicycle infrastructure, 2) finding smarter and low-carbon solutions for public transportation and 3) increasing pedestrian-friendly spaces in Lahti's urban core.

SUMP development plan 2017-2020:

1. 2017: Analysing the present state, setting of vision and targets has been done. An evaluation of the current state of mobility was carried out by arranging numerous workshops in 2017-2018 (Fig. C4) with different stakeholders and by using the “Porukka” application.
2. 2018: Efficient action plan is being developed.
3. 2019: Responsibilities and financing, monitoring and evaluation.
4. 2020: Introduction and communication, lessons to be learned for the next round.



Figure C4. SUMP and the Master Plan of Lahti 2017-2020 are co-created with its citizens.

#### City Centre for Sustainable Urban Mobility

The street network will undergo a major change (Figs. C2 and C3). Vapaudenkatu Street will be primarily reserved for public transportation. Vapaudenkatu's two-way high-quality cycling path will be lengthened. Most of the car traffic will be directed to an outer “circle” of the city centre, lessening the traffic inside the circle (see also Fig. A1). This enables additional separated cycling paths to be constructed (e.g. along Vesijärvenkatu Street). Public transportation will be supported by creating bus lanes on the busiest street of the centre.



Figure C2. Road network in 2020. The city centre is developed towards a pedestrian zone.



Figure C3. The foreseen main cycling network in the city centre, in 2020.

### Sustainable Mobility Within the City Organisation

The city has started drafting an action plan to promote sustainable and healthy commuting among its employees, based on workshop results and a questionnaire conducted on commuting habits. 1200 answered the questionnaire and 88% of the respondents said the city should support sustainable mobility.

Planned actions:

1. Public transportation ticket
2. Work from home arrangements
3. Renewed parking policy



#### 4. Campaigns

##### Public Transport Network Redesign

Lahti has started redesigning the public transport network in 2018. The goal is to make public transport more attractive. Actions include:

1. Design of the trunk bus network
2. Assessment of possibilities on new mobility services

Lahti has utilized innovative ways to analyse the current situation, such as map based questionnaire for public and movement data produced by telecommunication company Telia. The design process will be finished by the end of 2018 and implemented by 2022.

##### CitiCAP Project for Smart & Sustainable Mobility

The UIA project CitiCAP (2018-2020), with a budget of 4,7 M€ will:

1. Be the first city to implement a Personal Carbon Trading (PCT) scheme for mobility to reduce traffic emissions.
2. Develop an open mobility data platform to implement the PCT.
3. Support the SUMP process with a focus on participation.
4. Construct a 2,5 km long smart bicycle highway.

##### Directing Lorry Traffic Away from the City Centre

Constructing a bypass (Main Road 12) that will allow passing cars and especially lorry transportation to be directed away from the city centre and allows new land use possibilities. The cost is 300 M€, with Lahti's share equalling 77 M€.

##### Promoting Cycling with National Programmes

The project "Paths to Sustainable Mobility Services" studies possibilities for car-sharing, city bicycles and safe bicycle parking in cooperation with a few other cities.

##### Winter Cycling (Fig. C5)

During winters 2018 and 2019 Lahti will trial new winter maintenance measures, such as salt brushing.



Figure C5. We promote winter biking with special maintenance practices and campaigns.

##### Alternative Fuels

A long-term preliminary decision has been made for buses to be changed to electric. In logistics the share of biogas cars will be increased. 6 new charging points for electric cars



are planned.

## 4. Sustainable Land Use

### 4A. Present Situation

Land use within the city				
Land Use Data	Inner City <i>*See Fig. A1</i>	Overall City <i>*only "urban", See Fig. A1</i>	Unit	Year of Data Provided
Green area* <i>*It was not possible to calculate private and public green areas separately</i>	23	39* <i>*Significantly more if including rural areas of Lahti</i>	%	2017
Private Green Area	*			
(Urban) Agricultural Land		7		
Blue	1	4* <i>*Misleading due to defining "city" as "urban" area. See Fig. A1</i>		
Residential	22	24		
Industrial/Economic	8	9		
Mixed	included in residential	included in residential		
Brownfield	4	1		
Other (incl. municipal buildings and structures, also roads)	42	16		
<b>Total</b>	<b>100</b>	<b>100</b>		
Population Data	Inner City	Overall City	Unit	Year of Data Provided
Population density in built-up areas (city area minus green and blue)	63	18	Inhabitants per ha	2017
Population density (inhabitants per hectare) for new developments	High rise block mean 103	Low-rise mean 21	Inhabitants per ha	2017
Percentage of people living within 300 m of green urban areas of any size	99	99	%	2017
Percentage of people living within 300 m of green urban areas of >5000 m <sup>2</sup>	99	99	%	2017

#### Green Urban Lahti and Ecosystem Services

City of Lahti has set ambitious targets for protecting the green and blue urban areas and their valuable functions. Due to a specific geographic structure, the Ice-Age ridge "Salpausselkä", there is a green spine-like-structure throughout the whole city (Fig. A1). This provides easily accessible green urban infrastructure for the citizens and provides an ample of ecosystem services. Regional green network connects the recreational and sport facilities of Lahti Region (Map 2).

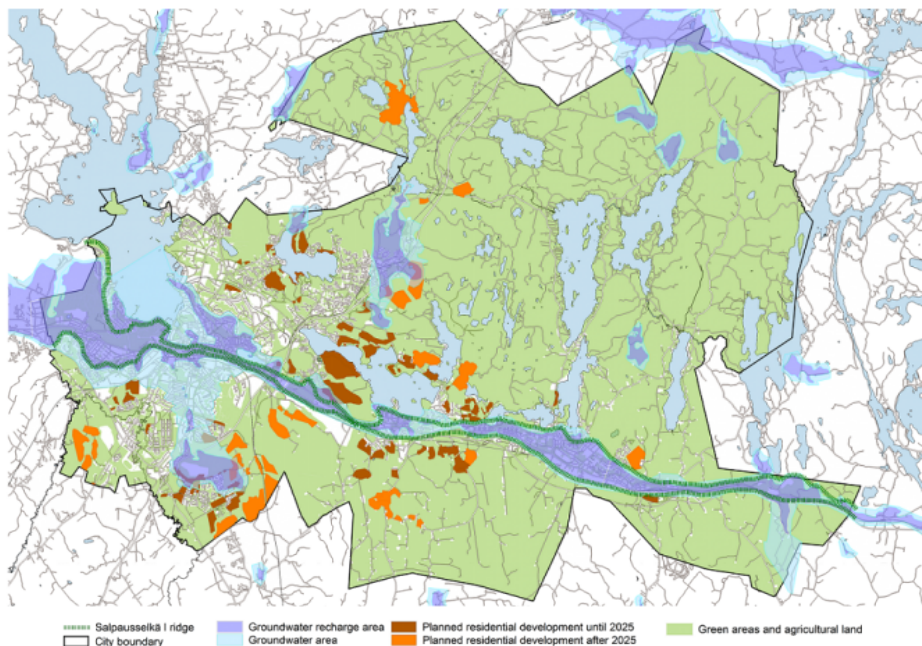


Figure A1. Salpausselkä ridge forms a green corridor for urban area of Lahti. Click to enlarge map.

Ecosystem services are being mapped for the entire Lahti area. The Master Plan requires evaluation of impacts on ecosystem services, when developing new areas. Green infrastructure is kept and improved with future wildlife over- and underpasses (4C). Wetlands are used for managing stormwater in new developments or added to old urban areas. A system of meandering streams, a retention pond and a wetland have been built in Karisto. Approximately 10-20 green roofs or other green structures (e.g. rooftop gardens) exist in Lahti.

The quality of the green and blue infrastructure is monitored and progressively improved. City of Lahti annually publishes an Environmental Review with the key blue and green infrastructure indicators. These key indicators are, e.g.:

- Areas protected, percentage of the municipal land area (%)
- Habitat sites protected under the Environmental Protection Act (ha)
- Traditional landscapes (ha)
- Percentage of lakes in good or excellent condition (% of total lake surface area)
- Lake water chlorophyll a, measured in August ( $\mu\text{g/L}$ )

#### Accessible Blue and Green Areas of Lahti

- Blue and green areas cover over 80% of Lahti (Fig. A1).
- In 2015, Lahti had 164 playgrounds, 39 kindergarten yards, about 30 schoolyards, 40 sporting grounds and 8 communal gardens.
- Urban green areas are mostly forests with extensive path networks and other recreational structures (huts, bonfire sites).
- All forests and meadows, in Finland, are freely accessible for roaming or picking wild berries and mushrooms (Everyman's Right).
- Forest paths have many information signs, but more need to be installed.
- Forest paths are often covered with wood chips (soft, for running).
- In winter, some forest paths are managed for skiing. Lakes have managed skiing and skating paths.
- Nature conservation areas have good and accessible infrastructure: information signs, wooden paths and bird watching towers.
- Lake Vesijärvi and smaller lakes are actively used for swimming (16 public beaches), fishing and skiing.

#### Growth of Lahti

In 1868, Lahti had merely 18 houses but then, a railway was built and a canal to Lake Vesijärvi was constructed. These transport routes spurred development. New residential and

industrial areas were rapidly built. Only 10 years later, Lahti received market town rights and a first urban plan was devised. The City of Lahti was established in 1905. In the 1930's, Lahti was one of the fastest-growing cities in Finland (Fig. A2). The population grew exponentially until 1975. Since the mid-1990's, the population has slowly increased. Since merging with the neighbouring municipality of Nastola in 2016, Lahti has about 120 000 residents.

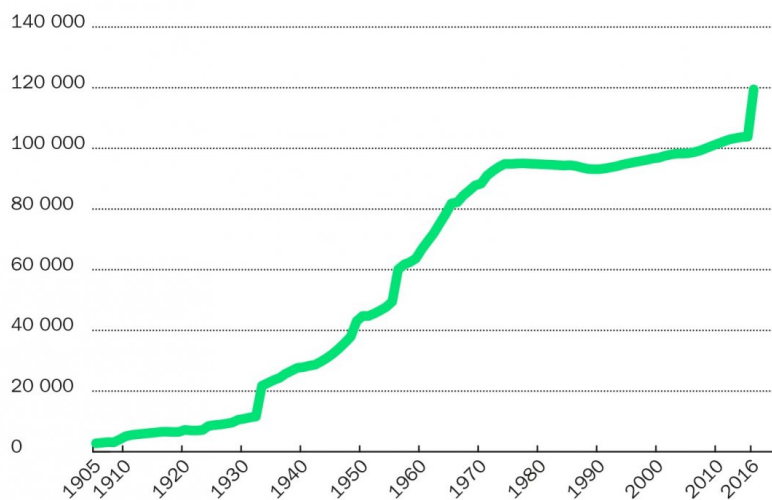


Figure A2. The population growth of Lahti City.

### Urban Structure

The urban development is compact, but green, and the city centre is densely built (imperviousness approx. 65%) (Figs. A1, A3). Large and continuous forests on the Salpausselkä ridge reach into the centre. This important green connection will decidedly be conserved and has been improved. In 2016, 754 new dwellings were built: 22 apartment buildings, 21 terraced houses and 131 detached houses.

The amount of sealed surface was calculated by the Finnish Environment Institute in 2010, but current data is not available, due to the lack of a monitoring tool.

### Continuous Master Planning

The City of Lahti has developed a continuous, strategic Master Plan process, with four-year cycles. This enables a long-term view of urban development, while allowing adjustments for pressing development needs and challenges. During each Master Plan cycle, various impacts of the proposed plan are assessed by city officials and qualified academic experts (e.g. economy, walking and cycling, children, climate change, ecosystem services and ecological infrastructure). Residents of all ages are encouraged to actively participate (4B). The implementation of the Master Plan is programmed for each four-year period. It is followed up with many indicators. During the next cycle (2017-2020), a Master Plan covering the whole new Lahti will be devised, including the creation of a Sustainable Urban Mobility Plan (4C).

Smart growth is a key goal of the Master Plan. The projected population growth is 1% annually, and roughly two thirds of this growth has been planned for existing built-up areas (Fig. A3). This is achieved through consolidating the inner urban area and controlling growth in the outer areas. A new underground parking structure, in the city centre, has freed land for new developments. In recent years, brownfields, within 3 km of the urban core, have undergone regeneration, with many projects underway (Fig. A4). Lahti strives to keep urban sprawl under control and only limited areas are developed for detached houses. Local services are accessible by public transport, bicycling and walking in these fringe areas (e.g. grocery stores, kindergartens and schools). Master Plan follow-up includes measures of liveability on a city-wide level.

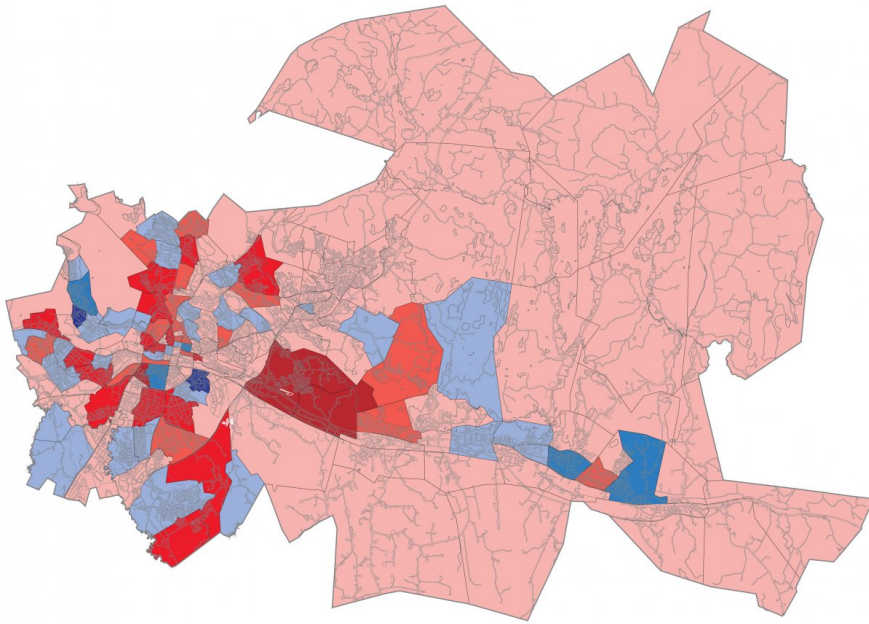


Figure A4. Population density in 2025 compared to year 2017.

### Redeveloping Brownfields

Brownfields along railways and near Lake Vesijärvi have been or are being re-developed (Fig. A3). The former industrial harbour area is now very popular. In 2000, a modern extension was added to an old factory to build, Sibeliustalo, a concert hall. Apartment buildings were constructed and cafeterias opened in old buildings. Similar areas of mixed land use are planned for existing brownfields. The areas of Sopenkorpi and Radanvarsi areas are close to a new transit hub (trains, buses) and the city centre ( $\leq 1$  km); the areas are currently under detailed planning, and over 110 000 m<sup>2</sup> of mixed-use and residential buildings will be constructed in the next ten years (Fig. A5). The Niemi industrial area is undergoing renewal to become a mixed-use area.

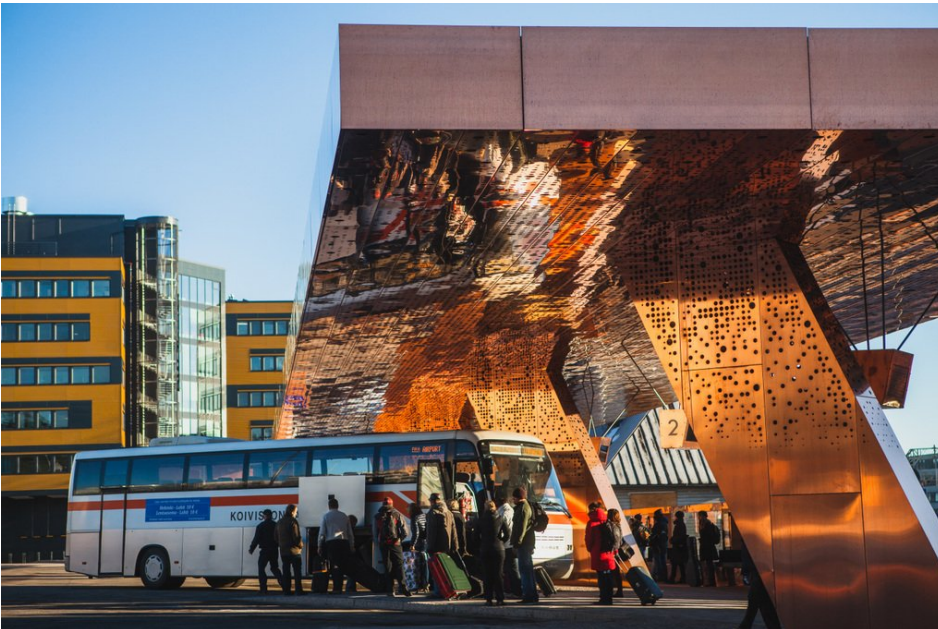


Figure A5. The travel hub of Lahti (completed 2016 ) started a large-scale brownfield development along the railway.

### Urban farming

- The City rents allotment garden plots for its inhabitants use. There are 8 different allotment gardens areas. In 2017 there were 171 allotment gardeners. In spring 2017 and 2018, the

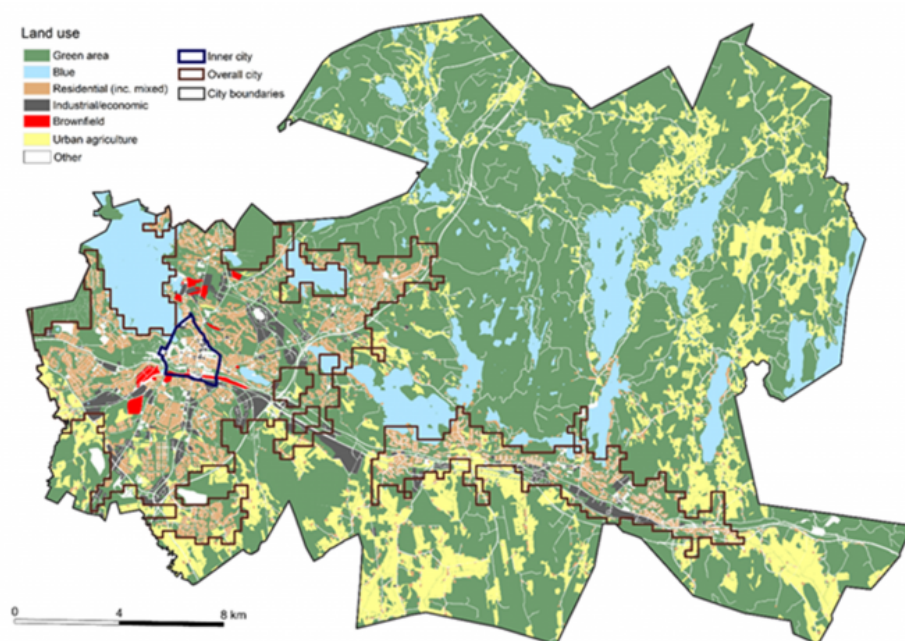


City offered free education for gardeners. Information and tips on gardening as well as knowledge about alien species was given at the education day.

- Lahden Ruokaosuuskunta, ROK, is a community supported agriculture group, established in 2013. Currently there are about 150 members.

## Maps

- Provide a land use map that indicates (Map 1)
  - a) the municipality boundaries delineating the overall city area;
  - b) the inner city area;
- Provide additional map(s) showing green and blue areas in the city, and their connectivity and coherence (Map 2);
- Provide map(s) of the location of brownfield sites (derelict zones) that (Map 3):
  - c) Have been regenerated in the past ten years;
  - d) Have not been redeveloped (yet).



Map 1. Land use within the City of Lahti.

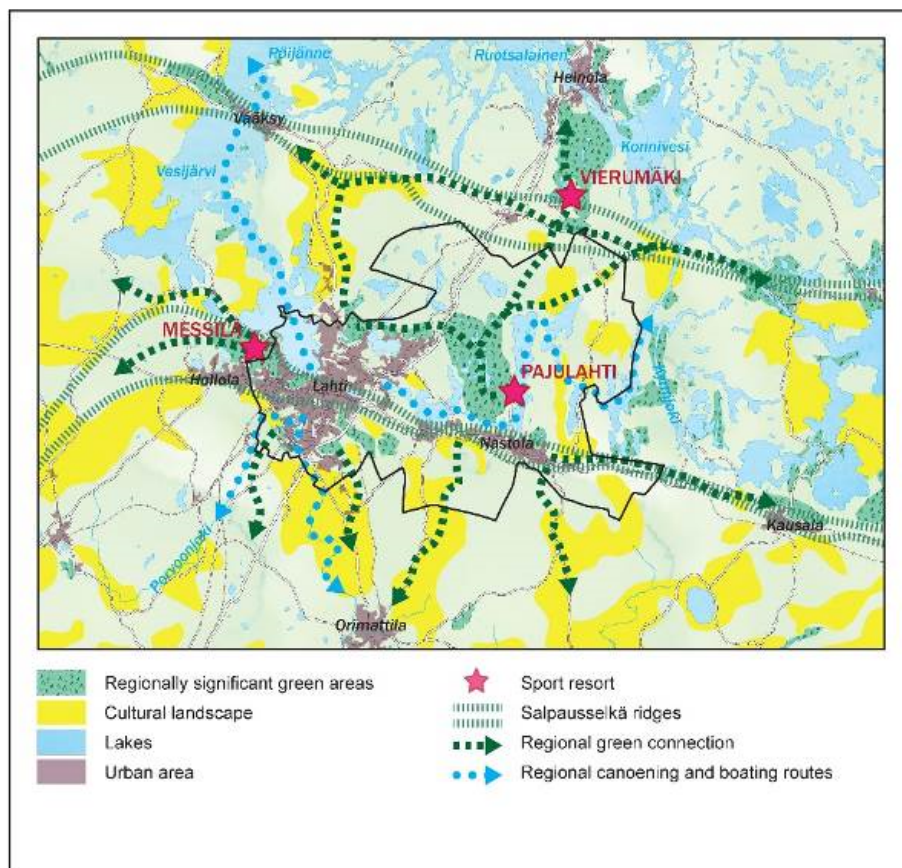
"Overall city" defined by YKR (Finnish division of densely and sparsely populated areas) [1].

Due to YKR urban division, data in the table above could be misleading.

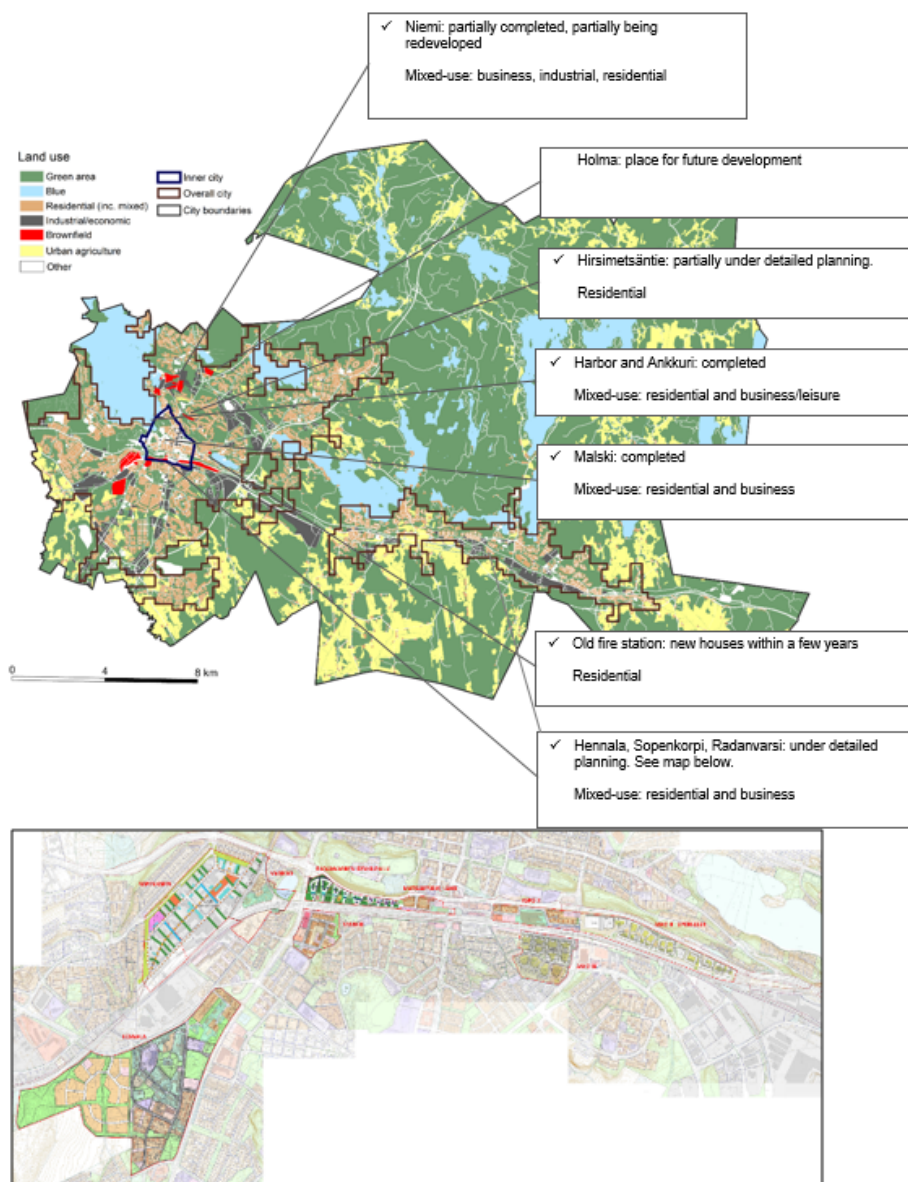
"Inner city" defined according to the Master Plan of Western Parts.

"Other" represents municipal buildings and structures, including roads.

## Regional green area network



Map 2. Salpausselkä ridge forms a green corridor for urban area of Lahti, while forests and cultural landscapes connect the rural and urban areas.



Map 3. Brownfields: already developed and being developed. Below: close-up of brownfield re-development along the railway.

## 4B. Past Performance

### Green Urban Lahti and Ecosystem Services

Green urban areas provide important ecosystem services, with clean air, clean water and recreational services for the residents being most valuable in Lahti [7]. To increase this green infrastructure and the services, new management protocols for urban forestry were created and implemented [8]. This protocol stresses the importance of ecosystem services as an integral part of forestry management. The City of Lahti owns a large forest owner in the inner city area, which has a significant positive impact on the green infrastructure.

Green area accessibility has increased through improved route markings, new nature paths, improved maps and continuous information given to residents. Approximately 40 000 residents visited e.g. the Lapakisto nature area in 2017.

### Water – Creating Wellbeing

In 1970, Lake Vesijärvi was highly polluted. Restoration started in the mid-1970s and continues today. Measures included controlling pollution and biomanipulation. The lake was restored in co-operation with several municipalities, universities and other research organizations, and funded by the Lake Vesijärvi Foundation. About 250 000 € was covered by the Lahti City Group, with the remainder is covered by other municipalities, private companies



and persons. The lake is now actively used for swimming. Other waterbodies have been subject to pollution, but their condition is improving. Sustainable stormwater management also enhances the visual quality of different areas (Fig. B1).



Figure B1. Retention pond of a large stormwater management system in Karisto.

### Your Green City

Residents are involved in Lahti's planning. In the current Master Plan, residents were able to affect the outcome through online-feedback enquires (1 340 responses): four "Our Lahti" evenings (107 participants; nearly 400 comments/ideas), a "Dream playground" event (36 children, aged 7-10, drew their dream playground and 10 were interviewed) along with other options (Fig. B2). Children requested places for adventures and climbing places that were safe. Residents' opinions are often requested for other plans. We use Maptionnaire, a mapping tool, and the Porukka mobile application. Maptionnaire has been used for collecting local experiential knowledge and getting feedback for urban plans.

In 2014 and 2016, all the urban natural areas used in Lahti's early childhood education in Lahti were mapped using Maptionnaire. Findings were incorporated into the city's GIS system. All 59 day-care units responded to the questionnaire. Urban nature is an important element in early childhood education and its use is frequent and varied.



Figure B2. Lahti is full of diverse nature areas that are all important for environmental education and



recreation. Children are especially prioritised.

Knowledge gained together with residents is stored in the city's GIS system and is actively used in planning. We have evidence that this local experiential knowledge affects planning outcomes. The Porukka application was developed to ask residents more general questions. Lahti monitors residents' satisfaction of green spaces: e.g. residents desire more trash bins, benches, fitness equipment and nature trails. Lahti attempts to fulfil these wishes (e.g. Liipola).



Figure B3. Local inhabitants participated to forest walking and co-creation session in 2017.

The forestry department and residents walked together in the woods to gather information about residents' forest experiences and what it means to them (Fig. B3). This walk was part of the planning and participation process of building a new main road 12.

Maintaining a high-quality environment for children and youth is one of Lahti's priorities. Socially important locations for children/youth are monitored. Walking and cycling safety, near schools and residential areas, is very important. Nature in Lahti is an excellent setting for learning about biodiversity (Fig. B5) and lessons are held outdoors. In 2015, UNICEF declared Lahti to be a Child Friendly City.

The University of Helsinki's ADELE research project, which is underway in Lahti, studies the links between biodiversity and human immune system strength.

#### Ensuring Sustainable Land Use

Our Master Plan is based on the Päijät-Häme Regional Plan, which safeguards sustainable development of the entire region. Although Lahti has reserved areas for urban growth away from the centre (Fig. A4), these can only be developed after areas close to the centre have been completed. Short-term development is directed by land acquisition and housing policies that are in line with the Master Plan.

As a rule, recreational and urban natural areas are excluded from urban development. To safeguard the most valuable natural areas, Lahti has designated new protected areas, almost yearly. In 2017, 995 ha of land is protected under national legislation, and 1933 ha of land is protected as sites of local conservation value. No development is allowed in these areas. The basis for conservation is not only in the strategy, but also in public opinion, where the results of public participation, questionnaires and surveys, e.g. in the master planning process in 2014, indicated residents valued urban green areas.

In recent years, the city centre has been mainly developed (infilling, underground parking,

replacing old inefficient buildings). Compared to the 1990s, the population of the city centre has doubled. In 2015, an underground public parking facility was built at the market square (1.3 M€).

Contaminated lands have been mapped to start restoration and re-development. Re-development has started in the Sopenkorpi, Niemi and Radanvarsi areas (Fig. A5). The harbour area was under development in 1995-2000, and within the recent 5-10 years, additional tens of hectares have been re-developed.

Although, the city centre is emphasised, development of a few detached-housing areas, about 5 km from the centre, helps to meet the needs of families with children. New neighbourhoods are developed with sustainable mobility in mind (Fig. B4). Child-friendliness is a key goal for Lahti, including children's independent mobility.



Figure B4. We develop new neighbourhoods with sustainable mobility and child-friendliness in mind.

Developing Lahti is partially based on urban zones (Fig. B5). Zones are defined on measures as distance from the city centre, frequency of public transportation and distance to a bus stop. Development can be planned by concentrating on areas close to the centre, with good existing public transportation.

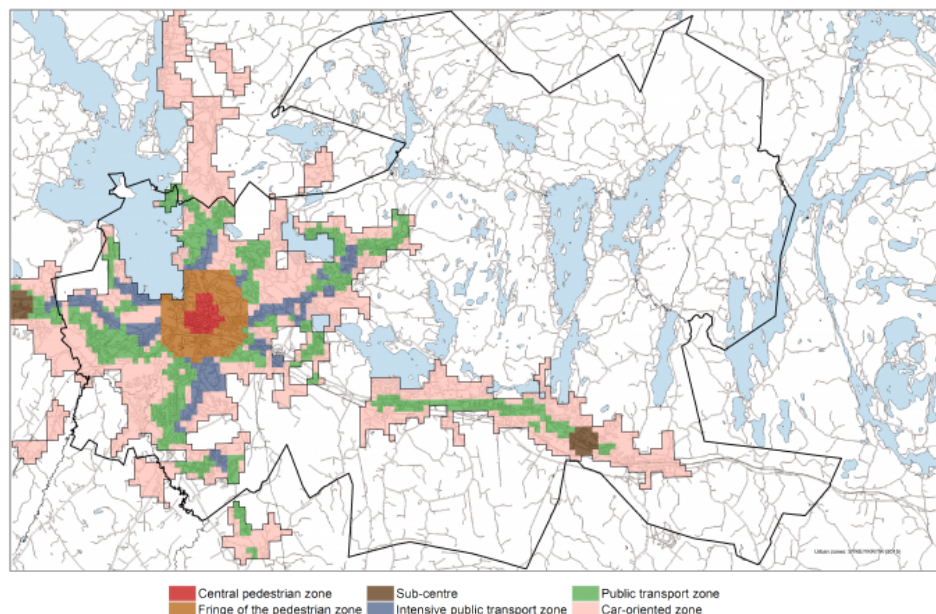


Figure B5. Urban zones of Lahti. Click to enlarge map.

Lahti has started using a new eco-efficiency tool, KEKO. It estimates the impact of development plans and plan alternatives on GHG-production, use of natural resources, biodiversity and ecosystem services. Lahti has used KEKO for development projects (e.g. Radanvarsi) to compare alternatives and their impacts.

#### From Sealed to Green and Functional: Green Infrastructure of Lahti City Centre

Currently Lahti transforms an important part of the city center “Ranta-Kartano area” from parking lot to an urban residential and recreational area with integrated green infrastructure. This brownfield area has been completely sealed but is currently changed to permeable or semipermeable surface with major stormwater management facilities (Fig. C4). The project cuts approximately 30% of phosphorus load from urban areas to nearby Lake Vesijärvi.

#### Urban Farming

City of Lahti has provided urban gardening lots for residents for over 50 years. During the last 10 years, increasing interest in guerrilla gardening has increased. Different local citizen communities take part in urban farming. The local farming groups are multi-cultural communities that may support the integration of newcomers.

## 4C. Future Plans

#### Future of Green Urban Lahti and Ecosystem services

The Master Plan (2016) emphasizes the need for improved ecological infrastructure in the city and along the Salpausselkä ridge. Two wildlife overpasses are planned along the ridge for use by wildlife and for recreation. Existing ecological connections are improved with additional vegetation. Already fragmented forests are developed for recreation, to meet the increasing number of residents. More paths will be covered with boardwalks to protect nature, while providing better access for people (Fig. C1). We have initiated a project to receive the status as a UNESCO Global Geopark for the Salpausselkä region (Figs. A1, A3). A wider geographical area has also been started to apply for UNESCO Biosphere Reserve status, of which Lahti would be part.





Figure C1. Accessible boardwalk in the Lapakisto nature conservation area.

### Management of Green Urban Areas

The ecosystem services approach will continue. The Green Factor Tool (green factor = scored green area/lot area) will be used in groundwater areas. The Green Factor Tool has been tested (e.g. Kortteli) and will be soon used for Radanvarsi. New building in groundwater areas is discouraged by Master Plan regulations.

To adapt to climate change, sustainable water retention systems are built, where possible. Laune Central Park will have a retention pond and channels for stormwater. Flood areas have been mapped for the city and this data has been incorporated into land-use plans. Stormwater issues are covered in Lahti's Stormwater Management Plan. The drafts for the Invasive Alien Species Management Plan, and Green Networks Plan are almost completed. Also children are invited to develop the playgrounds (Fig. C2).



Figure C2. Children evaluate the playground of Laune Central Park.

An annual budget of circa 1 M€ is used to support the green infrastructure by the city Lahti. Several schemes are applied for monitoring the performance. The main indicators are reported annually.



### Sustainable Land Use

The City of Lahti has started a rather unique process to unite the city strategy, master planning and transport planning. Master plan work for 2017-2020 (Fig. C3) is integrated with making a Sustainable Urban Mobility Plan, SUMP. The forces of the city are combined; all administrative sections, along with other stakeholders and residents, jointly strive for a more sustainable city entity. At the time of this writing, the participation and evaluation plan is finished, and the objectives for Process 2017-2020 are being formulated in collaboration with the participants.



Figure C3. Continuous master plan process of Lahti 2017-2020.

One showcase of sustainable urban mobility is the Aleksanterinkatu Street renewal project, completed in November 2016. Nowadays, the street is primarily a pedestrian area, with a high-quality cycling route. Cycling path widening covered two blocks. Investment 3.1 M€.

### Brownfield Areas Under Sustainability Transformation

The core urban areas need to be consolidated and new development must be close to services. There are several brownfield areas that will be developed into residential/mixed use areas (Fig. A4, C2).

Sustainable stormwater management systems must be incorporated into new development areas. In one of these areas most of the stormwater will be infiltrated on site and some water will be directed into a retention pond. In other areas we highlight the importance of green roofs. Plans for the renewal of the Hennala old military base are in the initial stages but, areas are reserved for natural stormwater systems. Contaminated land will be removed/cleaned. These new blue-green structure also provide an R&D platform for universities, companies, the city and citizens on which to collaborate (Fig. C4). The new solutions in urban planning are supported by the political leaders of Lahti and have also received external funding from the National government and local ERDF. The progression of sustainable land use development is continuously monitored through a master planning process (Fig. C3).



Figure C4. New stormwater management structures of Ranta-Kartano area also provide an R&D platform.

#### Future of Urban Farming in Lahti

Currently there are several future-oriented approaches for urban farming in Lahti:

##### 1. Schools and kindergardens

Schools and kindergardens are becoming increasingly interested in gardening. Last summer, one primary school in Lahti organised a community gardening for the summer and included it in their used learning program. Further school projects could be arranged to provide unemployed youth with new working opportunities.

##### 2. Community gardening in Lahti's city centre

We expect to continuously increase urban farming also in the heart of Lahti's downtown. These will, however, only occur if the citizens of Lahti increasingly request such possibilities. Currently, there is a community box garden in the Lake Vesijärvi's central park, in close proximity to the city centre.

## 5. Nature and Biodiversity

### 5A. Present Situation

Indicator	Number	Total Area (ha)	Year of Data Provided
Number and total area of Natura 2000 sites that are located in the city or nearby (i.e. within 10 km)	2	370	2016
Number and total area of designated sites of <b>national</b> biodiversity importance within the city (habitat/species management areas)	14 (incl. Natura 2000)	995 (incl. Natura 2000)	2017
Number and total area of designated sites of <b>local (city)</b> biodiversity importance within the city (habitat/species management areas)	417	1693+(240 private)	2017
Date and time horizon of your city's Biodiversity Action Plan	None, incorporated into other plans		

### Diverse Lahti

The junction of four dominant landscapes creates our unique natural environment (Fig. A1). Lahti's landscape was formed by the last Ice Age, 12 000 years ago [1]. The Salpausselkä ridge system has numerous kettle holes and is covered by forests. The lake district has many forests and a varying landscape: steep ridges and cliffs, rivers and lakes. Clay and silt plains, south of the ridge, are accented with sparse moraine ridges, granite cliffs and the Porvoo River.

Figure A1. Four major landscape features.



### Continuous Species and Habitat Monitoring

Mapping of the Siberian flying squirrel in 2014-2015, revealed that the species occurs in nearly all of the larger forests. Mapped species data is used in land use planning. All bird species have been mapped. We are monitoring the abundances in co-operation with the Päijät-Häme Ornithology Society. Abundances of black woodpeckers and Eurasian three-toed woodpeckers are increasing and both are protected under the EU Birds Directive Annex I. Bird maps were published in book format ("Bird Atlas of Lahti") in 1999 and 2012 (freely available online). Otters and rattle grasshoppers are monitored in 5-year cycles that follow populations and habitats. A bird and plant atlas is published every ten years, and bats and the Siberian flying squirrel are monitored in 10-year cycles.

Nature protection targets for 2030, is implemented into the new Environmental Programme of Lahti 2017-2030. We are committed to increase the share of protected sites to 8% of total city area by 2030.

### Green and Blue Lahti

Over 80% of Lahti is covered by water and green spaces (Figs. A3-A5). 995 ha are protected by national legislation (Fig. A2). Two core areas for biodiversity, Pesäkalio and Linnaistensuo, were included in the Natura 2000 network in 2004. Lahti has designated over 400 smaller sites (1 933 ha) representing a variety of habitats (meadows, old-growth forests, cliffs, springs, small rivers, ponds and individual trees). Most of the forests are not protected yet. They generally receive minimal management, and are close to their natural state [6]. Mature street trees and smaller green spaces in the inner city (Fig. A4) function as green corridors (e.g. for flying squirrels).

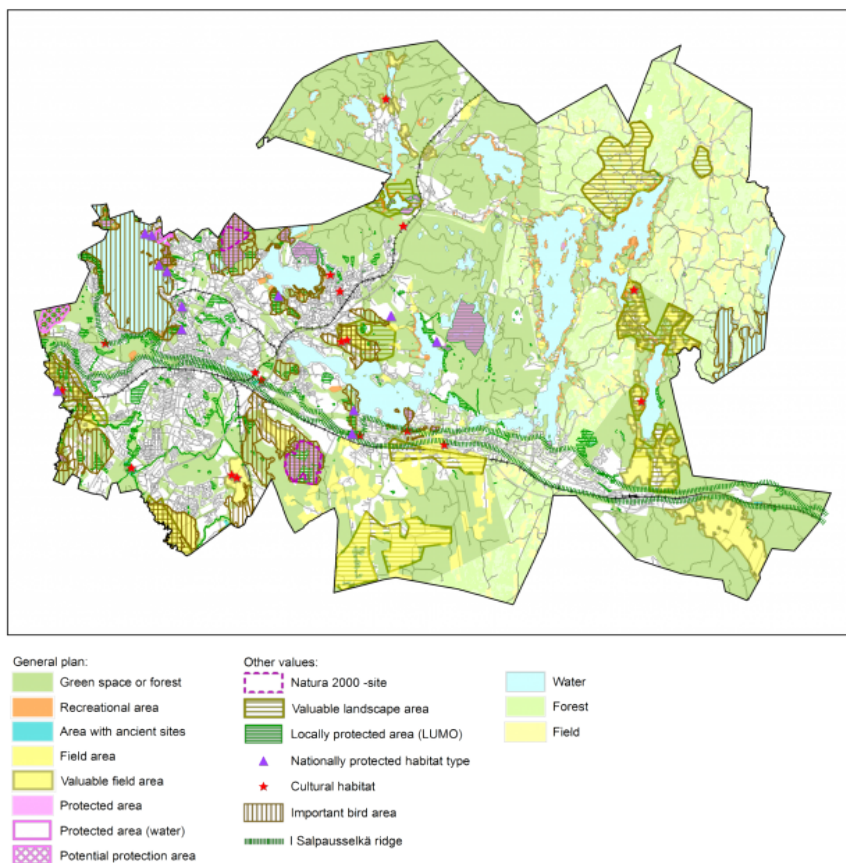


Figure A2. Valuable habitats and areas.

### Green and blue spaces in Lahti, and recreation facilities

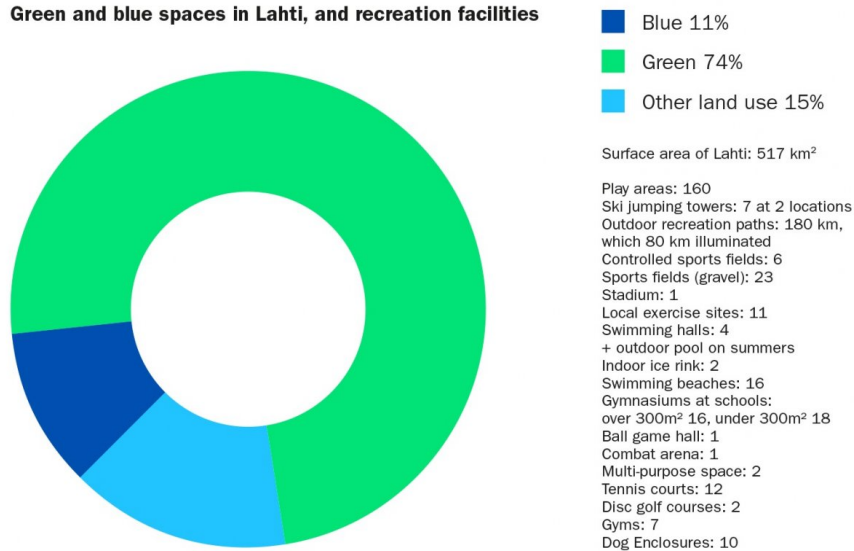


Figure A3. Green and blue spaces in Lahti and recreation facilities.



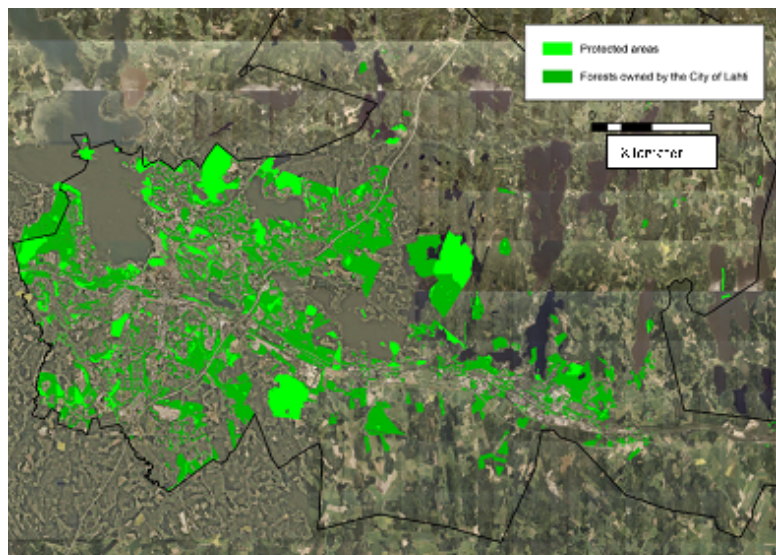


Figure A4. Protected areas and forests in Lahti.

Compensation to land owners (METSO funding) from the Finnish government has made designating protected areas easier. All protected sites have management plans.

Restoration has involved closing drainage ditches in the Linnaistensuo Bog and grazing sheep and cows along the Luhdanjoki River. The restoration of Lake Vesijärvi is an internationally renowned success story (5B).

#### Participatory Planning of Urban Nature

Protecting common urban species has not been regarded as being as important compared to more pristine areas. This attitude is changing as ecosystem services and the need for wide ecological connections are being recognized.

The value of biodiversity is emphasized in many of our projects and programmes for residents, especially for children, e.g. in the LUMA projects, where children study natural sciences outdoors. Adults are encouraged to take care of their local nature i.e. by removing invasive species.

Lahti University of Applied Sciences launched the Salpausselkä Geopark project in 2017 with the goal of applying for UNESCO Global Geopark status. Seven municipalities situated along the Salpausselkä formations or around Päijänne National Park, with some 182 500 inhabitants in total, form the area of the aspiring geopark and are the main stakeholders (Fig. A5).



Figure A5. Salpausselkä Geopark project is an on-going project carried out by the local university, municipalities, citizens and companies.

## 5B. Past Performance

### Early Start Building Nature Protection Network

Biodiversity protection started in 1962 (first protected site), but truly gained momentum after the 1990s. Linnaistensuo was partially designated (100 ha) as a Natura 2000 site in 1998, as being representative of a southern Finnish bog. The bog had already been drained, but the value had been preserved. We began restoring the Linnaistensuo Bog in 1995, by closing the ditches. Linnaistensuo is important to black grouse and butterflies (Light Brocade, Freija Fritillary, Streaked Wave). The conservation area has been enlarged (currently 200 ha). Other protected areas, e.g. Pesäkallio, have been enlarged and improved (from 70 hectares to 200 hectares, since 2013). Many of the conservation sites are still small (average 30 ha).

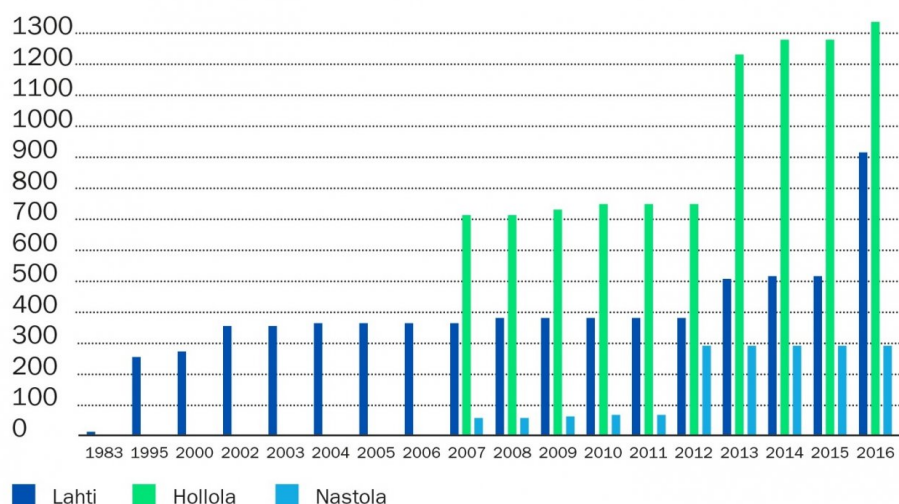
New conservation sites have been added, almost annually, through METSO funding (Fig. B1). In 2012, the hugely popular Lapakisto site (230 ha) was protected.

Locally protected smaller biodiversity sites (LUMO) were first designated in 1995 and by 2016 covered 1933 ha of Lahti. Nationally protected areas and LUMO sites cover 24% of the total forest area owned by the City of Lahti. Many of the LUMO sites are located in the inner-city, making them important for urban biodiversity and to residents.

All protected sites have management plans (drafted for designation and updated when widened). Due to changes in farming practices, open habitats have started to becoming overgrown. To preserve the valuable habitats, sheep and cows have been re-introduced to the Luhdanjoki conservation site. Additionally, sheep are annually used to maintain the Paakkolanmäki and Ristolanniitty meadow sites.

Information signs are installed to inform visitors of the value and rules of the conservation sites. Many of the protected sites have good quality wooden paths. Fallen trees are used to guide people to recommended paths, to avoid wear and tear from walking.

### Areas protected under the Environmental Protection Act (ha)



### Habitat sites protected under the Environmental Protection Act (ha)

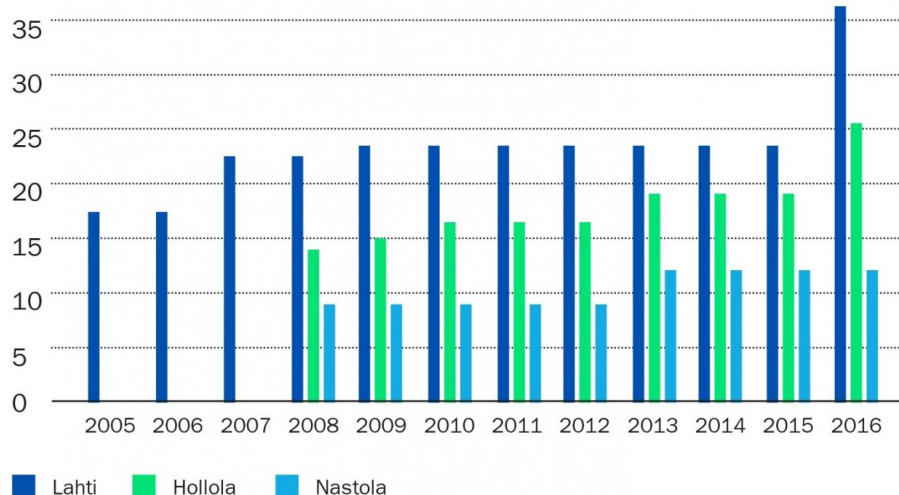


Figure B1. Protected areas have increased over the past years.

### Other Green Spaces

The 2013-2025 Green Spaces Programme focuses on ecosystem services. Urban ecologists from the University of Helsinki drafted a sound programme for enhancing biodiversity and ecosystem services. Opinions of residents and other interested parties were also considered. Residents desired both higher maintenance levels and ecological management. Thus, important nature areas (e.g. forests on the Salpausselkä Ridge) will receive very little maintenance, while city centre parks will be highly managed. A diverse set of local plant species is recommended for aesthetic purposes.

Biocides are only allowed, by special permit and only if other measures have failed (no biocides were used in 2015-2016). A non-toxic hot foam system has been tested for controlling weeds and invasive plants, although generally, simple weeding is used.



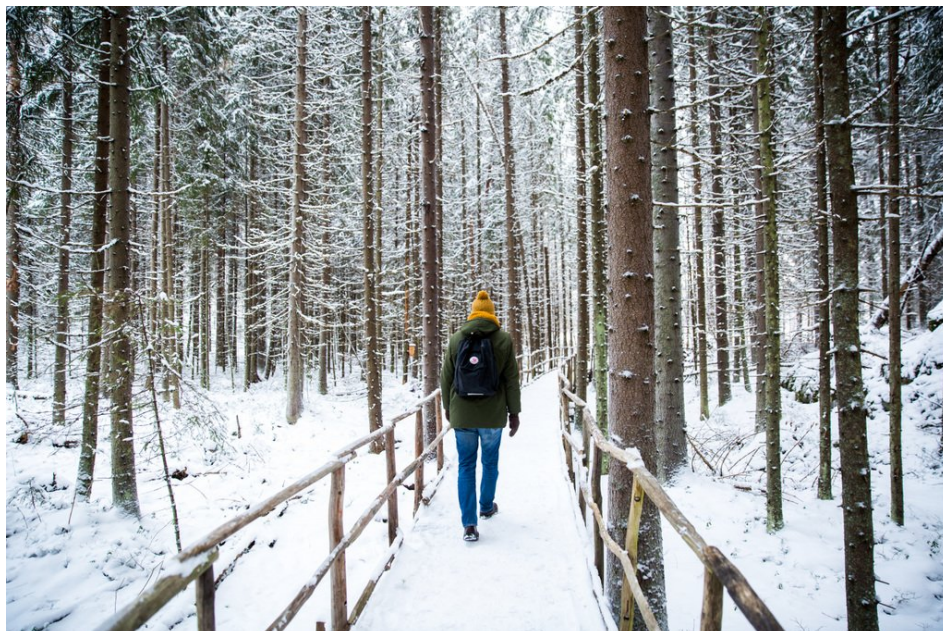


Figure B2. The majority of city owned forests are over 80 years old.

We manage forests according to our Guidelines for Management and Use of Municipal Forests, and the 2013-2025 Green Spaces Programme. Lahti owns 7 000 ha of forest, where nearly 40% is over 80 years old (Fig. B2). Most forests have trees of the same age and species. We are now planting new trees and keeping old-growth trees to increase diversity. Management involves thinning and making small gaps, to allow forest regeneration. Tree species diversity of trees has increased, recently. This ensures forest sustainability as a habitat, increases pest resistance and resilience to climate change. If possible, dead wood is left in urban forests by girdling trees or by cutting living trees at a height of 2-4 meters. Ditch drainage is only carried out if absolutely necessary. Protected sites are minimally managed. The high share of old-growth trees and dead wood is evident from the city's species list (see 4A) and population trends (Fig. B3).

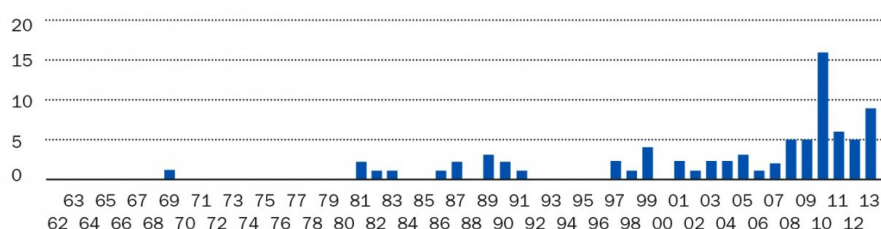


Figure B3. Increasing abundance of red-breasted Flycatcher habitats 1962-2013, an old-growth forest indicator.

### Precious Lake Vesijärvi and Other Water Bodies

In the 1970s, Lake Vesijärvi (Fig. B4) was one of the most polluted lakes in Finland. Restoration started in the mid-1970s, when an urban wastewater treatment plant was built. Later, biomanipulation was used. In 2001, restoration began in co-operation with several municipalities, universities and research organizations. The work is funded by the Lake Vesijärvi Foundation (primarily funded by the Lahti City Group: 250 000 €). The current restoration stage involves such measures as mapping pollution sources, eliminating wastewater sources from private dwellings, constructing retention ponds and wetlands, management fishing (roach, bream, bleak) and planting predatory fish. As a result, oxygen depletion occurs less often, populations of predatory fish and several rare species have increased (e.g. eel, pike perch, sea trout, moor frog, dragonflies). We annually stock 10 000 elvers, since traditional eel populations are endangered.

We have constructed about 20 wetland systems for treating stormwater, before release into water bodies, over the past 10 years. Wetlands and retention ponds are used in new



developments or added to old urban areas, whenever possible.

Since 2012, Lahti has participated in the “Jokitalkkari” Project. The project aims to improve river conditions so that salmonid populations will increase or return. The project also improves living conditions for other migrating fish and grayfish. We also stock the rivers with sea trout. Over the past three years, we have helped nearly 1 000 mature eels migrate to the sea.

In 2016 we mapped all the springs. This data was set in the city’s GIS system, where information is available to all experts on WebMap, to assist with managing land use, building sector and environmental services.



Figure B4. The Lake Vesijärvi restoration is one of the world’s leading examples of biomanipulation.

#### Biodiversity and Residents

Nature protection investments reach approximately 95 000 € yearly, and are mainly used to improve access to protected and other nature areas (paths, resting sites, information signs) and for education (e.g. guided tours, nature trails publications, protected species and habitats information signs, bird watching towers).

Lahti has numerous programmes and projects related to environmental education, including:

- A permanent environmental teacher position to guide and train schoolteachers in organizing outdoor lessons and provides equipment (e.g. trekking bags, loupes, binoculars and simple identification keys).
- A mobile classroom, “Ecovan”, equipped with modern technology for studying nature.
- Environmental grandparents: volunteers who teach children about environmental issues and nature - connecting children and the elderly.
- 50 kindergartens that mapped interesting nature objects and species in nearby green spaces to help find them more easily. The data is stored in the city’s GIS system for use in detailed planning and forest management.
- The project “Mun juttu” (“My Thing”) for improving wellness of young adults and reconnecting them with nature.

Another unique project, taking place in Lahti, is the ADELE research project from the University of Helsinki, which studies the links between biodiversity and the human immune system strength (Fig. B5).



Figure B5. ADELE Project focuses on the effects of our everyday living environment on health.

Residents finance or volunteer for nature conservation and restoration. Community work is organized to control invasive species [19]. We provide advice and equipment. In 2016, giant hogweed and its early development stages were demonstrated at exhibitions in the city centre to ensure early control of this species. A clean-up campaign [20] is organized yearly in schools and residential areas: In 2016, nearly 10 000 children and adults participated in cleaning the city.

## 5C. Future Plans

### Keeping the Blue, the Green and the Biodiversity

The pressure to build houses, industrial areas and roads in green spaces and wider nature areas is increasing. Forecasted population growth is 1% annually. Meanwhile, the ecological network needs to be improved and expanded, to ensure the survival of local populations and increase resilience (Fig. C1). To safeguard the functioning of ecosystem services, the quality of green spaces must be enhanced.

## Regional green area network

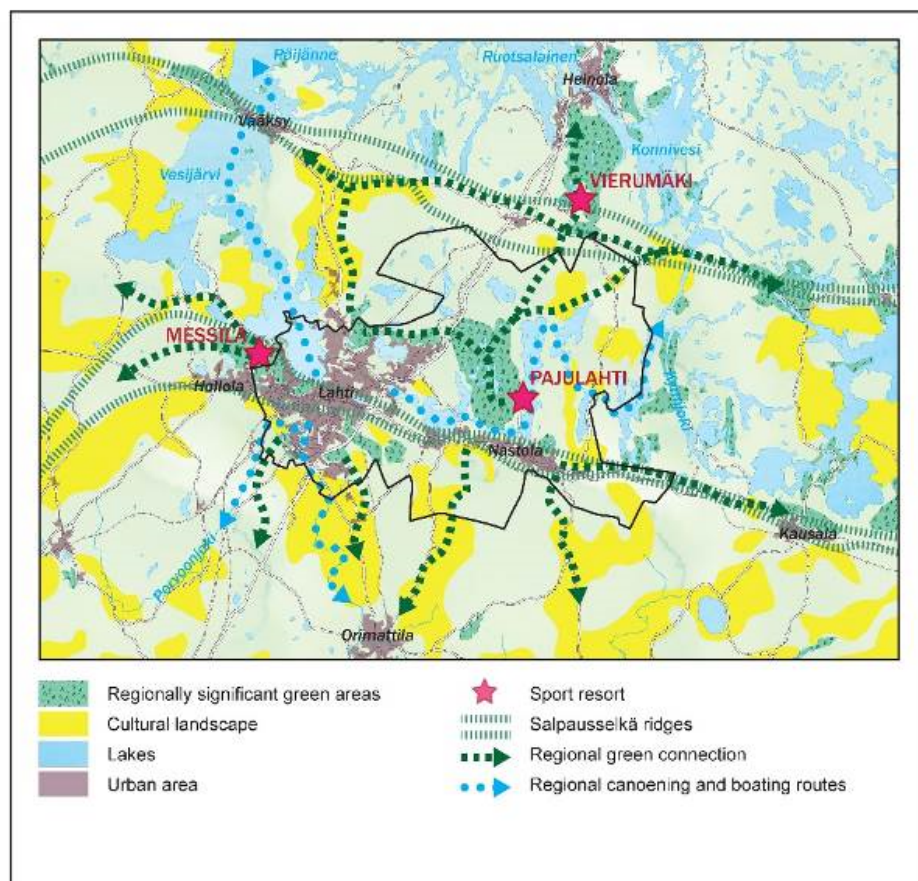


Figure C1. Salpausselkä ridge forms a green corridor for urban area of Lahti, while forests and cultural landscapes connect the rural and urban areas.

### Strategies and Plans

The Lahti City Strategy 2030 states that Lahti will succeed as a bold environmental city. Taking care of the environment is at the heart of the strategy and is to be incorporated into all plans, budgets and actions. The Master Plan emphasizes the need for improved ecological connections and the recreational importance of green spaces within and around the city area.

Actions in the Programme of Green Spaces 2013-2025 and Guidelines for Management and Use of Municipal Forests will continue (5B). Urban forests will be managed as little as possible, a diverse set of local species are recommended and ecosystem services are considered. Implementation of the plan is monitored yearly.

According to our Stormwater Management Plan, stormwater must be managed ecologically in newly built areas (Fig. C2).

A Biodiversity Action Plan is currently in preparation and targets are also incorporated into many other plans, such as the Green Spaces Programme, the Master Plan, Guidelines for Management and Use of Municipal Forests, Controlling of Invasive Alien Species etc. We consider and incorporate the EU Habitats and Birds Directives, e.g. protecting critically endangered eel. The biodiversity area targets are incorporated into the Environmental Programme 2030, which states that 8% of the city's area should be protected by 2030.

### Our Future Actions

- New protected areas are added and old ones enlarged: Kinttö, Viuha and Lapakisto in 2017.
- To celebrate Finland's centenary year, we will donate a new area to protect the Sammalisillan suo (bog). A nature path will be built to increase accessibility of all people.
- We have initiated a project to apply for UNESCO Global Geopark status for the



### Salpausselkä Ridge around Lahti.

- Small and previously fragmented forests are made available for recreation to meet the increasing number of residents. Large and pristine areas are protected from wear and tear.
- More circular hiking routes are planned to complement existing ones, to create a walkable city. We will build a circular trail around Lake Joutjärvi and lengthen the trail from River Porvoonjoki to Okeroinen.
- In the immediate future, wetlands will be built in Ranta-Kartano and Hennala. Stormwater from the city centre will be managed in these areas (Fig. C2).
- Planting 150-250 trees along streets and 200-300 in parks, yearly, to improve connectivity for flying squirrels and bats. The City of Lahti has roughly 10 000 street trees, of which 3 000 are in the city centre.
- 10 000 € yearly to eliminate alien species, such as Persian hogweed, Himalayan balsam and garden lupine (since the 1990s). In 2016-2018, we will invest 24 000 € and concentrate on hogweed in forested areas and finding the best non-toxic solutions.
- In the coming years, we will draft more detailed action plans (for local sites of biodiversity value, build urban parks).
- The drafts for Invasive alien species management plan, and Green networks plan are almost completed.
- Over the next five years, we will update old species maps, e.g. bats (existing 2004), the Siberian flying squirrel (existing 2015), the European otter (existing 2014), birds (existing 2010).
- School students have now mapped their local nature areas, similarly to that done by the kindergartens. The data is to be incorporated into the city GIS systems.
- The environmental teacher and the Ecovan will continue working with children (Fig. C3). Other successful environmental education projects will continue, such as “Environmental Grandparents”.
- “A whole day outside kindergarten” is to be created (Fig. C4).
- Health and wellbeing: Kintterö “healing forest” in 2018 will be created in cooperation with Aalto University, the Natural Resources Institute Finland, Lahti University of Applied Sciences, the Central Hospital of Päijät-Häme Region, the Ministry of Social Affairs and Health and the National Institute for Health and Welfare (Fig. C5).
- Mapping of experience-based information from residents, regarding favourite places in the forests, launched in September 2017.



Figure C2. Installation of stormwater management elements in Ranta-Kartano, a developing residential area.





Figure C3. The Ecovan and some of the modern equipment for teaching children about nature.



Figure C4. Lahti will have a kindergarten where children will stay outdoors the entire time.



Figure C5. A forest designated for recreational use that will promote good health is planned in Lahti.

## 6. Air Quality

### 6A. Present situation

Indicator		Unit	Year of Data
Number of PM <sub>10</sub> monitoring stations	2	No. of monitoring stations	2018
For each station provide the number of days per year PM <sub>10</sub> exceeded 50 µg/m <sup>3</sup>	Laune 7 Saimaankatu 2	Days	2017
For each station provide annual average PM <sub>10</sub> concentration	Laune 16 Saimaankatu 6	µg/m <sup>3</sup>	2017
Number of NO <sub>2</sub> monitoring stations	3	No. of monitoring stations	2017
For each station provide the number of hours with NO <sub>2</sub> concentrations higher than 200 µg/m <sup>3</sup>	Vesku 0 Laune 0 Kisapuisto 0	Hours	2017
For each station provide annual average NO <sub>2</sub> concentration	Vesku 21 Laune 13 Kisapuisto 8	µg/m <sup>3</sup>	2017
Number of PM <sub>2.5</sub> monitoring stations	1	No. of monitoring stations	2017
For each station provide the annual average PM <sub>2.5</sub> concentration	4	µg/m <sup>3</sup>	2017

#### Geographical Factors and Topographical Constraints

Our city is located in a temperate coniferous-mixed forest zone, with cold, wet winters, according to Köppen's climate classification. The mean temperature of the warmest month is at least +10 °C and the coldest at least -3°C, with moderate rainfall in all seasons.

Lahti's city centre is located in a valley between ridges (Fig. A1). This induces problems (inversion) with air quality during unfavourable weather conditions. The northern location also influences air quality. Inversion occurs during winter and especially during early spring, trapping air pollutants close to the ground and inhibiting dilution. Due to cold winters, there is



a need for studded tires as well as for sanding and salting roads to prevent slippery conditions. Spring is especially challenging for air quality, when sand and pulverized asphalt rise into the air.

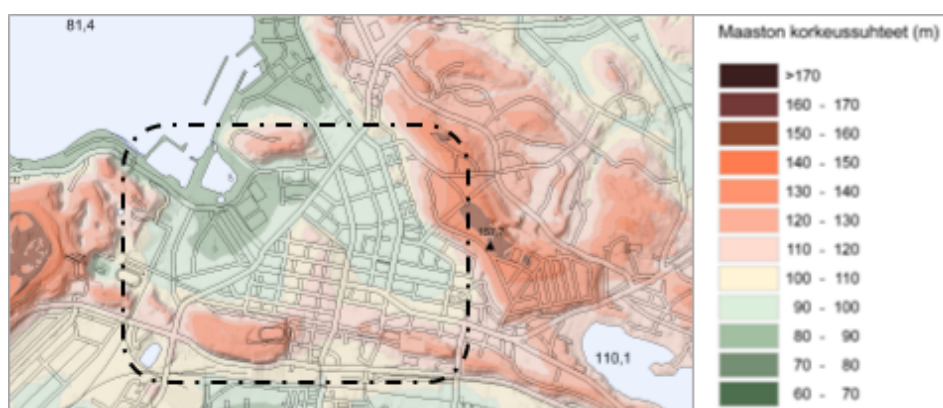


Figure A1. Ridges form a circle around the city centre (marked with a dashed line), trapping air pollution.

### Extensive Monitoring

Despite being a small city (120 000 inhabitants), Lahti monitors air quality at five stationary automatic measuring stations (Fig. A2). In addition, Lahti has had a mobile station since 2015. The mobile station is relocated yearly. In 2017, it was located in Hollola (Salpakangas) (Fig. A2). Besides automatic monitoring of NO<sub>x</sub>, O<sub>3</sub>, PM<sub>10</sub> and PM<sub>2.5</sub>, there are passive two-week monitoring pipes, in three different locations, to monitor VOCs. The measuring stations in Saimaankatu and Vesku represent the city centre, while Laune is located on a busy road. Kisapuisto is located in a recreational area and represents urban background air quality. Satulakatu is located away from the city centre and significant emission sources. VOC measuring stations are located in industrial and business areas and are close to residential areas, except for Laune, which is in a traffic area. There is one meteorological station (Vesku) that aids in analysing the data.

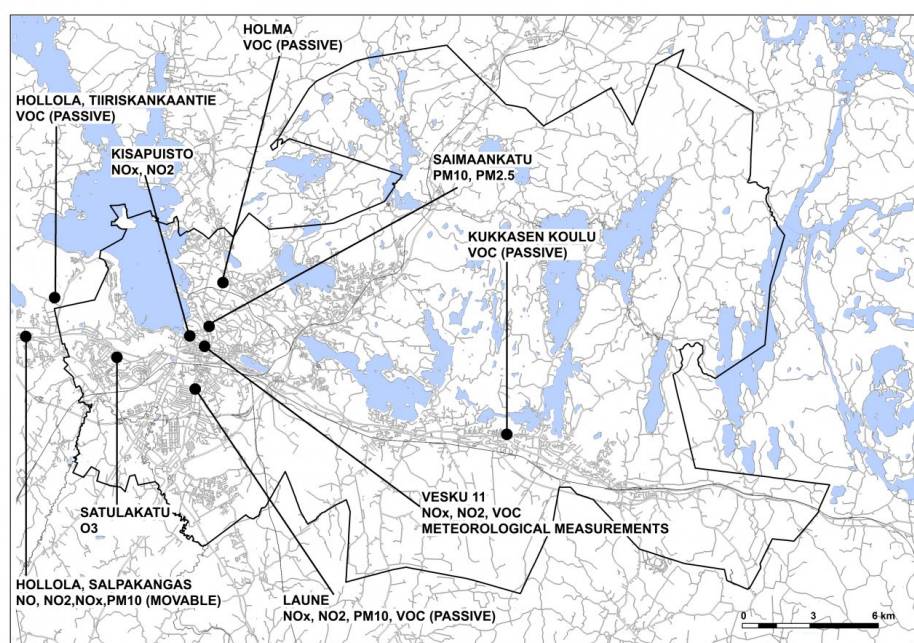


Figure A2. Air pollution measuring stations in Lahti.

### Sources of Air Pollution

Air pollution primarily originates from energy production and traffic. Of the annual mean NO<sub>x</sub>, about 55% originates from industry and 45% from traffic. For particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>) (annual mean), about 40% originates from industry and 60% from traffic. Concentrations of PM<sub>2.5</sub> are usually rather small in Finland. From time to time, long-range transboundary pollution caused by forest fires can be seen in the monitoring. There are a few

small companies that use solvents that generate VOC emissions, along with household wood combustion in residential areas. The proportion of air pollution from long-range transport is not estimated separately.

Concentrations of hourly NO<sub>2</sub> (120 µg/m<sup>3</sup>) levels were not exceeded in 2017; this may happen in traffic areas but, is unlikely in other areas. There were 7 occasions when the daily PM<sub>10</sub> average concentration limit of 50 µg/m<sup>3</sup> was exceeded in March and November, in areas that were sanded.

#### Air Quality Index

Finland uses an air quality index based on national guidelines and limit values. The air quality index is calculated hourly. Air quality is classified as Good, Satisfactory, Tolerable, Poor or Very poor. The City of Lahti is responsible for updating and monitoring the information, based on the collected data (Fig. A2). To keep the residents informed of air quality, data is sent to a national air quality portal, where it can be followed in real-time at [www.ilmanlaatu.fi](http://www.ilmanlaatu.fi).

In 2017, air quality was classified as Good 53.9%, Satisfactory 39.6%, Tolerable 4.3%, Poor 1.5% and Very poor 0.4% of the time (Fig A3). There were 182 hours of poor or very poor air quality in 30 days. The reason for this was the high amount of particulate matter concentrations.

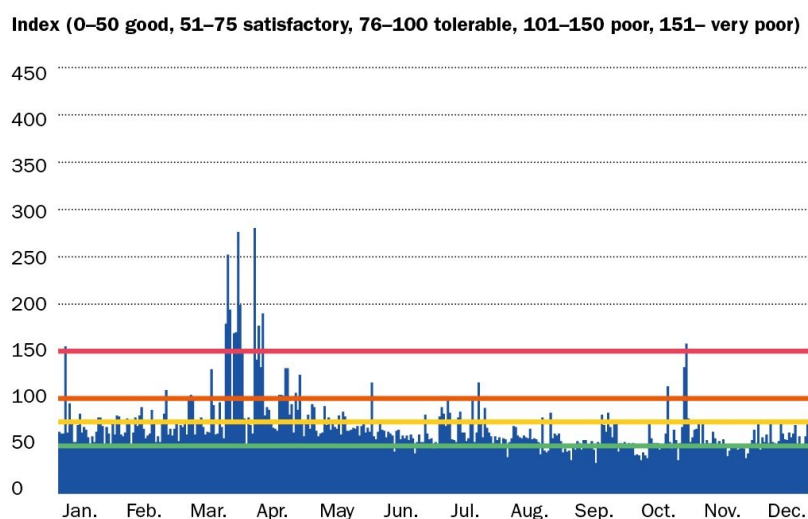


Figure A3. Air quality indexes in 2017 in Lahti.

#### Particulate Matter

Poor and very poor air quality index values (30 days in 2017) are nearly always caused by high PM<sub>10</sub> concentrations. PM<sub>10</sub> concentrations were high in March and April, due to large amounts of pulverized sand and asphalt, after the snow melt. At the Laune and Rakokivi measurement stations, the national guideline value of 70 µg/m<sup>3</sup> (second highest daily value for a month) was exceeded in March as well as in April, in Laune.

The EU daily mean limit value of PM<sub>10</sub> (50 µg/m<sup>3</sup>) was exceeded 18 times at the Laune station (35 allowed times). The annual mean concentrations of PM<sub>10</sub> are below the EU limit value of 40 µg/m<sup>3</sup> (Chart 2, Tori's measurement station was replaced by that in Saimaankatu in 2014, which is situated close to the previous location). As usual, the EU limit value of PM<sub>2.5</sub> (25 µg/m<sup>3</sup>) was not exceeded in 2017. The highest daily means for each month were between 5.5 µg/m<sup>3</sup> and 17.4 µg/m<sup>3</sup>. The latter was measured in January. The annual mean concentration of PM<sub>2.5</sub> was 3.6 µg/m<sup>3</sup>.

#### NO<sub>x</sub> Gases

NO<sub>2</sub> concentrations were low level in 2017 (long-term mean or below it throughout the year). Generally, NO<sub>x</sub> concentrations remained around average, throughout the year. The effect of traffic is evident, as NO<sub>x</sub> concentrations follow traffic rhythms.



Annual mean concentrations of NO<sub>2</sub> have decreased considerably, over the past decades (Chart 1). The EU limit of 40 µg/m<sup>3</sup> was never exceeded. In 2017, the annual mean concentrations of NO<sub>2</sub> were as follows: Vesku 21 µg/m<sup>3</sup>, Laune 13 µg/m<sup>3</sup> and Kisapuisto 8 µg/m<sup>3</sup>.

The NO<sub>2</sub> EU hourly mean limit value (200 µg/m<sup>3</sup>) was never exceeded at any of the stations. The hourly mean values (second highest value per month), comparable to the national guideline value, varied at the measurement stations as follows: Vesku 39-75 µg/m<sup>3</sup>, Laune 27-90 µg/m<sup>3</sup>, Kisapuisto 23-59 µg/m<sup>3</sup> and Hollola 15-48 µg/m<sup>3</sup>.

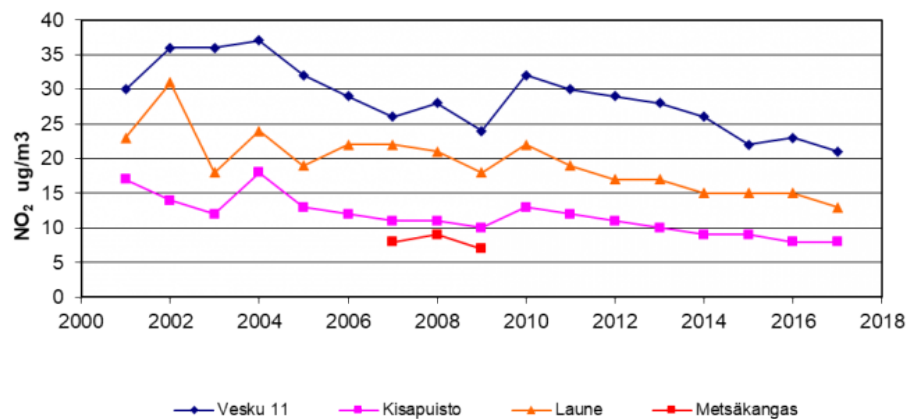


Chart 1. Trend of annual average NO<sub>2</sub> in different measuring stations (Vesku 11, Kisapuisto, Laune and Metsäkangas).

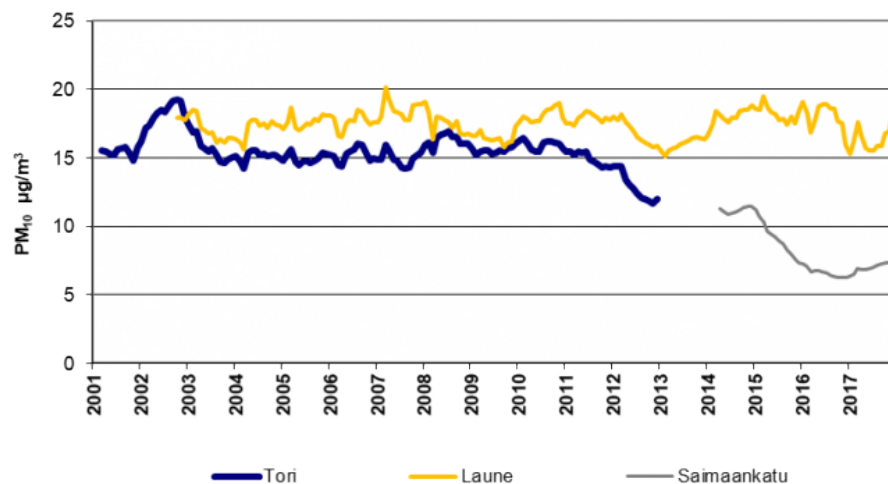
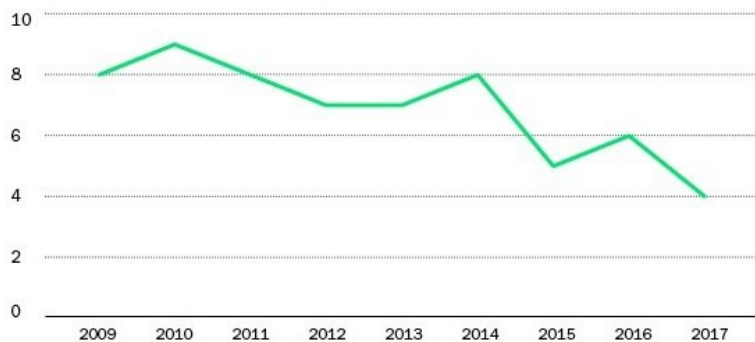
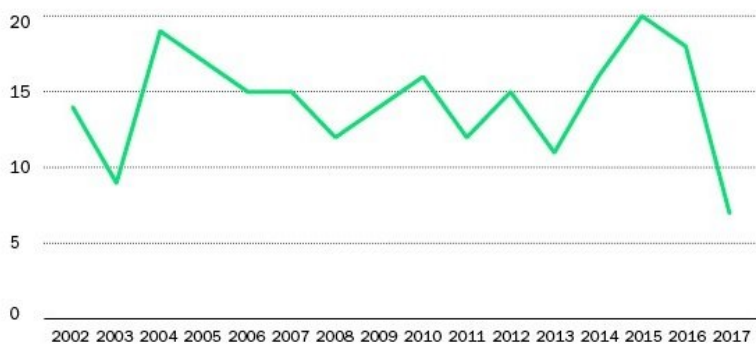


Chart 2. Trend of annual average PM<sub>10</sub> in different measuring stations (Tori, Laune and Saimaankatu).

Annual average PM<sub>2,5</sub> µg/m<sup>3</sup>Chart 3. Trend of annual average PM<sub>2,5</sub> in Lahti city centre.Exceeding PM<sub>10</sub> 50 µg/m<sup>3</sup>Chart 4. Trend of number of daily limit exceedances of PM<sub>10</sub> in Laune.

Requested Chart 5: There were no single hour from 2000 which would exceed the 200 µg/m<sup>3</sup>.

## 6B. Past Performance

### Air Quality Management

An Air Quality Action Plan (1997), is the basis for today's actions and strategies. The most important measures for reducing air pollution target road traffic. Thorough monitoring ensures that immediate action is taken and residents are warned if air quality deteriorates.

As a complement to national and European Union regulations, Lahti has additional local air quality regulations. These are included in the Environmental Regulations of the City of Lahti.

The City and local businesses have signed an agreement to monitor air quality. The businesses fund the monitoring work according to the polluter pays principle.

Sanding of streets causes health hazardous dust. To minimize sand pulverization, a sand type that causes less dust is selected. When air quality worsens in the early spring, we immediately inform our street cleaning operators. Large-scale and thorough street cleaning operation are carried out to minimize the period of bad air quality (Fig. B1).



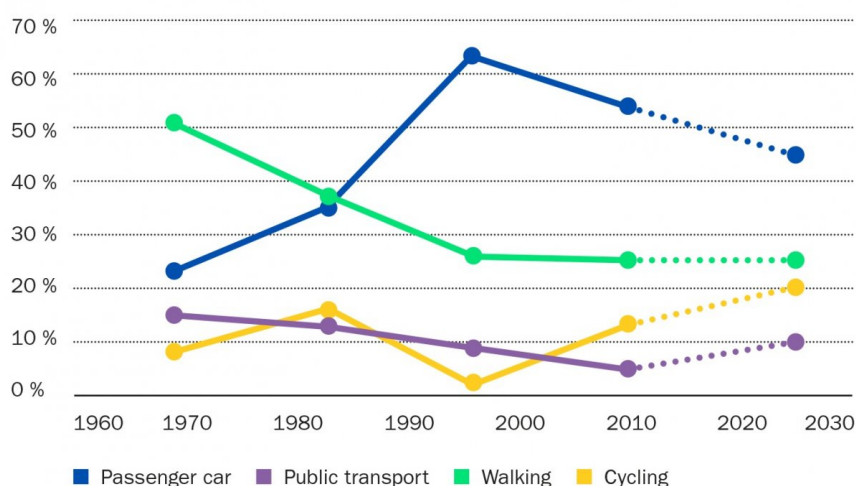
Figure B1. Street cleaning operation are organised as a joint project with building owners to reduce bad air quality days.

### Promoting Sustainable Transportation and Walking

- Pedestrian city centre:
  - Car-free zones in the city centre.
  - Widened pedestrian paths.
  - Transformation of Aleksanterinkatu Street to a primarily pedestrian area, completed in November 2016 (cost 3.1 M€) (Fig. B2). Additional bicycle racks, parking for 1 100 bicycles.
- Great cycling path network: 532 km of combined pedestrian and cycling paths [4].
- During the winter, main cycling network are highly maintained to promote winter biking.
- 2014 public transportation network reform:
  - Approximately 90% of local public transportation is operated by Euro VI (investment 1.5 M€).
  - Increased frequency of bus service.
  - New routes added (40% increase in kilometres).
  - Nearly all routes go through Lahti's market square and the new Travel Centre.
  - In 2015, 82.8% of residents lived in the pedestrian/public transportation zone (maximum frequency for public transport: every 30 minutes; maximum distance to a bus stop: 250 m).
- Lahti's Master Plan is concentrates on consolidating land use and ensuring a population density of at least 15 inhab./ha enabling a good public transportation and cycling path network.
- 2016 a transportation hub was built uniting train and bus transportation, parking houses for bicycles and cars. Investment 18 M€.
- To enhance smart mobility, i.e. commuting, we financed companies to execute smart mobility plans for their employees.
- Lahti City consortium owns 8 electric cars, 35 biogas vehicles and a few electric bicycles and traditional bicycles for use by city employees.
- The city arranged an electric bicycle test-ride in 2016.
- Campaigns to support the use of public transport: On the World Car Free Day bus tickets on reduced price.
- City has ambitious SUMP targets (Fig. B3).



Figure B2. Over the past few years, we have created widened pedestrian paths and car-free zones in the city centre.



\* These are not comparable to 2010 & 2016 numbers due to differences in the research methods and period.

Figure B3. We are designing an ambitious SUMP policy as part of Lahti Master Plan.

### Sustainable Energy

2010-2016 Consumers Energy Advisory in the Päijät-Häme project: energy counselling targeted residents and housing cooperatives in the Lahti region. Budgeted 77 000 € during 2014-2015 and then 25 000 € annually for 2016-2020.

2015-2016 the "Eco-efficient Energy Solutions" project developed an e-service for property owners and residents to assist in comparing different sustainable energy solutions. Investment 190 000 €.

Lahti Energy Ltd. (part of the Lahti City Group) invested in energy efficient and sustainable district heating. The district heating network is extensive; over 90% of the population and 99% of municipal buildings uses district heating. Over 95% of district heating is produced efficiently in the Kymijärvi CHP-plant I-II.

Lahti Energy Ltd.:

- Supports schools with educational kits on energy saving.
- Advises residents on solar power, delivers ready-made solar power packages to



households.

- Electric charging points, charging is free for registered users.

#### Public Information

- Air quality can be followed in real-time at [www.ilmanlaatu.fi](http://www.ilmanlaatu.fi).
- SMS warning service: message sent if air quality reaches a harmful level (Fig. B4).
- Our website offers air quality reports from 2006-2017.
- A Facebook posting is immediately set (on the Urban Environment Facebook page) if air quality reaches unhealthy levels.
- Media releases are given to local media, when air quality deteriorates, and forecasts are compiled so that vulnerable groups may plan their actions and outings.



Figure B4. We use an SMS warning service to inform residents of harmful air quality levels.

#### Results

Air quality has improved over the past few decades (Fig. B5).

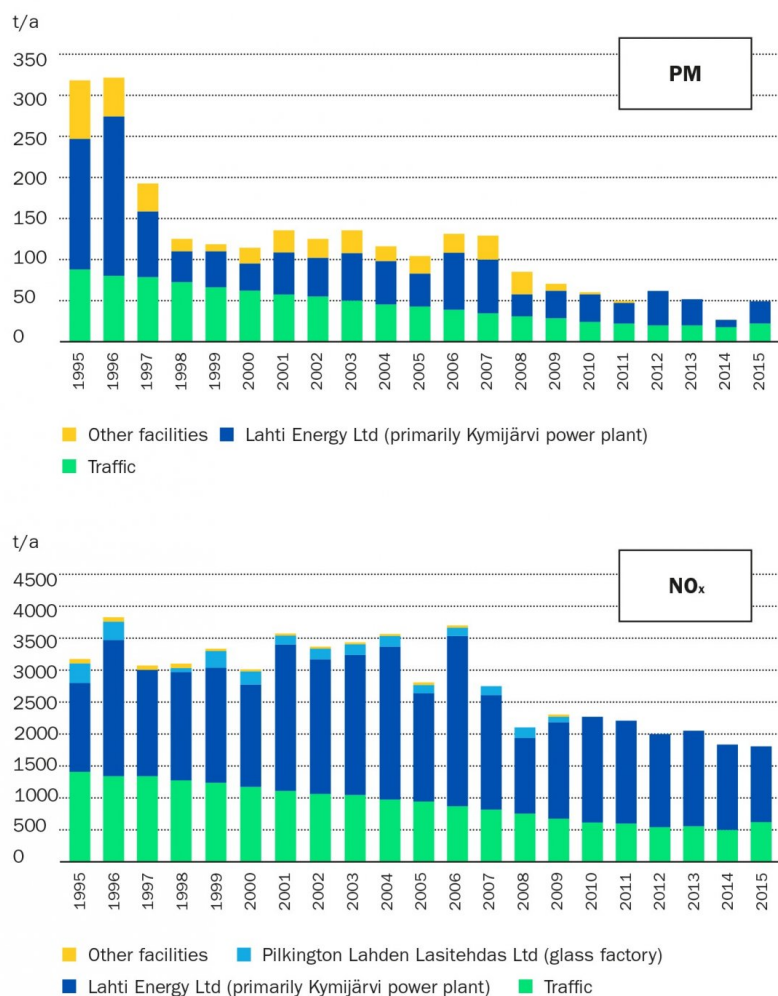


Figure B5. Significantly less particulate matter and NO<sub>x</sub> gases are emitted from traffic and industry today.

## 6C. Future Plans

Our vision is: “Lahti – Bold Environmental City”. Environmental protection is at the heart of this strategy and taking care of the environment is one of the five promises. Lahti will invest in a circular economy and in developing a carbon neutral and sustainable resource managed city. We are committed to increasing the use of public transportation, walking and cycling.

### Development Plan for Walking and Cycling 2025

We aim to achieve easy walking and cycling in the city. To promote sustainable transportation modes and lessen the negative effects of car traffic (e.g. pollution), three strategic goals have been set:

- 1) Changing attitudes.
- 2) Urban structure.
- 3) Infrastructure (Fig. C1).

The city is planning to launch a bicycle borrowing system (long-term goal). A preliminary long-term decision has been reached, whereby public transportation buses will be changed with electric buses and biogas will be enhanced in other logistics.

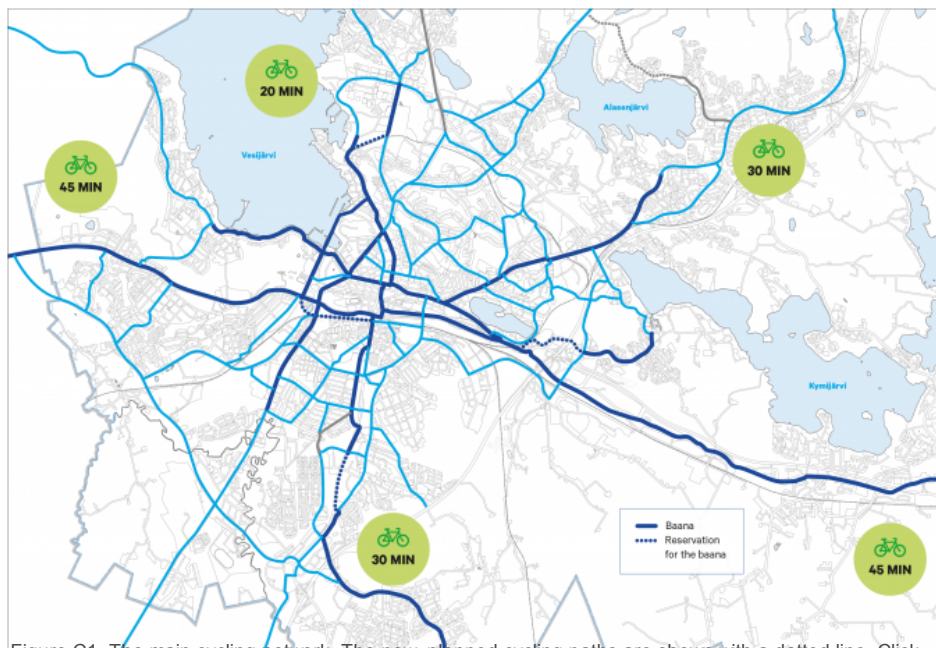


Figure C1. The main cycling network. The new, planned cycling paths are shown with a dotted line. Click map to enlarge.

### Better City Centre

The street network will undergo a change (Fig. C2). Vapaudenkatu Street is developed primarily for public transportation. Vapaudenkatu's two-way, high-quality cycling paths will be increased westward. Rautatiekatu Street (not highlighted on the map) will be further developed as a pedestrian zone. Most car traffic will be directed to an outer "circle" around the city centre, lessening traffic inside the circle (see also Fig. A1). This enables additional cycling paths (e.g. along Vesijärvenkatu Street) to be constructed.



Figure C2. Road network in 2020. The city centre is developed into a pedestrian zone.

### Directing Lorry Traffic Away from the City Centre

Construction of a bypass road will start in 2018. The bypass road will allow lorry transports to be directed away from the centre and enable the city centre to be developed into a pedestrian zone. Air pollution will reduce in the centre and on Mannerheiminkatu Road (currently main road no. 12, red line) can be developed into a normal city street.

Although the new bypass will not reduce total city traffic volume, it creates smoother traffic and promotes walking and cycling in the city centre, as well as reduces air pollutants in more people-dense areas.

### Sustainable Energy

The Sustainable Energy Action Plan (SEAP) includes measures for more sustainable heating and electricity production, energy efficiency, traffic and traffic planning, and increasing environmental awareness.

At least six new charging points will be installed by the Lahti City Group organizations.

In 2015-2018, Lahti Energy Ltd. invests 20 M€ in wind power, mainly on Finland's west coast.

Lahti Energy Ltd. and the City Council have decided that a new biofuel power plant, Kymijärvi III, will be built in Lahti and operational by 2020. In 2017, 40.53% of district heating was generated from renewable sources and, with the new biofuel power plant, it will increase to 80%. The investment will cost 150 M€. The old coal-operated power plant, Kymijärvi I, will be phased out, which will improve air quality by reducing emissions (SO<sub>2</sub>, NO/NO<sub>x</sub>, PM).

### Monitoring of Air Quality

Together with local businesses, we have decided to start monitoring benzo(a)pyrene B(a)P during certain periods in winter 2017-2018. Since benzo(a)pyrene comes from traffic and burning wood, it will be measured in an older residential area.

**Benzo(a)Pyrene ng/m<sup>3</sup>**

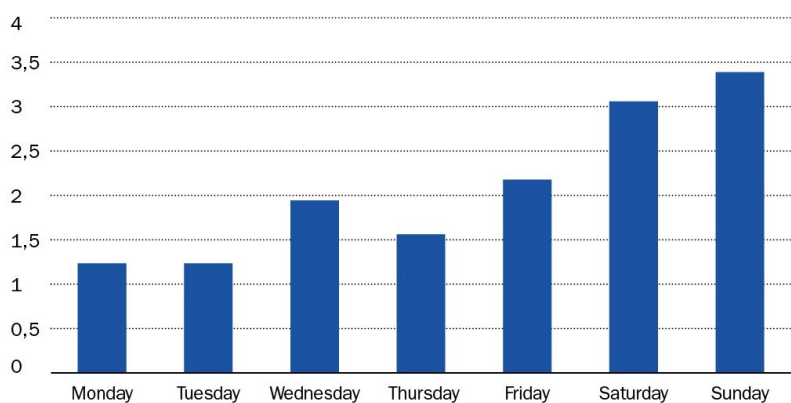


Figure C3. Preliminary results of Benzo(a)Pyrene measurements (winter 2017-2018) show increasing concentrations during weekends due to wood burned in fireplaces.

Lahti has joined the Smart & Clean Foundation. The Smart & Clean Foundation is setting up a comprehensive, city-wide, air quality system test bed in the Helsinki Region, which could also be set up in Lahti. This kind of air quality system would produce open data and enable targeted measures to prevent and lower air pollution and its consequences.

### Budget

In 2017, the Lahti City Group's expenditures on air and climate protection amounted to 5 M€, investments were 3.4 M€. We will continue to invest in keeping our streets clean, reducing pollution from power plants and reducing traffic.

### Public Information

There is a plan to put a mobile application (free of charge for users) into use where residents can access information on current air quality.

The National Air Quality Portal will be integrated into the national Finnish Meteorological Institute web pages at [www.fmi.fi](http://www.fmi.fi). It may improve visibility for inhabitants, as people tend to



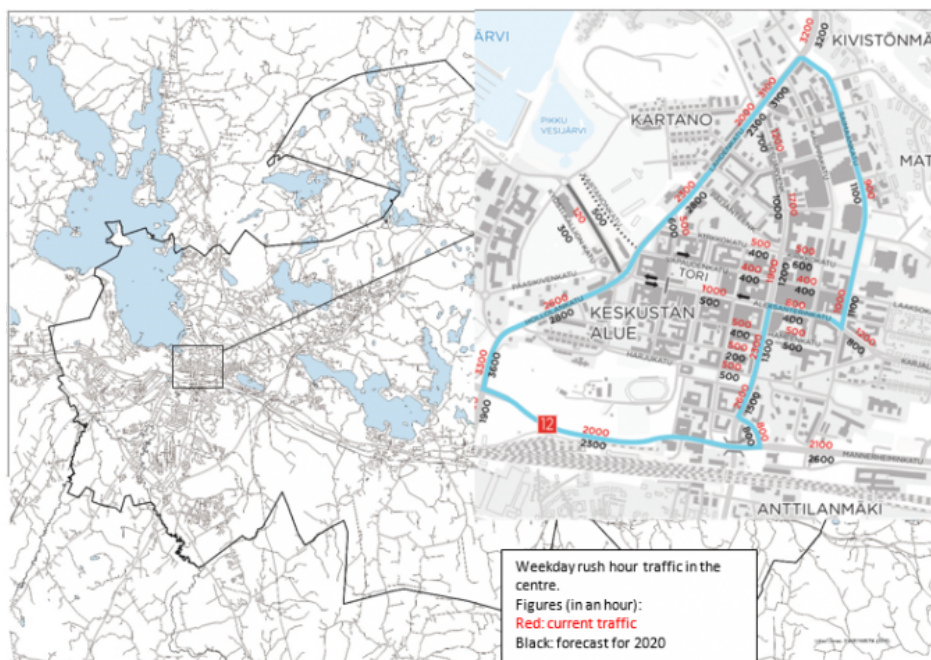
use the Finnish Meteorological Institute web pages to check the weather forecast. The new air quality service will replace the Air Quality Portal, by the end of 2017.

## 7. Noise

### 7A. Present Situation

Indicator		Unit	Year of Data
Share of population exposed to total noise values of $L_{den}$ above 55 dB(A)	28	%	2017
Share of population exposed to total noise values of $L_{den}$ above 65 dB(A)	4	%	2017
Share of population exposed to total noise values of $L_n$ (night noise indicator) above 45 dB(A)	29	%	2017
Share of population exposed to total noise values of $L_n$ (night noise indicator) above 55 dB(A)	17	%	2017
The percentage of citizens living within 300 m of quiet areas	41.4	%	2015

Lahti is small and green; the city centre is densely built (imperviousness approx. 65%). The urban structure is largely inherited from the 1950s-1970s. Major transport routes cut through the city centre (Fig. A1). A motorway (E75) bypasses the eastern part of Lahti. Smaller roads and railway routes intersect the city.



The E75 motorway affects the eastern part of Lahti. Traffic volume in city centre is high: about 20 000 – 38 000 cars on Main Road 12 (red square), 24 000 – 31 000 cars on Hollolankatu (left blue line) and 4 000 – 20 000 cars in the centre. The railway station is well used.

Traffic is the most significant noise source (Fig. A3). 19% of the population is exposed to total noise values of  $L_{den}$  (day, evening and night noise level) above 55 dB(A) due to road traffic and 9% due to railway traffic (Table A2). Only significant industrial noise pollution originates

from the Kymijärvi power plant (IPPC Directive location). According to the noise mapping in 2017, ~50 residents were exposed to Lden levels above 55 dB (A) due to industry (Table A2). Although the city centre is noisy, many building blocks have quiet courtyards. Excluding buildings that are partially located in more silent areas reduces the figures by approximately 1/3 but, the true figures are somewhere in the middle.

Table A2. The number of residents exposed to noise pollution (2017). Rounding of the numbers follow the rules of the directive.

Total noise value Lden			
dB	Road traffic	Railway traffic	Industry
45–50	33 800	13 100	700
50–55	30 000	13 400	300
55–60	13 400	7 500	0
60–65	5 600	2 300	0
65–70	2 900	600	0
70–75	900	0	0
> 75	0	0	0
Total: > 55	22 800	10 800	00
Night noise Ln			
dB	Road traffic	Railway traffic	Industry
45–50	21 400	13 000	200
50–55	7 900	6 100	0
55–60	3 300	1 600	0
60–65	1 000	600	0
65–70	0	200	0
70–75	0	0	0
> 75	0	0	0
Total: > 45	12 200	8 500	0

#### Noise Mapping before 2012 and during 2017

The city has comparable noise mapping data since 2012. In 2007, the E75 motorway and Main Road 12 were mapped. In 2004, the railway route noise levels were measured. In 2009, noise levels were measured for railway routes and city roads with over 5 000 cars/day (located outside the centre). The latter was updated in 2010. About 1/4 of residents were exposed to noise levels above 55 dB during the daytime, of which half in the city centre. Nearly 14 km of noise barriers should be built, costing approximately 20M€. Lahti is designing new actions based on 2017 mapping data.

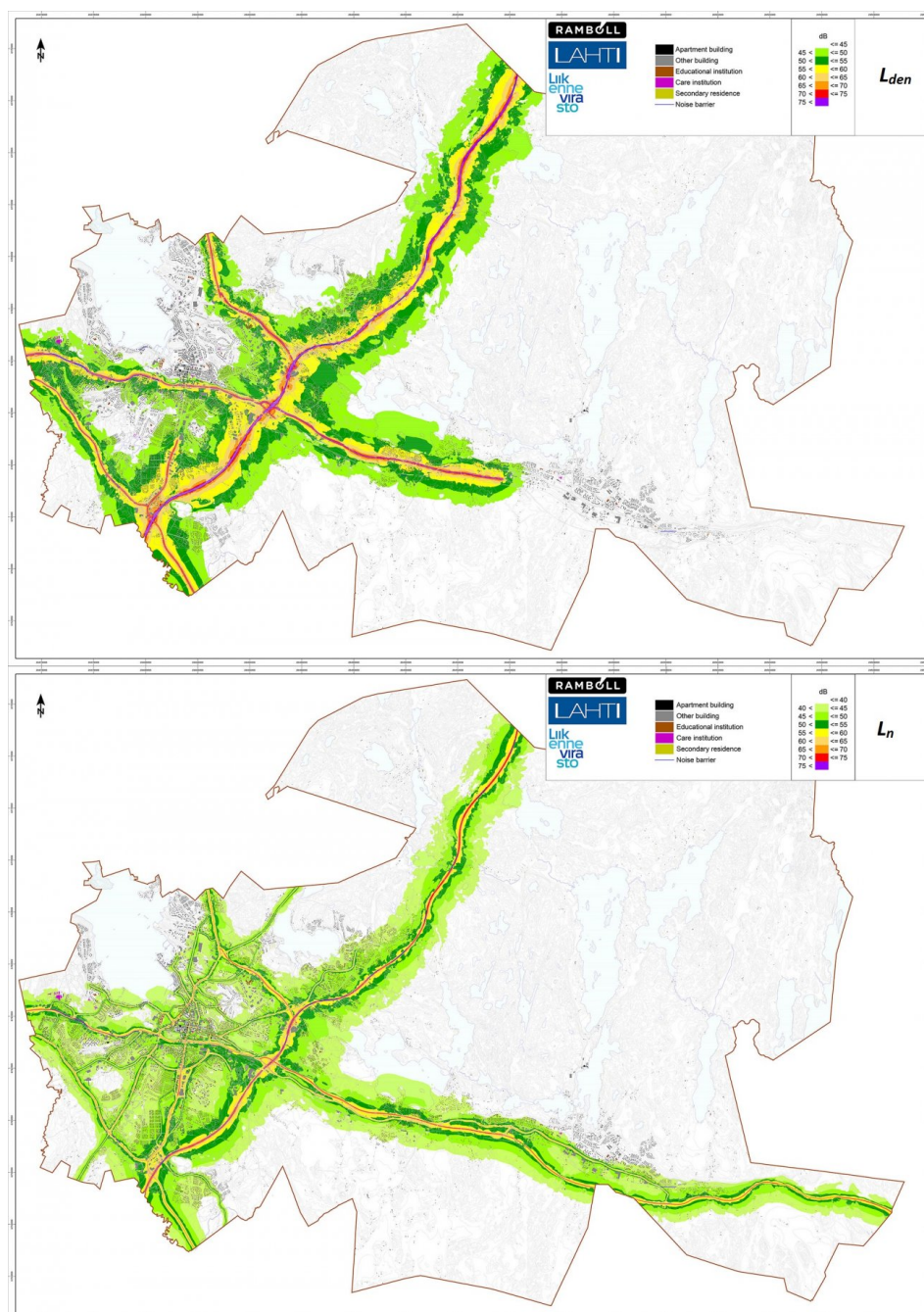


Figure A3. Traffic noise values of  $L_{den}$  and  $L_n$  (2017).

### Quiet Areas

Quiet areas were mapped in 2010 and updated in 2016 (Fig. A5). Lahti has many quiet areas with high recreational value. Although the largest areas are located further from the city centre, smaller high-quality areas are easily accessible from the city centre. Since Lahti has abundant quiet areas, sites smaller than 2 ha were excluded from the mapping. A quiet area was defined as an area with noise levels lower than 50 dB during the day or less than 45 dB during the night. 56 areas fulfilled the criteria. Noise levels in these areas are below 45 dB(A) or even < 40 dB(A). Quiet areas were divided into three: 1) quiet areas of high recreational or ecological value, 2) other quiet areas and 3) special areas. Lahti monitors the coverage of quiet areas every four years in the master planning process.

Continuous forests on the Salpausselkä ridge act as an important recreational and quiet area (Fig. A4).





Figure A4. Forests near the centre provide quiet areas for citizens.

In 2015, 41.4% of the population lived within 300 m of quiet areas, but in reality the figure is much higher. Besides quiet areas smaller than 2 ha, and quiet areas visible on the map, lakes serve as quiet areas (Fig. A5). During the summer, quiet locations on lakes are accessible by boat. During the winter, they are accessible by anyone.

#### Reducing Noise Pollution and Preserving Quiet Areas

A new Noise Abatement Action Plan will be adopted in Oct 2018. Measures for highways and railways are covered in the Finnish Transport Agency Noise Abatement Action Plan. Noise issues, such as reduction of car traffic, are considered in Lahti's Master Plan.

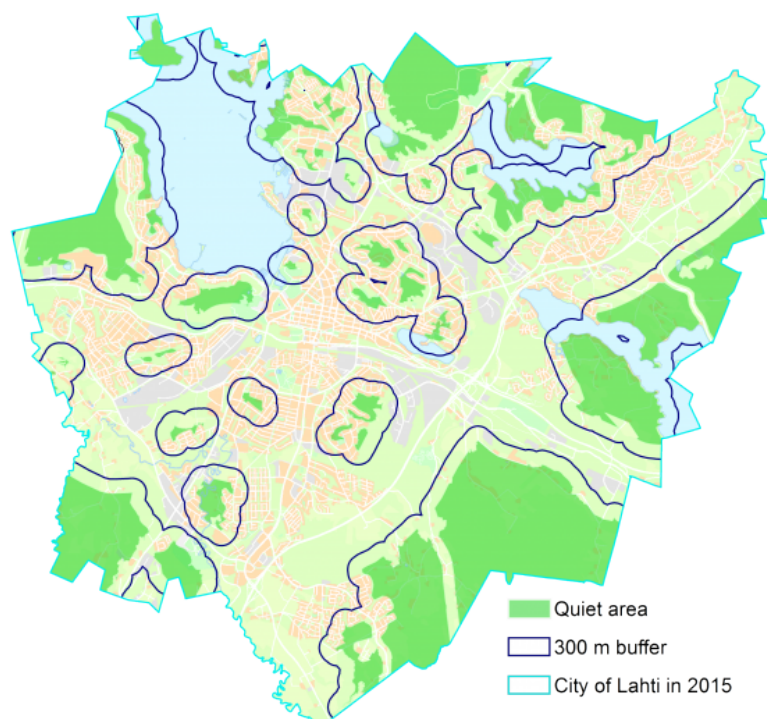


Figure A5. Quiet areas of Lahti city urban area.

## 7B. Past Performance

### Communication with Citizens

The noise mapping (2017) results and the Noise Abatement Plan are presented to residents at



public events. Quiet area and detailed noise maps, along with the Noise Abatement Plan and noise reports are available on our website [13].

Lahti has been arranging an Environmental Week for 22 years. In 2003, the whole week was devoted to noise issues, and included seminars and walking trips. During the 2016 Environmental Week, a public event was organized where residents were able to learn about quiet areas and noise levels.

### **Preserving Quiet Areas**

The city is striving to, at least, exclude first class quiet areas from construction.

### **Constructing in Noisy Areas**

Noise issues are carefully considered before constructing. If there is a possibility of high noise levels, noise must be thoroughly mapped. Solutions to achieve noise levels below 55 dB are decided site-specifically, including measures such as soundproof windows, noise walls, and sound berms, or arranging buildings in a way that they function as noise walls. If the property developer implements appropriate measures, the developer may receive benefits, such as a permit to construct more buildings on the plot. To consolidate land use and rehabilitate old industrial areas, we are developing the brownfields, adjacent to the main railway route, as mixed-use/residential areas. These areas are subject to higher noise levels. Hence, noise must be carefully considered.

Noise levels have been modelled for the Hennala area. Due to noise pollution, buildings should be arranged in an L or U shape, to provide quiet areas. High-rise apartment buildings are recommended to protect areas further from the railway. It is advised that buildings closest to the railway be used for businesses. The City of Lahti arranged a competition to find the best planning solution for Hennala. The detailed plan was enforced in January 2017.

### **Reducing Car Traffic**

To lessen noise pollution, emphasis is on reducing road traffic, i.e. the source of the noise. The Noise Abatement Action Plan measures include:

Developing the city centre towards a pedestrian zone:

- Car-free zones in the city centre (Lanunaukio in 2007). (Fig B1).
- 2012 Development Plan for Walking and Cycling 2025 [8].
- In 2013-2015, a parking garage for 600 cars was built underneath Lahti's market square and a number of parking spaces were removed from the streets. Reducing street parking increases the quality of urban space for pedestrians and enables development of the city centre towards a pedestrian zone (Fig. B2).
- Transformation of Aleksanterinkatu Street to a primarily pedestrian area, completed in November 2016 (cost 3.1 M€).
- Pedestrian paths are widened by taking space from cars.
- Installation of additional bicycle racks, adding space for up to 1 100 bicycles.
- Speed limits are reduced to 30 and 40 km/h on some streets.



Figure B1. Lanunaukio is one of the car-free zones in the city centre.



Figure B2. Lahti's city centre, around the market square, is undergoing a transformation.

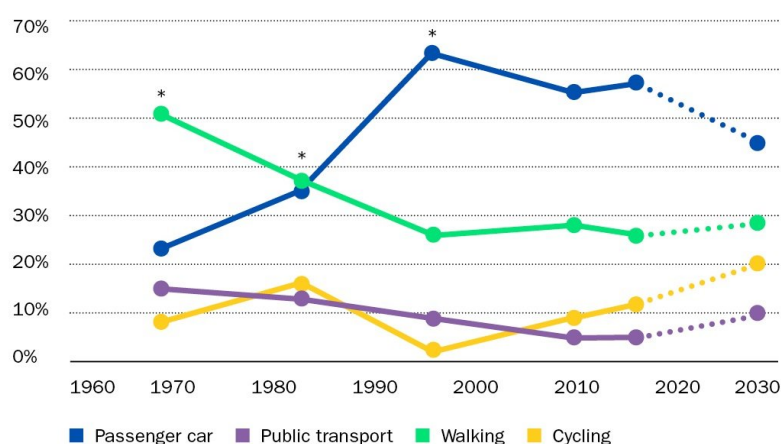
Promoting quiet transport modes and public transportation (Fig. B3-4):

- A bicycle friendly city: 532 km of combined pedestrian and cycling paths (2016).
- In 2014, public transportation was reformed. New routes were added (40% increase in kilometres) and service frequency was increased.
- In 2015, 82.8% of residents lived in the pedestrian/public transportation zone (maximum frequency for public transport: every 30 minutes; maximum distance to a bus stop: 250 m).
- Lahti's Master Plan concentrates on consolidating land use and ensuring a population density of at least 15 inhab./ha to enable good public transportation.
- A new Travel Centre was built in 2015 [11] that combines the railway and buses for a smooth transition between the different modes, along with parking garages for bicycles and cars (investment 18 M€).
- The City of Lahti owns 3 electric bicycles and 8 electric cars.
- There are about ten public electric car charging outlets, more are planned.
- A test-ride of electric bicycles was arranged by the city, in 2016, for local companies' workers and for residents (Fig. B3).
- Reducing speed limits close to sensitive areas (schools, residential areas) to decrease noise and increase safety.





Figure B3. We are promoting electric bicycles. E-bicycles are a viable option instead of traditional bicycles, due to Lahti's hilly landscape.



\* These are not comparable to 2010 and 2016 numbers due to differences in the research methods and period. Figure B4. The popularity of different modes of transport has varied, in the Lahti area, over the decades.

### Noise Barriers

Besides sound berms, Lahti has approximately 9.9 km of noise walls. These are mostly located by the E75 motorway and Main Road 12. Our Noise Abatement Action Plan includes constructing new noise barriers. New noise barriers are built to protect the most sensitive areas (e.g. kindergartens, schools, hospitals, residential areas) and the most noisy areas, as well as locations benefitting the largest number of residents.

- In 2016, construction of a new noise wall was completed on Tapparakatu Street (cost: 140 000 €), protecting a kindergarten and detached housing area (Fig. B5).
- Other planned noise walls (3 locations) will be constructed in Lahti during 2017-2018; detailed planning is completed or under way (see 6C).





Figure B5. The new noise wall in Tapparankatu protects the kindergarten and residential area.

## 2 in 1: Buildings as Noise Barriers

Constructing new buildings in locations with noise problems can reach two goals at once: 1) consolidating land use and 2) lessening noise levels by using the new buildings as barriers. Buildings are well insulated in Finland, so noise levels inside the buildings are very low. Apartment buildings are long and high, and function as a noise barrier protecting the areas behind them. For example, three long apartment buildings have been planned for Tapparankatu Street, with the first one already under construction. These buildings will reduce noise levels in the residential area.

## 7C. Future Plans

### Stakeholder Involvement on Noise Mapping

The new noise mapping was completed in 2017. The upcoming Noise Abatement Action Plan (2018-2019) will include measures to reduce the number of residents subjected to high noise values. For example, additional noise barriers will be built by the railway.

A new evaluation on health effects of traffic noise (Case Lahti) was performed by Ramboll Ltd (consultant) in cooperation with the National Institute for Health and Welfare. During Environmental Week of Lahti 2017, preliminary noise mapping results were presented to citizens.

### Noise Abatement Action Plan 2018

The action plan aims to lessen noise pollution and to especially protect residents from loud noise (> 65 dB), highly populated areas, schools and kindergartens, and quiet areas.

Actions to reduce noise pollution:

- Limiting car traffic (especially in the city centre).
- Lowering speed limits (to 30 and 40 km/h).
- Directing lorry transports away from residential areas.
- Land use solutions promoting public transportation, cycling and walking.
- Noise level criteria for public procurement: public transportation and other transportation.
- Noise mapping, together with planning processes.
- Locating excess soil, already in the planning processes, to reduce the need for noise barriers.
- Building Control pays attention to the realization of noise abatement measures on private properties (noise proof windows, glazed balconies, location of other buildings, such as garages, so that these lessen noise levels on the property, noise walls or sound berms).
- Using silent asphalt and renewing it.
- Constructing noise walls and sound berms.

A Noise Abatement Group monitors the implementation yearly. The plan is also updated

yearly, based on the city's construction programme and budget for the next year. [4]

### New Noise Barriers

Over the next two years, noise barriers will be constructed/improved on Ahtialantie and Hirsimetsäntie roads (estimated cost 2.4 M). Sound berms are built in Nastola to protect residents from railway noise. All noise barriers will achieve noise levels below 55 dB. About 517 residents and 300 children/students will be protected when these barriers are built.

After constructing the abovementioned noise barriers, new ones are planned for other parts of Kärpäsenkatu Street (close to Kiekkostenkuja Road and Kaivotontinkatu Street costing 157 000 € (Fig. C1), close to Harjunalustankatu Street for 179 000 €, and close to Okeroistentie Road for 147 000 €), Ahtialantie Road (close to Purorinteenkatu Street for 190 000 €) and Lahdenkatu - Mukkulankatu (Kivimaa School; 700 000 €). Noise barriers are also planned for the main railway route.



Figure C1. Long noise walls will be constructed along Kärpäsenkatu Street.

In new detached housing areas, space will be reserved for noise barriers, where excess construction soil can be used. The Noise Abatement Group has selected 10 preliminary sites where noise reduction will be managed through excess soil use, by 2021.

### Quieter City Centre

Besides Aleksanterinkatu Street, other streets will also undergo a change (Figs. C2, C3). Vapaudenkatu Street (adjacent to the market square "Tori" and parallel to Aleksanterinkatu) is being primarily developed for public transportation. Vapaudenkatu's two-way high quality cycling path will be increased westward. Rautatiekatu Street (not highlighted on the map) will be further developed as a pedestrian zone. Most car traffic will be directed to a city centre outer "circle", lessening traffic inside the circle. This enables additional cycling paths to be constructed (e.g. along Vesijärvikatu Street).



Figure C2. The main road network of Lahti city centre, by 2020.

#### Noise Reduction in New Developments

The currently enforced detailed plan for a new residential area between the railway and Main Road 12 emphasizes noise control. The plan prevents traffic noise from reaching the south and railway noise the north. Noise protected blocks are placed inside the area.

#### Lessening Noisy Transportation

Lahti is committed to improving the already very good cycling network (Fig. C3). Campaigns will be organized to advertise cycling. We are currently benchmarking smart bike-sharing concepts and intend to create a sustainable test platform for these new service concepts. A long term goal is to replace the current bus fleet with electric buses.

Constructing a bypass road (2018) will allow directing the lorry transport away from the centre. The new road will be partially located in tunnels or below ground level. Noise barriers will be constructed along the rest of the highway in Lahti. Directing the Main Road 12 away from the centre enables Mannerheiminkatu Road (currently Main Road 12) to be developed into a normal city street (e.g. lower speed).



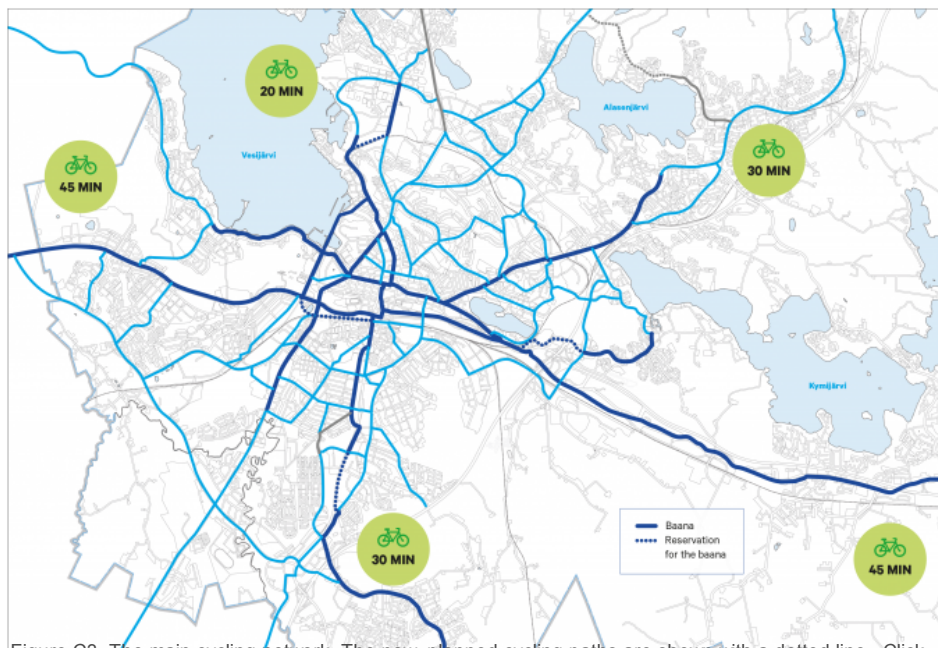


Figure C3. The main cycling network. The new, planned cycling paths are shown with a dotted line. Click to enlarge map.

### Active Marketing of Recreational Possibilities of Surrounding Nature

Lahti has a high-quality nature environment with numerous recreational possibilities for enjoying peaceful, quiet time (Fig. C4).



Figure C4. Lakes and forests, swamps and meadows – Lahti is rich in peaceful nature areas.

## 8. Waste

### 8A. Present Situation

Indicator	Type of Data (City/Regional/National)		Unit	Year of Data
Amount of municipal waste generated per capita	577 (Regional)		kg/capita/year	2017
Percentage of municipal waste that is recycled (including through composting and digestion of biowaste)	43 (Regional)		%	2017
Percentage of municipal bio-waste that is recycled (through composting and digestion)	90 (Regional)		%	2017
Percentage of municipal waste sent for energy recovery (R1 code)	52 (Regional)		%	2017
Percentage of municipal waste sent to landfill (or other forms of disposal (D codes))	5 (Regional)		%	2017
Percentage of municipal waste that is collected separately	54 (National)		%	2017
Percentage of recycled packaging waste	65 (National)		%	2016
Percentage of packaging waste that is collected separately	35 (National)		%	2012
Established collection systems for hazardous waste:	Type of Data (City/Regional/National)	Yes/No	Unit	Year of Data
i) WEEE	7.2	yes	kg/capita/year	2017
ii) Batteries	0.51	yes	kg/capita/year	2017
iii) Waste oils	0.47	yes	kg/capita/year	2017
iv) Household chemicals	n.a.	yes	kg/capita/year	data not found
v) Asbestos	4.3	yes	kg/capita/year	2017
vi) Construction & demolition waste	8.1	yes	kg/capita/year	2017
vii) Unused pharmaceuticals	0.07	yes	kg/capita/year	2017

### Finnish Waste Plan to 2023

The national waste management plan “From Recycling to Circular Economy” to 2023 sets out the objectives for waste management and prevention. Detailed targets and measures are set for four key areas: construction and demolition waste, biodegradable waste, municipal waste, and electrical waste and electronic equipment. Lahti belongs to the forerunner cities network of CIRCWASTE (Life IP 2017-2023), a project that implements national policy and pilots circularity models on an ambitious scope and timing.

### Prevention of Waste Production

Päijät-Häme Waste Company (hereafter: PHJ) has many campaigns, such as the 4-year BioBertta campaign, in the Päijät-Häme region, to reduce food waste. Food waste is also prevented:

- By organising biowaste reduction competitions at schools with municipality owned Päijät-Häme Catering Service Company
- Via the ResQ (private) app, where restaurants offer their left-over food. More than 45 restaurants in Lahti utilise this app.

The City of Lahti has an environmental counselling unit (8B).

PHJ’s “LOKKI” calendar, with waste information, is distributed yearly to all households and companies. PHJ’s website: Kierrätyskaista, where residents can sell, trade and give away usable goods, also includes a search feature to assist waste sorting.

### Reuse and Repair

Lahti has several recycling centres for usable goods. Flea markets are very popular and approximately 20 privately owned markets exist in Lahti (Fig. A1).



Figure A1. During summer, there are numerous flea markets at popular Lahti Harbour.

In 2016, the Kujala Waste Centre started accepting usable goods, in cooperation with PHJ and Lahden Työn Paikka Ltd, which offers work possibilities for long-term unemployed persons.

Repairing services exist in Lahti but, are relatively unknown or unreachable by its citizens. Lahti University of Applied Sciences created a joint service model for differential repair services and piloted it in autumn 2017. Nearly all pilot-customer feedback (+90%) was positive.

#### **Municipal Waste Management System**

- Sorting waste at the source (Fig. A2).
- Properties with  $\geq 10$  apartments: seven bins (biowaste, energy waste, mixed waste, carton, paper, metal and glass).
- Smallest residential buildings: at least two bins (energy waste and mixed waste) + recommendation to compost their own biowaste.
- Waste transportation organized by private transportation businesses, tendered by real estate owners.
- Producer communities (Rinki) organize producers' responsibility for waste (e.g. paper, packaging) (8B).
- PHJ's waste stations have hazardous waste containers and transportable compartments (e.g. campaigns for collecting furniture).





Figure A2. Waste is sorted where produced.

### Receiving and Processing Waste at Kujala Waste Centre

Päijät-Häme Waste Management Ltd. (PHJ) is in charge of municipal waste management for the City of Lahti. PHJ is a company owned by 10 municipalities and handles reception, processing and utilization of municipal waste (Fig. A3). The operation area covers approximately 200 000 residents. PHJ's operation management system is certified under relevant standards: ISO 14001:2015, ISO 9001:2015 and OHSAS 18001:2007.

PHJ is in charge of handling municipal solid waste that is not part of the producers' responsibilities. The households waste station "Pilleri" is located in Kujala. Since PHJ cooperates with producer communities, Pilleri also receives electronic waste, tyres, paper and packaging waste. Waste can be sorted into at least twenty different types.

Separately collected biowaste, garden waste and sewage sludge are composted in LABIO Ltd.'s biogas and composting facility. In 2016, the amount of municipal biowaste and garden waste was approximately 73 kg/inhabitant.

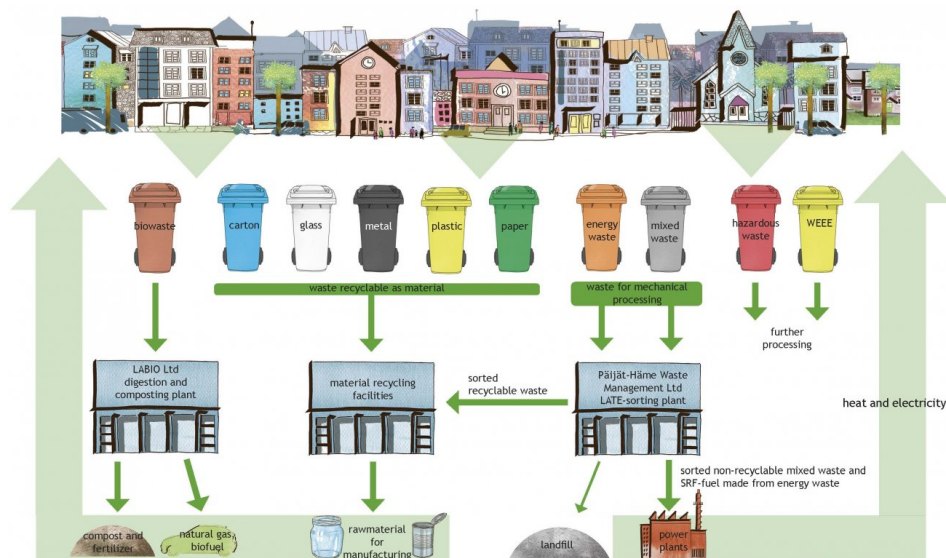


Figure A3. Processing and utilization of separately collected municipal waste (Source: PHJ). Click to enlarge image.

In 2017, the recovery rate was 97% for municipal waste, with 3% ending up in landfills (figures include all municipal waste from the area, except separately collected packaging/plastic waste or electronic devices received by stores). 42% of the total municipal waste was recovered as material.

PHJ is striving to achieve a 50% recycling rate by processing waste into raw materials for industry and by minimizing the amount of waste incinerated or taken to a landfill. The LATE sorting plant, is the first of its kind in Finland to tackle this issue (Fig. A4). The plant separates fibres, plastics and metals that can be recycled or further processed. The LATE sorting plant receives 250 tons of waste a day (66 000 tons per year).



Figure A4. Ballistic separator at LATE separates waste into 2D and 3D fractions.

#### Polluter Pays Principle

Finnish Waste legislation carries out the Polluter Pays principle by stating that one who pollutes, should also pay for it and take care of the cleaning. In Lahti it means that each waste producer pays for emptying their waste bins, based on emptying frequency.

Waste management is funded by waste payments and other waste-based incomes. Recycling is beneficial, as the household waste handling fee for unsorted mixed waste is higher than, e.g. the energy waste fee.

## 8B. Past Performance

#### Waste Production

Despite all our efforts to curb waste production, the generated amount of municipal waste (kg/inhab.) is still quite high (Fig. B1). The most effective measure for control of waste management has been regulation of municipal waste management (incl. sorting regulations) along with economic guidance and consulting.

The utilization level has increased considerably over the last 10 years (Fig. B1) and is now over 90%. Previously, the focus has been on utilizing waste as an energy source. Our future challenge is to raise the share of material recycling.

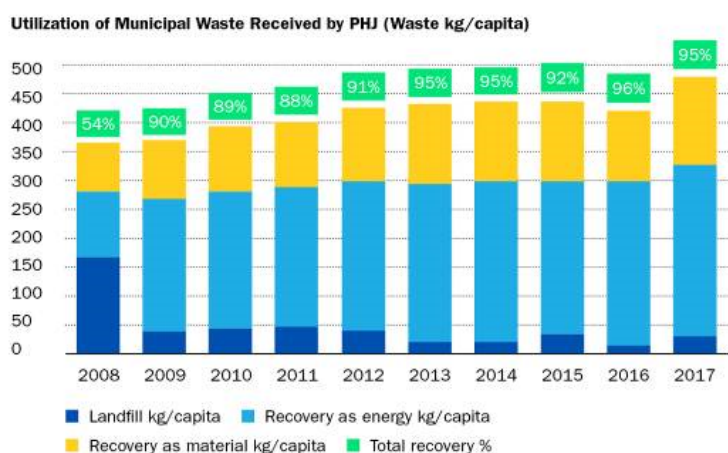


Figure B1. Utilization level of municipal waste 2008-2017. (Source: PHJ, 2018).

### Waste Prevention and Recycling

- Consulting events and campaigns are organized at kindergartens, schools, libraries, fairs etc. (Fig. B2).
- The environmental counselling unit of the City of Lahti advises residents at events. With the help of the special eco-van, Kaisla, residents throughout the Lahti region are reached (Fig. B2). Many NGOs and smaller municipalities around Lahti often use this service [10].
- We have many campaigns to encourage residents to sort waste. For example, with the “Luukuta oikein” campaign (2015-2016), Lahti Housing Ltd. succeeded in reducing the number of “mixed waste” bins and clarified the liability of waste management distribution for properties. The campaign covered about 5% of all residents of Lahti [11].
- It has been possible to keep the biowaste processing price lower than that for mixed waste processing. In 2016, the biowaste processing price was 79 € per ton, while it was 111 € per ton for mixed waste.





Figure B2. Waste sorting information given at the Lahti Environmental Week, Sept. 2017.

#### Trends in municipal and Packaging Waste Treatment

- Over the past 25 years, 15 landfills have been closed in the Lahti region.
- The municipal waste utilisation rate has significantly increased over the last 10 years (Fig. B1).
- In 2012, Kymijärvi II, an innovative waste gasification plant, and combined heat and power plant was completed (investment 165 M€).
- In 2013, Lahti Aqua Ltd. started utilizing the biogas generated in sludge processing. The energy is utilized for heating.
- In 2015, a new collection system based on the legislation of producer responsibility for packaging waste was started. National Rinki Ltd. is owned by the companies who pack or import packed products. Rinki Ltd has 53 Eco take-back points in the Päijät-Häme Region.
- The amount of separately collected biowaste has increased over the past ten years (Fig. B3). Approximately half of the residents are within the reach of separate biowaste collection, in the operational area (i.e. about 110 000 residents). Effective consulting and economical guidance have helped to achieve the good results [12].
- The composting facility started operations in 2005 (Fig. B4). The biogas production and refining plant, LABIO Ltd. (owned by Lahti Aqua Ltd. and Päijät-Häme Waste Management Ltd.), was completed in 2014, making it Finland's largest biowaste treatment plant. The investment totalled 17 M€.

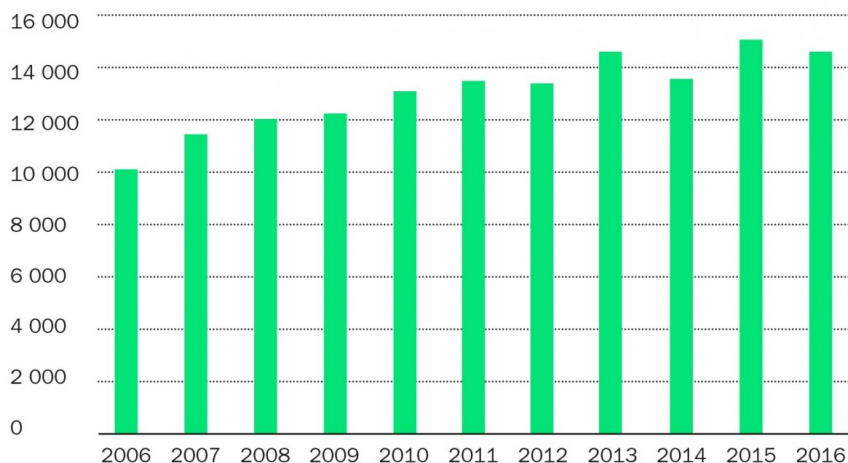
**Separately Collected Biowaste and Garden Waste 2006–2016 (tons)**

Figure B3. Separately collected biowaste and garden waste 2006–2016 (Source: PHJ, 2017).

### Evolution of Separate Collection Systems in Lahti Area

The strategic decision of offering a separate waste collection system for households was a pioneering solution, in the mid-1990's. Very few other cities in Finland offered a functional waste separation system at the time. Today, it is obligatory for residential buildings, of over than 10 apartments, to offer separate waste collection bins for 7 different waste segments: mixed, energy (plastic), cardboard, paper, glass, metal and biowaste.

### Infrastructure for Municipal and Packaging Waste Handling

Biogas production:

- The sludge is composted together with biowaste.
- After digestion, the mass goes on for composting and turns into soil.
- Biogas is sold to Gasum Ltd. to be utilized as fuel. There is one biogas fuel station in Lahti.

Lahti Aqua owns 35 biogas cars.

- The residual is composted and the end product is used to create soil or fertilizers.
- The facility can also process packed biowaste from grocery stores.
- The yearly capacity is 80 000 tons of biowaste and a biogas production of up to 50 GWh (9 million m<sup>3</sup>).





Figure B4. Biowaste from gardens waiting to go to the biogas and composting facility.

#### Liquid waste processing:

- Since 2007, different kinds of sludge (other than wastewater treatment sludge) have been solidified through the geotube process.
- Geomembrane – is a method where coagulation chemicals are used to separate the liquid and the solids. The liquid part is led to sewers.
- After PHJ, similar facilities have also been built elsewhere in Finland.

#### Recyclables sorting (2016):

- The LATE plant sorts recyclables (plastics, metals, and fibres) out of mixed, energy and construction waste.
- The goal is to increase material recycling. The facility is sized for 66 000 tons of waste. Recyclable materials are sorted based on different characteristics (e.g. shape, mass, size and magnetism). Various screenings and separators (e.g. NIR technology) are used.

#### Other Utilization of the Kujala Waste Centre:

- Tarpaper Recycling Finland Ltd. has operated in Kujala since 2015. It collects and handles roofing felt waste from the whole of Finland. The waste is processed into a bitumen mix that can be used in asphalt production. The Bitumen mix has an "end of waste" status (Fig. B5).
- Construction-based waste can be efficiently utilized in excavation works. Contaminated soil will be treated with screening and stabilizing. Stabilized soil can be used at the Kujala Waste Centre for landscape bank structures with an accepted environmental permit. Slightly contaminated soil and regular surplus land are used in closed landfill surface structures.



Figure B5. Turning bitumen roofing shingle waste into asphalt in Kujala.

#### City Economic and Regulatory Instruments

Waste management is funded from waste payments and other waste-based incomes. Each waste producer pays for emptying their waste bins, based on emptying frequency. It is costlier for consumers to not recycle, as the waste handling fee for households for unsorted mixed waste is higher than, e.g. the fee for energy waste.

The municipalities and Päijät-Häme Waste Board carry out the organizational responsibility of setting up municipal waste handling. The operational responsibility has been given to municipality-owned PHJ Ltd.

## 8C. Future Plans

#### Moving Towards Circular Economy in Lahti



One general challenge for local waste management is to achieve a more comprehensive picture of its entire waste production and utilization. Currently, we have good data on municipal waste (sources, utilization and development needs). However, we only know a little about industrial waste, agricultural waste and waste from construction businesses. A more wide-ranging picture that encompasses all waste production and utilization in the area is needed to minimize the current level of material loss (Fig. C1).

The solution to this problem is available. A circular economy roadmap of the Päijät-Häme Region was recently finalized and it includes a wide variety of different actions, covering a vast amount of different waste segments and businesses. The work was conducted by the Lahti University of Applied Sciences and began with a thorough analysis of material flows in the region.

The roadmap includes five general themes, each with a strategic goal for 2030. One of the themes includes material circulation. To implement these goals, each theme has from three to seven regional actions, for a combined total of 26.

The best practices of bio-based circular economy are identified and promoted by the BIOREGIO project in six European regions.

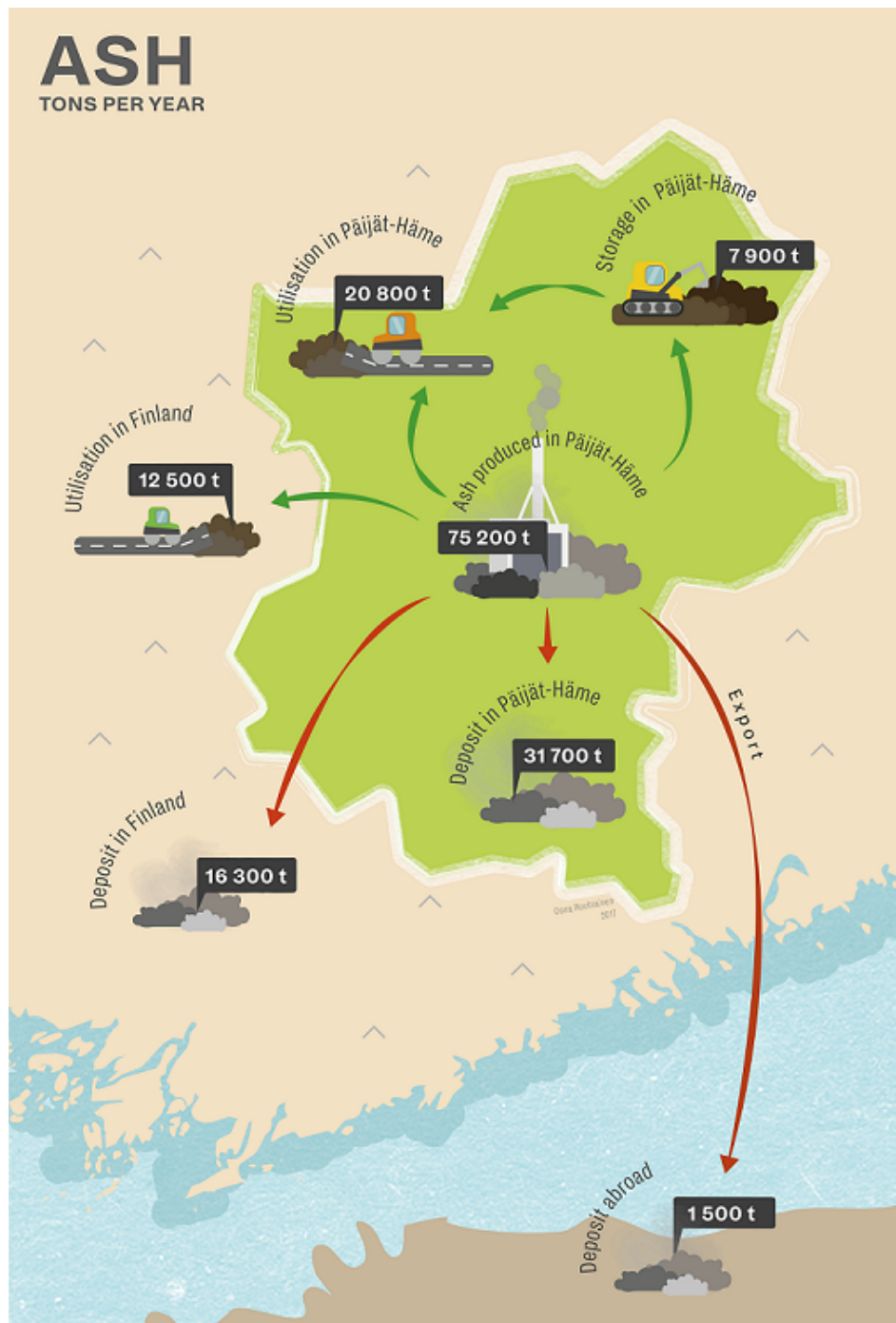


Figure C1. Example of material circulation in Lahti Region.

#### Future Management of Plastics in Lahti

The primary goal of waste management in Lahti is to increase the added value so that waste can be turned into saleable products/materials. The goal is to achieve a 50% recycling rate of municipal waste by 2020 (NOW: 38 %) (Fig. C2). A strong link to EU Plastic strategy goals (all plastic packaging material recyclable by 2030; consumption of single-used plastics reduced; microplastic evolution restricted) exists.

Valuable and recyclable plastic materials are already separated from the landfill and energy waste segments (Fig. A4). However, there are not enough markets for the recyclable plastics. Especially, dirty plastics derived from the mixed waste, do not appear to have a current value. To increase the recycling rate of plastic and packaging materials, differential packaging materials and plastics are need to be separated, as early on as possible. Therefore, Lahti will start to offer enhanced collection of plastic waste from all larger apartment buildings, by 2020. Currently “energy waste bins” (Fig. A3) are mandatory for all houses in the Lahti region, while “plastic waste collection (material recycling) bins” can only be found at Rinki collection

sites.

To further process the differential waste plastic segments into products, several new areas for this kind of business development are needed. Therefore, a new Recycling Park is currently under planning. Differential co-operation and scientific research supports the city area in achieving its circularity targets.

**Treatment and Utilization of Municipal Waste in 2016, 513 kg/resident**

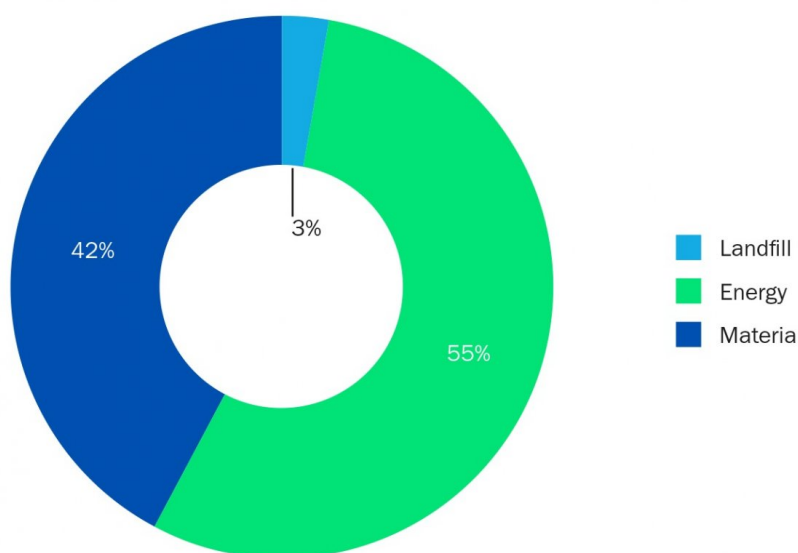


Figure C2. Nearly 100% of all municipal waste is recovered. The figure includes all municipal waste in the area, not only the waste collected by PHJ (Source: PHJ, 2017).

#### Preventing Food Waste Evolution

Currently City of Lahti is designing a new approach for the preventing food waste. For example, shared refrigerators for household leftover food are currently being discussed. Food waste prevention is also carried out in schools and kindergartens together with the Päijät-Häme Catering Service Company. Restaurants and food markets could co-operate more to reduce the amount of leftover food. A good examples is the Lahti Further Education lunch restaurant run by the school's student cooks, where leftover lunch food is sold to citizens.



Figure C3. In Lahti, food waste is also prevented in schools and kindergartens.

#### Other Measures to Increase Circularity in Lahti



One of our goals is to increase the amount of separately collected biowaste. Currently, we are studying how biowaste could also be collected from small properties in a cost-effective way. Based on surveys, mixed waste includes approximately 20% biowaste.

In October 2016, a joint development project by the City of Lahti and PHJ was initiated. In it, we are looking for sustainable solutions for utilization of leftover land. The main goal is to increase its reuse and find new uses, in addition to utilization in landfill structures.

The Kujala Waste Centre is also working on improving sustainable development through energy solutions. PHJ has an ongoing project, where the energy efficiency of the Kujala Waste Centre is to be improved. The goal is to design and acquire new energy efficient power production solutions that use renewable energy for both the Kujala Waste Centre area and nearby areas.



Figure C4. Soil masses are huge waste segments that we are increasingly utilizing as a resource.

The City of Lahti and the Finnish Sustainable Communities (FISU)

The City of Lahti joined the Finnish Sustainable Communities (FISU) network in 2016. Lahti applied to the network, signed the agreement and committed to working towards becoming emission-free and waste-free, and to curbing overconsumption by 2050.

## 9. Water

### 9A. Present Situation

Indicator		Unit	Year of Data
Domestic usage (drinking water) - litres per capita per day	119	Litres/capita/day	2017
Total usage (drinking water) - litres per capita per day	181	Litres/capita/day	2017
Water loss in pipelines	7.1	%	2017
Percentage (%) of total annual generated waste water load, connected to waste water collecting system + urban waste water treatment plants (UWWTPs)	>99	%	2017
No. of WWTP	3	Number	2017
Total design capacity (Population Equivalent - PE)	Kariniemi 130 000	PE	2017
	Ali- Juhakkala 120 000		
	Nastola 22 000		
Total load received by UWWTP (PE)	Kariniemi 107 700	PE	2016
	Ali- Juhakkala 77 000		
	Nastola 20 300		
Connection rate	>99	%	2017
Treatment level which is applied in each UWWTP: secondary or more stringent; in this case, type of treatment: nitrogen and/or phosphorus removal, disinfection etc.	Kariniemi, Ali- Juhakkala: primary, secondary (active sludge) and tertiary. UV disinfection. Iron (ii) sulphate for removing phosphorus.	Treatment level	2017
	Nastola in 2016: primary, secondary		

### Drinking Water

Lahti Aqua Ltd (part of Lahti City Group) is in charge of drinking water and waste water management [1]. Groundwater is used as only drinking water source. In 2017, 95% of water users were connected to the municipal network and subjected to water metering, and the total water consumption was 7.5 Mm<sup>3</sup> (approx. 45 m<sup>3</sup>/capita/a) compared to 7.8 Mm<sup>3</sup> (approx. 79 m<sup>3</sup>/capita/a) in 2006 (Fig A1). Water consumption has mainly decreased as a result of decreased use by apartment building residents, industry and the service sector. In 2006, residents consumed 139 litres/capita/day compared to 119 litres/capita/day in 2017. Today, 7.1% of water is lost in pipelines (Fig A2), while in 2006, the loss was nearly 11%. Effectiveness is achieved using modern control and digital information systems. The energy consumption of drinking water production was 0.69 kWh/m<sup>3</sup> in 2017 (Fig. A3).

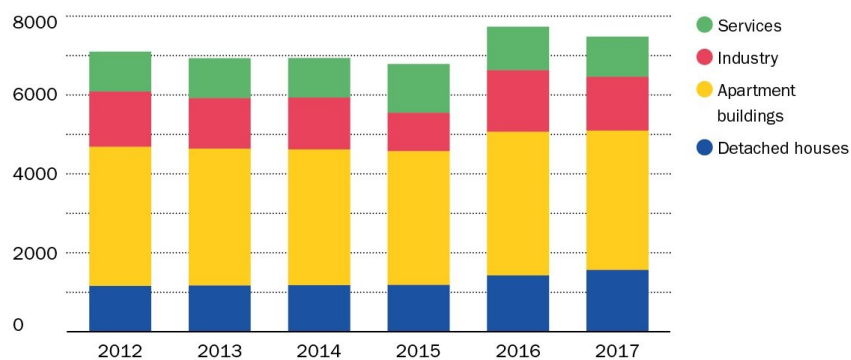


Figure A1. Total water consumption by different sectors/users (1000 m³) 2017.

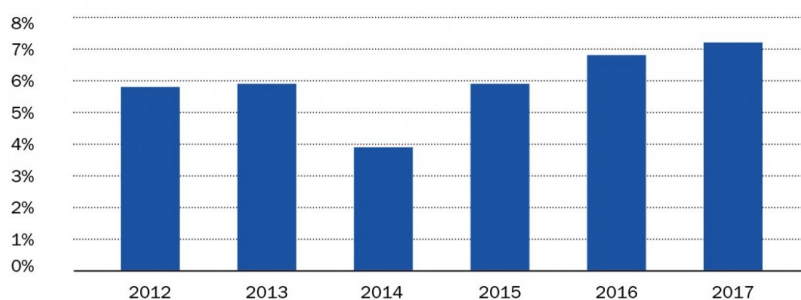


Figure A2. Water loss in pipelines in Lahti (%) 2017.

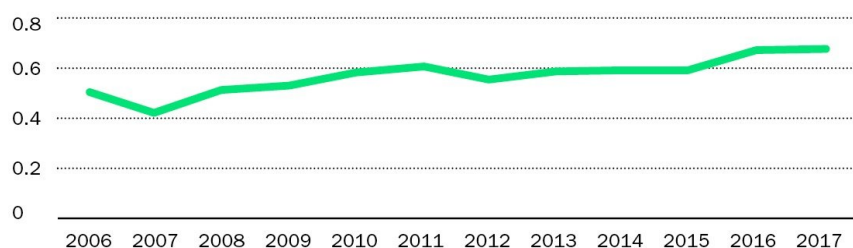


Figure A3. Energy consumption of drinking water production in Lahti (kWh/m³) 2017.

Drinking water quality is excellent. In 2010, 98% of the samples complied with the quality standards. Lahti Aqua has upgraded the purification technology, and in 2017, 100% of the samples complied with the quality standards (Drinking Water Directive). Due to the groundwater's good quality, only minimal treatment is needed. The groundwater in Lahti is soft (pH 6.5). Therefore, calcium oxide or sodium hydroxide (50%) is added to prevent pipeline corrosion. Bacterial growth is prevented with a small amount of sodium hypochlorite (10%) or ammonium chloride. All water towers are equipped with UV water purification systems.

#### Wastewater Collecting Systems

Virtually all urban areas have separate sewers for storm water and wastewater. In 2017, Lahti had 767 km of wastewater sewers and 454 km of storm water sewers. Combined sewers remain in the area adjacent to the Lahti Market Square. The amount of storm water runoff, from this area, has been estimated by Lahti Aqua as being approximately 50 000 m³/a (1% of the runoff from the city centre).

#### Storm Water Management and Floods

The Storm Water Management Plan (2012) promotes the use of sustainable drainage systems (SuDS) [3]. For all new development areas and sites, a specific plan must be presented for storm water management. Alternative solutions are often necessary in the southern parts of Lahti, due to the soil type (clay/silt).



Flood risk areas were mapped, for Lahti, in 2010. Possible flooding is not expected to cause significant damages, since vulnerable areas are generally not inhabited and are excluded from future construction.

**Water Bodies**

The Lake Vesijärvi and seven other lakes have a “moderate” status, six lakes have a “good” status and one has a “poor” status. There has been a Vesijärvi Action Plan since 2009, and a regional action plan to improve the condition of rivers and lakes. There are four rivers in Lahti, two have a “moderate” status, one has a “good” status and one has a “poor” status.

A Water Management Plan (2010) is in place to develop water management.

**Quantity of Wastewater**

The quantity of wastewater has decreased: 7.5 Mm3 in 2017 and 8.4 Mm3 in 2006 (Fig. A4).

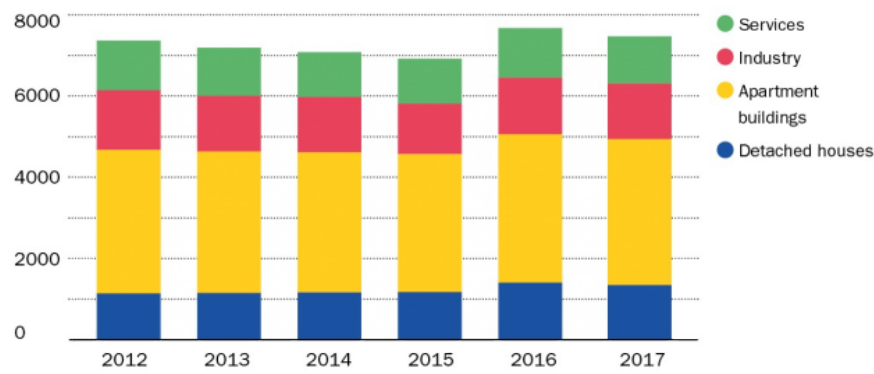


Figure A4. Generated wastewater, by sector, in Lahti (1000 m³).

94.6% of households were connected to a sewage network in 2016. Close to 2 000 citizens or 600 buildings in the rural areas of Lahti used onsite sewage facilities. The methods vary from simple septic tanks to modern facilities. The most common method is a combination of a septic tank and a drainfield, which results in about 80-90% of nutrients from wastewaters being removed. Sewage sludge from tanks is transported to UWWTPs. Properties that are situated within the sewage network area must connect to the sewage network system (Fig. C1).

**UWWTPs**

Table A5. Waste water treatment 2011-2017.

	Unit	2012	2013	2014	2015	2016	2017
Total wastewater load Lahti	Mm³/a	7.4	7.2	7.1	6.9	7.7	7.5
Wastewater load Kariniemi	Mm³/a	7.8	6.7	6.1	6.1	5.6	6.3
Wastewater load Ali-Juhakkala	Mm³/a	6.9	5.8	5.3	5.4	5.1	5.5
Wastewater load Nastola	Mm³/a					1.1	1.0
Treated total	Mm³/a	14.7	12.5	11.4	11.6	11.9	12.8
Energy consumption	kWh/m³	0.60	0.67	0.77	0.73	0.82	0.76
Generated sludge (dry)	m³	13 769	11 978	12 103	11 420	15 131	14 647
Sludge gasification	%	26	28	28	29	25	25
Generated gas	Mm³/a	2.95	2.72	2.73	2.3	2.6	2.6
Gas utilization	%	100	100	100	98	99	100
Incoming loads Kariniemi							
BOD7	t/a	2685.8	2670.0	2612.0	2751.2	2768.2	2866.3
COD	t/a	5196.6	5163.4	4797.6	5186.9	5051.6	5440.7
Ntot	t/a	498.5	467.4	469.1	462.8	349.7	375.9
Ptot	t/a	67.1	63.7	60.5	60.3	50.7	54.0
Incoming loads Ali-Juhakkala							
BOD7	t/a	2823.4	2174.7	1849.5	1964.3	2341.5	2428.3
COD	t/a	5367.7	4189.2	3958.0	4131.5	4985.9	5312.2
Ntot	t/a	366.0	320.5	336.6	361.3	375.6	421.6
Ptot	t/a	54.7	51.5	50.9	49.2	49.3	55.8
Discharged loads Ali-Juhakkala and Kariniemi							
BOD7	t/a	89.8	74.5	73	52	43	60
COD*	t/a					394.2	587.3
Ntot	t/a	237	235	221	170	125	169
Ptot	t/a	3.3	3.3	2.6	1.8	1.9	2.3
Incoming loads Nastola							
BOD7	t/a					527.4	463.2
COD	t/a					1080.4	1277.5
Ntot	t/a					85.41	79.9
Ptot	t/a					13.1	12.0
Discharged loads Nastola							
BOD7	t/a					2.2	2.2
COD	t/a					30.7	36.1
Ntot	t/a					16.1	11
Ptot	t/a					0.25	0.37

Since Kariniemi's and Ali-Juhakkala's waste waters are directed to Nikula's waste water equalization basin (9B), discharged loads are combined, with \*COD n/a.

## 9B. Past Performance

### Reducing Water Consumption

The reduction in water consumption is performed by improving metering and appliances, tariff policies, and raising awareness:

- The "Water School" website for children: water consumption, purification and wastewaters (Fig. B1).
- The water saving competition by Lahti Housing in 2012 and 2014; reduced consumption 10-19%.
- Water prices have been raised to cover running expenses and the upgrading of pipelines, and to motivate reducing water consumption.
- Water losses in pipelines have been reduced (9A).



Figure B1. Primary school children measuring pH Values of surface water at Likolampi Pond.

### Quality of Drinking Water

Lahti Aqua has renewed water towers and added UV water purification systems. In 2013-2015, the Laune well was upgraded, to remove pesticides from the groundwater, with an activated carbon filter and a UV water purification system. Groundwater protection plans are in place for all wells. Lahti Aqua hands out information guidelines about permitted and prohibited activities on groundwater areas.

### Groundwater

Since 1990, groundwater protection has been coordinated and implemented by a Groundwater Workgroup. The first groundwater protection plans were implemented in 1995 (Lahti) and 1999 (Nastola). Examples of actions:

- Oil tanks cannot be installed underground in important groundwater areas and the existing ones need to be inspected at least every 10 years.
- Oil tanks have been mapped (2012-2015).
- Since 2015, companies that are not required to have an environmental permit are checked for activities that could impair groundwater bodies.
- All springs were mapped in 2016.
- Protecting groundwater is carefully considered in the Master Plan (2016).
- 2017, road salt (NaCl) was replaced with a biodegradable EcoMelter product (potassium and sodium formate) in the centre, increasing costs 250-300 000 € yearly.
- The contaminated soil underneath the Market Square was cleaned in 2013-2015 (Fig. B2).
- Lahti has invested about 3.5 M€ for cleaning contaminated land, over the past 10 years.
- Biocides are only allowed, with a special permit, if other measures have failed (no biocides used in 2015-2017). A non-toxic hot foam system has been tested for controlling weeds and invasive plants.





Figure B2. Outdoor drinking water fountain was created after building the Lahti Market Square underground parking.

### Increasing Capacity

Construction of a UV disinfection facility in Nikula was completed in 2015. All purified wastewater from two UWWTPs are directed to Nikula's wastewater equalization basin (Fig. B3) and disinfected before release into the Porvoonjoki River. Permits require a purification efficiency of 90%, and Lahti Aqua Ltd aims to reduce the load of bacteria so that the treated wastewater is in a good state, according to the Finnish bathing water ordinance (EU Bathing Water Directive); an investment of 2 M€.

To increase the efficiency of the biological treatment, Lahti Aqua upgraded the operation of the aeration basins in 2010-2012; an investment of 0.3 M€.



Figure B3. The wastewater equalization basin in Nikula (Source: Lahti Aqua Ltd, 2015).

### Maintaining the Network

The total network was 2 053 km in 2016, with 584 km gained from Nastola. Freezing temperatures may cause pipes to burst. Maintaining the network is crucial to prevent accidental pollution. Due to the hilly landscape, Lahti Aqua Ltd has pumps to direct wastewaters towards UWWTPs. In 2011, a project to upgrade the pumps was initiated, with an investment of 1 M€. In 2015-2016, six other pumps were upgraded. The renewal of the wastewater monitoring systems and pumps was completed in 2012. All wastewater pumps

have monitoring systems and backup solutions. In 2017, 3.1 km of network and 3 pumps were renovated.

In 2013-2017, Lahti Aqua has built a backup system for the tunnel directing treated wastewaters from the Kariniemi UWWTP to Nikula. This ensures that waters are disinfected before being released into water bodies; an investment of 5 M€.

The sewer network is constantly widened to cover new residential areas and to reach households using onsite sewage facilities. In 2010, Lahti Aqua drafted a plan that covers the renewing and widening of the pipeline network stretching to 2030; an investment of 2.9 M€ in 2016.

#### Citizen Engagement

We have been restoring Lake Vesijärvi, since the mid-1970s, in co-operation with several municipalities, universities and other research organizations. The yearly restoration investment is over 250 000 € and is covered by the City of Lahti, Lahti Aqua Ltd and Lahti Energy Ltd. Past measures included improving wastewater treatment and biomanipulation. The current restoration stage involves mapping pollution sources, eliminating wastewater sources from private dwellings, constructing retention ponds and wetlands, aeration and biomanipulation (Fig B4). In the past, Lake Vesijärvi was not suitable for swimming, but today, it has many public beaches.

River conditions are improved through SuDS. The river's condition (including water quality, fish, fishing and benthic fauna) has been monitored, together with other municipalities, companies and non-governmental organizations, for over 20 years. The fraction of cyprinids has lessened and the population of more demanding fish has increased.



Figure B4. Restoring Lake Vesijärvi is a long, but successful story.

Further actions to improve water bodies:

- 2012-16: The "Jokitalkkari" project aims to improve river conditions so that salmonid populations will increase or return.
- 2017, 2018: The "Jokitalkkari"; The previously canalized stream site was restored and a small fishway was constructed at the Seestaanjoki River at two locations.
- 2016: Lahti Catering offered fish patties to children at school made of Lake Vesijärvi's roach.
- 2016-2018: Lake Vesijärvi Week, used to bring residents, companies and organizations together and increase the conception of the lake's value with events and activities.
- Monitoring and management of small lakes.
- Lake Kymijärvi management agreement and research projects.
- Every year, we stock Lake Vesijärvi with 10 000 critically endangered eels, and then to



secure their migration, they are caught and moved to the Gulf of Finland.

- Waste water counselling project.

### Circular Economy

The biogas production and refining plant of LABIO Ltd (owned by Lahti Aqua Ltd and Päijät-Häme Waste Management Ltd) was completed in 2014, making it Finland's largest biowaste treatment plant; at an investment of 17 M€:

- The sludge is composted with biowaste.
  - After digestion, the mass goes on for composting.
  - Biogas is sold to be utilized as fuel. Lahti Aqua owns 35 biogas cars.
  - The residual is composted and the end product is used to create soil or fertilizers.
  - The yearly capacity is 80 000 tons of biowaste and a biogas production of up to 50 GWh.
- Sewers Are Not Garbage Bins

Lahti Aqua informs residents, via the media, about not throwing food and other waste into the sewer network, to avoid blockages. The City has an environmental counselling unit and a special eco-van Kaisla, which enables us to advise residents all over the region and at various events. Päijät-Häme Waste Management Ltd distributes a calendar to serve as a waste management information package.

### Sustainable Stormwater Management and Treatment

Sustainable drainage systems (SuDS) are important for adapting to climate change and improving the quality of water bodies. About 1 500 kg of phosphorus and 12 000 kg of nitrogen are added to Lake Vesijärvi through stormwater, yearly.

Over the past 10 years, we have constructed about 20 retention ponds or wetlands (Fig. B5). Our SuDS are estimated to reduce nutrient loads efficiently. Green roofs are promoted.



Figure B5. New stormwater retention pond in the Länsi-Hennala area.

## 9C. Future Plans

### Water Management Plan

Main goals of the Water Management Plan (2010):

- Comprehensive risk management.
- Upgrading and renewing pipeline networks and equipment and their monitoring and management.
- Upgrading and renewing UWWTPs, ensuring sufficient purification levels and energy

efficiency.

- Improving the network of separate sewers.
- Connecting 100% of buildings that are in use most of the year (Fig. C1).
- Ensuring good water management for residents outside the public network.
- Processing sewage sludge sustainably and energy efficiently.
- Improving operational reliability during electricity shortages.
- Managing heavy rain events by delaying and planning flood routes.
- Lessening the negative impact of storm waters on water bodies.

One of our future challenges is how to treat microplastics. University of Helsinki is currently researching how to treat storm waters with plant fiber to prevent microplastics discharge.

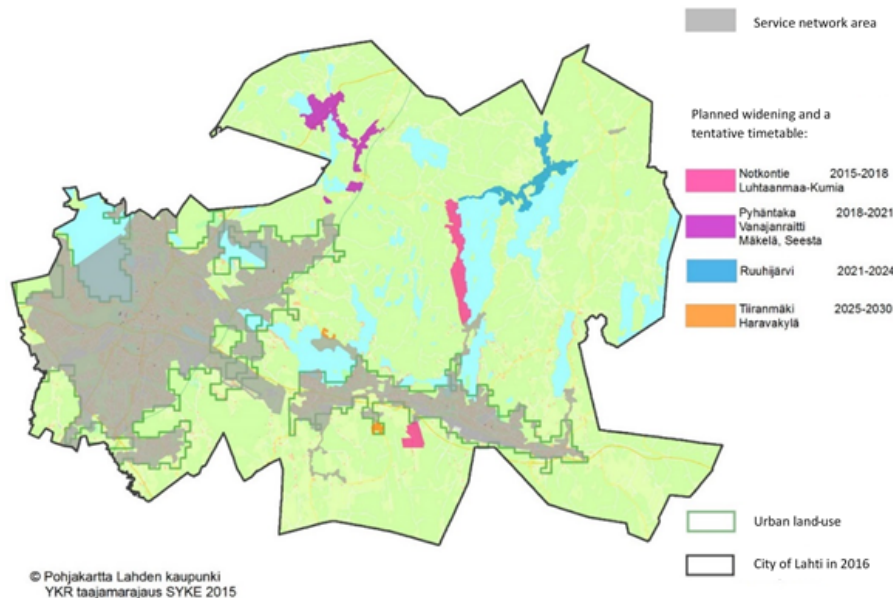


Figure C1. The service network: existing network and planned widenings. All investment costs are covered by the sewage charge.

### Improvement and Maintenance

Lahti Aqua is aiming to lessen leakages by monitoring the condition of pipelines and renewing pipes. Blockages are unclogged with a high-pressure water jet. Lahti Aqua's Plan for Developing Sewer Network (by 2030) aims to maintain the sewage network in good condition. The annual allocation is 4.5-5 M€.

### Climate Change and Urbanization

Urbanization, land use densification and climate change are a reality in Lahti. Heavy rainfall events caused flooding of some locations, including the city centre, in July 2004 and 2018.

Managing heavy rain events will be enhanced by improving the current separate sewer network, and delaying and planning flood routes. If technically possible, the storm water should be infiltrated on site. As a result, loading on sewer networks and water bodies will be reduced, while also enabling groundwater levels to recharge (Fig C2). New developments should consider SuDS or NbS. New retention ponds or wetlands will be constructed in new urban residential areas.

UWWTPs of Kariniemi and Ali-Juhakkala have a sufficient capacity to manage the increased wastewater loads from an increasing population. The current assessment for 2020 is based on data from 2005-2007. Lahti Aqua requires separating property owners' storm water from wastewater, when pipeline networks are upgraded.



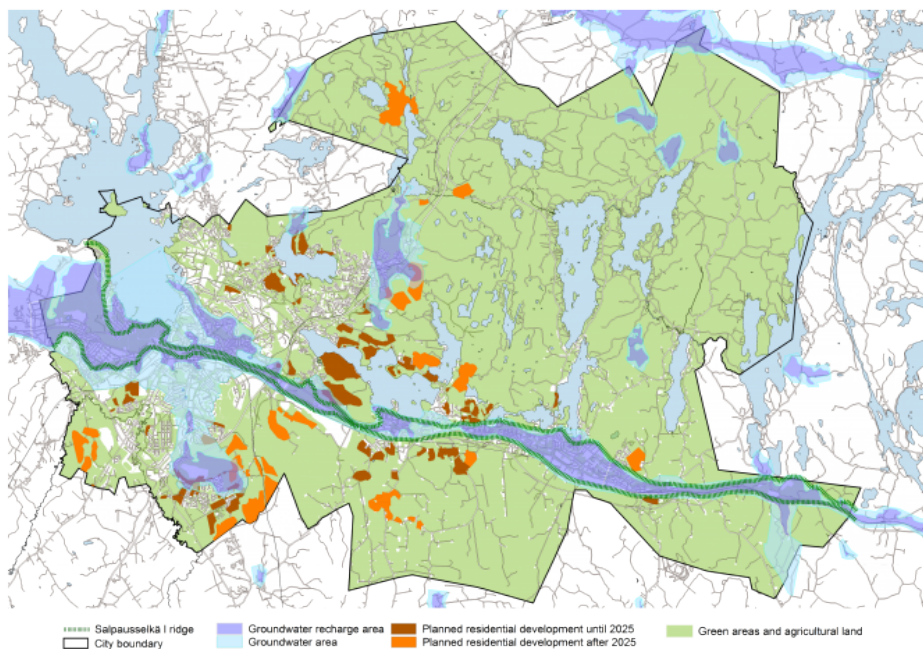


Figure C2. Groundwater bodies in the City of Lahti. Click map to enlarge.

### Regional Groundwater Protection Plan

The plan includes an extensive list of measures to improve groundwater quality, but it takes a lot of time. The groundwater body of Lahti can be cleaned to a good state by 2027 and other groundwater bodies by 2021. Measures include:

- Directing gasoline stations and other risky actions away from groundwater recharging areas.
- Rehabilitating quarries immediately after mining has stopped.
- Cleaning and removing old oil tanks.
- Installing additional groundwater protection systems along roads.
- Connecting remaining households to municipal water networks.
- Avoiding further construction on the Salpausselkä I Ridge (Fig. C2, C3).
- 2018, use of EcoMelter (potassium and sodium formate) to replace road salt (NaCl) continues in the centre, increasing costs 250-300 000 € yearly. 2019-2020 area to use EcoMelter will be extended.



Figure C3. We avoid construction on the valuable Salpausselkä ridge system.

We have initiated a project to apply for status as a UNESCO Global Geopark for the

Salpausselkä Ridge around Lahti (C3).

Clean Surface Waters

Climate change is well-considered in measures for achieving or maintaining the good state of water bodies. Rainfall is expected to increase significantly and winters will be warmer (less snow), resulting in increased urban runoff. Then again, spring flooding from melting snow will probably lessen. Lahti is aiming to manage the heavy rain events by delaying and planning flood routes.

Our Storm Water Management Plan aims to:

- Improve storm water management (i.e. avoid floods and ensure that building foundations remain dry).
- Ensure groundwater quality and recharging.
- Improve storm water quality and reduce negative impacts on receiving water bodies.
- Add biodiversity and increase its value.
- Improve co-operation and knowledge of storm water issues.
- Develop new best practices.

New construction projects in the city must follow the requirements set by the plan.

Several measures are being planned to reduce storm water pollution. The new residential area, within the city centre (Fig. C4), will be built utilizing the recent knowledge of NBS (Fig. C4-C5). Additionally, an auxiliary transport pipeline, which is under construction, will provide the option of redirecting storm water overflows, from the city's two largest storm water sewers, to nearby constructed wetlands, where adequate capacity exists for their retention, infiltration and filtration [20]. It will be carried out in co-operation with the University of Helsinki's Department of Environmental Sciences and the Lake Vesijärvi Foundation.

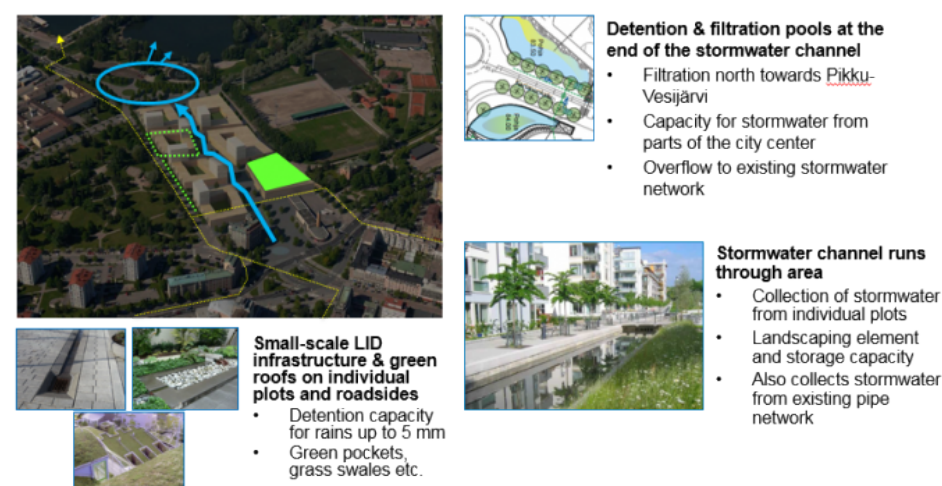


Figure C4. The planned SuDS system to Ranta-Kartano. It can also treat stormwaters from the city centre.



Figure C5. A modern and sustainable new residential area, in Lahti's city centre, with state-of-the-art storm water management systems.

#### Investments and Budget

Specific actions and measures are determined yearly and based on the budget, strategies and plans. In 2017, Lahti City Group used 9.6 M€ for water protection and wastewater treatment. Investments were 6.5 M€.

## 10. Green Growth and Eco-innovation

### 10A. Present Situation



Indicator		Unit	Year of Data
Number of electric (green) vehicles owned by the municipality	8	Number	2016
Share of electric vehicles owned by the municipality (as a percentage of all cars owned by the municipality)	8	%	2016
Number of charging outlets available for cars owned privately in the public space	7 + private (heating) plugs	Number	2016
Number of procurement contracts that include green issues	80	Number	2016
Percentage of all procurement contracts that include green criteria	70	%	2016
Share of the city budget dedicated to support environmental R&D by public and private entities	1	%	2018
Number of jobs created in green economic activities including:	Jobs created by municipality initiatives in the private and public sector	200	2018
i) Jobs created by municipality initiatives in the private and public sector; and	Jobs in the municipality	49 760	2015
ii) Jobs in the municipality			
Number of initiatives for promoting and enabling sharing, reuse and repair such as, repair cafés, etc. initiated or facilitated by the municipality	6	Number	2015-2018

1. Due to a strong strategic choice to provide an efficient waste sorting system to households and industries, the Lahti region has been a pioneer in waste management (Fig. A1). Waste sorting provides a basis for material utilization of different resources. There are several acknowledged industrial symbioses in the Lahti region (Figs. A2, A3).

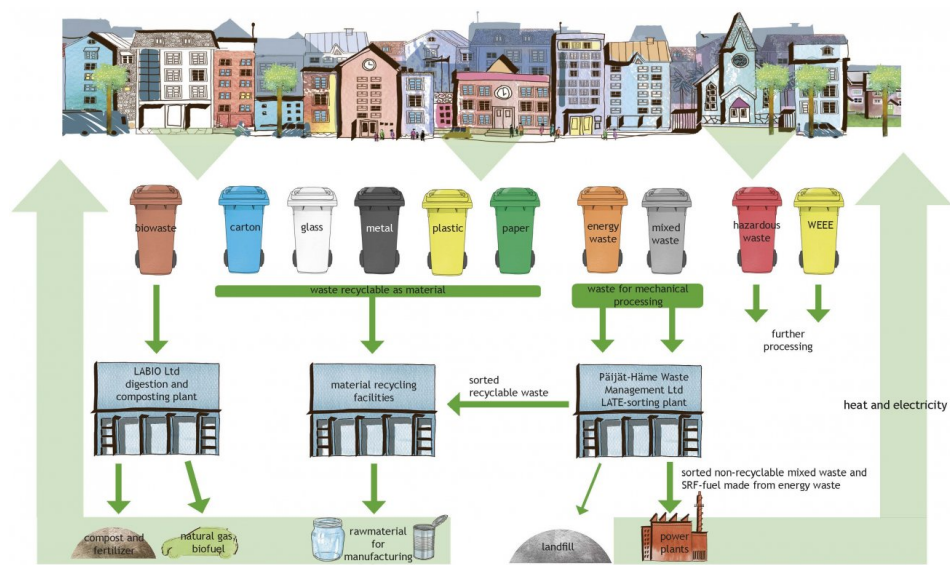
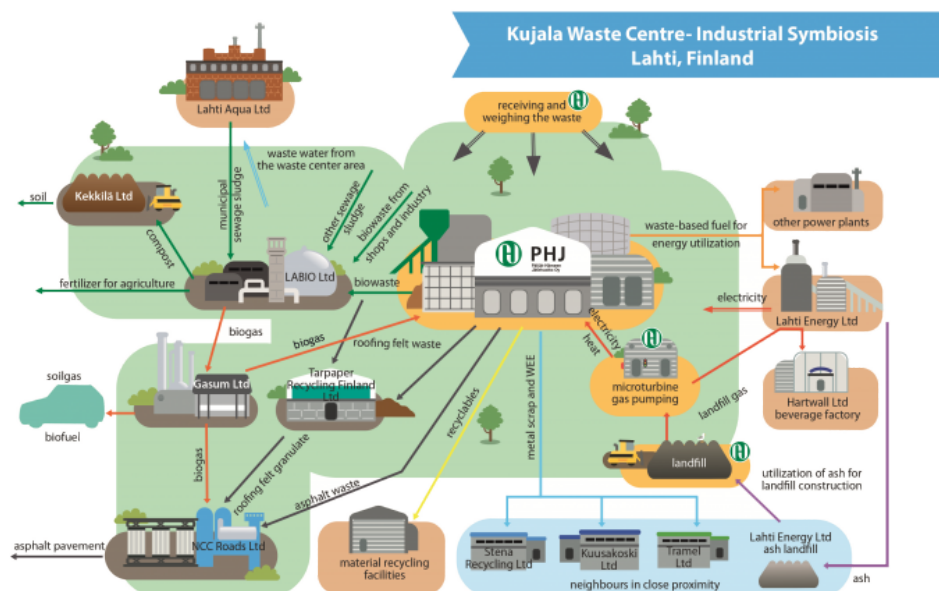
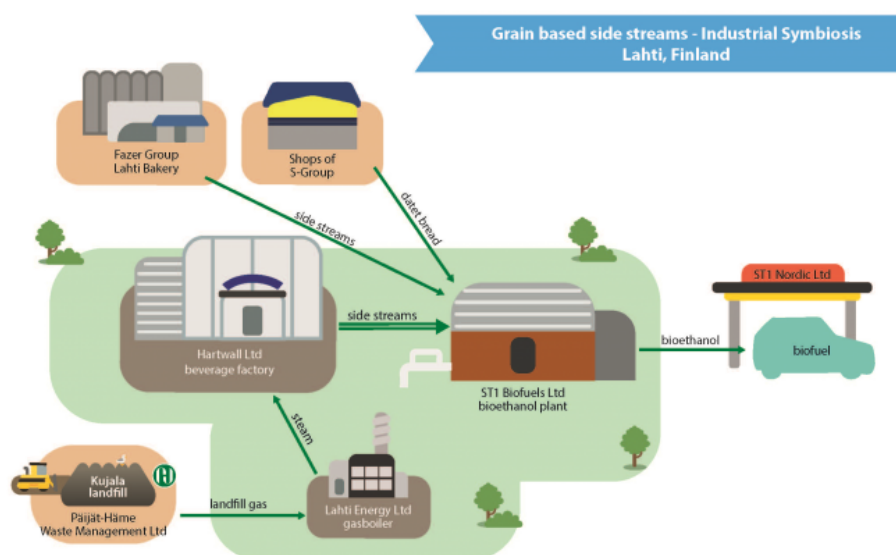


Figure A1. The household waste sorting and management system in the Lahti region. [Click to enlarge image.](#)



Booster by LADEC Designed Anna Polkute in collaboration with Esa Ekholm and Hanna Bergman  
Figure A2. Industrial symbioses in the Kujala Waste Centre area. Click to enlarge image.



Booster by LADEC Designed Anna Polkute in collaboration with Esa Ekholm

Figure A3. Industrial symbioses of the brewing and bakery industry in the Lahti region. Click to enlarge image.

2. At the beginning of 2016, the City of Lahti launched a voluntary Climate Alliance agreement to encourage local companies to reduce their CO<sub>2</sub> emissions. So far, 10 companies have signed the agreement. The process is especially targeted to smaller companies.

The Lahti University of Applied Sciences (LUAS) has developed a new circular economy training programme that incorporates all major educational programmes.

3. The Lahti Business Region has since 2006 hosted an annual investment event for Cleantech companies and investors, Cleantech Venture Day. In June 2018, the venue gathered participants from 18 different countries and hosted over 60 investors.

The new e-service, Energiavalinta.fi, creates customer potential for small-scale renewable energy production, by providing one-building scale energy data.

Lappeenranta University of Technology recently started a new master programmes in Lahti with a circular economy and sustainable business focus.

4. The City of Lahti has an ambitious Procurement Policy (2014-2020) stating that all

municipal units should realize their role in creating new markets for innovative and sustainable products and services.

5. We use the Porukka mobile application for co-creation. By September 2018, over 235 000 responses have been gathered through this application.

“My Lahti” open innovation evenings are part of the city master planning process. The City of Lahti also has a special Neighbourhood Godparent model that encourages citizens to take responsibility at the local level.

Lahti City’s countryside, the Nastola area, has a special board for citizen participation with the ability to fund grassroots eco-innovative projects.

6. In early 2000, cleantech i.e. energy and material efficient production and design, was chosen as one of the three key strategic priority areas for Lahti region. The regional smart specialization strategy (EU RIS3) is not restricted to the transformation of the business environment, as it also influences the strategies of the regional higher-education schools: LUAS, HU and LUT (Fig. A4)].

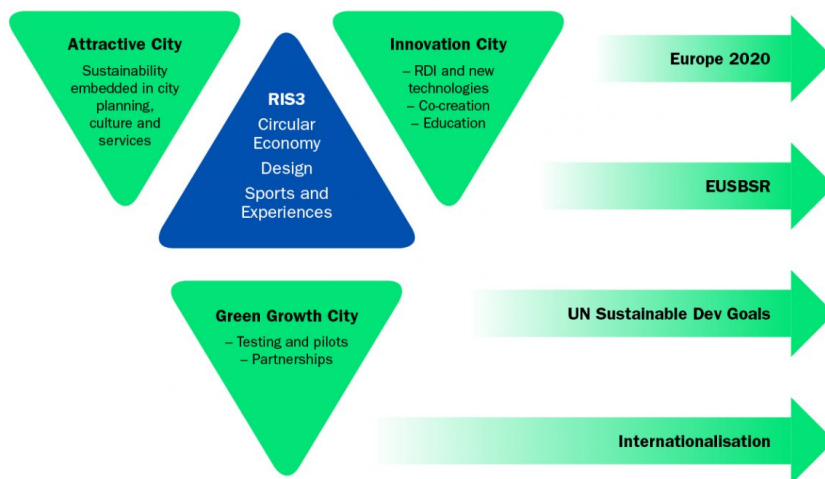


Figure A4. The focus points of Lahti on regional EU-RIS3 strategy. Source: Regional Council of Päijät-Häme.

7. The City Board of Lahti made a public announcement on 5 Sept. 2016 that by 2020 at least one third of the public procurements and investments will target projects that create new innovations in a circular economy. The Helsinki Metropolitan Smart & Clean Foundation is used as one of the co-creation platforms.

In 2018 the city conducted a survey of existing sharing services. The city decided to create a new platform, which allows citizens and employees to rent any kind of city-owned space. This will be opened in early 2019. Several other sharing economy services are also being considered.

Lahti city and the Lahti Applied Science University tested a centralized repairing logistics-service in 2017. Over 90% of customers reported satisfaction with it.

8. Liveability of a city is increased through:

- Well functioning waste management infrastructure and services
- New ecosystem services created by stormwater management projects.
- Eco-innovations of mobility (EU-UIA CitiCAP).



## 10B. Past Performance

### Green Growth and Eco-innovation Initiatives

Since the early 1990s, Lahti region waste management policy has been very comprehensive and concretely aimed at reducing landfill waste [16]. The Lahti region development company LADEC, Päijät-Häme Waste Management and the City of Lahti participated in the Ecopol Project 2011-2014, funded by the EU CIP. During the Ecopol Project, several eco-innovation and eco-procurement recommendation papers were created.

Lahti has actively participated in the Finnish eco-procurement network led by Motiva. The network was established in 2002 by 9 cities. The Procurement Policy of Lahti City (2014-2020) received an honorary award in the Sustainable Public Procurement competition held by Motiva, in 2014 .

The Lake Vesijärvi long-term management project is one of the best-known environmental projects in Finland (Fig. B1). The formerly severely eutrophicated lake is today a well-known example of ecosystem restoration. The project has received funding from LIFE (Life for Lake Vesijärvi 1996-1998) and the national ERDF. Local citizens and companies are participating to sustain the life of Lake Vesijärvi.

Smart City initiatives are part of the smart specialization strategy of the Lahti region. LADEC has led several smart city initiatives targeting the international co-operation between Finnish and Chinese cities and companies. Currently, the City of Lahti and partners are implementing a personal carbon trading scheme as a practical smart city solution, an action funded by the EU Urban Innovative Actions programme (CitiCAP, 2018-2020).



Figure B1. The restoration of Lake Vesijärvi is a famous and powerful example of R&D based ecosystem restoration.

### Influence of EU and National Policies

The EU 2020 Strategy forms the backbone of national and local policies by incorporating smart, sustainable and inclusive growth into a single strategy. The aim is to integrate environmental, social and economic targets into the same action programme, which is made very clear in the new City Strategy of Lahti (Fig. B2).

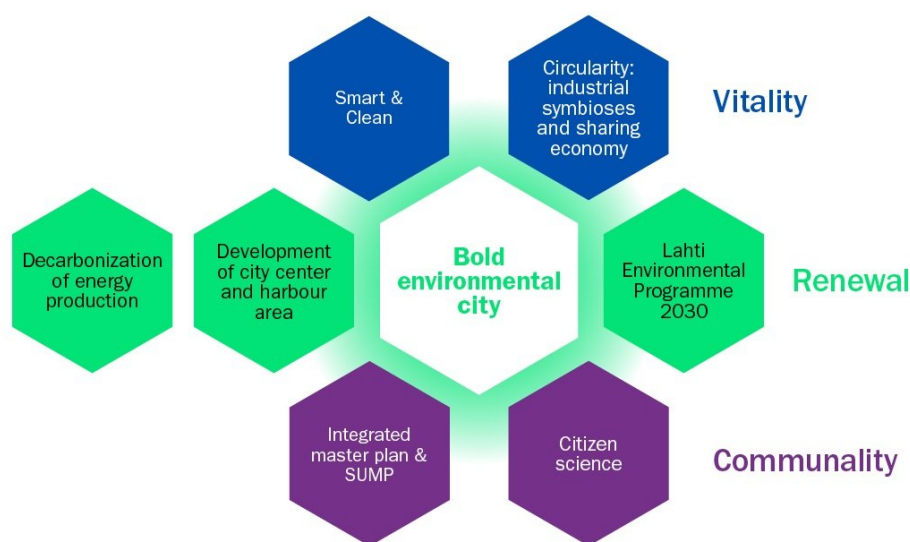


Figure B2. Main environmental city actions and projects of Lahti City Strategy for council period 2017-2020.

Finland's Energy and Climate Strategy was approved in 2013. The long-term goal (2050) for Finland is to be CO<sub>2</sub>-neutral. The City of Lahti is committed to cut CO<sub>2</sub> emissions by 70%, from 1990 levels, by 2030. However we are currently tightening the climate mitigation targets in the SECAP process during 2018-2019. The new suggestion for CO<sub>2</sub> reduction target is – 70% from 1990 level by 2021 and carbon-neutrality by 2030. The progress is followed up by the EU Covenant of Mayors Climate & Energy agreement signed by the City of Lahti in 2017.

As an Energy Agreement Municipality, the City of Lahti develops its old and new premises with strategic goals for increasing energy efficiency.

The EU Circular Economy Package is an ambitious strategy that aims to close the loops of product lifecycle through enhanced recycling and re-use of materials and products. Finland's waste law was renewed in 2011, to correspond with EU-goals of sustainable use of natural resources and prevent any harm being caused by waste. The Waste Management Policy of the Lahti region is in line with Finland's national goals, but aims to enhance recycling of municipality waste faster than the national goals. The Finnish future fund, Sitra, published a national roadmap for a circular economy for 2016-2025. The roadmap highlights three cases from the Lahti region. Lahti was the first region in Finland (September 2017) to publish a regional circular economy roadmap.

#### Report Publications

Environmental accounting is performed annually as a part of the city financial statements. Environmental expenses, income and investment data are collected from the whole City Consortium organization.

The annually published Environmental Review contains roughly 30 environmental indicators. The energy efficiency improvement actions, related to the National Energy Agreement, are reported annually to Motiva.

#### Urban Structure Development

The master planning process is used as a strategic tool for sustainable city development. The City of Lahti has developed a continuous, four-year cycle, strategic master plan process (Fig. B3). Ongoing planning enables a strategic long-term view of urban development, while allowing adjustments for pressing development needs and short-term challenges, as predicting the future is challenging. Currently, the City of Lahti is incorporating the Sustainable Urban Mobility Plan (SUMP, EU) into this strategic city master plan process.



Figure B3. Continuous master plan process of Lahti 2017-2020.

Sustainability and a circular economy rational is incorporated into several urban planning and building projects:

- KEKO Planning Tool for Eco-efficient Urban Structure

The City of Lahti has used the national eco-efficiency planning tool, KEKO, to calculate the environmental impacts of different suggested plans for Lahti's railway corridor area. The KEKO tool gives information on CO2 emissions, natural resource use and impacts on local nature, and allows several plans to be compared.

- Low Energy Houses of Lahden Talot, Case Lanskikatu Houses

Lahden talot, Lahti's rental housing company, has built several energy efficient houses topped with other quality parameters, such as indoor air quality. The Lanskikatu houses were built in 2011-2012 and represent a smart energy design, where the energy comes from ground heat pumps and solar panels.

- Development of the Former Industrial Milieu of Niemi

Niemi is an industrial area where the University of Helsinki established its environmental ecology unit in the 1990s. Currently the Lahti University of Applied Sciences (LUAS) is relocating their campus in the Niemi area, which increases the need to combine different land-use types (industrial, educational, services, possibly housing) into this same area. The use of cleantech and circular economy products, as well as a user-oriented design approach are at the core of the LUAS campus plan.

- Energon Renewable Energy Research Centre

Energon provides opportunities for developing equipment that runs on liquid and gaseous fuels, as well as equipment suited for utilising solar energy, geothermal and air-source heat pump solutions and hybrid solutions (Fig. B4). The facilities and equipment are also well-suited for measuring flue-gas emissions. Energon's services are available to companies, universities, other institutions of higher education and research facilities - either in cooperation or individually. Energon is owned by Lahti's development company, LADEC.





Figure B4. Energon offers unique facilities for versatile research into renewable energy and energy efficiency.

- Motorcycle Museum of Finland - Surprisingly Cleantech

The Motorcycle Museum of Finland is located in Lahti's Niemi harbour area. The museum also demonstrates several local cleantech solutions, such as the Kemppe Ltd recharging facility and an Oilon ground heat pump.

#### Flagship

The Lake Vesijärvi Project (1987-present) is the flagship for environmental innovation projects in the Lahti region. The long-term environmental management project has been successful in several ways: by allocating investment money for ecosystem restoration and Lahti harbour area development, founding a common ground for university research and private company interests in cleantech and creating momentum for citizens to participate in practical improvements of their surrounding environment (Fig. B5).



Figure B5. Artist Tiina Salmi (right) worked with school children during the Lake Vesijärvi Art Project in 2017.

## 10C. Future Plans

Plans to Establish Eco-innovation Clusters, Strategies and Initiatives

Lahti City Strategy was completely renewed in 2018 (Fig. B2). The implementation of the strategy is carried out through a programme consisting of several projects and therefore it has been necessary to create a common and shared understanding of the transformation in target. The Environmental Programme of Lahti 2017-2030 has been chosen as one part of the larger strategy programme.

Building up reference environments for cleantech is a shared vision and strategy of the university departments (HU, LUAS, LUT), the City of Lahti and the neighbouring municipalities of Hollola and Orimattila. These partners developed a common competitiveness strategy for the urban region of Lahti 2016-2020.

Lahti is a member of the Smart & Clean Foundation (Fig. C1). The Smart & Clean puts into practice the aim of the Government of Finland and the Helsinki metropolitan cities and Lahti City to create a world renowned cleantech reference platform by 2020. The Smart & Clean initiative has several focus areas, but the City of Lahti aims to create an outstandingly diverse development platform within the circular economy and stormwater management topics.



Figure C1. The Helsinki Metropolitan Area together with Lahti aims to be the best testbed in the world for smart and clean solutions.

## 2. Future Targets for Application of Eco-innovations

E-mobility and biogas both hold interesting potential for the future development of the city's mobility environment. In 2016, there were 8 e-cars, out of the total stock of 100 cars used by the municipality (Fig. C2). During a special energy support scheme for e-cars in 2012-2016, it was possible to receive 30 % off of the e-car costs. It is highly likely that in the near future a greater share of the cars will be using locally produced biogas. However, at this time, there is no defined goal to increase the share, as the energy support systems are under national reconsideration.





Figure C2. E-cars have been used by Lahti elderly care services.

The City of Lahti conducted a cost-benefit analysis of e-buses, hybrid buses and biogas buses. The e-buses and hybrids turned out to have the greatest potential for next-generation solutions, which will be taken into account in the next public transportation procurement in 2018.

The Lahti Energy Company is involved in the national coalition of energy companies, Virta Ltd, which aims to build a nation-wide charging point infrastructure. Public charging stations are now built into all larger public parking garages.

A new e-car sharing scheme is currently under development in the Hennala area, which is one of the fastest growing areas and belongs to the railway growth corridor.

A smart lighting project is under implementation in the harbour area (Fig. C3). The aim of the project is to create a practical test environment for smart lighting products and sensors.

Moreover, we are currently benchmarking smart bike-sharing concepts with the aim to create a sustainable test platform for these new service concepts.



Figure C3. Visualization of smart lighting on the pedestrian street in Lahti harbour.

#### Innovation and Green Business Networks

National and international sustainability networks are very important for the development of Lahti. The sustainable city network of Lahti has several focus areas (Fig. C4).

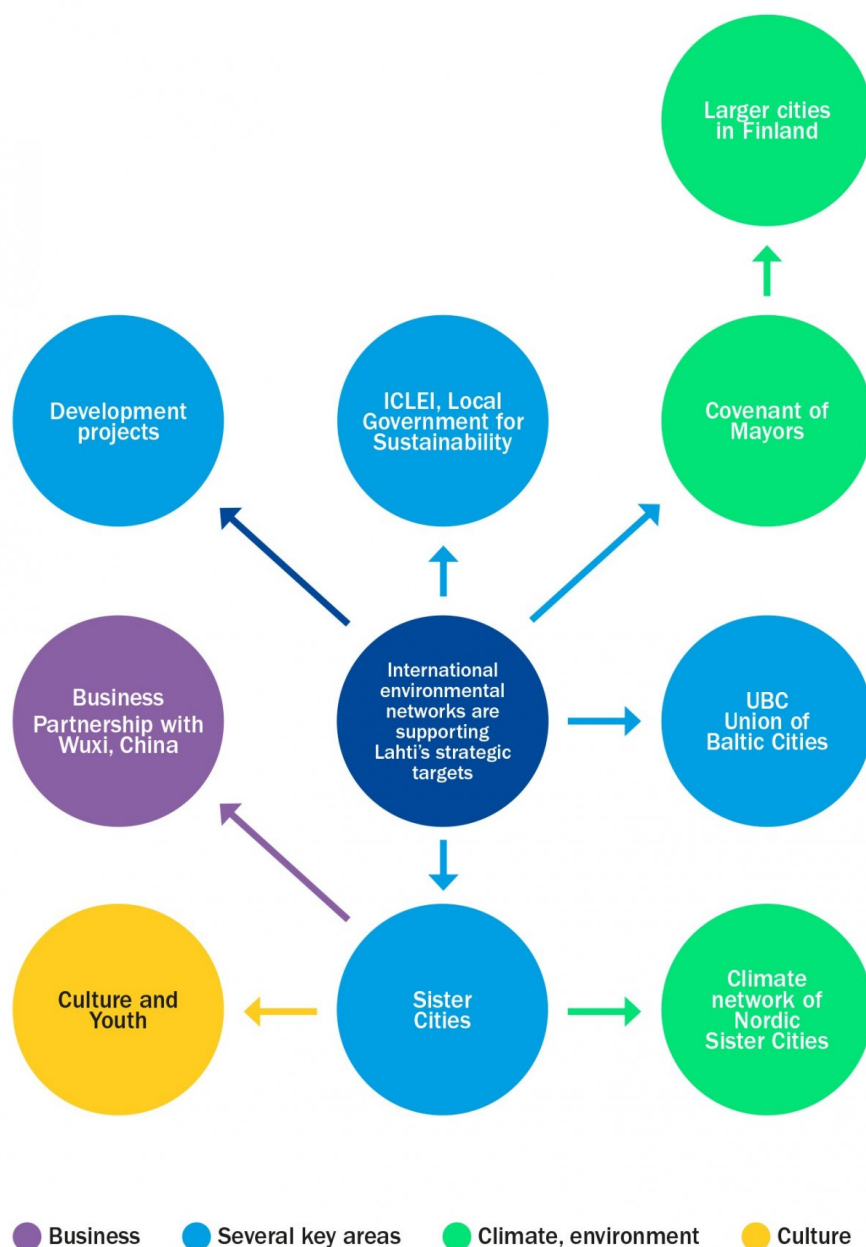


Figure C4. International city networks supporting the sustainable development of Lahti.

Cleantech Venture Day is an international clean technology event, which gathers investors and companies from all continents. The event was created by the predecessor of the Lahti Development Company, LADEC.

#### Programmes Promoting Green Economy

The City of Lahti is committed to the long-term sustainability goals of the Finnish Sustainable Communities [39] of becoming carbon-free with zero-waste and having sustainable consumption by 2050. The new Environmental Programme of Lahti 2018-2030 has a strong focus on these long-term sustainability goals [46]. Several participatory tools are being used to reach out to businesses and residents [7-11].

#### Future Flagship Project: My Carbon Neutral Life 2021

As part of the preparation for EGCA2021 Action and Communications Plan, City of Lahti is planning future flagship project called "My Carbon Neutral Life 2021". We aim to invite 1000 residents from Lahti and other EGC Network cities for a carbon-neutral lifestyle trial during the year 2021 (Fig. C5). My Carbon Neutral Life 2021 project would be a large city-scale demonstration of carbon-neutrality and how it affects on everyday life of European people. Scientific community would support the project by producing necessary information on



carbon-neutral lifestyle choices. We would also set an international open call for private and NGO partnerships in order to create an interesting testbed for services and solutions that are needed to bring the carbon-neutrality into reality.



Figure C5. Citizens would be invited to take part in My Carbon Neutral Life 2021 project that would provide differential new tools and services for realizing the target.

# 11. Energy Performance

## 11A. Present Situation

Indicator		Unit	Year of Data
Final energy consumption	4712500	MWh	2017
Final energy use per capita	39411	kWh/capita	2017
Share of renewable energies of final energy demand	35	%	2017
Share of locally produced renewable energies of final energy demand	24	%	2017
Energy performance of municipal buildings *	55.7	kWh/m <sup>3</sup>	2017
Final Energy Use/Sector			
Agriculture	0.6	%	2017
Industrial	9		
Transport	17.1		
Domestic	56.7		
Services	10.7		
Other (municipal services and other public sector services)	6		
Total	100		

\*Energy use is presented in m<sup>3</sup> and not in m<sup>2</sup> because heating plays a major role in the Finnish climate.

### Energy Consumption by Sectors

Lahti population grew by 11.5% from 1990 to 2015 and energy consumption per capita by

4.4%. In the Lahti area, primary energy sums, equivalent to consumption, have increased from 3 663 GWh in 1990 to 4 268 GWh in 2015. This is mainly due to population growth, growing building stock and an increasing share of 1-2 person households. Our specific future challenge is traffic; its output increased by 59.5% from 1990-2015 (Fig. A1).

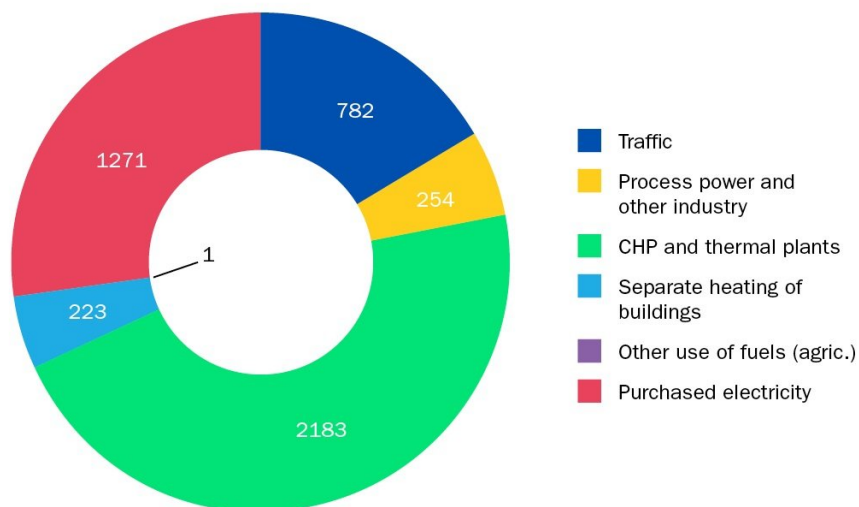


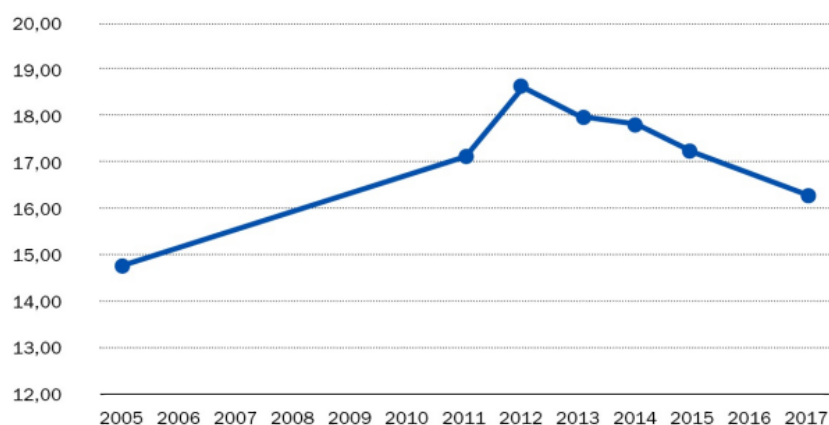
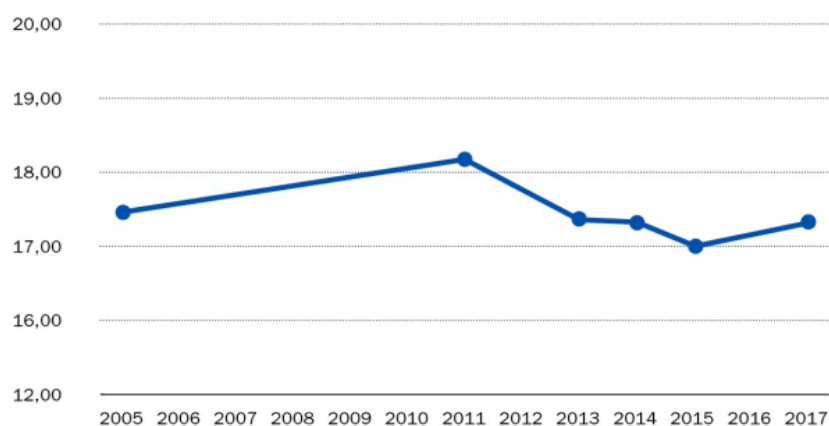
Figure A1. Primary energy sums equivalent to consumption in Lahti (GWh). Data: 2017

### Energy Efficiency Measures

Our actions to change to renewable energies and increasing energy efficiency have dropped Lahti's CO<sub>2</sub> emissions per capita from 10.99 tons in 1990 to 6.9 tons of CO<sub>2</sub>e in 2015. Total emission have dropped from 1 023.9 kilotons of CO<sub>2</sub>e in 1990 to 717.1 kilotons of CO<sub>2</sub>e in 2015.

Over 40 energy efficiency measures have been taken and reported via SEAP. The total energy savings of SEAP actions between 2010-2020 are estimated to be 177 736 MWh, while increase in renewable energy production is 360 871 MWh. The most important measures have been the investments on low-energy premises by Lahti consortium and installation of landfill gas collection system in Kujala waste management area.

Since 2011, the city has measured building energy use in real-time. Lahti Premises' total energy consumption decreased over 4% in 2011-2017 (Fig. A2). Due to union of municipalities in 2016, Lahti Premises obtained buildings that haven't been under energy efficiency actions before.

**Lahti Municipal Premises Electricity Consumption 2005–2017 (kWh/m<sup>3</sup>)****Lahti Municipal Premises Heating Energy Consumption 2005–2017 (kWh/m<sup>3</sup>, Weather corrected)**Figure A2. Energy consumption in municipal premises in 2005–2017 (kWh/m<sup>3</sup>).

To further enhance the energy efficiency of premises, city of Lahti signed a new Energy Efficiency Agreement for 2017–2025, targeting 7% energy saving by 2025 (from the 2017 level). This implements the EED-EC. Lahti Housing Ltd. had managed to save 8 949 MWh of energy by the end of 2016.

#### Present Situation and Future Scope of Energy Supply Mix

Over 95% of district heating is produced energy efficiently in the combined heat and power plant of Kymijärvi I-II. The Kymijärvi II power plant (2012) is a unique gasification power plant that uses SRF. A complete change to renewables in centralized energy production will be performed by 2020 (Fig. A3). In 2017, 40.5% of district heating was generated with renewables.

The share of renewables in Finland's transport sector is currently 8.4% of the gross final energy traffic consumption.



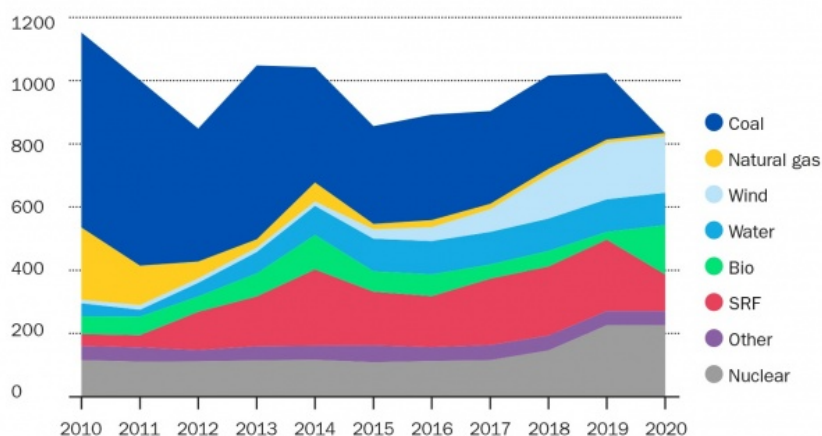
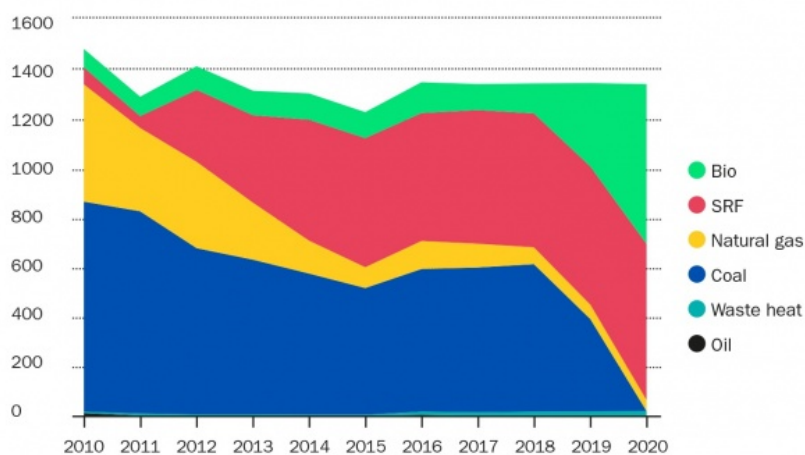
**Lahti Energy Ltd: Electricity production 2010–2020 (GWh)****Lahti Energy Ltd: District heating production 2010–2020 (GWh)**

Figure A3. District heating and electricity production (GWh) of Lahti Energy Ltd 2010-2020. Data: 2017.

### Renewable Energy Technology and District Heating

Lahti Energy Ltd.'s district heating network is extensive, with over 90% of the population and 99% of the municipal buildings using district heating (Fig. A1). District heating in the densely populated city will continue to be significant in near future. Therefore, the biggest shift on renewables will be performed through energy production changes (Fig. A3). However, solar power plants and heat pumps are also becoming more common. A 460 panel solar power plant (2017) in the Lahti Winter Sport Arena was part of the ESCO project.

### Application of Innovative Technologies

The current code of conduct for public building projects in Lahti emphasises the role of energy efficiency innovations in all building projects. These include, e.g. use of LED lamps, heat pumps and passive energy efficiency solutions (building architecture). Smart lightning technologies are used in Lahti Harbour pedestrian area (Fig. A4).



Figure A4. Smart and energy efficient lightning project of Lahti Harbour 2016-2020.

## 11B. Past Performance

### Improving Energy Performance

- Municipal building energy saving potential between 2010-2020: 95 000 MWh. This is governed through 2008 and 2017 Energy Efficiency Agreement. Hour-based follow-up created immediate changes in 2012-2014 (Fig. A.2)
- New municipal building code of conduct (2018) requires all new buildings to be low energy. All schools and office buildings must use less than 90 kWh/m<sup>2</sup>/a, while Finnish legislation sets the limit at 100 kWh/m<sup>2</sup>/a for these types of buildings. It is a very efficient measure for long term energy efficiency.
- 2012: More efficient landfill gas collection system in Kujala waste management area, energy savings 33 000 MWh by 2020.
- Lahti Housing rental property action plan, 7000 MWh energy savings 2010-2020.
- 2010-2018 Päijät-Häme project consumers' energy advisory: Energy counselling targeted residents in the Lahti region (Fig. B1), not possible to evaluate savings.
- 2015-2018 Street lighting towards LED use, 6000 MWh by 2020.



Figure B1. Energy counselling at events, fairs and lectures. Counselling is also available by phone or e-mail.

### Renewable Energy

- Since almost all municipality-owned buildings use district heating, the strategy is to renew the centralised energy production with renewables (Fig. A3).
- 2013: Lahti Energy Ltd- invested in Swedish hydro power (11 M€).
- 2013: Biogas production at Lahti Aqua wastewater treatment plants.
- 2014: Renewable Energy Possibilities audit by an energy consult.
- 2014: LABIO biogas production plant started operating (17 M€). Biogas is produced from bio waste and sewage sludge from Lahti Aqua. After digestion, the mass goes for composting and turns into soil. Its capacity is 80 000 tons of bio waste per year and biogas production up to 50 GWh (9 million m<sup>3</sup>) per year.
- 2015: ESCO (Energy Services Company) project started: Lahti Premises in co-operation with Siemens. Investment 10 M€, aiming to save 6 GWh of energy.
- 2015-2016: Lahti City Group organizations install at least six new electric car charging points
- 2017-2020: Building of Kymijärvi 3 power plant.
- Lahti Energy involved in cooperations with companies, e.g. Fazer Mills, milling by-products (oats husks) are utilized as energy. Lahti Energy delivers hot water and steam to Polttimo, a malting company, from the steam plant, built in 2016 on the Polttimo premises, which mainly uses woodchips.
- Lahti Energy delivers small-scale solar power systems to households and housing cooperatives, in cooperation with local companies. Lahti Energy has solar power systems at two of their own plants.
- To enhance alternative fuels, Lahti Energy Ltd. has installed six electric car charging stations, delivers charging stations and owns six alternative fuel cars.

### Integrated District System Solutions

Kymijärvi II, an innovative combined heat and power (CHP) gasification plant, started full-scale operation in 2012 (investment 165 M€) (Fig. B2). The district heating network forms a core of the energy system in Lahti. The clients' energy meters are read through a remote access. All users can view their real-time energy data via online strict identification system.





Figure B2. Kymijärvi II is the world’s first gasification plant utilizing solid recovered fuel (SRF).

Stakeholder Engagement

The aim of Lahti city is to give open and easily available information on different renewable energy options. Residents can calculate energy efficiency and renewable energy options on single-building scale through Energiavalinta.fi (Fig. B3). The service uses open data sources (e.g. age and energy efficiency of buildings) and maps (e.g. geothermal energy potential and solar radiation maps). The e-service assists in comparing sustainable energy solutions, suitable for each particular building, and acts as a contact channel to local businesses. Budget 190 000 €.

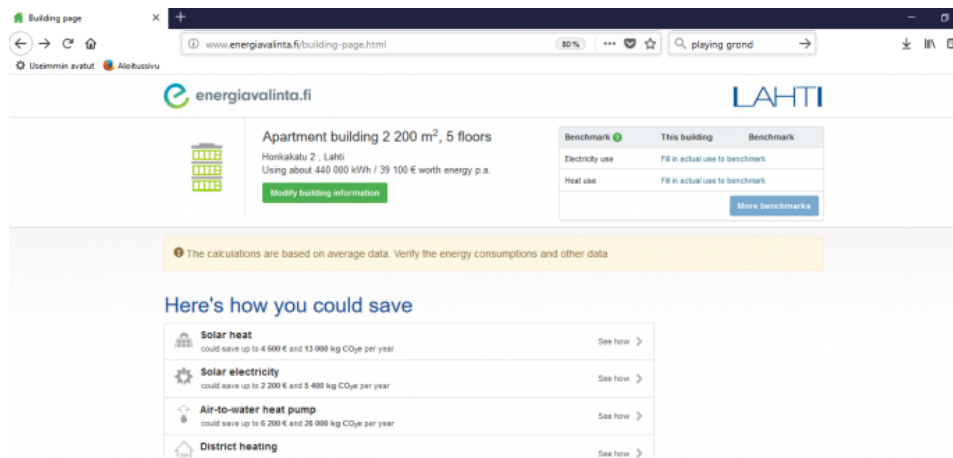


Figure B3. Energiavalinta Platform combines average energy utilisation data of premises with different renewable energy options.

Energy Efficient Housing

In 2012, Lahti Housing Ltd. constructed three low-energy houses (56 rental apartments). The houses use geothermal or solar energy, employ energy recovery ventilation and have an excellent energy class. Also, the electrical system is energy efficient. The buildings have 20 solar panels (area 43 m2).

In 2013, an almost zero-energy house was completed by a company providing housing for the elderly (part of the Lahti City Group). The building uses central heating and partially solar energy. The consumption of electricity and heating energy is 50% less, compared to similar traditional house. In 2016, low-energy house (energy class A) for elderly was completed, building uses district heating and solar energy (Fig. B4).





Figure B4. One of the newest low-energy houses in Lahti, the Aavatar Care Home, is equipped with solar panels.

### WWF Earth Hour City Challenge

In 2015, Lahti was awarded in the WWF Earth Hour City Challenge. Lahti was the Finnish winner that year, and among the 16 best worldwide. The evaluators appreciated the energy investments and concrete solutions Lahti has made.

## 11C. Future Plans

In 2016, Lahti joined the FISU Network [25]. We will strive to be emission free and waste-free, and to curb overconsumption by 2050. The intermediate climate change mitigation goals are: CO<sub>2</sub> emission –70 % by 2030 from 1990 level and carbon neutral by 2040. The roadmap for these city-wide targets are described and governed through Environmental Programme 2018-2030 and SECAP, which is under construction in Oct 2018.

### Role of Energy Efficiency Improvements

- 2011-continues: Energy efficiency improvements of public buildings and street lightning. These actions form a majority of the energy saving potential of Lahti organisation. City of Lahti signed a new Energy Efficiency Agreement for 2017-2025, targeting 7 % energy saving by 2025 (from the 2017 level).
- 2015- continues: Climate Partnerships with companies and organizations (Fig. C1). We challenge companies to lower their CO<sub>2</sub> emissions in cooperation with the Lahti University of Applied Sciences and Ladec, a development company. After surveying the company's current emissions, the company makes a climate pledge and receives a diploma from the Mayor. Additionally, joining the Cleantech Finland network is encouraged.
- 2017: World Skiing games in Lahti and the walking passage had smart LED lighting and other environmentally friendly solutions (e.g. recycling) were introduced. These are very visible measures for energy efficiency.
- Special focus is on reducing the energy consumption and CO<sub>2</sub> emissions of traffic. Traffic will be the largest CO<sub>2</sub> emission sector after 2020, when investments on centralised renewable energy production have been conducted. Innovative measures are needed: e.g. CitiCAP-project (UIA 2018-2020) aims to provide a personal carbon trading scheme for 1300 individuals of Lahti, which may cut 25 % of their mobility-related emissions.

### Role of Renewable Energy Investments

- 2015-2018: The Lahti Energy company will invest 20 M€ in wind power.
- 2016 Lahti City Group target: Share of certified green electricity should be 10% by the end of 2020.
- 2017-2020: Lahti Energy Ltd. and the City Council have decided to build a new biofuel

power plant, Kymijärvi III, in Lahti, which should be operational by 2020 (Fig. C2). With the new biofuel power plant, 80% of district heating will be generated from renewable sources. The investment will cost 150 ME. The old coal-operated power plant, Kymijärvi I, will then close. A large energy storage tank will be built to cope with energy consumption peaks. The new power plant will reduce our GHG-emissions considerably, as district heating will be more sustainable.

- Sustainability biomass criteria of Kymijärvi II-III: FSC or PEFC forestry certificates.



Figure C1. Climate Partnerships encourage companies and organizations to lower their CO2 emission.

**Towards 100% Renewable: Kymijärvi III**

Lahti Energy Ltd. aims for development of local energy production to become coal-free and renewable (Fig. A3, C2). The biomass used in Kymijärvi III will largely come from nearby forests and create around 75 new jobs. Kymijärvi III’s energy efficiency is created through the use of the latest technology, heat recovery and condensing water from combustion gases. Efficient purification of condensation water enables it to be released into the river, as well as be used at the plant. Heat recovery will lower emissions (SO<sub>2</sub>, NO/NO<sub>x</sub>, PM) significantly, which affects air quality. Resultant ash can be used as fertilizer in forests.





Figure C2. The completion of Kymijärvi III bio-heating plant in 2020 means Lahti abandons coal.

### Other Measures Affecting Energy Use

We have a strong focus on improving traffic system energy efficiency. Traffic GHG emissions, in Lahti, grew by 17% from 1990-2015. However, traffic output simultaneously grew by 59.5%. This is a national challenge; and although modern cars and buses have lower emissions, the total traffic increase has been so dramatic that it has overtaken the positive developments, in the traffic sector (Fig. C3). Lahti City has reached a preliminary long-term decision to have public transport buses change to electric buses. In other logistics, biogas car use will be enhanced.

Lahti has started an innovative project, CitiCAP (2018-2020), which aims to build a holistic data platform for mobility and build, pilot and implement a personal carbon trading scheme for mobility.



Figure C3. Mayor of Lahti Pekka Timonen encourages city employees to cycling and saving energy.

The industrial companies of Lahti area improve their energy efficiency through process development and local co-operation (Fig. C4).



Figure C4. Kujala Waste management area is an example of industrial symbiosis with energy utilisation synergies.



## 12. Governance

### 12A. Plans and Commitments

Commitments	Yes/No	Date From:	Comments
Signatory of CoM	Yes	2012	Climate & Energy signatory from 2017
Aalborg signatory	Yes	2007	
ISO14001 for municipal operations	Yes	2007	Municipal waste management company PHJ; Lahti Energy Company Ltd.
Eco-management and audit scheme for municipal operations	Yes	2012	WWF Green Office EMS for 10 office units of Lahti: Lahti City Hall, Lahti Urban Development, Lahti Educational Department, Lahti Social and Health Care Department, Lahti Housing company office, Lahti Development Company office, Lahti Regional Cleaning Services, Lahti Regional Catering Services, Main library of Lahti

#### Lahti City Strategy

The City Council accepted the new City Strategy for 2030 in May 2018. Its vision “Lahti – Bold Environmental City” emphasises the critically important role of environment on the growth policy and development of Lahti. Three transformation lines (Vitality, Renewal, Community) guide the delivery (Fig A1).

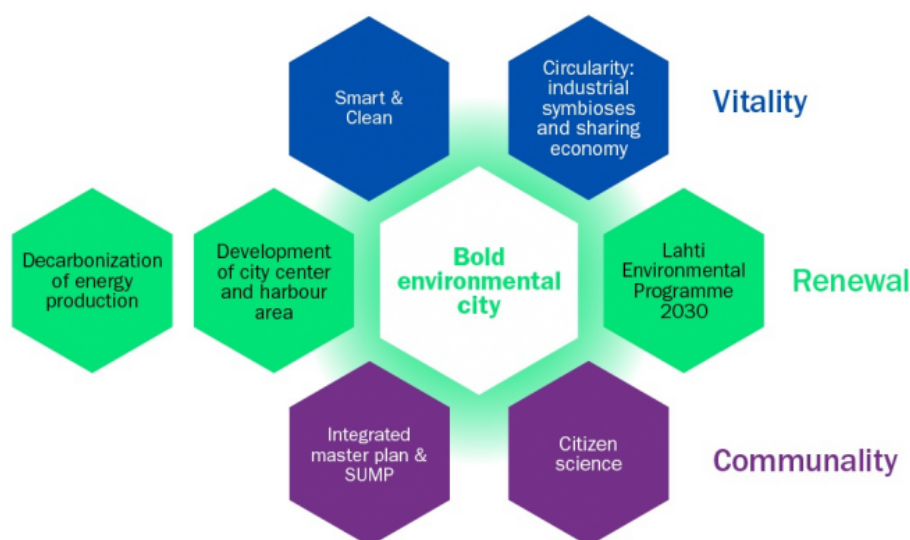


Figure A1. City strategy (2018) consists of three transformation programmes; vitality, renewal and communitary.

#### Strategic Plans and Processes

The strategy vision and goals have been incorporated into the Lahti City Group budgets and more detailed plans.

- Lahti has developed a cyclic, continuous master plan process (Fig. A2), which is monitored using 20 ecological, social and economic measures.
- The Environmental Program (2018) and more detailed management plans support the

delivery of the key environmental commitments outlined in the strategy.

- 5 annual city strategy related lighthouse projects are closed as part of the budget negotiations.
- Unicef's Child-friendly City status was given to Lahti in 2015 and 2018.
- In 2015, Lahti won the Finnish WWF Earth Hour City Challenge.
- Schools and kindergartens use sustainable development indicators.
- The Procurement Programme (2018) promotes green public procurement.



Figure A2. Continuous master plan of Lahti (current cycle: 2017-2020) provides a strategic planning process with integration possibilities.

### Short and Long-term Environmental Objectives

The city strategy sets targets for year 2030. The aim is to grow into a "Bold Environmental city", an international university city that solves the challenges of the future. New processes are developed flexibly by experimenting. City of Lahti aims to cut 70% of the CO<sub>2</sub> emissions by 2030 from 1990. While designing the city strategy, Lahti City Council emphasized the importance of cleantech RDI, wider utilization of local water-knowhow and also nature's impacts on well-being.

Long-term environmental objectives are governed through Lahti Environmental Program. It aligns the major transition targets of the city: a carbon-free, zero-waste and sustainable city by 2050. The program also provides a more detailed and continuously updated implementation roadmap until 2030.

The annual lighthouse projects, that are part of the city strategy, enable the execution of rapid strategic changes. The evolution of the lighthouse projects is a bottom-up process: the employees suggest project ideas for the city's governmental board. The board chooses 5 best ones for implementation. Currently the city is designing its first SUMP (integrated with master plan). Therefore the mobility changes of urban area are also well presented in the 2019 Strategy Lighthouse project portfolio.

### Present and Future Projects of Urban Environment Smart Lahti Innovation Platform

We have launched a new, for companies targeted co-creation platform (Smart Lahti), where the cleantech solutions from our region will be showcased.

There are several Smart City projects in Lahti that provide interesting innovation platforms for companies and students. For instance, a project piloting smart lighting is currently in the construction phase (Fig. A3).



Figure A3. The Smart Lighting Project is currently in the construction phase at the Lahti Sport Centre and Harbour area (Source: Henrika Pihlajaniemi, 2017).

We received funding from UIA 2nd Call (2018-2020) for the CitiCAP project to:

- Co-create and implement a Personal Carbon Trading (PCT) scheme to reduce traffic emissions.
- Build a new model for the SUMP process integrating the traffic and spatial master planning processes.
- Develop a light and replicable mobility data platform to implement the PCT.

#### **Complete Green Shift of Local Energy Production for Lahti**

Lahti Energy Ltd. (part of the Lahti City Group) has invested in energy efficient and sustainable district heating. The City of Lahti is currently undergoing a complete transformation in centralized energy production with the aim to give up on coal by 2020 (Fig. A4).





Figure A4. Lahti Energy’s Kymijärvi II power plant is an important element in the green shift of local energy production.

12B. Governance and Management Arrangements

Organisation

The City of Lahti has three departments (Fig. B1). The Department of Urban Environment is the smallest. Four boards regulate its operations: the Technical and Environmental Committee, the Building and Environmental Permit Committee, the Regional Public Transportation Committee and the Regional Waste Committee. The department is responsible for land use and regional projects, the urban environment and construction and environmental supervision. The Department of Administrative Affairs is responsible for leading development of environmental issues in a city-wide scale (e.g. sustainability and environmental education).

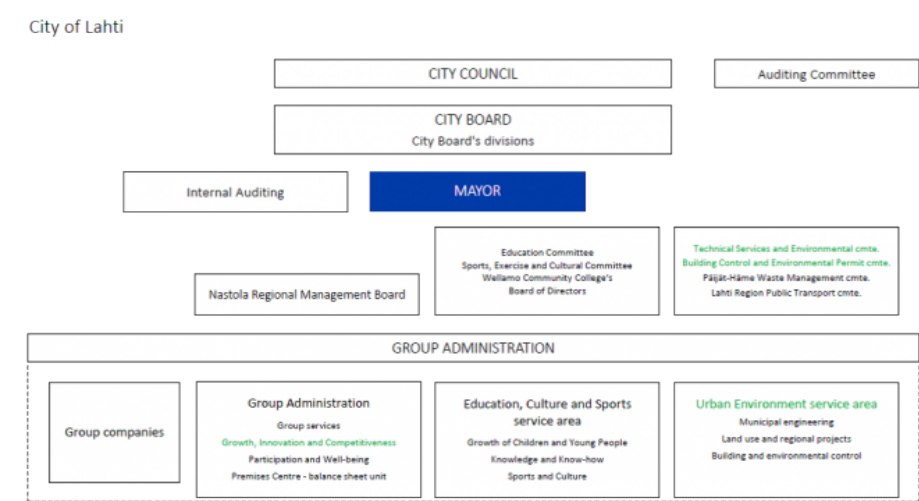


Figure B2. City Strategy, commitments and practice – reporting at different levels. Click to enlarge image.

Budget

Annual environmental budget is allocated to different city departments. In 2017 the overall environmental expenses of Lahti City were 3.6M€ and Lahti Group (incl. municipality owned companies) 39.7M€.

Management, Monitoring and Evaluation

Achievements of the environmental strategy are monitored using strategic indicators. The results are reported together with the annual financial statement (Fig. B2). Leadership

networks have their own reporting periods (e.g. Energy Agreement annually, CoM every second year etc.). Operational level reporting is performed continuously in dedicated Boards and Committees (Fig. B1). The City Strategy (Fig. A1) and its annual lighthouse projects build upon cross-sectoral governance with dedicated Steering Groups for the three transformation programmes.

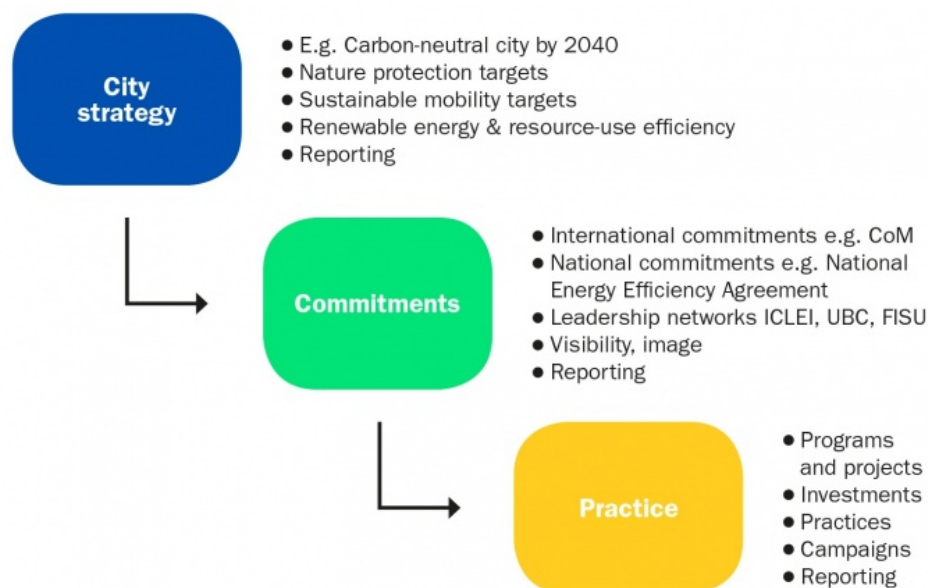


Figure B2. City Strategy, commitments and practice – reporting at different levels.

Lahti has been implementing the National Environmental Policy and Local Environmental Plans since 1996. The Environmental Workgroup (incl. representatives of the Lahti City Group) is responsible for reviewing the environmental management system.

City of Lahti is a member of Finnish Sustainable Communities network (FISU) that brings residents, companies and organizations together to discuss and decide on measures to achieve carbon neutrality, zero waste and sustainable consumption goals. Lahti Region was the first Finnish region to design and execute a Regional Roadmap for Circular Economy.

We audit our work with regular self-evaluation (tool for departments) and citywide audits. For example, in 2015, Technical and Environmental Services conducted an audit of the processing of stormwater issues within the city organization.

In Finland the municipalities have the mandate to regulate some sectors and decide on environmental permits, and to control smaller facilities. Municipalities are also in charge of building controls and environmental health inspections.

#### Management Innovations: Child Participation

In 2014 and 2016, all urban natural areas used in early childhood education were mapped using Maptionnaire. All of Lahti's 59 day-care units responded to the questionnaire and marked down interesting areas or objects. Study findings were incorporated into the city's GIS system to instruct planning and forest management.

For the Master Plan, a "Dream Playground" event was arranged in 2017. 36 children, 7-10 years old, drew their dream playground, and 10 were interviewed (Fig. B3).



### Leadership by the City Council

City of Lahti is the first city in the world to have the WWF Green Office Environmental Management System in place in a city-wide scale. Environmental aspects are already a major consideration in 70% of the centralised procurement decisions (2016). Examples of GPP:

- Lahti Energy Ltd. investments on renewable energy production (11M€ in 2013, 20M€ in 2015-2018, 160 M€ in 2017-2020).
- In 2012, Lahti Housing Ltd. constructed three low-energy multi-unit houses. In 2013, a near zero energy multi-unit house was built. In 2017, new houses were taken to Green Bond scheme of MuniFin.
- 7 electric cars, 35 biogas cars and a few electric bicycles for the personnel.
- Lahti Ateria Ltd. (municipal catering service): new vegetarian dishes and an increased share of organic foods.

## 12C. Partnerships and Public Involvement

### Involvement of Citizens

Both the city vision “Bold Environmental City” and the strategy were developed in close collaboration between City Council of Lahti, students and youth, entrepreneurs of the region, local residential associations and other interest groups. Feedback was gathered using variety of methods (Fig. C1; C2). Lahti personnel was immediately engaged to design the lighthouse strategy projects for 2019 as part of the city strategy implementation.





Figure C1. Porukka application has been actively used to increase public participation.



Figure C2. Lahti Lackathon event gathered youth, students and other interested residents to innovate the City Strategy in February 2018.

Our Youth Council, Elderly Council and Disability Council are active. For example, the Youth Council reviews and comments our plans, and drafts a youth project list for the city government every other spring.

The City of Lahti has an Environmental Counselling unit. The unit has developed several innovative environmental education methods. We have had “Area Godparents” and “City Officer Godparents” for over 15 years. These groups act as mediators between the city organisation and citizens.

In 2018, we celebrated Regional Environmental Week for the 22nd time together with different residential groups with the SUMP theme “Change the world by moving” (Fig. C3).



**22. YMPÄRISTÖVIIKKO 17.–23.9.2018**

Asikkala • Hartola • Heinola • Hollola • Lahti • Sysmä

## Kestävä liikkuminen - Muuta maailmaa liikkumalla

Lisätietoa, toimintavinkkejä, ilmoittautuminen ja tapahtumat

[www.ymparistoviikko.fi](http://www.ymparistoviikko.fi)



Tuuli Hakkarainen 17v.  
Kannaksen lukio kuvataidelinja

Figure C3. Poster for Environmental Week 2018 was designed by 17-year old Tuuli Hakkarainen.

We organise resident evenings for many reasons. During the spring 2018, a series of “My Lahti” resident evenings were arranged to discuss the master plan and SUMP targets at the local level. Approximately 300 residents participated to workshops and 570 residents gave feedback through the Maptionnaire tool.

Participation of citizens, companies, university departments and the third sector is our strategic value. We want to approach them in a compelling and practical way.

- We shall collaborate with our residents on improving the energy efficiency of buildings, on

everyday transportation and sustainable food choices, as well as on developing new services.

- Our long-term goal for companies is their commitment to finding solutions for reducing CO2 emissions and enhancing a circular economy.
- Since 2015: Climate Partnerships with companies and organizations. The City of Lahti challenges companies to lower their CO2 emissions. The current emissions of the company are calculated and based on the results the company makes climate commitments. (Fig. C1).
- The City of Lahti is part of the Helsinki Metropolitan Smart and Clean Foundation, which aims to build a world-class test platform for smart and clean solutions and services. We launched a new internet platform, Lahti Smart & Clean, in Nov. 2017, to enhance and improve co-creation between the city and companies.

### **Co-operation and Learning**

We are participating in the national FISU (Finnish Sustainable Municipalities) network. The network has shared long-term sustainability goals: carbon-neutrality by at least 2050, zero waste by 2050 and responsible consumption. These long-term goals are further broken down into manageable targets for 2021 and 2030, which are governed by the Environmental Programme of Lahti 2017-2030.

The university departments and their students have actively participated in forming the FISU targets. Furthermore, the university students have processed the impacts of the urban sustainability transition on the daily lives of the people of Lahti.

### **International co-operation networks:**

- Union of Baltic Cities (UBC) since the 1990s.
- UBC SCC Advisory Board (2016-2018).
- Sustainable Towns and Cities and Resilient Cities (ICLEI), since the 1990s.
- Local Agenda (1993-1996).
- Cooperation with Saint Petersburg since 1995.
- Aalborg Charter 1996, Aalborg Commitments 2007.
- Covenant of Mayors since 2012.
- Active cooperation with nordic twin towns: Nordic Climate Declaration 2012, seminars on climate issues.
- Sustainability co-operation with Wuxi, China since 2010 and Japan since 2016.
- EGCN since 2017.

Lahti has been a partner in many international projects since the 1990s. Examples include:

- Managing Urban Europe 25 (2005-2008).
- Baltic Eco Region (2008-2012).
- ICER (2010-2012).
- EU Cities Climate Adapt (2012 -2013).
- BIOREGIO, EU Interreg (2017-2021) (LUAS, lead)
- CitiCAP, EU UIA (2018-2020) (LAHTI, lead)
- Over 10 years of North-South cooperation with Rustenburg and Madibeng, South Africa and Ho, Ghana.

### **Participation to EGCA2021 Bid**

Our EGCA campaign is an open innovation process. We have completely opened the previous application (EGCA2020) [33] and encouraged residents, universities, NGO's and other cities to utilise and develop it further.

For the current EGCA2021 Bid, a special emphasis will be on the citizen and company participation. We are planning to organise the year with preliminary idea of "My Carbon Neutral Life 2021", providing a city-wide testbed for carbon neutral lifestyle innovations and services supporting it (Fig. C4). Lahti is the first city in the world implementing a personal carbon trading scheme from 2019.





Figure C4. What it means to live in carbon-neutral way? We will demonstrate it with citizen and companies during EGCA2021.

## Good Practices

### Good Practice 1 - Integrated Management Approach

#### Future Flagship: My Carbon Neutral Life 2021

As part of the EGCA2021 Action and Communications Plan preparation, Lahti is planning a future flagship project called "My Carbon Neutral Life 2021". We aim to invite 1000 residents from Lahti and other EGC Network cities for a carbon-neutral lifestyle trial during the year 2021 (Fig. C5). My Carbon Neutral Life 2021 project would be a large city-scale demonstration of carbon-neutrality demonstrating what kind of effects it would have on the everyday life of a European citizen. The Scientific community would support the project by producing necessary information on carbon-neutral lifestyle choices. We would also set an international open call for private and NGO partnerships in order to create a testbed for services and solutions that are needed to put the trial into practice.

The IPCC Special Report (2018) states the importance of creating multi-level governance structures for actions on climate change mitigation. Partnerships that involve a broad spectrum of private and public actors are crucial to facilitate actions and responses for limiting global warming to 1.5°C. Our project would address climate change mitigation in a new and inspiring way. Transition from linear, fossil-fuel based economy towards renewable and circular economy has versatile impacts on peoples' daily lives. However, it also brings many new opportunities, e.g. MaaS or circularity based consumption, which are likely to become more common during 2030s. To create leadership for the transition, it is important to showcase the opportunities – and not only to concentrate on the risks. My Carbon Neutral Life 2021 is a project that will engage the whole city being simultaneously a grassroot-level and a strategic project – a real future flagship project for the year 2021.



Figure 1. Housing co-operatives may work as one of the platforms for My Carbon-neutral Life 2021 — a future flagship project.

## Good Practice 2

### Cyclic and Strategic Master Planning Model

Lahti has developed an integrated and continuous master planning process (Fig. 2). In this model the planning work proceeds in four-year cycles and is reviewed during each city council term. A continuous planning process provides a holistic approach to strategic land use, enabling the appropriate timing and targeting of more detailed city planning and building projects. [Watch video.](#)

An electronic geographical information system enables continuous planning work. The knowledge gathered by the residents is also saved in the GIS system (Fig. 3). The progress of master planning is monitored using 20 ecological, social and economic measures. During each Master Plan cycle, various impacts of the proposed plan are assessed (e.g. walking and cycling, children, climate change and ecological networks) by city officials and qualified academic experts.

Our future challenge is to stop the increase in traffic emissions (Fig. 4). Special emphasis will now be placed on integrating the Sustainable Mobility Plan (SUMP) into the process, which will create the analytic city-wide framework for cutting CO<sub>2</sub> emissions from the traffic sector, e.g. by 1) improving the bicycle infrastructure, 2) finding smarter and low-carbon solutions for public transportation and 3) increasing pedestrian-friendly spaces in Lahti's urban cores.

SUMP development plan for 2017-2020:

- 2017: Analysis of the present state, setting of vision and targets.
- 2018-2019: Efficient action plan.
- 2019: Responsibilities and financing, monitoring and evaluation.
- 2020: Introduction and communication, lessons to be learned for the next round.

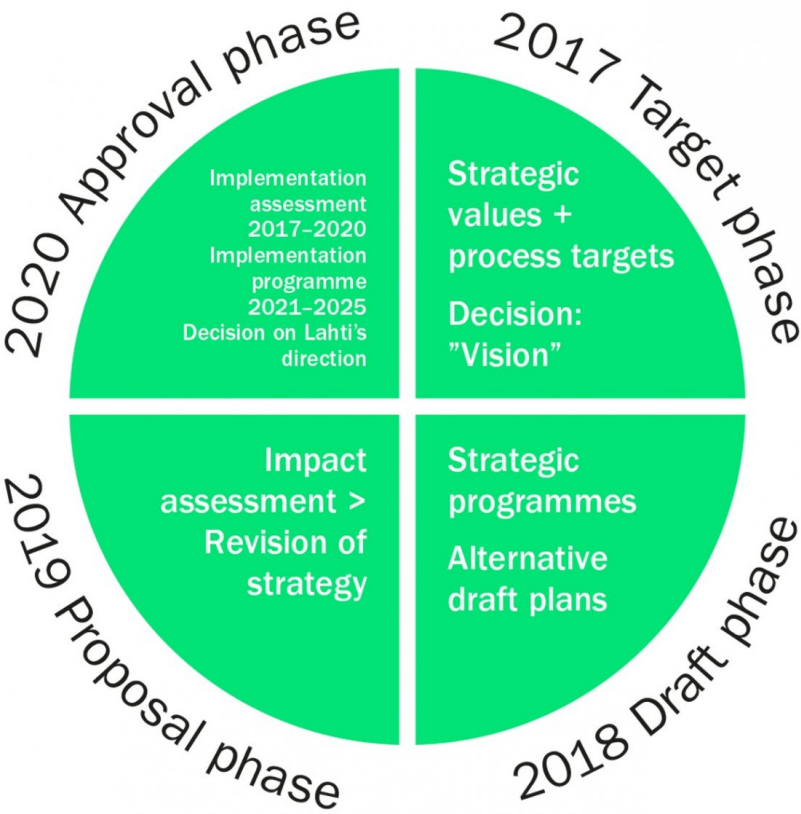


Figure 2. The Continuous Master Plan of Lahti provides a strategic planning process with integration possibilities.



Figure 3. Practical knowledge of residents is taken into the GIS planning process of the city's master plan.





Figure 4. The shift to sustainable urban mobility is currently the biggest city transformation process in Lahti.

## Good Practice 3

### Hybrid Solutions for Treating Urban Stormwater

Finding the best solutions to treat urban stormwater is currently high on the city's agenda, as the city is preparing a large-scale investment project called "Hybrid Solutions for Urban Stormwater". This project received a Finnish Government Programme Key Pilot Project status and funding for 2017-2018. The idea is to find both large and small scale solutions to treat urban stormwater and to integrate them into the development areas in Lahti (Fig. 5). Our aim is to find the best Nature-based Solutions (NBSs) to retain the nutrients and micro/nano-plastics that leach from the streets together with urban stormwater.

The University of Helsinki acts as an innovation partner for the city, and private companies are also encouraged to join in this investment and R&D project. We are currently expanding the storm water innovation co-operation to include the Helsinki Metropolitan Area via the Smart & Clean Foundation, in which Lahti is a partner. Our aim is to increase international co-operation within this theme.

Treating urban stormwater, in a more sustainable and smarter way, is a very important adaptation measure, as the increasing precipitation, which causes e.g. urban and river flooding, is expected to be one of the most problematic climate change impacts in Northern Europe. Cities can greatly benefit from and create a more adaptable infrastructure by using the research from ecosystem ecology.



Figure 5. Stormwater management is improved in the Ranta-Kartano area by using distributed systems.

## Good Practice 4

### Indicator 3: Sustainable Urban Mobility Personal Carbon Trading Scheme

The CitiCAP project (Citizens' cap-and-trade co-created) received funding from the EU UIA 2nd Call, Urban Mobility theme (2018-2020). The project concentrates on enabling and promoting sustainable urban mobility in Lahti (Fig. 7). Among other measures such as an open mobility data platform and a SUMP, the project develops a model for personal carbon trading on mobility and an application for the citizens that enables real-time tracking and visualization of one's mobility carbon footprint (Fig. 8). The application will be launched in September 2019. The basic idea of the application is the following. Every user will receive a certain amount of carbon allowances that will get spent based on their travel mode choices. By making more sustainable travel choices the user earns virtual euros that can be exchanged on a marketplace to services, products or discounts. The marketplace enables companies to get involved, gain visibility and new customers. What is more, the mobility data platform opens up possibilities for new mobility service development.

Part of the project money will be invested in cycling infrastructure. A 2,5 km long smart bicycle highway will be built in order to demonstrate how safe, convenient and fast cycling can be. The cycle lane will be separated from other travel modes and constructed using recycled or recyclable materials. It will act as a test bed for smart solutions that add value to the cyclists, such as information screens, smart bicycle racks and smart lightning.



Figure 7. Residents giving feedback on urban mobility to the CitiCAP project team.



Figure 8. Personal carbon trading system basis on mobility tracking application.

## Good Practice 5

### Indicator: 9: Water Rescuing Our Sensitive Water Bodies

We have been restoring Lake Vesijärvi since the mid-1970s in co-operation with several municipalities, universities and other research organizations. The annual restoration investment exceeds 250 000 € and is covered by the City of Lahti, Lahti Aqua Ltd and Lahti Energy Ltd. Past measures include improving wastewater treatment and biomanipulation. The current restoration stage involves the mapping of pollution sources, eliminating wastewater sources from private dwellings, constructing retention ponds and wetlands, aeration and biomanipulation (Fig. 9). In the past, Lake Vesijärvi was not suitable for swimming, but today, it has many public beaches. Two books on Lake Vesijärvi and its restoration story have been published (1992, 2010).

River conditions have been improved through sustainable drainage systems. The Porvoonjoki River is now cleaner due to effective wastewater treatment. The river's condition (including water quality, fish, fishing, and benthic fauna) has been monitored, together with other



municipalities, companies and non-governmental organizations, for over 20 years. The fraction of cyprinids has lessened and the population of more demanding fish has increased. We are reducing the negative impacts to the Baltic Sea by improving the Porvoonjoki River's condition.



Figure 9. Lake Vesijärvi is a globally interesting example of water restoration.

## Good Practice 6

### Indicator: 11: Energy Performance

#### Complete Green Shift in Lahti's Local Energy Production

Lahti Energy Ltd. (part of the Lahti City Group) has invested in energy efficient and sustainable district heating. The district heating network is extensive, with over 90% of the population and 99% of the municipal buildings using district heating. Over 95% of district heating is produced energy efficiently in the combined heat and power plants of Kymijärvi I and Kymijärvi II. The Kymijärvi II power plant (2012) is a unique gasification power plant that uses solid recovered fuel, SRF (Fig. 10), and waste wood to generate electricity and district heat. The net efficacy of waste gasification is much better in comparison to traditional waste combustion, which emphasizes that gasification represents the BAT of the much-argued energy-utilization of waste.

However, the City of Lahti is currently undergoing a complete change in centralized energy production, by replacing the old Kymijärvi I power plant with the new Kymijärvi III power plant by 2020 (Fig. 11). When procuring biomass, Lahti Energy demands FSC or PEFC forestry certificates.



Figure 10. The Kymijärvi II power plant is the world's first gasification power plant to use waste-based solid recovered fuel (SRF).

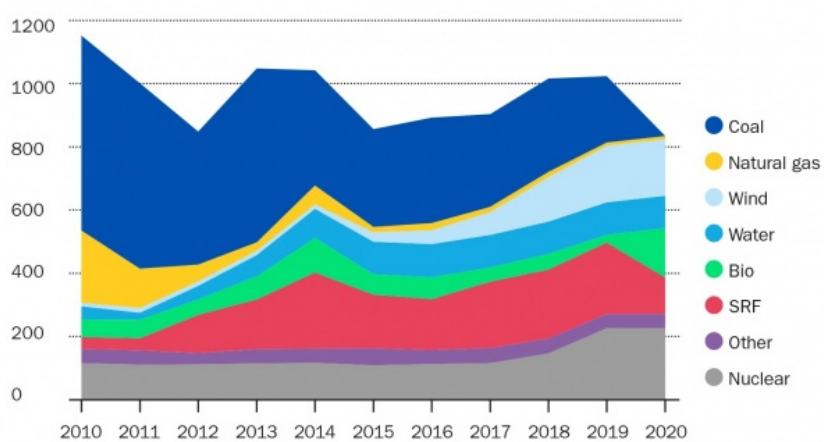
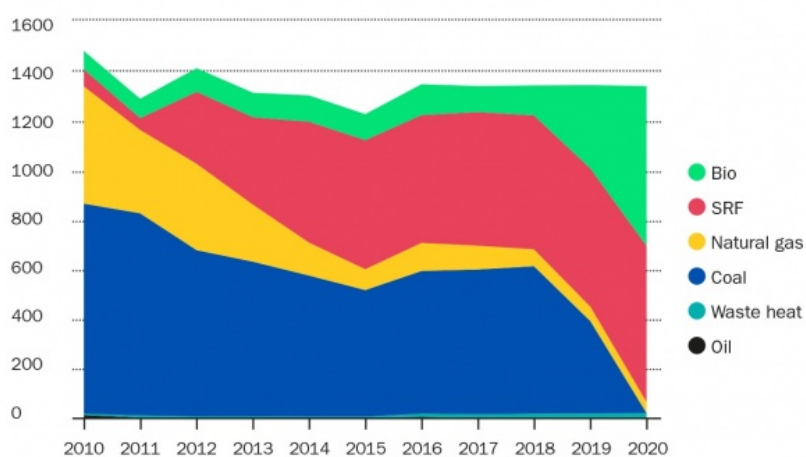
**Lahti Energy Ltd: Electricity production 2010–2020 (GWh)****Lahti Energy Ltd: District heating production 2010–2020 (GWh)**

Figure 11. District heating and electricity production (GWh) of Lahti Energy Ltd 2010-2020. Source: Lahti Energy, 2017.