Turku Climate Plan 2029

The City of Turku Sustainable Energy and Climate Action Plan 2029

Turku City Council 11 June 2018 § 142

Abstract:

Turku Climate Plan 2029 has been prepared in accordance with the common model of the European Union (SECAP, Sustainable Energy and Climate Action Plan) and it includes climate policies and milestones for years 2021, 2025 and 2029. The plan includes both climate change mitigation and adaptation. The objective is to collectively implement the goal of a carbon neutral city area 2029 laid out in the city strategy and to consolidate Turku's position as an international pioneer of climate solutions. The plan also includes justifications for why and how the objective of carbon neutrality will be met.

Contents:

1. Target, strategy and vision, implementation and monitoring

1.1. Climate targets

Turku City Council decided on the strategy on 16 April 2018. The main target of climate policy in accordance with the city strategy is a carbon neutral city area by the year 2029.

In order to meet the target, the Turku area strives to reduce greenhouse gases by 80 per cent compared to the 1990 level by year 2029. This target will be reached through milestones that are set for each council term.

- By 2021, reducing emissions by 50 compared to the 1990 level.
- By 2025, reducing emissions by at least 65-70 per cent compared to the 1990 level.
- By 2029 at the latest, reaching carbon neutrality and entirely compensating for any remaining emissions left.

From 2029 onwards, Turku strives to be a climate positive area with negative net emissions (meaning that compensation will be greater than emissions).

Simultaneously with reducing emissions, Turku prepares for climate change as comprehensively as possible and the city is developed to better sustain the change.

Turku implements strong climate policy and strives to be an internationally recognised pioneer and developer of sustainable solutions and expertise.

1.2. Key means for meeting climate targets/strategy and vision

The following measures are needed in order to meet the set climate targets:

- Bringing energy and mobility system emissions to a low level
- Reaching a sustainable low carbon community structure and development
- Implementing Turku City Group's own climate responsibility
- Mobilising citizens, communities, companies, stakeholders, development partners and universities – the entire civil society – to create climate measures together and to implement a carbon neutral Turku
- Increasing carbon sinks, production of renewable energy and other compensations
- Increasing awareness of the risks of and vulnerabilities to climate change and planning and implementing measures to prepare for change

Turku City Group’s measures effectively intervene with the most significant emission sources and reduce emissions comprehensively in all operation. The measures help consistently implement climate responsibility, encourage and set an example.

The climate actions put together amount to ambitious pioneership, making Turku a leading development area of sustainable solutions in practice.

The status of adaptation and preparedness for climate change will be analysed and measures will be mapped out and prioritised.

Sufficient resources will be allocated for steering and implementing climate policy and the planning and allocation of our investments and operation are reformed so that they better represent a life cycle approach.

The effects of different measures on emissions can be classified as follows:

1. Direct effect on emissions
    - The measure reduces emissions directly – for instance, an investment in renewable energy

2. Indirect effect on emissions
    - The measure reduces emissions indirectly – for instance, an improved public transport service system that is estimated to increase the use of public transport, simultaneously reducing the use of private cars

3. Exemplary/pilot effect
    - The measure is visible and encourages other bodies to implement measures that reduce greenhouse gas emissions – for instance, a solar panel on the roof of a school or a library bus or a new energy solution for an entire residential area

In addition to effects on emissions, other impacts can also be identified for each measure. These impacts may be used to justify implementation of measures:

- The city's climate responsibility – how the measure demonstrates responsible action from the part of the city
- Turku City Group’s climate responsibility – how the measure implements Turku City Group’s climate responsibility
- Innovation / business impact – how the measure produces/implements innovations and develops sustainable business
- Participation effect – how the measure enables and encourages the participation of the civil society and stakeholders in climate action

One measure can have several impacts – in fact, a good one often does.

Turku will prepare for the risks caused by climate change and their impacts, striving towards becoming a more climate-proof city. The most significant entities in terms of adaptation measures include:

- Increasing information on climate
- Water management and construction
- Safeguarding ecosystems
- Adaptation projects
- Supporting the sense of community

Turku implements strong climate policy and strives to be an internationally recognised and acknowledged pioneer and developer of sustainable solutions and expertise. Turku is already an internationally desirable partner and a city sharing its experience with others – a climate city with global visibility. Turku has what it takes to become one of the best climate cities in the world and it is our vision to turn Turku into the best. This calls for strong actions and a shared story that must be passed on.

1.3. Implementation and monitoring

The climate plan is approved by and its implementation is annually monitored by Turku City Council. Plan objectives are evaluated and revised more thoroughly each council term.

- Monitoring is carried out annually simultaneously with strategy monitoring.
- Implementation is reported every other year as required by the SECAP monitoring of the EU.
- Simultaneously with strategy update each council term, the implementation of milestones set for years 2021 - 2025 - 2029 is monitored and the results are reported as required by the SECAP monitoring of the EU. The plan is updated when necessary.

In accordance with administrative regulations, the City Development Section of Turku City Board steers climate and environment policies.

- The implementation and development of the climate plan will be reported to the department at least twice a year.
- Reporting includes an extensive measure update from all participating bodies (SECAP climate action cards, further information in section 3).

In accordance with administrative regulations, the City Development Group at the City of Turku Central Administration is responsible for steering and preparing climate policy and environmental policies.

- Sufficient resources are allocated for the task to support the management responsible for climate policy and environmental policies.

All city divisions and Turku City Group's subsidiaries implement the climate plan.

- A coordinating group will be assigned for Turku City Group level preparation, implementation and development.

The entire society is challenged to take part in the creation of a carbon neutral Turku. Common climate work arenas will be created for this purpose:

- Climate forum, once a year, with the following agenda:
  - Announcing main results of climate work and emission report
  - New initiatives
  - Acknowledging accomplished actions and actors
  - Communication and media

- Climate solutions forum, continuously available online with content such as
  - SECAP climate action cards – from all actors
  - Action presentation videos – from all actors
  - Effective communication in collaboration

Turku City Group’s actions have a significant role in the implementation of climate targets. Carbon neutrality and the objective of being the best climate city in the world will not be met without wide participation, effort and shared development. Turku will become the world’s best climate city through collaboration.

2. Calculation of greenhouse gas emissions for base year and monitoring years

2.1. Calculation methods used and further development

The calculation of greenhouse gas emissions in the Turku area is completed annually using the best method available. The emissions are monitored as part of the implementation of city strategy and climate plan and reported in accordance with UN requirements through the CDP system. Calculations have been made for years 1990 and 2000 and then annually from 2008 onwards using the CO2 report method.

In accordance with EU requirements, the base year of Climate Plan 2029 is 1990 and the principal monitoring years to be reported to the EU are 2015, 2021, 2025 and 2029. Calculation of greenhouse gas emissions for base year and monitoring years is normally completed using the CO2 report method and further elaborated and reported to the European Union in accordance with SECAP requirements.

In the future, calculation of emissions will be developed to cover also the annual capacity of the Turku area to absorb atmospheric carbon and to produce renewable energy exceeding its own need as well as potential other compensation mechanisms. Turku strives to develop the calculation and definition of carbon sinks and other compensations in collaboration with the Finnish Climate Change Panel and the Finnish Environment Institute SYKE and other potential partners.

- The distribution of greenhouse gas emissions in the Turku area steers climate policy measures. Changes in emission levels indicate the impacts of climate policy.
- When the calculation of compensations is also linked to calculation of emissions, it is possible to create a more comprehensive view of the progress towards carbon neutrality and climate positivity in the area.
- SECAP calculation in accordance with EU requirements is based on the annual CO2 report but takes into account e.g. the energy production and holdings of Turku City Group in more detail.
- In the future, emissions will still be calculated in accordance with the CO2 report but data on emissions is reported to the European Commission in accordance with the SECAP format every four years.
- The status and calculation of carbon sinks will be included in the same process. As carbon sinks generally change slower than emissions, they will be calculated every four years.

Calculation methods have been explained in more detail in the annex (annex 1).

2.2. The distribution and development of greenhouse gas emissions in the Turku area (emission inventories)

Annual calculation of emissions in accordance with the CO2 report

Using the CO2 report calculation method, normalised greenhouse gas emissions in Turku in 2015 amounted to 989.0 kt CO_2 eq. The most significant sectors causing emissions (figure 1) were district heating (381.8 kt CO_2 eq), electricity consumption (226.8 kt CO_2 eq) and road transport (183.6 kt CO_2 eq).

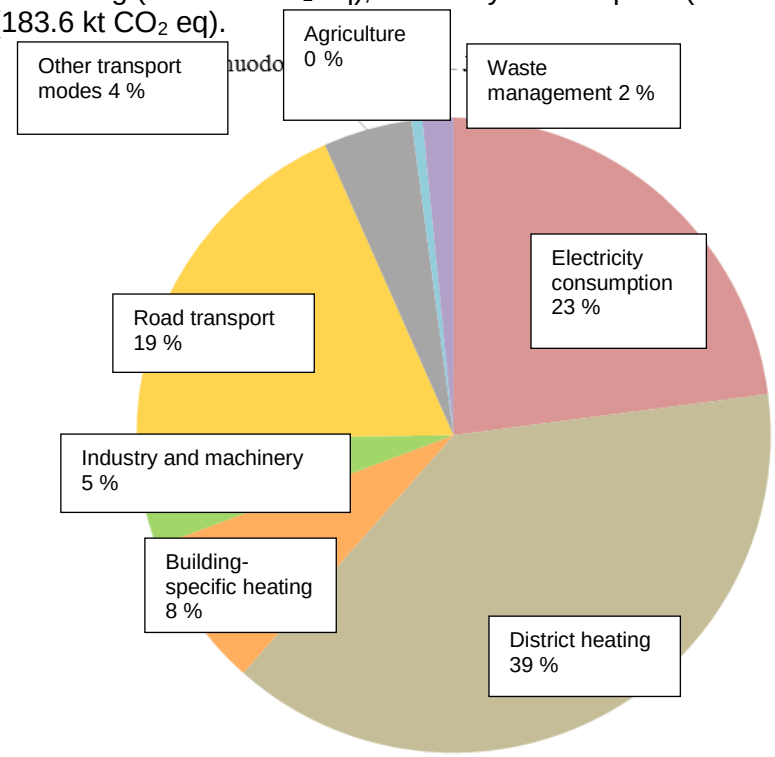
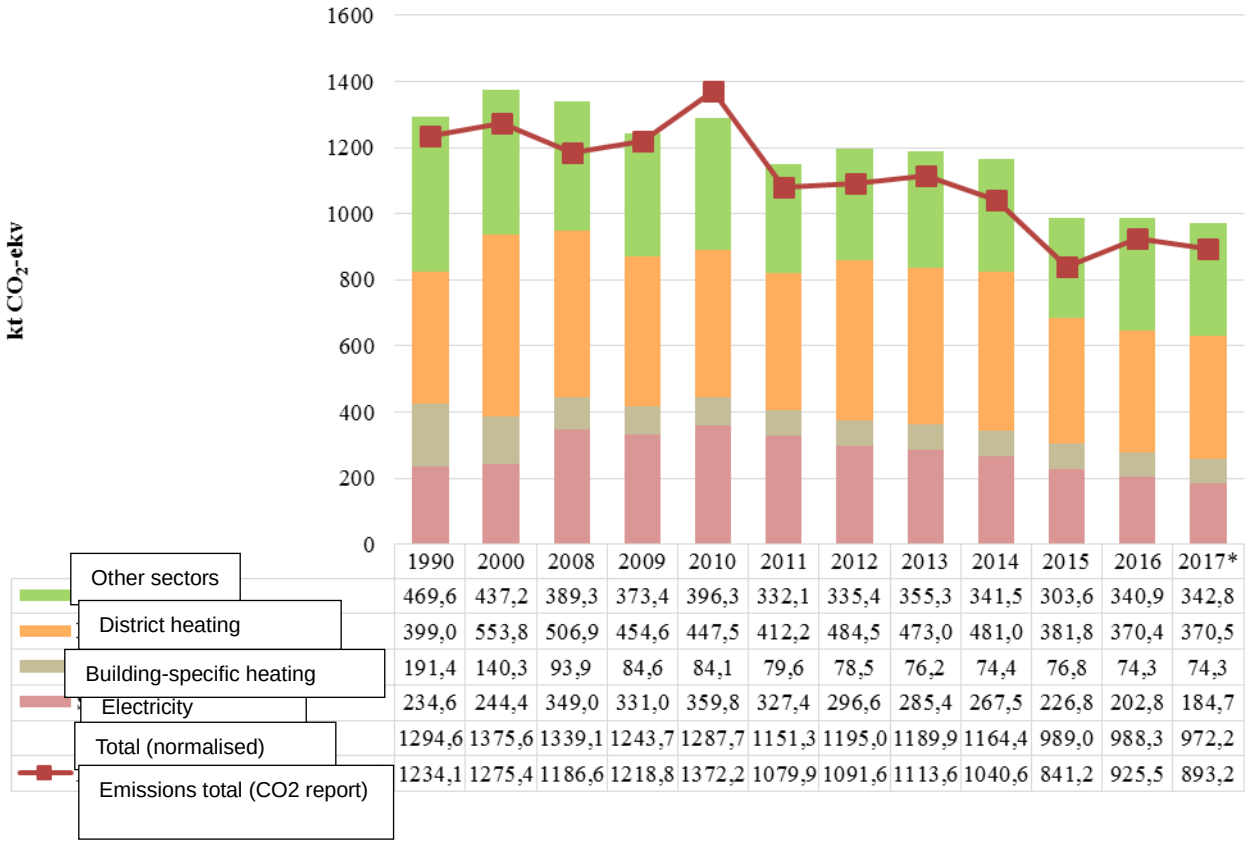


Figure 1. Turku greenhouse gas emissions by sector in 2015 calculated using the CO2 report method. Emission development has been normalised in the calculation to equate to the climatological normal period 1981–2010 and using a five-year moving average for the emission factor of electricity.

Greenhouse gases in the Turku area have decreased significantly during the years of monitoring. Since 2009, normalised emissions have been below the level of 1990 and in 2015, emissions were 24 per cent lower than in 1990 (figure 2). According to preliminary information,[1] normalised emissions hit their lowest point of the entire time series in 2017 (972.2 kt CO_2 eq).

[1]Preliminary information on the calculation of emissions for year 2017, CO2 report 2018

The greatest emission reduction in terms of quantity compared to the top level (year 2000) was accomplished by increasing renewable energy in district heat production. Compared to year 1990, the reduction in emissions results particularly from building-specific heating. These emissions have decreased 60 per cent. Also industrial and machinery emissions (68 per cent) and waste management emissions (42 per cent) have decreased significantly. Mobility emissions have decreased to some extent. In addition to Turku area measures, Government policies have contributed to meeting climate objectives.



	1990	2000	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*
Other sectors	469,6	437,2	389,3	373,4	396,3	332,1	335,4	355,3	341,5	303,6	340,9	342,8
District heating	399,0	553,8	506,9	454,6	447,5	412,2	484,5	473,0	481,0	381,8	370,4	370,5
Building-specific heating	191,4	140,3	93,9	84,6	84,1	79,6	78,5	76,2	74,4	76,8	74,3	74,3
Electricity	234,6	244,4	349,0	331,0	359,8	327,4	296,6	285,4	267,5	226,8	202,8	184,7
Total (normalised)	1294,6	1375,6	1339,1	1243,7	1287,7	1151,3	1195,0	1189,9	1164,4	989,0	988,3	972,2
Emissions total (CO2 report)	1234,1	1275,4	1186,6	1218,8	1372,2	1079,9	1091,6	1113,6	1040,6	841,2	925,5	893,2

Figure 2. Emission development in Turku calculated using the CO2 report method in 1990, 2000 and 2008 - 2017. The bars represent normalised emissions and the line represents materialised emissions.

Calculation in accordance with the EU SECAP method

Degree day corrected emissions in Turku calculated using the SECAP method amounted to 1236.2 kt CO_2 eq in 1990 and 1020.3 kt CO_2 eq in 2015. From the point of view of emissions, the most significant sectors as defined in SECAP were residential buildings, causing 44 per cent of total emissions in Turku in 2015 (figure 3). Second most significant sectors in terms of emissions were industry and private and commercial transport.

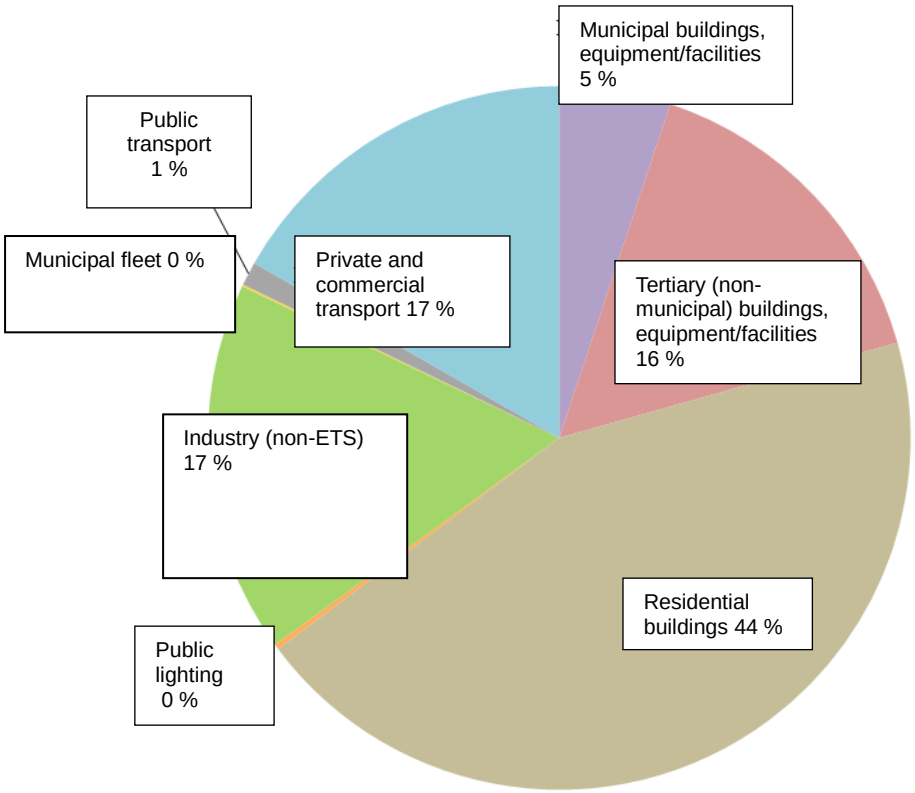


Figure 3. Degree day corrected emissions by sector in Turku in 2015 calculated using the SECAP method. Calculation methods have been explained in more detail in the annex.

Besides by sector, emissions calculated with the SECAP method can also be presented by source of energy (figure 4). Most emissions in Turku are caused by district heating and electricity consumption. In 2015, their share of total emissions was 69 per cent.

Based on calculations using the SECAP method, emissions have decreased 17 per cent in Turku between 1990 and 2015. Particularly the decreased use of fossil fuels has contributed to the reduction in emissions. Between 1990 and 2015, emissions caused by fuel heating have decreased 60 per cent, emissions caused by other fossil fuels used by industry have decreased over 80 per cent and emissions caused by industrial use of coal have decreased 45 per cent. Also district heating emissions have decreased even though the district heating network has expanded significantly and the energy consumption of district heating has increased (district heating emissions per used energy have decreased by a third).

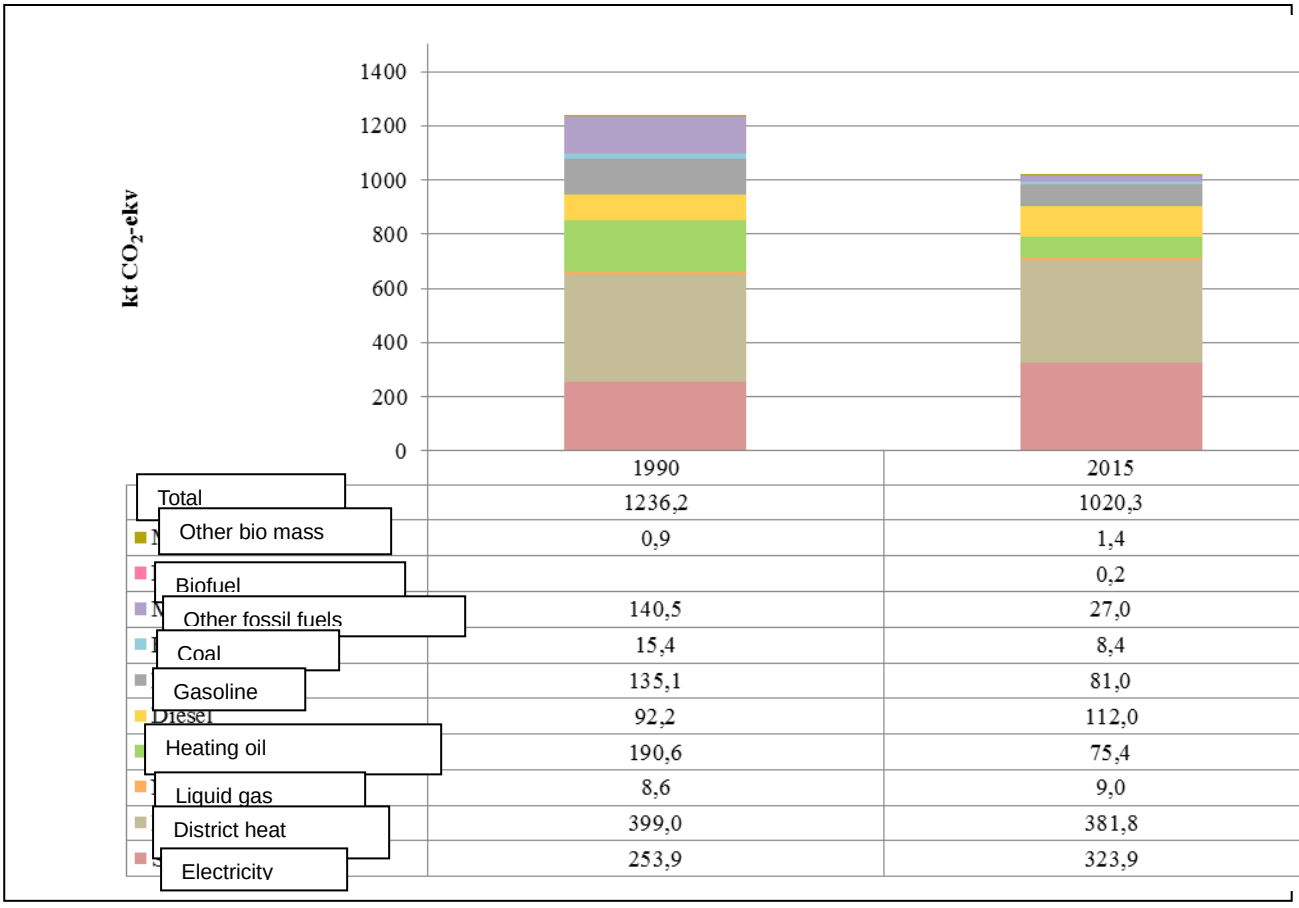


Figure 4. Degree day corrected emissions by source of energy in 1990 and 2015 in Turku, calculated using the SECAP method.

3. Climate change mitigation measures

3.1. Targeting the measures

Mitigation measures will be targeted as efficiently as possible on the basis of the emission distributions presented above. Actions are aimed at reducing emissions as efficiently and sustainably as possible (direct effect on emissions, indirect effect on emissions and exemplary / pilot effect). As presented in section 1 above, the measures are also based on Turku City Group's climate responsibility, innovation impact/business impact and participation impact. The most significant entities in mitigation actions include:

- Carbon neutral energy system
  - Approximately two thirds of greenhouse emissions in the Turku area
- Low carbon sustainable mobility
  - Approximately one fifth of greenhouse emissions in the Turku area
- Sustainable urban structure
  - Affects both energy and mobility in the entire urban area
- Turku City Group's climate responsibility
  - Turku City Group sets an example and creates the story of a carbon neutral Turku together

- Strengthening carbon sinks
    - The ability of the Turku area and region to absorb atmospheric carbon is improved

The main objectives and policies of mitigation measure entities are presented in the next section. Climate plan measures are continuously developed and complemented during the implementation of plan and they are steered as presented above in section 1. SECAP climate action card model has been created in order to define actions.

3.2. Carbon neutral energy system

The heat, cold, steam and electricity used in the Turku area will be produced in a carbon neutral manner at the latest in 2029 (considering compensations).

- The use of coal for energy will be phased out already in 2025, if the Government participates in the resulting investment costs.
- The share of renewable energy of district heat is at least 65 per cent in 2021.
- The share of renewable energy of electricity and heat sold by Turku Energia is at least 80 per cent in 2025. Significant effort in the next few years is required to meet the objectives together with other functional and economical objectives of Turku Energia
- Impacts on sustainability and regional economy are emphasised in acquisition of renewable fuel.
- Solutions will advance economic effectiveness and feasibility (and these will be taken into account in decision-making).

Turku City Group develops the production and ownership of renewable energy in a way that the production serves an area wider than Turku and helps turn Turku into a climate positive area.

Smart solutions, multidirectionality, storage and the entire potential of the sources of energy and production opportunities in the area will be used and energy efficiency will be improved in the development of energy system of the Turku area and region.

- Municipal residents, businesses and communities are activated to join energy measures with the help of the Citizens' energy transition project. Banks are encouraged to develop provision of energy loans and energy investments are promoted using the city's own means (e.g. permit processes, planning and other steering).
- Energy expertise and new solutions are developed in collaboration with universities, educational establishments, development organisations and businesses.

Effort is put into energy efficiency in the entire Turku City Group and energy losses will be harnessed and/or eliminated as extensively as possible. The City of Turku is a pioneer in energy efficiency and strives to remain as such also in the future.

- The city develops and implements comprehensive energy efficiency leadership and invests in improvement of energy efficiency.
- A model for steering and assessing climate and life cycle impacts of investments will be developed and utilised from pre-analysis throughout the entire life cycle of projects.
- Energy efficiency investments with credit can be made with a repayment period of 5-15 years, making use of green financing in particular. The return on investment is calculated for 10-20 years.
- Skanssi and Science Park / Kupittaa will be special target areas for energy investments between 2019 and 2025. However, efforts are made to make economical energy investments at all times and in all areas.

The objectives of the city's energy efficiency in the city's own property stock and infrastructure are prepared and steered with the help of an energy efficiency agreement.

- Energy efficiency agreement 2008-2016: 18.100 MWh saving achieved 2008-2016 (improvement of approximately 7.5 per cent)
- Energy efficiency agreement 2017-2025: improvement of 7.5 per cent 2017-2025 (milestone set as 4 per cent for 2017-2020)
- Energy efficiency measures/objectives/agreement 2025-2029: the target will be set later

3.3. Low carbon sustainable mobility

Active mobility and development of public transport have an important role in the implementation of a carbon neutral Turku. Simultaneously, they have a positive impact on the healthiness and safety of urban environment, the physical and psychological wellbeing of citizens and quality of life. New mobility solutions also represent a significant development target and platform for innovations and business.

The share of walking, cycling and public transport will be increased through active measures in accordance with objectives of Master plan 2029. The objective for the share of sustainable means of transport according to Turku master plan and the Structural Model 2035 for the Turku Urban Region is over 66 per cent in 2030.

Simultaneously, efforts will be made to reduce greenhouse gas emissions caused by street and road traffic by 50 per cent from the level in 2015 by the year 2029. National level targets and measures support meeting the objectives of Turku.[2]

- In order to meet the objective of carbon neutrality, Turku actively creates sustainable mobility culture that includes old and new sustainable means of mobility and smart technical and digital solutions that facilitate mobility.
- Cycling and walking conditions are significantly improved around the year and citizens are encouraged to actively engage in exercise in everyday life and free time. Cycling significantly affects wellbeing and health, and the benefits of cycling and active exercise will be promoted variedly. A development programme for cycling is implemented methodically and sufficient resources are allocated for it.
- Car traffic emissions are reduced by investing in electric motoring and developing adequate conditions for it. Investments are also made into other emission-free and / or low emission sources of energy and new alternative means of transport such as electric bicycles and automatic tools of transport.
- Investments in Mobility as a Service solutions help renew means of transport and steer the market towards lower emissions. Simultaneously, development of new innovations based on digitality is supported and market is created for them.
- Low emission logistics will also be developed in the area with the help of smart digital solutions.

Developing public transport and increasing its use is important for reducing greenhouse gas emissions caused by mobility. At the same time, reducing emissions caused by growing public transport is a significant and exemplary climate measure.

[2] The national reduction target for year 2030 is 50 per cent of the level in 2005 (medium-term climate change policy plan (*KAISU*)

- Public transport in Turku will be turned into a carbon neutral service by 2029. In terms of urban traffic in Turku, carbon neutrality will be reached already by 2025.
- Electrification of lines proceeds in the pace enabled by technical development and competitive tendering and electrification is complemented with biofuel solutions.
- The service capacity of public transport will be significantly improved in order to implement the strategic carbon neutrality objective of the City of Turku and to support sustainable and attractive urban development.

  - Carbon neutral public transport system of large capacity (separate decision)
  - Improved public transport services (trunk routes, route planning, guaranteed transfer, smart buses and systems)
  - The use of public transport will be significantly promoted by means of urban and traffic planning
  - The public transport service will be subject to active communication and its use will be supported with campaigns and spreading of information.
  - Public transport is a strong and natural part of trip chains and development and implementation of Mobility as a Service concepts. Innovative businesses and developers have a significant role as solution makers.

3.4. Sustainable urban structure

Sustainable urban structure has a positive impact on low emission energy and low emission mobility in the entire functional urban region[3]. At the level of Turku urban region, sustainable development of community structure is steered and advanced through the regional structural model (the Structural Model 2035 for the Turku Urban Region) and the MAL agreement (concerning land use, housing and transport planning) and programmes, transport system work and transport system plan in collaboration with regional municipalities and the Government.

- The MAL agreement and related collaboration is a significant tool for Turku in consolidating development that supports carbon neutrality.
- Turku is active and uses initiative in developing the community structure in the urban area. By its own actions, Turku advances climate objectives in the entire functional urban area.
- Greenhouse gases in the urban region are an indicator of the MAL agreement and they have been calculated for the entire region and for each of its municipalities since 2015 (many years longer in several municipalities).

Within the area of the City of Turku, the sustainable development of community structure is steered through zoning, land use, traffic planning, construction and related development projects.

- In accordance with urban strategy, land use in Turku is focused on reaching a carbon neutral urban area by 2029. This calls for energy efficient development of community structure that encourages the use of sustainable means of transport.
- Sustainable mobility is significantly supported with traffic planning, and projects that enable smart mobility are prioritised also in building lanes and in maintenance throughout the year.

[3] The functional urban region of Turku consists of the 13 municipalities of the Turku urban region commuter area that are also the MAL agreement municipalities.

- Sustainable construction is developed and promoted not only in pilot areas but also extensively in the entire city area. Using wood as building material is developed, new energy solutions are implemented and energy effectiveness is improved.
- The objective of a low carbon climate change resilient city is strongly advanced in applicable city spearhead projects throughout the implementation period of Climate Plan 2029.
- The new solutions and development partnerships of the sustainable city district Skanssi will be implemented ambitiously and the resulting solutions will also be applied in other districts/areas. Sustainable solutions are searched by default and pilots are developed also in other areas.

The Turku Master Plan 2029 under elaboration is a significant process to implement strong climate policy. The City Board approved on 30 September 2013 the § 399 initial state report and the objectives set for master plan work. On 9 November 2015, the City Board approved the § 479 Growth Corridors development plan as a basis for continued drafting of master plan work. Approved master plan objectives and development strategy significantly support reaching carbon neutrality in the Turku area in 2029 and preparing for climate change.

- Turku advances sustainable development by uniting community structure.
- Water bodies and green areas form a solid ecological network.
- In land use planning, limitations caused by physiographic features and resulting economic and environmental risks will be taken into consideration and conflicts with sustainable development targets will be identified.
- Land use will be developed urban economically and energy efficiently by making use of existing community structure and infrastructure. Housing, services, trading venues, workplace areas and infill construction focus areas will be placed in a way that they promote a city of walking, cycling and public transport.
- Walkers and cyclists will be provided with uninterrupted main connections of high quality, safe routes and convenient city centre arrangements.
- The regional public transport system is based on trunk network with competitive speed and frequent operating times.
- The share of walking, cycling and public transport in Turku will be over 66 per cent in 2030.

3.5. Turku City Group’s climate responsibility

By acting responsibly, the City of Turku and Turku City Group’s subsidiaries can significantly reduce the direct and indirect greenhouse gas emissions caused by their operation, demonstrate climate leadership and set an example. Simultaneously, they develop their operation, implement the Turku strategy and values and together create the story of a carbon neutral Turku.

Sustainable investment principles and modalities will reduce emissions economically.

- The City of Turku is developing a model for steering and assessing impacts on climate and environment during the life cycle of investment projects. This enables an overall economic evaluation and implementation of projects. The City of Turku takes the model into use in its investment processes as effectively as possible during years 2019 – 2021.
- From 2019 onwards, Turku City Group’s subsidiaries will be obliged to focus on the impacts on climate, environment and life cycle of their investments and acquisitions and to participate in the development and implementation of an assessment model for them in collaboration with the City of Turku.
- In city premises, improvement of energy efficiency will be implemented along with investments in renewable energy when possible.

- Energy efficiency will be stressed as one of the decisive criteria in the acquisition of new premises.
- In investments and acquisitions, circular economy solutions will be promoted and consumption of natural resources will be reduced.
- Impacts on climate, environment and life cycle will be emphasised in acquisitions as efficiently as possible from 2019 onwards. Sufficient resources will be allocated for this and expertise will be created in collaboration.

From 2019 onwards, Turku City Group's subsidiaries that are responsible for premises, residential buildings and/or other buildings, will be obliged to consider the following:

- Initiating new projects concerning premises must be built and/or purchased in a way that a high-level environmental classification can be acquired for the premises.
- When new construction is situated in the Science Park spearhead project area and/or the Skanssi district and/or Turku city centre area, projects concerning construction and premises must be prepared in a way that exemplary and innovative energy solutions and other sustainable development solutions can be implemented in them;
- The energy efficiency and other environmental impact of their old building stock must be improved. Renewable energy investments must be implemented in collaboration where possible and sustainable further use of building must be looked after.

Turku City Group is committed to sustainable mobility.

- In the acquisition of vehicles and transport services for the city and for Turku City Group's subsidiaries, extensive investments are made in stock that uses electrical and renewable sources of energy.
- Fossil-fuelled vehicles can only be acquired in special cases with reasonable justification, and existing fossil-fuelled vehicles will be replaced rapidly (taking life cycle impact into account)
- Charging points will be located in the city's own properties.
- In commuter transport, effort is put into improving conditions for active mobility and employer-subsidized commuter tickets for public transport.
- Shared use vehicles and/or services offering them will be acquired for mobility in business affairs.
- Staff parking will be reduced and a sufficient fee will be collected. Staff members are encouraged to use sustainable means of transport.

All city units and Turku City Group's subsidiaries aim at implementing resource-wise policies such as saving energy, prioritising sustainable mobility, reducing material loss, maintaining operational culture that supports sustainable development and using natural resources within the planet's limits. Eco-support activity is allocated and consolidated to support these efforts.

The climate efforts of the Turku City Group are strong and active. It is also desirable for Turku City Group's subsidiaries to:

- promote resource wisdom in their operation and to plan their own responsibility measures and climate and environmental programmes;
- propose and develop effective climate measures alone, together and in collaboration with the city
- participate actively in implementing innovative and effective climate measures and communicate the shared story of a carbon neutral Turku.

3.6. Strengthening carbon sinks

Strengthening carbon sinks that absorb atmospheric carbon is a significant climate change mitigation measure. Without tree felling, the carbon absorption of forests owned by the City of Turku already compensates for passenger car emissions in the Turku area. Increasing the carbon absorption capacity of vegetation and soil is affordable in terms of costs and it also has other significant positive effects.

Carbon sinks, production of renewable energy and other compensations must be increased to reach carbon neutrality and to become a climate positive area. In accordance with its strategy, the City of Turku looks after the carbon stock in the soil and vegetation by striving towards increasing green areas and maintaining forests, fields and the amount of vegetation within its area and preferring naturalness in planting areas. New kinds of urban nature and green area development will be increased as the city becomes more condensed.

- Maintaining carbon sinks will be taken into consideration in updating the city's forest plan. Fragmented green infrastructure is fixed by forestation of suitable field areas.
- New land areas will be acquired with trees when possible, and forest property will not be used to compensate for a short-term cash deficit.
- Urban parks and related green infrastructure will be further developed to mitigate climate change (carbon sinks) and to support preparedness (runoff waters, effect on microclimate).
- Green-blue factor will be taken into use in construction planning. Maintaining soil and using long-lasting woodwork will be preferred in construction. Using wood as construction material is developed and its share is increased.
- Carbon stock in vegetation and soil and carbon sinks will be calculated every four years. Their monitoring is developed taking also water bodies into account where possible.

3.7. SECAP climate action cards for mitigation measures

Reacting to climate change and implementing climate measures is a right of every Turku resident and everyone can take part in the story and creation of a carbon neutral Turku. This is what makes our story a shared and a strong one. At the same time, measures of Turku City Group need to be supported by citizen actions, so that the carbon neutral city area can be implemented.

Participation and co-development also help to get all possible business, innovation and participation benefits out of ambitious climate actions. All willing and capable actors must be able to participate in the creation of a carbon neutral Turku and its story. To enable this and to describe the actions as concisely and at the same time comprehensively as possible, we have developed the SECAP climate action card.

SECAP card models have been made to serve both the city organization and Turku City Group's subsidiaries as well as other actors. The goal is to activate citizens, communities, businesses and universities – the entire civil society – to join in the creation of climate measures and implementation of a carbon neutral Turku. Section 1 describes in more detail how the cards are annually linked to the implementation and steering of climate plan.

SECAP card is a short, user friendly and guiding way to create climate measures and to take them as part of implementing a carbon neutral Turku together. At the moment (on 24 May 2018), 25 cards have been created regarding measures of the city and of Turku City Group's

subsidiaries. A table presenting SECAP climate action cards and examples of cards can be found in the annex (annex 2).

4. Scenarios and demonstrating the attainment of target

4.1. Turku's objectives

Turku has set ambitious targets for mitigating climate change. These include a decrease of at least 50 per cent in greenhouse gas emissions of the level in 1990 by 2021, a decrease of at least 65–70 per cent by 2025 and carbon neutrality by 2029. Carbon neutrality has been defined in a way that emissions in the city area will decrease by at least 80 per cent and the remaining emissions will be compensated by carbon sinks or other mechanisms of compensation. The attainment of target has been examined using a scenario analysis.

4.2. Scenario methods and assumptions

Emissions in Turku in 2015 form the starting point of the scenario. Business as Usual scenario has been compiled as baseline development without measures implemented by the City of Turku but taking into account national level actions and their impacts. Baseline emission development is based on interviews with experts and national level material such as the National Energy and Climate Strategy 2030[4] and its background documents, the Government report on medium-term climate change policy plan for 2030[5] and its background documents and the current government policy accord.

The SECAP scenario has been compiled by adding the impact of Turku Climate Plan 2029 actions to baseline emission development. The most important underlying assumptions and impact assessments for Turku measures are presented in tables 1 and 2.

[4] http://tem.fi/strategia2016

[5] http://www.ym.fi/Ilmastosuunnitelma2030

Table 1. Underlying assumptions of the SECAP scenario

Parametre	Baseline and national level measures	SECAP measures
Electricity consumption	Moderate growth	Citizens' energy transition and the city's energy efficiency measures will mitigate consumption growth, limiting it to 0.5 per cent per year
Electricity emission factor	The national emission factor will decrease approx. 50 per cent compared to the 2015 level by 2029 as a result of national level measures. National level measures support phasing out coal in Turku Energia's own production	Turku Energia's own production will be carbon neutral in 2029 (phasing out coal and 80 per cent carbon neutral production in 2025)
District heating consumption	Moderate growth	Citizens' energy transition, the city's energy efficiency measures and reduction of network losses will mitigate growth so that consumption remains at 2015 level in 2029
District heating emission factor	National level measures support phasing out coal	Turku Energia's own production will be carbon neutral in 2029 (65 per cent carbon neutral production in 2021, phasing out coal and 80 per cent carbon neutral production in 2025)
Oil consumption in building-specific heating	Decreases 65 per cent compared to the 2015 level by 2029 as a result of national level measures	Decreases by 15 per cent compared to the 2015 level as a result of Citizens' energy transition project measures
Industrial and machinery use of fuel	The use of coal will end and the use of oil will halve compared to the 2015 level by year 2029 with the help of national measures.	
Road transport emissions	Emissions will decrease by a quarter compared to the 2015 level by 2029 as a result of national level measures	New means of mobility and technological solutions will reduce road transport emissions by almost a quarter compared to the 2015 level by 2029
Public transport emissions		Public transport will be carbon neutral in 2029 and its use will have increased
Emissions caused by other transport modes (rail, waterborne transport and aviation)	Decrease proportionally to street traffic emissions	
Agriculture emissions	Remain at 2015 level	
Waste management emissions	Halve from the level in 2015 by 2029	

Table 2. Impact assessments for Turku SECAP measures. Emission reduction in 2029 compared to degree day corrected emissions in 2015.

Measure	Emission reduction (kt CO_2 eq)
Carbon neutral heat	378
Skanssi two-way heat	
Share of renewable fuel TSE Naantali 4	
Increasing energy storage solutions (district heating and district cooling)	
Reducing network losses in the district heating network	
Citizens' energy transition	11
Share of renewable fuel TSE Naantali 4	234*
Carbon neutral electricity	
Building solar systems on Turku City Group properties	1**
Energy efficiency audits in city properties	
Promoting demand response for electricity and heat in city properties	
Replacing fossil fuels in public transport with biofuels	11
Electrification of bus lines	
Piloting and development of a two-way charging point (V2G)	21
Implementing charging points within city properties	
Improving charging opportunities for electric cars	
Promoting transport use of biogas	
Carbon neutral public transport system of large capacity	21
Public transport trunk routes	
Traveller information and disruption management in public transport	
Quality routes for cycling, main network	
City bike system	
Harnessing large volume masses	*not evaluated*
Climate networks and development partnerships	*not evaluated*
Carbon sinks in forests	*compensations*
Carbon sinks in the city	

* Only the SECAP method

** The emission reduction impact of the measure remains relatively low, as electricity and district heating during the target year will be carbon neutral.

4.3. Scenario results and target attainment

Normalised emissions in Turku calculated using the CO2 report method for the years 1990, 2000 and 2008 - 2016, and scenarios for years 2021, 2025 and 2029 are presented in figure 5. On the basis of scenario examination, the emission reduction targets of Turku for years 2021 and 2025 will be met and emissions will be below target level.

On the basis of examination, emissions will decrease further between 2025 and 2029 but remain slightly above the target level of 2029 (-80 per cent).Thus, in order to meet the carbon neutrality objective in 2029, further measures beyond those described in this plan are required.

The greatest emission reduction will be achieved by switching to carbon neutral district heating (378 kt CO_2 eq emission reduction 2015–2029). Factors affecting road transport emission reduction (97 kt CO_2 eq 2015–2029) include measures that aim at low carbon mobility and sustainable urban structure. Also national level measures contribute to the development of emissions from road transport. Citizens' energy transition project and energy efficiency measures reduce emissions caused by building-specific heating, electricity consumption and district heating.

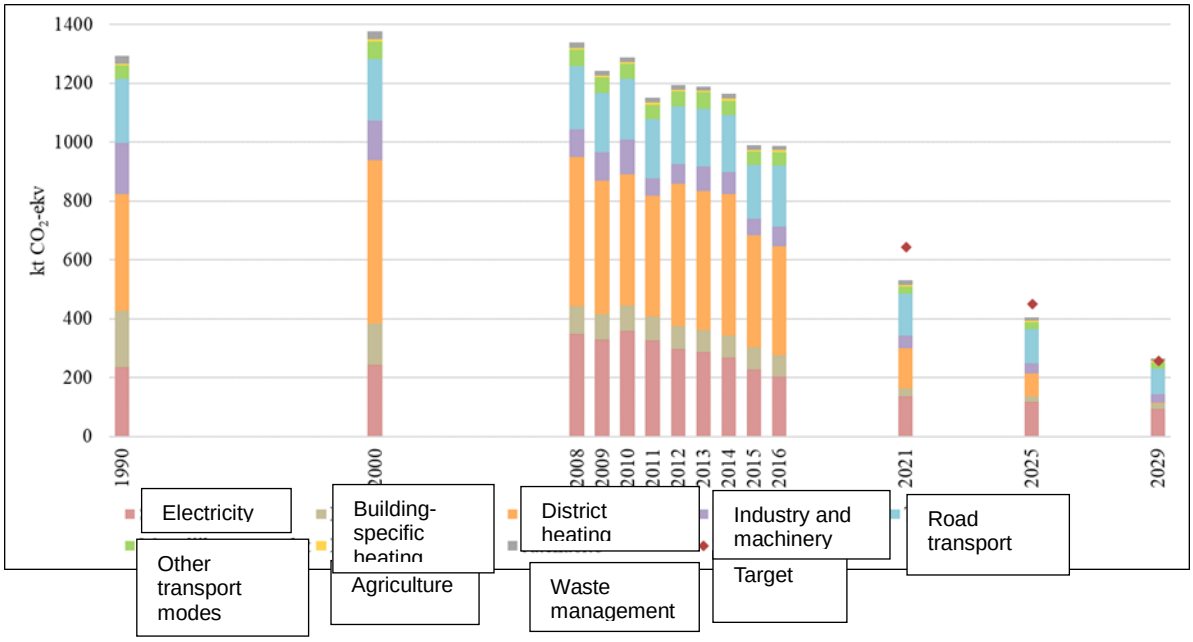
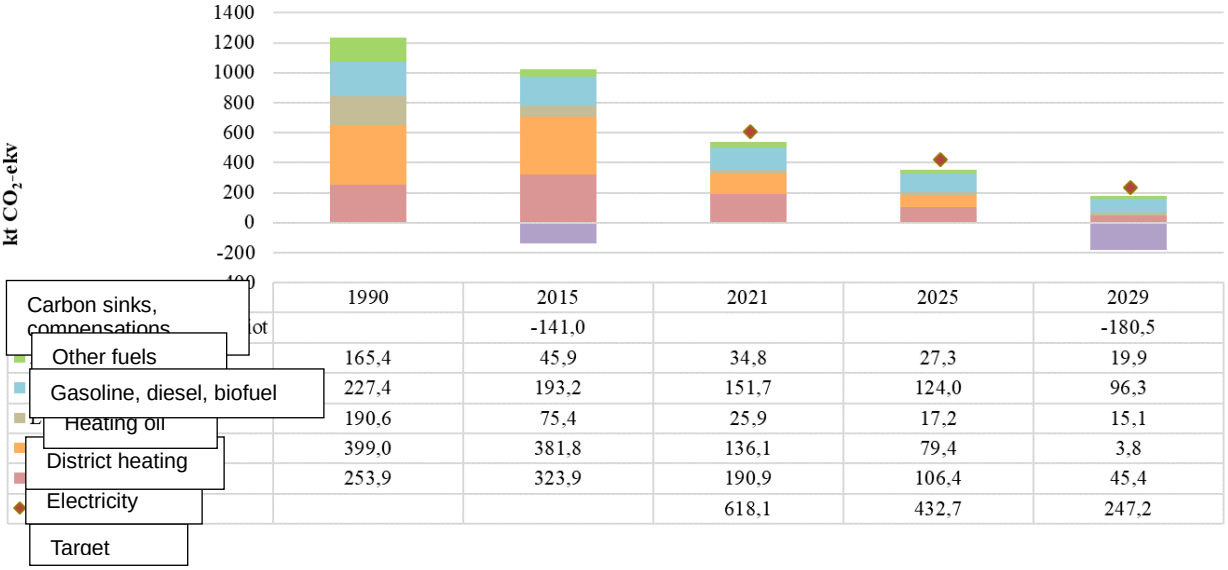


Figure 5. Emissions in Turku calculated with the CO2 report system in Turku in 1990, 2000 and 2008-2016, scenarios and target levels for years 2021, 2025 and 2029.

Emissions in Turku in 1990 and 2015, calculated using the SECAP method, are presented in figure 6. The carbon sink estimation for year 2015 is based on the ILKKA project calculation for the year 2011. Scenarios for years 2021, 2025 and 2029 and the compensation required to meet carbon neutrality in 2029 are also presented in the figure. On the basis of the scenario,

measures are sufficient to meet the targets for years 2021, 2025 and 2029. Emission reduction of electricity consumption in 2029 (279 kt CO_2 eq) is greater than in the figure above, as the SECAP method takes into account not only national electricity production but also the switch made by Turku Energia into production of carbon neutral electricity.



	1990	2015	2021	2025	2029
ot		-141,0			-180,5
	165,4	45,9	34,8	27,3	19,9
	227,4	193,2	151,7	124,0	96,3
	190,6	75,4	25,9	17,2	15,1
	399,0	381,8	136,1	79,4	3,8
	253,9	323,9	190,9	106,4	45,4
			618,1	432,7	247,2

Figure 6. Materialised emission development in Turku (1990, 2015) and scenario (2021, 2025 and 2029) in relation to targets and compensation needed for carbon neutrality.

The effect of different measures and factors on the emission level in Turku in 2029 is presented in figure 7. Effects have been examined and calculated using the SECAP method for the timeframe 2015–2029. Baseline development equates to approximately one fifth of emission reductions achieved within the timeframe in question and the remaining emission reductions are achieved by measures implemented in the city. Of all measures, those aiming at a carbon neutral energy system are the most significant: carbon neutral district heating (45 per cent of emission reduction) and electricity (28 per cent). The estimated share of mobility measures of the emission reduction is approximately 6 per cent.

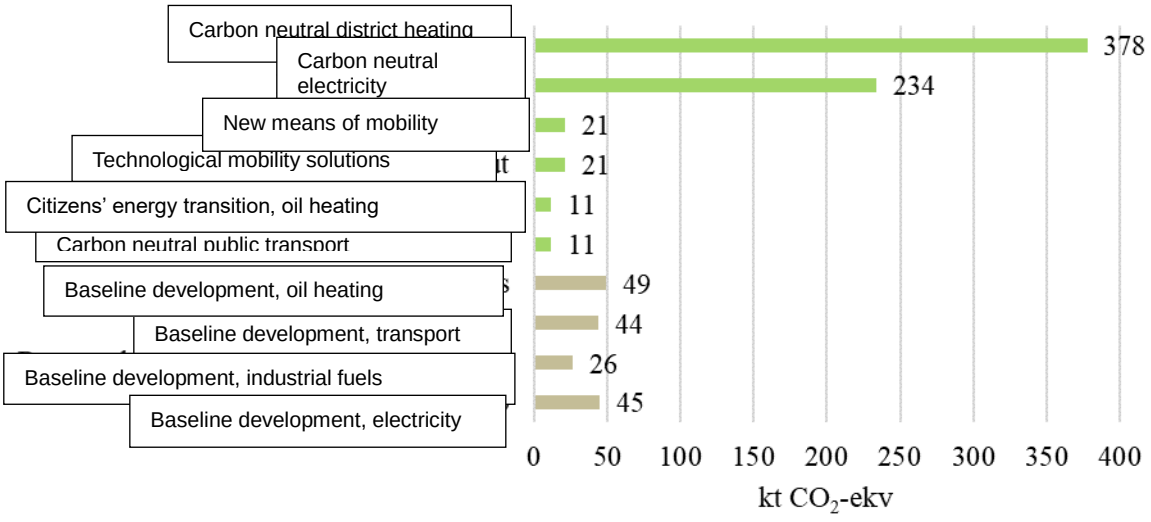


Figure 7. The effect of measures and baseline development on emissions in Turku in 2029 compared to the 2015 level using the SECAP method

5. Risk and vulnerability assessment

5.1. Method and concepts

As part of Mayors' Sustainable Energy and Climate Action Plan, an extensive analysis of climate change risks and vulnerabilities was carried out in Turku for the first time. In the analysis, an overview was created of the climate risks presenting a threat to the City of Turku. Climate risks refer to potential direct and indirect harm to people, businesses and environment caused by climate, weather and their development. In addition, the city's vulnerabilities, i.e. areas in which the city is unable or poorly prepared to respond to changes and extreme weather events caused by global warming, were identified. Both socio-economic factors and physical and environmental factors were identified as vulnerabilities. In addition to vulnerabilities, such factors were identified that could have an impact on and increase vulnerability in the area of the City of Turku. Finally, those sectors were mapped out that are considered most exposed to changes caused by global warming.

Following the SECAP guidelines, the analysis was carried out in four parts. The first one included an extensive city exploratory analysis. This involved studying previous reports made in the Turku area that examine risks and impacts of climate change. In order to have a comprehensive overview, regionally and nationally completed reports were also studied. The material used in the city exploratory analysis is presented in table 3. The reports used in the analysis can be used in work aiming at climate change adaptation also in the future if necessary.

Table 3. Local, regional and national reports on the basis of which the city exploratory analysis on climate change risks and vulnerabilities was carried out in Turku.

Year	Title	Scope
2018	Hulevesitulvariskien alustava arviointi tulvariskimallinnuksen tuloksia hyödyntäen	Local
2018	Ehdotus Varsinais-Suomen ja Satakunnan maakuntien tulvariskialueiksi	Regional
2017	Turun CDP-raportti	Local
2017	Yhteiskunnan turvallisuusstrategia	National
2016	Turun kaupungin hulevesiohjelma 2016-	Local
2016	Turun kaupunkipuulinjaukset	Local
2016	Ilmastonmuutos pääkaupunkiseudulla	Regional
2015	Turun, Raision, Naantalin ja Rauman rannikkoalueen tulvariskien hallintasuunnitelma vuosille 2016–2021	Regional
2014	Suomi kestävän luonnonvaratalouden edelläkävijäksi 2050	National
2014	Kansallinen ilmastonmuutoksen sopeutumissuunnitelma 2022	National
2013	Luonnon puolesta – ihmisen hyväksi, Suomen luonnon monimuotoisuuden suojelun ja kestävän käytön toimintaohjelma 2013–2030	National
2012	Toimintaohjelma luonnononnettomuuksien vahinkojen rajoittamiseksi	National
2012	Ilmastonmuutos, hyvinvointi ja kuntatalous	Regional

The climate change risk and vulnerability assessment in Turku was carried out with the help of expert interviews. The reporting model of SECAP guidelines and observations concerning the city exploratory analysis were used in the interviews. Interview participants from the City of Turku

included Development Manager Risto Veivo, Specialist Miika Meretoja, Environmental Protection Manager Olli-Pekka Mäki and Environmental Protection Planners Liisa Vainio and Tanja Ruusuvaara-Koskinen. The wellbeing steering group of the City of Turku also took part in the discussion. Representatives of the City of Turku stakeholders who took part in interviews included CEO Mirva Lehtomäki, Electricity Use Manager Esa Malmikare and Quality and Environmental Manager Jarkko Laanti from Turun seudun puhdistamo Oy (wastewater treatment service provider); CEO Irina Nordman from Turun Vesihuolto Oy (Turku Region Water Supply Ltd), Environment and Quality Manager Minna Niemelä and Development Manager Antto Kulla from Turku Energia; and Björn Grönholm from the Union of Baltic Cities. Interviewees from the University of Turku included Professor Jukka Käyhkö, specialist in climate change and environmental changes, and Lecturer Timo Vuorisalo, specialist in urban ecology and evolutionary ecology.

On the basis of interviews, the risks posing a threat to the City of Turku currently and in the coming years were identified. In accordance with the SECAP guidelines, current level, expected changes and a likely timeframe were assessed for each risk. In Turku, a decision was made to also assess reliability of estimations. It was also discussed which sectors the impacts of the risk are likely to hit in particular if they materialise. For each sector, the probability of the risk materialising, the expected impact and the timeframe within which the impacts are expected to take place were assessed.

5.2. Analysis results

On the basis of the city exploratory analysis and expert interviews, it was possible to identify two clear main risks that pose a threat to Turku now and in the near future: risks related to water bodies and water management and risks caused by change in ecosystems. Several other risks that were considered to present a threat to Turku were also identified and analysed. All recognised and assessed risks in the analysis are presented in table 4.

Table 4. Climate risks presenting a threat to Turku as identified in the risk and vulnerability assessment; an estimation of their development and the reliability of estimation.

Climate hazard type	Risk level	Expected change in intensity	Expected change in frequency	Timeframe	Reliability of estimation
Extreme heat	!	↑	↑	▶▶▶	*
Extreme cold	!	?	?	▶▶▶	*
Extreme precipitation	!!!	↑	↑	▶	***
Floods	!!!	↑	↑	▶	***
Sea level rise	!	↑	↑	▶▶▶	*
Droughts	!!	↑	↑	▶	*
Storms	!!!	↑	↑	▶	*
Diseases	!!	↑	↑	▶	***
Changes in ecosystem	!!!	↑	↑	▶	***
Introduced species	!!!	↑	↑	▶	***
River erosion	!!!	↑	↑	▶	***
Freezing-melting cycle	!!!	↑	↑	▶	***

!: Low ↑: Growth **|**: Current *: Low

!!: Moderate	↓: Decline	►: Short-term	⁎⁎: Moderate
!!!: High	↔: No change	►►: Mid-term	⁎⁎⁎: High
?: Not known	**?**: Not known	|►►►: Long-term	

In addition to local risks in Turku, such risks and threats caused by global change were identified that would affect Turku if they were to realise. An example of such a threat is the increasing number of climate refugees, in other words people who are forced to migrate due to a change in local climate or an environmental disaster. Attention must be paid to the fact that if realised, this threat may cause segregation in the city.

Regional collaboration and its adequate functioning were considered very important in expert interviews from the point of view of climate change mitigation and adaptation. Many environmental management functions have already been organised regionally in Turku and for their sake, continuous functioning collaboration is important. Ensuring the regional availability of biomass for Naantali multifuel power plant was identified as a future challenge. Switching to renewable forms of energy in Naantali was considered critical from the point of view of Turku's carbon neutrality objective. Therefore, strong and persistent regional collaboration has been called for to ensure that it will be met.

Waters and water management

On the basis of the city exploratory analysis and expert interviews, risks related to waters and water management were identified as particularly significant from the point of view of the City of Turku. Risks related to water bodies and water management include rains and heavy rains, floods, runoff waters, rise of sea level and storms. Risks related to water bodies and water management are naturally linked to the geographic location of Turku on the coast and the clay soil that slows down the absorption of water. At the moment, all water bodies and sea areas in Turku are in poor or moderate condition at best, so the role of water protection as part of climate work was emphasised.

Rains in the Turku area were estimated to develop in a way that winter rains increase while summers will be drier. Increased winter rains combined with milder winters when the ground remains without frost for longer times will lead to increased nutrient runoff into water bodies. This in turn will lead to eutrophication of water bodies and potentially also an increased need for dredging. Dredging in the River Aura was seen as particularly problematic due to poisonous harmful substances absorbed in the sediment and management of dredging waste. River erosion and failure of river banks were also identified as a problem caused by increased winter rains. These were considered to cause potential damage to streets, bridges and buildings located in the immediate vicinity of the river bank. In the summer, rains are estimated to decrease and dry periods are expected to increase. The change may result in an increased need for irrigation in the Turku area. Increased draught was also identified as a potential threat for rock meadows typical of nature in Turku.

Runoff water and runoff water management were also identified as one of the most significant risks. In addition to increased winter rain, the lack of green areas and absorption surfaces in the urban area contribute to the problem. In order to mitigate and solve the problem, it is important to increase green areas in the urban area for instance by means of plantings, city boulevards and green roofs. Increasing wetlands in a densely built area was not considered a likely solution but existing small water systems were identified as an important part of the runoff water network. From the point of view of the functionality of runoff water network, catchment areas of small water systems should be in good condition as this allows them to take in more runoff water, retain it more efficiently and to simultaneously improve the quality of water. Infill construction was identified as a potential threat to current urban green areas and small water systems and it was

considered desirable that factors which are important for solving the runoff water problem would be taken into consideration already in the land use planning phase. Also shortcomings in the sewer system, its capacity and condition were identified as vulnerabilities related to runoff waters and their management. In addition, experts considered that human resources allocated for runoff water problems and for water protection in general remain insufficient.

Storms were estimated to become stronger and increased in the future and this, together with the rise of sea level, was considered to cause an increased risk of flooding in the area. However, experts considered that the reliability level of the estimation concerning the risk was weak. Runoff water floods were identified as the most common type of flood in Turku. Storms and the rise of sea level were considered to increase the probability and intensity of runoff water floods, as they cause runoff water areas to fill with sea water.

Threshold values set by the Finnish Meteorological Institute concerning rains and draught, and observing the altitude reservation of waterways were proposed as indicators for risks related to waters and their management. It was noted in the analysis that plenty of research concerning runoff waters and their management is underway in universities and polytechnics in Turku. As work aimed at preparing for risks continues, harnessing local expertise was found important.

Changes in ecosystems

Changes in ecosystems were identified as another significant risk representing a threat to the City of Turku. This risk was estimated to cause potentially very severe effects but predicting them is extremely challenging. However, changes have already occurred and they are likely to occur also in the future, even very rapidly.

Changes in species and their effects on forestry and agriculture were identified as one example, including changes in tree species in forests. In terms of changes in species, introduced species and their spreading as the climate warms were considered as an extremely important risk. For instance, the spreading of new pests and plant diseases in the area is even likely. In addition to forestry and agriculture, these were seen as a threat to urban nature in Turku. One example identified is the Dutch elm disease that would be extremely harmful, as there are plenty of elms in the City of Turku area and they form an integral part of city landscape. Experts stated that the changing ecosystem poses challenges for green area planning in the city. The spreading of new diseases is a potential threat not only to species but also to humans. Ageing population and a deteriorated physical condition caused by lifestyle habits were considered as vulnerabilities that weaken the ability of Turku to react to this risk.

Changes in ecosystems will also result in diminished biodiversity in the Turku area. In terms of halting the decrease in biodiversity, maintaining blue and green areas and ecological corridors and increasing their number where possible is crucial. Urban green spaces as well as green areas (such as green roofs and other plantings) are crucial for biodiversity. For instance, pollinators and other insects may depend on them. The fallen number of pollinators was seen as a particularly significant threat and e.g. bee farming in the city area was proposed as a partial solution. In addition to securing biodiversity, urban blue and green areas offer a wide range of ecosystem services, absorb pollution, cool and even out temperatures in the city and in city buildings and offer a partial solution to the absorption problem of rain and runoff waters.

In terms of biodiversity and its maintenance, ecological corridors are also significant. When planning infill construction, it is important that corridors remain uninterrupted and that they will not become too narrow. In Turku, the ecological corridor located on the bank of River Aura, the area between Turku Cathedral and Halinen, the area between Kupittaa and Vartiovuori, and the ecological corridor extending from Luolavuori to the Sports Park via Mäntymäki were identified as particularly significant ecological corridors. In terms of ecological corridors and their role, the

significance of unmanaged nature from the point of view of ecosystems and their biodiversity was also emphasised in expert interviews.

Taking blue and green factors into use and monitoring how their target levels are met were proposed as potential indicators for changes in ecosystems. Also the amount of green area in the city was considered a suitable indicator.

5.3. Next steps

The risk and vulnerability assessment completed alongside the SECAP action plan was the first of its kind in Turku. The completed analysis is part of work aimed at preparing for and adapting to climate change, and it consolidates the effort of Turku to be a responsible and leading climate city.

Determining indicators for monitoring was identified as the next step. Indicators make it possible to monitor whether risks and their effects materialise, monitor the development of vulnerabilities and develop climate work. Closer analysis of identified vulnerabilities and reacting to them are important measures from the point of view of preparedness. Planning and implementation of adaptation measures also form an important part of future work.

6. Adaptation scoreboard and adaptation measures

6.1. Adaptation scoreboard

The assessment of current status of adaptation was completed using an adaptation scoreboard in accordance with the SECAP report model. The city's status in climate change adaptation work was entered into a scoreboard. The city’s situation was assessed using the A-D scaling system where:

A = Taking the lead (over 75 % completed)
B = Forging ahead (50-75 % completed)
C = Moving forward (25-50 % completed)
D = Not started or getting started (less than 25 % completed)

The self-assessment scoreboard was completed by the City of Turku specialists with the help of Benviroc Oy consultants and it helped create a view of the current state of the adaptation process in the City of Turku. Steps of adaptation work are presented in more detail in annex 3.

The current status of the adaptation process was illustrated in the SECAP report model with a radar chart (figure 8). Those sectors in the City of Turku adaptation work that have already been developed further and discussed at length have been marked with green colour. Sectors where further work is required are left outside the green area.

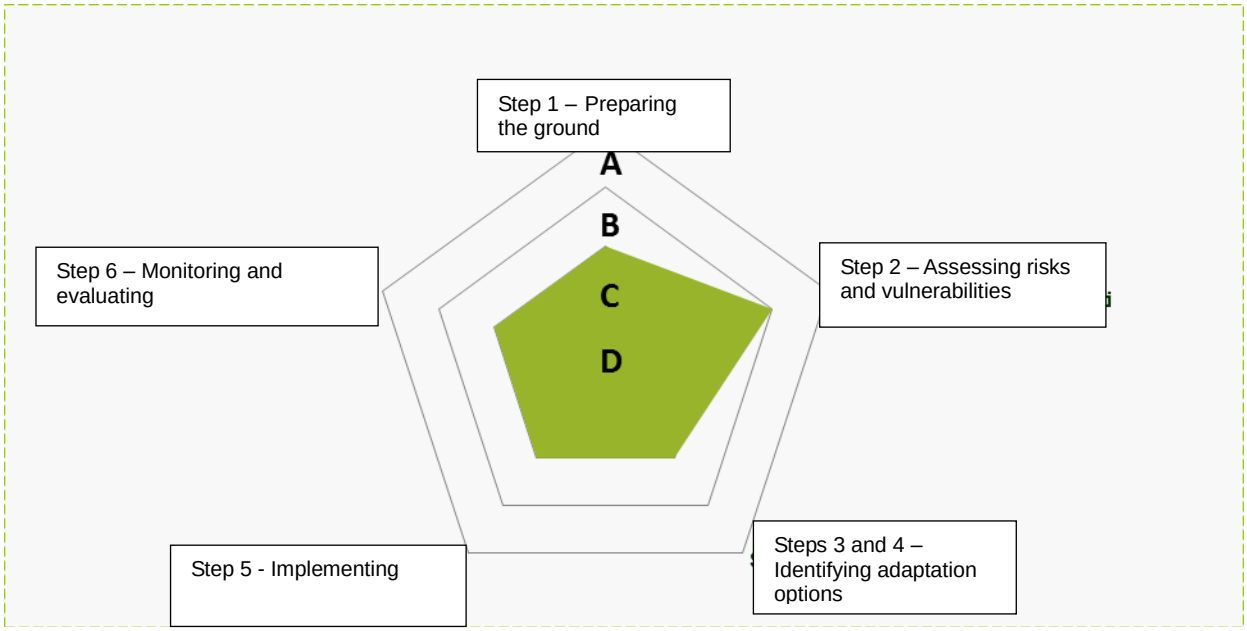


Figure 8. Turku climate change adaptation scoreboard

On the basis of the adaptation scoreboard, it can be said that climate change risks and vulnerabilities in Turku have been fairly well assessed. In other areas, work has been initiated and/or fair progress has been made. Significant adaptation measures have already been planned and carried out for instance related to runoff water management and underground cabling of electrical power system. However, consolidating the overall view of adaptation measures and coordination remains an extensive challenge. At the same time, key adaptation measures such as those related to water management and ecological risks should be consolidated. The next section (6.2.) presents the adaptation progress lines and measures created on the basis of the adaptation scoreboard.

6.2. Adaptation measures

Turku will prepare for the identified risks and their effects, striving towards becoming a more climate-proof city. This is partly fulfilled through already completed measures and plans.

The most important entities in adaptation measures include:

- Increasing information on climate
- Water management and building
- Safeguarding ecosystems
- Adaptation projects
- Supporting a sense of community

Increasing information on climate

The effects of climate change are diverse and include a great deal of uncertainty. The effects may be sudden and unpredictable. Adaptation requires up-to-date information on the state of the environment and the world. These will be actively monitored.

- Sufficient resources will be reserved for monitoring the status of the environment.

- The expertise of universities in the area will be harnessed as a strength.
- Solutions will be sought in cooperation across administrative borders.
- Information will be shared, communication will take place actively.

Water management and building

Climate proofness will be taken into consideration in the design, construction and maintenance of the energy network, the traffic system and other infrastructure.

Runoff water programme measures help manage water related risks:

- Runoff water management planning and implementation will be organised and resourced clearly and responsibilities will be clearly assigned.
- Awareness and expertise related to sustainable runoff water management will be increased continuously.
- Runoff water will be harnessed in building an attractive urban milieu.
- Reaching a good state in terms of water bodies and groundwater will be supported with runoff water management.
- Urban flooding will be prevented and the city will be prepared for it.

Significant preparation measures include underground cabling of the power grid and the new discharge pipe separated from runoff water sewer at the sewage treatment plan. Taking green factor into use in construction planning and adding the number of green roofs and other green areas support the objectives of adaptation.

Safeguarding ecosystems

The fragmentation of green areas will be stopped by complementing green networks and increasing ecological corridors. The most important green corridors will be taken into account and maintained in land use planning. Forest management plan is updated in a way that it helps integrate the green network and the maintenance of forest ecosystems will be secured.

The urban tree policy measures of the City of Turku help prepare for climate change. The objective of the variety of tree species is that the urban growing stock is ecologically and climatically sustainable and diverse both in terms of species and genetically. A diverse urban growing stock with several species reduces the risk of diseases and pest, reduces risks caused by climate change and improves the city scenery, creates a pleasant environment and increases economic activity.

Sufficient resources will be reserved for the prevention of non-native species. Bee farming in the city and urban agriculture will also be promoted.

Adaptation projects

Active participation in development projects will ensure the use of latest information, consolidate the pioneering status and increase the attractiveness of Turku internationally.

Tools for adaptation have already been developed for instance in the Climate-Proof City project, and integrated runoff water management has been developed in the iWater project. The new i-Tree project will produce data on the significance of urban tree stock and other nature based solutions in adapting to climate change and in striving towards carbon neutrality. The project will also produce data that will help the city describe the quality and significance of its tree property, and the

economic value of tree ecosystem services. The city will also be able to justify the investment and management resources needed for urban tree stock.

Supporting a sense of community

Extreme weather events may cause regionally extensive exceptional conditions which the current resources do not allow to be addressed quickly enough. For instance, a rainstorm in August 2012 blocked the emergency response centre. In exceptional and unpredictable situations, the preparedness of city residents for independent initiative, knowing one's own environment and knowing the people that may need help is critical. Thus, supporting a sense of community is an excellent way to prepare for exceptional conditions and simultaneously help advance the realisation of other objectives listed in the action plan 2029.

In addition to the measures discussed above and to support them, it is important to further elaborate an overall view of adaptation measures. Furthermore, it is crucial to strengthen coordination as part of climate policy steering and implementation and as part of management and operations of divisions and Turku City Group’s subsidiaries. Preparation for climate change and adaptation measures widely concern the city's operation and affect the wellbeing of citizens particularly in situations where climate risks become reality.

7. Conclusion

Becoming carbon neutral challenges the city to renew itself.

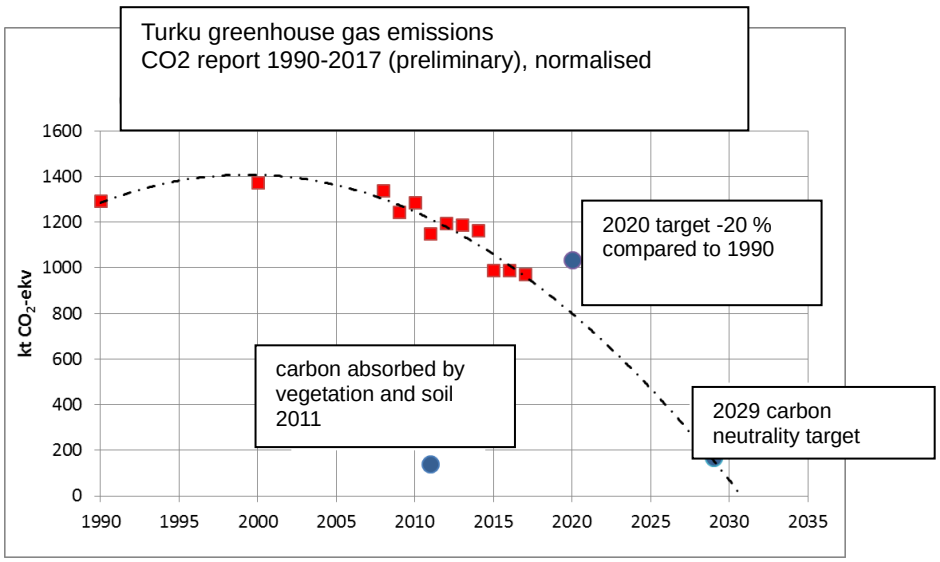
A renewing city is created again and again, every day. Yet the city of today has been made yesterday, it is a city produced by the past. And a city is never completed – the great innovations of today will only be memories of the past tomorrow.

The best solutions are created together and the story is told together. The story of a city is passed on to the future and our past actions affect the environment and starting point of the next generation.

A carbon neutral Turku will be made together. The work continues for a long time but there is no time at all to waste.

Your contribution makes a difference in our journey towards carbon neutrality and in what we can achieve!

Thank you for your effort!



Turku is on a steady path towards reaching carbon neutrality in 2029. The greatest emission reduction so far has been achieved by increasing renewable energy but also improvement of energy efficiency has had an impact and emissions caused by mobility have decreased to some extent. In addition to the city's own actions, Government policies have also supported meeting the objectives.

Climate plan 2029 annexes

1. Emission calculations for base year and monitoring year

2. SECAP climate action cards

3. Adaptation scoreboard

ANNEX 1. Emission calculations for base year and monitoring year

L1.1 Calculation method

Several different methods can be used to calculate greenhouse gas emissions of cities. Emissions in Turku have been monitored for several years using the CO2 report calculation method which is extensively used in Finland. Emission calculation in accordance with the CO2 report has also been selected as the indicator of strategy monitoring and its results are presented in figure L1.2. CO2 report calculation methods and results have been described in more detail in the annual report of 2018 (CO2 report, 2018).

In JRC instructions for compiling SECAP, the preferred method for SECAP emission calculation (SECAP method) is presented. The CO2 report calculation method is mainly compatible with the SECAP method. The most significant differences can be found in presentation of data (division into sectors) and the emission factor for electricity consumption. For the SECAP report and its monitoring, emissions in accordance with the CO2 report have been modified to correspond the SECAP method. The calculation in accordance with the SECAP method has been completed for years 1990 and 2015 and will be completed for years 2021, 2025 and 2029 in the future.

L1.2 Scope of the calculation using SECAP method

Year 1990 was selected as the base year and 2015 as the monitoring year for SECAP in Turku. The calculation included the most important greenhouse gases caused by human actions: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Greenhouse gas emissions have been converted to carbon dioxide equivalent (CO_2 eq) by multiplying CH_4- and N_2O emissions by a coefficient that equates to their global warming potential (GWP). The GWP factor for CH_4 has been 21 and the GWP for N_2O has been 310[6]. In accordance with the SECAP guidelines, GWP factors remain the same throughout the monitoring period.

The Covenant of Mayors is focused on reducing emissions through measures that reduce energy consumption and through increased energy efficiency and use of renewable forms of energy. The calculation of base year and monitoring years thus includes all energy-related emissions of municipal buildings, equipment and facilities, tertiary buildings, public lighting, industry not covered in the EU Emissions Trading Scheme and transport. Emissions caused by transport have been divided into municipal fleet, public transport and private and commercial transport. Sectors included in the SECAP calculation are presented in table L1.1. Compared to emission calculation made using the CO2 report method, SECAP calculation does not include emissions from rail and waterborne transport, aviation, agriculture or waste management. Their significance from the point of view of the emission inventory in Turku remains small. (figure L1.1.).

Table L1.1. Turku SECAP calculation sectors, definitions and sources of information in terms of energy

[6] These factors were used also in the CO2 report calculation

Sector	Definition	Source of information (energy)
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES		
Municipal buildings, equipment/ facilities	Buildings and facilities owned or managed by the City of Turku. Does not include residential buildings. Fuels used by city machinery*	City of Turku
Tertiary buildings, equipment/ facilities	Buildings and facilities of the tertiary sector (services), for example offices of private companies, banks, commercial and retail activities, hospitals, etc.	CO2 report
Residential buildings	Residential buildings, including residential buildings owned and managed by the city	CO2 report
Public lighting	Public lighting	City of Turku
Industry not covered in the EU Emissions Trading Scheme	Industry not covered in the EU Emissions Trading Scheme (all industry in the Turku area). Energy consumption of industry buildings and industrial use of fuel	CO2 report
TRANSPORT		
Municipal fleet	Vehicles owned and used by the City of Turku administration	City of Turku
Public transport	Public transport buses * (Föli transport within city area)	City of Turku
Private and commercial transport	Road transport taking place in the City of Turku area. Does not include municipal fleet or public transport buses.	Liisa model of VTT

*Data on the city's own buildings and functions from year 1990 was not available, so their energy consumption and emissions were included in data found in other sectors (mainly service buildings and the transport sector).

Energy used in buildings has been divided into electricity, district heat and fuels used in heating. District cooling is used in some buildings in Turku. District cooling has not been separately presented in the calculation because district cooling in Turku is produced either in combined production of heat and electricity or by using waste heat (without emissions) or electricity. Energy consumption of the production of districting cooling and potential emissions are thus already included in emissions caused by district heating or electricity consumption. Energy consumption of industry not covered in the EU Emissions Trading Scheme has been divided into heating energy consumed by industrial buildings, electricity, fuels used by industry and fuels used by machinery. Transport fuels cover gasoline, diesel and bio components included in fuels. The energy consumption of machinery used by the City of Turku has also been calculated.

L1.3 SECAP method emission factors

The SECAP emission calculation is based on a so called consumption-based calculation method, the starting point of which is energy consumption in the Turku area in sectors of table L1.1. Emission factors for energy consumption (emission per consumed energy unit) are defined as follows:

- Fuels: emissions caused by fuel consumption per consumed fuel unit
- District heating: emissions caused by the production of district heat distributed in the Turku area by Turku Energia; emissions in relation to delivered district heating. The emissions from combined heat and power (CHP) production have been allocated to

electricity and heat using the 'benefit allocation method', in which the amount of fuel used by the CHP plant has been allocated to electricity and heat based on the fuel required for separate production of respective amounts of electricity and heat

- Electricity: Electricity consumption emission factor in accordance with SECAP guidelines that takes into account local production[7]

In accordance with the SECAP calculation guidelines, the emission factor for electricity used in Turku is calculated taking into consideration the electricity production of Turku Energia and other actors owned by the City of Turku, and certified green electricity used in city buildings. Emission factor for electricity changes annually and it is calculated using the following formula:

$$EFE = \frac{[(TCE - \sum LPE - \sum GE) * NEEFE + \sum CO2_{LPE} + \sum CO2_{GE}]}{TCE}$$

where:

EFE = local electricity emission factor
TCE = total consumption of electricity in Turku
$\sum$***LPE*** = energy production of Turku Energia and other actors owned by the city
$\sum$***GE*** = certified green electricity used in city's own functions
NEEFE = national electricity emission factor for year of calculation
$\sum CO2_{LPE}$ = emissions caused by electricity production of Turku Energia and other actors owned by the city
$\sum CO2_{GE}$ = emissions resulting from production of green energy (calculated as zero-emission)

Emission factors used in SECAP calculation are presented in tables L1.3 and L1.4. At the end of this annex.

L1.4 Degree day correction

Emissions of the City of Turku have been monitored through the CO2 report, and in addition to the calculation taking into account the annual heating need, emissions are also calculated as degree day corrected. In this case, the heating energy needed for buildings is corrected to equate to the climatological normal period (1981-2010). Annual heating degree days have a significant impact on the development of emissions, and therefore by removing fluctuation in heating degree days it is possible to monitor e.g. the effects of implemented measures. Also the SECAP calculation guidelines enable degree day corrected calculation. In the emission calculation of the City of Turku SECAP action plan, degree day corrected calculation is used primarily. In addition, emissions are also monitored without normalisation.

L1.5 Energy balances

Energy balances in Turku (MWh) in 1990 and 2015 are presented in tables L1.5.-L1.8. in accordance with SECAP reporting at the end of this annex. Energy consumption in 1990 and 2015 is presented both as degree day corrected to equate to the climatological normal period (1981–2010) and without adjustment for heating degree days. A summary of energy consumption in 1990 and 2015 is presented in table L1.2.

Table L1.2. Summary of City of Turku energy balances in 1990 and 2015.

[7] In the calculation of CO2 report, the emission factor used is a national emission factor for electricity consumption. This explains the differences in results of SECAP calculation and CO2 report.

Energy consumption(MWh)	1990	2015
Degree day corrected	4575952	4785307
Without adjustment for heating degree days	4368649	4420519

L1.6 Emission inventories

L1.6.1 CO2 report

The greenhouse gas emissions of the City of Turku and their development have been monitored using the CO2 report calculation method in 1990, 2000 and 2008–2017. Similarly to SECAP calculation, also CO2 report calculation covers the following three greenhouse gases: carbon dioxide, methane and nitrous oxide. The figures below present emission development in Turku calculated using the CO2 report method that has been normalised to equate to the climatological normal period 1981–2010 and using a five-year moving average for electricity's emission factor.

Calculated using the CO2 report method, the normalised greenhouse gas emissions in Turku in 2015 amounted to 989.0 kt CO_2 eq. The most significant sectors causing emissions in 2015 were district heating (381.8 kt CO_2 eq), electricity consumption (226.8 kt CO_2 eq) and road transport (183.6 kt CO_2 eq) (figure L1.1.). Sectors outside SECAP calculation (agriculture, waste management and other transport modes) caused 65.7 kt CO_2 eq emissions in total, equivalent to 7 per cent of degree day corrected total emissions in Turku in 2015.

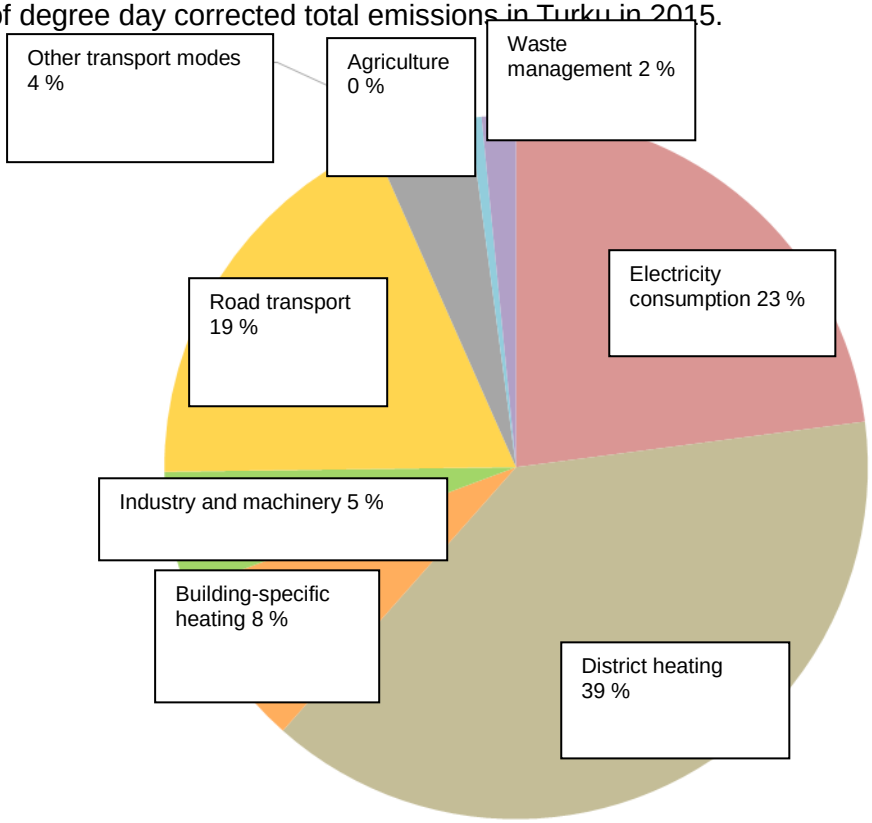
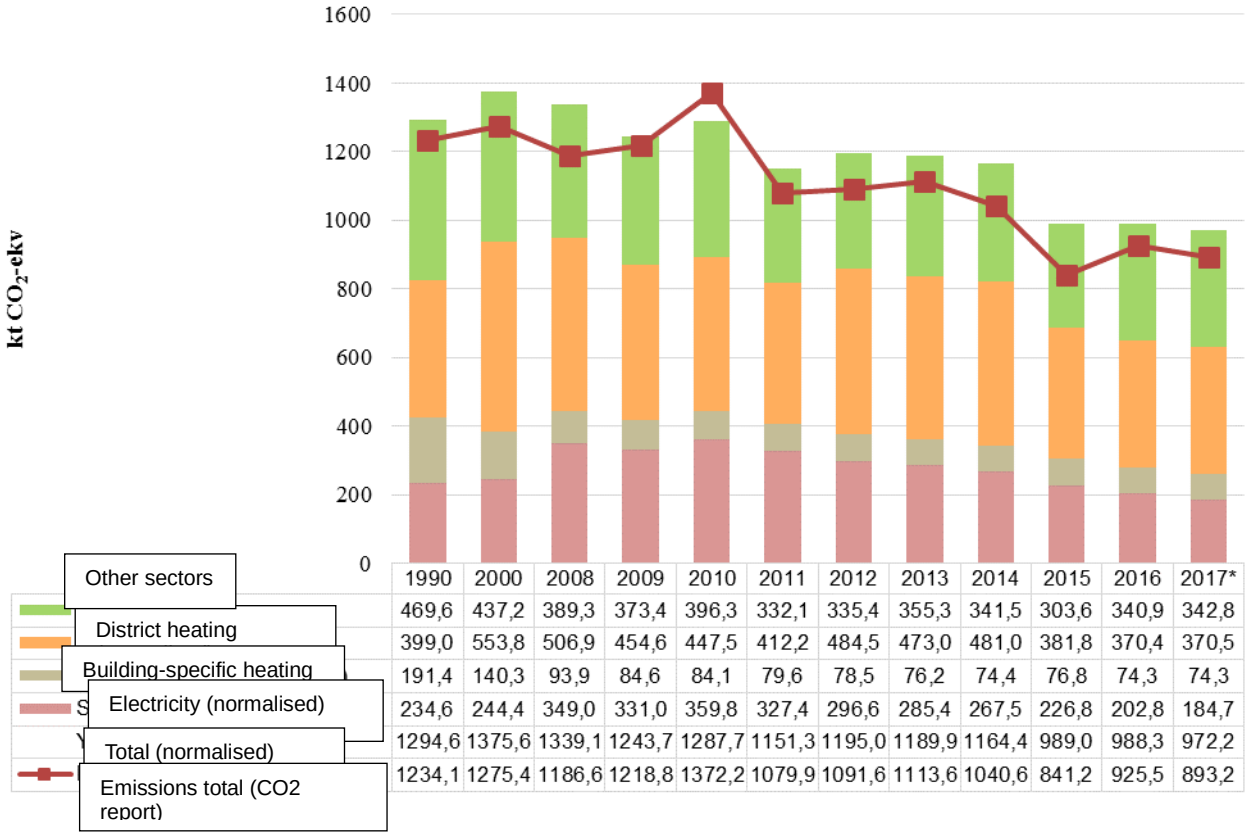


Figure L1.1. Normalised emissions in Turku by sector, calculated using the CO2 report method in 2015.

The emission development of the City of Turku calculated using the CO2 report method and degree day corrected to equate to the climatological normal period 1981–2010 using a five-year moving average for the emission factor of electricity is presented in figure L1.2. Emissions without adjustment for heating degree days, calculated using the CO2 report method, are also presented. It can be said on the basis of the figure that from 2009 onwards, normalised emissions have been lower than the 1990 level. Normalised emissions in 2015 were 24 per cent lower than emissions in 1990. According to preliminary information, emissions hit their lowest point of the entire time series in 2017 (972.2 kt CO_2 eq). The decrease in emissions is particularly affected by emissions caused by building-specific heating as they have decreased 60 per cent between 1990 and 2015. Of emissions in other sectors, those that have decreased the most include emissions caused by industry and machinery (68 per cent), and emissions caused by waste management (42 per cent).



	1990	2000	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*
Other sectors	469,6	437,2	389,3	373,4	396,3	332,1	335,4	355,3	341,5	303,6	340,9	342,8
District heating	399,0	553,8	506,9	454,6	447,5	412,2	484,5	473,0	481,0	381,8	370,4	370,5
Building-specific heating	191,4	140,3	93,9	84,6	84,1	79,6	78,5	76,2	74,4	76,8	74,3	74,3
Electricity (normalised)	234,6	244,4	349,0	331,0	359,8	327,4	296,6	285,4	267,5	226,8	202,8	184,7
Total (normalised)	1294,6	1375,6	1339,1	1243,7	1287,7	1151,3	1195,0	1189,9	1164,4	989,0	988,3	972,2
Emissions total (CO2 report)	1234,1	1275,4	1186,6	1218,8	1372,2	1079,9	1091,6	1113,6	1040,6	841,2	925,5	893,2

Figure L1.2. Normalised emissions in Turku (bars). "Other sectors" include sectors where normalising has no impact (industry and machinery, transport, agriculture, waste management). The line indicates the total of non-normalised emissions.

L1.6.2 SECAP method

Degree day corrected emissions in 2015 calculated using the SECAP method amounted to 1020.3 kt CO_2 eq. In terms of emissions, the most significant sector was residential buildings which caused 44 per cent of total emissions in Turku. The second most significant sectors from the point of view of emissions were industry and private and commercial transport (figure L1.3.).

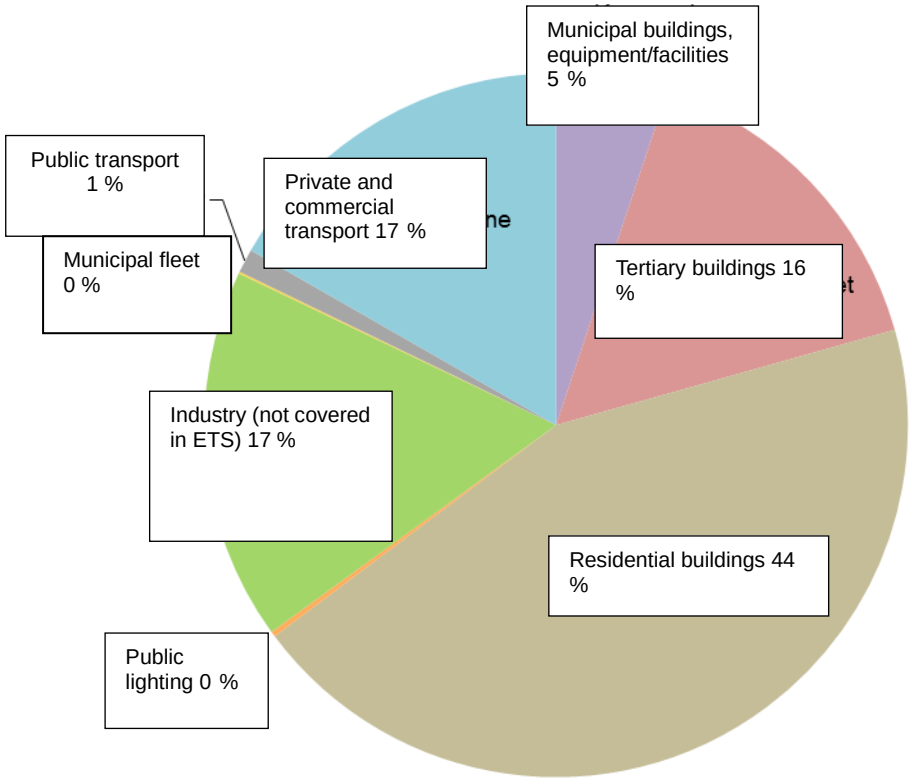
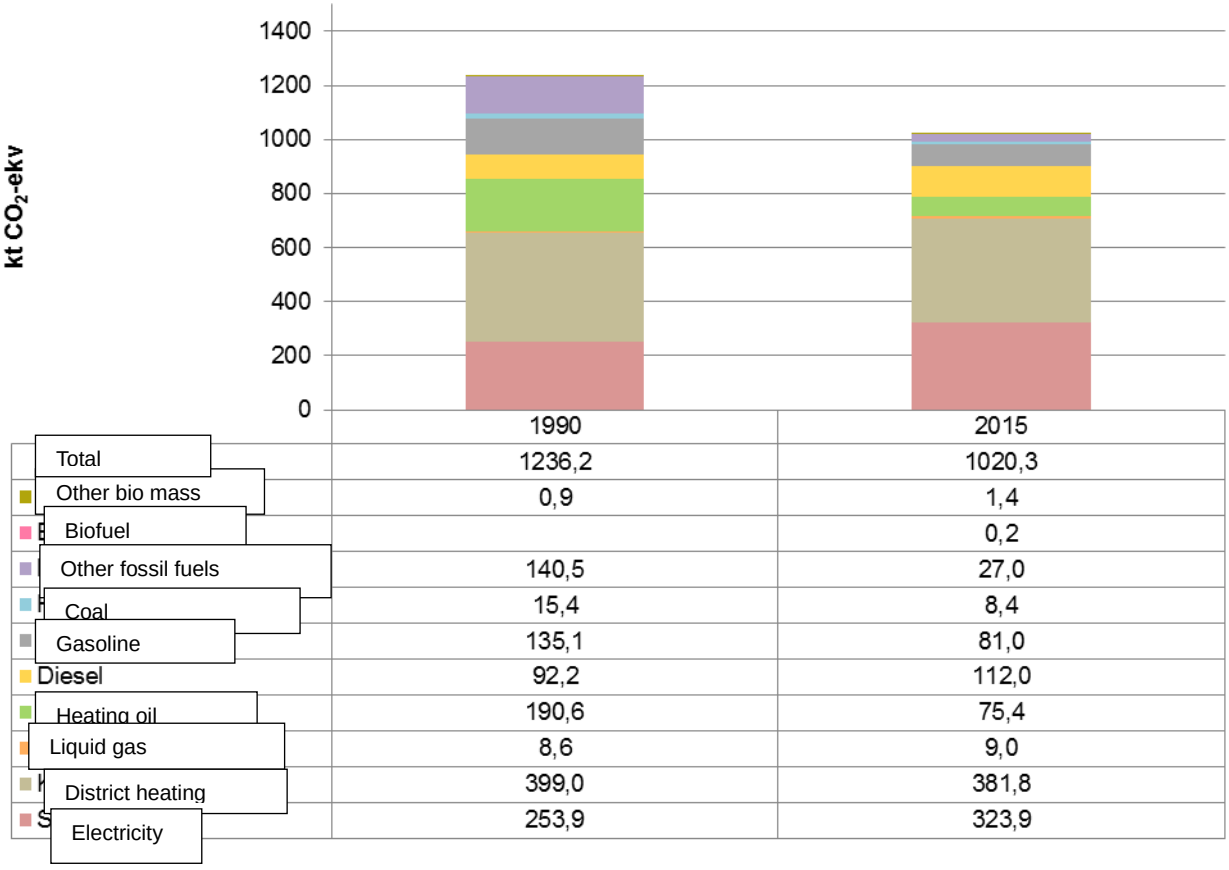


Figure L1.3. Degree day corrected emissions in Turku by sector calculated using the SECAP method in 2015.

Degree day corrected emissions in Turku by source of energy in 1990 and 2015 calculated using the SECAP method are presented in figure L1.4. In 1990, degree day corrected emissions altogether amounted to 1236.2 kt CO_2 eq and in 2015 they amounted to 1020.3 kt CO_2 eq. Most emissions in Turku are caused by district heating and energy consumption. In 2015, their share of total emissions was 69 per cent. Between 1990 and 2015, emissions in Turku have decreased 17 per cent. Particularly the decreased use of fossil fuels has contributed to the decrease in emissions. Between 1990 and 2015, emissions resulting from heating oil have decreased 60 per cent, emissions caused by other fossil fuels used by industry have decreased over 80 per cent and emissions caused by industrial use of coal have decreased 45 per cent. District heating emissions have decreased 4 per cent even though the district heating network has expanded significantly and the energy consumption of district heating in 2015 was 41 per higher than in 1990 (tables L1.5.and L1.7.).



	1990	2015
Total	1236,2	1020,3
Other bio mass	0,9	1,4
Biofuel		0,2
Other fossil fuels	140,5	27,0
Coal	15,4	8,4
Gasoline	135,1	81,0
Diesel	92,2	112,0
Heating oil	190,6	75,4
Liquid gas	8,6	9,0
District heating	399,0	381,8
Electricity	253,9	323,9

Figure L1.4. Degree day corrected emissions in Turku by source of energy in 1990 and 2015 calculated using the SECAP method.

Tables L1.3-L1.8. Emission factors and energy balance in 1990 and 2015 calculated using the SECAP method

Emission factors and energy balances from years 1990 and 2015 used for SECAP calculation are presented in tables L1.3.-L1.8. of annex 1. Energy balances are presented both as degree day corrected and without adjustment for heating degree days:

- Emission factors for year 1990 used in SECAP calculation
- Emission factors for year 2015 used in SECAP calculation
- Degree day corrected energy balance in 1990
- Energy balance without adjustment for heating degree days in 1990
- Degree day corrected energy balance in 2015
- Energy balance without adjustment for heating degree days in 2015

L1.3. Emission factors for year 1990 used in the SECAP calculation (t CO_2 eq/MWh).

Electricity		Heat/cold	Fossil fuels								Renewable energies				
National	Local		Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal
	0,234	0,312		0,234	0,269	0,252	0,289		0,342	0,285			0,009		

L1.4. Emission factors for year 2015 used in the SECAP calculation (t CO_2 eq/MWh).

Electricity		Heat/cold	Fossil fuels								Renewable energies				
National	Local		Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal
	0,210	0,212		0,234	0,266	0,252	0,289		0,342	0,275		0,002	0,009		

L1.5. Degree day corrected energy balance in Turku in 1990 using the SECAP method.

Sector		FINAL ENERGY CONSUMPTION [MWh]															
				Fossil fuels								Renewable energies					Total
		Electricity	Heat/cold	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Municipal buildings, equipment/facilities																	0
Tertiary (non municipal) buildings, equipment/facilities		388640	436699			220990											1046328
Residential buildings		410286	719061			286811								86950			1503107
Public lighting																	0
Industry	Non-ETS	287310	122741		36870	201129		27028		45000	493725			6028			**1219830**
	ETS (not recommended)																**0**
Subtotal		**1086235**	**1278501**	**0**	**36870**	**708929**	**0**	**27028**	**0**	**45000**	**493725**	**0**	**0**	**92977**	**0**	**0**	**3769265**
TRANSPORT																	
Municipal fleet																	**0**
Public transport																	**0**
Private and commercial transport																	**0**
Subtotal		**0**	**0**	**0**	**0**	**0**	**365632**	**441054**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**806686**
OTHER																	
Agriculture, Forestry, Fisheries																	**0**
TOTAL		**1086235**	**1278501**	**0**	**36870**	**708929**	**365632**	**468082**	**0**	**45000**	**493725**	**0**	**0**	**92977**	**0**	**0**	**4575952**

L1.6.T Energy balance in Turku in 1990 using the SECAP method without adjustment for heating degree days.

Sector		FINAL ENERGY CONSUMPTION [MWh]															
		Electricity	Heat/cold	Fossil fuels								Renewable energies					Total
				Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Municipal buildings, equipment/facilities																	0
Tertiary (non municipal) buildings, equipment/facilities		386263	393501			197608											977372
Residential buildings		406026	647933			263301								86950			1404209
Public lighting																	0
Industry	Non-ETS	281800	110599		36870	179330		27028		45000	493725			6028			1180381
	ETS (not recommended)																0
Subtotal		1074089	1152033	0	36870	640239	0	27028	0	45000	493725	0	0	92977	0	0	3561962
TRANSPORT																	
Municipal fleet																	0
Public transport																	0
Private and commercial transport																	0
Subtotal		0	0	0	0	0	365632	441054	0	0	0	0	0	0	0	0	806686
OTHER																	
Agriculture, Forestry, Fisheries																	0
TOTAL		1074089	1152033	0	36870	640239	365632	468082	0	45000	493725	0	0	92977	0	0	4368649

L1.7. Degree day corrected energy balance in Turku in 2015 using the SECAP method.

Sector		FINAL ENERGY CONSUMPTION [MWh]															
				Fossil fuels								Renewable energies					Total
		Electricity	Heat/cold	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Municipal buildings, equipment/facilities		116257	126125				4198	73									246652
Tertiary (non municipal) buildings, equipment/facilities		597250	48425			84582											730256
Residential buildings		560233	1396874			131504								144227			2232838
Public lighting		11740															11740
Industry	Non-ETS	255938	229790		38576	67226		32548		24600	98398		19766	10327			777170
	ETS (not recommended)																0
Subtotal		**1541418**	**1801213**	**0**	**38576**	**283312**	**4198**	**32621**	**0**	**24600**	**98398**	**0**	**19766**	**154554**	**0**	**0**	**3998656**
TRANSPORT																	
Municipal fleet							3040	305					482				3827
Public transport							44219						6375				50593
Private and commercial transport							392443	247527					92261				732231
Subtotal		**0**	**0**	**0**	**0**	**0**	**439702**	**247831**	**0**	**0**	**0**	**0**	**99118**	**0**	**0**	**0**	**786651**
OTHER																	
Agriculture, Forestry, Fisheries																	0
TOTAL		**1541418**	**1801213**	**0**	**38576**	**283312**	**443900**	**280452**	**0**	**24600**	**98398**	**0**	**118884**	**154554**	**0**	**0**	**4785307**

L1.8. Energy balance in Turku in 2015 using the SECAP method without adjustment for heating degree days.

Sector		FINAL ENERGY CONSUMPTION [MWh]															
				Fossil fuels								Renewable energies					Total
		Electricity	Heat/cold	Natural gas	Liquid gas	Heating oil	Diesel	Gasoline	Lignite	Coal	Other fossil fuels	Plant oil	Biofuel	Other biomass	Solar thermal	Geothermal	
BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES																	
Municipal buildings, equipment/facilities		116257	105712				4198	73									226240
Tertiary (non municipal) buildings, equipment/facilities		591003	40588			70044											701634
Residential buildings		547000	1170800			114010								144227			1976037
Public lighting		11740															11740
Industry	Non-ETS	246000	192600		38576	55401		32548		24600	98398		19766	10327			718217
	ETS (not recommended)																0
Subtotal		1512000	1509700	0	38576	239455	4198	32621	0	24600	98398	0	19766	154554	0	0	3633868
TRANSPORT																	
Municipal fleet							3040	305					482				3827
Public transport							44219						6375				50593
Private and commercial transport							392443	247527					92261				732231
Subtotal		0	0	0	0	0	439702	247831	0	0	0	0	99118	0	0	0	786651
OTHER																	
Agriculture, Forestry, Fisheries																	0
TOTAL		1512000	1509700	0	38576	239455	443900	280452	0	24600	98398	0	118884	154554	0	0	4420519

ANNEX 2. SECAP climate action cards

SECAP card models have been made to serve both the city organization and Turku City Group's subsidiaries as well as other actors. The objective is to describe the city's and Turku City Group's own climate change mitigation measures in a clear and concise manner and to activate citizens, communities, businesses and universities – the entire civil society– along to create and implement a carbon neutral Turku.

Section 1 of the climate plan describes in more detail how the cards will be linked to annual implementation and steering of climate plan. Section 3 describes the kind of thematic entity the mitigation measures form. Presented below is a table of SECAP cards with examples of cards representing each theme of climate mitigation measures. The cards are updated and new ones are constantly being made as part of implementing the climate plan. All cards will be found online on the Carbon neutral Turku website.

SECAP card is a concise, user-friendly and guiding means for creating climate measures and to bring them as part of implementing a carbon neutral Turku together.

List of SECAP climate action cards (23 May 2018):

Card number and name	Objective	Executing bodies
Carbon neutral heat	Turku Energia is setting an 80 per cent target for the share of renewable energy of sold heat in 2025.	Turku Energia with its affiliated companies and partners
Two-way heat in Skanssi	Developing district heating with lower emissions, opening up the heating network for new producers and innovations	Turku Energia, City of Turku, Tekes, VTT, Sitra, Finnish Energy, Skanssi shopping centre, YH-kodit, Hartela
Share of renewable fuel TSE Naantali 4	Increasing the bio share of Naantali multifuel power plant (owned by Turku Energia's affiliated company Turun Seudun Energiantuotanto Oy) towards carbon neutral production	Turku Energia, Turun Seudun Energiantuotanto Oy, Fortum
Increasing solutions to store energy (district heating and cooling)	Enabling increase in low emission renewable production of district heating. This is achieved by developing storage of heat and cold to even out peaks of production and consumption	Turku Energia
Reducing network losses of district heating network	Optimising energy use by reducing heat loss in the district heating network	Turku Energia
Citizens' energy transition	Significantly improving and speeding up the efforts to enable energy investments of citizens, businesses and communities	City of Turku, Sitra, Turku Energia, subsidiaries and companies responsible for Turku City Group's premises and housing, University of Turku

Carbon neutral electricity	Turku Energia is setting an 80 per cent target for the share of renewable energy of sold electricity in 2025. In this way, the electricity sold is almost entirely carbon neutral.	Turku Energia with its affiliated companies and partners
Building solar systems on Turku City Group's properties	Optimising energy use in Turku City Group properties and increasing renewable energy	Turku Energia, City of Turku, Turku City Group's subsidiaries and subsidiaries
Energy efficiency audits in city properties	Optimising energy use and saving energy	City of Turku, Turku Energia, partners and experts
Promoting demand response in terms of electricity and heat in city properties	Optimising energy use and saving energy in Turku City Group, properties	Turku Energia, City of Turku and Turku City Group's subsidiaries
Replacing fossil fuels in public transport with biofuels	Replacing the use of fossil fuel by biofuels on lines that are not electrified during 2020's	Föli, traffic contractors and suppliers
Carbon neutral public transport system of large capacity	Building a carbon neutral public transport system of large capacity to support sustainable urban development and serve the growing need on main lines	Turku and other participating municipalities, Government, Föli, builders and suppliers
Electrification of bus lines	Electrifying public transport lines as efficiently as possible (Carbon neutral public transport 2029)	Turku and Föli, developers, builders and suppliers
Public transport trunk routes	Implementing public transport trunk routes	Föli, City of Turku and other participants' associations, traffic contractors and suppliers
Public transport traveller information and disruption management	Increasing the use of public transport by improving service	Föli, City of Turku and other participants' associations, traffic contractors and suppliers
Improving charging opportunities for electric cars	Methodically improving market-based conditions for the use of electric cars	City of Turku, Turku Energia, charge point operators, property owners and users
Piloting and development of a two-way charge point (V2G)	Advancing electric traffic and integration of mobility and energy system	Turku Energia, City of Turku and charge point operators
Implementing charge points within city properties	Advancing electric traffic in the Turku region	Turku Energia, City of Turku, other municipalities in the Turku area

Promoting transport use of biogas	Improving refueling opportunities of biogas, creating fruitful conditions for biogas production and increasing gas vehicles	City of Turku, Turku University of Applied Sciences, the Growth Corridor project partners and other collaboration partners
Quality routes for cycling, main network	Improving cycling conditions and promoting cycling all year round	City of Turku and other TKS municipalities
City bike system	Offering a year-round city bike system service that is conveniently linked to public transport	City of Turku, Föli, ECCENTRIC project, executors and supplier
Harnessing large volume masses	Transferring soil and other masses is optimised by using digital solutions. Masses are better delivered to customers, emissions are reduced and circulation improves	CIRCVOL 6Aika project, TScP, Kiertomaa, 12 executors in total
Carbon sinks in forests	Increasing carbon stock of forest land and trees and carbon sinks in the Turku area, thus compensating for emissions	City of Turku, other forest owners and residents
Carbon sinks in the city	Increasing carbon stock and carbon sinks in the soil and vegetation and using sustainable construction, thus compensating for emissions	City of Turku, administrators, landowners, contractors
Climate networks and development partnerships	Turku acquires climate expertise and capacity for development by actively creating development partnerships and by networking at all levels	City of Turku, ICLEI, UBC, CDP, Sitra, CLC, universities and development organizations

Examples of SECAP climate action cards (23 May 2018):

Name of action:	**Carbon neutral heat**						
Objective	Turku Energia is setting an 80 per cent target for the share of renewable energy of sold heat in 2025.						
Summary (100 words maximum)	The share of renewable energy in production and acquisition of heat will be increased considerably and methodically. The use of coal for energy purposes will be given up by 2025, if the state takes part in resulting investment costs. By 2029, district heating, district cooling and steam used in the Turku area will be produced carbon neutrally.						
Message for Turku and the world	This is a very ambitious objective and it implements strong and responsible climate policy and creates opportunities for new solutions and innovations. Meeting the objective alongside other functional and economic objectives of the Turku Energia Board of Directors and owner will require considerable effort in the next few years.						
Responsible bodies	Turku Energia with its affiliated companies and partners						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	yes	yes	yes	yes	yes	yes	maybe
What is the level of significance?	high	medium	medium	medium	high	medium	medium
Indicator for monitoring							
Implementation	**2019-2021**		**2022-2025**		**2026-2029**		**2030-**
Schedule	The share of renewable grows – plan for replacing unit of Naantali 3?		80 % of heat renewable in 2025 – power plant replacing Naantali 3?		Carbon neutral heat 2029		continues
Emission reduction (estimation / t CO2 eq/ year)	will be calculated						
Costs for the city	will be calculated						
Yield for the city	will be calculated						
Funding of measure	will be calculated						
Costs for other actors	will be calculated						
Required decisions	Investment decisions and decision on state aid		Building decisions				

Name of action:	**Piloting a smart two-way heating network in the Skanssi area**						
Objective	Developing district heating with lower emissions, opening up the heating network for new producers and innovations.						
Responsible bodies	Turku Energia, City of Turku, Tekes, VTT, Sitra, Energiateollisuus ry, Skanssi shopping centre, YH-kodit, Hartela						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	yes	maybe	yes	yes	yes	yes	maybe
What is the level of significance?	medium	low	high	high	high	high	low
Indicator for monitoring	district heat emissions				In 2021, at least 65 % and in 2025 80 %		
Implementation	**2019-2021**		**2022-2025**		**2026-2029**		**2030-**
Schedule	Being prepared	Ongoing	→	→	→	→	→
Costs for the city	Further development of Skanssi plot allocation conditions		Skanssi multipurpose facility				
Funding of measure	Budget: City of Turku 10 thousand euros		Budget: City of Turku 30-40 million euros				

Name of action:	Citizens' energy transition (project / projects)						
Objective	The objective of the Citizens' energy transition project is enabling and speeding up energy investements of citizens, businesses and communities considerably better than now						
Summary (100 words maximum)	District heating, use of electricity and separate heating now produce over 60 per cent of greenhouse gas emissions in the Turku area. Approx. 300 million euros have been invested in the energy reform of the Turku area in 2015-2018, mainly directed towads improving energy production, transmission and storage. Also two-directionality of systems, smart steering of consumption, storage and distribution, and combining						
Message for Turku and the world	The implementation of the energy reform calls for citizens, businesses and communities as actors, investors and potential producers of energy. We share this challenge with other Finnish cities, and the theme is internationally relevant. For this reason, the City of Turku has prepared the Citizens' energy transition project						
Responsible bodies	City of Turku, Sitra, Turku Energia, subsidiaries and wholly-owned companies responsible for Turku City Group's premises and housing, University of Turku						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	yes	yes	yes	yes	yes	yes	yes
What is the level of significance?	high	high	high	high	high	high	high
Indicator for monitoring	energy saving of Turku City Group	private energy saving	New solutions in Turku	City of Turku pilot targets	Turku City Group pilot targets	Increased energy solutions	Private energy investments
Implementation	**2018-2021**		**2022-2025**		**2026-2029**		**2030-**
Schedule	First project 2018, second project 2018-2020.		Expansion of energy transition		continues		continues
Emission reduction (estimation / t CO2 eq/ year)							
Costs for the city	energy investments		energy investments		energy investments		energy investments
Yield for the city	energy saving		energy saving		energy saving		energy saving
Funding of measure	own funding and potential green funding		own funding and potential green funding		own funding and potential green funding		own funding and potential green funding
Costs for other actors					operators		
Required decisions	project decisions made 2018		new projects and development / investments		new projects and development / investments		new projects and development / investments

Name of action:	Electric bus transport						
Objective	Electrifying public transport lines as efficiently as possible (Carbon neutral public transport 2029)						
Summary (100 words maximum)	A plan for electrifying public transport lines will be made in 2019. The plan will be implemented in the order of priority and competitive tendering of lines from 2921 onwards, taking into consideration service reliability and technical prerequisites. (See also decision made by Turku City Board in October 2013)						
Responsible bodies	Föli, participants' associations, Turun Kaupunkiliikenne Oy ("Turku Urban Traffic Ltd."), traffic contractors, technology developers.						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	yes	yes	yes	yes	yes	yes	maybe
What is the level of significance?	high	medium	high	high	high	high	medium
Indicator for monitoring							
Implementation	**2018-2021**		**2022-2025**		**2026-2029**		**2030-**
Schedule	Plan		Implementation		Implementation		Implementation

Name of action:	Improving the charging point network for electric cars						
Objective	Significantly improving conditions for private motoring (private use and business use) by improving the rapid charge network in public spaces and by promoting charging opportunities in connection with residential and business premises.						
Summary (100 words maximum)	The rapid charge network for electric cars is expanded systematically and in a market-based manner. Charging opportunities are improved in connection with parking at residential and business properties. Charging opportunities are taken into consideration in city and transportation planning. building permits and other planning and implementation of property use. Parking lots with charging opportunities are reserved for electric cars for parking related to Turku City Group services.						
Responsible bodies	City of Turku, Turku Energia, charge point operators, property owners and users						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	yes	yes	yes	yes	yes	yes	yes
What is the level of significance?	medium	medium	high	medium	medium	medium	medium
Indicator for monitoring	number of charging points and development of charging opportunities in connection with parking at properties						

Implementation	**2018-2021**	**2022-2025**	**2026-2029**	**2030-**
Schedule	general plan and implementation continues	continues	continues	continues
Emission reduction (estimation / t CO2 eq/ year)				
Costs for the city	work input	work input	work input	work input
Funding of measure	work input	work input	work input	work input
Yield	business-based yied	business-based yield	business-based yield	business-based yield
Costs for other actors	market-based implementation of charging points	market-based implementation of charging points	market-based implementation of charging points	market-based implementation of charging points
Required decisions:	status of general plan and building/implementation permits	building/implementation permits	building/implementation permits	building/implementation permits

Name of action:	Piloting and development of a two-way charging point (V2G)						
Objective	Advancing electric transport and integrating mobility and energy system						
Summary (100 words maximum)	Implementation of a two-way charging point (V2G) initiates the development of a new generation's charging system in the Turku area. Two-way charging is also a way to combine mobility and energy systems synergically. Electric cars form a growing energy stock. Two-way charging allows to use this stock two even out consumption and price peaks in the network. It can also be used as a stock in properties that are not linked to an electrical power system.						
Responsible bodies	Turku Energia, City of Turku and charging operators						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	maybe	maybe	yes	yes	yes	yes	yes
What is the level of significance?	low	low	high	high	high	high	low
Indicator for monitoring							

Implementation	**2019-2021**	**2022-2025**	**2026-2029**	**2030-**
Schedule	Implementation and experiences	development and expansion	market-based development	
Emission reduction (estimation / t CO2 eq/ year)				
Costs for the city	work contribution (small)			
Funding of measure	Turku Energia	operators		
Yield		potential yield	market return	
Costs for other actors			operators	
Required decisions	Turku Energia, investment	Turku Energia and operators, investments	operators, investments	

Name of action:	City bike system						
Objective	Offering an opportunity to use a good city bike system as a year-round service						
Summary (100 words maximum)	Developing and maintaining a high-quality city bike system as a year-round service that is conveniently linked to use of public transport. Growing use, expanding network.						
Responsible bodies and partners	City of Turku, Föli, ECCENTRIC project (until 8/2020 at the latest), executors and supplier						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation impact**
What is the impact?	maybe	yes	yes	yes	yes	yes	yes
What is the level of significance?	medium	medium	high	medium	medium	medium	high
Indicator for monitoring							
Implementation	**2018-2021**		**2022-2025**		**2026-2029**		**2030-**
Schedule	**Initiated (ECCENTRIC 2020)**		**Permanent service 2020-**		**Development and expansion**		
Emission reduction (estimation / t CO2 eq/ year)							
Costs for the city	1 million euros per year		1 million euros per year		1 million euros per year		1 million euros per year
Funding of measure	CIVITAS and the city		the city				
Costs for other actors							
Required decisions:							

Name of action:	Harnessing large-volume masses in the city						
Objective	Transportation of soil material and other large-volume masses is improved using digital solutions. The masses are more easily delivered to clients and emissions and other harm caused by transportation are reduced.						
Summary (100 words maximum)	Transportation of soil material and other large-volume masses is improved using digital solutions. The masses are more easily delivered to clients and emissions and other harm caused by transportation are reduced, along with waste and the use of masses quarried from the ground.						
Executors and partners	CIRCVOL 6Aika, TScP, Kiertomaa, 12 executors in total						
Message for Turku and the world	Unnecessary transportation of masses is not sensible – we need a smarter solution. At best, emissions can be reduced by 99 per cent and several million euros of costs per year can be saved						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	yes	yes	yes	yes	yes	yes	yes
What is the level of significance?	medium	medium	high	high	high	high	high
Indicator for monitoring							
Implementation	**2018-2021**		**2022-2025**		**2026-2029**		**2030-**
Schedule	Project 1 June 2018-31 December 2020		new practice continues		new practice continues		
Emission reduction (estimation / t CO2 eq/ year)	significant (compared with current practice)						
Costs for the executing body	project budget 0.5 million euros						

Costs for partners	project budget 0.5 million euros			
Yield		savings in transportation costs		
Funding of measure	own funding and 6Aika			
Required decisions:	project decision made in 2018			

Name of action:	**Carbon sinks in forests**						
Objective	Increasing carbon stock and carbon sinks in woodlands and trees, compensating for emissions						
Summary (100 words maximum)	Valuable nature and carbon sinks are secured through proper forest management planning. The number of trees is increased. An uninterrupted green network is created through forestation. Tillage of soil and ditching are avoided and the natural forest surface area is increased. Logging waste is collected and used appropriately. The city sets an example for other landowners.						
Message for Turku and the world	Restoring carbon sinks is as crucial as reducing emissions. The diversity of nature is important for Turku.						
Responsible bodies	City of Turku, other forest owners and residents						
Impacts	**Direct effect on emissions**	**Indirect effect on emissions**	**Exemplary / pilot effect**	**City responsibility**	**City Group responsibility**	**Innovation / business impact**	**Participation effect**
What is the impact?	yes	yes	yes	yes	maybe	maybe	yes
What is the level of significance?	high	medium	high	high	small	small	high
Indicator for monitoring							
Implementation	**2019-2021**		**2022-2025**		**2026-2029**		**2030-**
Schedule	revising forest management plan		implementation		implementation		implementation
Emission reduction (estimation / t CO2 eq/ year)	carbon sink of own forest approx. 100 000 t/year without felling						
Costs for the city	not significant		not significant		not significant		
Yield for the city	not significant		not significant		not significant		
Funding of measure	not significant		not significant		not significant		
Costs for other actors	not significant		not significant		not significant		
Required decisions:	Turku City Board / approval of plan						

ANNEX 3. Adaptation scoreboard

The assessment of current status of adaptation was completed using an adaptation scoreboard in accordance with the SECAP report model. The city's status in climate change adaptation work was entered into a scoreboard. The city's situation was assessed using the A-D scaling system where:

A = Taking the lead (over 75 % completed)
B = Forging ahead (50-75 % completed)
C = Moving forward (25-50 % completed)
D = Not started or getting started (less than 25 % completed)

Conclusions of the adaptation scoreboard are presented in section 6.1 of the Climate Plan 2029.

Adaptation cycle steps	Actions	Self-check of the status
STEP 1 – Preparing the ground for adaptation STRATEGY	Adaptation commitments defined/integrated into the local climate policy	B
	Human, technical and financial resources identified	C
	Adaptation team (officer) appointed within the municipal administration and clear responsibilities assigned	C
	Horizontal (i.e. across sectoral departments) coordination mechanisms in place	C
	Vertical (i.e. across governance levels) coordination mechanisms in place	B
	Consultative and participatory mechanisms set up, fostering the multi-stakeholder engagement in the adaptation process	C
	Continuous communication process in place (for the engagement of the different target audiences)	C
STEP 2 – Assessing risks & vulnerabilities to climate change RISKS AND VULNERABILITIES	Mapping of the possible methods & data sources for carrying out a Risk & Vulnerability Assessment conducted	A
	Assessment(s) of climate risks and vulnerabilities undertaken	A
	Possible sectors of action identified and prioritised	B
	Available knowledge periodically reviewed and new	C

	findings integrated	
STEPS 3 & 4 – Identifying, assessing and selecting adaptation options ACTIONS	Full portfolio of adaptation options compiled, documented and assessed	C
	Possibilities of mainstreaming adaptation options compiled, documented and assessed	B
	Adaptation actions developed and adopted (as part of the SECAP and / or other planning documents)	C
STEP 5 – Implementing ACTIONS	Implementation framework set, with clear milestones	C
	Adaptation actions implemented and mainstreamed (where relevant) as defined in the adopted SECAP and/or other planning documents	C
	Coordinated action between mitigation and adaptation set	B
STEP 6 – Monitoring and evaluating INDICATORS	Monitoring framework in place for adaptation actions	C
	Appropriate M&E indicators identified	C
	Progress regularly monitored and reported to the relevant decision-makers	D
	Adaptation strategy and/or Action Plan updated, revised and readjusted according to the findings of the M&E procedure	D