TARK TARTU
SMART CITY

Energy – and Climate Action Plan of Tartu City

Tartu Energia 2030

Tartu 2021

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Foreword

According to the estimation of the International Panel on Climate Change (IPCC), human activity has raised the average temperature of the climate by 1 °C compared to the time before the industrial revolution. It is highly likely that in 2023–2052, there will be another 1.5 °C increase in global temperature as a result of human activity. Climate warming has a negative effect on the health and livelihood of people, availability of fresh water, food security, the economy, and biodiversity.

One of the greatest values of Tartu City is its clean, human-friendly, and natural living environment. Human-induced climate change is one of the greatest hazards to the living environment and current living arrangement of Tartu. Mitigating climate change and decreasing the consequences of the environmental impact caused by humans is one of the most important activities for preserving Tartu's values and retaining the current living environment.

In 2014, Tartu joined the Covenant of Mayors. In 2015, the city government prepared the document *Tartu Linna Säästva Energiamajanduse Tegevuskava 2015–2020* (*Tartu City Sustainable Energy Management Action Plan for 2015–2020*) which laid down the goals of reducing energy consumption and carbon emission by 20% compared to 2021 and consuming at least 20% of energy from renewable sources. The sustainable energy management plan was valid until the end of 2020. The 2017 interim evaluation of the plan revealed that although the municipal sector managed to reach the goals set in the plan, the emission of greenhouse gases in the city as a whole increased. The main causes are increase in emissions in private transport and electricity consumption in the private sector (mainly undertakings). On the one hand, it refers to growth in economic activity, which is of course positive, on the other, it clearly highlights those groups of the community that require more cooperation to achieve the common goals. In must be born in mind that the activities designed in the sustainable energy management action plan were addressed to the municipal sector and there were no activities aimed at the private sector. The 2015–2020 action plan can be assessed fully once the follow-up evaluation has been conducted.

2018 marked the beginning of preparing the Tartu City sustainable energy and climate plan, *Tartu Energy 2030*.

Following the Covenant of Mayors, Tartu aims to reduce carbon emissions in the city by 40% by 2030 compared to 2010. Resulting from the European Green Deal, Tartu aims to achieve climate neutrality by no later than 2050.

Tartu Energy 2030 is an energy and climate action plan focused on mitigating the impact of climate change that highlights the need and activities for climate change adaptation. The action plan summarises activities from various fields: government, energy management, building management, power consumption, housing, production and distribution of thermal energy, and production of renewable energy. In addition, the action plan addresses increasing awareness and involvement of residents and activities of the public and private sector. It also analyses the impact of the planned activities on achieving the goals. Representatives from the city government, institutions and organisations engaged with this subject matter, and residents of the city were involved in preparing the document. Co-funding and results of the Horizon 2020 programme's SmartEnCity project were used in preparing the action plan.

The action plan was prepared by the Tartu City Government in cooperation with the Tartu Regional Energy Agency.

We would like to thank all the parties involved!

Short summary

According to the goal set in the Tartu city energy and climate action plan, *Tartu Energy 2030*, Tartu strives to become energy neutral by 2050. The action plan provides the vision and strategic goals and activities for achieving them until 2030. In addition to activities by the city government, residents of the city, companies, and other organisations also play an important role.

The following is the vision formulated in *Tartu Energy 2030*:

Tartu is a smartly developing community with good energy, and a green pioneer.

Strategic goals:

- Decreasing carbon emissions by 40% (216,320 tonnes per year) by 2030 compared to 2010.
- Stopping the use of non-renewable energy sources in the municipal sector (buildings owned by the city, street lighting, public transport, means of transportation).
- Reaching a new level of production and consumption of renewable energy.
- Adapting to climate change.
- Strengthening cooperation with other European cities in achieving climate neutrality and participating in different European initiatives, including the *100 Climate-neutral Cities by 2030*.

Emission of greenhouse gas has increased by 31% over the past decade in Tartu. The increase in emissions is mainly the result of power consumption by the private and public sector and increasing use of private vehicles in the city of Tartu.

Table 4.4. CO_2 emission divided by sectors (thousand tons)

	2010	2017	Change	Change (%)
Municipal sector	43	35	-8	-19%
Private and public	248	406	158	64%
Housing sector	187	184	-3	-2%
Private transport	62	84	22	35%
TOTAL	**540**	**709**	**169**	**31%**

Reaching a community agreement is the most important activity for achieving the goals of the action plan. All residents of Tartu, organisations that operate in or are connected to Tartu, and apartment associations can join the agreement.

The Tartu City Government is the leader and role model for the agreement, committing to terminating the use of all non-renewable energy sources (buildings owned by the city, street lighting, public transport, means of transportation). In addition, the Tartu City Government aims to transition to renewable energy and emission-free transport fuels in providing public services.

The main activities of the action plan for reducing emissions from **private transport** are aimed at increasing pedestrian and bicycle traffic inside the city, reducing car transport that crosses the city border, and decreasing the number of cars in the city. The underlying principle for designing mobility in the city is that the following modes of travel are preferred in the respective order: walking, cycling (including e-mobility), public transport, private transport.

The following activities will have been carried out by 2030 to increase the percentage of sustainable modes of travel and decrease the use of cars:

- a uniform main network of cycling tracks has been constructed;
- mobility centres have been established in the outskirts and centre of the city that are connected to main destinations in the city with fast public transport connections;
- public transport services of the city have been expanded to the nearby settlements.

The goal is to decrease the average number of vehicles crossing the city's border by 35% by 2030 compared to 2020.

The **district heating network** that covers nearly the entire city of Tartu is one of the most environmentally friendly solutions in Europe. The use of fossil energy sources in the district heating network will be terminated no later than by 2030 to achieve the goals of the plan. Wood used in the production of thermal energy must be of low value (timber sector's leftovers as per recommendations) and certified accordingly. The main tool for decreasing emissions originating from the use of electricity and natural gas is the community agreement that was already mentioned. However, production of local renewable energy and enabling its local consumption is also important. Production of solar energy is increased in municipal buildings. Establishment of renewable energy associations is supported to foster the production of renewable energy.

Carbon emissions from waste management were not considered in the preparation of the plan, as their impact is usually indirect. In developing waste management, main attention should be placed on decreasing the generation of waste and separate waste collection with the aim of recycling it. Promoting separate waste collection and increasing its efficiency enables to decrease the negative environmental impact caused by waste. The residents play an important role in this regard, as their awareness and consumption habits largely influence waste reduction. In

turn, the city plays a key role in raising the awareness of residents and creating favourable conditions for it.

Climate change is becoming our new reality. We are not yet noticing high climate-related risks in Tartu that would endanger the lives of the residents or cause significant economic damages. The risk of cold waves, heat waves, and floods is average. The statistics from the last few years primarily indicate an increase in the risk of heat waves. Tartu and its residents must inevitably adapt to climate change. Adaptation measures depend on risks related to the climate and options for mitigating them. In addition, Tartu must support the implementation of the national adaptation plan.

Considering the increase in energy consumption and carbon emission in the city over the past decade, achieving carbon neutrality is a great challenge that requires meaningful impact from all parties for achieving the common goals.

The Tartu city energy and climate plan *Tartu Energy 2030* is approved, implemented, and updated according to regulation No. 5 of 19.04.2021 of the Tartu City Council *Rules of Procedure for Preparing Development Documents of Tartu City*.

The implementation of the energy and climate plan *Tartu Energy 2030* is organised and coordinated by the Tartu City Government. The strategic partner of the city government in implementing the plan is the Tartu Regional Energy Agency.

Vision and strategy

The potential scenario for the future chosen in vision workshops and the vision and strategy along with strategic goals prepared based on this were used as a basis for preparing the Tartu city energy and climate action plan *Tartu Energy 2030*.

Scenario for the future

Two vision workshops were organised in Tartu to prepare the energy and climate action plan. Both workshops assembled representatives from more than 60 different fields. We analysed four different future scenarios using the foresight methodology and formulated the vision for Tartu in 2030 together. The scenario 'Tartu lost its footprint' illustrated in the following figure was considered to be the most perspective.

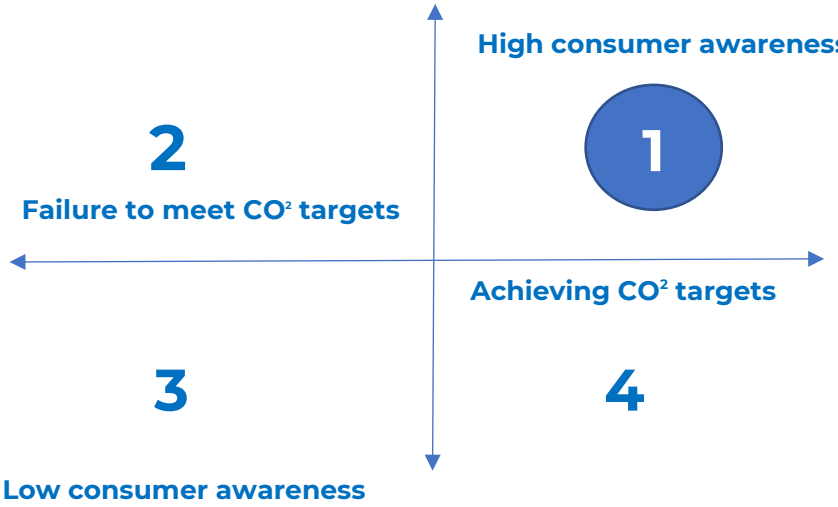


Figure 3.1. Future scenarios for *Tartu Energy 2030*

The development of this scenario is significantly influenced by global trends such as increase in oil and gas prices, continued dependency on fossil fuels, and risk of not achieving the CO_2 goals. Since the impact of climate change is becoming ever clearer and starting to impact our everyday lives, **it is important to raise awareness among people about environmental problems early on**. According to this scenario, both the public sector and residents of the city realise that action is needed now and quickly and start solving the problems and reshaping the society with awareness and enthusiasm.

The strategy that was developed based on the scenario which was selected in the workshops guides the entire city in a comprehensive and integrated manner to reduce its carbon footprint through conscious consumption and purposeful actions. The city's governance is transparent and inclusive and new goals are reached in cooperation with the residents. The actions of the city government set an example for organising energy management. Tartu becomes even more attractive as a city. The number of residents of Tartu increases but its ecological footprint decreases. Residents of Tartu feel that this is a good place to live.

The plan aims to involve all groups of the society – the residents, businesses, and other stakeholders. Involvement is a wide-scale process, and a community agreement is seen as one option for this.

Tartu is the most active Estonian city, leading the way in achieving carbon neutrality in Estonia by 2050. Tartu also plans to join the mission of the European Commission, *100 Climate-neutral Cities by 2030*. Since Estonia and especially Tartu are already known for their smart and digital solutions, this mentality is also extended to preserving the environment and green thinking. Tartu is a smart city with conscious and responsible consumers.

Vision

Tartu is a smartly developing community with good energy, and a green pioneer.

Good energy – using alternative energy, renewable energy solutions, mentality of preserving the environment, nature-friendly living environment, and a good place to live.

Smartly developing community – co-creation, involvement of residents, acknowledgement of climate change, environmentally friendly actions, smart consumption, happy and healthy highly aware people, trust, openness and cohesion, economy that prefers repairing existing things over purchasing new ones.

Green pioneer – development and implementation of smart and green solutions, smart use of resources, economic growth through environmental sustainability, clean energy policy, recycling, example to others, moving towards erasing its ecological footprint.

Strategic goals

- Reducing carbon emissions by 40% (216,320 tonnes per year) by 2030 compared to 2010.
- Transitioning to renewable energy in the municipal sector (buildings owned by the city, street lighting, public transport, means of transport, etc.)
- Reaching a new level of production and consumption of renewable energy.
- Adapting to climate change.

Achieving the goals of *Tartu Energy 2030* depends on three main courses of action:

- **Energy efficiency**
- **Wider use of renewable energy**
- **Climate change adaptation**

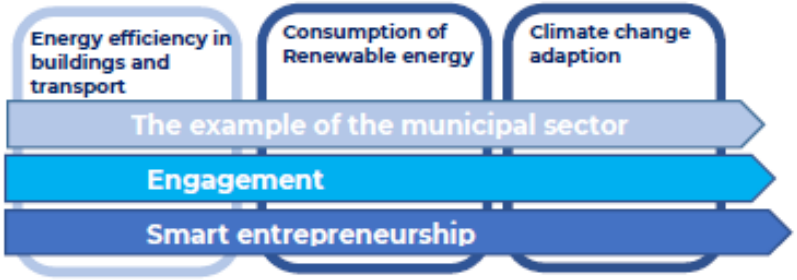


Figure 3.2. Outline of implementing the strategy

Two courses of action – energy efficiency and use of renewable energy – are aimed at reducing the impact of climate change and main ways of decreasing carbon emission and energy consumption.

The success of implementing these courses of action and meeting the objectives of the entire energy plan depends on a **synergy between the three horizontal conditions**.

Example of the municipal sector

The municipal sector of Tartu acts as a role model by using renewable energy sources and simultaneously reducing its energy consumption. The city government aims to organise energy management in a well-thought-out and systemic manner that is based on collection of consumption information, analysis, and decisions based on the data. Energy management involves all the areas of activity of the city government. The principle of green procurement is considered in organising procurements.

Public transport is emission-free and only renewable energy sources are used. Sustainable and active modes of travel are developed first.

Outreach and conscious consumers

Consumers know where energy comes from and what consumes it. Buildings are actively renovated.

Over time, the use of private vehicles is replaced by alternative modes of transport. People are flexible in organising their everyday mobility and select their mode of travel based on the circumstances and context. Sustainable modes of travel that help reduce the use of cars in the city and improve the air quality in Tartu are popular.

Awareness among consumers is high – they consume less and more consciously and prefer local produce. Equipment and items are rather repaired and reused than discarded and replaced.

The community agreement concluded between Tartu City, undertakings, organisations, and natural persons is popular. The goal of the agreement is to invite all parties to stop using fossil energy sources.

Smart businesses

The business sector plays a crucial role in achieving the climate and environment-related goals. Close cooperation between the Tartu municipal sector, business sector, and research and development institutions helps to introduce new technologies and services with a great

potential for export in the course of achieving the goals. One possibility of achieving climate neutrality through cooperation and development of innovative technologies is applying to join the European Commission's mission *100 Climate-neutral Cities by 2030*.

Energy consumption and emission of greenhouse gases in Tartu City

Energy consumption and emissions in Tartu City divided by energy sources

By 2017, energy consumption in Tartu City had increased by 18% compared to 2010 (see table 4.1). The main increase occurred in electricity consumption and the increase in consumption of fossil fuels also plays a crucial role.

Table 4.1. Energy consumption by energy sources (GWh)

Energy source	2010	2017	Change	Change (%)
District heating	504	514	10	2%
Fossil fuels	428	522	94	22%
Electricity	340	464	124	36%
TOTAL	**1,272**	**1,500**	**228**	**18%**

By 2017, CO_2 emission in Tartu City had increased by 31% compared to 2010 (see table 4.2). Emission from consumption of electricity and fossil fuels increased. At the same time, emission from district heating decreased.

Table 4.2. CO_2 emission by energy source (thousand tons)

Energy source	2010	2017	Change	Change (%)
District heating	71	61	-10	-14%
Fossil fuels	101	124	23	23%
Electricity	369	524	155	42%
TOTAL	**541**	**709**	**168**	**31%**

Energy consumption per resident in Tartu City has increased by 16%, amounting to 0.015 GWh in 2017. Over the same period, CO_2 emission per resident increased by 33%, amounting to 7.32 t CO_2 per year.

Energy consumption and emissions in Tartu City divided by sectors

Increase in energy consumption in Tartu City mainly results from increased use of private vehicles and increase in energy consumption in the business sector. The increase in energy consumption resulting from the use of private vehicles surpasses the energy savings achieved in the municipal and housing sector (see table 4.3).

Table 4.3. Energy consumption by sectors (GWh)

Sector	2010	2017	Change	Change (%)
Municipal sector	91	87	-4	-4%
Private and public	427	621	194	45%
Housing sector	514	463	-51	-10%
Private transport	240	329	89	37%
TOTAL	**1,272**	**1,500**	**228**	**18%**

The pace of growth of carbon emission resulting from energy consumption has been nearly doubled compared to the increase in

energy consumption. The reason is increased use of electricity and fossil fuels that have a much higher carbon intensity than district heating.

Table 4.4. CO_2 emission divided by sectors (thousand tons)

	2010	2017	Change	Change (%)
Municipal sector	43	35	-8	-19%
Private and public	248	406	158	64%
Housing sector	187	184	-3	-2%
Private transport	62	84	22	35%
TOTAL	**540**	**709**	**169**	**31%**

Municipal sector

Tartu City Government provides more services with higher quality while decreasing energy consumption and carbon emission. The main sources of efficiency gains have been renovating administrative buildings, including schools and preschools, and increasing the efficiency of water treatment. Increase in energy consumption in public transport results from the larger number of route kilometres related to improving the quality of the service.

Table 4.5. Energy consumption by the municipal sector (GWh)

	2010	2017	Change	Change (%)
Administrative buildings of	58	55	-3	-5%
Street lightning in Tartu	7	7	0	0%
Water treatment	11	9	-2	-18%
Public transport	15	16	1	7%
TOTAL	**91**	**87**	**-4**	**-4%**

Savings in carbon emission by the Tartu municipal sector surpass the energy savings many times over. Decrease in emission mainly results from purchasing so-called green energy.

Table 4.6. CO_2 emission of the municipal sector (thousand tons)

	2010	2017	Change	Change (%)
Administrative buildings of	21	16	-5	-24%
Street lightning in Tartu	8	6	-2	-25%
Water treatment	11	9	-2	-18%
Public transport	4	4	0	0%
TOTAL	**44**	**35**	**-9**	**-20%**

In 2017, energy consumption by the municipal sector only amounted to 5.8% of the entire city's consumption. More attention should be paid to reducing the use of private vehicles in the city and increasing the energy efficiency of the business sector to achieve the climate goals.

Table 4.7. CO_2 emissions in Tartu City (thousand tons) and their changes

	2010	2017	2030	Change compared to 2010	Change compared to 2017	Change (%) compared to 2010
Municipal sector	43.2	35.1	0	-43.2	-35.1	-100%
Private and	248.	406.	191	-57.1	-215.1	-53%
Housing sector	187	183.5	77	-110	-106.5	-58%
Private	62.5	84.2	53	-9.5	-31.2	-37%
TOTAL	**540.**	**708.**	**324**	**-216.8**	**-384.9**	**-40%**

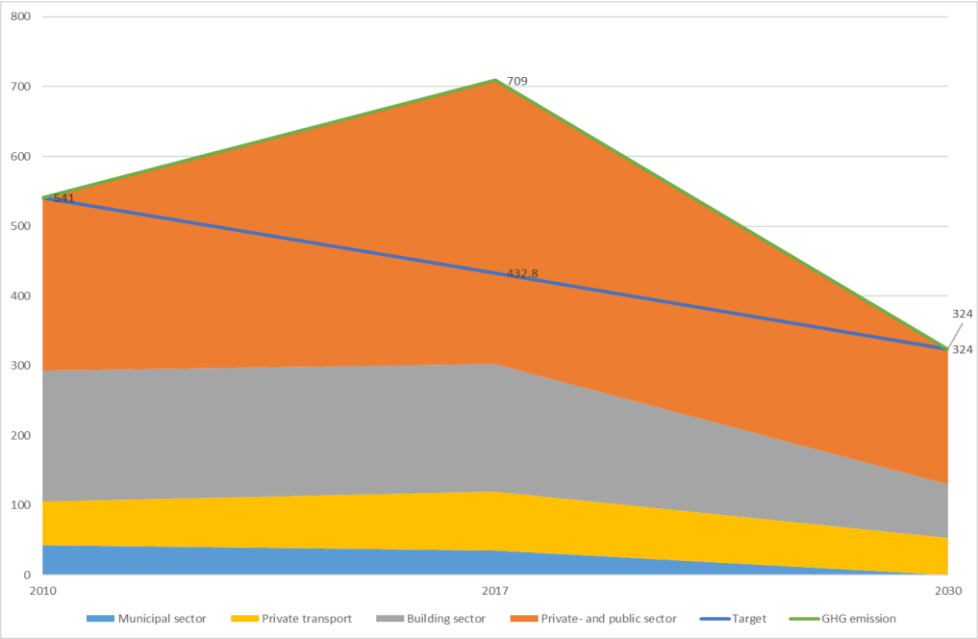


Figure 4.1. CO_2 emissions and change (thousand tons) of Tartu City

Decreasing the impact of climate change

5.1 Community agreement

One of the most important activities and main engagement tools of *Tartu Energy 2030* is the community agreement, the parties of which assume an obligation to contribute to achieving the goals set in the energy and climate plan.

The leader and role model for the agreement is the Tartu City Government that has set a goal of consuming energy from renewable sources in its activities and its agencies **by 2024**. This means that:

- **renewable electricity** is used in all activities;
- renewable energy sources or district heating are used for heating the municipal buildings;
- energy from renewable energy sources is used in public transport (including buses and smart bikes);
- renewable electricity or renewable fuels are used in vehicles;
- the shipment of waste and street cleaning services managed by the city gradually transition to transport fuels from renewable sources;
- the use of fossil fuels and energy sources in water treatment is minimised.

The extent, goals and activities of the community agreement will be laid down in detail in the course of the agreement. The largest consumers of energy will be contacted to reach the annual objectives for CO_2 savings and the goals agreed on with them may not be less ambitious than the objectives provided in *Tartu Energy 2030*.

Those who join the community agreement do not take on any monetary responsibilities in the form of a membership fee or similar cost. Those who join also do not receive monetary support for performing their obligations.

Priority activities

No	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy sources	Tartu City Government	2024
1.2	The private and public sector transition to renewable electricity and thermal energy (considering the exception of district heating)	Tartu City Government, TREA, parties to the agreement	2030
1.3	The housing sector transitions to renewable electricity and thermal energy (considering the exception of district heating)	Tartu City Government, TREA, parties to the agreement	2030

1.4	Applying to join the European Commission's mission *100 Climate-neutral*	Tartu City Government	2022

Important stakeholders for achieving the goals of the energy and climate plan:

- residents of the city;
- companies and organisations;
- energy producers;
- universities (both as expert organisations and large consumers);
- various structural units and agencies of the city government;
- apartment associations and their umbrella organisations;
- building owners;
- schools;
- preschools;
- civil society organisations (organisations involved in the process of the energy and climate plan, city district associations, etc.)

The community agreement is an important form of co-creation and work that is used to apply for joining the European Commission's mission *100 Climate-neutral Cities by 2030*. Joining the mission would enable Tartu to:

- help accelerate achieving its goal of climate neutrality;
- significantly increase involvement of the union's research and development resources and structural resources;
- stimulate local green and smart entrepreneurship;
- intensify cooperation between the city, research institutions, and undertakings;
- improve the international recognition and reputation of Tartu.

5.2 District heating and district cooling

The European Union has categorised district heating under means of heating that should be given priority, as it allows to use various energy sources, including cogeneration and industrial waste heat. AS Epler & Lorenz plans to establish a waste incineration plant solution and its waste heat produced in the manufacturing process would cover the summertime thermal energy need of Tartu City in the district heating network. The options for constructing the plant will be specified after the evaluation of environmental impact. Central network also allows storing heat. Mainly using carbon-free district heating and its development is an important way to decrease CO_2 emissions in Tartu City. It is important to ensure that the wood used in district heating is of low value and certified accordingly.

The district heating areas of Tartu have been established in the *Tartu City Comprehensive Plan to 2030* (2017) [3]. Approximately 1,700 buildings consume heat from district heating in Tartu. 50% of the consumers are in the housing sector, 8% municipal authorities, and 42% other authorities and undertakings.

The energy group Fortum Tartu supplies consumers in Tartu City with district heating and district cooling. The highest percentage of fuels used in producing heat are biofuels (wood chips, over 75%), followed by natural gas (18.5%) and to a lesser extent peat (5.5%). Fortum Tartu is the first in the Baltic States to provide the service of district cooling.

The goals of Tartu in heating and cooling buildings owned by the city:

- fossil fuel-free district heating and cooling by 2030;
- as from 2024, buildings of the Tartu municipal sector no longer consume energy produced of fossil fuels (except for district heating that will be free of fossil fuels by 2030);
- expansion of the district heating network primarily in the city districts Karlova and Supilinn.

As a result of achieving the goals, consumption of thermal energy from district heating has increased by 15% by 2030. Energy consumption of district cooling amounts to 29,000 MWh. The estimated carbon emission from the city's district heating and district cooling in 2030 is 0 tonnes. By joining the district heating service, carbon emission from the business sector has decreased further by up to 13,000 tonnes per year.

Furthermore, only low-value timber that has been certified accordingly will be used in the district heating of Tartu City. It must be ensured for the timber used that cutting does not damage nature conservation values (e.g. key habitats). By increased use of waste heat, storing energy, low-temperature district heating and applying alternative technologies for producing heat, the volume of wood used in district heating in Tartu is declining.

Table 5.1. Indicators characterising district heating and cooling

	2010	2017	2030	Change	Change %
Sale of heat (MWh)	504,118	514,231	580,000	75,882	15%
Sale of cooling (MWh)	0	2,949	29,000	26,000	90%
CO_2 emission goal (t CO_2	71,000	66,196	0	105,333	-100%
Absolute heat loss	68,560	63,000	63,000	-5,560	-8%
Relative heat loss	13.6%	12.3%	10.9%		
Number of customers	982	1,411			
Total length of the	115	177			

Priority activities in district heating

No.	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy sources (community agreement)	Tartu City Government	2024
2.1	Cooperation agreement between the City of Tartu and energy producers to achieve carbon neutrality in district heating	Tartu City Government, energy producers	2021
2.2	The use of fossil fuels in district heating and cooling is terminated	Energy producers	2030
2.3	Increased use of waste heat in the city's district heating	Energy producers	2030

Supporting activities in district heating

No.	Activity	Responsible party	Year
2.3	Expanding the area of district heating	Tartu City Government	2021
2.4	Introduction of energy storage in the production and distribution of district heating energy	Energy producers	2030
2.5	Reduction of network losses in district heating	Energy producers	continuous
2.6	Use of low-temperature district heating and waste and residual heat in the district heating network	Energy producers	continuous
2.7	Gradually joining buildings in Karlova and Supilinn with the district heating network	Tartu City Government, energy producers	continuous
2.8	Analysis of possibilities for separating residual heat from wastewater	Tartu City Government, energy producers	2024

The existing cooling market is dominated by traditional building-specific electrical air conditioning devices with low energy efficiency. District cooling decreases CO_2 emissions by 50–70% compared to the regular solutions, considering the current primary energy use.

Main benefits of district cooling compared to the traditional cooling systems:

- higher energy efficiency ensures lower need for energy and reduced CO_2 emission;
- prevents the development of heat islands in the city;
- less noise in the city;
- the utility equipment of the buildings is less visible, improving the appearance of the cityscape;
- no need to use the capacity of the electricity grid which allows to optimise the infrastructure;
- decreases greenhouse gases caused by spillage of coolants.

Tartu has two cooling plants: the city centre cooling plant with 13 MW capacity located by Turu Street near the River Emajõgi that was opened in 2015 and the Aardla cooling plant with a capacity of 5.4 MW that was finished in 2017. As of January 2020, the total length of the cooling network was 7.2 km. Based on the Rescue project funded by the European Commission, it can be estimated that the actual need for district cooling capacity in Tartu in 2030 will be 25 MW per year and consumption volume will be approximately 29 GWh.

The goal in district cooling for achieving the consumption volume is to connect the Turu and Aardla cooling plants into a central district cooling network. The network will be supported by a refrigeration battery established by the Tulbi 12 boiler station that enables to cover the hottest periods of the summer and ensures additional backup for hospitals.

Activities to support district cooling

No.	Activity	Responsible	Year
2.8	Include district cooling in planning documents	Tartu City Government	2021
2.9	Analyse the possibility of expanding the district cooling network in the Ropka	Energy producers	2024
2.10	Develop a joint cooling network with energy storage facilities for Turu, Aardla, and Tulbi areas	Energy producers	2028
.2 11	Reduce network losses in district cooling	Energy producers	continuous

5.3 Electricity and fuels

Electricity

The Estonian *Development Plan of the Energy Sector until 2030* provides national goals in the energy sector until 2030:

- Final energy consumption in 2020 and 2030 is at the same level as in 2010 (~32 TWh).
- In 2030, renewable energy accounts for at least 50% of final energy consumption.

The vision for the development of Estonia's energy sector is to ensure energy supply with market-driven prices and availability for consumers in line with the long-term energy and climate targets of the European Union, while contributing to the improvement of Estonia's economic climate and environmental status and increased long-term competitiveness.

The main goals for energy production and consumption are achieving fuel and electricity markets that operate in a free, unsubsidised, and open manner and that electricity generated from renewable sources accounts for 50% of domestic final electricity consumption.

The long-term goal of the EU and Estonia is to achieve carbon neutrality in energy production by 2050.

Based on the data from the past decade, we are facing a great challenge. In Tartu City, electricity consumption in 2010–2017 increased by 36% and carbon emissions from electricity consumption increased even more – by 42%. The increase has been stable and mainly resulted from increased use of electricity in the private sector. Consumption of electricity in the municipal sector has been largely on the same level in Tartu over that period.

Electricity has by far the greatest impact on carbon emissions in Tartu City out of all the types of energy. While in 2017, electricity amounted to 31% of the entire city's energy consumption, it made up 74% of the city's carbon emissions. Therefore, it is very important for the whole city to achieve efficiency gains in electricity consumption and decrease consumption in general and mainly to increase the share of electricity from renewable sources in the total energy consumption.

Due to oil shale energy, Estonia's electricity emission factor has been among the highest in Europe. The emission factor (special emission factor) of electricity consumption used in this energy plan is the 2017 factor 1.147 $kgCO_2/kWh$ calculated using the residual mix calculation methodology of Elering AS.

The indicators of Estonia's neighbouring countries are as follows:

Finland – 0.155
Latvia – 0.121
Lithuania – 0.096
Sweden – 0.015

Production of electricity in Estonia is multiple times more polluting than in neighbouring countries. If we manage to decrease the role of oil shale energy or cast oil shale aside in electricity production and bring the emission factor down to the EU average, we can considerably reduce greenhouse gas emissions in Tartu and Estonia as a whole. The competitiveness of oil shale energy is directly related to the prices of CO_2 emissions in the EU. CO_2 prices are rising, and according to experts they will not fall below the current level, meaning that oil shale energy will become increasingly less competitive.

Table 5.2. Cost of CO_2 emissions per tonne in the EU

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Cost €/tonne	15.2	12.9	8.1	5.8	6.5	5.9	6.75	7.35	22.3	25.9

The preparation of this plan was based on the estimation that the electricity emission factor in 2030 will not exceed 0.7 kg per CO_2 /kWh.

In 2017, the Tartu City Government purchased a total of 6,405 MWh of **green energy**, including 4,275 MWh for buildings and 2,130 MWh for street lighting. The total energy consumption of buildings of the city government and street lighting in 2017 was 21,350 MWh. If the city of Tartu only consumes electricity from renewable sources, 14,100 tonnes of CO_2 emissions can be avoided.

In 2017, the total electricity consumption of the private and public sector in Tartu was 316 GWh.

According to AS Elering, there were 50 producers of renewable energy in Tartu that sold a total of 183 MWh into the grid. There is no information on own consumption. In addition, there may be producers who use all of their product and do not sell any into the grid. There is no data regarding the use of renewable energy in the private sector.

Local governments can influence the use of renewable energy in several ways, including in the private and public sector.

The municipal sector acts as a role model for the private sector by producing renewable energy and increasing demand on the market by purchasing it. **The more electricity is produced from renewable sources, the more the electricity emission factor** and emissions **decrease.** Considering that **electricity is twice as expensive as heat**, supporting local production of electricity is even more important. Energy associations and other business models are an important resource for achieving the goals. Although the city itself does not produce a considerable amount of energy, it can promote and support private initiative and remove administrative obstacles (including by granting building rights through plans or planning conditions) for the introduction of renewable energy.

Carbon emissions are reduced significantly through production of renewable energy. The load on transmission lines and substations is decreased by consuming locally produced energy.

Goals for 2030

- Carbon emissions from consumption of electricity by the Tartu municipal sector (excluding water treatment) is 0 tonnes.
- Carbon emissions from consumption of electricity by the public and private sector is below 179,000 tonnes of CO_2 per year.
- Inspiring the housing sector (private and apartment buildings) i.e., households to use 15 GWh of renewable energy that helps to decrease annual CO_2 emissions by 16,000 tonnes.

Priority activities in electricity

No.	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy sources (community agreement)	Tartu City Government	2024
1.2	The private and public sectors transition to renewable electricity and thermal energy (community agreement)	Tartu City Government, TREA	2030
1.3	The housing sector transitions to renewable electricity and thermal energy (community agreement)	Tartu City Government, TREA	2030
3.1	Solar energy plants with a total capacity of at least 1.5 MW will be established for buildings owned by the local government	Tartu City Government, TREA	2030
3.2	Developing a local consumption scheme and business model for renewable energy produced in the Tartu area	TREA, Tartu City Government	2024

Supporting activities in electricity

No.	Activity	Responsible party	Year
3.3	Motivating the private and public sector to increase own production of energy with a capacity of at least 125 MW	TREA, Tartu City Government	2028
3.4	Increasing the production of renewable energy through association activity. Achieving the establishment of renewable energy plants owned by energy associations with a capacity of at least 10 MW by 2028	TREA	2028
3.5	Conducting a research regarding the potential of producing solar energy with buildings owned by the local government	Tartu City Government	2022

In total, these activities enable us to save carbon emissions from electricity consumption in the city by 148,000 tonnes of CO_2 annually.

Gas

Another widely used energy source that has a large impact is natural gas.

Table 5.3. Consumption of natural gas in the city of Tartu

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Natural gas, million m^3	17	14	30	10	16	16	12	19	17

In Tartu City, natural gas is mainly consumed for the production of thermal energy and to a lesser extent also as transport fuel (urban buses, county buses, private vehicles). Over the past decade, natural gas has been used quite consistently in the city and is dependent on the weather.

The location and development perspectives of the natural gas network have been laid down in the Tartu comprehensive plan pursuant to the Natural Gas Act. If possible, joining new buildings to the district heating network for heat supply is preferred. In Tartu, use of local heating based

on natural gas is only possible in areas where a district heating area has not been established or in buildings located in the district heating area that consume less than the value established by the Tartu district heating regulation.

Goals

- Consumption of natural gas (including biomethane) does not exceed the 2017 level.
- The use of natural gas is gradually replaced by biomethane and hydrogen produced from renewable energy sources.

Priority activities in natural gas

No.	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy sources (community agreement)	Tartu City Government	2024
1.2	The private and public sectors transition to renewable electricity and thermal energy (community agreement)	Tartu City Government, TREA	2030
1.3	The housing sector transitions to renewable electricity and thermal energy (community agreement)	Tartu City Government, TREA	2030

Hydrogen

Hydrogen is a versatile, clean, and safe energy source material that can be used as fuel for energy. Hydrogen does not produce any emissions at the place of use, and it can be produced from (renewable) electricity and fossil fuels with less carbon dioxide emissions, achieving completely emission-free energy. The use of hydrogen is increasing, as it can be stored and transported with great energy density in liquid or gaseous form and burned or used in fuel cells for producing heat and electricity.

Thanks to its versatility, hydrogen has a key role in transport, industry, and housing, as well as storing renewable energy in large volumes, making it a promising solution for facing the challenges of redesigning energetics.

Currently, the technologies for producing, storing, and using hydrogen are quite expensive, however, their price is dropping fast over time and the use of hydrogen is expected to rise significantly in the next decade in both Europe and the rest of the world. It is therefore necessary to keep up do date with current developments and seek possibilities for cooperation with the private and public sector to prioritise and apply hydrogen solutions.

One of the most practical means of using hydrogen on a wider scale is its production from renewable energy (mainly solar and wind energy in Estonia) and use for energy recovery, heat production in local heating solutions, and as fuels in the transport sector (including public transport and various services commissioned by local governments, such as garbage removal, street cleaning, etc.) A local initiative group that would coordinate activities related to the production and use of hydrogen in the Tartu area is needed for developing this area.

Synthetic fuels

Several changes are needed in the European energy industry to achieve CO_2 neutrality by 2050. The most important is terminating the use of fossil fuels. Transport emissions also need to be reduced. Vehicles using fossil fuels (e.g. petrol and diesel) must be replaced by electric vehicles. However, if this is not possible, for example in long-distance road haulage, shipping and aviation, sustainable biofuels and CO_2 neutral synthetic fuels need to be introduced that have been produced using electricity and thermal energy with low carbon emissions. Hydrogen and carbon dioxide are mainly used for producing novel synthetic fuels. Synthetic methane i.e., natural gas is created by combining hydrogen and carbon dioxide and it can be used as fuel. This in turn can be valorised to produce liquid fuels. Although this technology has existed for a long time, its introduction and development has been mainly hindered by the high price of renewable energy.

Carbon capture is possible for CO_2 that causes problems related to climate change. Carbon capture enables making the production of electricity and

heat that is based on combustion of fuels more environmentally friendly. Carbon capture to produce, for example, synthetic fuels may bring us one step closer to achieving carbon-free energetics.

Transport fuels

In general, the use of transport fuels in Tartu is increasing every year. The use of diesel fuel and natural gas (including biomethane) has increased significantly. The increased use of natural gas is mainly due to the larger number of city and county buses that use natural gas. The number of private vehicles using natural gas is also on the rise.

Table 5.4. Transport fuels used in Tartu City (MWh)

	Diesel	Petrol	Gas	Electricity	Total
2010	82,614	139,892	157	74	222,737
2017	122,207	206,934	233	109	329,482

Electricity is also used in the transport sector as an energy source, mainly for taxis. Tartu has the largest number of electric taxis in Estonia. Since the percentage of electricity in transport is currently marginal, the impact of this energy source is not reflected in this document.

Pursuant to the EU environmental policy, we see that electricity will be used increasingly in the transport sector, but other energy sources will also be added. Mainly, wider use of vehicles using hydrogen and synthetic fuels is expected.

The state and local governments must foster and promote the use of locally produced renewable transport fuels, as it has a positive socio-economic impact and increases energy security.

Activities to support transport fuels

No.	Activity	Responsible party	Year
3.5	Foster the use of renewable transport fuels (biomethane, hydrogen, synthetic fuels, etc.)	Tartu City Government, TREA	continuous

5.4 Transport

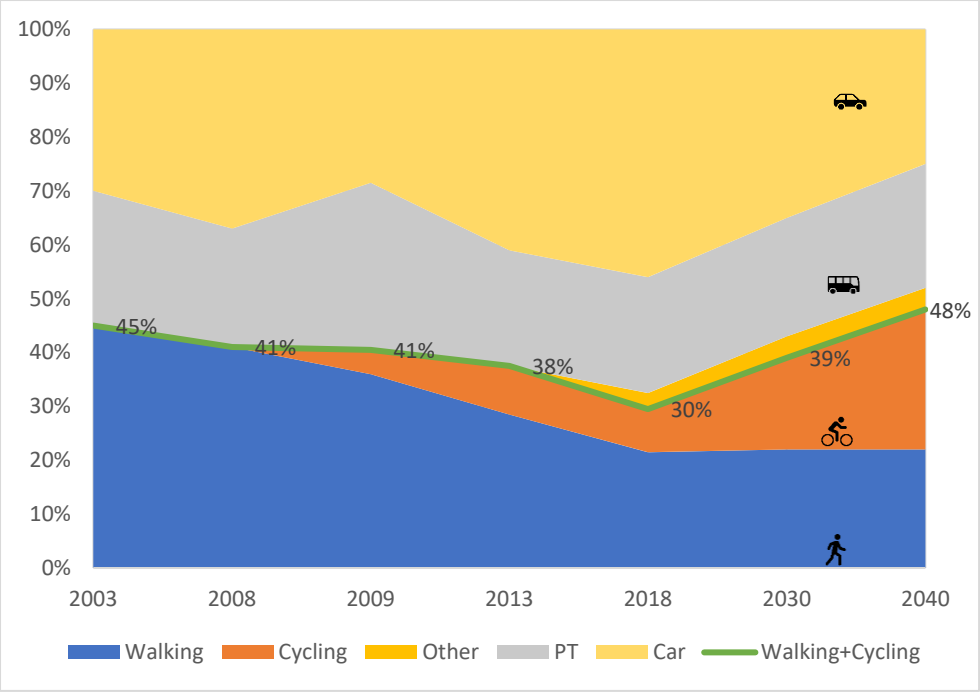
The objective of the EU transport policy is to maintain the dynamic nature of the European economy by developing a modern infrastructure that makes travelling faster and safer and by supporting sustainable and digital solutions. Introduction of sustainable and innovative means of transport play an important role in achieving the EU's energy and climate objectives. Compared to 1990, the EU must decrease emissions from the transport sector by 60% by 2050.

The energy consumption and environmental impact of transport in Tartu has increased by a third compared to 2010, whereas energy use in the private sector has undergone the most rapid growth. The number of private vehicles in Tartu has increased consistently in the past decades.

The transport objectives of the Tartu City energy and climate plan are as follows:

- increase the percentage of sustainable modes of transport in all travels;
- reduce the use of private vehicles in city traffic;
- establish an infrastructure required for active mobility;
- ensure safety of mobility;
- develop public transport that is separated from the rest of traffic, is fast, and has minimal environmental impact;
- better coherence of modes of transport;
- bring services closer to the people;
- innovative development of services.

As a result of the action plan, the percentage of sustainable modes of travel will amount to approximately 60% of all daily mobility in the city.



	2003	2008	2009	2013	2018	*2030*	2040
	45%	41%	36%	28.5%	**21.5%**	22%	22%
	-	-	4.5%	9%	**8%**	17%	26%
	25%	22%	31%	21.5%	**21.5%**	22%	23%
	30%	37%	28.5%	41%	**46%**	35%	25%
	-	-	-	-	**3%**	4%	4%
+	45%	41%	40.5%	37.5%	**29.5%**	39%	48%

Figure 5.1: Distribution and prognosis of modes of travel until 2040

Note: mode of travel 'Other' includes different means of transport, e.g. scooter, skateboard, moped, etc.

Compared to 2010, cross-border traffic caused by urban sprawl has increased significantly. According to the report of the Tartu City traffic load study conducted by Stratum OÜ in 2017, traffic load in suburbia has increased by more than a tenfold over the past 30 years and is still on the rise.

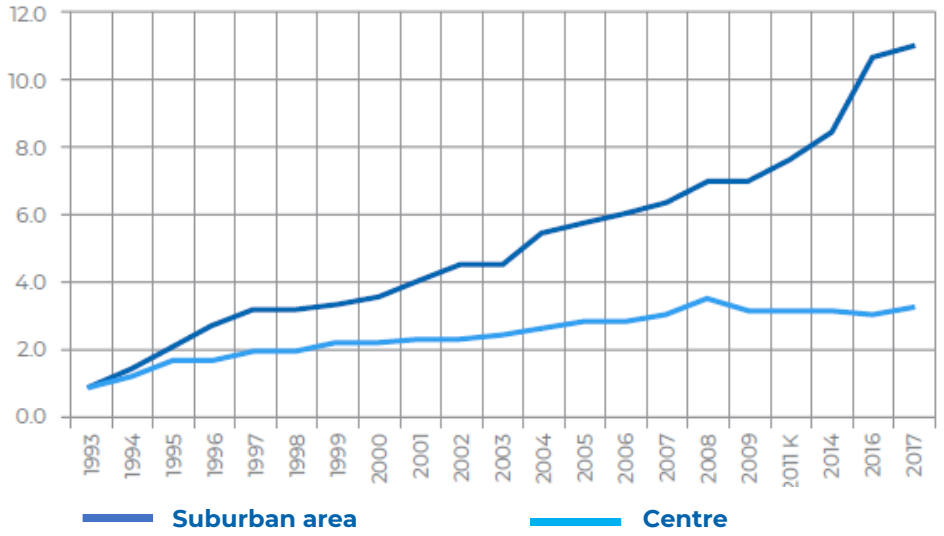


Figure 5.2: Developments in Tartu traffic load in 1993–2017 (multiplication compared to the 1993 value) during the evening rush hour, total of both traffic directions

Although the energy efficiency of vehicles increases every year, the ever-growing number of private vehicles causes a rise in greenhouse gas emissions. This creates a challenge for promoting sustainable transport and achieving the city's strategic goals.

Table 5.5. Energy use and emission in Tartu private transport in 2010 and 2017 and prognosis for 2030. Data: Estonian Road Administration and National Bureau of Statistics

	2010	2017	2030
Energy consumption (GWh/mln km)	0.906	0.842	0.723
Carbon emissions (kg CO_2/km)	0.234	0.214	0.178

In 2018, the Tartu City Government commissioned a study to map the modes of travel preferred by residents of Tartu City and its nearby areas. The study was meant to provide an overview of the daily mobility habits of people and the factors that influence them. The outcomes of the study indicate modes of travel the residents of the city and its surrounding areas

would prefer if there were better conditions for public transport, walking, and cycling.

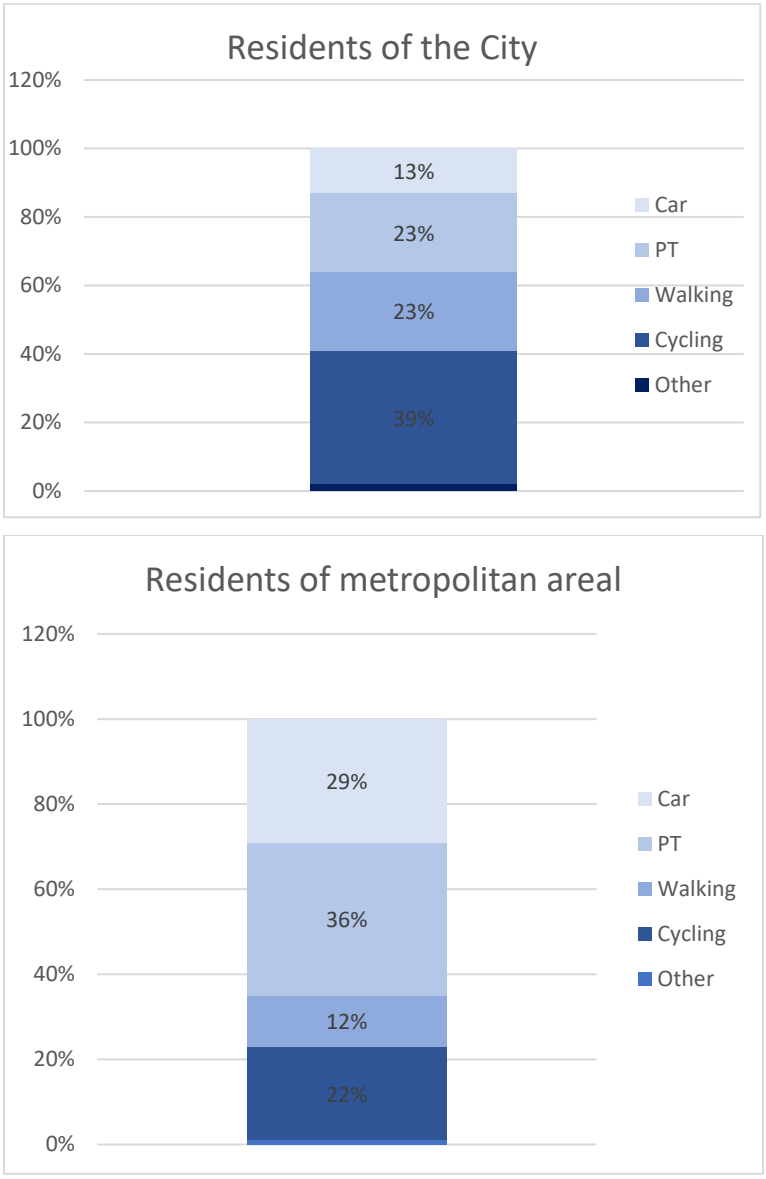


Figure 5.3: Preferred modes of travel of residents in the Tartu area

If all the suitable preconditions were met,

- residents of Tartu would prefer cycling,
- residents of the areas surrounding Tartu would prefer public transport.

The main obstacles to cycling are:

- weather,
- road safety;
- lack of suitable cycle and pedestrian tracks;
- lack of bicycle parking facilities.

The main obstacles to using public transport are:

- the frequency of public transport;
- lack of suitable routes;
- the possibility to arrive and leave at a suitable time (especially in the near vicinity of Tartu).

An important thing to note regarding car use is that in more than half the cases in Tartu, most trips are taken alone. Car use could primarily be reduced by better cycle and pedestrian paths (mainly important to residents of the City of Tartu), faster public transport connections (important to people who live in the vicinity of Tartu), and suitable public transport routes (important to people who live in the surrounding areas).

Compared to the residents of the city, people who live in the surrounding areas also find it important that their children and other family members can travel independently and there are a joint ticket system, better 'Park and walk" solutions, and better 'Park and travel' conditions.

Walking

Increased traffic density caused by motorisation has had a negative impact on the pedestrians' sense of security. Conditions and possibilities of active mobility need to be improved by increasing safety and road quality. In addition, activities of the action plan help to acknowledge the possibilities and preferences of active mobility among residents of the city and its surrounding areas.

In the course of implementing the Action Plan, the share of walking in all mobility in Tartu City will rise to 22% by 2030 and will then stay on at least this level.

Cycling

In this energy and climate action plan, cycling means cycling, electric cycling and other electric vehicles such as skateboards, electric scooters, etc.

Cycling is the most preferred mode of travel among Tartu residents (outcome of the mobility study conducted in 2018) and its popularity is constantly increasing, however, conditions for it are inconsistent. Some of the bike paths are in poor condition, fragmented and poorly marked and do not form a functioning unit that would enable to move quickly between different districts. Development of shared cycle and pedestrian tracks creates artificial boundaries between faster road users (bicycles, roller blades) and road capacity and endangers pedestrians, especially the most vulnerable groups such as children, the elderly, and people with impaired physical mobility.

Implementation of the action plan enables to use bicycles for fast mobility in the city. This reduces car use, fuel consumption, and carbon emission. It is important to create a fast network of bike paths between districts and connect the bike paths surrounding the city with the city centre.

In the first stage of creating a comprehensive network of bike paths, the area between the railway and River Emajõgi will be connected from the Tähtvere District to the Ropka District through Narva maantee and Riia Streets from the city centre to the city's border. The necessary connections in the rest of the city and with the surrounding areas will be created in the second stage.

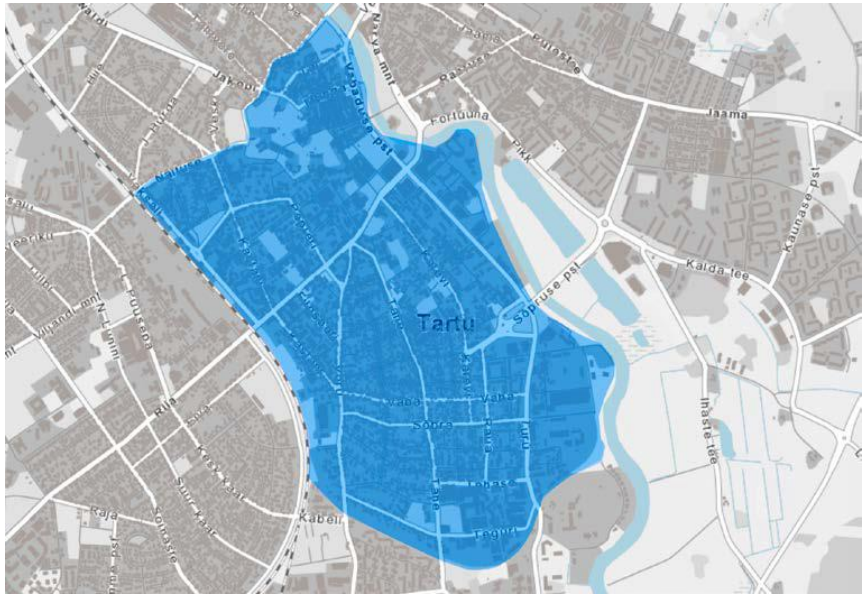


Figure 5.4: Area where the 1st stage of the comprehensive network of bike paths will be established.

In June 2019, Tartu City launched the city-wide bike share service that includes 69 parking areas and 750 bikes (500 of which are electric bikes and 250 are regular bikes). The first year of the bike share was successful. Over 2,000,000 kilometres were covered with the bike share bikes and more than 800,000 trips were made. In the coming years, the bike share service is planned to be extended to the areas surrounding the city and the number of parking areas inside the city will be increased.

In the course of implementing the Action Plan, the share of bike traffic will increase to 17% of all traffic by 2030 and to 26% by 2040.

E-mobility

Emission-free electric transport using electricity produced from renewable energy sources helps to reduce emission in the city. Electric vehicles have great potential for the city's public transport, goods logistics, and fleet vehicles. The network of fast chargers for electric vehicles will be expanded. So-called slow chargers will be installed in residential areas and parking lots. The development of e-mobility will introduce energy

technologies that support it, including the use of hydrogen as fuel, using fuel elements and supercapacitors in vehicles.

Public transport

In 2019, Tartu updated its public transport network and introduced new low-floor buses that use renewable energy (biomethane). The upgrade had a positive impact on the usability of public transport: the number of passengers in public transport increased by approximately 10% by the beginning of 2020. At the time of preparing the action plan, there is no exact information on how the updated transport network has impacted cross-border mobility and what the share of commuters among daily bus users is.

Tartu has set the goal of increasing the usability of public transport both among the residents and visitors. To achieve this, public transport must be a convenient, fast, and safe mode of travel that would ensure access to all the services provided by the city. New public services (e.g., school bus, transport-on-demand, etc.) need to be developed for better connection between the outskirts and the city. These new services must be safe and enable independent, convenient, and fast daily mobility for children and the elderly. Public transport plays an important role in connecting different modes of travel. As a result, vehicles used in public transport must meet high requirements (including requirements of users with special needs, notification of passengers of next stops, information about layover options, etc.) The Tartu public transport service is developed alongside suburban, regional, national, and international public transport services. Public transport uses carbon-neutral and emission free energy source materials such as biogas, electricity produced from renewable energy sources, or hydrogen.

In the course of implementing the Action Plan, the share of public transport will increase to 22% of all traffic by 2030 and to 23% by 2040.

Private transport

Increased motorisation has caused problems in Tartu City traffic. This trend and the problems accompanying it are on the rise. Compared to other road users, cars take up a disproportionate share of the streets and restrict the movement of cyclists, pedestrians and public transport, as well as street maintenance. The ever-increasing need for parking spaces reduces the attractiveness of the cityscape and turns private courtyards from recreational areas into parking lots. Pedestrians and cyclists perceive traffic unsafe due to increased car traffic and that in turn makes road users more reluctant to choose active mobility inside the city.

Wide streets and convenient parking options favour the use of private vehicles.

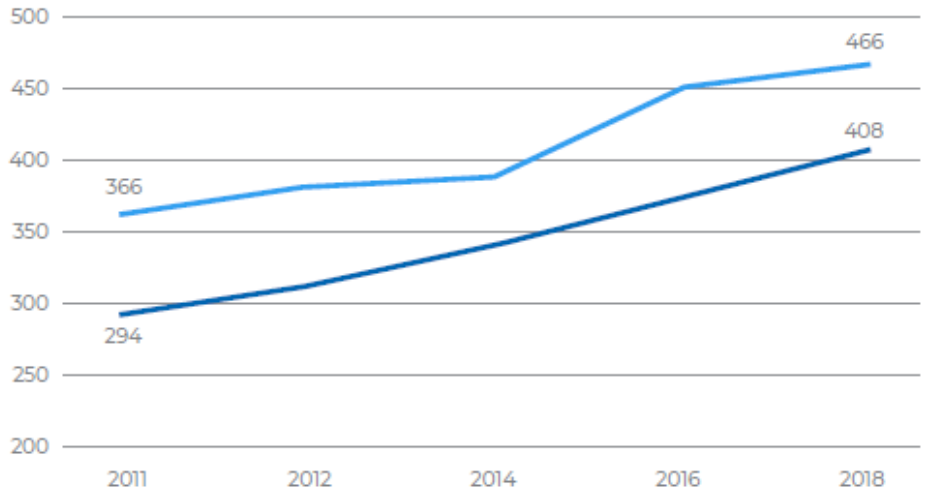


Figure 5.5. Number of passenger cars per thousand residents and kilometres travelled in Tartu City

Table 5.6. Ratio of passenger cars per thousand residents and kilometres travelled with private vehicles in Tartu City. Data: Estonian Road Administration and National Bureau of Statistics

	2011	2012	2014	2016	2018
Number of vehicles	366	383	392	454	466
Million km travelled	294	315	344	375	408

Technical developments in the car industry in the coming decade are mainly focused on the development of electric and autonomous vehicles. It is important to take these changes into account to achieve the

objectives of the energy and climate action plan and guide and support the development of the relevant infrastructure. In addition, the city has influence over the development of the vehicle fleet (parking, traffic restrictions, etc.) to achieve these goals. Clear preference must be given to vehicles using renewable energy. The trend of prohibiting the use of vehicles with diesel engines in large cities in Europe causes a price drop of diesel cars on the market. The absence of a car tax and the low diesel fuel tax in Estonia increase the possibility that the number of diesel vehicles in the Tartu City vehicle fleet will rise. This could increase the negative impact of motorisation on the environment and air quality even further.

The action plan aims to decrease car use. As a result of the planned activities, the share of light traffic and the use of public transport will increase, and car use will decrease.

In the course of implementing the Action Plan, the share of car transport will decrease to 35% of all traffic by 2030 and to 25% by 2040.

Combined mobility (multi-modality)

The continued problem with cross-border mobility is lack of diversity. Separate public transport systems in the city and county and lack of 'Park and travel' and 'Park and walk' solutions in the outskirts do not favour the use of sustainable modes of travel.

The objective of the action plan is to propose activities for combining the different modes of travel. We need to create a mobility model that would better serve the needs of the people and decrease car use. By combining various modes of travel and services, this mobility model allows to utilise the pros of each mode of travel and overcome their cons.

One key activity in the action plan is establishing mobility centres in the outskirts and city centre. The mobility centres enable to seamlessly switch between various modes of travel. The centres provide relevant support services such as a safe waiting area that is open 24 hours, services for planning a journey and purchasing tickets, parcel terminals, tourism information, etc.

Fast public transport services

Cross-border fast and independent public transport services will be developed to increase the quality of public transport. Such public transport connections can ensure that the public transport service is of high quality and fast irrespective of the current inconsistent street capacity and space taken up by cars and offer a good alternative to passenger cars in daily commute. We hope that these mobility centres support the fast public transport solutions that are being planned.

Sharing economy, new mobility services and business models

Globally, sharing economy is one of the most rapidly developing forms of economy that is changing the functioning and meaning of our current economic environment. Although the total volumes of sharing economy are currently small compared to the regular economy, this field has a lot of potential, it is rapidly growing and is gaining a significant market share in the transport sector as well. A good example is ride sharing in private vehicles, car-sharing (including short-term rent) and sharing of electric vehicles (e.g., scooters). At the same time, many people have personal vehicles (passenger cars, mopeds, bicycles, etc.) that they do not use daily and that could be used by other people. Although shared services should be provided by the private sector, the city can support them and promote the development of shared services (e.g., creating charging points for electric vehicles, designated parking areas in the public space, promotion activities, etc.)

One area that is virtually non-existent in Estonia but can be promoted by local governments is Mobility as a Service (MaaS) type of services. The development of MaaS services would improve mobility options for people, decrease the environmental impact of transport, make door-to-door mobility more affordable, and foster innovation in the private sector. In addition, introduction of a MaaS mobility service enables the public sector to use this platform for providing flexible and personalised solutions/services such as social transport, school transport, etc. in addition to convenient public transport services. All these services must provide a fast and convenient alternative to using a personal vehicle.

Mobility goals

Reducing emissions in the transport sector largely depends on how we manage to connect the areas surrounding the city with fast and sustainable transport solutions and provide their residents with a safe mode of travel that would be a competitive alternative to using a private vehicle.

On average, cross-border mobility in 2020 amounted to 93,000 vehicles per day and 2,790,000 vehicles per month. To achieve the goals of this action plan, the number of vehicles in cross-border mobility should be decreased by at least 35% by 2030. As the activities planned to reduce carbon emissions in the transport sector will be implemented over 10 years, the use of vehicles is expected to slow down until 2024 and start to decrease as from 2025.

Table 5.7. Car traffic density on the city border

	2020	2024	2028	2030
Day	93,000	93,000	74,400	60,450
Week	651,000	651,000	520,800	423,150
Month (30 days)	2,790,000	2,790,000	2,232,000	1,813,500
Change compared to 2020	0%	0%	-20%	-35%
Change compared to annual average	0%	0%	-5%	7.5%

In the transport sector, the action plan is focused on achieving five main strategic goals:

- walking, cycling and use of public transport increase;
- car use decreases;
- the outskirts are connected to the city through sustainable transport solutions;
- mobility centres are connected by various modes of transport;
- transport plans are connected to climate, energy, environment, health, and economy plans.

Priority activities in transport

No.	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy (community agreement)	Tartu City Government	2024
4.1	Pursuant to the comprehensive plan, designing new and existing streets shall ensure a high-level network of pedestrian and bike paths, even if this means developing carriageways on a lower baseline level.	Tartu City Government	Continuous
4.2	Planning and development of infrastructure is based on the principle of improving connections of sustainable modes of travel in cross-border mobility	Tartu City Government	Continuous
4.3	Local mobility centres are created in the remote regions of the city to improve transport connections (at least two centres will be created in the most important locations on the city's border)	Tartu City Government	Continuous
4.4	Seek opportunities to create public transport lanes on the main streets of public transport.	Tartu City Government	Continuous
4.5	The city's public transport services are expanded into surrounding areas	Tartu City Government, neighbouring local governments	Continuous
4.6	Combine the public transport systems of the city and county	Tartu City Government, Tartumaa ühistranspordikeskus, the Transport	Continuous
4.7	Establish a comprehensive network of bike paths. Step 1: The Emajõgi River region, Kroonuaia Bridge, Näituse Street, port railway	Tartu City Government	2024
4.8	Establish a comprehensive network of bike paths. Step 2: the rest of the city	Tartu City Government	2028
4.9	Expand the bike share service to the areas surrounding the city	Tartu City Government, neighbouring local governments	Continuous
4.10	Widen the network of parking areas for the shared bikes in the city	Tartu City Government	Continuous

Activities to support transport

No.	Activity	Responsible party	Year
4.11	Organisation of traffic monitoring and data collection	Tartu City Government	Continuous
4.12	Cooperation with providers of mobility services to use renewable energy in the city's transport (taxi, share service, transport-on-demand, rental service, etc.)	Tartu City Government	Continuous
4.14	Joint ticket system and journey planning solution for public mobility services	Tartu City Government	Continuous
4.15	A mobility centre is established in the city centre	Tartu City Government	2028
4.16	Support new transport solutions (e.g., school bus, transport-on-demand, car share, community ride sharing)	Tartu City Government, private sector	Continuous
4.17	Create an area that favours light transport and can be accessed by car in the city centre (area: Soola, Lai, Narva mnt and Ülikooli Streets)	Tartu City Government	2030
4.18	Change the parking arrangement in areas where it restricts foot and bike traffic	Tartu City Government	Continuous

4.19	Create an environment that favours walking and biking in areas surrounding educational institutions	Tartu City Government, TREA	Continuous
4.20	The real-time public transport information system covers most of the city and is extended to the nearest rural municipalities	Tartu City Government	Continuous
4.21	The design of the cityscape is based on enabling fast public transport connections (e.g., rail transport), considering other sustainable modes of travel	Tartu City Government	Continuous
4.22	Support the development of mobility plans in institutions	Tartu City Government	Continuous
4.23	Increase the speed and frequency of railway connections in the Tartu area	Ministries, Estonian Railways Ltd, Elron Tartu City Government	Continuous
4.24	Prepare proposals for the state to stimulate the transition to electric transport both in the public and private sector.	Tartu City Government	2022

Activities required to achieve the transport objectives have been specified in the two strategic documents annexed to the action plan: *Tartu Bicycle Traffic Strategic Action Plan 2020–2040* and *Development Plan for Regional Public Transport and Multi-Modal Transportation Solutions*.

In the course of implementing the action plan, CO_2 emissions from public transport will be decreased by 15% by 2030 compared to 2010.

5.5 The residential sector

Consumption of heat and electricity in Tartu residences

Energy consumption of buildings is interpreted as energy consumption by humans. The action plan focuses on energy consumption in buildings and does not account for energy consumption or emissions related to building, renovating, or demolishing a building.

In 2017, the surface area of residential buildings in Tartu amounted to 1,960 000 m². It has increased annually by 4.1% compared to 2010. In the same period, 14.7% of the surface area of residential buildings was renovated or reconstructed.

Energy consumption remained on the same level in that period. Considering the 4.4% increase in the surface area of residential buildings, consumption per square metre decreased by 3.5%. CO_2 emission decreased by 10%. This was achieved by replacing natural gas with district heating in thermal energy supply and reducing the emission factor of district heating.

Electricity consumption in households increased by 4.6%. This was likely due to electricity-based ventilation and other equipment in new and renovated buildings. Wider use of electronics also plays a part in this. CO_2 emissions also increased alongside electricity consumption, as the electricity emission factor changed from 1.09 tCO_2/MWh in 2010 to 1.147 tCO_2/MWh in 2017.

District heating in Tartu City is among the most environmentally friendly and advanced ones in Europe. As a result, CO_2 emissions from electricity consumption vastly overweighs thermal energy consumption (figure 5.13). Renovation of buildings aims to achieve more than just energy and environmental savings. Above all, the goal is to ensure proper indoor climate and create a better living environment. The best solutions for ensuring good indoor climate with the lowest resource consumption and environmental impact should be ensured in renovations. It is equally important to promote the production of renewable energy in Tartu and in Estonia, as it decreases the total environmental impact of electricity consumed in homes.

Table 5.8. Energy consumption and emissions of apartment buildings in Tartu (energy quantities have been normalised and reduced to degree days pursuant to the methodology used in Estonia)

	2010	2017	Change	Chang e (%)
Living space in apartment buildings, m²	1,879,000	1,960,000	81,000	4%
Normalised consumption, MWh	**373,156**	**374,438**	**1,282**	**0%**
incl.				
Electricity, MWh	112,900	118,100	5,200	5%
District heating and fuels, MWh	284,000	256,057	-27,943	-10%
incl. natural gas, MWh	113,000	95,000	-18,000	-16%
CO_2 emission, tCO_2	**190,596**	**184,900**	**-5,696**	**-3%**
incl.				
CO_2 emission from electricity	123,000	135,000	12,000	10%
CO_2 emission from thermal energy	67,596	49,900	-17,696	-13%

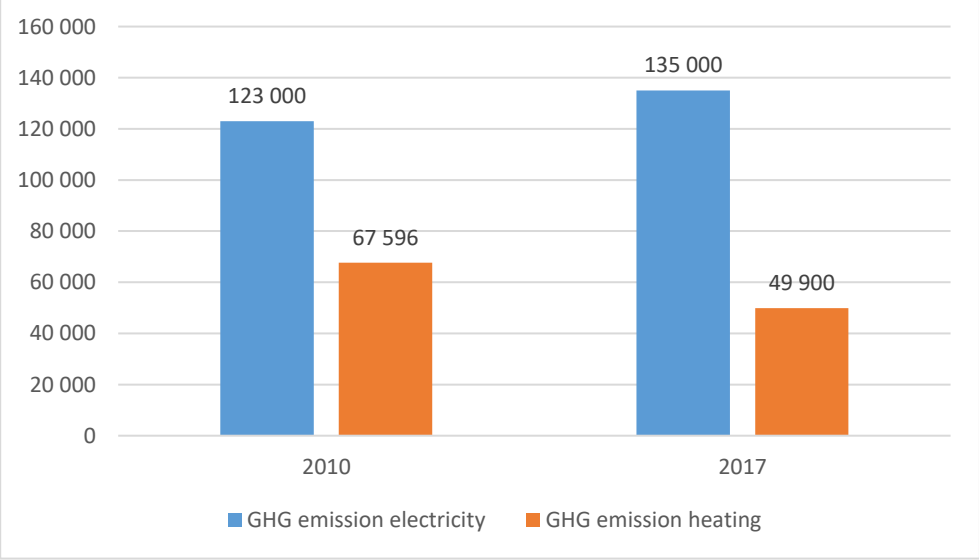


Figure 5.6. Emissions from energy sources of the Tartu residential sector (CO_2 emissions)

Reducing greenhouse gas emissions in Tartu residences by 2030

The Government Office commissioned SEI Tallinn and Finantsakadeemia OÜ to prepare the document *Analysis of Possibilities for Increasing Estonia's Climate Ambition* that enables to calculate Tartu's potential to reduce greenhouse gas emissions if the emission factors remain the same. The document presents the total area of buildings with various purposes in the country and the volume of emissions that could be decreased by 2030 for each type of building, considering actual construction rate and capacity. By calculating the drop in emissions per square kilometre based on this and correcting the results to match the volumes of buildings in Tartu, we get Tartu's potential.

Table 5.8. Potential for decreasing the carbon emission from buildings in Tartu City

Building type	Net area	Renovation of minimum	CO_2 decrease	CO2 decrease tCO2
Apartment buildings	1,960,000	50%	0.03	29,400
Private homes	1,030,000	40%	0.062	25,500
TOTAL	**2,990,000**			**59,920**

Therefore, annual CO_2 emissions in Tartu could be reduced by 60,000 tonnes by renovation alone. Currently, about 5% of all the apartment buildings in the city have been renovated. Approximately 500 private homes have been renovated with KredEx support. There is no information on buildings renovated without the grant.

One of the main initiatives of the European Green Deal is the Renovation Wave that aims to double the number of energy-efficient renovations over the next decade. To achieve these goals and make maximum use of the allocated resources, the Tartu City Government and the Tartu Regional Energy Agency play an important role in supporting apartment and private house owners in Tartu. A renovation support centre based on the Tartu Regional Energy Agency will be established to boost renovation activity in Tartu. Its task is to mainly support the renovation of buildings in the residential sector from planning to post-renovation fine-tuning and consultation of residents.

Tartu wishes to participate in the New European Bauhaus initiative to improve Tartu and its living environment with the help of the Renovation Wave. This is a creative and interdisciplinary initiative to establish a venue for shaping future lifestyles where art, culture, social inclusion, science, and technology interact with one another. This brings the Green Deal to our living environment, making it sustainable, enriching, inclusive, and accessible.

Priority activities in the residential sector

No.	Activity	Responsible party	Year
1.3	The housing sector transitions to renewable electricity and thermal energy (community agreement)	Tartu City Government, TREA, TarKül	2024
5.1	Develop financing opportunities and schemes for renovating residences	TREA, KredEx, Tartu City Government	2021
5.2	Renovate 50% of apartment buildings (980,000 m^2)	Apartment associations	2030
5.3	Renovate 40% of private houses (412,000 m^2)	Owners of private houses	2030

Supporting activities in the residential sector

No.	Activity	Responsible party	Year
5.4	Establish renovation support centres based on TREA	TREA	2021
5.5	Map application for production options of and limitations to renewable energy (specifying the data and conducting additional research, if necessary, including analysis of potential use of geothermal heat pumps)	Tartu City Government	2023

5.6 The municipal sector

Provision of public services in Tartu has become more energy efficient. Energy consumption in buildings of the Tartu City Government and buildings managed by it has decreased.

Table 5.9. Energy consumption by municipal buildings in Tartu reduced to a base year (unit MWh)

	2010	2017	Change	Change (%)
Thermal energy MWh/y	43,774	36,489	-7,285	-17%
Electricity MWh/y	12,757	12,755	-2	0%
Thermal energy tCO_2	6,960	4,305	-2,655	-38%
Electricity tCO_2	13,905	14,630	725	5%
TOTAL energy	56,531	49,244	-7,287	-13%
TOTAL emission	20,865	18,935	-1,930	-9%

Emissions from thermal energy and fuels have decreased by 38% which is a significant result. There has been no change in emissions with regards to electricity consumption. At the same time, it should be noted that emissions have mainly decreased due to reduced emission factors which in turn depends on the calculation method.

Table 5.10. Decreasing carbon emissions from municipal buildings in Tartu (unit tCO_2)

Building type	Net area	Renovated by 2030 (%)	Decreased emission 2030
School buildings	153,400	40%	3,900
Administrative	29,300	20%	500
Preschools	62,800	40%	290
Other buildings	38,800	25%	330
TOTAL			**5,020**

Street lighting

Street lighting is an essential part of the city's environment and safety. The share of energy efficient and easily controlled LED lights has consistently grown in Tartu thanks to various projects and grants but also the significant drop in the price of this technology. Streetlights are replaced by economical LED lights. The number of streetlights has increased owing to new streets, cycle and pedestrian tracks, and the administrative reform. Table 5.1 provides a more detailed overview.

Table 5.11. Energy consumption by street lighting in Tartu

Year	LED lights	Non-LED lights	Total	Percentage of LED lights (%)	Annual energy consumption, MWh	Energy consumption per light, kWh/vp
2010	-	-	11,500	-	7,456	648
2014	632	10,915	11,547	5.50%	7,361	637
2017	1,550	11,242	12,792	12.10%	7,100	531
2019	3,062	10,942	14,004	21.90%	6,810	486
including the city area	2,991	10,667	13,658	21.90%	6,665	488
including the former Tähtvere rural municipality	71	275	346	20.50%	145	419

The current pace of transitioning to more sustainable lighting sources in Tartu should be maintained and most of the lights should be energy efficient and remotely controlled by 2030 (controlling is based on switchboard, line, or light). Projects to upgrade street lighting have quite a long payback period, since in most cases depreciated light posts and

cables also need to be reconstructed in addition to switching out the lights. However, upgrading street lighting and its infrastructure cannot be avoided in the next decade.

Table 5.12. Energy consumption and emission of water treatment in Tartu

	2010	2017	2030	Change	Change (%)
Energy, MWh	11,144	9,290	11,800	+ 2,510	+27%
Emission, t CO_2	10,587	8,836	8,979	+ 143	+1.6%

In 2017, the water treatment company AS Tartu Veevärk purchased 7603 MWh of electricity from the grid and produced 706 MWh of electricity from biogas for its own consumption. It sold no electricity into the grid. If AS Tartu Veevärk purchased the required electricity with a green certificate, they could reduce their CO_2 emissions by further 10,600 tonnes. AS Tartu Veevärk is implementing several development projects related to improving the quality of drinking water and environmental requirements for wastewater treatment: the Kobrulehe drinking water treatment will be added in 2021 and the Staadioni drinking water treatment in 2024 (reverse osmosis) and sewage sludge drying will begin in 2027. All these activities increase energy consumption in water treatment. Irrespective of this, carbon emissions can still be reduced in the sector by using renewable energy. The water treatment company is systemically striving to minimise energy use and carbon emissions.

Priority activities in the municipal sector

No.	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy sources (community agreement)	Tartu City Government, TREA	2024
6.1	Transition to 100% economical LED lights in street lighting and introduce a modern system of controlling street lighting	Tartu City Government	continuous
3.1	Solar energy plants with a total capacity of at least 1.5 MW will be established for buildings owned by the local government	Tartu City Government, TREA	2030

Activities to support the municipal sector

No.	Activity	Responsible party	Year
6.3	Establish an energy management system for Tartu	Tartu City Government	2022
6.4	Renovation of municipal buildings	Tartu City Government	continuous
6.5	Share data collected in the course of implementing the climate action plan and grant research institutions access to it	Tartu City Government	continuous
6.6	Participation in research and development projects in cooperation with research institutions and companies in Tartu and Estonia	Tartu City Government	continuous

Energy management

Energy management is an activity for conscious and planned use of energy that ensures optimal use of energy and resources to improve the quality of the living environment in an area, institution, or building. Energy management comprises governance, data management, and monitoring activities.

Tartu City has introduced the Internet of things (IoT) solution Cumulocity in the framework of the SmartEnCity project. By using HTML protocols, the system enables to register events, save indicators and alarms, and manage simpler and more complex systems. This is a great basis for establishing an energy management system for Tartu City and measuring the achievement of the *Tartu Energy 2030* objectives. The platform was interfaced with data stores of energy providers in 2019, enabling to gain an overview of the consumption of thermal energy and electricity in

buildings owned by the Tartu City Government. The platform is also used for traffic counting on the city's border and in significant junctions.

The next objective is to reach a new level in energy management – real-time energy management. The existing systems (above all, the Cumulocity platform) make it technically feasible. To achieve this objective, the Tartu City Government joined two international projects in 2020: EnergyAudit and Microgrids. The goal of these projects is to develop real-time management solutions for the interior climate and energy use of buildings and create local area networks for electricity with local energy trading. In the future, experiences gained from the projects and solutions developed in the course of the projects can be used both in municipal buildings and the entire city.

A significant set of data describing energy consumption, emissions of greenhouse gases, car traffic, bike traffic, air quality, and the general behaviour of Tartu residents is collected in the course of implementing *Tartu Energy 2030* and measuring its outcomes. It is important to share the collected data with research institutions, companies, and interested residents to conduct research studies and develop new services. An important aspect of energy management is designing a cost-effective and energy-efficient infrastructure. There are various methodologies and technological solutions (e.g., PropTech, etc.) for such evaluations that should be considered in evaluating infrastructure investments.

Cooperation in research and development

The Tartu City Government has participated in several research and development projects funded by the European Commission. The SmartEnCity project is the most significant and has the largest impact. It was used to renovate 18 apartment buildings, establish a cooling plant and the bike share service, install chargers for electric cars, and modernise street lighting.

Participation in research and development projects is a good way to strengthen cooperation between the Tartu City Government and universities in Tartu and support the development of green and smart entrepreneurship in Tartu. Tartu should participate in various European initiatives and partnerships to strengthen cooperation in research and development and reach the city's climate objectives. Examples of such initiatives and partnerships are:

- *100 Climate-neutral Cities by 2030*,
- *Driving Urban Transition to a Sustainable Future,*
- *European Bauhaus*.

Public transport

Public transport constitutes a significant part of the energy consumption in the municipal sector. The action plan covers the organisation and environmental impact of public transport in sub-section 5.4 *Transport*.

5.7 Waste management

Waste and circular economy

Waste is the last part of the general consumption cycle. All materials used in manufacturing products and providing services go through life cycles and inevitably end up as waste. Waste management determines the further environmental impact of these materials. Environmental impact depends on various factors: the composition of the materials, waste management processes, volume and characteristics of the handled materials, energy intensity of the management process, and energy source materials used for it. It is important to develop waste management in a way that minimises the short- and long-term environmental impact of the handled materials and the management process.

On average, 343,793 tonnes of waste per year were collected from the territories of Tartu and the former Tähtvere rural municipality in 2015–2017. In this period, waste collected from the territory of the former Tähtvere rural municipality amounted to 17% of the collected waste on average. The amount of collected waste has not significantly changed as from 2014. 91% of all collected waste originates from companies. Approximately 9% of waste is collected from households.

The largest share (50–60%) is made up of construction waste, the share of municipal waste is c. 10-15%.

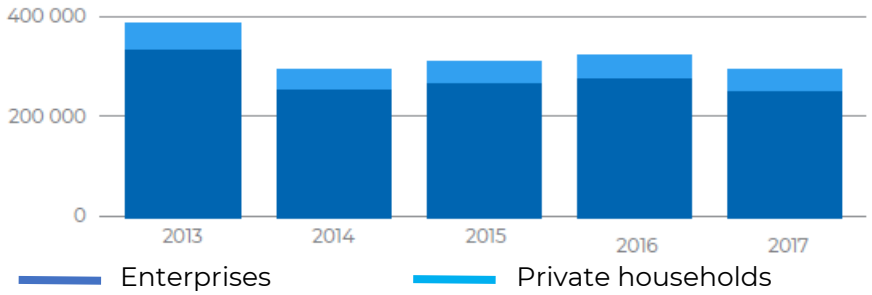


Figure 5.7. Waste collected in 2013–2017 in Tartu City and the former Tähtvere rural municipality (source: The Environmental Agency)

In developing waste management, main attention and efforts should be on decreasing the generation of waste and separate waste collection with the aim of recycling it. Promoting separate waste collection and making if more efficient enables to decrease the negative environmental impact caused by waste.

In November 2019, the Tartu City Council adopted the Tartu City waste management plan for 2020–2024.

Pursuant to the plan, the most important activities for avoiding and reducing waste generation are raising the awareness of residents and increased waste sorting at the source, development of waste management centres, and promotion of circular and repairs-based economy.

The strategic goals of Tartu City for 2020–2024 are:

- Avoid and reduce waste generation.
- Recycle waste or reuse it in another way to the maximum extent.
- Decrease the environmental risk caused by waste, among other things by making monitoring and supervision more efficient.

55% of municipal waste shall be recycled in Estonia by 2025. In 2018, this indicator was nearly 31% in Tartu.

The main tasks for reducing emissions

The total volume of waste has been growing over the years. This is mainly caused by people's habit of consuming ever more packaged goods.

According to the prognosis of the Statistical Office, the population of Tartu will be 101,639 in 2024. The population of the Tartu urban area is also increasing. Considering the growing number of people and general upward trend of waste generation, certain increase in waste generation can be expected in Tartu City in 2020–2024.

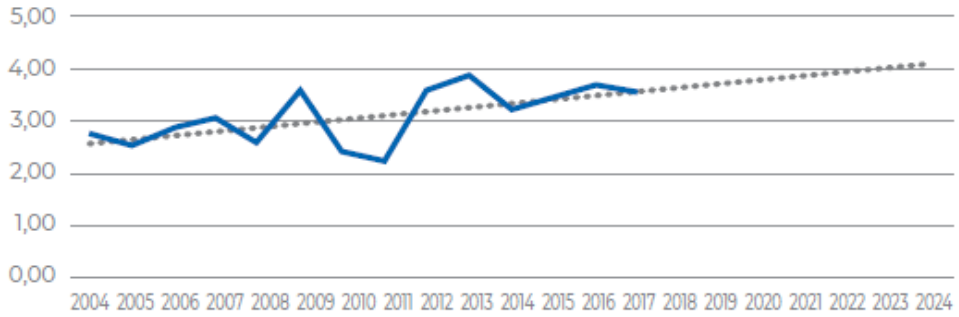


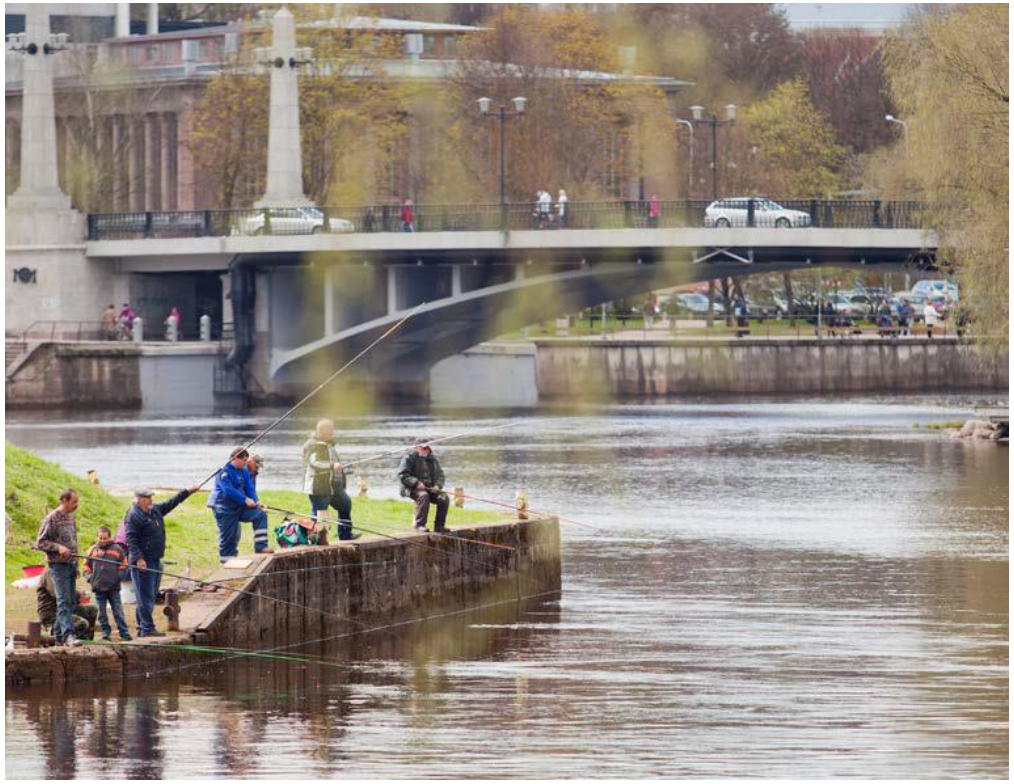
Figure 5.8. Waste generation in Tartu City and the former Tähtvere rural municipality per person in tonnes in 2004–2017 and waste generation trend until 2024. Source: Statistical Office, the Environmental Agency)

The wider objective of the European Union in waste management is to move towards a society that recycles waste. To achieve this, waste management is based on the following waste hierarchy (figure 5.9): avoid waste generation, reuse generated waste, recycle the waste as materials or energy, and dispose in a landfill (the last step).

Figure 5.9. Waste hierarchy

Pursuant to the waste management plan of Tartu City, one of the most important objectives is to decrease the share of mixed municipal waste in the total volume of municipal waste. The waste management plan provides for recycling 55% of municipal waste of the total volume of municipal waste by 2025 and 60% by 2030.

The first and main objective of the city's waste management policy is to avoid waste generation to the maximum extent. The residents whose awareness and consumption habits largely determine the reduction of packaging, food, and other municipal waste play the key role in avoiding municipal waste generation. In turn, the local government plays an important role in raising the awareness of residents and creating favourable conditions. The best results in raising awareness among consumers and implementing measures to reduce waste generation are achieved through regional cooperation between local governments, undertakings, and third sector organisations engaged in avoiding waste generation. In addition to continuous awareness-raising, the availability of reuse centres and various services (e.g., clothing and shoe repair, etc.) and other community initiatives (e.g., the food bank) play an important role in reducing waste generation. Community workshops and third sector organisations that contribute to increasing the value of products and materials play an important role in extending the life cycle of products. Information on such service providers should be collected. The possibility to provide feedback to and assess the quality of the services increases the added value.



Priority activities in waste management

No.	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy sources (community agreement)	Tartu City Government	2024
7.1	Establish a third waste management centre in Tartu	Tartu City Government	2025
7.2	Raise awareness of the population on avoiding waste generation, sorting waste, and recycling	Tartu City Government	continuous
7.3	Increase the effectiveness of sorting waste	Tartu City Government	continuous

Activities to support waste management

No.	Activity	Responsible party	Year
7.4	Impose the requirement to collect waste by type in public events	Tartu City Government	2021
7.5	Collect packaging waste locally	Tartu City Government	2022
7.6	Support community workshops	Tartu City Government	continuous
7.7	Map production residues of undertakings in the Tartu area with the purpose of reusing it	Tartu City Government	2025

CO_2 emissions from waste management were not accounted for in preparation of this action plan, as its impact is usually indirect (CO_2 efficiency gains from waste transport, recycling, etc.) and it is difficult to assess the extent of the impact.

6 Climate change adaptation

In addition to mitigating the impact of climate change, Tartu and its residents inevitably have to adapt to climate change. This chapter describes the objectives and activities for the adaptation based on the climate risks and analysis of damages to the city and its residents. The methodology is based on the guidelines and methods of the Covenant of Mayors for Climate and Energy. Although Tartu City has no sectoral plan for climate change adaptation, the needs and measures for adaptation have been described in the development plan of Tartu City, the comprehensive plan, and Tartu City development plan for public water supply and sewerage system.

The main objective of climate change adaptation is to increase the resilience and adaptability of Tartu City to climate change. Adaptation measures depend on risks related to the climate and options for mitigating them. In addition, Tartu must support the implementation of the national adaptation plan and plans and activities of its neighbouring local governments that are related to climate change adaptation.

6.1 Climate risks

A climate dataset was put together to evaluate climate risks and ascertain the possible damages and negative aspects. The risks were evaluated pursuant to the criteria of dangerous weather phenomena relevant to Estonia, adapting them to the circumstances in Tartu if necessary. The weather data were based on the Tartu-Tõravere weather station, and the water condition data of the Emajõgi River was based on the Kvissentali hydrometric station. In general, the Tõravere weather station represents weather conditions in Tartu, although there may be differences in the weather phenomena such as strong wind, showers, thunder, hail, fog, etc.

There are currently no high climate-related risks that endanger the lives of the residents or cause significant economic damages. Risks of cold spells, heat waves, strong winds and floods of the Emajõgi River were considered average, whereas the risk of heat waves will become more prevalent in the next decades and the risk of cold spells is already decreasing due to global warming. Winters with little snow decrease the springtime risk of floods of the Emajõgi River. Risks of showers, drought, wildfires, snowstorms, and temperatures fluctuating around zero degrees were considered low. In the medium-term perspective, the risk of

showers, droughts, wildfires, and temperatures fluctuating around zero degrees will rise, increasing the level of risk in the future.

The number of hot days with temperatures exceeding 27 degrees has increased in Tartu in 1961–2017 from an average of five days to an average of 13, reaching 20 and more hot days during the summer (the summer of 2010 had 32 hot days). Cold days with temperatures dropping below -25 degrees has significantly decreased in Tartu in 1961–2017 (the coldest winters in the 1960s and 1980s had 14–15 extremely cold days, whereas there were eight extremely cold days in 2011, two in 2015 and none in 2017). The number of days with snow cover has also decreased by half a month in the period mentioned, dropping to 95 days on average. The number of stormy days (> 15 m/s gusts) has also decreased over the past decade when there were less than ten days with strong winds per year (15–20 stormy days on average in the previous decade). There were four instances in 1961–2017 when precipitation exceeded 50 mm over 24 hours. There have been no more than 15–20 days with more than 10 mm of precipitation, whereas the number of days with a high level of precipitation has generally declined in this decade. August is the month with the most precipitation with an average of 91 mm of rainfall.

Table 6.1. Climate risks endangering Tartu and their estimated change

Climate risk	Risk level (high, average, low)	Intensity (increases, remains on the same level, decreases)	Frequency (increases, remains on the same level, decreases)	Occurrence of the risk
Extreme cold, cold spell				Current climate
Heat, heat wave				Medium term
Strong wind				Current climate
Floods of the Emajõgi River				Current climate
Showers, flood				Medium term
Drought				Current climate
Forest and wildfire				Current climate
Snowstorm				Current climate
Temperatures fluctuating around zero				Current climate

Explanations for table 6.1:

Red – high / will increase
Yellow – medium / will remain on the same level
Green – low / will decrease
Current climate – 1–5 years
Medium term – future climate 5–15 years
Long term – projection of the future climate exceeding 15 years

With regards to flood risks, Tartu should be prepared for flash floods, floods caused by high water level, precipitation or sewerage (accidental), and flooding of flood plains. In the 150-year measurement period, there has only been one flood of the century (probability of exceedance 1%) at the beginning of the measurement period in 1867. There have been a total of 18 so-called floods of the decade with a level of 32.71 metres. In general, floods have occurred in cycles with periods of 5–6 years. Rain showers in the summer and fall do not cause the water level of the Emajõgi River to rise significantly or close to the critical level. The highest flow rate of the Emajõgi River in the summer and fall has been 120 m3/s and 118 m3/s, respectively. However, heavy rainfall can cause localised floods in the city. Water levels that may cause a flood of the Emajõgi River and their occurrence has been provided in table 6.2.

Table 6.2. Water levels that cause a risk that the Emajõgi River may flood and their occurrence in Tartu over 150 years

Probability of exceedance	Height in metres The Baltic system	Number of exceedance	Cumulative	Occurrence
1% – high	33.36	1	1	1867 – 33.34 m
2% – large	33.19	2	3	1923, 1868
5%	32.92	7	10	1899, 1921, 1923, 1931, 1951, 1956, 2010
10% – very high	32.71	8	18	1912, 1917, 1922, 1924, 1931, 1953, 1955, 2011

Possible damages caused to the residents of the city, the urban systems, and various sectors were considered in preparing the action plan. National criteria and risk thresholds are not always appropriate for evaluating the risks a city is exposed to, as weather effects may already have an impact on the residents, urban systems, and infrastructure separately or as interdependent systems at lower risk levels. Primarily, areas at risk and vulnerable sectors or population groups are exposed to climate risks.

Damages depend on the following conditions:

Exposure factors: on which spatial scale Tartu may be exposed to climate risks.

Sensitivity: in what conditions and with what intensity do the risks materialise for the residents of Tartu, vulnerable population groups, and vulnerable site types. Resilience: what systemic measures and solutions are available for mitigating the climate risks, avoiding their impact, or adapting to them.

In addition, it should be taken into account in an urban environment that the risk of exceptional weather conditions is enhanced if several weather risks or factors occur at the same time or even more so, if dangerous weather conditions occur over a long period, e.g., winter or summer storms or long periods of rain or drought. In addition, cities should pay attention to winter storms that could interrupt traffic and energy and water supply.

As an innovation, variations in microclimate have been taken into account when evaluating damages. To this end, climatopes are included in the adaptation plan, according to which districts and settlements with tall trees are better protected in exceptional weather conditions compared to areas with apartment buildings, university and hospital campuses, shopping areas, and the densely populated city centre (table 6.3). The protection provided by microclimate shall be taken into account in preparing plans and designing the infrastructure and buildings.

Table 6.3. Climatopes in Tartu City and the relative safety of their microclimate

Climatope	Location	Safety
Water body climate	The Emajõgi River and Anne Canal	High
Open landscape climate	Flood plain	High
Park climate	Toomemägi, cemeteries, Ihaste woods, Sanatoorium park, Raadi park, Ülejõe park, Dendropark, Mathiesen park, Ropka park, Tähtvere park, Karu park, etc.	High
Garden city climate	Tammelinn, Karlova, Raadi	High
Apartment building district climate	Annelinn, Räni, Veeriku	Average
University and hospital campus and shopping area climate	Maarjamõisa, Tähtvere / industrial area, Lõunakeskus	Average
City centre climate	City centre	Average

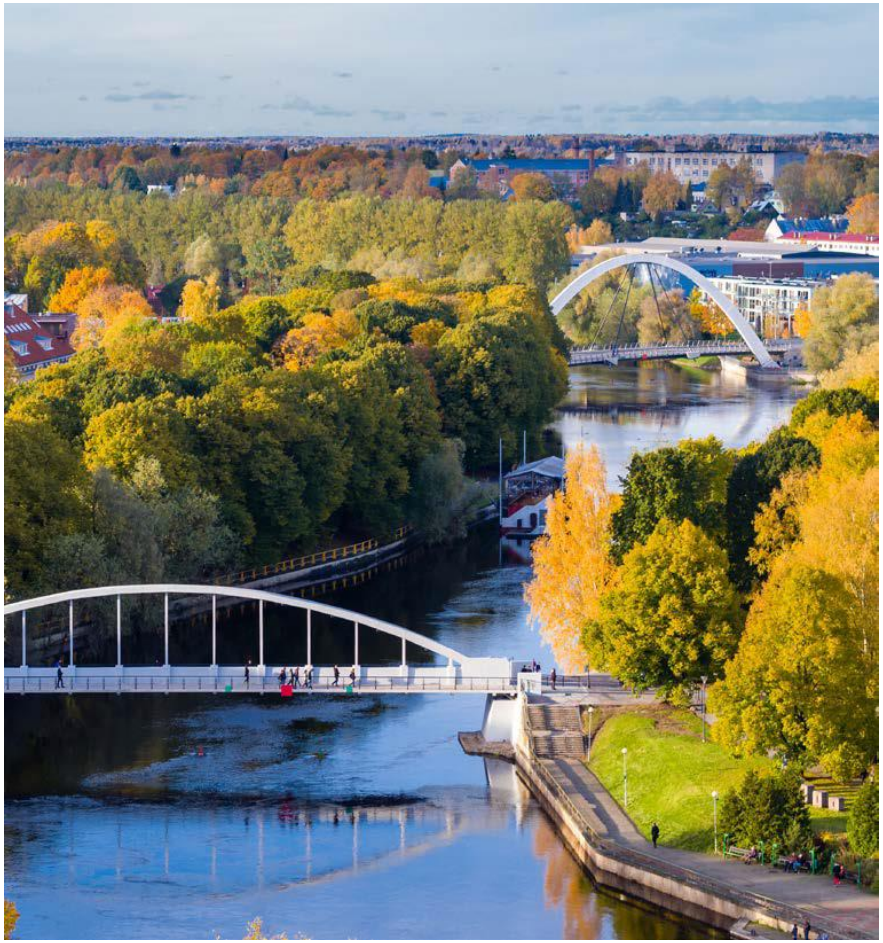
6.2 Adaptation goals

Climate change adaptation in Tartu City is based on the following principles:

Tartu adapts strategically. Strategic development documents of Tartu City take long-term climate changes into consideration to make the city an inspiring living environment that is considerate, enterprising, and innovative and to include the prevention and mitigation of climate risks in all topics related to governance and administration of the city. Climate change is also seen as an opportunity for development for the city.

Tartu adapts spatially. Tartu considers climate change adaptation on all spatial levels (the city, district, settlement, block, building) separately and as a whole. Urban planning is the most important adaptation measure that determines the urban type, infrastructure, and conditions of Tartu for a long period. In addition, the various needs and opportunities of the city's residents must be taken into account which requires fair and solidarity-based approach to risk mitigation.

Residents of Tartu are rea dy for a change. Tartu has adaptation topics and risk areas that require a fundamental change and revaluation of the city's development to increase its resilience and adapt to climate change. In addition to the best knowledge and technology, adaptation is also based on the attitudes and skills of the residents.



Adaptation plan.

Tartu City has initiated climate change adaptation pursuant to the goals of the Tartu City development plan and comprehensive plan. Pursuant to 'City with an inspiring living environment', which is the strategic goal of the Tartu City development plan, Tartu is developed as a sustainable and environmentally friendly city. Mitigation of climate risks is also one of the goals of Tartu as a 'considerate city' that requires protection for these groups of the population that are vulnerable to climate change (young children, the elderly, the chronically ill, people with low income, the homeless).

The Tartu City comprehensive plan until 2030 provides several objectives directly related to climate change adaptation as general conditions, whereas priority is given to planning the green network and landscaping and planning the blue network to mitigate flood risk.

Four adaptation paths have been provided in the adaptation plan:

- Green. Improving the green network and landscaping to mitigate climate risks.
- Blue. Mitigating flood risk, including risk of flood caused by downpours.
- Infrastructure. Mitigating the risk of storms and other exceptional weather conditions.
- Awareness. Increasing the safety of residents (and visitors) through risk prevention.

6.3 Adaptation activities

The activities of climate change adaptation are based on the evaluation of climate risks. The majority of the activities will be carried out before 2022. Some activities have a longer period, continuing until 2030 (marked 2030).

Green activities

Green networks and landscaping, especially tall trees play a significant role in preventing and mitigating climate risks. Parks and landscaping

regulate temperature and water supply, obstruct heavy winds, and store carbon. Thanks to this, each individual tree in Tartu should be regarded valuable. In addition, the coherence of the green network should be improved, as the widening of streets and new buildings have reduced the links between core areas or interrupted them in several regions of the city. The green index of each lot will be introduced in Tartu as an innovative planning method. Plans are in place for conservation landscaping. Instead of the current relatively fragmented implementation, new-generation urban development solutions based more specifically on ecosystem services will be used for settlement planning and climate protection will be taken into account in comprehensive construction of settlements. Jaamamõisa has been presented as one developing pilot settlement that has available land but also existing buildings.

Climate risks: flood, downpour, storm, heat waves, drought, snowstorm, wildfire

No.	Activity	Responsible party
9.1	Clarify the borders of the green network in the comprehensive plan that is being prepared and determine the conditions of and limits to the functioning of the network.	Tartu City Government
9.2	Determine the locations of conservation landscaping in the comprehensive plan that is being prepared to protect the residential areas against pollution, noise, strong wind, or snowstorm.	Tartu City Government
9.3	The impact, climate risks and spatial developments for climate change adaptation shall be evaluated in the framework of the SEA of the comprehensive plan.	Tartu City Government
9.4	Establish a framework for implementing the green value index of lots in plans.	Tartu City Government
9.5	Develop the city's landscaping to regulate temperatures and water supply and improve drainage conditions (ecosystem services) (2030)	Tartu City Government
9.6	Implementation of weather-proof settlement planning and adaptation measures (e.g., in Jaamamõisa) (2030).	Tartu City Government
9.7	Clarify landscaping requirements for facilities that do not require a building permit in the comprehensive plan (e.g., heat islands caused by paved lots)	Tartu City Government
9.8	Development of a separated sewer system for stormwater	Tartu City Government
9.9	When building new paved surfaces, sufficient treatment of rainwater that gets collected on it shall be ensured so as not to pose a threat to the neighbours, streets, facilities, and the environment	Tartu City Government
10.0	Construction of paved surfaces is limited in the city to prevent rising temperatures and the need to manage rainwater	Tartu City Government
10.1	Analysis of the socio-economic impact of climate change	Tartu City Government

Blue network

The planning of the blue network (lakes, rivers, streams, ponds, etc.) in Tartu now has clearer outputs and the planning, designing and, building methods have improved in areas susceptible to floods. If the flood levels of the Emajõgi River are expected to drop as a result of climate change, adaptation activities should focus on protection from isolated downpours in the conditions of ground compaction and (non-porous) pavements in the urban environment. In addition, this means combining different solutions of draining rainwater. A good example is the Ihaste bridge that was constructed with dikes, rainwater infiltration ditches and ponds to prepare for floods. In 2018, Alkranel OÜ and its partners prepared the research paper *Forecasting the Flood Risk in the Emajõgi River Basin Caused by Climate Change and Determining Mitigation Measures for Areas of Tartu City with a High Flood Risk (*Kliimamuutustega kaasneva üleujutusohu prognoosimine Emajõe vesikonnas ning leevendavate meetmete määramine Tartu linna üleujutusriskiga aladel) (Alkranel OÜ *et al*, 2018) as part of the iWater project. The following probable water levels have been determined for the Tartu (Kvissentali) hydrometric station (mAS, Normal Amsterdam's Peil): 1% 33 metres, 5% 33.1 metres and 25% 32.5 metres. In planning new developments with closed rainwater systems, a minimum of 0.5 metres should be added to the 1% water level probability and at least 0.8 metres to the building's datum level, i.e., 0.5 metres plus 0.3 metres of base height which makes a total of 0.8 metres.

Climate risks: flood, downpour, storm

No.	Activity	Responsible party
10.2	The blue network and its conditions of use should be clarified in the comprehensive plan that is being prepared	Tartu City Government
10.3	Clarify the term 'building exclusion zone of a shore or bank' in the comprehensive plan that is being prepared and determine limitations to land use and construction in areas with a high flood risk.	Tartu City Government
10.4	Consider the flood risk in plans and implement measures in areas with a flood risk	Tartu City Government
10.5	Map land improvement systems and prepare and clarify the basic scheme for the drainage system	Tartu City Government
10.6	Implement rainwater infiltration and on-ground drainage systems on a wider scale	Tartu City Government
10.7	Systematically solve the problem of flooded streets	Tartu City Government

Infrastructure

Climate change, storms, and the occurrence of extreme temperatures should be taken into consideration in managing energy systems and energy supply. In supplying buildings with warm and cool indoor climate, district heating and district cooling systems shall account for rapid temperature changes. Smart city solutions are mainly based on electricity supply which in turn provides stricter criteria for security of supply. (Semi)automatic systems should be introduced in the future to mitigate risks. It is important to evaluate the conformity of the mitigation activities in urban development and this plan and, on a wider scale, the investments with the adaptation to avoid discrepancies in the occurrence of climate risks and additional expensive adaptation measures.

Climate risks: storm, including snowstorm, extremely high and low temperature, wildfire

No.	Activity	Responsible party
10.8	Increasing the security of supply of street lighting with underground wiring	Tartu City Government
10.9	Clarify matters related to climate change adaptation and climate proofing, including risks to third persons (neighbouring lots, etc.) when planning urban infrastructure	Tartu City Government
11.0	Update maintenance agreements with relation to reacting to extreme weather conditions, e.g., winter maintenance in warm winters, transitions between seasons with rapid weather changes	Tartu City Government
11.1	Evaluate mitigation activities (renovation of buildings, energy and other infrastructure) from the adaptation aspect and add adaptation measures, if necessary	Tartu City Government

Awareness

In addition to planning, building and technological activities, the residents of Tartu play an important role in climate change adaptation. Increasing awareness is the fastest and cheapest way of preventing climate risks and skilfully mitigating them through behaviour if they occur. As a considerate city, Tartu should aim its prevention activities related to adaptation to those groups that are the most vulnerable to climate change, including young children, the elderly, the chronically ill, people with low income, and the homeless to protect them. This involves close cooperation with relevant officials to increase their practical skills of reacting to a crisis, improving monitoring and warning systems, and disseminating weather information. Implementing the adaptation plan requires training of officials and employees of other implementing authorities and companies. In addition, universities should research climate changes and offer innovative adaptation solutions to protect the climate in both Tartu and Estonia in general. The role of social campaigns in raising awareness on climate change has been relatively small and they need to be connected to well-established environmental awareness programmes.

Activities to mitigate climate risks:

No.	Activity	Responsible party
11.2	Improve reaction, monitoring, and warming systems related to climate risks in cooperation with authorities. Organise trainings (including a crisis committee, involvement of the Estonian Rescue	Tartu City Government
11.3	Specify risk analyses of emergency situations caused by climate risks	Tartu City Government
11.4	Prepare an action plan to raise awareness among vulnerable population groups (to avoid and reduce health damages caused by heat and extreme cold, risks posed by homelessness)	Tartu City Government
11.5	Organise specialised training courses for officials and other parties	Tartu City Government
11.6	Increase the coherence of the city's administration to implement adaptation activities faster and more efficiently	Tartu City Government
11.7	Ascertain the need for climate risk studies in cooperation with universities and start carrying them out (2030)	Tartu City Government
11.8	Increase the awareness of residents on climate-related topics and support project initiatives (2030)	Tartu City Government
11.9	Restore the weather column, i.e., the information and warning display by the Emajõgi River	Tartu City Government

Implementation and funding sources

Most of the adaptation activities will be carried out in departments of the Tartu City Government by supplementing or changing the current tasks of officials. Adaptation activities related to capital investments, such as promotion of the green and blue network or transport infrastructure, do not considerably increase the cost of investments. Parks, landscaping and rainwater systems will be established in stages using procurements. The requirements of climate change adaptation will be provided in detail in design provisions. A part of the applied research needed in the design process or for reacting to and prevention of crises requires additional funding from the budget. The majority of the activities will be carried out before 2022. Long-term and continuous adaptation activities such as the development of a climate-proof pilot settlement, restoration of parks and landscaping, establishment of rainwater systems, and regular activities for raising awareness, will be carried out by 2030.

Awareness and outreach

Outreach

There are various methods for involvement of stakeholders and their choice depends on the objective and task at hand. Both more traditional options such as public discussions, roundtables and workshops with stakeholders, as well as modern forms of involvement based on digital solutions are available. Tartu has successfully gathered ideas through the ArcGis platform that could also be used for achieving the objectives provided in the energy and climate plan. Systemic and targeted cooperation with neighbouring local governments is also important.

Awareness

Mitigation of climate changes (reduction of greenhouse gases and emissions) and adapting to the effects of climate changes are directly related to consumer behaviour and transitioning to a resource efficient economy. Various studies have revealed that consumer behaviour can help to reduce energy consumption by 5–10% and achieve a more environmentally friendly lifestyle. This makes systemic and targeted awareness-raising activities among stakeholders that are based on their needs and requirements highly important.

Shaping environmentally friendly and energy-saving behaviour starts in childhood. This is why developing and implementing relevant educational programmes for children and young people plays an important role. The Eco School programme coordinated by the Tartu Nature House that is part of the international Eco-Schools Global programme aimed at promoting sustainable development through environmental education should be continued and supported.

It is important that the city government and its agencies are kept up to date with relevant policies and support measures, outcomes of studies and analyses, and experiences of other local governments in implementing the energy and climate policy to gain a better understanding of the objectives of the energy and climate plan. Since the local government and its agencies are considerable energy consumers, different opportunities and technical solutions for saving energy and acting in a more environmentally friendly manner should be systematically introduced (including e.g. wider use of green procurements).

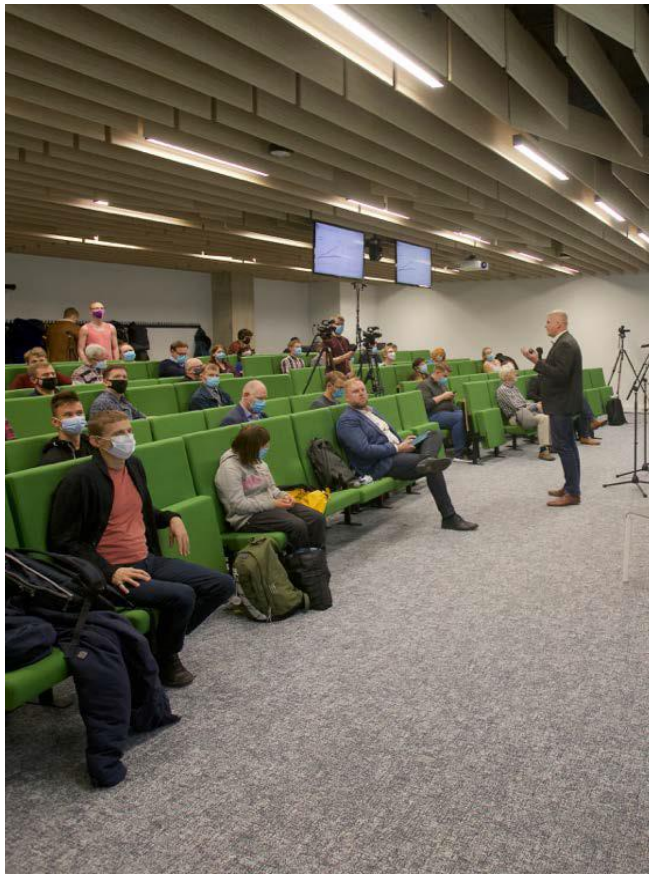
In order to promote energy efficient renovation of apartments and private houses and wider prevalence of sustainable consumption habits, Tartu City Government should cooperate with organisations of environmental education (e.g., Tartu Nature House), apartment associations and their umbrella organisations (Estonian Union of Co-operative Housing Associations and Tartu Union of Co-operative Housing Associations), as well as various specialised and umbrella organisations (e.g., Tartu Regional Energy Agency, Eesti Kinnisvara Korrashoiu Liit, MTÜ Eesti Pottsepad, etc.) and civil society organisations (e.g., city district associations, Estonian Green Movement, etc.) Various information-spreading events are organised, good practices are introduced, and campaigns are organised to promote the energy efficient renovation of apartment buildings and private houses and wider prevalence of sustainable consumption habits (e.g., energy saving week, Car-Free Days, etc.)

For companies and institutions, reaching the objectives of the energy and climate plan is mainly related to the development and implementation of resource-efficient economic models and introduction of various tools for energy and environmental management, as well as green procurements, circular economy, and digitisation of industry.

It is important to showcase significant experiences (achievements) and disseminate relevant practices to introduce the objectives provided in the energy and climate plan. This should be done systemically and consistently through strategic planning of activities. The main information channels are the website of Tartu City, the city's social media channels, and public media.

Priority activities in outreach

No.	Activity	Responsible party	Year
1.1	The municipal sector transitions to renewable energy sources (community agreement)	Tartu City Government	2024
1.2	The private and public sectors transition to renewable electricity and thermal energy (community agreement)	Tartu City Government, TREA	2030
1.3	The housing sector transitions to renewable electricity and thermal energy (community agreement)	Tartu City Government, TREA	2030



Activities to support outreach

No.	Activity	Responsible party	Year
12.0	Organisation of regular roundtables with stakeholders	Tartu City Government, TREA	continuous
12.1	Collection and dissemination of best practices	TREA, Tartu City Government	continuous
12.2	Organisation of information days	TREA, Tartu City Government	Continuous

Energy poverty

More than 50 million households in the EU have difficulties paying for energy services in a timely manner and providing sufficient heating for their buildings. This has a negative impact on the people's health and well-being. The prevalence of energy poverty has gained wider acknowledgement in Europe and abolishing energy poverty has been set as a political priority by several institutions of the European Union.

The definition of energy poverty differs by sources. Energy poverty is the condition of a household where the household members are unable to sufficiently heat or cool their building or consume energy services in a way that is affordable for them. Energy poverty differs from income poverty, as damages to well-being caused by it also occur in households with a higher income that spend too much of their income to cover energy bills.

Energy poverty results from the combination of three main factors:

- low income,
- relatively high energy bills (relative to the income),
- low level of energy efficiency.

One indicator of energy poverty could also be the financial inability to renovate one's house or apartment to be more energy efficient and to

purchase energy-efficient household appliances. Several indicators show that the problem of energy poverty in Estonia is greater than the European average. The secondary effect of energy poverty results from the primary effects. If a household has experienced energy poverty over a longer period, the primary manifestations of energy poverty such as low temperature at home and insufficient use of energy services, start to have an impact on the mental and physical health of the residents. Energy poverty in Estonia has not yet been sufficiently researched.

A new aspect of energy poverty could be the inability to sufficiently purchase any fuels used by a household, including both car fuels and energy, that prevents people (households) from living a quality life (e.g., drive from rural areas to the city for work, take part in events, take children to after-school activities, etc.) In addition, energy poverty could be linked to the ability to utilise renewable energy sources both in apartment buildings and private houses (mainly solar panels, geothermal heat pumps, etc.)

In Estonia, the three most significant manifestations of energy poverty are the inability to carry out activities that would help to reduce current expenditures on energy:

- inability to renovate one's residence to make it energy efficient;
- purchase energy-efficient household appliances;
- utilise renewable energy sources in a household.

Approximately 20% of the population is estimated to experience energy poverty in Estonia. However, the number of people living in energy poverty is expected to decrease over time, as several support measures have been taken every year and these will hopefully continue. The topic of energy poverty is also covered in the Estonia's 2030 energy and climate plan NECP 2030.

The following measures should be taken in Tartu on the local government level to mitigate energy poverty:

- support the establishment and promotion of renewable energy communities (energy associations);
- provide technical, legal and economic counselling (TREA);
- raise awareness and educate the residents on the topics of energy efficiency and energy poverty;
- establish a working group on renovation capacity;
- support the preparation of design documentations for renovating apartment buildings.

Energy efficiency gains can be achieved quite fast with moderate expenditures by raising awareness of the residents on their energy use (primarily electricity and thermal energy) and easy ways to save energy. One opportunity to increase the residents' capability to renovate buildings is to initiate a specialised city-wide working group and support measure for preparing renovation projects for apartment buildings. The working group would be tasked with monitoring the Tartu housing market and supporting renovation activities in the city. The working group could include representatives of various parties (e.g., the city government, TREA, apartment association unions, representatives of universities, representatives of settlement associations, etc.) The working group would evaluate the state of, need for, problems with and measures for the renovations.

The support measure for preparing renovation projects would help to overcome one of the obstacles in the renovation process which is the reluctance of associations to order design documentations for the renovation. At the moment, ordering a project is a financial risk, as receiving a grant (including the design grants of Kredex) depends on the outcome of the competition. The measure would primarily be aimed at reducing renovation inability. For example, the working group for renovation capacity could make the decision to grant the support.

Activities to mitigate energy poverty

No.	Activity	Responsible party	Year
12.1	Raise awareness and educate the residents on the topics of energy efficiency and energy poverty	Tartu City Government, TREA	Continuous
12.2	Establish a working group on renovation capacity	Tartu City Government, TREA	2022
12.3	Support the preparation of design documentations for renovating apartment buildings	Tartu City Government, TREA	2022

Implementation

The Tartu city energy and climate plan *Tartu Energy 2030* is approved, implemented, and updated according to regulation No. 5 of 19.04.2021 of the Tartu City Council *Rules of Procedure for Preparing Development Documents of Tartu City*.

The implementation of the energy and climate plan *Tartu Energy 2030* is organised and coordinated by the Tartu City Government. As it is a cross-cutting development document, an interdepartmental working group will be established in the city government that will monitor the implementation of the planned measures and activities. In addition, the working group will ensure that the measures and activities provided in the energy and climate plan are reflected in other development documents of Tartu City.

The Tartu City Government will also be responsible for monitoring the implementation of the energy and climate plan, involving different parties and organising their cooperation, regularly reviewing the plan, and reports and updates. The strategic partner of the city government in implementing the plan is the Tartu Regional Energy Agency.

The energy and climate plan Tartu Energy 2030 will be implemented in three stages:

I stage

Performance of the activities planned in the energy and climate plan will be reviewed annually. To this end, departments of the Tartu City Government will prepare a performance report on the implementation of the measures and activities included in the development plan and submit this to the city government. If something was not performed or additional activities are required, proposals are made to amend the energy and climate plan. The performance of the energy and climate plan will be evaluated together with evaluating the Tartu City development plan. The

annual review of the energy and climate plan only involves the objectives and activities related to the municipal sector and community agreement and the outcomes will be published on the city's website.

II stage

Pursuant to the Covenant of Mayors, the city government will review the measures and activities of the energy and climate plan every two years and evaluate their relevancy and submit the relevant review and amendment proposals to be approved by the city council. Based on this, Tartu City will submit the report of the action plan to the Secretary of the Covenant once every two years.

III stage

A Monitoring Emission Inventory (MEI) will be organised every four years to monitor the energy consumption and carbon emission data that is used to evaluate the achievement of the objectives provided in the energy and climate plan, primarily the reduction of CO_2 emissions. Outcomes of the inventory and amendments to the action plan will be disclosed on the website of Tartu City and submitted to the Secretary of the Covenant. Evaluation of adaptation management is done simultaneously with the inventory.

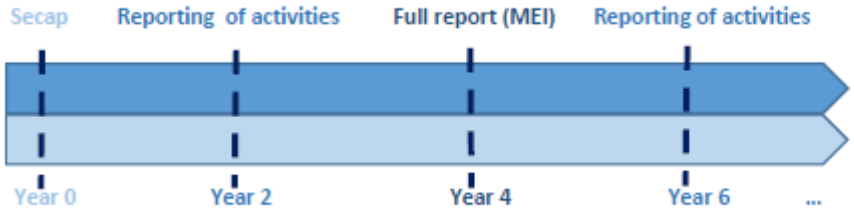


Figure 7.1. Monitoring and reporting of the strategy and action plan

Evaluation of adaptation management is based on the methodology of the energy and climate plan adaptation scoreboard. Initial adaptation management evaluation was carried out in the course of preparing for the energy plan where most of the management indicators were in the initial stage (state D) or were declared to be moving forward (state C). The city government has initiated and carried out activities related to climate change adaptation with relation to plans, mitigating floods, city governance, and organisation of municipal services. Adaptation is monitored and evaluated based on specific targets and indicators that indicate progress in sectors and across risks.

Measuring outcomes

A monitoring solution is required to evaluate the impact of the climate and energy plan. Data should be automatically processed and collected on the city's data platform. If necessary, cross-usage of data with external databases (e.g., the Transport Administration, Statistical Office, etc.) shall be ensured. The main indicators are public and displayed on the city's website. Raw data as will be made available to third parties as open data to the maximum extent. This enables to carry out research and create new services.

In collecting quantitative data, long-term systemic target group studies should be added the current practice of organising occasional surveys. This would give an overview of the people's consumption habits and preferred modes of travel in Tartu over decades. Such research that is carried out over a long period with a carefully selected target group provides a better overview of the people's habits and their results may largely differ from the replies to the occasional quick surveys. Based on the practice of other countries, long-term target group studies should be carried out in cooperation with local research institutions and developed and carried out methodically by researchers, and their outcomes should be comparable with research outcomes in other regions. Long-term studies establish a methodological background system that enables to carry out short-term surveys and also e.g. awareness-raising campaigns in the future. Qualitative and quantitative studies play different roles in understanding the overall picture: while quantitative analyses show how things change, qualitative analyses highlight the reasons of these changes and how they work.

Energy use indicators

Indicator	Unit	Period	Base level	Target level	Source
Energy consumption of district heating	GWh	year	522	580	Energy producers
Emissions from district heating	t/ CO_2	year	61	0	Energy producers
Emissions of fossil fuels	t/ CO_2	year	124,000	79,000	TREA
Emissions from the municipal sector	t/ CO_2	year	35,000	0	TREA, Tartu City Government
Emissions from the residential sector	t/ CO_2	year	184,000	77,000	TREA
Emissions from the private and public sector	t/ CO_2	year	406,000	191,000	TREA
Energy consumption in the transport sector	GWh/ mln km	year	0.842	0.723	TREA, Tartu City Government
Emissions from the transport sector	Kg CO_2 /km	year	0.214	0.178	TREA, Tartu City Government
Electricity emission factor	kg CO_2 /kWh	year	1.147	0.7	The Ministry of Economic Affairs and Communications
CO_2 emission per resident	t/ CO_2	year	7.3	3.2	Tartu City Government
Percentage of renewable energy from total energy consumption in the municipal sector	%	year	30	100	Tartu City Government, Elering
Consumption of renewable energy in the residential sector	GWh	year	0	15	TREA
Percentage of renewable energy from total energy	%	year	0	50	TREA, Tartu City Government

Transport sector indicators

Indicator	Unit	Period	Target level	Source
Number of cars in Tartu per 1,000 residents	pcs	year	< 300	Transport Administration (registered vehicles), Statistical Office (population size)
Number of cars arriving in / departing from the city daily	pcs	24 hours	60,450	Tartu City Government
Energy use in the transport sector per resident	kWh	year	2,140	Transport Administration, Statistical Office
Emissions in the transport sector per resident	kg CO_2	year	530	Transport Administration, Statistical Office
Door-to-door travel time by sustainable transport	km, minute	year	< 20	Tartu City Government (test drives)
Door-to-door travel time by car	km, minute	year	> 20	Tartu City Government (test drives)
Volume and share of walking from all the modes of travel in the city (modal distribution)	km, %	year	23%	Tartu City Government
Volume and share of bus trips from all the modes of travel in the city (modal	km, %	year	24%	Tartu City Government

Volume and share of biking from all the modes of travel in the city (modal distribution)	km, %	year	17%	Tartu City Government
Volume and share of car trips from all the modes of travel in the city (modal distribution)	km, %	year	30%	Tartu City Government
Volume of serious road traffic accidents and number of road deaths	pcs, pcs	year	0	Southern precinct of the Police and Border Guard Board
Energy use in transport by sectors (private and public transport)	GWh	4 years	214	Transport Administration, Tartu City Government
Emissions in transport by sectors	1,000 tCO_2	4 years	53	Transport Administration, Tartu City Government

Adaptation indicators

Vulnerability indicators	1980-2017	Future climate
Average number of cold days <-25 ^{0}C in the normal climate	2.3	Decreasing
Average number of hot days >+27 ^{0}C in the normal climate	9.8	Increasing
Occurrence of downpours 50 mm per 24 hrs	4	Same level
Occurrence of strong winds (gusts >15 m/s)	15.7	Same level
	2018	2030
Residents above the age of 75	6,800	8,000
Surface area / share of green and water areas	988 ha 22%	-1% 943 ha 21% Depending on the comprehensive
Deaths caused by freezing (58 in total in Estonia)	No data available for Tartu	0
Power outages caused by weather Elektrilevi SAIFI 1.344 SAIDI 105 min (2017)	No data available for Tartu	Decreasing on average over 5 years 20%
Flood damages (2010)	€64,000 (2010)	< €50,000
Above-average mortality during heat waves (2010, data for Estonia)	-30% (2010)	-15%
Adaptation investments €	N/A	> €100,000

Impact of the energy and climate action plan on the city budget

A little over 100 different activities have been planned in the energy and climate plan to achieve the objectives. The majority of the planned activities are so-called 'soft' activities (awareness-raising, studies, planning of activities in development documents, etc.) with no direct impact on the city budget. These activities will mainly be carried out either in the course of the everyday work of the city government or with the support of various cooperation projects.

Several activities related to investments and development of services (renovation of buildings, construction of bike paths, establishment of mobility services) that have a certain impact on the city budget have also been planned in addition to soft activities.

The following table provides the most significant activities that require funding from the city budget to be carried out. Several activities will be carried out in cooperation with neighbouring local governments, and these have no significant impact on the city budget.

Table 10.1. Activities that have an impact on the city budget

Activity	Funding sources	Estimated financial impact on the city budget
Solar energy plants with a total capacity of at least 1.5 MW will be established for buildings owned by the local government	Various support schemes, partnership with the private sector, energy associations	minimal
Extending the city's public transport services to the surrounding areas	Neighbouring local governments, the Transport Administration	minimal
Expanding the bike share service to the areas surrounding the city	Neighbouring local governments	minimal
Tightening the network of parking areas for the shared bikes in the city	City budget	40,000 €/year
Implement rainwater infiltration and on-ground drainage systems on a wider scale	City budget, support schemes	solved in the course of street construction
Increasing the security of supply of street lighting with underground wiring	City budget, support schemes	solved in the course of reconstruction of street lighting and street construction
Construction of bicycle parking areas in districts with apartment buildings	City budget, support schemes	20,000 €/year
Safe bicycle parking areas are used near schools and other childcare facilities	City budget, support schemes	20,000 €/year

Two positions need to be created to carry out the activities provided in the plan (bike traffic coordinator, plan coordinator). Expenditures related to these jobs can be funded through various thematic external projects.

Bicycle paths

One of the main activities provided in the plan for reducing motorisation is the construction of a bike paths network that covers the entire city. The construction is carried out in two stages and is included in the framework of the new Tartu City comprehensive plan that is being prepared. The network of bike paths in the city centre area will be completed in the first stage (until 2024) and in the rest of the city in the second stage (by 2028). The following tables present the volumes and estimated cost of the planned bike paths. The volumes provided in the table do not reflect these parts of the main and supporting network of bike paths that have already been constructed.

Table 10.2. Network of bicycle paths (unit: metre)

	Length
I stage of the main network (city centre)	10,390
II stage of the main network (the rest of the city)	31,060
Main network total:	41,450
I stage of the support network (city centre)	5,100
II stage of the support network (the rest of the city)	34,200
Support network total	**39,300**

Table 10.3. Estimated cost of building the network of bike paths

Stage	Cost
I stage (2021–2024)	€3,891,500
II stage (2025–2028)	€12,581,000
TOTAL	**€16,472,500**

The calculations of the cost of the bicycle paths are based on the cost of the cycle and pedestrian paths constructed in Tartu over the past two years. At the same time, the costs of building the bike paths network can be optimised (depending on the specific section) with easier and more cost-efficient solutions, e.g., by separating a part of a carriageway for bikes.

Mobility centres

The establishment of mobility centres is planned for places on the city border with the heaviest traffic to better connect the outskirts to the city centre and reduce car traffic caused by urban sprawl. The main objective

of these centres is to provide a cheap option for people who drive into the city for parking their car and for fast public transport connections (bus, bike share) to city districts. In addition, a mobility centre is planned for the city centre on Riia Street (in the area between shopping centres). The primary objective of the mobility centre in the city centre is to connect various public transport solutions (urban buses, county buses, long-distance buses, and bike share). This creates a fast, safe, weather-proof, and convenient option for travellers for switching modes of transport in the city centre.

Table 10.4. Estimated cost of building the mobility centres

	Size (m²)	Cost
Mobility centre by Ringtee Street (Lõunakeskus shopping centre)	9000	€533,571
Mobility centre by Aruküla tee Street	7000	€415,000
Mobility centre in Raadi	7000	€415,000
Total of the mobility centres in the outskirts:	23.000	€1,363,571
Estimated cost of the mobility centre in the city centre	-	€2,500,000
Total mobility centres	**-**	**€3,863,571**

The cost of other similar objects (car parks, bike parking areas, parking areas for the bike share bikes, bus stop shelters) built in Tartu in recent years was taken into account in estimating the cost of the mobility centres. The possible cost of land under the mobility centres was not accounted for. Tartu City owns suitable plots for the mobility centres in the city centre and by Ringtee Street (at the end of Ilmatsalu Street and near the Lõunakeskus shopping centre). Cooperation with the surrounding local governments is possible in other locations which helps to optimise the cost of building the mobility centres (cost of land under the mobility centre).

Budgeting

Reconstruction of municipal buildings is already included in the city budget strategy. Above all, allocation of funds for building the mobility centres and the first stage of bike baths needs to be included in the budget strategy.

The annual volume of the investment budget of Tartu City does not enable to carry out the activities to the required extent. External funding through various support measures is required to achieve the objectives.

The cycle and pedestrian paths built in Tartu City over the past five years have primarily been constructed with the support of grants (the contribution is usually 50–75% of the cost of the paths) or as part of reconstructing an existing carriageway.

The state is planning various support measures with EU funding to support the development of the mobility sector in cities (including light traffic, mobility centres, city environment that is friendly and safe to road users, etc.)

The financial burden that accompanies the performance of these activities can be significantly reduced with external funding.

Definitions

Greenhouse gases – greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Greenhouse gas emissions are expressed as carbon dioxide equivalent (t CO_2 equivalent).

Carbon dioxide equivalent (CO_2 equivalent) – unit of measure of greenhouse gases that has been recalculated into the volume of carbon dioxide based on the global warming potential of greenhouse gases.

Environmental impact – presumed direct or indirect impact of any activity on the environment, human health and well-being, cultural heritage or property.

Climate – the average weather in a given area over a longer period of time.

Climate change adaptation – activities that help to prepare for coping in the circumstances of a changing climate and adapting to the consequences of climate change on the level of households, settlements, companies, economic sectors, and states.

Mitigation of climate change – activities that limit the extent of impact of climate change caused by humans and increase the carbon-sequestration capacity of ecosystems in forests and oceans.

Climate risk – likelihood that a harmful impact caused by climate change (changes in weather) is manifested in the built or natural environment (including humans).

Final energy consumption – energy consumption after its intermediate transformations into other types of energy (electricity, heat, fuel). Final consumption does not include energy use for raw materials, own consumption in power plants, or loss.

BEI (**baseline emission inventory**) – baseline emission inventory for greenhouse gases.

IPCC – Intergovernmental Panel on Climate Change.

Green network – a strategically planned, spatially, functionally, and ecologically coherent network of natural and seminatural areas and other environmental elements that functions on various hierarchical levels. Green infrastructure was established to provide ecosystem services. Technical facilities (ecoducts, green roofs, green walls, etc.) are also part of the green infrastructure.

Blue network – blue network includes water ecosystems (lakes, rivers, streams and other ecologically functioning water bodies) with their shore or bank areas.

Annexes:

Annex 1: The SECAP methodology

Tartu City has joined the Covenant of Mayors and with that has assumed the obligation to reduce the emission of greenhouse gases in the city's territory and regularly report on its activities for reducing greenhouse gas emissions and climate change adaptation. An important part of reporting is conducting inventories of greenhouse gas emissions. The objective of the Covenant of Mayors is that calculations are carried out based on a shared methodology and it recommends using the IPCC (Intergovernmental Panel on Climate Change) methodology to calculate emissions. Using the same methodology ensures that the outcomes can be compared to other European cities.

Based on this methodology, this plan uses standard emission factors and considers biomass and biofuels to have a neutral carbon balance.

Environmental impact can also be evaluated through Life Cycle Assessment (LCA). According to this approach, the total environmental impact of a product/service or activity is evaluated throughout its life cycle. The main downside of conducting life cycle assessment is the excessive use of data, funds, and time. There is currently no common methodology to implement life cycle assessments in energy and climate plans.

Pursuant to the voluntary obligations of the Covenant of Mayors, baseline emission inventory (BEI) has been carried out regarding CO_2 emissions in Tartu City in 2010 (baseline year) for the Tartu City SEAP (2015–2020) and data on energy consumption in 2017 were collected and used to calculate the emissions of the relevant year for the intermediary inventory. A monitoring emission inventory (MEI) shall be carried out at least every four years. The basic scheme for the methodology of calculating emissions has been provided on figure 8.1.

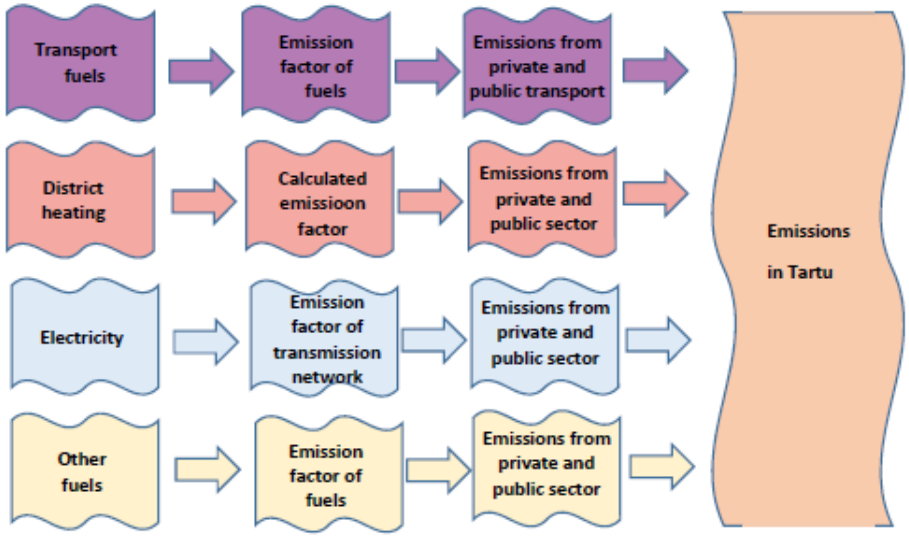


Figure 8.1. Principle of the methodology of calculating emissions in the energy and climate plan

Energy consumption data are used for calculating emissions. The following table provides a general description of data and their collection divided by sectors.

Table 8.1. Description of data sources

Sector	Data sources and their collection
Administrative buildings of Tartu City	Energy consumption in administrative buildings is based on a list of buildings confirmed by Tartu City. The Tartu Regional Energy Agency shall provide annual overviews of energy consumption for these buildings. The general information of buildings has been specified based on the building register and information from the city government. Source of energy consumption data: Elering, Elektrilevi, Eesti Gaas, Fortum Tartu. Consumption data is requested from service providers based on relevant lists and identification codes.
Street lightning in Tartu	Information on the energy consumption of streetlights and number and type of lights has been acquired with the help of the street lighting specialist of the city government based on an extract from the electricity database and description of the situation.
Water treatment	Information on imported thermal energy and electricity, produced biogas and electricity, and use of the cogeneration plant was received from the representative of Tartu Veevärk.
Buildings and facilities of undertakings	Location-specific (Tartu City) data on electricity consumption and production were received from the Elering database through Elektrilevi. Information on the sale (consumption) of district heating, fuel use and electricity production was received from the contact person of Fortum Tartu. Information on natural gas consumption in Tartu City was received from the Statistical Office. As no distinction had been made, natural gas consumption was divided equally between private and commercial consumers.
Public transport	Data on route kilometres of public transport based on fuel type used by buses were received from providers of the transport service through the Tartu City Government. Fuel consumption, energy consumption and emission factor values received from the lipasto.vtt.fi database were used based on the EURO class of the buses (EURO IV) (total mass of the vehicle 18 t, capacity 6 t, automatic transmission, urban).
Private transport	The mileage of passenger cars in Tartu City was obtained from the summary *Car Fleet Mileage 2017* issued by the Estonian Road Administration. Pursuant to the distribution based on age and fuel types provided in the passenger car register of the Estonian Road Administration (as at 31/12/2017), the mileage was divided into EURO classes. The energy consumption of the relevant EURO class and fuel type was calculated based on the database of average energy consumption of each EURO class lipasto.vtt.fi (urban).

The following table provides emission factors used throughout the energy and climate plan per year to clarify the scheme provided in figure 8.1.

Table 8.2. Emission factors in 2017

Energy source materials	Emission factor, $kgCO_2/kWh$	Reference
Electricity	1.147	Elering residual mix 2017[1]
District heating (Tartu Fortum, efficient)	0.118	Environmental report emission[2]
Natural gas	0.202	CoM, IPCC[3], Ministry of the Environment regulation[4]
LPG	0.227	CoM, IPCC[3], Ministry of the Environment regulation[4]
Heavy fuel oil	0.278	CoM, IPCC[3], Ministry of the Environment regulation[4]
Light fuel oil	0.259	CoM, IPCC[3], Ministry of the Environment regulation[4]
Diesel fuel	0.266	CoM, IPCC[3], Ministry of the Environment regulation[4]
Motor gasoline	0.249	CoM, IPCC[3], Ministry of the Environment regulation[4]
Oil shale oil	0.278	Ministry of the Environment regulation4
Peat	0.381	CoM, IPCC[3], Ministry of the Environment regulation[4]

Renewable energy, including timber and wood biomass, wind and hydro energy, PV electricity, biomotor gasoline, biodiesel fuel	0.0	CoM, IPCC, CO_2 neutrality criterion (ncn)[3]

1. 2017 residual mix in Estonia (electricity from an unproven source) and calculation methodology for residual mix.
2. Reported thermal energy emissions in the 2017 environmental reports of Fortum Tartu.
3. CoM Default Emission Factors for the Member States of the European Union - dataset version 2017.
4. Annex 2 to Regulation No. 86 of the Minister of the Environment.

The principles and factors provided in the methodology of emission factors overview in this annex shall be taken into account in preparing and reading this document and in preparation of future monitoring emission inventories.

Annex 2:

Tartu bicycle traffic strategic action plan 2020–2040

Annex 3:

Development plan for regional public transport and multi-modal transportation solutions (Commuting Master plan)