TOWARDS SMART ZERO CO_2 CITIES ACROSS EUROPE

VITORIA-GASTEIZ ✣ TARTU ✣ SØNDERBORG

Deliverable 4.1: Tartu Diagnosis and Baseline

WP 4, Task 4.1

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Abbreviations and Acronyms

Abbreviation/Acronym	Description
ICT	Information and Communication Technologies
KPI	Key Performance Indicator
LH	Light House
SmartEnCity	Towards Smart Zero CO2 Cities across Europe
SWOT	Strengths, Weaknesses, Opportunities and Threats
WP	Work Package

Table 1. Abbreviations and Acronyms

0 Publishable Summary

The overall objective of WP4 “Tartu Lighthouse Deployment” is to develop the detailed planning and coordination, to set up the management structures and procedures, and to implement construction works in the Tartu demo site according to the initial process layout.

This deliverable develops an in-depth evaluation of Tartu at a city level, making use of the indicators system provided in WP7. The main outputs of this deliverable are a comprehensive diagnosis of Tartu and the baseline evaluation framework to be used in the intervention. This diagnosis phase, including baseline calculation and city needs identification and prioritization should be the first step of any intervention process.

This deliverable has been divided in four parts describing main aspects of Tartu diagnosis and baseline definition.

Chapter 4 delves on the diagnosis process definition, regarding activities, phases, agents, methods and tools, among others factors.

Chapter 5 relies on indicators to describe and characterize Tartu performance regarding local conditions, energy supply and consumption, building stock and retrofitting needs, urban mobility, ICTs infrastructures and services, and citizen engagement.

Chapter 6 identifies and prioritizes city needs through SWOT analysis, defining the intervention area. This analysis will set the ground for the intervention baseline definition, which framework is presented on chapter 7.

Finally, last chapters draw conclusions of the deliverable and outputs of D4.1 for other WP.

1 Introduction

1.1 Purpose and target group (Common approach D3.1/D5.1)

The aim of this deliverable is an in-depth evaluation of the situation in Tartu at a city level, making use of the indicators system developed in WP7. The main outputs of this deliverable are a comprehensive diagnosis of the area in Tartu centre and the baseline framework definition to be used in the intervention. In a wider sense, D4.1 can be useful for any European city willing to identify and prioritise its needs before any urban regeneration process.

Concerning other deliverables, D4.1 diagnosis and baseline becomes the stepping stone for remaining WP4 deliverables, shaping the ground of Tartu LH intervention. In addition, D4.1 provides valuable inputs for both designing the citizen engagement strategies of D2.6 and the integrated and systemic SmartEnCity urban regeneration strategy of D2.7 and D2.8. Furthermore, the city diagnosis will be taking into account as baseline in the evaluation process of impacts in D7.13.

Project stakeholders are also a target group of D4.1, helping them to visualize a comprehensive scenario for setting goals, further development and assistance for decision making in down-the-line integrated planning.

1.2 Contributions of partners

Participant short name	Contributions
TREA	General structure and coordination, final analysis and suggestions
CAR	Methodology for indicators, common approach for WP3 and WP5
TAR	Statistic data, input for analysis
IBS	Statistic data, input for analysis

Table 2. Contribution of partners

1.3 Relation to other activities in the project

The following Table 3 depicts the main relationship of this deliverable to other activities (or deliverables) developed within the SmartEnCity project and that should be considered along with this document for further understanding of its contents.

Deliverable Number	Contributions
D7.1	D7.1 provides a first proposal of city characterization indicators that has been filtered by LH cities to define the definitive list of common and optional indicators included in D2.4 and applied in D4.1, D4.1 and D5.1.
D2.1, D2.2, D2.3	D2.1, D2.2, D2.3 give input on specific topics (Polilcy & Regulation, Standards, Business environment) for diagnosis and baseline definition of LH cities on D4.1, D4.1 and D5.1.
D2.4	D2.4 describes the overall method and process, as well as the template to be applied in diagnosis and baseline definition of D4.1, D4.1 and D5.1
D2.6, D2.7	D4.1 provides valuable information for designing the Citizen Engagement Strategy of D2.6. D4.1 also provides inputs for the integrated methodology strategy of SmartEnCity to be defined on D2.7
D3.1, D5.1	D3.1, D4.1 and D5.1 are aligned providing a diagnosis and baseline definition for each LH city, following a parallel process described in D2.4.
WP4	Diagnosis and baseline definition of D4.1 sets the common ground for the remaining WP4 deliverables.
WP7, D7.13	City diagnosis will be the starting point for the city impact evaluation to be done at WP7 (D7.13, Assessment of the overall performance)
WP8, D8.6	D4.1 becomes a relevant output for defining Integrated Urban Plans.

Tabel 3. Relation to other activities in the project

2 Objectives and expected Impact

2.1 **Objective** (Common approach D4.1/D5.1)

The overall objective of WP4 “Tartu Lighthouse Deployment” is to develop the detailed planning and coordination, to set up the management structures and procedures, and to implement construction works in the Tartu demo site according to the initial process layout.

Task 4.1 is closely linked to this deliverable. The main objective of this task is to provide an in-depth evaluation of the situation in Tartu at a city level and in the demonstration area, making use of the indicators system developed in WP7 and the methodology developed in WP2. Furthermore, this task intends to allow stakeholders to visualize a comprehensive scenario for setting goals, further development and assistance for decision making in down-the-line integrated planning, as well as to work as valuable input for citizen-engagement processes.

This D4.1 accomplishes these goals through the evaluation of Tartu at a city level and provides a comprehensive framework to identify the needs and priorities of the city and the demo area, having an accurate approach to define the intervention baseline.

2.2 **Expected Impact** (Common approach D4.1/D5.1)

D4.1 diagnosis and baseline definition becomes the stepping stone for remaining WP4 deliverables, shaping the base of Tartu LH intervention. Furthermore, D4.1 provides valuable inputs for both designing the citizen engagement strategies of D2.6 and the integrated and systemic SmartEnCity urban regeneration strategy of D2.7 and D2.8. In a wider sense, D4.1 can be useful for any European city willing to identify and prioritize its needs before defining any urban regeneration process.

3 Overall Approach (Common approach D3.1/D5.1)

Task 4.1 focused on diagnosis and baseline framework definition of Tartu LH intervention requires inputs from previous SmartEnCity tasks. Firstly, D4.1 makes use of the indicators system developed in WP7 (D7.1), transforming city performance into numbers in order to quantify the intervention baseline. Secondly, D4.1 is steered by the methodology described in WP2 (D2.4). According to this methodology, this deliverable has been divided in four parts, describing main aspects of Tartu diagnosis and baseline definition.

Chapter 4 delves on the intervention process definition, regarding activities, phases, agents, methods and tools, among others factors. Here, TREA describes this process, with the contribution of CAR as coordinator of indicators definition for the three LH cities of SmartEnCity.

Chapter 5 relies on indicators to describe and characterize Tartu performance regarding local conditions (TAR), energy supply and consumption (TREA), building stock and retrofitting needs (TREA), urban mobility (TREA, with TAR contribution), ICTs infrastructures and services (TREA), and citizen engagement (IBS). Due to its central role in Tartu, TAR was the partner mainly involved in obtaining and selecting indicators process.

As main reference of characterization chapter, Annex 1 includes a detailed table of indicators provided by CAR, where all indicators are explained, providing common units and framework for the three LH interventions of SmartEnCity.

Chapter 6 identifies city needs through SWOT analysis, defining the intervention area. Here TREA makes an analysis of provided data by the previous chapter and additional sources, narrowing down to the case of demo area. This chapter includes a contribution for the specific spatial analysis. This analysis sets the ground for the intervention baseline framework definition, presented on chapter 7, developed by CAR.

Finally, last chapters draw conclusions of the deliverable and outputs of D4.1 for other WPs.

This deliverable has been coordinated with deliverables D3.1 and D5.1 in order to harmonize diagnosis processes in all three LH cities. PLAN, TREA, TEC and CAR have participated in this parallel process.

4 (A) Diagnosis and Baseline process as a whole

4.1 Process in Tartu

- Activity sequence
- Relationship between phases

The Diagnosis methodology in D2.4 describes that a partnership of local stakeholders needs to be formed, to provide local knowledge on city needs:

> *"…a critical decision to make at the earliest (in the Diagnosis process ed.) should be the definition of an **initial partnership**, which should bring together different municipal departments and public bodies, local stakeholders, as well as knowledge and technology partners to take part in the whole process. Different levels of participation, specific coordination procedures, etc. should be defined and periodically revised." – D2.4, p. 38*

In the project partners will assess the energy performance and savings, environmental impact, the cost effectiveness and the social acceptance of the three types of interventions defined in the project: district renovation, sustainable mobility actions and citizen engagement actions.

Process implies the participation of all stakeholders, and the examination of all dimensions of a city, in order to determine the most appropriate options and to arrange a suitable course of action.

The stages for evaluating the intervention performance of a city consist of:

- Technical definition of the district integrated intervention through a diagnosis phase of the existing systems, the design of alternatives, the definition of concept designs and the implementation plan.
- Development of an evaluation plan for assessing the performance of interventions. This plan consists of setting appropriate KPIs and deployment of customized procedures for their evaluation.
- Definition of monitoring program to be deployed in the demonstrators. Tailored and rigorous monitoring programs will be defined to meet the evaluation objectives.
- Design of a data collection approach which allows collecting and storing the data compiled from the monitoring systems.
- Execution of the intervention and installation of monitoring equipment according to the general schedule of the project and the monitoring program previously defined.
- Evaluation of the intervention performance through a comparison of baseline and final performance.

An effective evaluation and feedback system provides regular information to both service providers and users about important changes in local conditions and progress towards targets. With this information, the actors can adjust their own actions and behaviors. Evaluation information is used to guide planning and resource allocation (budgeting) processes so that these processes are kept accountable. If an Action Plan fails to correct

problems or to satisfy prioritized needs, the feedback system triggers further planning or action.

Baseline and diagnosis is based on the existing data and on data generated from interventions also on experiences of City of Tartu and TREA in different initiatives (Covenant of Mayors and others). Sustainable Energy Action Plan[1] developed by TREA for the City of Tartu in 2015 is one of the main sources of information throughout this document. City of Tartu has joined to Covenant of Mayors, investing into the sustainability and this has been a constant strategy for several last years. Diagnosis takes also use of the assessment done by TUWIEN in 2014 during the PLEEC project and presented in European Smart Cities web page www.smart-cities.eu.

The diagnosis phase is focused in recollecting, processing and analyzing data that will become the basis for decision making, so the role of the partners involved in this stage of the process can be defined from their relation to these data-related tasks

4.2 Governance, involvement and public ownership

- Participating agents in each phase
- Roles
- Decision-making mechanisms
- Interdisciplinary cooperation
- Community involvement / citizen engagement

Baseline and diagnosis is carried out in Tartu mainly in cooperation of 4 partners : TAR, TREA, IBS and ET. The main expertise areas are for TAR governance, planning, administration and regulations, for TREA energy technologies, for IBS citizen engagement and communication issues and for ET is the main expertise ICT and telecommunications. The following is a partners' participation in the various domains:

- City characterization : TAR, TREA, IBS, ET
- Energy supply network : TAR, TREA
- Transport and mobility: TAR,TREA
- Urban infrastructures: TAR, TREA
- City plans & regulation and governance: TAR
- Citizens: TAR, IBS

Among above listed partners will be involved in to diagnosis in different phases other partners, external experts (service providers, constructing companies, energy companies) and local community.

Baseline and diagnosis will provide the necessary input to decision makers and planning activities. As a result of the diagnosis revealed shortcomings enable update existing and create new action plans to overcome this weaknesses.

[1] Action Plan for Sustainable Energy Management 2015-2020 for the City of Tartu. TREA 2015. Available: www.tartu.ee/data/SEAP_Tartu_ENG_2015.docx

Once the scope of the planning exercise is determined, the partnership structures are defined, and participants are identified, terms of reference will be developed to define roles and responsibilities in the planning process.

Experts, residents, key institutional partners, and interest groups (stakeholders) will be involved in designing and implementing action plans. Planning is carried out collectively among these groups. It is organized so as to represent the desires, values, and ideals of the various stakeholders within the community. Planning domain is responsible for design and research, while community domain is responsible for choice and legitimation of selected options. Results – action plans will be approved by appropriate body (City Government or City Council).

The interdisciplinary cooperation involves basically two main components:

1. citizen engagement - process to gather and discuss the knowledge and wisdom of local residents about local conditions
2. technical assessment - carried out by project partners in accordance of their expertise in order to provide stakeholders with further information that may not readily be available to them.

Popular knowledge and technical research are then reviewed together by the stakeholders. Experts considering systemic links and harmonizing results.

Involving local communities in the analysis is essential in order to achieve accurate results.

Community involvement/citizen engagement methodology will be in more depth explained in D 2.1 “Citizen Engagement Strategy and deployment plan”.

4.3 Methods

- Knowledge domains
- Relationship between disciplines
- Planning techniques
- Tools (data sources & processing methods, others)

References: Chapter 4; Annex A2

Baseline and city diagnosis is drawn up on base of domains and indicators which are described in D2.4. The objective of methods is to set up an easy and fast way for the identification of the strategic city needs in order to make a diagnosis of the city in terms of energy demand and consumption, energy efficiency, energy supply, CO2 emission, city structure, regulation and normative, standards, stakeholders, citizens and financial schemes.

The description of the city and the indicators can be divided into two: characteristics that help to understand the overall socio-economic context of the city, but during the project will probably not change; although these indicators are not conditioned to change they are essential to be acknowledged for the intervention methods (e.g. population, ethnic composition, age structure, ICT use, income, etc.), and 2) characteristics that will probably change during the project as a result of the intervention (e.g. number of initiatives for smart city growth).

Indicators are defined in order to characterize and identify the main features of a city, strengths and weaknesses and evaluate the current situation. The diagnosis done through these indicators will allow to define the needs of the city (e.g. most suitable interventions), setting city objectives (e.g. to create a Smart Zero Carbon City) and/or the type of strategy to be adopted in the future (e.g. Urban Integrated Plan).

Evaluation is based on indicators and KPIs has been defined for the identification of strategic city needs and assessing the performance of the interventions. This plan is directly applied into two stages:

Stage 1: Baseline

- Characterization of the city in order to know the current city profile in areas such as energy, transport, infrastructure, governance and citizens before the intervention.
- Definition of baseline of the demo-area in technical, environmental, social and economic performance before the intervention.

Stage 2: diagnosis after the intervention starts

- Evaluation of the performance gained after the interventions in the demo-area in technical, environmental, social and economic performance.
- Analysis of the impact in order to calculate the benefit of the intervention in the city and show changes in the city profile in the areas agreed in the city diagnosis.

Once stakeholders are organised and governance procedures established, other methodological issues should be addressed, such as the selection of relevant knowledge domains for the project. It is crucial to gather basic information for the intervention in order to evaluate it and identify which results are interesting for the partners involved. When having main knowledge domains selected, relevant indicators should be identified in order to be able to calculate and evaluate relevant information of those domains.

Some problems might appear when carrying out this process. Accordingly, data management should be planned thoroughly in advance.

4.3.1 Knowledge domains

As already analyzed in D2.4, the Aalborg Commitments defined a set of domains in which could be divided the actions carried out towards sustainable urban development. Also the Leipzig Charter and LC-FACIL URBACT II defined later on a reference framework for sustainable cities with 30 objectives and 5 dimensions. All these actions are related to the city scale, while district level is much more undeveloped. At district level, there are several certification tools which deal with common aspects (environmental, social and economic issues). However, other aspects vary depending on the certification tool (mobility and governance are the most extended ones while energy is the most popular).

After going through all this information, D2.4 established a proposal of knowledge domains that should be taken into account in SmartEnCity project.

Domain	Subdomain
City characterization	Key features of the city
	Land use characterization
	Socio-economic features of the city

	Environmental features of the city
Energy supply network	City energy profile Potential local energy resources in the city Environmental impacts in the city due to energy consumption
Transport and mobility	Mobility City profile City statistics for mobility Environmental impact of the mobility
Urban infrastructures	Available infrastructures in the city for managing transport, waste, water and environment Existing transport utilities Existing environment monitoring infrastructure Existing city monitoring infrastructure Communication infrastructure in the city
City plans & regulation and governance	City plans and strategies Public procurement procedures & regulations and normative Governance
Citizens	Existing actions for citizen engagement Channels for citizen engagement Current scenarios of citizen engagement

Table 4. City characterization indicators: domains and subdomains – D. 2.4.

4.3.2 Procedure for the selection of indicators

In the framework of the project, indicators have been selected as potential tool to be employed for any city which intends to be transformed into a Smart Zero CO_2 City.

In deliverables D3.1, D4.1 and D5.1 this selection of indicators are used to characterize and diagnose the three lighthouse cities in a comparable form. The indicators are found in fact several boxes in chapter 5 of this document as well as in the Annex where definitions have been included for a better understanding of the document.

Through a city diagnosis based on these key indicators for different application areas (named as domains), city planners can know the potential features and adverse conditions of urban areas as well as identify their main needs which lead to define the objectives and strategies to be implemented in the cities, making decisions for the most suitable interventions. Consequently, once the city demand is known, strategic plans and actions can be launched within the roadmap of the city in order to overcome detected barriers. These plans help to promote those technologies, necessary to reach the city objectives. Finally, specific plans can be developed for the implementation of these technologies.

Taking into account this premise, main partners in charge of the deployment of the evaluation framework in SmartEnCity project (CAR and TEC) defined application areas as well as a set of indicators to be proposed to the cities involved in SmartEnCity (lighthouse cites and follower cities). These areas (*Domains* in table 4 above) and indicators will assist them in the general process of developing smart and sustainable urban plans for their city (D7.1).

These indicators were selected after a review of the available sources, focused on the measurement of the city in terms of sustainability, since there is not an only source which satisfies all the application areas previously identified. Finally, chosen indicators (template in

Annex 1) came from shared working documents, agreeing an indicator system among a wide sample of stakeholders.

These well-accepted documents were:

- ISO 37120. It is the only standard already developed for city indicators. Although it is not focused on indicators for smart cities, it delves on city services and quality of life.
- SCIS and CITYKEYS, which integrate the existing results from previous smart city initiatives.
- PLEEC and STEEP projects, where the selection of indicators were done by city representatives.
- ITU as main source for indicators in ICT issues.
- Sustainable Energy Action Plan and Covenant of Mayors commitment for energy, transport and emission indicators.

Criteria for this first selection of indicators were:

- **Relevance**. Each indicator has a significant importance for the evaluation process and for the goals of the project.
- **Completeness**. The set of indicators consider all aspects of the planning and implementation of smart city projects, covering all the pillars of the project: interventions (building, mobility, ICT), actions (engagement), impacts (energy, economy, social, environment) and non-technical barriers (governance, people and finance).
- **Reliability**. The definitions of the indicators tried to be clear and not open for different interpretations. This holds for the definition itself and for the calculation methods behind the indicator.
- **Measurability**. The identified indicators were accompanied by units (for quantitative data available in data sources) and with a Likert scale (for qualitative information linked with own criteria of respondent).
- **Non-redundancy**. Indicators within a system/framework should not measure the same aspect of a subtheme.
- **Independence**. Small changes in the measurements of an indicator should not impact preferences assigned to other indicators in the evaluation.

In a further stage, partners involved directly with LH cities (CEA from Vitoria-Gasteinz, TREA from Tartu and SONF, ZERO, VG and PLAN from Sonderborg) participated in the selection of most suitable indicators for their cities taking into account the below set of criteria. This process was done in D2.6.

- **Relevance**. Each indicator has a significant importance for the evaluation process and for the goals of the project in the city.
- **Availability**. Data for the indicators seem to be easily available.
- **Familiarity**. The indicators were easy to understand by the users.

This process finished with the question: *Would you like this indicator to be included in the template for **city** diagnosis?*

A posterior analysis of the answers received from the three cities established two types of indicators for this process of city diagnosis:

- **Mandatory** indicators correspond to those indicators selected by the three cities.
- **Optional** indicators correspond to those indicators not selected by the three cities.
- The agreement reached consisted of the search of mandatory indicators for the three cities in order to make a comparable analysis of the three lighthouse cities. The indicators are found in fact several boxes in chapter 5 of this document, being mandatory indicators marked in green

for a better identification. In additional, optional indicators could be searched by the cities for complement the characterization of the cities. The whole list of indicators are found in Annex.

4.3.3 Procedure for the search of indicators

A **template was provided to the cities** with the aim to include the **value** found by each indicator, the **data source** and some **comments** related to the difficulty to gather some data, the non-reliability of found data or other obstacles to be mentioned (template in Annex 1). This search and analysis of available information is done by each LH city in D3.1, D4.1 and D5.1, being a valuable input for the regeneration strategy to be deployed in the framework of the SmartEnCity project (D2.7).

In the case of Tartu, the gathering process has been developed by TREA, closely linked to the different departments of Tartu Municipality. The gathering process has been hard for different reasons, and a few indicators were finally inaccessible, as it can be noted in the city characterization chapter of this D4.1 (Chapter 5).

The city diagnosis process had several difficulties in the city of *Tartu* to find information from selected domains. Main difficulties concerned data management (identification of the source of the information, achieving the collaboration of the depository, requirement of interaction between different sources to obtain specific data), quantification of data (fixed scale units with little flexibility, existence of aggregate data which is not collected regularly and even lack of data), and timing (very tight deadlines for data collection).

Despite the mentioned difficulties, interesting information has already been achieved by consulting the Municipality of Tartu website and other previous reports as Sustainable Energy Action Plan because this data has been verified and is 100% reliable.

Unfortunately, the most interesting data is not previously collected in the mentioned reports and it is very difficult to generate it in the tight deadlines given.

As brief reflexion about indicators obtainment process, it should be said that is a work which huge dimension requires coordination of much people, departments and institutions holding the diverse information, would require more time than the period that is given and maybe the indicator list is too ambitious taking that in account.

Preexisting indicator initiatives in Tartu

Despite the indicators selected in his project, Tartu has its own system of indicators, which was developed by TREA. The objective of this system is to give a description and evaluation of the current sustainability situation and tendencies in Tartu in the framework of Covenant of Mayors. This system is an instrument that responds to a more sustainable vision of the city, with the intention of evaluating quantitatively and qualitatively the urbanization process of Tartu from an integrated and systemic point of view, incorporating sustainability criteria.

The document which explains the system is structured in two parts. First one consists of conceptual reflections about sustainable city models and stability logics in city ecosystems. Second part delves on practical application of indicators and posterior analysis of its accommodation degree to the integrated and systemic model, already exposed on the conceptual framework.

All indicators were selected including key aspects for the definition and accommodation of Tartu to a more sustainable urban model. In this case, indicators respond to a double vision: performance and prediction of current and future situations. Four basic criteria were

considered for the selection: relevance for sustainable city models, evaluation of progress towards goals, potential comparison between territories and urban fabrics, and viability regarding information of base.

Besides this system of indicators, Tartu has also its own indicators defined in the SEAP report, as well as a compilation of applicable indicators developed by several studies and statistics cabinets. This compilation is divided in several domains: population movement, population structure, family, education, health, activity situation, economic situation, social protection, free time, society of information, public function, soil uses, dwellings, economic fabric and associative movements. The application area is also specified.

Besides new indicators defined for SmartEnCity project, there were several already existing initiatives which had already defined suitable indicators for measuring Tartu's sustainability and this is why this kind of method might already be familiar for implied authorities and stakeholders.

5 (B) City characterization: Tartu

5.1 Local conditions

5.1.1 Tartu in text

[Story telling section about Tartu in text, explaining data from 5.1.2]

Tartu is located on the old travelling route crossing river Emajõgi ("Mother river") in the centre of Southeastern Estonia, about 185 km southeast of the capital Tallinn. With about 100,000 inhabitants Tartu is the second largest city in Estonia. The area of the municipality is roughly 40 km². The University of Tartu, founded in 1632, is the oldest university of Estonia. Thus, Tartu is considered to be the intellectual centre of Estonia which is also reflected of the 20,000 students enrolled in one of the local universities.

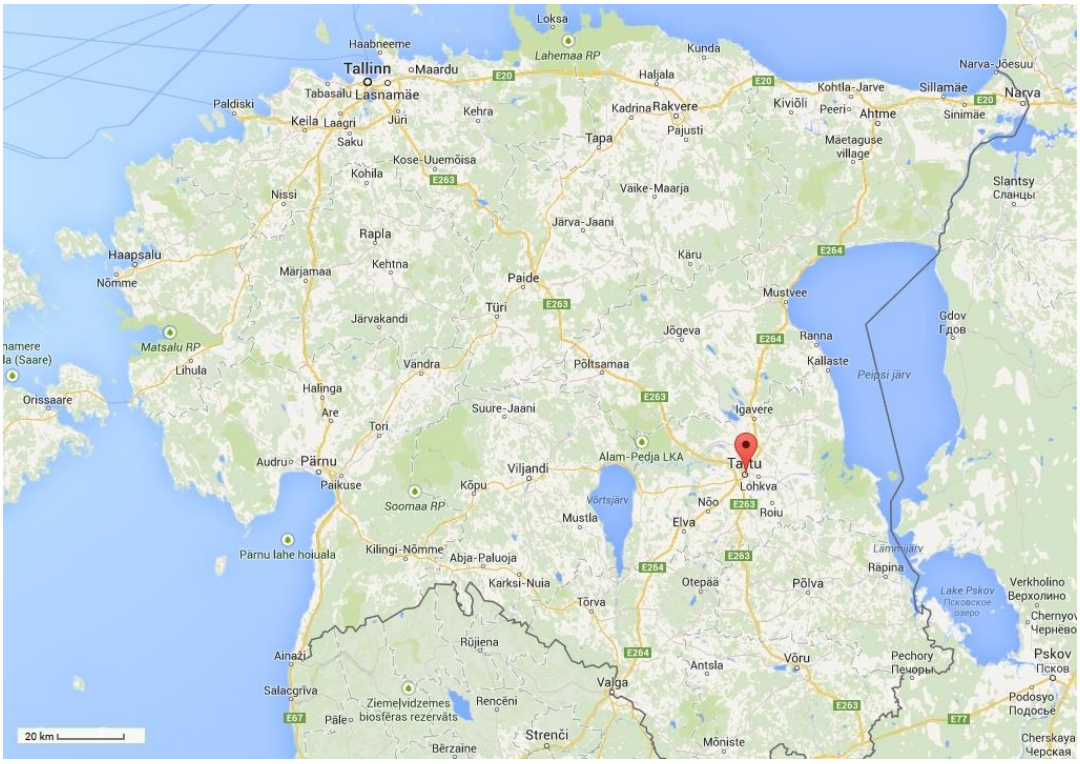


Figure 1. Tartu on the map of Estonia[2]

Tartu is geographically situated close to Latvia and Russia and it is part of the so-called Tallinn – Riga (Latvia) – Pskov (Russia) triangle.

The average population density of the city is about 2,500 inhabitants/km². The district Annelinn has by far the highest population of all districts of Tartu with more than one quarter of the city's population living there and a population density about twice as high as the average of Tartu.

[2] Source: maps.google.com

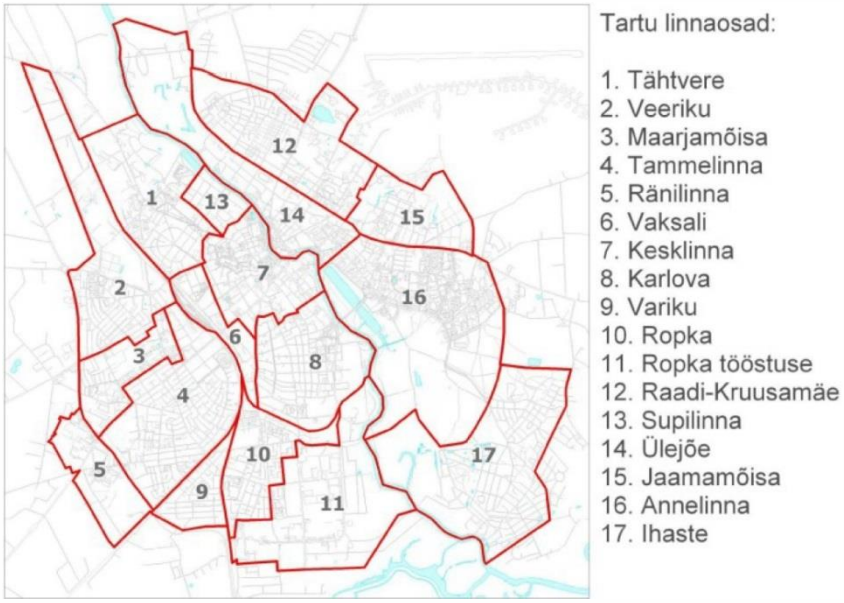


Figure 2. Districts of Tartu[3]

The City of Tartu is situated in Tartu County (in Southern Estonia) and is surrounded by Luunja, Ülenurme, Tähtvere and Tartu municipalities. As a university town, it is the second biggest city in Estonia by the number of residents, and it is also a pole of attraction for both the county and Southern Estonia overall.[4]

Figure 3. The City of Tartu and its location in Tartu County

Topics to address:

- Socio-economy (Section 6.1.1)
- Business & funding (Section 6.1.2; D2.3)
- Environment (Section 6.1.3)
- Policies and regulations (local, regional, national level)

98,480 residents were living on Tartu's 38.87 km^2 area[5] as of 1 January 2013. The number of residents has remained relatively stable in the last years. Although the population growth in Tartu has been positive throughout the years, emigration exceeds yearly immigration. As a result of that, the total number of residents has decreased by ~0.2% per year. The fact that at

[3] Source: www.tartu.ee

[4] Action Plan for Sustainable Energy Management 2015-2020 for the City of Tartu. TREA 2015. Available: www.tartu.ee/data/SEAP_Tartu_ENG_2015.docx

[5] http://www.tartu.ee/data/tartuarvudes%202014_EST.pdf

the same time the number of residents in Tartu County has not decreased proves that emigration could be happening to municipalities near Tartu. Still it must be remembered that Tartu is a university town and a rather large group of people living in Tartu (university students) are not listed in the data of Tartu's population registry and in turn in the total number of residents.6

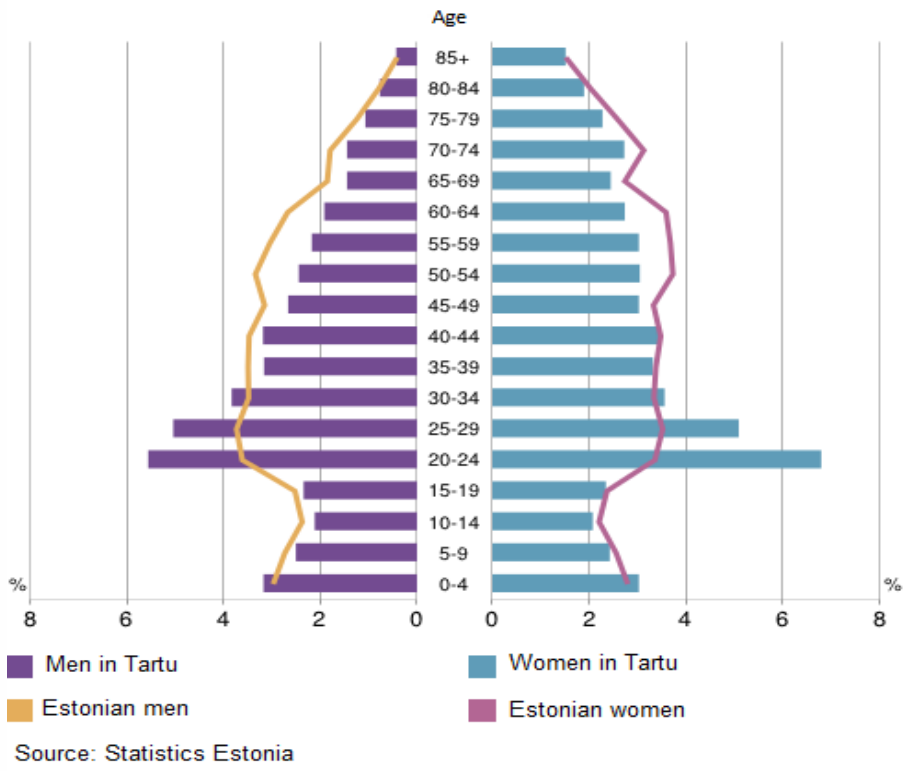


Figure 4. Population pyramid for the City of Tartu[7]

Population8 is relatively young one with many young people in Tartu (between the ages 20–30).

During the Soviet period Tartu was an instantly growing city, the population almost doubled up to about 114,000 inhabitants in 1990, due to immigration from other Soviet republics and natural population growth. After the independency of Estonia in 1991 the population decreased, even though the natural growth is positive, down to about 101,000 inhabitants in 2000 and about 97,000 inhabitants in 2016. Tartu County, which consists of Tartu and 21 other municipalities in its surroundings, gained however a little in population in recent years. Seen in a regional perspective this means a further concentration of population in and around Tartu while the rest of Southern Estonia lost on average 25 % in population since 1991.

[6] Action Plan for Sustainable Energy Management 2015-2020 for the City of Tartu. TREA 2015. Available: www.tartu.ee/data/SEAP_Tartu_ENG_2015.docx
[7] Source: www.stat.ee
[8] Statistikaamet. Piirkondlik portree Eestist. www.stat.ee/ppe

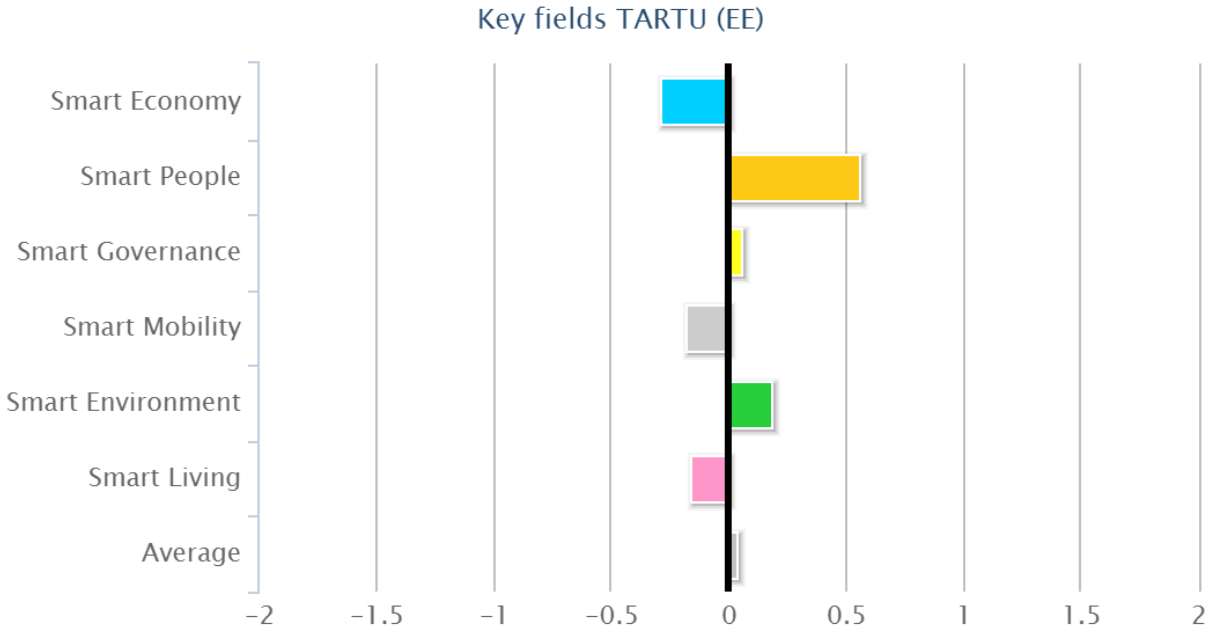


Figure 5. The assessment of City of Tartu[9]

Tartu ranks 15th in the European Smart Cities benchmark for smart people (esp. flexibility and level of qualification). Tartu has been the first in the world in many smart solutions and continuously developing its Tartu City has a vast experience in participating in several inter uses an integrative approach to achieve the sustainable, energy–efficient, smart city.

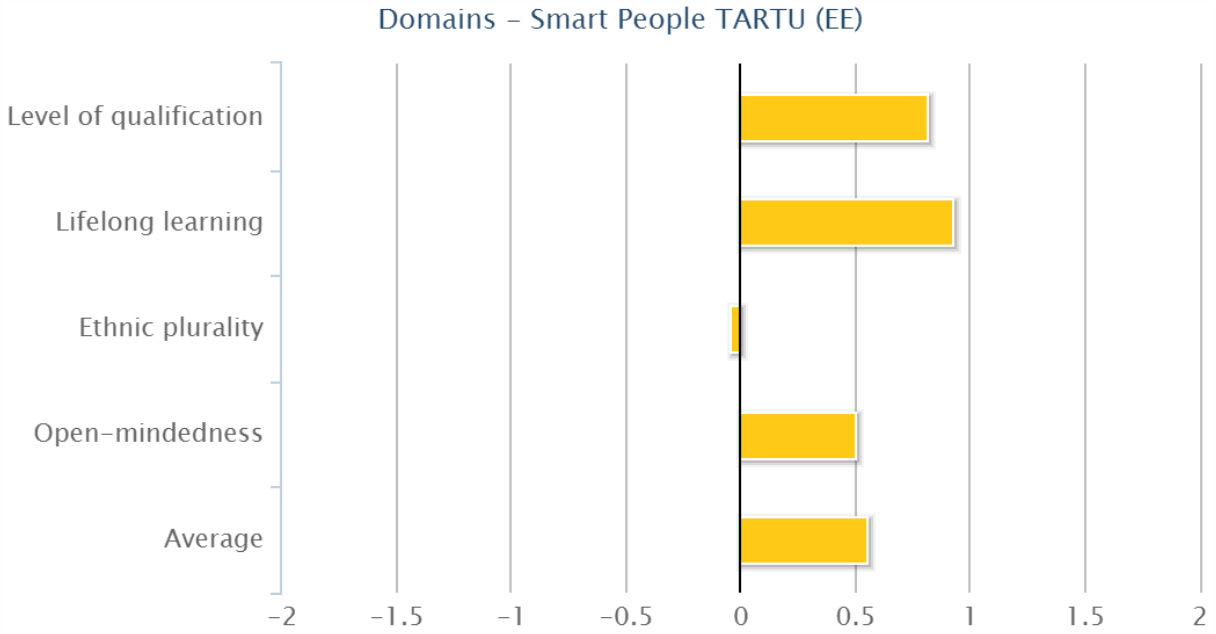


Figure 6. The assessment of Smart People in Tartu[10]

Tartu is seen as "second city" in Estonia – intellectual and cultural capital of the country. It is also known for its active art community and cultural life. The biggest assets of Tartu are its highly qualified and smart citizens – scientists, teachers, writers, intellectuals, artists, students etc. Universities are the biggest single economical driver of the local economy and are also sharing the mission of promoting the city in front of the international audience.

[9] Source: www.smart-cities.eu
[10] Source: www.smart-cities.eu

Growing number of international students and visiting teachers are caring the name of the city to all over the world. With about 3,500 employees, the University of Tartu is one of the largest employers. Being the hub of research and education Tartu has traditions and high competence levels in electronics, engineering, ICT and biotechnology and these enterprises are also internationally competitive.

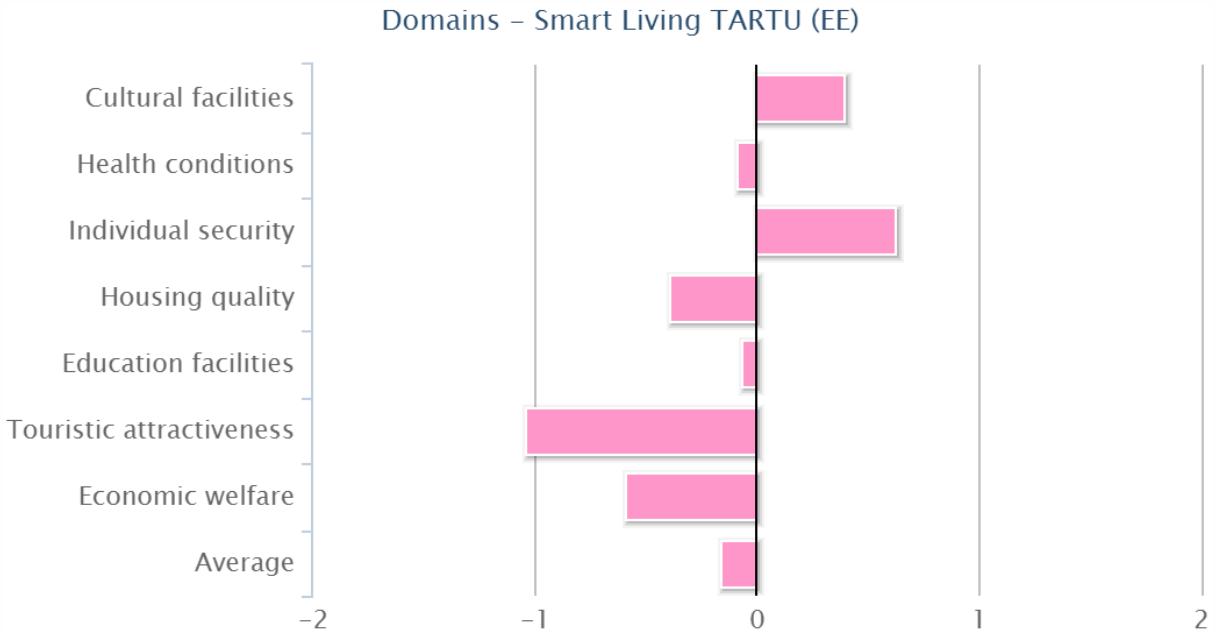


Figure 7. The assessment of Smart Living in Tartu[11]

Tartu is internationally not knows as a tourist location and this has to do with the low international accessibility. It's difficult to justify the 5 hours bus ride for a brief visit. The lack of high-speed mass transit solutions are reducing the attractiveness of the city for a casual tourism market. Lack of economic opportunities are hindering the development of the city. This is also the reason for housing quality not improving as the lack of investing power in not making Tartu appealing for the developers. Investors do prefer the suburban developments because of the higher market value. Administrative inability to regulate urban sprawl is only supporting that trend. Urban sprawl is reducing the economic opportunities of the city further because local tax payers are leaving to suburbs outside the city boarders but still consuming many services.

Business and funding

Keywords: industrial jobs, areas which are increasing or decreasing, EU regulations, Public-Private partnerships etc.

[11] Source: www.smart-cities.eu

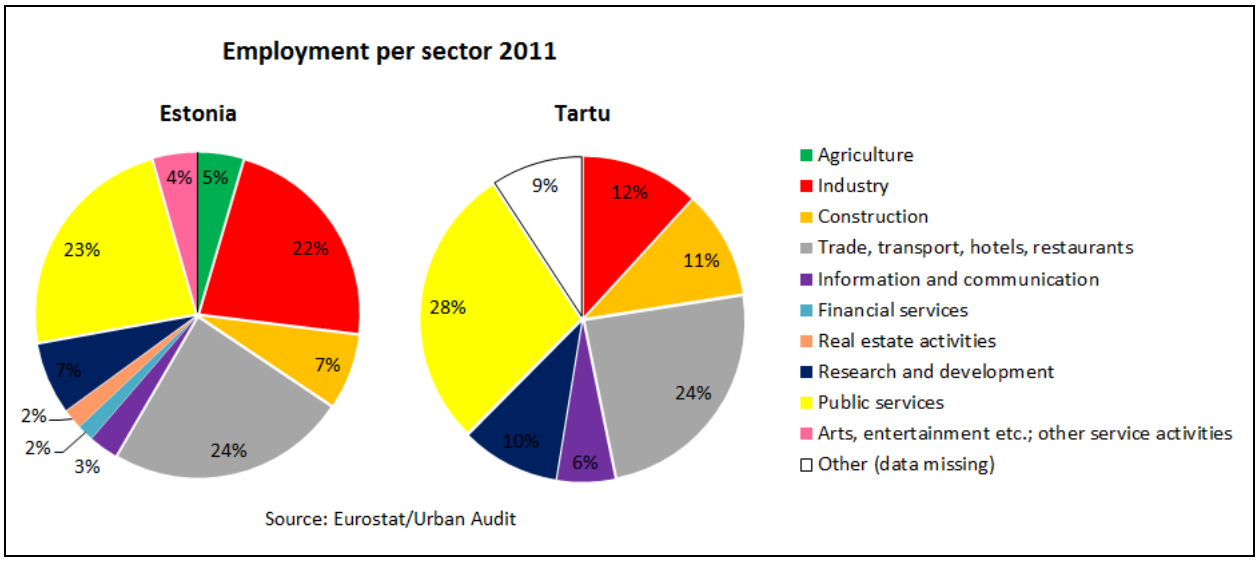


Figure 8. Employment in Tartu[12]

Tartu is an administrative and service centre, also including trade and tourism, in Southern Estonia. The main employers are the universities (incl. hospital) and the city administration. Within the municipality, the service sector has by far the most employees, and many of those work in public administration.

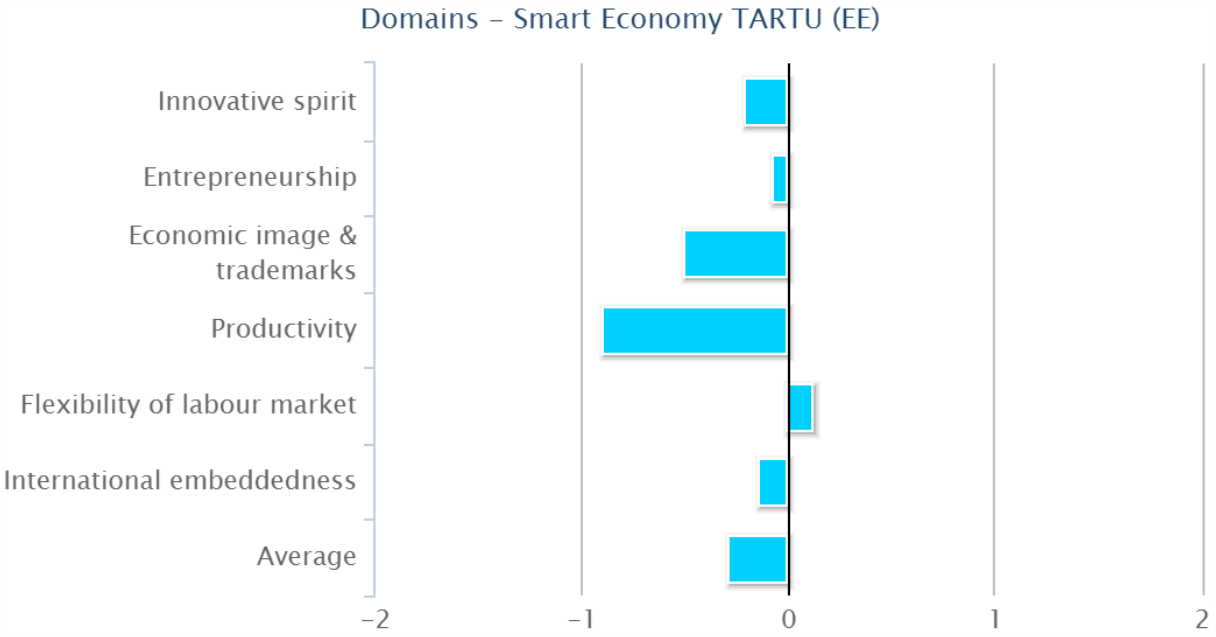


Figure 9. The assessment of Smart Economy in Tartu[13]

The evaluation of the local economy has found that the biggest obstacle is the low productivity of economical activities: low GDP, low employment in business sector and high share of informal activities. Compared to Estonia in general Tartu has a relatively low employment in industry with the exception of the construction sector. Lack of high quality jobs and economic opportunities is the main reason for people leaving the city. Leaving mostly young well educated people who don't find the opportunities to enter into the job

[12] Source: Eurostat/Urban Audit
[13] Source: www.smart-cities.eu

market. Economic image and trademarks are appreciated on local level but are not strong on international level.

Environment

Keywords: city climate overall, comparing the climate with Estonia average (temperature, wind etc.), land use around the city (agriculture, livestock, industries, living areas etc.)

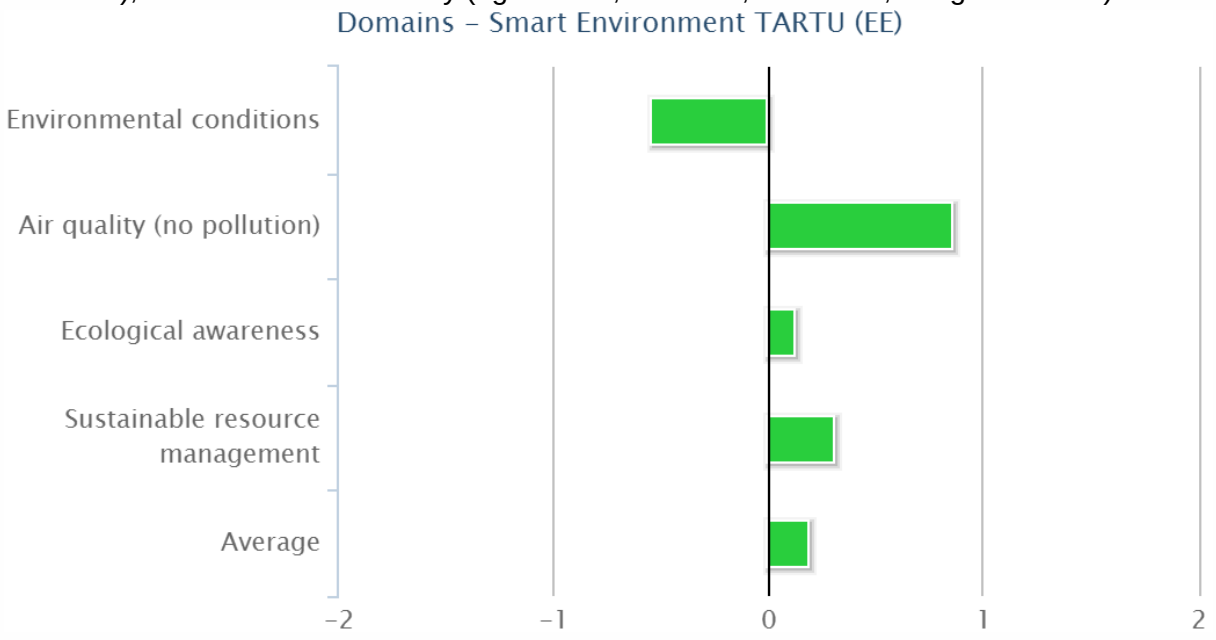


Figure 10. The assessment of Smart Environment in Tartu[14]

Citizens are praising the local environment highly. Life quality in the city is high with its green environment, fresh air, lots of cultural opportunities and stress free attitude of the citizens.

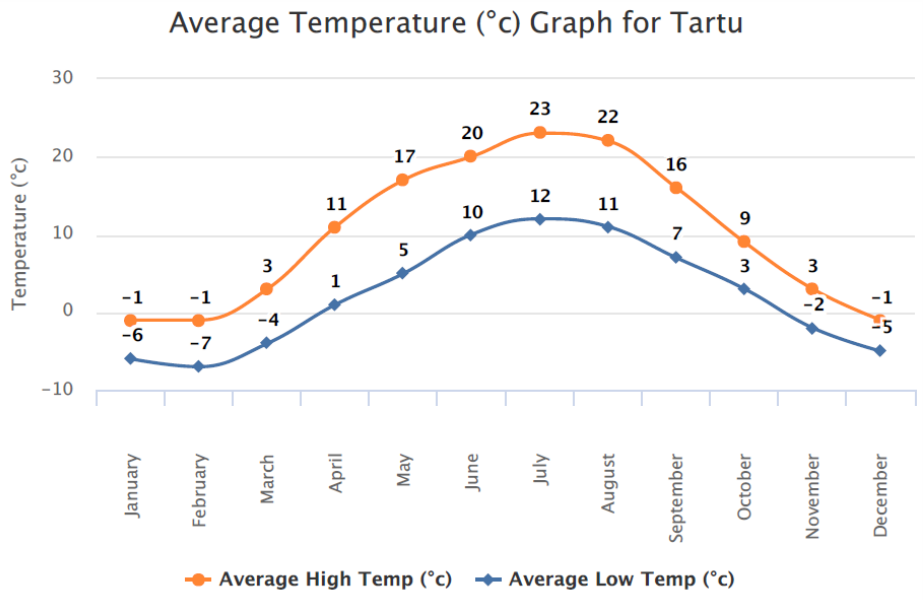


Figure 11. Average temperature in Tartu

Tartu has a humid continental climate with severe winters, no dry season, warm summers and strong seasonality. Tartu lies within the temperate humid continental climate zone. The climate is rather mild considering the high latitude, largely due to the proximity of the Baltic

[14] Source: www.smart-cities.eu

Sea and warm airflows from the Atlantic. Nevertheless, continental influence can be felt on hot summer days and cold spells in winter, when temperature can occasionally (but rarely) drop below −30 °C (−22 °F). Generally, summers are cool to warm and winters are cold. In comparison to other areas of Estonia (especially Nordic and Western part) there is slightly higher average temperatures and more humidity.

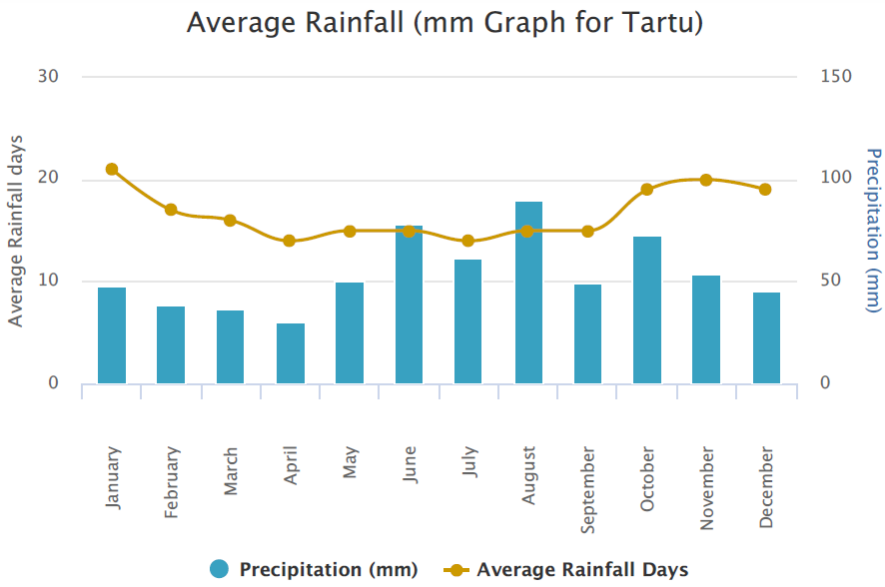


Figure 12. Average Rainfall in Tartu

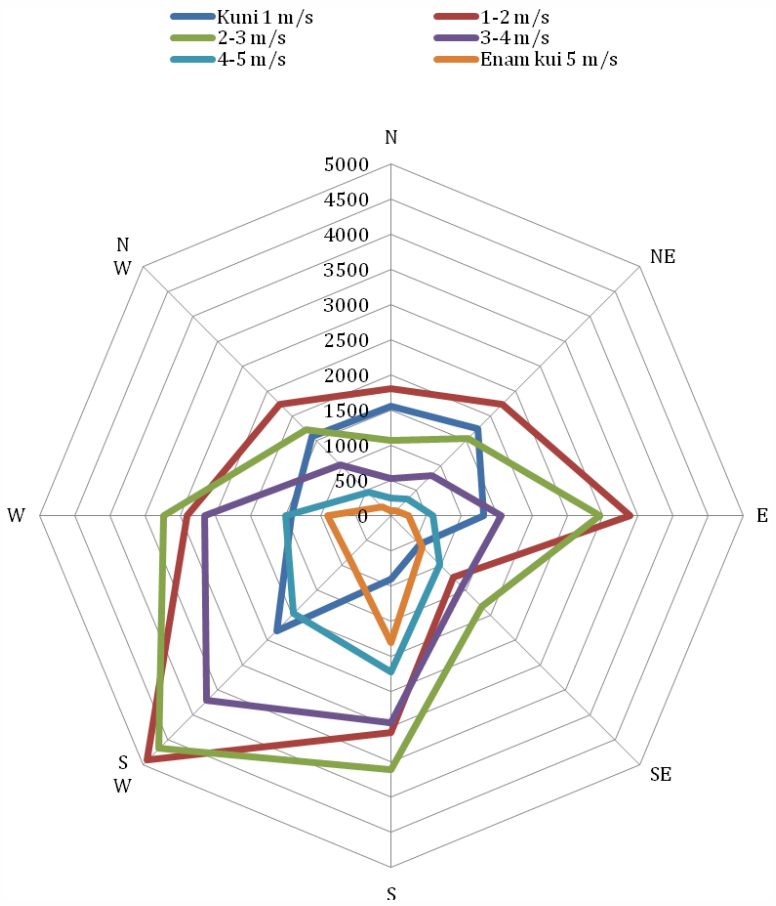


Figure 13. Wind direction and amplitude

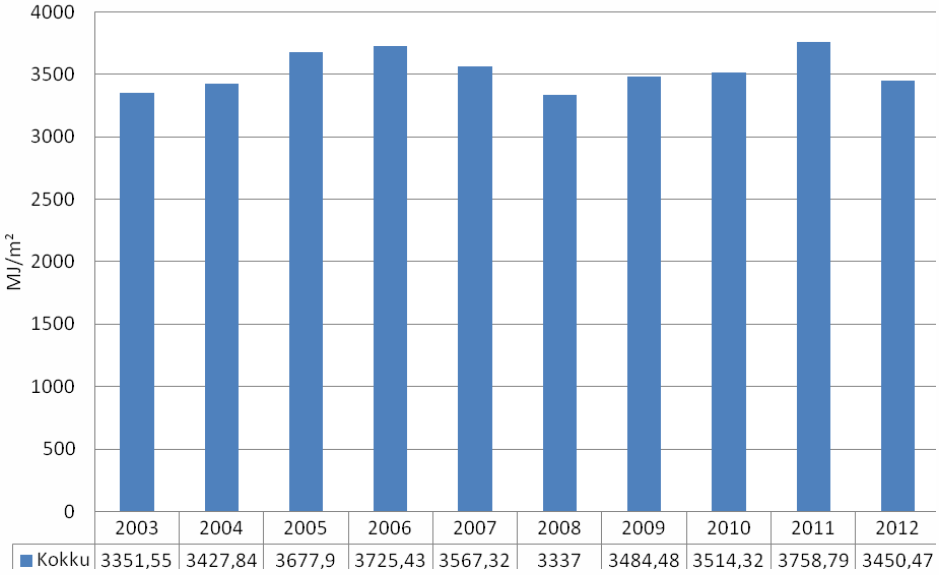


Figure 14. Annual solar radiation in 2003 - 2012

Policies and regulations

Keywords: City goals and visions to create better living environment, citizen engagement, successful events (ex. car free day, studentdays etc.)

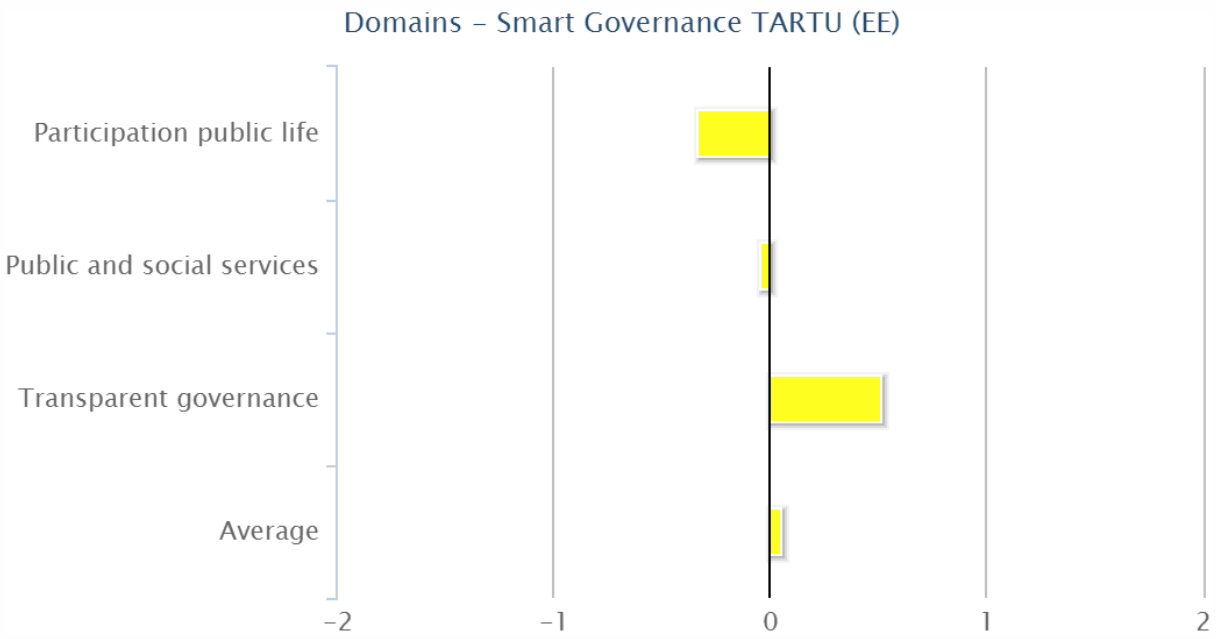


Figure 15. The assessment of Smart Governance in Tartu[15]

The main interest of the city and the various campaigns and training courses aimed at guiding the behavior of the inhabitants in order to ensure the future of a cleaner urban environment and improve the quality of life for residents.

The main key words are: the development of foot and public transport, sustainable energy and sustainable resource use. An important part of a campaign organized and conducted by the city itself. To a lesser extent, the NGO-s. Importance given to children's environmental awareness campaigns and it is always a part of the children's sake. The main tool for the

[15] Source: www.smart-cities.eu

campaigns and training days / workshops. To a lesser extent, to use social media, and publications.

In Tartu, active work on energy efficiency and behavior change started in the beginning of 2000s'. Most actions and campaigns have been made during recent years. The reason for the raised awareness on environmental issues is EU's climate policy and rapidly growing energy prices. The 20-20-20 targets set by European Union are leading decisions and actions in Tartu City Government. Tartu has also joined the Aalborg Commitments. Important point in promoting energy sector has been the establishment of Tartu Regional Energy Agency in 2009.

The main tools in changing behavior in energy efficiency have been the study days, contests and promotions. An important role is played by various projects carried out by means of information dissemination. One method that has been used by the city to promote the development of sustainable solutions is personal example. The city of Tartu has introduced environmentally friendly means of transportation (gas cars, electric cars) to draw attention to the city's citizens and businesses, and develop solutions for sustainable habits.

Over the years, a number of traditional campaigns have been developed which are organized on a regular basis: a car-free day, city leaders bicycle trip, celebration of Children's Day, a competition to identify most energy-saving buildings , construction of underground waste containers for apartment buildings, to save space and to direct more residents to sort waste and re-use. Since 2002 Tartu has also been actively involved in EU cooperation projects, including ones promoting energy-related issues. Key areas have been transport, water, waste, alternative fuels and building technologies.

By Tartu Agenda 21, the main target is "Tartu – a sustainably developing, socially responsible and economically thinking town". The main applied areas are administration, environment and society. No exact information and numbers about the fulfilling this agenda are anyhow offered.

Tartu joined the Covenant of Mayors 20 February 2014 with a wish to increase energy efficiency and make better use of renewable energy sources in their territory. This action plan for sustainable energy management has been co-funded by Intelligent Energy Europe in connection to their project Meshartility. The Sustainable Energy Action Plan was completed in close cooperation with the officials in Tartu city government and different stakeholders. The document describes the possible and currently planned actions related to the energy sector and their prospective effect on energy consumption and the CO2 emissions resulting from that in the territory of Tartu. The results of the survey CO2 Baseline Emission Inventory in the City of Tartu was used as an input while compiling this action plan.

In recent years, "Tartu City Transport Development Plan 2012-2020" was accepted. The main objectives in this plan are to reduce motorization and to increase the share of public transport and light traffic in the overall urban transport also with the help of mobility management and behavioural change. The introduction of biogas in the city buses will start in 2017 and half of the public transport vehicles should be environment friendly.

Main tools are campaigns and workshops, lesser extend social media and publications. In Tartu, the city itself is main the organizer of projects and campaigns on behavioural change, in lesser extend the NGOs are involved in this work. At present, the most important target group is seen to be the children, and the idea is "for children's sake".

The Development Strategy "Tartu 2030" as a basic strategic document for the long-term development of the city addresses future challenges for the city's development in various fields of actions.

Among others, the strategy focuses on necessary changes related to urban structure: An identified obstacle towards more sustainable transport flows is to zone the urban space in combination with automobile-oriented transport respectively separation of transport modes. Instead, urban space should be organised rather district-centred and by these means attracting the use of public transport as well as an integrated use of transport modes.

Thus, on the one hand high-rise and dense construction in the city centre shall be avoided, but on the other hand, in terms of intensifying land use, industrial areas are to be restructured. Furthermore residential, industrial and recreational areas in the environs of Tartu shall be connected with Tartu.

Regulations connected to the energy sector in Tartu is regulated by the following development and planning documents:

- Development strategy Tartu 2030
- Development plan of the City of Tartu 2013-2020;
- Comprehensive plan of the City of Tartu;
- Tartu City Transport Development Plan 2012–2020;
- Tartu City Water Supply and Sewerage Development Plan 2012-2025;
- Tartu City bicycle traffic development plan, Hendrikson & Ko, 2006;
- Tartu City Energy Development Plan Phase II;
- Environmental noise reduction action plan for Tartu city;
- Tartu Sustainable Energy Action Plan and Covenant of Mayors commitment.

5.1.2 Fact box: Tartu in numbers

Area	Field	Indicators	Value	Units	Data source	Comments
City characterization	Key features of the city	Size	38,966	km^2	TAR	
		Population	97847	Inhabitant (inh)	TAR	
		Population density	2511	Inh./km^2	TAR	
		Annual population change	-0,7	%	TAR	
		Median population age	37,0	Years	TAR	
		% of population > 75	9,2	%	TAR	
		Land consumption	18,0	Km^2/Km^2	TAR	
	Socio-economic	GDP per capita		M€/inh		Not available
		Median disposable income	12000	€	TAR	

	features of the city (Current economic performance of the city)	Energy intensity of economy		MWh/M€	TAR	Not available
	Socio-economic features of the city (City prosperity)	New business registered per population	1513	Number	TAR	
		Proportion of working age population with higher education	29,5	%	TAR	
City characterization	**Socio-economic features of the city** (Equity)	City unemployment rate	3,2	%	TAR	
		Youth unemployment rate	13,1	%	TAR	
		Percentage of the stock reserved for social housing	1,3	%	TAR	
		Energy poverty level	6,6	%	TAR	
	Environmental features of the city	Waste generated per capita	3,7	Ton/inh	TAR	
		Nitrogen dioxide emissions	0,6	µg /m^3	TAR	
		Fine particulate matter emissions	1,4	µg /m^3	TAR	
		Air quality index	15,9	ppp or µg /m^3	TAR	
		Days PM10 > 50 µg/m3	5,0	days/year	TAR	
		Noise pollution	32,0	%	TAR	
		Green space	28,3	ha/ha	TAR	

Table 5. City characterization: common and optional indicators

Area	Field	Indicators	Value	Units	Data source	Comments
City plans and regulation & Governance	**City plans and strategies**	Existence of plans/programs to promote energy efficient buildings	YES	YES/NO	TAR	
		Existence of plans/programs to promote sustainable mobility	YES	YES/NO	TAR	
		Existence of local sustainability action plans	YES	YES/NO	TAR	
		Signature of Covenant of Mayors	YES	YES/NO	TAR	
		Existence of Smart Cities strategies	NO	YES/NO	TAR	
		Existence of public incentives	YES	YES/NO	TAR	

		to promote energy efficient districts				
		Existence of public incentives to promote sustainable mobility	YES	YES/NO	TAR	
	Public procurement procedures & Regulations and normative	Existence of regulations for development of energy efficient districts	NO	YES/NO	TAR	
		Existence of regulations for development of sustainable mobility	NO	YES/NO	TAR	
		Existence of local/national Energy Performance Certificate (EPC)	YES	YES/NO	TAR	
		Share of Green Public Procurement	5,0	%	TAR	
	Governance	Involvement of the administration on smart city projects	Disagree	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree	TAR	
City plans and regulation & Governance	**Governance**	Involvement of the administration on smart city projects	Agree	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree	TAR	
		Multilevel government	Agree	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree	TAR	
		Paperless governement (incl e-signature)	Strongly agree	Likert scale Strongly disagree Disagree Neither	TAR	

				agree nor disagree Agree Strongly agree		

Table 6. Governance, city plans & regulation: common and optional indicators

For a comprehensive analysis City of Tartu should update the missing indicators.

5.2 Energy supply and consuming patterns

Relation to D2.4: Section 6.2.1

Data sources: SEAP 2015

5.2.1 Energy system of Tartu in text

[Story telling section about the energy system in Tartu in text, explaining data from 5.2.2]

Topics to address:

- Energy sources and distribution infrastructures
- Consuming sectors
- Energy policies and management (Table 14).
- Policies and regulations (D2.1)
- Standards (D2.2)
- Business model and funding (D2.3)

The first comprehensive review of the energy consumption and the resulting CO2 emissions in Tartu was published in Sustainable Energy Action Plan[16] in 2015 (based of the data of 2010).

Consumer data from the year 2010 was used when compiling the CO2 baseline emission inventory. The following figure (figure 16) and table (table 9) illustrate energy consumption and the resulting CO2 emissions in sectors connected to the baseline inventory.

[16] Action Plan for Sustainable Energy Management 2015-2020 for the City of Tartu. TREA 2015. Available: www.tartu.ee/data/SEAP_Tartu_ENG_2015.docx

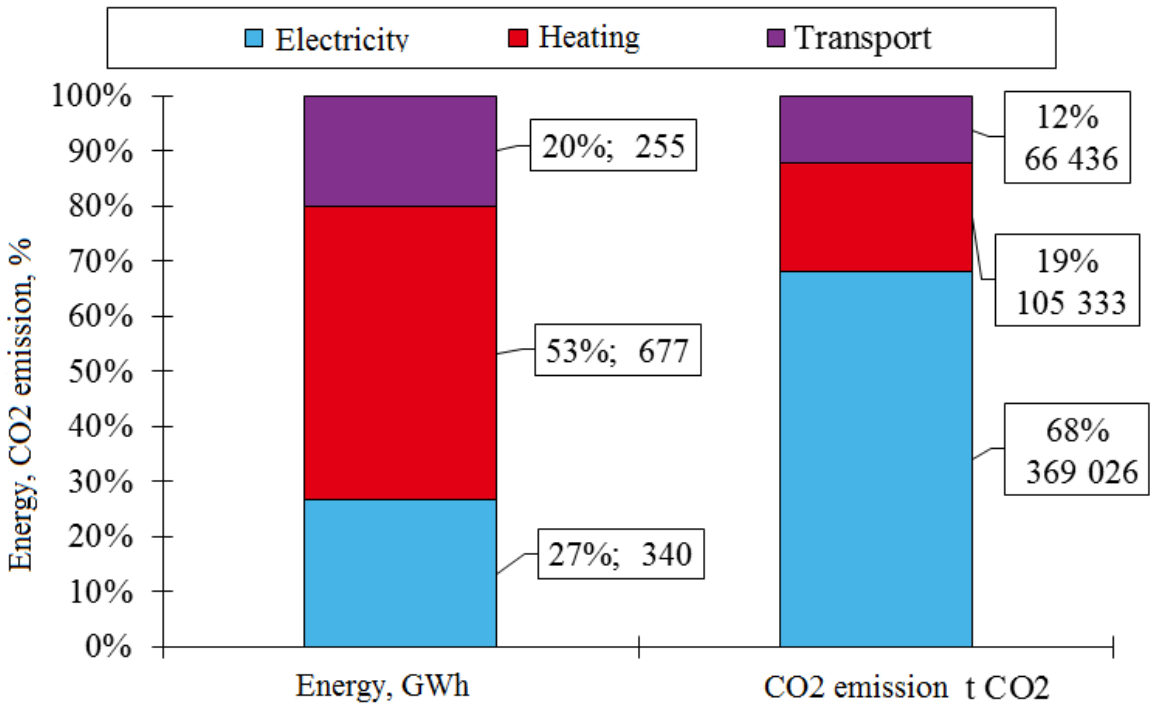


Figure 16. Energy consumption and the CO2 emission in Tartu, 2010

Parameter	Using district heating / fuels, MWh/year	Electricity, MWh/year	Energy consumption in total, MWh/year	CO2 emission t CO2
Tartu administrative buildings	44 810	12 963	57 773	20 586
Tartu street lighting	-	7 456	7 456	8 102
Water management	1 627	9 517	11 144	10 587
Business buildings and facilities (except industry)	230 181	196 788	426 969	248 082
Housing (except consumption in private residences)	400 725	112 905	513 630	187 001
City government cars	152	-	152	40
Public transport	14 834	-	14 834	3 898
Private transport	240 235	-	240 235	62 498
In total	**932 564**	**339 629**	**1 272 193**	**540 794**
including district heating, MWh			504 118	
including fossil fuels, MWh			428 445	
including electricity, MWh			339 629	
Energy consumption per resident, MWh/ (resident·year))			**13.31**	
Transport kilometers per person by cars, km/ (person·year)			**2780**	

Table 7. Energy indicators of Tartu in 2010

In total, sectors connected to the baseline inventory used 1.27 TWh worth of fuels and converted energy (electricity, district heating) which resulted in an emission of ~541 000 t CO2. Although the majority of fuel and district heating consumption (53%) was needed for heating, the biggest CO2 emission resulted from the use of electricity (70%). This is related to the fact that most of the heat is produced from biomass but most of the electricity used in Estonia is produced from oil shale.

In the base year 2010 the percentage of renewable energy used in Tartu was above average, making up about 38% of energy consumption.

In addition to using district heating, the consumption of heating (5) also illustrates the consumption of fuels in businesses (excluding industry) and in the private sector (natural gas). As we can see, in 2010 Tartu city administrative buildings and facilities used 4% of the heating consumed in the city territory, however, coming from the fact that city's administrative buildings mainly use district heating, the consequent CO2 emission makes up only 1% of the total.

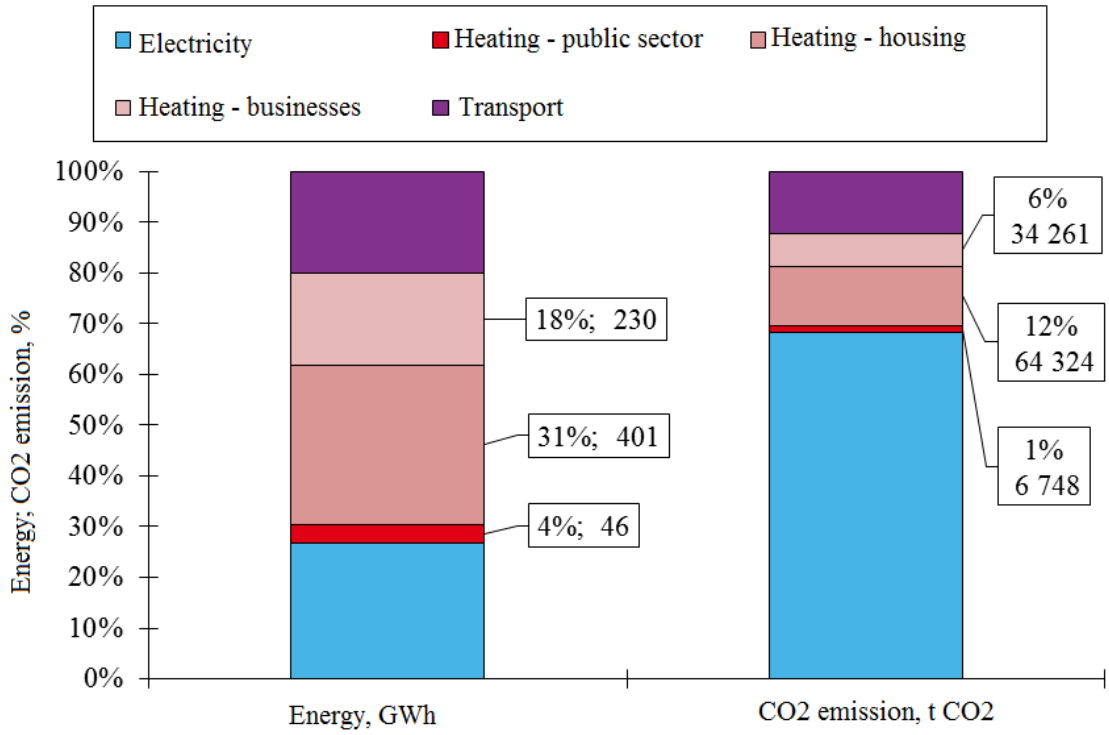


Figure 17. Use of heating and CO2 emission in Tartu, 2010

The use of electricity (figure 18) that makes up ~70% of the carbon dioxide emission in Tartu amounted to 30 GWh in the city's administrative buildings and facilities, taking account of the fact that ~7.5 GWh of electricity is used for street lighting.

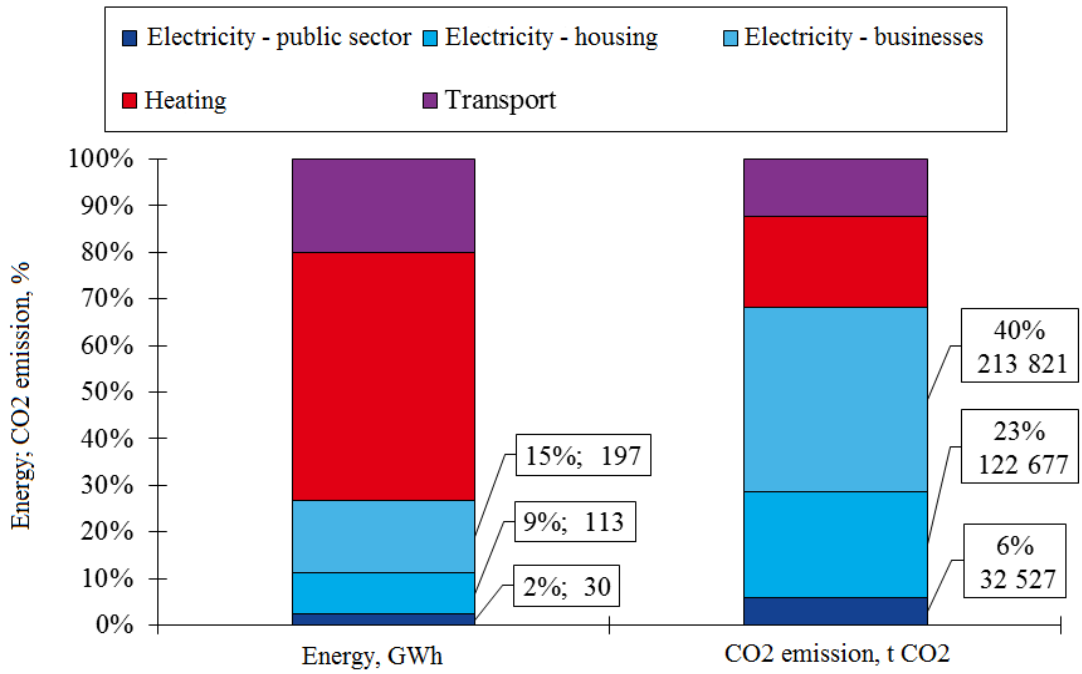


Figure 18. Use of electricity and CO2 emissions in Tartu, 2010

12% of CO2 emissions in Tartu were caused by the use of transport fuels (petrol, diesel) (Figure 19), while 95% of the transport fuels consumed in Tartu were used in cars. This is why actions in the transport sector have considerable potential in decreasing carbon dioxide emission.

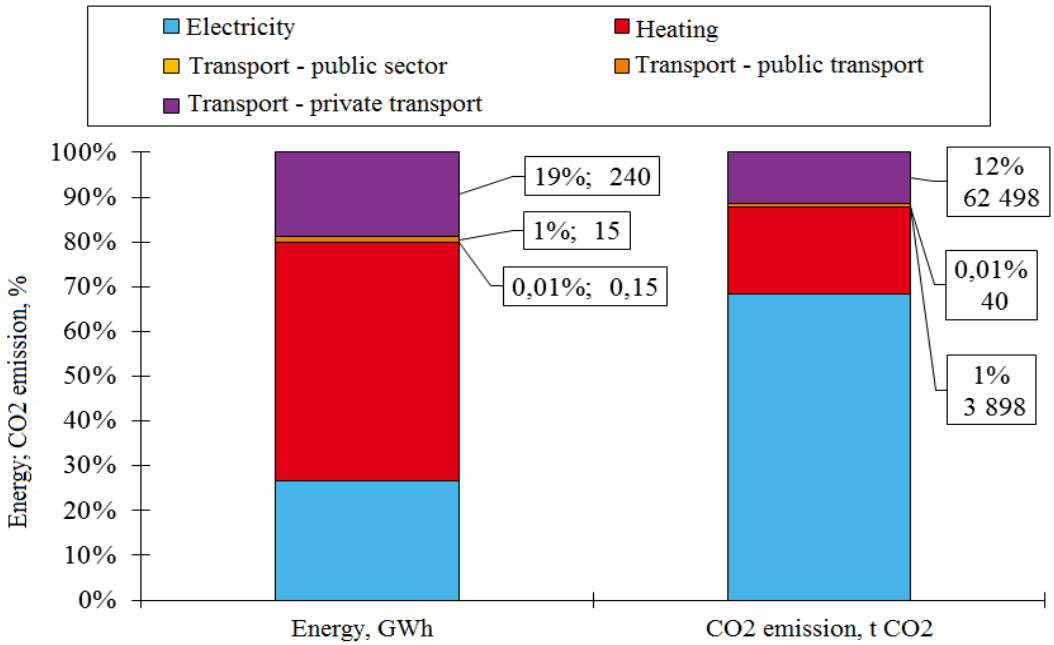


Figure 19. Use of transport fuels and CO2 emissions in Tartu, 2010

The division of carbon dioxide emissions in the territory of Tartu among consumer groups is visible below (figure 20).

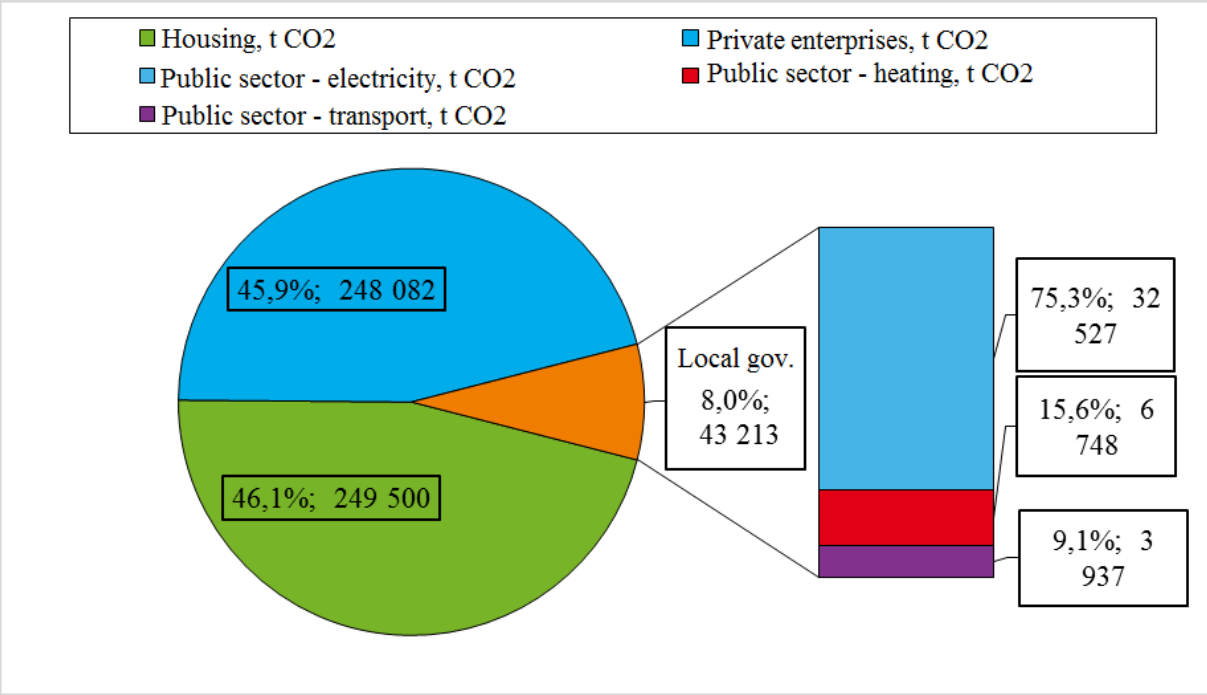


Figure 20. CO2 emissions in Tartu city territory

Although the majority of CO2 emissions arise from the use of electricity, the profitability of cutting the use of heating and transport fuels should not be underestimated. The importance of electricity is significant because of the peculiarities of Estonian electricity production, and for the local governments it is something that cannot be changed very easily. It should be taken into consideration that the more electricity is produced from the renewable energy sources, the smaller the emission factor gets. So in this case a local government can, in addition to the results of its own actions, also use the contribution of Estonia as a whole to cut its carbon dioxide emission. Also, considering that electricity is ~2x more expensive than heat, then different ways of saving electricity should definitely be thought of.

The annual energy consumption has been increasing for the last years and in 2015 it has reached 1448 GWh.

Heat from district heating network, GWh	Households	232
	Public	99
	Other	98
Heat losses from district heating, GWh		67
Households private heating, GWh		66*
Electricity from the grid, GWh	Private user	108
	Business	317
Consumed heat energy (natural gas)	Households	65
	Other	141

Transportation, GWh	Public sector and private sector	255**
Total, GWh		1448
Notes: * Number is an estimated value, data about actual consumption is missing ** Actual transport data is missing and the value is estimated based on SEAP 2015		

Table 8. Estimated energy consumption in Tartu in 2015

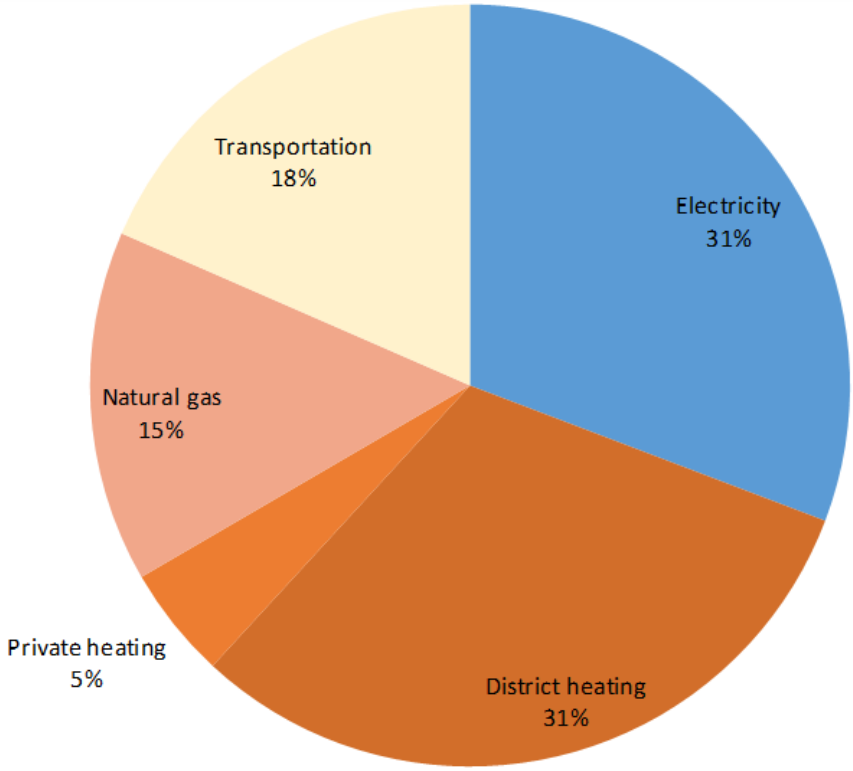


Figure 21. Energy mix in final consumption in 2015

Heat, GWh	Total		752
	Renewable energy		366
Electricity, GWh	Total		181
	Renewable energy	PV	0,087
		Woodchips	154

Table 9. Heat and electricity produced into the grid in Tartu in 2015

The vision for the development of sustainable energy management is:

Tartu has a healthy and high-quality living environment which promotes energy efficient solutions and the use of renewable energy and the residents of Tartu are energy-conscious and are energy efficientl.

The general strategic targets of the sustainable energy management action plan for Tartu by 2020 are to reach through smart and conscious consuming:

- the decrease of CO2 emissions by 20% which is 108 159 tCO2/y in comparison to 2010
- consume 200 000 MWh less energy in final consumption per year
- the increase of the share of renewable energy from 38% (2010) to 45% by 2020

Strategic targets are reached through a symbiosis of conscious consuming and innovative smart solutions.

The following 15 targets have been set up by policy for 2020:

The production and distribution of district heating and district cooling

Target No. 1. Assure a sustainable supply of district heating and district cooling that is based on renewable energy sources in the City of Tartu.

Target No. 2. Keep the district heating exhaust gas emission at the same level with 2010, reducing the loss of heat energy that happens with distributing, to at least 15%.

Target No. 3. Offer district cooling produced from renewable energy sources to the extent of at least 52,000 MWh, reducing CO2 emission in the cooling sector by 70%.

The distribution and consumption of natural gas

Target No. 4. Using natural gas as a means of heating can only happen in places where using district heating, solar- and geothermal energy is not possible. The consumption of natural gas remains on the same level as in 2010.

Building Fund

Target No. 5. The consumption of heat energy in the buildings belonging to the city government's administration has decreased 20%, the electricity used is 100% produced from renewable energy sources.

Target No. 6. Energy consumption has decreased 20% in the housing sector, 10% of consumers use renewable electricity.

Transport

Target No. 7. The vehicles used by the city government bear the energy label A or B.

Public transport

Target No. 8. 25% of all buses in public transport are replaced with gas buses. The preferred types are gas-hybrid- and electric buses as means of transport with low local emission level. If there is a market for it, biogas will be used as fuel.

Target No. 9. Functioning bicycle sharing which replaces the use of car transport in the city reducing CO2 emissions. The share of bicycle transport in 2020 is 15% and the share of car transport remains at the same level with 2010.

Street lighting

Target No. 10. Street lights are renovated, it is controlled using smart management and the consumed electricity is 100% produced from renewable energy sources.

Using renewable energy sources

Target No. 11. The heating and electricity consumed in the public sector of Tartu is produced almost entirely out of renewable energy sources.

Target No. 12. Private initiative has led to the installation of devices producing electricity out of solar power with the total capacity of 2 MW.

Sustainable energy management

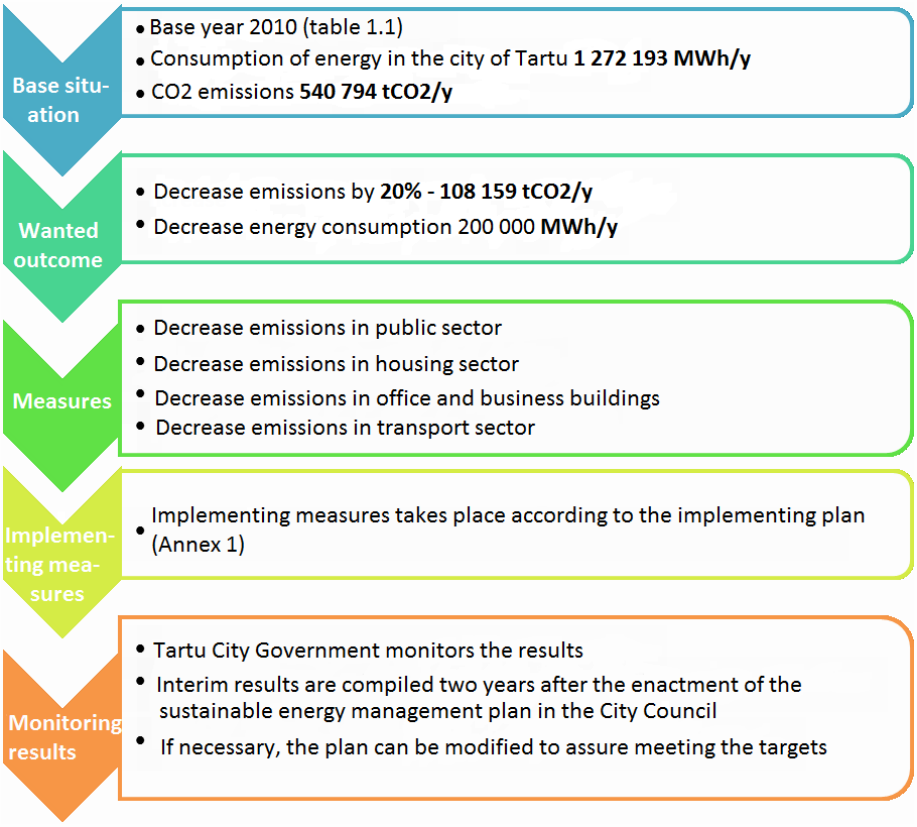
Target No. 13. The city government has implemented a system of sustainable energy management and is being a role-model for businesses and citizens.

Target No. 14. Provide remotely readable meters for all buildings in the city's administration for measuring the consumption of electricity, heat energy and water and with "smart house" technological solutions for the management of energy consumption.

Target No. 15. A conscious energy consumption management takes place, modern technological solutions are being implemented to read and save the data about energy consumption. As a result of the data analysis based on conscious consumption management, a 10% decrease in energy consumption is achieved.

Target No. 16. Increase the awareness of energy consumption among the city's residents, provide training, informative events, thematic days and put together information materials.

The process of implementing the sustainable energy management action plan is illustrated by the following figure.



Tabel 10. Process of implementing the SEAP

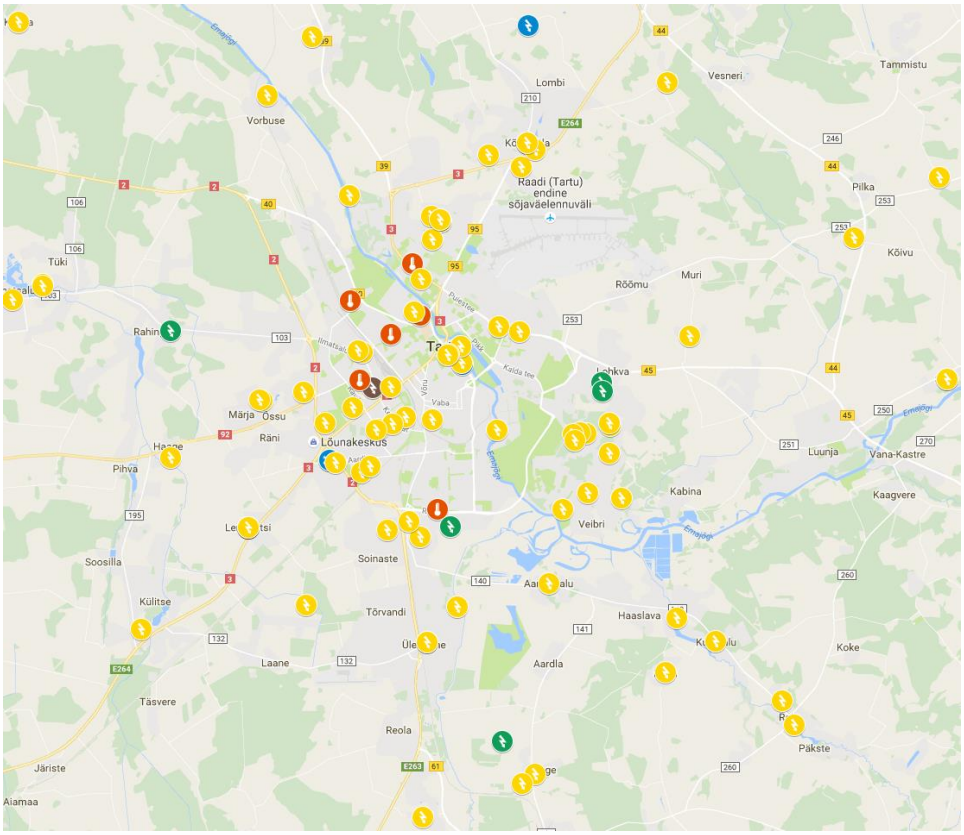


Figure 22. Grid connected energy production units in Tartu area

Nr.	Name	Type	Rated output MW	Rated Voltage kV	Grid connection date
1.	CHP station	Biomass	0,6	10	-
2.	Männimetsa Solar Station	Photovoltaic	0,025	0,4	7.10.2015
3.	Solar Station (Vitamiini st)	Photovoltaic	0,12	0,4	18.02.2016
4.	Solar Station (Vitamiini st)	Photovoltaic	0,12	0,4	22.06.2016
5.	Solar Station (Jaama st)	Photovoltaic	0,0998	0,4	18.02.2016
6.	Solar Station (Jaama st)	Photovoltaic	0,0998	0,4	22.06.2016
7.	Solar Park	Photovoltaic	0,12	0,4	31.07.2015
8.	Tartu Aardlapalu Landfill CHP Station	Biogas	0,398	0,4	09.05.2014
9.	Tartu Power Plant*	Biomass/peat/ gas	25	110	29.05.2009
Notes: *Gas is only used occasionally as a reserve fuel					

Table 11. Green power production in Tartu

5.2.2 Fact box: Energy system of Tartu in numbers

Area	Field	Indicators	Value	Units	Data source	Comments
gy supply	City energy	Primary Energy Consumption in the city per year	1272193	MWh/year	TAR	In 2010

	profile	Final Energy produced in the city per year	Heat for private heating		MWh/year	TAR	Not available
			Heat for district heating	336000	MWh/year	TREA	
			Electricity	181088	MWh/year	TREA	
		Public lighting energy use per year		7774973	kWh/year	TAR	
		Primary Energy Consumption in the city per capita		13,12	MWh/year per inhabitant	TAR	
		Final Energy produced in the city per capita	Heat for private heating		MWh/year per inhabitant	TAR	Not available
			Heat for district heating	3,43	MWh/year per inhabitant	TREA	
			Electricity	1,85	MWh/year per inhabitant	TREA	
		Public lighting energy use per capita		79,5	kWh/year per inhabitant	TAR	
		Total residential natural gas energy use per capita		667	kWh/hab·year	TREA	
		Total residential oil energy use per capita			kWh/hab·year	TAR	Not available
		Total residential biomass energy use per capita			kWh/hab·year	TAR	Not available
	Potential local renewable energy resources	Percentage of total energy derived from renewable sources		36	%	TREA	
		Energy use from District Heating		429000	MWh/year	TREA	
		Energy use from Biomass		154000	MWh/year	TREA	
		Energy use from PV		87,6	MWh/year	TREA	
		Energy use from Solar Thermal			kWh/year	TAR	Not available
		Energy use from Hydraulic			kWh/year	TAR	Not available
		Energy use from Mini-Eolica			kWh/year	TAR	Not available
	Potential local renewable energy resources	Energy use from Geothermal			kWh/year	TAR	Not available
		Budgets devoted to renewable energies and Energy Efficiency		62,28	Euros / Persons	TAR	
	Environmental impacts of the energy consumption	Global Warming Potential (GWP) per capita			Tn equi. CO_2 / year capita	TAR	Not available

Table 12. Energy supply network: common and optional indicators

For a comprehensive analysis City of Tartu should update the missing indicators.

5.3 Building stock and retrofitting needs

5.3.1 Buildings in Tartu in text

The built infrastructure of Tartu is an outcome of three processes. The town was created and inhabited during the historical era (pre 1900), developed and redesigned during the soviet era (1945 – 1991) and further developed after regaining the independence in 1991. The streets and buildings are reflecting these experiences and representing the culture of these times. We can see and feel the human experience in the buildings where we spend our lives in and the buildings also represent the way people are living in different times – our dreams, fears, values and expectations. City works as a collective entity incorporating all of these aspects.

City is shaped by the wars. Today's appearance and layout of the city started to develop after the Great Northern War (in the start of 1700) and the great fire in 1775, after which the town's borders were shifted in 1787. Tartu lost its fortress and more than two thirds of it's wooden houses were destroyed by the fire. The reconstruction plan implemented a well-planned construction of the town, superimposing the modern grid-like structure to the medieval street system. Besides the New Town Hall and the Stone Bridge, which became the architectural dominants of the market square, the new University building became another compositional landmark next to the Town Hall. Furthermore the outskirts of the town started developing, mainly along the descending roads of the old valley of Emajõgi. Tartu has been expanding ever since incorporating nearby agricultural and semi-urban areas. This is visible in the spread-out urban fabric and the dominance of low-density wooden architecture of the buildings.

Figure 23. Tartu Town Hall Square, 1925[17]

[17] Image via Wikimedia Commons, commons.wikimedia.org/wiki/Tartu, author unknown

City was redesigned again by World War II. Large parts of Tartu on both sides of river were destroyed by Russian airstrikes. Large amount of green spaces in the city remain from former stone buildings, which were destroyed in the war, their ruins were removed, but not rebuild or replaced by new buildings. After the war Estonia was occupied by the Soviet Union and a major Soviet military airport was constructed on Raadi Airfield northeast of Tartu. For this reason Tartu became a 'closed city' for foreigners for several decades and included significant amount of Soviet military personnel. The air base was closed in the 1990s.

After 1956, during the period of Nikita Khrushchev, instead of "architectural excesses", like the neo-Classicist "Illusioon" ("Komsomol") cinema and dwellings in the city centre and on Riia Hill, only "box-shaped buildings with the most essential standard details" were allowed by the soviet architecture. These standards came up "in order to more rapidly satisfy the need for new flats". The new type of soviet architecture – so called 'hruschovka' was born from the combination of soviet plan economy, lack of experts (imprisoned, murdered and deported by the new regime), buildings squads of the amateur workers and constant lack of high quality (or even low-quality) building materials. Today 'hruschoskas' represent the lowest construction quality of European building stock.

The short era of 'hruschovkas' lead the way to the 'building boom' in Soviet Union starting in 1970 that was dominated by the new precast concrete panel buildings that were designed and built by the new generation of soviet architects, designers and builders. This created a distinct facade of all the post-soviet cities all over the region and it was resonating with the large scale building project in other parts of the Europe. Soviet 'building boom' included residential buildings, health and educational institutions, etc and more buildings ware created in Tartu than in the previous 200 years together, as well as production space and related administrative buildings and leisure facilities. During 1970' and 1980' about 25,000 m² of new living space was built in Tartu every year and about 70 % of the citizens moved into these apartments. Residential building construction was concentrated on the edges of the town. The biggest new residential area was the "city's bedroom" in Annelinn district. The residential building construction came along with establishing of the district heating system in Tartu in the 1970s.

The historical urban development of Tartu is hence, among others, strongly related to its soviet background and the former influence of the Soviet Union. Urban planning was particularly relevant as towns played an important role in the organisation of the economic development during the soviet period. Thus, urban planning was part of the organisation of the society and subject of hierarchical planning practices entailing particular land-use patterns (e.g. suburban neighbourhoods, industrial areas in the outskirts).

Nowadays' urban structure of Tartu reflects a town following "the soviet pattern of a town built partially before the soviet period, reorganised during soviet era, and redeveloped after". The new era of urban development in Tartu has been as eclectic as the times of social reforms of 1990'. With the structural reforms in the society and economy a new type of ownership models were superimposed to the real-estate market. In the focus of the reforms has been the relationship between the public and the private and the dynamics of this duality is echoing in the heart of social development up to the present day. The building stock was privatized and the inhabitants became the owners or renters of their living environment. Technical infrastructure was privatized or transformed to municipal enterprises and the prizes of the municipal services were upgraded to the level of newly established market economy. As a downside, this transformation ended up with rapidly increasing communal costs that

had a hard prize for the society generating new types of problems for economically vulnerable people - energy poverty and homelessness.

The most notable changes of the building structure of Tartu have been in previously underdeveloped sector of shopping and business buildings. The new era of development has created a vast network of shopping centers (0,75 m2 per capita - twice as much compared with the neighboring CEE countries) both in the centre and in the surroundings of the city and is representing the interest and growing influence of the 'new money' – new financial elite emerging from the ashes of the Soviet Empire. With its distinctive box-like form, anemic interiors of its non-spaces and the wasteful environment these buildings are visualizing our era with the similar intensity and glare as the precast concrete block houses of the Soviet Union – a new layer on the urban fabric that is both visible and has an effect to the lives of citizens. This new type of built environment is offering us a new type of semi-public space that creates an illusion of accessibility and openness but has strict rules of how this space can and will be used leading to direct and indirect privatization of the public space.

Increase of the residential buildings has not been that active. Most of the new living spaces are built outside of the city borders creating new suburbs in the unregulated territory of urban sprawl. Universities and national institutions are actively renovating their real estate and University of Tartu is developing its new campus area in Ravila district, further away from the town centre. City centre is increasingly left for administration and shopping.

New ownership models defined also a new relationship between the owners and the state/municipality and demanded the later to take more active role as a regulator of the building market – the process that has been questioned formally and non-formally by the new class of owners that saw the building code of the municipality as an artificial restriction for their investment. The construction quality of the 1990' and 2000' has had big variations and has been established in 2010' with the help of evolving national building regulations. Nevertheless a moderate energy performance of the new building stock is only implementing the bare minimum requirements required by the national regulations (based on the European regulation for energy performance).

There are few remarkable examples of energy efficient buildings in Tartu, notably the new public environmental education centre in Tartu Loodusmaja and apartment building Vanemuise 45. Many existing public, private and residential buildings have been refurbished during last 25 years, supported in many cases (during the last 7 years) by the funding of European Commission, but until recently the energy performance has not separately been addressed. The main obstacle in the renovation process has been the high cost of the renovation work and the lack of the financial means by the larger community. Because of that (and because of the lack of awareness) additional costs for higher energy performance has been considered by the developers and end users as a luxury and avoided during the renovation process.

Energy efficiency has been addressed in the national renovation program facilitated by the financial support from national entity KredEx, using support from European Commission. Under this program 663 apartment buildings have been refurbished during the period of 2010-2014, 107 buildings in Tartu County (38 in City of Tartu, see the Figure 24). These buildings have distinctively improved energy performance but they make less than 4% of all the existing apartment buildings in Tartu.

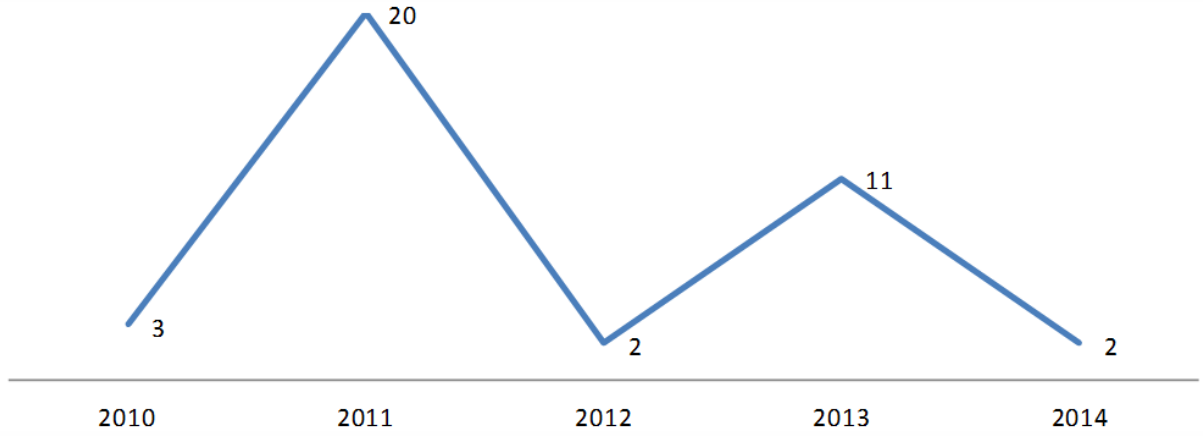


Figure 24. Amount of refurbished residential buildings supported by KredEx in Tartu, 2010 – 2014[18]

According to Sustainable Energy Action Plan[19] and national studies[20] the annual technical energy saving potential of Estonian buildings is 9.3TW/h for heat and 0.2 TW/h for electricity. The technical thermal energy saving potential is approximately 80% of the current thermal energy consumption. Electric energy saving potential is, on the other hand, practically non-existent, as guaranteeing a consistent internal climate environment (ventilation) and using heat pumps neutralise the amount of electric energy that could be saved.

In the case of renovating apartment buildings, it has been found that even if the state provides only a small amount of financial support, the results of the investment calculations may be sufficient to support a building's renovation to the extent that it would reach the energy efficiency classes C and B. At the same time, it does not matter whether the building is renovated to a B or C efficiency class in terms of organising the renovation. In case of new small residential buildings, only small-scale repairs (installing ventilation with heat recovery or replacing the heat source) are economically reasonable. In case of older small residential buildings, however, large-scale renovation solutions, which include insulating the exterior structure and replacing utility systems, are more cost-efficient. Renovation is cost-efficient in the context of the following 20 years for office buildings, school houses, commercial and industrial buildings, as these buildings have good market-economical prerequisites for the improvement of energy efficiency. In the case of office buildings and school houses it is cost-efficient to renovate the new building as a whole so that it would correspond to the energy class C.

5.3.2 Fact box: Buildings in Tartu in numbers

Area	Field	Indicators	Value	Units	Data source	Comments

[18] Source of data: www.kredex.ee

[19] Action Plan for Sustainable Energy Management 2015-2020 for the City of Tartu. TREA 2015. Available: www.tartu.ee/data/SEAP_Tartu_ENG_2015.docx

[20] Allikmaa, A., Kalamees, T., Kurnitski, J., Kuusk, K.; Pikas, E., Tark, T., Uutar, A. Eesti energiamajanduse arengukava ENMAKi uuendamise hoonete energiasäästupotentsiaali uuring. Hoonefondi energiatõhususe parandamine – energiasääst, ühikmaksumused ja mahud. 2013. Source: http://www.energiatalgud.ee/img_auth.php/c/c1/ENMAK-Hoonete-uuring-20.09.2013.pdf (14.06.2014).

Energy supply network	Energy uses in building typologies	Total buildings energy consumption per year	Heat	819	GWh/year	TREA	
			Electricity	425	GWh/year	TREA	
		Public building energy consumption per year	Heat	133	kWh/m^2	TAR	
			Electricity	39	kWh/m^2	TAR	
		Residential buildings energy consumption per year	Heat	0,005	GWh/inhab.year	Value is estimated from usage of district heating	
			Electricity	0,001	GWh/inhab.year	TREA	
		Total building energy consumption in the city per capita		10290	kWh/year per inhabitant	TAR	
		Public buildings energy consumption per m^2		172	kWh/m^2	TAR	
		Residential buildings energy consumption per capita		0,006	GWh/inhab.year per inhabitant	TAR	
		Portion of households connected to the district heating and cooling		66	%	TREA	
		Percentage of the energy consumption by end use in residential buildings: space conditioning			%	TAR	Not available
		Percentage of the energy consumption by end use in residential buildings: domestic hot water			%	TAR	Not available
		Percentage of energy consumption by end use in residential buildings: lighting and appliances			%	TAR	Not available
		Percentage of the energy consumption by end use in public buildings: thermal and cooling uses			%	TAR	Not available
		Percentage of the energy consumption by end use in public buildings: electrical uses		22,4	%	TAR	

Table 13. Buildings: common and optional indicators

For a comprehensive analysis City of Tartu should update the missing indicators.

5.4 Urban mobility

Relation to D2.4: Section 6.2.3

5.4.1 Mobility in Tartu in text

[Story telling section about mobility in Tartu in text, explaining data from 5.4.2]

Topics to address:

- Mobility city profile
- City statistics for mobility
- Policies and regulations (D2.1)
- Standards (D2.2)Mobilty
- Business model and funding (D2.3)

Keywords: motorized private transportation, electric vehicles, cycling, aviation, railway (Rail Baltic).

According to Tartu Sustainable Energy Action Plan SEAP[21] is Estonian transport sector characterised by the fast intensification of car use and increasing road transport, as well as by an uneconomic vehicle fleet and the marginal use of renewable fuels. In the past 10 years the use of passenger cars in Estonia has increased by approximately 50%. At the same time, the number of public transportation users has decreased. A remarkable part (~44%) of transportation fuel use is connected to traffic within cities and settlements[22]. Figure 25 illustrates[23] the volume of the regular commuting between the bigger cities in Estonia. There are up to 5000 daily commuters between the two biggest cities Tallinn and Tartu.

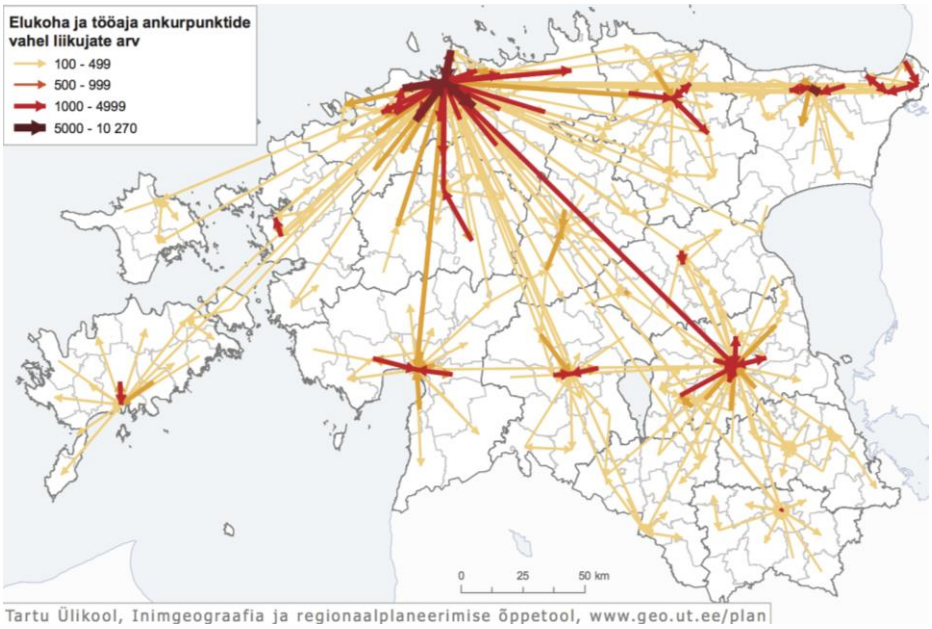


Figure 25. Volume of daily commuting between municipalities[24]

Nationally underdeveloped mass transit system has geared the daily commuters towards private car usage – a trend that is further enforced by the increasing centralization of the private and public services. This is clearly reducing the accessibility of these services for

[21] Action Plan for Sustainable Energy Management 2015-2020 for the City of Tartu. TREA 2015. Available: www.tartu.ee/data/SEAP_Tartu_ENG_2015.docx

[22] Jüssi, M., Rannala, M. Transport ja liikuvus. ENMAK stsenaariumid 2030+. 2014. Kättesaadav: http://www.energiatalgud.ee/img_auth.php/4/4a/Transport_ja_liikuvus._ENMAK_2030_stsenaariumid.pdf (03.05.2014).

[23] Ahas, R., jt. 2010. Regionaalne pendelrändeuuring. Siseministeerium 2010. Summary: www.siseministeerium.ee/sites/default/files/dokumendid/Uuringud/Regionaalareng_ja_poliitika/2010_pendelrandeuuringu_luhikokkuvote.pdf

[24] Ahas, R., jt. 2010. Regionaalne pendelrändeuuring. Siseministeerium 2010. Summary: www.siseministeerium.ee/sites/default/files/dokumendid/Uuringud/Regionaalareng_ja_poliitika/2010_pendelrandeuuringu_luhikokkuvote.pdf

marginalized and vulnerable social groups but also for international audience. European Smart Cities initiative[25] has identified under the PLEEC[26] project the poor national and international accessibility of Tartu as a key obstacle for further development that is seconded by the below-the-average local accessibility. Privatization of the main transport hubs – bus station and railway station - has alienated local stakeholders, reduced the accessibility of the transit network and also reduced their appeal for business community.

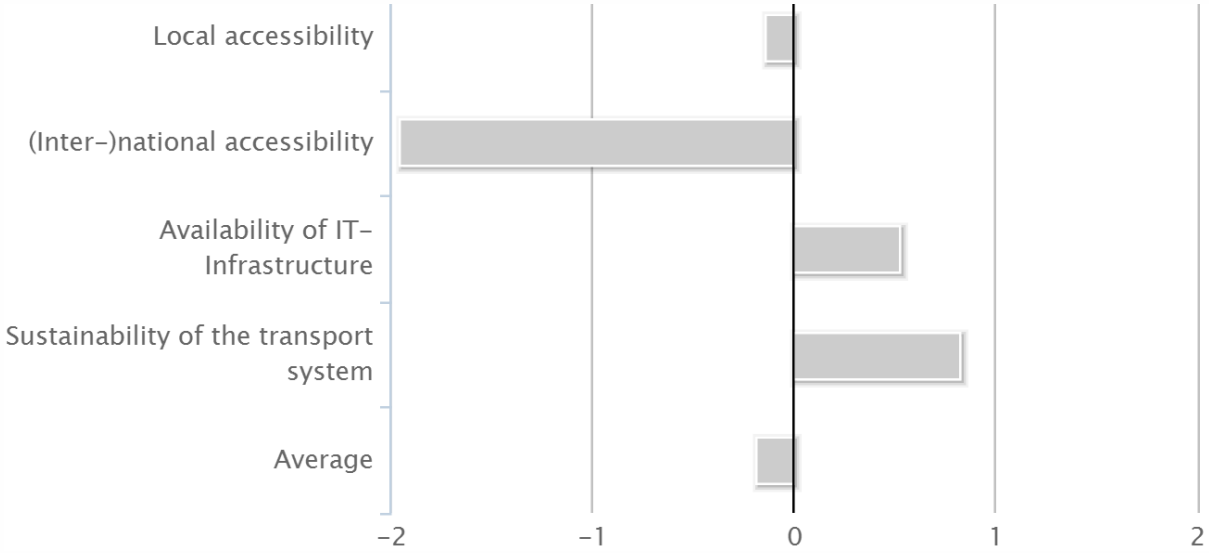


Figure 26. The assessment of Smart Mobility in Tartu[27]

Tartu has improved its international accessibility with developing the local airport. This has created new opportunities but it still is not enough to offer a convenient journey to Tartu from Brussels, London, Paris, Barcelona or in fact from any other place in the world. There has been only small effort on improving the rail connections with the world and today the rail service is ignoring the needs of the citizens and visitors alike. As of today there are 8 commuter trains connecting Tartu with Tallinn. There are no train connections between Tartu and any other cities outside Estonia. Tartu is not on the route of planned international high-speed railway connection Rail Baltic.

[25] www.smart-cities.eu
[26] www.pleecproject.eu/
[27] Source: www.smart-cities.eu

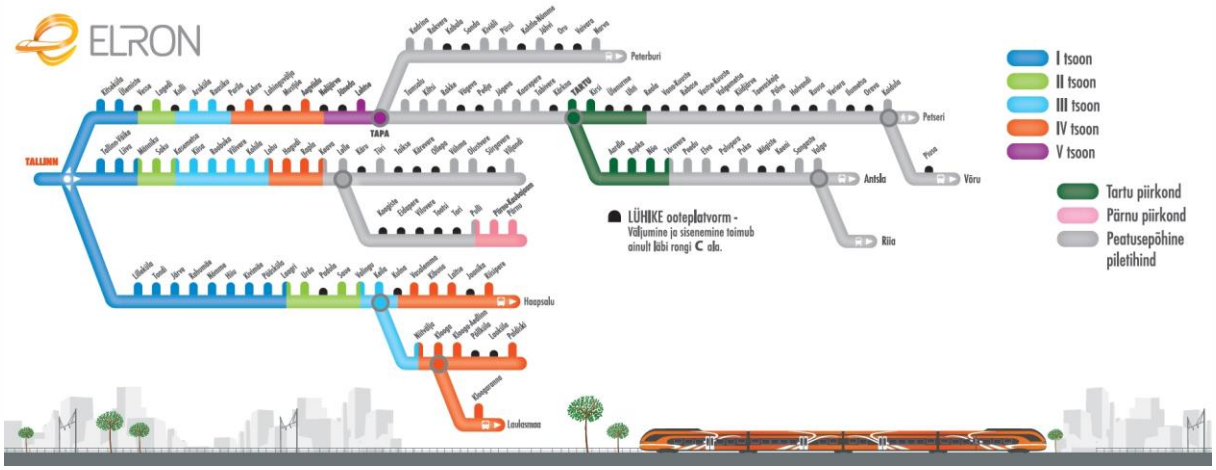


Figure 27. Railway lines of national passenger service provider Elron[28]

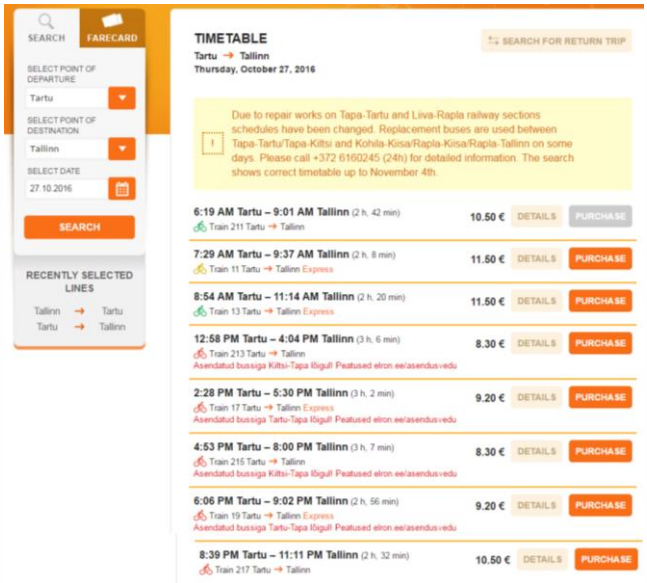


Figure 28. Time table of commuter trains between Tartu and Tallinn[29]

Tartu is connected with the world by bus. There are 38 direct coach buss lines commuting between Tartu and Tallinn daily, 6 lines between Tartu and Riga, Latvia and 5 lines between Tartu and St Petersburg, Russia. These are the main routes for the people to travel in and out of Tartu.

Destination	Accessibility
Tallinn	Direct connection with 38 coach bus lines and 8 commuter trains. Reduced access between 21:00 and 05:45 (only one bus at 02:30).
Riga, Latvia	Direct connection with 6 coach bus lines. Indirect connection by rail over Valga twice a day. Reduced access between 07:20 and 02:10 (only one bus at 18:40).

[28] Source: www.elron.ee
[29] Source: www.elron.ee

Helsinki, Finland	Direct connection over Tartu Airport with one flight per day. Indirect connections over Tallinn Ferry Terminal by ferry with several boats per day. Reduced access during the night.
Vilnius, Lithuania	Indirect connection over Tallinn Airport with several flights per day. Reduced access during the night.
Moscow, Russia	Indirect connection over Tallinn Airport with several flights per day. Reduced access during the night.
St Petersburg, Russia	Direct connection with 5 coach bus lines. Reduced access during the day.
Stockholm, Sweden	Indirect connections over Tallinn Ferry Terminal by ferry with several boats per day. Indirect connection over Tallinn Airport with several flights per day. Reduced access during the night.
Warsaw, Poland	Indirect connection over Tallinn Airport with several flights per day. Reduced access during the night.
Copenhagen, Denmark	Indirect connection over Tallinn Airport with several flights per day. Reduced access during the night.

Table 14. Direct and indirect access to the neighbouring countries

Tartu has always been the city for sustainable commuting with the share of sustainable transport modes comparable with Copenhagen or Amsterdam. This is supported by the small size of the city, compact urban structure and a rather slow rhythm of life. Only in recent years this trend has been changing towards less sustainable direction. Increasing amount of private cars and decreasing usage of the public transportation is signaling the new dangerous direction for the city to lose its sustainable approach. The main reasons for increasing car usage in Tartu are:

- low density of the population,
- semi-urban lifestyle,
- urban sprawl,
- development of large shopping centers,
- reducing access of public transportation,
- centralization of public and private services in Estonia,
- negative peer pressure from more developed countries.

While low density and semi-urban lifestyle have always influenced the decisions the main factors behind the increasing car usage are related with recent changes in the city structure and the structural changes in the region/country and the changes in society: development of suburbs; shopping centers replacing local shops; increased life standards together with learned desire for owning a car; reduced connections with rural areas by public transport and the disappearing services from rural areas. For people to have regular commuting to rural

areas (for recreation, summer houses, elderly relatives or for any other reasons) owning a car is increasingly convenient.

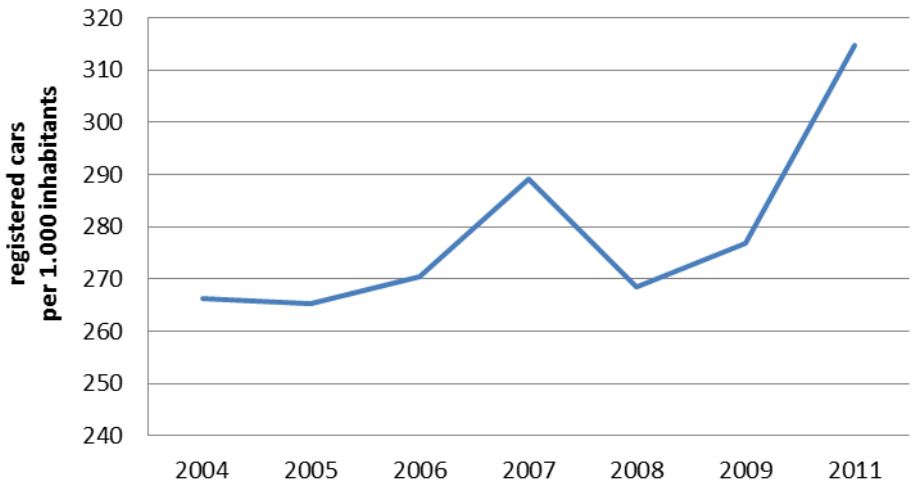


Figure 29. Car ownership in Tartu in 2004 – 2011

As main causes for increasing needs for mobility are the ongoing establishment of workplaces (industrial parks) separated from residential areas and the development of shopping centres in the outskirts of the city. A closer look at the workers distribution shows a remarkable higher share of car use than in the total distribution. One reason might be a deficit in convenient accessibility of workplaces by public transport or by foot/cycle. Considering there're about 6,000 workers commuting out of Tartu and about 16,000 workers commuting into the city these cause a remarkable volume of car traffic. Half of the population of Tartu above 18 has a driving license. Car ownership in Tartu (comparable with capital city Tallinn) is still about 20 % below the Estonian average, with about 27,000 registered private cars in Tartu in 2015 (population 97,200). Figure 29 shows the constantly increasing number of registered cars in Tartu since 2008.

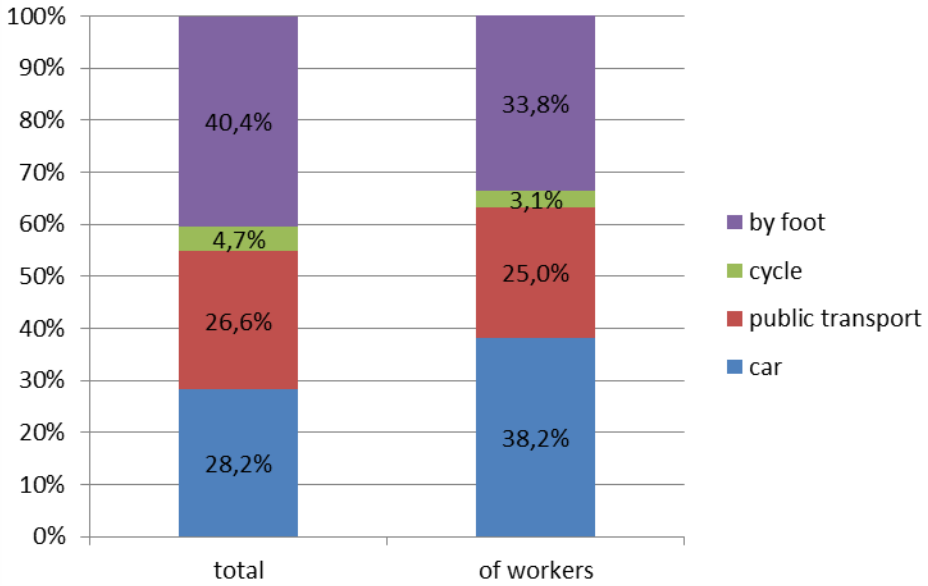


Figure 30. Modal split in Tartu in 2009

Modal split shows the distribution of types of movement total and for workers in Tartu. The combined share of walking and cycling is already quite high (45 % resp. 37 %). In the total distribution walking has the highest share compared to all other modes of transport in the

city, which shows, that the city basically has a compact structure and provides short distances for everyday requirements.

The former Master Plan (1999) implied no relevant changes in transport planning. For example cycling is quite a new topic for City of Tartu. First in 2001 a master plan on bicycle paths as key measure to establish cycling as an issue of city policies was implemented, not least because of very active bicycle organisations in Tartu. Due to lacking knowledge and capacity the plan was not implemented. In 2006 a report about bicycle traffic, which was also a tool for designers of streets, concluded that there's a need to account better for the needs and habits of cyclists regarding routes and bicycle stands. The current city government policy aims to install 100 km of biking paths within four years.

The workplaces in Tartu are mainly concentrated in the city centre (ca. 29 %) and in an important industrial area in Ropka district with about 10 % of the work-places. On the other hand in Annelinn district are only about 10 % of the workplaces, but more than 25 % of the population lives there. These proportions cause remarkable needs for commuting to work. The type of transport people chose to go to work highly depends on the distance and the accessibility of different modes of transport; these vary a lot across the districts. The highest share of car use to work is in Ihaste district which has also the longest average distance between home and work. But besides of the long distance there is particularly a poor accessibility of public transport in Ihaste. Furthermore there're mostly single-family-houses in Ihaste, which indicates a rather affluent population with a probably higher rate of car ownership. The comparison between the districts reveal that primarily not only the distribution proportion between workplaces and residents or the distances are determining, but rather the accessibility of public transport and probably also the level of income (car ownership) of the inhabitants. The urban sprawl has increased the transport distances together with its energy usage and the impact to the environment and human health. This disproportion between where people are living and where the jobs are located has never been adequately addressed on the political lever, nor are there any active measures used for improving the situation.

In 2006 a group of international experts on mobility and municipal development did evaluate the transport sector in Tartu during the BUSTRIP[30] project. After collecting the data, interviewing stakeholders and analyzing the situation they concluded that Tartu has a great potential for using sustainable modes of transportation and to the extent this is also realized. Nevertheless the policy response for the growing threats of congestion was found inadequate and was suggested to be prioritized in the future. Within the next ten years the car ownership has increased from 270 to 415 cars per 1 000 inhabitants adding 14 500 new private cars to the city streets, proving that the initial assessment was spot-on and showing the heavy prize that comes with ignoring the need for focusing on the sustainability. These new cars are here to stay.

In 2011 the Tartu City Transport Development Plan 2012–2020[31] was approved by the city council and was set up to specify the goals of the city's sectorial development documents as well as to create a basis for the development and financing of the transport system. The plan is primarily supposed to be a practical tool to enable long-term transport planning and to develop sustainable transport policy. The plan addresses problems of motorisation as well as

[30] http://www.trolley-project.eu/index.php?id=84
[31] www.balticbiogasbus.eu/web/Upload/Strategy_for_implementation_of_biogas/Act_3_2/32Final%20Report%20(Tartu%20City%20Transport%20Plan)web.pdf

the transportation system of Tartu: “Car usage has consistently grown while at the same time the use of public transport has decreased.” Furthermore, the Transport Development Plan emphasizes the strong interrelations between transport and other sectors and thus the necessity to implement the goals cross-sectorial by handling transport planning as integral part of city planning.

As the transport plan is guided by the goal to create a compact city and multifunctional space to reduce people’s needs for mobility, it’s directly referring to the relevance of urban structure to transport. “The needs and habits of movement thus depend on the spatial structure of the city and the connections between the locations of interest. A significant influence on the habits of movement is exerted by the transportation system, which creates links between different points and shapes possible types of connections and habits.”

In order to reduce private car use the transport plan aims for new transport and taxation policies on the one hand and on raising attractiveness of alternative modes of transport on the other hand.

The following three main principles – pointing at urban structure – are mentioned in the transport plan:

- To facilitate new developments in the vicinity of existing central locations (accessibility of basic everyday services, social infrastructure, leisure possibilities);
- To facilitate developments in the vicinity of existing transport grids to ensure accessibility of existing public transport (“transit oriented development”);
- To ensure education facilities for children near their residence.

In order to achieve the set up goals for the transport system the Transport Development Plan highlights the necessity to improve the cooperation between the different national and local organizations as well as the involvement of stakeholders in the decision making processes. Highly essential is the cooperation with the neighboring local governments. In fact this cooperation are not very well developed, there’s no established process to coordinate planning between the municipalities and the county plan is too weak to assume coordination.

A major challenge lies in the work related transport (commuting) both within the city area and in the functional urban area (suburbs outside the city borders).

Tartu SEAP[32] estimates that passenger cars travelled the distance of 265 million km in Tartu in 2010. At the same time, public transport vehicles travelled approximately 3.6 million kilometers en route. While 15 GWh of fuel was used in public transport, the fuel consumption of passenger cars reached 240 GWh. Owing to this, the CO2 emissions of public transport were eight times less than the total emissions of passenger cars.

For further reducing the emissions from the transport sector Tartu is looking for possibilities for implementing alternative transport fuels namely electricity, natural gas and biomethane.

A nationwide network of 167 rapid chargers for electric cars has been developed in Estonia by electro mobility program ELMO with the average distance of 40-60 kilometers between the charging points. Currently there are 11 rapid chargers in Tartu.

[32] Action Plan for Sustainable Energy Management 2015-2020 for the City of Tartu. TREA 2015. Available: www.tartu.ee/data/SEAP_Tartu_ENG_2015.docx

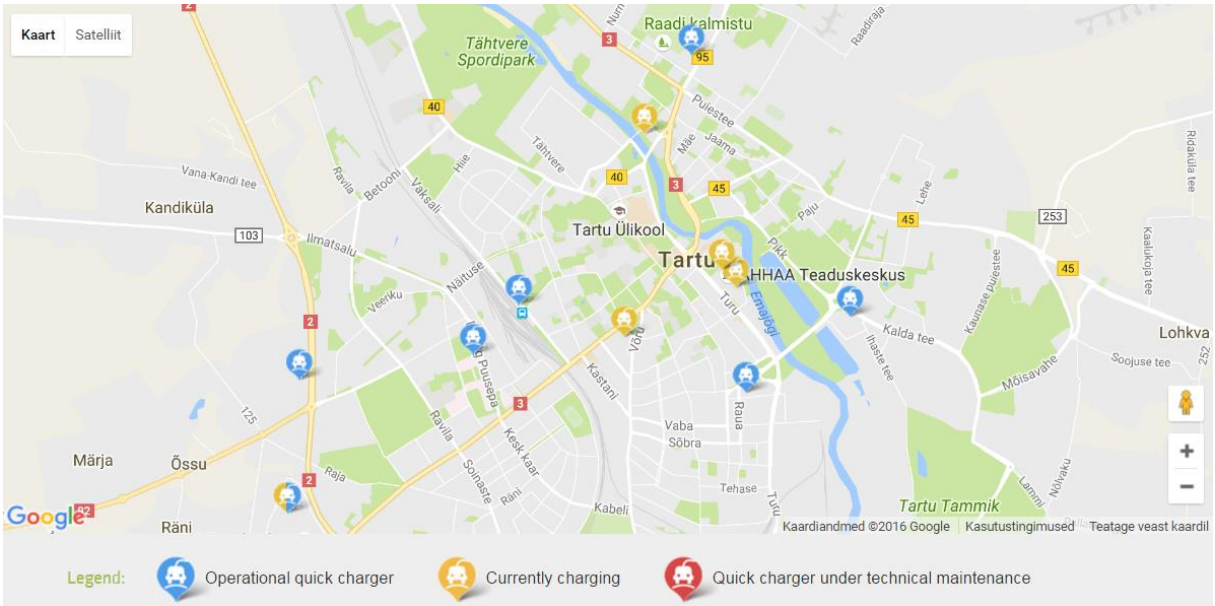


Figure 31. Rapid charging stations for electric vehicles in Tartu[33]

Today there are 5 city busses (about 11% of the existing fleet) operating in Tartu using CNG. Starting from 2018, the City of Tartu wants to increase the proportion of CNG buses in public transport to at least 25% of estimated 55 city buses by 2020. CNG, CNG hybrid and electric buses are preferred in the public transport of Tartu[34], as these means of transportation have low local emission levels.

The proportion travelled by buses that run on natural gas out of the travelled en-route kilometers per year was approximately 11.4% in 2013. CNG and diesel buses are compared in the following tables (Table 15).

Parameter	All on diesel fuel	All on natural gas	5 on natural gas, the rest on diesel
Line kilometers	3,600,000	3,600,000	3,600,000
Fuel consumption, 1,000 units (l or m3 or sum)	1,494	2,041	1,558
Fuel consumption, MWh per year	14,834	19,051	15,326
CO2 emissions in t per year	3,961	3,848	3,947

Tabel 15. The calculated fuel consumption of public transport in Tartu

Thus, by using a single CNG bus, approximately 2.6 t less of CO2 is emitted per year. Tartu City Government owns 43 passenger cars and 2 vans. In 2014, 34 of the 43 passenger cars were electric cars, 5 were natural gas vehicles (CNG), while the rest ran on petrol or diesel

[33] Source: www.elmo.ee

[34] Tartu Maavalitsuse, Tartu Linnavalitsuse, Majandus- ja Kommunikatsiooniministeeriumi ja Maanteeameti ühiste kavatsuste protokoll 04.11.2013. Kättesaadav: http://www.tartu.ee/data/Tartu_MV_Tartu_linna_MKM-i_ja_MNT__hiskavatsuste_protokoll_01_11.pdf (16.06.2014).

fuel. Environmental friendly vehicles—NGVs and electric cars—are preferred in purchasing new vehicles.

5.4.2 Fact box: Mobility in Tartu in numbers

Area	Field	Indicators	Value	Units	Data source	Comments
Transport and mobility	Mobility City Profile	Total number of vehicles in the city per capita	0,39	Number/inh	TAR	
		Total number of private cars per capita	0,29	Number/inh	TAR	
		Total number of commercial vehicles per capita	0,06	Number/inh	TAR	
		Total number of taxis per capita	0,005	Number/inh	TAR	
		Total number of trucks per capita	0,058	Number/inh	TAR	
		Total number of public buses per capita	0,00053	Number/inh	TAR	
		Total number of public bicycles per capita	0	Number/inh	TAR	
		Number of bicycles per capita		Number/inh	TAR	Not available
Transport and mobility	Mobility City Profile	Number of two-wheel motorized vehicles per capita	0,02	Number/inh	TAR	
	City Statistics for Mobility	Average age of motor vehicles for public transport	7,5	years	TAR	
		Kilometers of high capacity public transport system per population	0	Km/inh	TAR	
		Kilometers of light passenger public transport system per population	0,0052	Km/inh	TAR	
		Kilometers of bicycle paths and lanes per population	63	Km/inh	TAR	
		Total annual number of trips		Number of trips	TAR	Not available
		Total annual number of trips by private car		Number of trips	TAR	Not available
		Total annual number of public transport trips	13000000	Number of trips	TAR	
		Total annual number of trips by bike		Number of trips	TAR	Not available
		Total annual number of trips by motorbike		Number of trips	TAR	Not available
		Total annual number of trips by taxi		Number of trips	TAR	Not available
		Total annual number of trips on foot		Number of trips	TAR	Not available
		Annual number of public transport trips per capita	134	Number trips /inh	TAR	

		Daily average time by trip		min / vehicle ·day	TAR	Not available
		Daily average length by trip		km/ vehicle ·day	TAR	Not available
		Daily average length by private car trip	5	km/ vehicle ·day	TAR	
		Daily average length by public transport trip	250	km/ vehicle ·day	TAR	
		Daily average length by bike trip	5	km/ vehicle ·day	TAR	
		Daily average length by motorbike trip		km/ vehicle ·day	TAR	Not available
		Daily average length by taxi trip		km/ vehicle ·day	TAR	Not available
		Daily average length by foot trip		km/ vehicle ·day	TAR	Not available
Transport and mobility	**City Statistics for Mobility**	Percentage of electric private cars	3	%	TAR	
		Percentage of electric commercial cars		%	TAR	Not available
		Percentage of electric taxis	7,5	%	TAR	
		Percentage of electric motorcycles	0	%	TAR	
		Percentage of electric public buses	0	%	TAR	
		Percentage of biogas public buses	0	%	TAR	
		Number of public EV charging stations		Number	TAR	
		Total number of recharges per year		Number	TAR	
		Total kWh recharged in the EV charging stations		kWh	TAR	
		Parking facilities per capita	0,029	Number/inh	TAR	
		Number of public parking areas per capita	2	Number/inh	TAR	
		Number of available parking slots per capita	0,03	Number/inh	TAR	
		Pedestrian area per capita	0,6	Km^2/inh	TAR	
		Cost of a monthly ticket for public transport in relation to the national minimum wage or average wage	1,44	%	TAR	
		Transportation fatalities per capita	3,1	Number/inh	TAR	
	Environmental impact with mobility	Transport energy use per capita	2628	kWh /pers.·a	TAR	
		Transport greenhouse gas	0,68	t /(pers.·a)	TAR	

		emissions per capita				
Transport and mobility	**Environmental impact with mobility**	Percentage of renewable energy use in public transport	0	%	TAR	

Table 16. Urban mobility and transportation: common and optional indicators

For a comprehensive analysis City of Tartu should update the missing indicators.

5.5 ICT infrastructures and services

Relation to D2.4: Section 6.2.4

5.5.1 ICT in Tartu in text

[Story telling section about ICT in Tartu in text, explaining data from 5.5.2]

Topics to address:

- Monitoring & Communication Infrastructures
- Smart City Services (Table 16)
- Policies and regulations (D2.1)
- Standards (D2.2)
- Business model and funding (D2.3)

The share of Internet users in Estonia is above the EU average, ranking to 7th place according to the European statistics (together with France) - about 84% of the population used Internet in 2014 (88% in 2015). There are more than 600 thousand Internet connections in use and most people (37% of users) are preferring mobile broadband connection (both in 3G and 4G networks, with the download speed reaching 100 Mbit/s) and this preference correlates with the popularity of mobile computing devices – smart phones, laptops and tablet computers. Mobile broadband is the favored service also in the Internet of Things. The fastest growing sector of customers are using high-speed (up to 10Gbit/s) fiber-optic communication network.

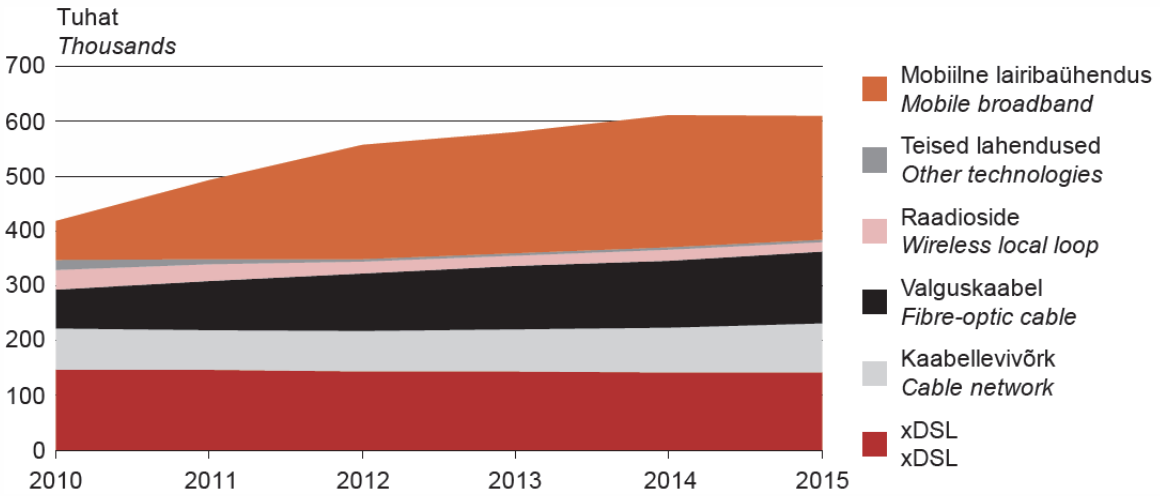


Figure 32. Broadband service users by connection technology, 2010-2015[35]

According to the Statistical Estonia[36] the most favored Internet services in 2015 were online banking with 91% of users, access to newspapers and magazines 91% of users, email with 89% of users and online search with 85% of users. 59% of users have bought goods or services online. Most popular have been travel- and accommodation services 60% of users of e-commerce, tickets for theatre, cinema, concerts etc with 57% of users, apparel and sport equipment with 52% of the users of e-commerce. Most of the users (85%) are preferring goods and services from Estonian providers, 44% are buying from other EU providers and 35% of users are buying from outside of EU.

Estonian success in developing and accessing Internet services is influenced by three factors. First of all the development of the network infrastructure has been active and most of the population has the access to the network in their home, work, school or using mobile devices. National program for developing fast network also to rural areas has supported this process as also the development of mobile broadband networks. Second factor has been the overall readiness of Estonians to invest their money and interest into the somewhat still ambivalent area of personal computer technology. The relative price of an average computer or a smartphone compared with the average income of community is clearly higher for people in Estonia compared with USA or Western Europe. Even more so Estonians are ready to accept many security risks of the Internet age implementing sensitive services like Internet voting or personal healthcare information platform.

The third factor for development of Internet services in Estonia has been the implementation of the national digital identification platform and connecting this with mandatory ID-card. It is true that many e-banking and e-commerce services can be developed without central identification protocol but combining these with secure identity management adds an extra layer of security and increases the acceptance among more conservative user groups. Combination of public and private services such as e-voting and electronic tax declaration with banking, online shopping and social networks is where the national digital identity really shines.

Development of the public services had a good head start but has seen a slowdown during last few years. Estonia was the first nation using e-voting over the Internet in general elections during municipal elections in 2005 and in parliamentary election in 2007. Paperless

[35] Source: www.stat.ee.
[36] www.stat.ee

e-governance, electronic taxing declarations together with cross platform applications for accessing personal data under national institutions have had equally good effect for increasing the accessibility of public services among the general population.

City of Tartu has adopted efficient digital workflow including digitally certified documents sent over the email and stored in secure servers as a part of the administrative correspondence. City administration has developed a fully digital repository for the municipal data management including special applications like Geographic Information Management systems for the city planning and construction. These systems have the basic level of readiness for developing the digital development platform further for implementing more complex applications like Building Information Management (BIM) systems or opening up the municipal data under the Open Data initiative. Fully automated monitoring of the environmental and behavioral data offers outstanding opportunities for data mining for the Open Data community in the future. This type of symbiosis can be used for developing starting position for new innovative service models. The biggest challenge here is not the technology itself but the mindset of the people and the culture of the organization.

5.5.2 Fact box: ICT in Tartu in numbers

Area	Field	Indicators	Value	Units	Data source	Comments
Urban infrastructure	Existing city monitoring infrastructure	Number of parking information panels	0	Number	TAR	
		Number of air quality stations	100	Ratio	TAR	
		Number of noise stations	0	Ratio	TAR	
		Number of weather stations	100	Ratio	TAR	
		Number of loan point for public bicycles	0	Ratio	TAR	
		Number of smart-meters installed	39159	Ratio	TREA	
		ICT citizen oriented platforms	YES	YES/NO	TAR	
		Data privacy	Agree	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree	TAR	
	Communication infrastructure in the city	Percentage of the population covered by a mobile-cellular network	100	%	TELIA	
		Percentage of the population covered by at least a 3G mobile network	100	%	TELIA	
		3G Mobile network cells		Number of 3G mobile network cells	TELIA	Not available
r a	Communication	4G Mobile network cells		Number of 4G	TELIA	Not

	infrastructure in the city			mobile network cells		available
		Number of cell phone connections per capita		Connections/inh	TELIA	Not available
		Number of internet connections per capita		Connections/inh	TELIA	Not available
		Number of landline phone connections per capita		Connections/inh	TELIA	Not available
		Smartphone penetration	81	%	TAR	
		Free Wi-Fi zones	1	Number of free Wi-Fi zones identified in the city	TAR	Offered by city government
		Cable Network		YES/NO	TAR	
		Cable Network Types	3	Types of cable network available in the city (twisted pair cable, coaxial cable, fibre optic,…)	TAR	Twisted pair, coaxial, fibre optic

Table 17. Urban infrastructure: common and optional indicators

For a comprehensive analysis City of Tartu should update the missing indicators.

5.6 Citizen engagement

Relation to D2.4: Section 6.2.5

5.6.1 Citizen engagement in Tartu in text

[Story telling section about Citizen engagement in Tartu in text, explaining data from 5.6.2]

Topics to address:

- Purpose, scope, forms and resources
- Coordination of activities
- Interest groups and stakeholders
- Communication strategy
- Monitoring and evaluation
- Standards (D2.2)

The purpose of engagement in Tartu is to engage citizens "in all stages", i.e. when defining problems, setting goals, analyzing solutions and making decisions. The communication and engagement strategy of Tartu involves identifying all relevant stakeholders and interest groups and tailoring the suitable communication and engagement activities to meet their needs. For this purpose, an engagement working group was formed in March 2016 that has been meeting regularly to discuss these issues and to compile Tartu's Communication and Engagement Strategy by the end of 2016. The working group consists of most partners developing the Tartu lighthouse project from the public, private and non-profit sector and involving also the University of Tartu.

So far, major identified stakeholders that have been intensively engaged include:

- Pilot area housing associations and their leaders
- Pilot area residents
- Designers, technical consultants and builders
- Other associations and unions (e.g. the Estonian Green Movement)
- KredEx financing institution
- General public

The communication activities are targeted at all the above target groups and also at Tartu and Estonian citizens and on an international level as well (e.g. multilingual project website and Facebook posts). The Communication Strategy details the means of communication for every target group separately and is constantly being updated by the working group.

For monitoring and evaluating the successfulness of the communication and engagement activities, a list of indicators and milestones is currently being compiled, which will include both numerical values (e.g. how many news bulletins per year) and general broader outcomes (e.g. how much has the participation of residents in awareness raising campaigns risen). Citizen engagement common indicators as set in SmartEnCity project will be taken into consideration while compiling the indicators for further monitoring and evaluation of the communication and engagement strategy.

The social engagement standards outlined in D2.2 will serve as an important basis for citizen engagement in Tartu. As the document states, at the heart of engagement lies social change – "alteration of mechanisms within the social structure, characterized by changes in cultural

symbols, rules of behavior, social organizations, or value systems" – which in Tartu's context, is defined as "mutual learning". This means changing the existing socioeconomic practices, which requires concentrated effort from all stakeholders as people must be taught how to adapt to and use the new technologies and live in a smart and sustainable way. Tartu wants to transition into a smart city, the key part of which is learning, and not merely implement new policies and technologies. Tartu city will be the driver of this learning process which will in time facilitate social change.

5.6.2 Fact box: Citizen engagement in Tartu in numbers

Area	Field	Indicators	Value	Units	Data source	Comments
Citizens	Existing actions related to citizen engagement	Recycling rate	55	%	UT	Year 2011
		Voter turnout in last municipal election	52,59	%	UT	
		Number of local associations per capita	3859	Number of consultations / inhab.	UT	
	Channels for citizen engagement	Number of information contact points for citizens	2	Number	UT	
		Number of municipal websites for citizens	2	Number	UT	
		Number of websites consultation per capita	0,005	Number	UT	
		Number of interactive social media initiatives	3	Number	UT	
		Number of discussion forums	63	Number	UT	Questionnaires by the city
		Number of awareness raising campaigns	0	Number	UT	Campaigns are made by government
		Number of thematic events	30-40	Number	UT	
		Number of newspaper columns	~20	Number	UT	
	Current scenarios of citizen engagement	Citizens participation in smart city projects	0,63	Number	UT	
		Professional stakeholder involvement	Agree	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree	UT	

Table 18. Citizen engagement: common and optional indicators

For a comprehensive analysis City of Tartu should update the missing indicators.

6 (C) City needs definition and prioritization

6.1 City-level SWOT analysis (inputs from city characterization)

STRENGTHS	WEAKNESSES
Willingness to study and innovation. Flexibility of labor market Lifelong learning Level of qualification Transparent governance Sustainability of the transport system Availability of IT-infrastructure Air Quality (no pollution) Cultural facilities Individual security Accessibility of clean drinking water	(Inter-)national accessibility Local Accessibility Economic image & trademarks Productivity Environmental conditions Participation public life Touristic attractiveness Economic welfare Housing quality Continuously high energy intensity of buildings, economy and living environment Urban sprawl
OPPORTUNITIES	THREATS
South-Estonian economic growth is low Development of Tartu Airport European policy moves forward to sustainable development Rapid social economic improvement Proximity of non-EU markets Overall acceptance of new ICT tools To be a lighthouse city in Estonia and Eastern Europe Accessibility of loans and leases A large number of universities and lectures High level of education Development of local sustainable energy production High potential for savings	Strong competition after residents in local, national and international level Rail Baltic transport corridor passes Tartu City Location in periphery Negative peer pressure of international non-sustainable practices Global threads in the ICT sector International security Sustainability of electric production national level Lack of skills in sustainable technologies Encapsulation of the population A small proportion of private housing in the district heating network Potential risk for energy security

6.1.1 Opportunities vs Strengths

e.g. Which of the company's strengths can be used to maximize the opportunities you identified?

Willingness to study and innovation helps to accept new ICT tools.

Flexibility of labor market and high level of qualification helps to create new jobs and improve the economic development.

Transparent governance helps to create more inclusive economic models.

Sustainable transport modes to create better accessibility.

Availability of IT-infrastructure helps to improve new ICT tools.

Air quality, cultural facilities, individual security and accessibility of clean drinking water helps to improve life quality.

Individual security helps to improve tourism.

Clean drinking water helps to improve the economic welfare.

6.1.2 Opportunities vs Weaknesses

e.g. What actions can you take to minimize the company's weaknesses using the opportunities you identified?

Improve the quality of the international transport services to and from Tartu.

Connect the loans and financial instruments with the energy performance of the buildings.

Use the knowhow from the universities to improve the quality of the products and services.

Create economic models that include all the members of the community

Develop ICT tools that help improve the accessibility, productivity, engagement and information.

Use the energy savings for reducing the consumption and shift the production to green technologies.

Use the innovative development projects as an image building tool.

Voluntarily adopt new EU energy and climate polices.

Engage international students as a future ambassadors of the city.

Encourage tourism from non-EU countries.

6.1.3 Threats vs Weaknesses

e.g. How can you minimize the company's weaknesses to avoid the threats you identified?

Improve the international accessibility to avoid the isolation.

Improve the productivity, economic welfare and environmental conditions to build up the resilience against to global threats and international security. Be aware of the trap of overconsumption!

Reduce the energy intensity of the economy and improve the housing quality to reduce the risk of energy security.

Increase economic welfare to reduce the risk of energy powerty.

Improve the international accessibility and tourist attractiveness to improve the competitiveness on the international level.

Improve the accessibility and participation of public life for the citizens to avoid the (mental) encapsulation.

6.1.4 Threats vs Strengths

e.g. How can you use the company's strengths to minimize the threats you identified?

Well developed IT infrastructure helps to create virtual connections with the 'global village'.

Innovative citizens and ICT capability creates a platform for building up resilience and green practices.

Clean environment and ICT infrastructures gives an global advantage compared to other cities (for example for the scientists, intellectuals or 'digital nomads').

High level of qualification and flexibility of labor market helps to minimize the threats in the ICT sector.

Willingness to study and innovate helps to overcome the lack of skills in sustainable technologies.

Local sustainable energy production helps to overcome the lack of sustainability of the national electric production. Be the forerunner of sustainable energy sector in Estonia!

New distributed energy technologies help to improve the energy performance of non-connected private housing.

6.2 Specific spatial analysis:

- Identification of priority areas and bottlenecks
- Demarcation of areas of intervention

6.2.1 Challenges of sustainability in Tartu

Lack of jobs and economical opportunities

Tartu is a 'second city' - national centre for culture and intellectual life. Its universities and thriving cultural scene are nurturing an environment for knowledge the creativity. The concept of the 'second city' is suggesting also that Tartu is not the leader of economic development in the country (but can be that in the South-Estonian sub-region). As today the economical opportunities are rather limited and this is the main reason for the lack of growth for last 40 years. Social development of Tartu is limited by its economical development - mainly with the amount of jobs available for the citizens. At the same time Tartu is identified as economical leader of the sub-region and attracting people from other parts of South-Estonia. Urban sprawl is reducing the economical opportunities even more, reducing the tax base, increasing the energy usage and the risks in the traffic.

The small and medium size cities are facing the risk of losing their population to the bigger cities that cannot always offer the same level of life quality but can more than compensate

that with better economical opportunities. This process is self supporting - people who are leaving tend to be more active and have better education. This is what has been happening in Tartu for decades. Despite the constant arrival of the students and the fact that many of them would like to stay, the population has not been increasing. One of the solutions for this could be the development of a symbiotic relationships with bigger cities (so called Malmo - Copenhagen model or in our case Tartu - Tallinn, Tartu - Riga, Tartu - Vilnius or Tartu - St Petersburg model) but for this a better and faster transport connections are needed.

Lack of access and connection

It is not easy to arrive to Tartu. It will take the better half of day to arrive to Tartu from almost any other European city. The backbone of pan-European mobility – fast railroad network, is missing in Tartu. Poor (inter)national accessibility is the single biggest challenge for Tartu to become a smart city.

High energy intensity

The historical background of energy intense industrial and agricultural production of soviet era has influenced the development of Central- and Eastern European countries for almost a century. This has its material dimension - the built infrastructure of that era, including vast majority of the living spaces. This also has a mental dimension - the people's attitude towards sustainability.

The spirit of sustainability

Capacity for the transition to become a smart city in Tartu is high but it also has it's challenges. Citizens value traditionally green and clean environment and still have many practices of resilient and self-sustaining lifestyle like gardening and commuting by foot. At the same time these practices have acquired a bad name by the soviet experience where they were extensively used. The spell of global consumer society is pushing people towards less sustainable/resilient practices. Negative peer pressure from over-consuming Western European countries and especially from USA is cultivating the non-sustainable lifestyle in all of the CEE communities.

Challenges of sustainability

Increasing usage of global products instead of locally produced goods is increasing the environmental impact of consumption. Some of the outcomes of this process has been - local and global food insecurity, loss of economical development on local level, monopolization of production, reducing control over the quality of the production etc. Almost all the consumption in Tartu is based on international trade - buying in the products from the retailers.

Resilience

One of the effects of the globalisation has been decreasing of resilience of local communities for economical, environmental and social catastrophes. Import based communities are most vulnerable for the disruptions on international trade that can halve the energy systems, food supply, medical supply etc. Dominating import economy is usually not supporting local economic development and can have a negative effect for local job market. Depending on the imported energy sources originating from unstable regions is reducing the energy security and increasing energy poverty during the period of volatile fuel prices.

Private interest

One of the prevailing factors of the rapidly changing societies is the private interests dominating over the public interest. This is especially visible in the societies with short democratic traditions what you would typically see in post-soviet countries. This creates additional barriers for reducing unnecessary consumption in the process of shifting the society towards low-carbon economy. One of the implications of this phenomenon is so called Right To Consume - the impression that the access to almost unlimited amount of consumer goods is elementary right of citizens despite its impacts. Negotiating the conflicts between the private and public is the next big challenge in the development of citizen society in Tartu.

Right to Consume

Restricting the over-consumption of goods and services is necessary for achieving low-carbon economy. At the same time the (almost) unlimited access of casual goods is the main indicators of market economy for many people and the idea for setting any kinds of limits non-financial limits is hard to accept. People feel that they have the right to consume and ignore the possible consequences.

6.2.2 Future proof policy

The Development Strategy “Tartu 2030” sets up a strategic vision for the city’s development up to 2030, including goals and directions of activities. By these means the Development Strategy “Tartu 2030” interlaces the formulated objectives for the city’s developments with the required planning model and implementation process.

Since Tartu has no relevant big industries, the main employers are the municipality and the university, energy related challenges occur from transport and residential (district) heating. The modal split shows big differences between journeys within Tartu and journeys between Tartu and its vicinity. While the first shows a high share of public transport and walking, the latter includes a high share of car use, especially in work related travelling.

The workplaces in Tartu are mainly concentrated in the city centre (ca. 29 %) and in an important industrial area in Ropka district with about 10 % of the work-places. On the other hand in Annelinn district are only about 10 % of the workplaces, but more than 25 % of the population lives there. This mismatch alone generates tens of thousands of travels every day.

This is closely related to the issue of ongoing urban sprawl and increasing car ownership. Although the Tartu City Transport Development Plan 2012-2020 points very clearly at the weaknesses in the transport system of Tartu, the plan is not addressing cross-border issues, like e.g. regional commuting.

The highest share of emissions is related with direct energy consumption. In terms of energy sources Estonia is very much dependent on imports like oil and gas and the Estonian electricity production is mostly based on production of oil shale. Tartu Power Plant is capable of covering more than half of the energy demand in Tartu if the citizens would exclusively buy the electricity with the green certificate.

The total distribution of energy use by sectors in Tartu shows that by far the highest share (50 %) is allotted to heating and cooling. Transport and electricity both have a share of about 25 %.

About 75 % of the housing stock in Estonia (also in Tartu) is the multiple-unit buildings. At the same time Estonia uses two to three times more energy in buildings than the Nordic countries. That reveals the low quality of the building stock in terms of energy efficiency. Thus, building refurbishment is one of the most urgent issues in order to de-crease energy use in households.

The Estonian energy policy emphasizes the importance of reducing dependency on imported resources as well as to ensure security of energy supply. A more decentralised regional energy production can improve the overall energy security as well as the better exploitation of local energy resources (wind, solar, biomass, earth heat). Furthermore integrated energy-production solutions, e.g. combined heat-power-production, shall be introduced more.

Currently about 90 % of the apartment houses are connected to district heating; but less than 5 % of the single-family-houses are connected. District heating in Tartu is green and clean so more consumers should benefit from it. The prize is one of the lowest in the country.

If available, residents have the option of choosing gas rather than district heating, since gas is available in most areas as energy source for cooking. However, in several single family housing areas, neither gas nor district heating is available; in these areas electricity is used for cooking and air-to-air heat pumps and wood furnaces for heating.

The Transport Development Plan addresses problems of motorization as well as the transportation system of Tartu: “Car usage has consistently grown while at the same time the use of public transport has decreased.” Furthermore, the Transport Development Plan emphasizes the strong interrelations between transport and other sectors and thus the necessity to implement the goals cross-sectorial by handling transport planning as integral part of city planning. It is guided by the goal to create a compact city and multifunctional space to reduce people’s needs for mobility and it’s emphasizing the relevance of supporting urban structure.

Limiting the urban sprawl in uncontrolled residential developments behind the city borders has a big potential for increasing the sustainability. This requires a well coordinated policy with the neighboring municipalities.

As Estonian energy generation is currently mainly based on non-renewable sources, further potential lies in the exploitation of large scale renewable energy generation that could provide a substantial share of the city’s energy demand. High potential lies furthermore in improving the quality of building stock including refurbishment of the existing buildings.

Thus identification of priority areas/bottlenecks and demarcation of areas of intervention in particular, must be guided by densely populated residential areas where are located mostly multi-apartment buildings from 1920-1990. In Tartu are such areas: City centre, Annelinn, Karlova and Supilinn districts.

6.3 Pre-definition of the district integrated intervention:

- General strategy (matching district and city-level needs)
- Selection of components

Figure 33. Tartu demo area

The pilot area is a part of the town centre and has a size of 0,39 km2 (marked in red). According to 2013 statistics, ca. 6,500 people lived in the city centre of Tartu, making up ca. 7% of all citizens. The pilot area includes a part of the city centre with about 4,000 citizens. The population density of the city centre is about 3,600 people/km2. The pilot area includes the University of Tartu Library, the Vanemuine Theatre, a big shopping mall, offices as well as several residential areas. There are ca. 1,600 multi-apartment buildings in the City of Tartu. 50% of these were built between 1960 and 1990. In the city centre, there are 42 hrustsovka-type apartment buildings which were mostly built in the sixties. The inhabitants are socially mixed and diverse. The apartments are privately owned and in many cases rented out (e.g. for students). The renovation activities will directly affect ca. 2,100 inhabitants of the pilot area. The pilot area makes up the part of Tartu that was completely destroyed in World War 2 bombing. This left the city centre of Tartu empty and under the Khrushchev housing scheme, it was decided that the area be filled with panel buildings. With little aesthetic appeal and low construction quality, the city has now taken the aim to renovate and smarten up these ‘relics’ of the past.

Figure 34. Street view of the Demo area

The town centre represents the most diverse usage of buildings: from office and administrative buildings to mainly residential ones. The project focuses on residential buildings built in the early 60’s.

Most properties are privately owned, the publicly owned urban space includes streets, parks etc. Technological infrastructure such as cables and pipes belong to their service providers. The property owners of residential buildings are organized into housing associations.

The main idea of the Tartu lighthouse project is to turn hrustsovkas into 'smartovkas' with accompanying innovative solutions in public transport, street lighting and monitoring. The aim of the investments is to create a high-quality living environment that inspires the pilot area community to make environmentally aware decisions and change their patterns of behaviour. A smart and participative community in combination with integrated and innovative technological solutions will create a new experience that can also be replicated elsewhere. In the field of retrofitting, the project seeks to tackle one of the greatest challenges of Europe's existing building stock – quickly deteriorating precast panel apartment buildings that were quickly produced in response to housing shortages. In case of Estonia, hrustsovkas make up a panel building type that was designed in the end of 1950's during the reign of Nikita Khrushchev and which were constructed in the 50's-70's. With an average life cycle of 30-40 years, many of these buildings have already outlived their time, meaning that the shortcomings in quality are becoming increasingly evident and might even pose a threat to their residents. Hereby, the project proceeds from an understanding that new buildings are constructed according to high contemporary standards and are thus energy-efficient anyways – the true challenge is how to retrofit the old panel buildings that have great energy saving potential. The market and replicability potential of respective solutions is enormous, evidenced by the variety of panel buildings in different countries. It is estimated, for example, that 3.5 million people in the Czech Republic and 1.7 million people in Hungary live in these types of apartments.

Tartu, also having a wealth of panel and *hrustsovka*-type apartment buildings, aims at piloting some of these solutions in its central area, after which best practices could be transferred to its residential areas (and anywhere else in Europe and beyond). Instead of quantity (e.g. insulating as many panel buildings as possible), the aim is to go for quality, testing the idea of 'smartened up' panel buildings through more radical intervention that e.g. promises up to 80% reduction in heating costs. One technology to be tested is a low-temperature district heating and cooling system which could meet consumer demands for thermal indoor comfort and domestic hot water while retaining high energy efficiency and high share of renewable energy. Piloting this and other solutions will be accompanied by an in-depth e-monitoring application (based on smart meters) that collects real-time data on energy consumption and encourages to save. The full effect of the planned actions will come from the innovative combination of green technologies, ICT solutions and the empowerment of citizens.

The proposed measures can be summarized as follows:

1. Increasing the energy performance of the demo area's housing stock through a 'smartovka' renovation package, resulting in reducing energy consumption from 270 kWh/m_2y to 90kWh/m_2y;
2. Installing low temperature cooling systems to complement the district heating of the pilot area;
3. Installing 253 kWp PV panels to provide additional energy for the housing sector;
4. Decreasing the energy consumption of street lighting by 60% through intelligent controlling systems;

5. Introducing 8 electric cars and 16 electric bikes in 4 charging points available for public use;
6. Supporting the purchase of 14 electric cars for public transport (taxis);
7. Supporting the purchase of 15 electric cars for private transport;
8. Purchasing 60 new biogas buses for public transport;
9. Setting up 5 new public charging points to meet the increased demand;
10. Implementing a general bike sharing system;
11. Developing a participatory transport planning system for increasing the efficiency of public transport;
12. Re-using EV batteries for storing and using renewable energy;
13. Integrating a smart monitoring and open Urban Management ICT platform for the demo area 'smartovkas'.

Figure 35. Tartu Lighthouse

7 (D) Preparations for Intervention baseline (DELAYED TO M18) (D2.4 Section 6.4)

7.1 Technical definition of the district integrated intervention

7.2 Evaluation plan: definition of KPIs

7.3 Data collection approach and monitoring program

7.4 Installation of monitoring equipment

7.5 Performance evaluation

SmartEnCity aims to develop an urban regeneration model towards the Smart Zero Carbon City concept to be implemented in three lighthouse cities, Vitoria-Gasteiz (Spain), Tartu (Estonia) and Sonderborg (Denmark), for improving energy efficiency in main consuming sectors in cities, while increasing their supply of renewable energies. The three cities will develop a number of coordinated actions aimed at reducing the energy demand of residential building stock through cost-effective low energy retrofitting actions at district scale; increasing the RES share of energy supply through extensive leveraging of local potentials; enhancing the use of clean energy in urban mobility by means of extensive deployment of green vehicles and infrastructure; using ICTs for the integration and consistency in demo planning and implementation; and engaging activities to secure the involvement of citizens.

In this regard, SmartEnCity will demonstrate that the interventions performed in the cities as well as the strategies addressing non-technical barriers (business models, citizen engagement strategies and public procurement among others) meet the foreseen ambitious objectives in the three LH. Given the complexity of the project, a common and holistic methodology will be defined in order to assess the interventions performance from multiple points of view based in the comparison of the **post-retrofit period** (called as *final performance*) against the period before the intervention, which is named as **baseline**.

The definition of this holistic methodology for the assessment of the performance of interventions in the three LH cities will be deployed in D7.3 where different protocols will describe how to evaluate the presumed benefits of SmartEnCity. This deliverable will also explain how to address the process for data collection, the adjustment required to estimate the baseline model and measurement requirements for the post-intervention period. These protocols will be based in a complete set of KPIs which should be useful during the entire renovation project. This is mainly because both in the baseline and in final performance, the evaluation should be carried out through well-established indicators in order to compare the before and after of the demo area.

Five protocols will take part of the methodology for evaluating SmarEnCity interventions in terms of energy consumption and greenhouse gas emissions savings, efficiency, social acceptance, economic performance and citizen engagement. During the next months, partners will be working in defining such protocols.

In this section of the deliverable some ideas are presented as the starting point for detecting how the baseline must be evaluated. In a further step, baseline will be calculated (D3.2, D4.2, D5.2) taking into account the protocols to be developed in D7.3. Following lines describe **each of the phases** which cover the evaluation of intervention performance and some details are introduced about how it is foreseen to deal with the baseline calculation. This description includes:

- Technical definition of the integrated intervention
- Evaluation plan
- Data collection approach for the evaluation of intervention performance
- Installation of monitoring equipment
- Data collection
- Performance evaluation

7.6 Technical definition of the integrated intervention

Technical definition of the district integrated intervention consists of the description of the main demo area characteristics, where project and implementation plans will be executed. Information included below would be needed to be compiled in order to make compatible the evaluation plan with the demo area features and procedures to be applied in each city.

For whole interventions, it is required to know the definitive technical solutions, the citizen engagement strategies, partners and stakeholders which will take part and their responsibilities and financial schemes, as well as the periods where they will be implemented. For the evaluation of district intervention, it is also recommended to count with the constructive characteristics of buildings and the current energy system of the district as well as the type of residents.

All these issues must be considered for defining the baseline evaluation approach.

7.7 Evaluation plan

7.7.1 KPIs for the intervention evaluation

The framework for the evaluation of interventions was defined in D7.2, where potential KPIs to be used in the project were identified for each type of intervention/action (district renovation, sustainable mobility and citizen engagement), in order to measure the objectives to be met according with the information collected from the DoA.

Thus, four types of objectives and KPIs were proposed taking into account the expectative of the project.

- Technical
- Environmental
- Social
- Economic

Figure below shows the framework of evaluation described in D7.2.

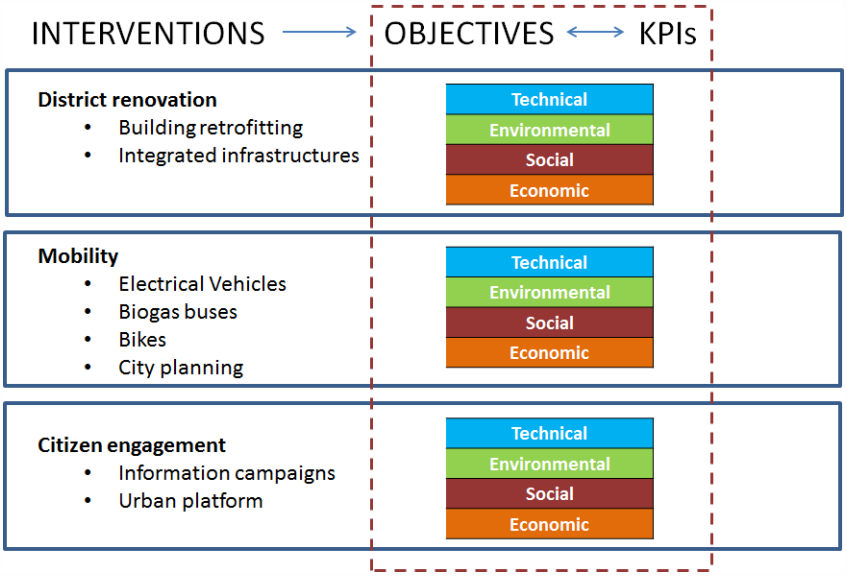


Figure 36. Types of interventions, objectives and KPIs

Table below compiles the KPIs proposed in D7.2 grouped by categories.

	Technical KPIs	Environmental KPIs	Social KPIs	Economic KPIs
District renovation	18	7	26	8
Mobility	9	3	13	8
Citizen engagement	23	3	10	3

Table 19. KPIs proposed in D7.2

These KPIs will be validated by the partners involved in LH cities and merged in the different **Protocols** to be deployed in D7.3.

- *Energy Assessment Protocol*
- *ICTs Protocol*
- *Life Cycle Analysis (LCA) Protocol*
- *Mobility Protocol*
- *Protocol for cross cutting issues*

7.7.2 Protocols for the intervention evaluation

Each of the protocols will be deployed by small groups with representative partners from the three LH cities which will collaborate in the definition of the scope, approach and set of KPIs to be included in these protocols taking as reference the evaluation framework described in D7.2.

Foreseen scope of each Protocol is described below, which will be totally defined in D7.3.

- *Energy Assessment Protocol* to cover the energy savings achieved with the implementation of energy performance solutions in the districts, the associated CO_2 avoided and the thermal comfort achieved.
- *ICTs Protocol* in order to carry out the evaluation of the efficiency gained and the higher use of RES in the district due to the implementation of ICT strategies during the intervention.

- *Life Cycle Analysis (LCA) Protocol* to determine the reduction of environmental impacts due to the district intervention.
- *Mobility Protocol* to calculate the energy and CO_2 emissions avoided with the implementation of mobility actions in the cities as well as the affections in the traffic and journey delays.
- *Protocol for cross cutting issues* which covers social acceptance, citizen engagement and economic performance to be measured through different tools.
    - Social acceptance protocol could aim to evaluate the perception of potential target groups: residents, drivers/vehicle owners and citizens about the project and the quality of life improvements achieved.
    - Economic protocol could deal with the cost effectiveness of the solutions and the return of the investments for potential target groups: residents, drivers/ vehicle owners and municipality.
    - Citizen engagement protocol could cover the influence of the information campaigns and the urban platform in potential target groups (residents, drivers/vehicle owners and citizens), as engagement activities carried out in the cities and the improvement of the Urban ICT infrastructure. It will measure the success of interventions, the use of web and other ICT applications and the attendance to information campaigns. participants.

Regarding KPIs, common indicators will be used for the whole process of evaluation, despite thinking about the possibility of using only a few KPIs for baseline definition in the case of some Protocols (e.g. ICT, social and citizen engagement), where it might not be useful to deploy all the set of KPIs but only the most representative ones.

Table below introduces the foreseen **scope, approach and KPIs for each Protocol** according to the current working plan defined in WP7.

Protocol	Scope proposed	Approach *	Type of KPIs
Energy assessment protocol	Energy and emissions savings & thermal comfort in district due to renovation	Deployment of IPMVP Protocol and adaptation to the district scale. Selection of options defined in this protocol according to the possibilities: data gathered from meters or from energy bills or simulation of the energy use of the whole facility	Technical and environmental indicators for district intervention from D7.2
ICT protocol	Energy efficiency & share of RES/self-energy supply in district due to the use of ICT	Tailored protocol for evaluating the data collected in meters	Technical indicators for district intervention from D7.2
LCA protocol	Reduction in the environment impact due to the intervention in the district	Tailored and simplified procedure for evaluating the data collected from the energy systems and materials of construction used in the district (before and after SmartEnCity). The LCA should be calculated through software SIMAPRO or GABI and the Life cycle inventory database ECOINVENT	Environmental indicators for district intervention from D7.2

Mobility protocol	Energy and emissions savings & traffic and journey delays reduction by mobility actions	Tailored protocol for evaluating the data collected in meters to be installed in vehicles and questionnaires to be distributed to drivers	Technical and environmental indicators for mobility action from D7.2
Social acceptance protocol	Social acceptance of project and interventions & quality life gained with interventions/actions in residents, drivers/vehicle owners and citizens	Tailored protocol for evaluating the data collected from the target groups selected	Social indicators for district intervention, mobility action and citizen engagement from D7.2
Citizen engagement protocol	Success of citizen engagement strategy implemented in the cities by the achievements in workshops/information campaigns and ICT platform (e.g. number of attendees and users from each target group (residents, drivers/vehicle owners and citizens) anddeployment of the urban ICT platform	Tailored protocol for evaluating the information collected from the potential target groups	Technical and environmental indicators for citizen engagement from D7.2
Economic performance protocol	Cost, economic savings & payback associated to the interventions for residents, drivers and municipality	Tailored protocol for evaluating the data collected in questionnaires/interviews and through ICT platform to the target groups selected	Economic indicators for district intervention, mobility action and citizen engagement from D7.2

Table 20. Protocols: scope and KPIs

In addition, this report includes some **details for each Protocol** approach in order to be considered as an introduction for the baseline definition.

Energy Assessment Protocol

Measurement and Verification (M&V) is a well-defined process, which reliably verifies the savings in terms of energy and greenhouse gas emissions achieved by an Energy Conservation Measure (ECM).

Since energy savings cannot be directly measured because this concept represents the absence of energy consumption, the savings have to be determined by comparison of the consumption between the periods before and after renovation, implementing adjustments when needed. With the aim of drawing the concept graphically, Figure below depicts the stages in the M&V plans, where the baseline is the period before the intervention; reporting period represents the post-retrofit period; and separating them, the refurbishment itself.

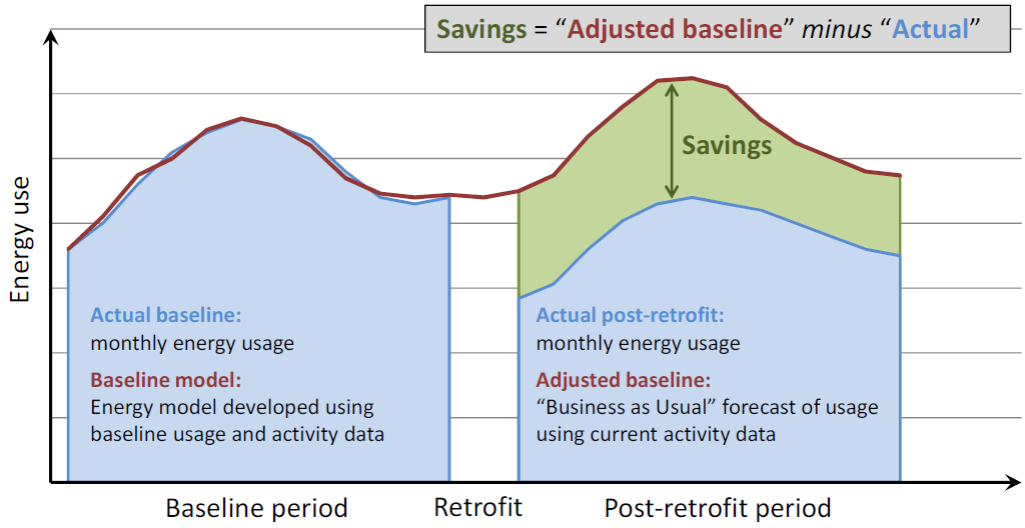


Figure 37. Measurement & Verification stages

IPMVP is the protocol selected at proposal stage for measuring the energy performance in SmartEnCity, being also the protocol implemented in other projects focused in energy renovations of districts. Each LH must establish its own specific Measure & Verification plan (M&V plan) based in the four options defined in IPMVP: (A) individual ECM with measured and estimated parameters; (B) single ECM, but all the values are metered; (C) whole facilities through measurements; (D) entire or partial installation by means of simulation.

In any case, the energy savings are calculated by means of a key-condition for long-term success. The equation below represents the baseline measurements, the actual energy and the adjustments which are used to re-formulate the baseline consumption under the same conditions than the ones in the reporting period.

Energy savings = Baseline energy – Post retrofit energy +/- Adjustments

Regarding the measurement periods, these ought to be selected to determine all the operational modes of the installation. Thus, they must cover a complete operational cycle from the minimum energy consumption to the maximum one. In a lot of projects, IPMVP recommends one year, taking into consideration the climate conditions that affect the energy consumption.

About the adjustments, IPMVP presents two possibilities: routine and non-routine. The first group describes the parameters that influence the energy, varying along the life cycle. On the other hand, the second one considers those variables that remain almost constant during the renovation project.

Finally, an important part within IPMVP is the definition of the boundary. The protocol offers a certain freedom degree for the selection of the boundary, but always considering the facilities involved in the renovation project inside it. In fact, the objective is to reduce the efforts in the independent metering variables. Thus, the boundary can cover an individual element (for instance, a pipe), a group of elements (for example, a boiler with its distribution circuit) and/or the whole building or group of buildings. Within this boundary, the metering equipment is in charge of taking the samples, ensuring to apply the quality assurance concept. In this way, IPMVP establishes that the electricity consumption must be measured in the same way than

in the company (i.e. similar equipment, poll rate, demand peak, etc.). As well, a calibration procedure is set up according to the law procedures so as to decrease the error percentage in the equipment measurements and/or simulation software.

For the case of baseline evaluation, one of the four options has to be selected and applied taking into account that this scenario is proposed to be quantified in an early stage of the project (M18).

(A) Individual ECM with measured and estimated parameters

(B) Single ECM, but all the values are metered

(C) Whole facilities through measurements

(D) Entire or partial installation by means of simulation

Protocols for Social Acceptance, Economic Performance and Citizen Engagement

Tailored protocols must be defined according to the possibilities to be implemented in the LH cities. D7.2 introduced the potential evaluation which includes the target groups (residents, drivers/vehicle owners, citizens and municipality) and the tools (questionnaire or interview to be launched via workshops, telephone calls, door to door, or urban platforms).

Questionnaires are proposed to be launched to residents (tenants or owners), drivers/vehicle owners, citizens and the municipality in order to know information related to social acceptance to the project and economic savings and payback reached with the project, as well as the success achieved through the project. These questionnaires can be distributed in workshop/information campaigns already foreseen in the project, being also possible to arrange another specific action for collecting this information. Furthermore, with the aim to know if it has produced a change in the opinions due to the implementation of actions/interventions, it is thought to launch them in two occasions (before interventions for evaluating the baseline and after the intervention for evaluating the final performance). For an accurate evaluation, the same people/people profile must participate in both stages. Finally, it must be remarked that an only questionnaire will be designed for each target group dealing with all the previous issues.

During the protocol definition, it should be agreed if all these groups can be involved as well as the most suitable tools to be used. These decisions must be made for the whole process of evaluation: baseline and final performance, being aligned with the citizen engagement strategies established in the cities, since involving citizens in this type of activities is not easy.

Different situations can occur:

- A well-established citizen engagement strategy has not been defined, finding difficulties in the collaboration of citizens. In addition, they do not have the knowledge to reply certain questions.
- Although a well-established citizen engagement strategy has been defined, it is considered that this type of actions can difficult the implementation of the intervention since, for example, residents can feel annoyed with this type of actions.

For the final performance, in which a continuous communication with residents, drivers/vehicle owners and citizens has been reached along the project, this type of evaluation should not imply any problem. However, for the case of baseline, which is intended to be evaluated at the beginning of the Project (M18), these difficulties can arise.

Mobility Protocols

Unlike in the building and district evaluation case, for which there is a well-known and established protocol, there is no standard protocol to evaluate the impact of the mobility actions to be implemented in the SmartEnCity. Nevertheless, the core concepts provided by the IPMVP can still be applied (setting a baseline, measuring, computing and reporting savings) with some limitations regarding the scope of the monitoring or the boundaries, given the differences between the studied systems.

As in the building retrofitting case, the baseline period should represent all operating models of the energy systems with a period length sufficient to represent all situations of energy consumption (e.g. different travel habits, weather conditions, holiday seasons, etc.). For the mobility case, this makes a desirable period of at least one year, since it is the minimum period that contains all the periodic holiday seasons and also contains the different weather conditions for all seasons.

Also, data should be gathered at the period immediately before the introduced actions, since periods further back in time would not reflect the starting conditions existing before so accurately.

The scope of the baseline, in terms of energy savings, could be an equivalent number and typology of internal combustion vehicles to the ones introduced by the different measures funded by the SmartEnCity project, although other indicators should be taken at the city level/demo site for those measures not directly related with clean vehicles introduction, such as the usage of public transport or average travel times.

ICTs Protocol

The assessment methodology for the ICT tools aim at ensuring that the implemented monitoring system is able to manage all variables and parameters, and must do it in a reliable and efficient way. Specifically, through this protocol it is expected to know the energy consumption profile of buildings, which allows to manage the energy demand of each substation and to adjust the power delivered by the generator of heat, the reliability of the system based in power interruptions, the ratio of energy produced at local level over the energy consumption, the share of renewable energy in energy consumption/demand of buildings, among other information.

A specific procedure, which includes the selection of only a few KPIs, will be defined for baseline evaluation taking into account that the information that can be gathered at the beginning of the project is related to the existing monitoring tools implemented in the demo site.

Life Cycle Analysis (LCA) Protocol

SmartEnCity intends to deploy a simplified environmental assessment of the renovation actions, undertaking a Life Cycle Assessment (LCA) study, one of the most internationally recognized and accepted methods to investigate the environmental benefits of the life cycle of products, processes and services. Environmental impacts include those from emissions into the environment and through the consumption of resources, as well as other interventions (e.g. land use) associated with providing products that occur when extracting resources, producing materials, manufacturing the products, during consumption/use, and at the products' end-of-life (collection/sorting, reuse, recycling, waste disposal). These emissions and consumptions contribute to a wide range of impacts, such as climate change.

The main objective of this study in SmartEnCity project is to assess the environmental impact associated with the current situation in the district (baseline) in comparison to a future scenario in which efficient energy solutions are implemented in the districts. The final performance will also include the affections to the environment during the retrofitting activity. Therefore, the aim is to consider the changes that will be incorporated in the districts throughout the project development comparing to the baseline scenario. This way, the environmental burdens associated with the demonstrative intervention will be characterised. Finally, LCA will permit to evaluate and identify critical points of the stages or subsystems of the renovation actions, from extraction of raw materials to the end of life of the involved products.

7.8 Data collection approach for the evaluation of intervention performance

Once the protocols are developed, it is necessary to define the programs that compile the monitoring requirements for metering data from interventions (e.g. variables and frequency), as well as the approach which allows to collect data and store them in urban platforms or other storage sources (e.g. questionnaires fulfilled). Monitoring program and data collection approach will include the specifications for baseline and post-intervention period.

These tasks correspond with T7.2 (monitoring program) and T7.3 (data collection approach) which have M18 as deadline. A coordination with the partners involved in the definition of evaluation protocols, monitoring programs, execution of interventions and actions, and performance evaluation must be done in order to align all these issues. There is room in the project for that purpose, establishing the procedure to start such collaboration (T7.4).

The figure below represents the stages until the final performance evaluation of the interventions is completed.

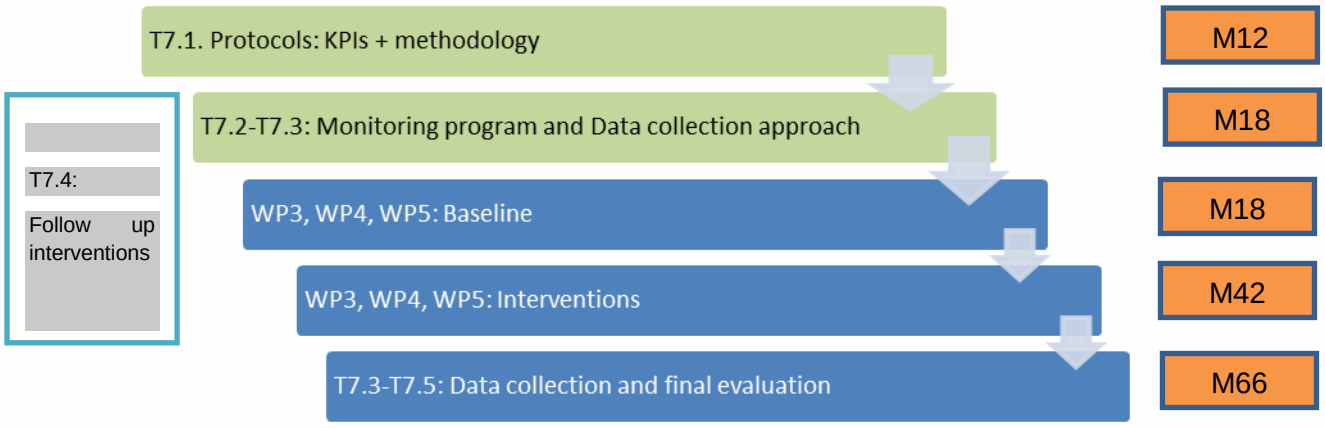


Figure 38. Stages of interventions performance evaluation.

For the case of baseline to be evaluated at M18, monitoring programs and collection approach will be defined as follows.

- *Energy Assessment Protocol***.** Simulation seems the best way to evaluate the energy behavior of the district, since it seems there is not possibility to implement meters with time enough to evaluate the energy consumption before the retrofitting works. If this is the scenario, monitoring metering will not be defined for baseline and data collection approach will refer to collect the data from the district which allows to simulating the buildings.

- *ICTs Protocol***.** Since this protocol is related to the information compiled through the ICT solutions (meters), the monitoring program and data collection for the baseline evaluation will be established according to the available information at the beginning of the project and the monitoring systems previously implemented in demonstrators.
- *Life Cycle Analysis (LCA) Protocol***.** The own protocol could define all the aspects of data collection approach and monitoring requirements for evaluating the environmental impacts.
- *Mobility Protocol***.** It is not well-known how monitoring and data collection approach will be defined for measuring the performance of mobility action, since it will be related to the tailored procedure to be designed.
- *Protocol for cross cutting issues,* which covers the social acceptance, citizen engagement and economic performance. The data collection approach and monitoring requirements are supposed to be part of the own Protocol.

7.9 Installation of monitoring equipment

Once the monitoring program and collection approach is defined, monitoring equipment will be selected and installed according to them in district and vehicles.

The implementation of the monitoring systems has to be developed in parallel to the construction works in districts, whereas for the mobility action, it will be defined a specific strategy for the implementation of monitoring equipment in the vehicles. Then, once the monitoring equipment is available, it is needed a commissioning phase to ensure that the implementation plan has been properly deployed in the three demo sites and that all the data acquisition systems work as expected, to assure that monitoring is performed in an appropriate manner. For the case of baseline, all these aspects must be considered.

7.10 Data collection

Concerning the period considered for collecting data, it will depend on the type of intervention. For the case of district renovation and mobility, it is important to meter all energy consumption data of the building and vehicles before the retrofitting works and mobility actions start during at least one year. Once the works have been concluded, it is recommend monitoring the energy generation, supply and consumption for at least two years in order to guarantee a consistent evaluation.

For the protocols which does not require a continuous collection of data through meters (LCA, Social acceptance, economic performance, citizen engagement), the data collection will finish once all the expected data has been gathered.

7.11 Performance evaluation

The evaluation of the intervention performance must be done according to the protocols established. All the details about how to implement them in baseline will be defined in D7.3.

Consequently, deliverables from WP7 will detail all the aspects related to how to evaluate baseline, dealing this section with some starting descriptions about how to deal with this issue.

8 Deviations to the plan

In case of deviation of submission / completion of Deliverable: reasons and justifications, description of interdependencies with other affected tasks / WPs

Evaluation Framework for Intervention Baseline

- Explain delay of intervention baseline definition > Evaluation Framework for Intervention Baseline

Regarding indicators selection and calculation

In Tartu characterization process (Chapter 5) there are few missing indicators which were identified as *mandatory*. After reviewing the proposal for the three cities, those indicators were identified as relevant, but after a hard gathering and calculating process by TREA, some of them were unavailable. Main reasons were lack of management time to request and receive data from the different responsible bodies, and data availability.

The difficulty of this task has been very useful to identify the potential barriers any city can face in the search, selection and calculation of indicators. This reflection will be a relevant output to include and develop in further generic urban regeneration strategies (D2.7/D2.8), even more bearing in mind the high environmental awareness of Tartu.

For more comprehensive analyses it is suggested for the stakeholders to improve the amount and the quality of the key information related with sustainability assessments. This list of the essential studies required for evaluating the sustainability of the city of Tartu includes the following (but this is no means a final list):

- Energy Balance and flow chart (Sankey diagram or similar) of all the major types of energy carriers;
- Detailed description and overview of the existing technical infrastructure: electricity, district heating, natural gas, water and waste water systems, communication and ICT systems etc;
- Regular analysis of modality and mobility, including usage of active modes of transportation, number of bicycles etc;
- Detailed overview of ICT infrastructure in Tartu including assessment of the ICT capacity in municipality.

Area	Field	Indicators		Units	Data source	Explanation
City characterization	**Socio-economic features of the city** (Current economic performance of the city)	GDP per capita		M€/inh	TAR	Lack of initial data
		Energy intensity of economy		MWh/M€	TAR	Lack of initial data
		Primary Energy Consumption in the city per year		MWh/year	TAR	Needs regular update
		Final Energy produced in the city per year	Heat for private heating		TAR	Private heating data is not collected
		Final Energy produced in the city per capita	Heat for private heating		TAR	Private heating data is not collected

Energy supply network	City energy profile	Total residential oil energy use per capita	kWh/hab·year	TAR	Residential oil energy data is not collected
		Total residential biomass energy use per capita	kWh/hab·year	TAR	Residential biomass energy data is not collected
	Potential local renewable energy resources	Energy use from Solar Thermal	kWh/year	TAR	Solar Thermal data is not collected
		Energy use from Hydraulic	kWh/year	TAR	Hydraulic data is not collected
		Energy use from Mini-Eolica	kWh/year	TAR	Mini-Eolica data is not collected
		Energy use from Geothermal	kWh/year	TAR	Geothermal data is not collected
	Environmental impacts of the energy consumption	Global Warming Potential (GWP) per capita	Tn equi. CO_2 / year capita	TAR	Lack of initial data
		Percentage of the energy consumption by end use in residential buildings: space conditioning	%	TAR	Data is not collected
		Percentage of the energy consumption by end use in residential buildings: domestic hot water	%	TAR	Data is not collected
		Percentage of energy consumption by end use in residential buildings: lighting and appliances	%	TAR	Data is not collected
		Percentage of the energy consumption by end use in public buildings: thermal and cooling uses	%	TAR	Data is not collected
Transport and mobility	Mobility City Profile	Number of bicycles per capita	Number/inh	TAR	Data is not collected
		Total annual number of trips	Number of trips	TAR	Data is not collected
		Total annual number of trips by private car	Number of trips	TAR	Data is not collected
		Total annual number of trips by bike	Number of trips	TAR	Data is not collected
		Total annual number of trips by taxi	Number of trips	TAR	Data is not collected
		Total annual number of trips on foot	Number of trips	TAR	Data is not collected
		Daily average time by trip	min / vehicle ·day	TAR	Data is not collected
		Daily average length by trip	km/ vehicle ·day	TAR	Data is not collected
		Daily average length by motorbike trip	km/ vehicle ·day	TAR	Data is not collected
		Daily average length by taxi trip	km/ vehicle ·day	TAR	Data is not collected
		Daily average length by foot trip	km/ vehicle ·day	TAR	Data is not collected
		Percentage of electric commercial cars	%	TAR	Data is not collected

Urban infrastructure	**Communication infrastructure in the city**	3G Mobile network cells	Number of 3G mobile network cells	TELIA	Data cannot be reached
		4G Mobile network cells	Number of 3G mobile network cells	TELIA	Data cannot be reached
		Number of cell phone connections per capita	Connections/inh	TELIA	The data are not public
		Number of internet connections per capita	Connections/inh	TELIA	The data are not public
		Number of landline phone connections per capita	Connections/inh	TELIA	The data are not public

Table 21. Indicators that cannot be provided as of today

9 Outputs for other WPs

Effects on other WPs

Interdependencies with other Deliverables

This figure shows the connection of Tartu Diagnosis (D4.1) with the next deliverables, being the Urban Regeneration Strategy (D2.7/D2.8) the most immediate report where bearing in mind the conclusions obtained in this deliverable. As the figure shows, the output of D4.1 is in line with D3.1 and D5.1 outputs (Vitoria-Gasteinz and Sonderborg diagnosis).

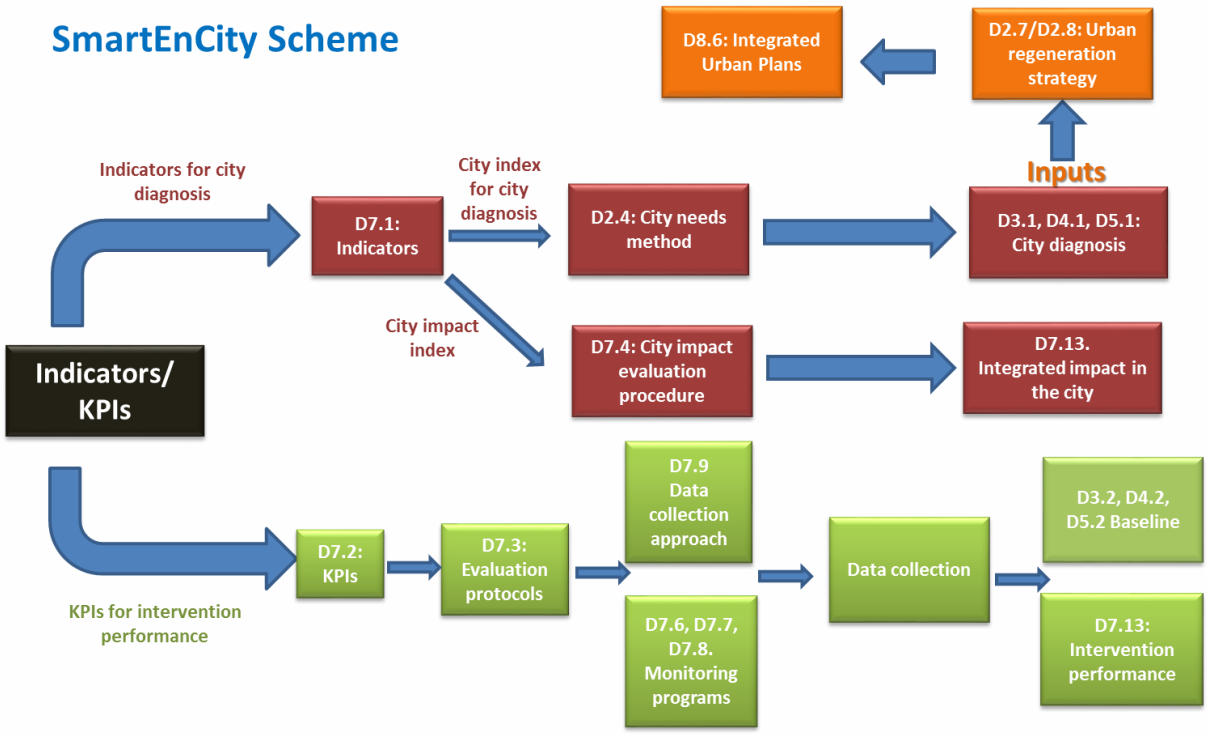


Figure 39. SmartEnCity Indicators/KPIs scheme

The city diagnosis will define the city needs and therefore it is an output for defining Integrated Urban Plans (WP8, D8.6). In addition, the city diagnosis will be the starting point for the city impact evaluation to be done at WP7 (D7.13).

Finally, diagnosis and baseline definition of D4.1 sets the common ground for the remaining WP4 deliverables, which will deal with LH intervention in Tartu.

10 Annex

Annex A1. List of final indicators for city diagnosis

If applicable

E.g., enclose background info or information

The indicators agreed with cities as mandatory (green cells) and optional (yellow cells) have been included in these tables, with updated definitions for those indicators which were classified as optional due to be unfamiliar for some partners. There are also few changes with mandatory indicators regarding previous versions. All changes in definitions/units have been marked in red.

For optional indicators, it is up to the city if they want to include them in the city diagnosis. Also, the city can incorporate (or not) data from other scales (e.g. regional or national) in case there are not data at city level.

All these indicators were introduced in D7.1 with the definitions. Then in D2.4, a further selection was developed, taking into account the opinion of the cities.

List of indicators for city diagnosis				
Area	***Field***	***Indicators***	***Description***	***Unit***
City characterization	***Key features of the city***	Size	Land area of city (total city surface)	km^2
		Population	Total number of persons inhabiting a city	Inhabitant (inh)
		Population density	Population per unit area in the city	Inh./km^2
		Annual population change	Change in the number of inhabitants in the last year	%
		Median population age	Median age is the age that divides a population into two numerically equal groups	Years
		% of population > 75	Number of persons older than 75 years	%
		Land consumption	Formula: *Total built surface/Total city surface* This indicator measures the land use intensity and urban areas density	Km^2/Km^2
	Socio-economic features of the city (Current economic performance of the city)	GDP per capita	The gross domestic product is the monetary value of all the finished goods and services produced within a city's borders in a specific time period considering the number of inhabitants	M€/inh
		Median disposable income	Median disposable annual household income	€
		Energy intensity of economy	Formula*: GDP value of the city /total energy consumption* This indicator is the ratio between the gross inland consumption of energy and the gross domestic product (GDP) for a given calendar year. The gross inland consumption of energy is calculated as the sum of the gross inland consumption of five energy types: coal, electricity, oil, natural gas and renewable energy sources. It measures the energy consumption of an economy and its overall energy efficiency and will serve to understand the energy consumed in relation with the economic situation of the city	MWh/M€
	Socio-economic features of the city	New business registered per population	Number of births of enterprises in a city per the number of inhabitants (or by region in the case) In can be found in EUROSTAT as Employer business demography by size class and NUTS 3 region in this link:	Number

	(City prosperity)		http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=bd_esize_r3&lang=en Alava can be found for the case of Vitoria. In the case of Denmark, I don't know if the regions that appear in the list include the city of Sonderborg.	
		Proportion of working age population with higher education	Proportion of working age population (18-65 years) qualified at level 5 or 6 ISCED (Short-cycle tertiary education or bachelor's or equivalent level)	%
	Socio-economic features of the city (Equity)	City unemployment rate	Unemployed citizens in relation to employed and unemployed who are legally eligible to work	%
		Youth unemployment rate	Percentage of youth labor force unemployed	%
		Percentage of the stock reserved for social housing	*Formula: Number of dwellings built dedicated for social housing/number of total dwellings built in a city* It a measure of the governmental action to improve housing accessibility	%
		Energy poverty level	Share of average energy expenses relative to the average disposable income (income minus taxes). The energy poverty can be understood as a lack of access to "modern" energy services and to goods comfort conditions. There are a lot of definitions for energy poverty but we will consider this ratio: It is considered that families belongs to energy poverty level if this ratio is higher than 10%.	%
	Environmental features of the city	Waste generated per capita	The amount of municipal solid waste generated per capita annually. It includes all economic activities and in addition waste generated by households.	Ton/inh
		Nitrogen dioxide emissions	Average annual nitrogen dioxide emissions per capita collected by environmental stations located in the city. It will also be reported the maximum amount allowed	µg /m^3
		Fine particulate matter emissions	Average annual fine particulate matter emissions (PM 2.5) per capita collected by environmental stations located in the city. It will also be reported the maximum amount allowed	µg /m^3
		Air quality index	Average annual concentration of relevant air pollutants (NOx and fine particles). It will also be reported the maximum amount allowed. This index represents the city's general air quality conditions throughout the year and compare to European air quality norms. This index is based on the pollutants year average compare to annual limit values, and updated once a year.	ppp or µg /m^3
		Days PM10 > 50 µg/m3	Number of days in a year in which the concentration of particles in the city is higher than 50 µg/m^3.	days/year
		Noise pollution	Share of the population affected by noise >55 dB(a) at night time	%
		Green space	Percentage of preserved areas/reservoirs/waterways/parks in relation to total city surface.	ha/ha

Energy supply network	***City energy profile***	Primary Energy Consumption in the city per year	Gross inland consumption of the city excluding non-energy uses	MWh/year
		Final Energy produced in the city per year	This indicator refers to the renewable & non-renewable energy generated in the city. The energy generation shall be expressed independently by type of energy produced.	MWh/year
		Public lighting energy use per year	Final energy consumption in the city for public lighting uses. The energy consumption of public lighting represents usually an important portion of the costs and of the energy consumed in the service sector of cities and it will be useful to evaluate the impact of investing in the public lighting	kWh/year
		Total buildings energy consumption per year	Final energy consumption of energy in whole buildings of the city (it includes residential and non-residential buildings) for heating and electricity uses Consider to split this in two: 1. Buildings heat consumption 2. Buildings electricity consumption.	GWh/year
		Public building energy consumption per year	Final energy consumption of energy in public buildings of the city for heating and electricity uses Consider to split this in two: 1.Public buildings heat consumption 2. Public buildings electricity consumption. It will be useful to evaluate the importance/impact of investing in the retrofitting of public buildings	kWh/m^2
		Residential buildings energy consumption per year	Final energy consumption of energy in residential buildings of the city for heating and electricity uses Consider to split this in two: 1.Residential heat consumption 2. Residential electricity consumption. It will be useful to know the share of energy consumption in heat and electricity in the buildings	GWh/inhab.year
		Primary Energy Consumption in the city per capita	Primary Energy consumption in the city per year and considering the number of inhabitants It will be required the data per capita in order to compare the three cities	MWh/year per inhabitant
		Final Energy produced in the city per capita	Final Energy produced in the city per year and considering the number of inhabitants It will be required the data per capita in order to compare the three cities	MWh/year per inhabitant
		Public lighting energy use per capita	Public lighting energy use in the city per year and considering the number of inhabitants It will be required the data per capita in order to compare the three cities	kWh/year per inhabitant
		Total building energy consumption in the city per capita	Residential + non-residential consumption in the city for heating and electricity uses considering the number of inhabitants It will be required the data per capita in order to compare the three cities	kWh/year per inhabitant
		Public buildings energy consumption per capita	Energy consumption by public buildings considering the surface of public buildings It will be required the data per capita in order to compare the three cities	kWh/m^2
		Residential	Residential consumption in the city for heating and electricity uses	GWh/inhab.year

		buildings energy consumption per capita	considering the number of inhabitants	per inhabitant
		Portion of households connected to the district heating and cooling	*Formula: Number of households connected to the district heating and/or cooling network / total number of households* The existence of decentralized energy generation in a city is in many cases linked to renewable energy generation. The district networks help to integrate the renewable energy and low carbon energy technologies in the energy mix.	%
	Energy uses in building typologies	Total residential natural gas energy use per capita	Total annual residential natural gas use / Total city population It will be required the data per capita in order to compare the three cities	kWh/hab·year
		Total residential oil energy use per capita	Total annual residential oil use / Total city population It will be required the data per capita in order to compare the three cities	kWh/hab·year
		Total residential biomass energy use per capita	Total annual residential biomass use / Total city population	kWh/hab·year
		Percentage of the energy consumption by end use in residential buildings: space conditioning	Measure of the total energy consumption of heating and cooling in residential buildings. Formula: [Energy consumption in the domestic sector related to heating and cooling over a calendar year / Total residential buildings energy consumption] x100	%
		Percentage of the energy consumption by end use in residential buildings: domestic hot water	Measure of the total energy consumption of DHW in residential buildings Formula: [Energy consumption in the domestic sector related to domestic hot water over a calendar year / Total residential buildings energy consumption] x100	%
		Percentage of energy consumption by end use in residential buildings: lighting and appliances	Measure of the electricity consumption in residential buildings Formula: [Energy consumption in residential buildings related to lighting and appliances over a calendar year / Total residential buildings energy consumption] x100	%
		Percentage of the energy consumption by end use in public buildings: thermal and cooling uses	Measure of the electricity consumption in public buildings Formula: [Energy consumption in public buildings related to heating, DHW and cooling over a calendar year / Total public buildings energy consumption] x100	%
		Percentage of the energy consumption by end use in public buildings: electrical uses	Measure of the electricity consumption in public buildings Formula: [Energy consumption in public buildings related to lighting and appliances over a calendar year / Total public buildings energy consumption] x100	%
	Potential local renewable energy resources	Percentage of total energy derived from renewable sources	Total renewable energy consumption in the city /gross inland consumption in the city	%
		Energy use from District Heating	Total energy supplied by district heating sources in the city/ Total energy consumption in the city	kWh/year

		Energy use from Biomass	Total energy supplied by biomass sources in the city/ Total energy consumption in the city	kWh/year
		Energy use from PV	Total energy supplied by photovoltaic sources (photovoltaic plants or distributed photovoltaic elements) in the city/Total energy consumption in the city	kWh/year
		Energy use from Solar Thermal	Total energy supplied by solar thermal sources/Total energy consumption in the city	kWh/year
		Energy use from Hydraulic	Total energy supplied by water sources (hydraulic plants)/ Total energy consumption in the city	kWh/year
		Energy use from Mini-Eolica	Total energy supplied by wind sources/ Total energy consumption in the city	kWh/year
	Potential local renewable energy resources	Energy use from Geothermal	Total energy supplied by geothermal sources/ Total energy consumption in the city	kWh/year
		Budgets devoted to renewable energies and Energy Efficiency	Public Budget (from the city council) of the projects related to Renewable Energy and Energy Efficiency /population	Euros / Persons
	Environmental impacts of the energy consumption	Global Warming Potential (GWP) per capita	Emissions of residential and non residential sectors / city population	Tn equi. CO_2 / year capita

City plans and regulation & Governance	**City plans and strategies**	Existence of plans/programs to promote energy efficient buildings	Is there any specific document promoted by the municipality which details a set of intended actions for promoting energy efficient buildings in the city?	YES/NO
		Existence of plans/programs to promote sustainable mobility	Is there any specific document promoted by the municipality which details a set of intended actions for promoting sustainable mobility in the city?	YES/NO
		Existence of local sustainability action plans	Is there any specific document in the city which provides direction on common management issues associated with water, waste, energy, biodiversity and pollution in the city?	YES/NO
		Signature of Covenant of Mayors	Has the municipality signed the Covenant of Mayors?	YES/NO
		Existence of Smart Cities strategies	Is there any specific urban development vision to improve quality of life by using technology to meet residents' needs and improve the efficiency of services (e.g. government services, transport and traffic management, energy, health care, water, innovative urban agriculture and waste management)?	YES/NO
		Existence of public incentives to promote energy efficient districts	Are there any specific public incentives for promoting the energy efficient districts in the city coming from the municipality (e.g. grant, tax exemptions and special loans)?	YES/NO
		Existence of public incentives to promote sustainable mobility	Are there any specific public incentives for promoting sustainable mobility in the city coming from the municipality (e.g. grant, tax exemptions and special loans)?	YES/NO
	Public procurement procedures & Regulations and normative	Existence of regulations for development of energy efficient districts	Is there any specific official rule or law performed by the municipality that says how to develop energy efficient districts in the city?	YES/NO
		Existence of regulations for development of sustainable	Is there any specific official rule or law performed by the municipality that says how to develop sustainable mobility in the city?	YES/NO

		mobility		
		Existence of local/national Energy Performance Certificate (EPC)	Is there any specific EPC for buildings in the city?	YES/NO
		Share of Green Public Procurement	Percentage of annual procurements in the city administration (public transport, construction, health services and education) that include environmental criteria	%
	Governance	Involvement of the administration on smart city projects	The extent to which the smart city strategy has been assigned to one department/director and staff resources have been allocated. The valuation will be made by working team working in the city diagnosis	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree
		Involvement of the administration on smart city projects	What extent to which the local authority is involved in the development of smart city projects, other than financial? The valuation will be made by working team working in the city diagnosis	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree
		Multilevel government	The extent to which the city cooperates with other authorities from different levels. The valuation will be made by working team working in the city diagnosis	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree
		Paperless governement (incl e-signature)	The extent to which the Information and Communication Technologies (ICTs), and other web-based telecommunication technologies have been deployed in the city to enhance the efficiency and effectiveness of service delivery in the public sector. The valuation will be made by working team working in the city diagnosis	Likert scale Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree
Transport and mobility	**Mobility City Profile**	Total number of vehicles in the city per capita	Number of public and private vehicles registered in the city divided by the number of inhabitants	Number/inh
		Total number of private cars per capita	Number of private cars registered in the city divided by the number of inhabitants	Number/inh
		Total number of commercial vehicles per capita	Number of vehicles used for the delivery of goods and services divided by the number of inhabitants	Number/inh
		Total number of taxis per capita	Number of taxis registered in the city divided by the number of inhabitants	Number/inh
		Total number of trucks per capita	Number of trucks registered in the city divided by the number of inhabitants	Number/inh
		Total number of public buses per capita	Number of buses registered in the city for public services divided by the number of inhabitants	Number/inh
		Total number of public bicycles per capita	Number of available bicycles in public initiatives divided by the number of inhabitants	Number/inh
		Number of bicycles per capita	Number of private bicycles registered in the city divided by the number of inhabitants	Number/inh

		Number of two-wheel motorized vehicles per capita	Total number of two-wheel motorized vehicles (including scooters and motorcycles, but no bicycles), related to the total number of inhabitants	Number/inh
	City Statistics for Mobility	Average age of motor vehicles for public transport	Mesure of the average age of motor vehicles for public transport	years
		Kilometers of high capacity public transport system per population	Length of high capacity public transport network (heavy rail metro, subway and commuter rail systems)	Km/inh
		Kilometers of light passenger public transport system per population	Length of light capacity public transport network (light rail streetcars, tramways, bus, trolleybus and other)	Km/inh
		Kilometers of bicycle paths and lanes per population	Length of bicycle paths (independent roads or parts of a road designated for cycles and signed-posted as such) and lanes (part of carriageways designated for cycles and distinguished from the rest by longitudinal road markings)	Km/inh
		Total annual number of trips	Total annual number of trips in the city	Number of trips
		Total annual number of trips by private car	Total annual number of trips by private car	Number of trips
		Total annual number of public transport trips	Total annual number of trips in public transport	Number of trips
		Total annual number of trips by bike	Total annual number of trips by bike	Number of trips
		Total annual number of trips by motorbike	Total annual number of trips by motorbike	Number of trips
		Total annual number of trips by taxi	Total annual number of trips by taxi	Number of trips
		Total annual number of trips on foot	Total annual number of trips on foot	Number of trips
		Annual number of public transport trips per capita	No. of trips made by public transport per year / Total city population	Number trips /inh
		Daily average time by trip	Annual time of total trips / total number of vehicles / 365	min / vehicle ·day
		Daily average length by trip	Annual length of total trips / total number of vehicles / 365	km/ vehicle ·day
		Daily average length by private car trip	Annual length of total trips by private car/ total number of vehicles / 365	km/ vehicle ·day
		Daily average length by public transport trip	Annual length of total trips by public transport/ total number of vehicles / 365	km/ vehicle ·day
		Daily average length by bike trip	Annual length of total trips by bike/ total number of vehicles / 365	km/ vehicle ·day
		Daily average length by motorbike trip	Annual length of total trips by motorbike/ total number of vehicles / 365	km/ vehicle ·day
		Daily average length by taxi trip	Annual length of total trips by taxi/ total number of vehicles / 365	km/ vehicle ·day
		Daily average length by foot trip	Annual length of total trips on foot/ total city population / 365	km/ vehicle ·day
		Percentage of	Number of electric vehicles related to total number of private cars	%

		electric private cars		
		Percentage of electric commercial cars	Number of electric vehicles related to total number of commercial cars (vehicles for delivery goods)	%
		Percentage of electric taxis	Number of electric vehicles related to total number of taxis	%
		Percentage of electric motorcycles	Number of electric vehicles related to total number of motorcycles	%
		Percentage of electric public buses	Number of electric vehicles related to total number of public buses	%
		Percentage of biogas public buses	Number of biogas vehicles related to total number of public buses	%
		Number of public EV charging stations	Total number of public EV charging stations in the city	Number
		Total number of recharges per year	Total number of recharges during a year in the public EV charging stations	Number
		Total kWh recharged in the EV charging stations	Number of estimated kWh recharged during a year in the public EV charging stations	kWh
		Parking facilities per capita	[No. of public and private parking facilities / Total city population] Measure of the facility to park vehicles.	Number/inh
		Number of public parking areas per capita	Total public parking areas in the city/Total city population	Number/inh
		Number of available parking slots per capita	Total number of public parking slots in the city	Number/inh
		Pedestrian area per capita	Surface in the city reserved for pedestrians related total surface in the city. It is a measure of the facility for pedestrian movement.	Km^2/km^2
		Cost of a monthly ticket for public transport in relation to the national minimum wage or average wage	[Price of a monthly ticket for public transport in the city / National minimum or average wage)] x 100. It is a measure of the weight of public transport in the household economy.	%
		Transportation fatalities per capita	[No. of transportation fatalities in the city over a calendar year / Total city population]. It is a measure of the overall safety of the transportation system.	Number/inh
	Environmental impact with mobility	Transport energy use per capita	Transport energy use over a calendar year / Total city population. Measure of the total energy use per capita due to public and private transport.	kWh /pers.·a
		Transport greenhouse gas emissions per capita	Transport GHG emissions, in equivalent CO2 units, generated over a calendar year / Total city population Measure of the total greenhouse gas emissions per capita due to public and private transport.	t /(pers.·a)
		Percentage of renewable energy use in public transport	[Renewable energy use in public transport over a calendar year (kWh) / Public transport energy use over a calendar year (kWh)] x100 Measure of the use of renewable energy in public transport.	%

Urban infrastructure	Existing city monitoring infrastructure	Number of parking information panels	Total numbers of panels in the city with availability information in public parkings	Number
		Number of air quality stations	Total number of air monitoring stations/points located in the city related to the minimum stations required by the law	Ratio
		Number of noise stations	Total number of noise monitoring stations/points located in the city related to the minimum stations required by the law	Ratio
		Number of weather stations	Total number of weather stations/points located in the city related to the minimum stations required by the law	Ratio
		Number of loan point for public bicycles	Total hire-points in the city to enable users to pick up and return public bicycles related to the number of public bikes	Ratio
		Number of smart-meters installed	Total number of smart-meters installed in the city related to the number of inhabitants	Ratio
		ICT citizen oriented platforms	Is there any public ICT global platform available for citizen offering general information about the city and including iinstitutional mechanisms which allow to provide to the managers or policy makers of the city the problems identified by the citizens in order to trigger administration action?	YES/NO
		Data privacy	The level of data protection by the city is defined as how the ownership of the data has been clearly defined and accepted by the residents	Likert scale: Strongly disagree/Disagree Neither agree nor disagree/Agree/ Strongly agree
	Communication infrastructure in the city	Percentage of the population covered by a mobile-cellular network	Number of persons who own a mobile cellular related to the city population	%
		Percentage of the population covered by at least a 3G mobile network	Number of persons who own a mobile cellular at least 3G related to the city population	%
		3G Mobile network cells	Total number of 3G (UMTS & CDMA2000) mobile network cells to cover the land area of the city from a mobile phone perspective	Number of 3G mobile network cells
		4G Mobile network cells	Total number of 4G (WiMAX) mobile network cells to cover the land area of the city from a mobile phone perspective	Number of 4G mobile network cells
		Number of cell phone connections per capita	Total number of cell phone connections in the city in relation to the population of the city	Connections/inh
		Number of internet connections per capita	Total number of internet connections in the city in relation to the population of the city	Connections/inh
		Number of landline phone connections per capita	Total number of landline phone connections (excluding cellular connections) in the city in relation to the population of the city	Connections/inh
		Smartphone penetration	Number of smartphones in relation to total mobile phones	%
		Free Wi-Fi zones	Total number of free Wi-Fi zones offered to citizens	Number of free Wi-Fi zones identified in the city

		Cable Network	Is there any network cable system deployed in the city?	YES/NO
		Cable Network Types	Different types of networks deployed in the city	Types of cable network available in the city (twisted pair cable, coaxial cable, fibre optic,…)
Citizens	**Existing actions related to citizen engagement**	Recycling rate	Amount of solid waste recycled/amount of municipal solid waste generated	%
		Voter turnout in last municipal election	Voter participation level: [Number of persons that voted in the last municipal election /Total city population eligible to vote] x 100	%
		Number of local associations per capita	Total number of citizen associations in the city: Number of associations / Total city population	Number of consultations / inhab.
	Channels for citizen engagement	Number of information contact points for citizens	Total number of information contact points for energy efficiency, sustainable mobility, environment, etc in the municipality	Number
		Number of municipal websites for citizens	Total number of available websites for informing citizens about the city	Number
		Number of websites consultation per capita	Total number of visits in the websites related to total city population	Number
		Number of interactive social media initiatives	Total number of municipality links in social media channel as Facebook, Twitter, YouTube, etc (It is required to mention the channels) as well as total number of followers of each initiative related to the population of the city	Number
		Number of discussion fórums	Total number of internet discussion site dedicated to the citizens	Number
		Number of awareness raising campaigns	Average number of awareness raising campaigns carried out in the city yearly for energy, mobility and environmental	Number
		Number of thematic events	Number of thematic events dedicated to citizens in the topics energy efficiency, sustainable mobility and environment. Previous term (awareness campaigns) tries to provide information about a topic to improve understanding as well as mobilising the society to bring about the necessary change in attitudes and behaviour. In this case, the purpose is only to inform about a topic	Number
		Number of newspaper columns	Number of columns addressed to topics related to energy efficiency, sustainable mobility, environment which appear in local newspapers each week	Number
	Current scenarios of citizen engagement	Citizens participation in smart city projects	The number of projects in which citizens actively participated as a percentage of the total projects executed	Number
		Professional stakeholder involvement	What extent to which professional stakeholders are involved in planning and execution of urban strategies in your city?	Likert scale: Strongly disagree/Disagree Neither agree nor disagree/Agree/ Strongly agree

Table A1. Common and optional indicators