



TOWARDS SMART ZERO CO<sub>2</sub> CITIES ACROSS EUROPE  
VITORIA-GASTEIZ + TARTU + SONDERBORG

## Deliverable 4.11: ICT infrastructure commissioned and deployed, CIOP in use.

### WP 4, Task 4.7

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PP = Restricted to other programme participants (including the Commission Services)

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## Abbreviations and Acronyms

Abbreviation/Acronym	Description
API	Application programming interface
CIOP	City Information Open Platform
DAL	Data Access Layer
ESCO	Energy Savings Company
EC	European Commission
EU	European Union
EV	Electric Vehicle
GDPR	The EU General Data Protection Regulation
GIS	Geographic Information Systems
GUI	Graphical User Interface
ICT	Information and Communication Technology
KPI	Key Performance Indicator
PI	Performance Indicator
SEC	SmartEnCity project
WP	Work Package

Table 1 Abbreviations and Acronyms

## Publishable Summary

Tartu has a long tradition of using smart solutions to enhance its citizens' quality of life. Various ICT solutions are an integral part of this approach and the reason for incorporating them also into the Tartu SmartEnCity (SEC) project. ICT solutions will not only boost the development of Tartu as a smart city but also offer comfort, security and an enhanced quality of life for its pilot area citizens.

The reasons for including ICT solutions in the Tartu SEC project are numerous as they:

- enhance automation and thus also increase optimization;
- gather all city-wide data relevant into one innovative platform;
- enable to freely monitor all the data both on a city, building and apartment level;
- enable to monitor the functioning of systems and prevent and detect errors;
- increase residents' awareness of their energy consumption and thus allow the residents to make better-informed consumption decisions;
- increase both the residents' and Tartu citizens' awareness of the potential of ICT solutions and how they can benefit their everyday life (i.e. the smart home systems that will be installed in the pilot area smartovkas).

To this end, the ICT infrastructure and the CIOP that has been deployed in Tartu includes the integration of several city-wide smart solutions: district heating, smart city lighting, smart buildings and apartments, traffic and public transport. Each of these aspects along with the system description of the CIOP can be found below.

# 1. Introduction

## 1.1. Purpose and target group

The purpose of this document is to provide an overview of the ICT solutions created in the Tartu SEC project, how they have been implemented and how they will be used. The detailed system description is expected to help both current users and with potential replication efforts. Thus, this description covers current implementation and as a dynamic system, both system components and/or user portals may change over time.

## 1.2. Contributions of partners

This document has multiple authors, all constituting the main partners of WP4. The following Table 2 depicts the main contributions from participant partners in the development of this deliverable.

Participant short name	Contributions
ET	Task Leader. Responsible for the content of the deliverable. The main contributor of Sections 2, 3, 5, 6 and 7, and contributor of Section 4
TAR	Contributor of Sections 1, 2, 4
IBS	Contributor of Section 0, 1, 2
SCL	Contributor to Section 4
UTAR	Contributor to Section 5

**Table 2 Contributions 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
D6.2	This demonstrator presents the Reference Architecture for SmartEnCity
D6.3	This demonstrator presents the Reference Architecture for SmartEnCity completed with the Data Models
D6.4	This demonstrator presents the Reference Architecture for SmartEnCity completed with the Interoperability Mechanisms
D5.11	This demonstrator will be complemented by the developments and implementations made under Sonderborg CIOP task.
D7.3	The implementation in each lighthouse will be measured with Key Performance Indicators described by WP7

**Table 3 Relation to other activities in the project**

## 2. Objectives

### 2.1. Objectives of WP

The objective of WP4 is to coordinate and implement all the planned interventions in the Tartu demo site and oversee the monitoring period that follows.

These interventions include implementing the smartovka retrofitting package, integrated infrastructure solutions, sustainable mobility actions, and ICT solutions.

### 2.2. Objectives of Task 4.7

Task 4.7 is led by ET, other participants include TAR, SCL, UTAR, and IBS. Under this task and following the efforts of WP6, the deployment of the ICT infrastructure that is needed for data harvesting, monitoring, and evaluation in Tartu's City Information Open Platform (CIOP) will be set up. This infrastructure deployment needs to be planned and carried out in close coordination with previous activities and taking into account the overall progress of WP4.

As the most tangible outcome for the pilot area residents, all smartovka apartments will receive a smart home system equipped with software that enables to monitor their energy consumption and control the functioning of their new smart homes.



### 3. City CIOP concept

Tartus' long term vision is to build a Digital Ecosystem for city data and services by integrating various data inputs and sensor systems together into one city ICT platform, where anyone could build their own Value Adding Services on top of city provided platform. The City Information Open Platform (CIOP) concept was introduced by Telia, within SmartEnCity project.

**Tartu CIOP** is a direct outcome of WP6 studies and is built on top of foundation described in WP6 deliveries, where a state-of-the-art study of available platforms and technologies was performed to find the best data and services integration solution for the city.

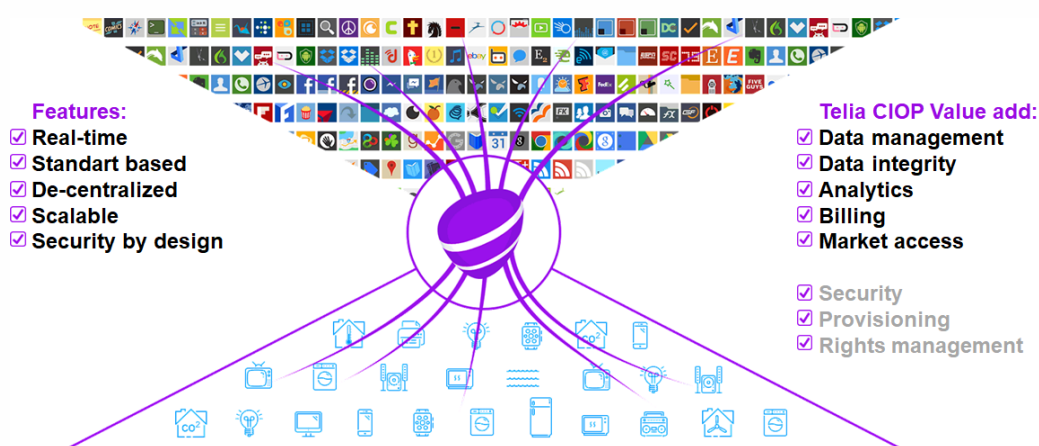


Figure 1 Digital Single Market for city services

The challenge was high due to the nature of data that had to be collected - City Level, Building Level and personalized Apartment Level data all in one platform. Whereas City-level data had to be open for anyone to use and at the same time personalized data had to be protected on the GDPR level.

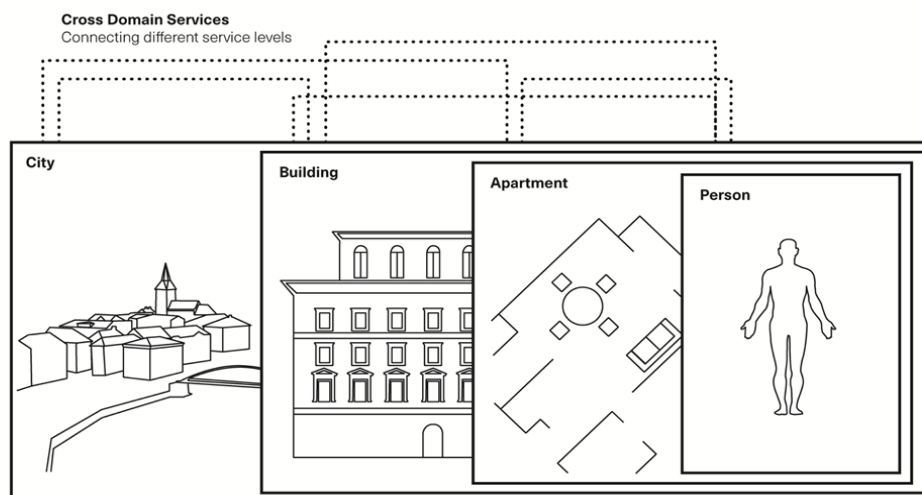


Figure 2 Cross Domain Data and Services

To best address the above-described challenge, the CIOP was designed with multiple separate modules:

- 1) IoT platform Cumulocity for easy integration of any sensor systems,
- 2) Data Access Layer (DAL) for Authentication and Consent Management. This layer also introduces an API for Third Party Access to the data,
- 3) Data Mapping Tool as a technical service for describing and allocating data for end-users,
- 4) City Portal for end-user access to City and personal data.

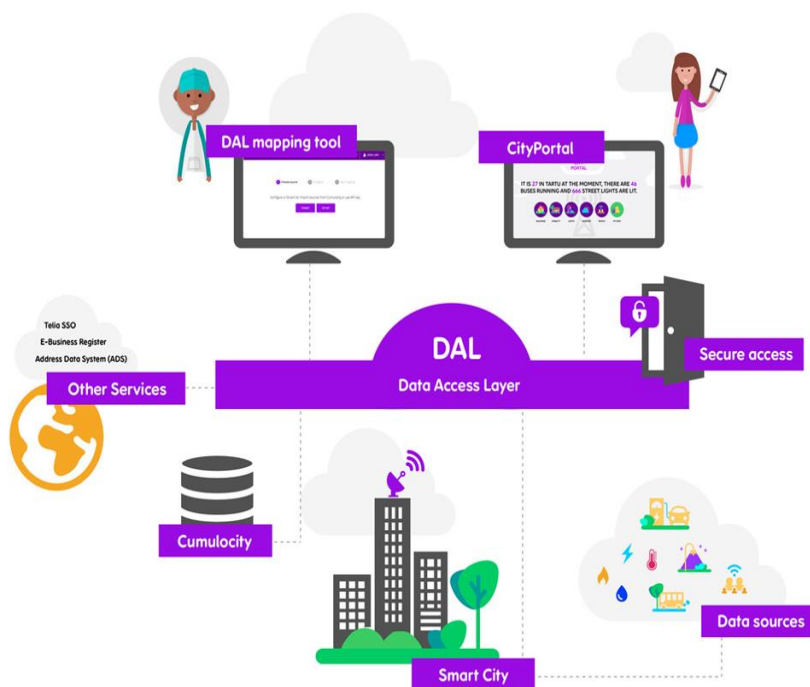


Figure 3 CIOP modules

After business and technical requirements were identified, the state-of-the-art study was performed and 54 smart-city, IoT and/or similar platforms were listed. After benchmark testing against above-mentioned requirements, Cumulocity was the one to outperform other similar platforms and was implemented as the first part of the CIOP.

On top of Cumulocity and other data inputs, one of the most important parts of the CIOP is **Data Access Layer (DAL)**. This is a secure gatekeeper module between data producers and consumers. All authentications are controlled by DAL, also sharing, delegation information and consent management is handled in this module. These are the components to secure the data and ensure the GDPR compliance.

**City Portal** includes two strictly separate parts - **Open Data** portal and My Data portal. Under the Open part of the portal, everyone can see, free of charge, the data that has been published by the city or building owners.

For the **My Data** part of the portal, Estonian national hard-authentication options are used - meaning every Estonian citizen can log in conveniently without a separate user-account needed. After login, a person can see all the data related to him/her and the data that is shared or delegated for him/her.

Please find a more detailed description of DAL and City Portal options under Value Added Services chapter.

Technically the CIOP consists of multiple services and technologies that are interconnected through API's. Some of which are only for internal use to ensure the futureproofness by modularity, where all the modules could be changed in the system, without changing the whole system itself at once. The rest of the API's are open to using by partners who have joined the ecosystem and want to utilize one or multiple benefits of the CIOP.

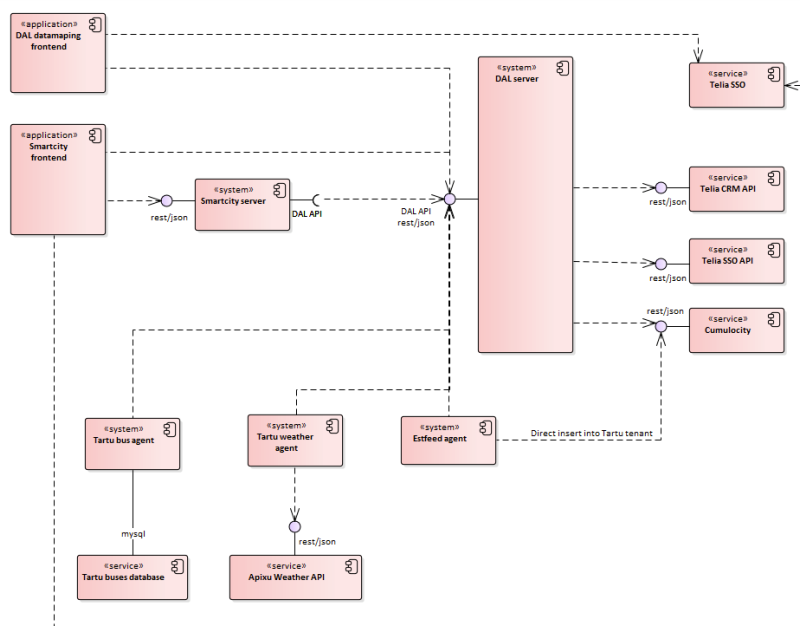


Figure 4 CIOP technical architecture

## 4. Integrated infrastructures

This chapter gives an initial overview of integrations made during the SmartEnCity project. After, or in parallel with the project, Tartu can make other integrations with other devices or data providers.

### 4.1. District heating and cooling

Fortum Tartu has its remote metering system for central heating that sends daily heat consumption to their information system. Fortum pushes then heating data directly to CIOP.

New cooling station stores all the data to separate Fortum system that is not accessible for 3<sup>rd</sup> parties due to security reasons. Monthly based data is reported by Fortum to city manually and then added into CIOP.

### 4.2. Smart City Lights

During the SmartEnCity project, 321 smart lights with controllers and more than 60 different sensors (movement, environment, video, noise) were installed in Tartu by Cityntel. Before the project started, Cityntel had installed another 1000 smart lights. After integration, all 1300 lights and sensors are reporting data to CIOP.

Besides Cityntel smart lights, there is another smart lighting company, Gridens Technologies that has installed ~1200 smart lights – as the API integration had been unified before the SmartEnCity project, now all ~2500 Tartu smart lights are connected into CIOP.

### 4.3. Smart Buildings and apartments

The smart home solution for Tartu pilot area apartment buildings 'smartovkas' was procured by public tender. Winning company EnLife Ltd produces and installs devices into 16 houses with 559 apartments. Both wired and wireless solutions are installed depending on house association preference. Every house gets a central server device which works independently but is connected to the internet to share data with CIOP. The role of the central device is:

- to gather and store data from sensors and meters
- to communicate with controllers and repeaters
- to deliver commands to heat and ventilation system
- to serve a web and app interface for home users
- to change data with CIOP

In addition to the central server the signal amplifiers, controllers, radio access points, impulse counters, thermostats, temperature and smoke sensors, tablet computers (control panels) are procured and installed.

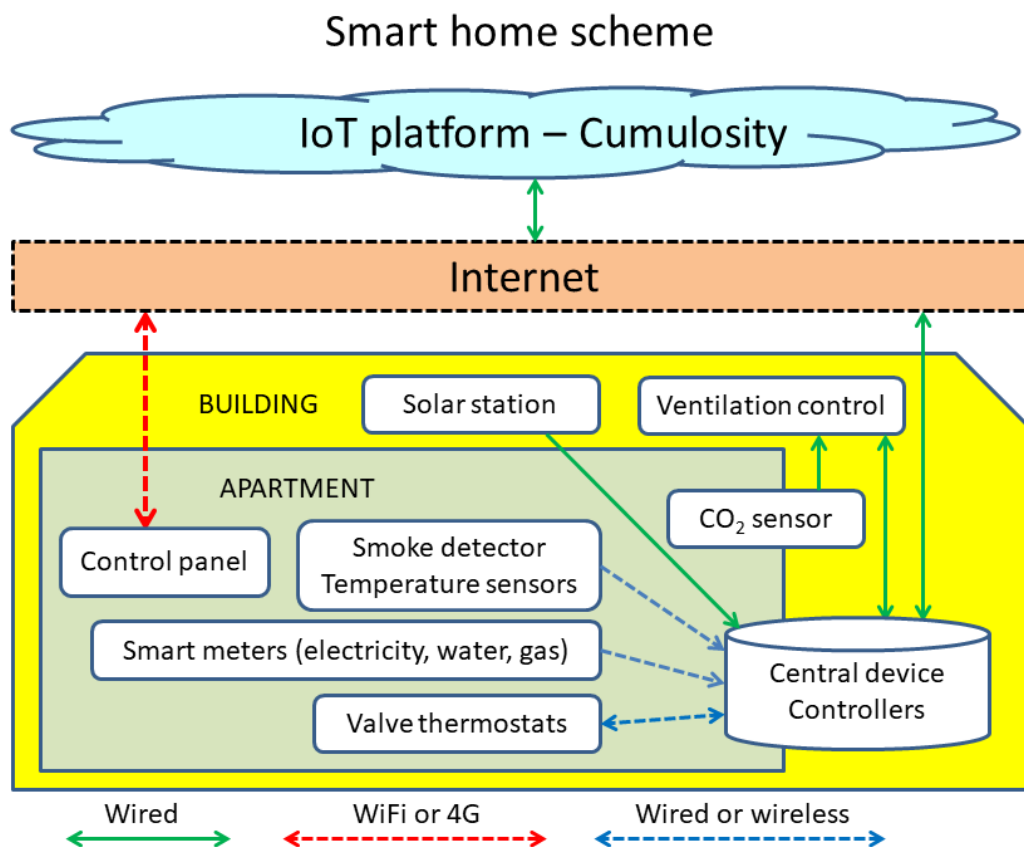


Figure 5 Smart home solution scheme

The smart home solution covers the following functionalities:

- **Heat control** – apartment owner can see and regulate the room temperature from the control panel or directly on radiator thermostats
- **Ventilation control** – apartment ventilation is controlled automatically based on apartment CO<sub>2</sub> level, the owner can maximize or minimize the ventilation for a shorter period and see current CO<sub>2</sub> concentration
- **Remote metering** – apartment's electricity, gas, and water meters are equipped with digital consumption readers; the consumption is displayed on the control panel and automatically delivered to the service provider
- **Solar production** – every 'smartovka' has installed solar panels for its' own small power station. The building will consume most of its' produced electricity, in case of extent production, the rest of the electricity is sold to the grid. The production information of the station is displayed on the home control panel.
- **Smoke detection** – every apartment gets a connected smoke detector and alarms will be delivered also to the mobile app and to other inhabitants
- **Data comparison** – owner can compare his apartment energy consumption to house average and house consumption to pilot area average
- **Other data** – current date, time and outside temperature are also displayed on the control panel
- **Data interchange** – consumption data is replicated to CIOP for pilot area monitoring

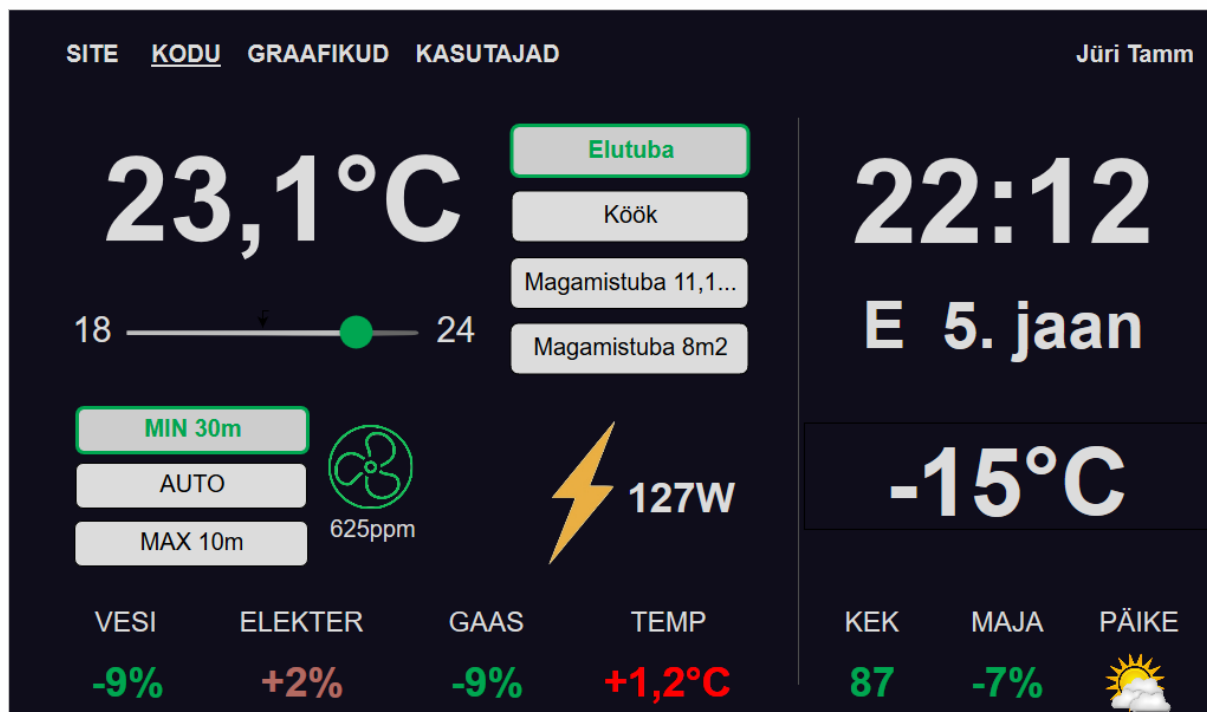


Figure 6 Apartments' Control panel dashboard

#### 4.4. Other integrations

Also, data from EV chargers, EV battery reuse system and Bike-sharing are already stored and integrations with CIOP will be finalized by the end of July 2019.

## 5. Value-Added Services on top of CIOP

This chapter will describe existing and future services that are built on top of data collection.

### 5.1. Tartu Smart City Portal

#### Frontpage

In the menu, you can choose between different pages: Buildings, Mobility, Lights, Weather, People, My data. The first five pages are open for exploring for everyone and My Data is secured for your personalized data.



Figure 7 City Portal landing page

#### Buildings view

This page shows smart apartment buildings' locations and average energy consumption on the map. For example, circled numbers on the map below show electricity consumption in the smart buildings integrated with SmartEnCity system.

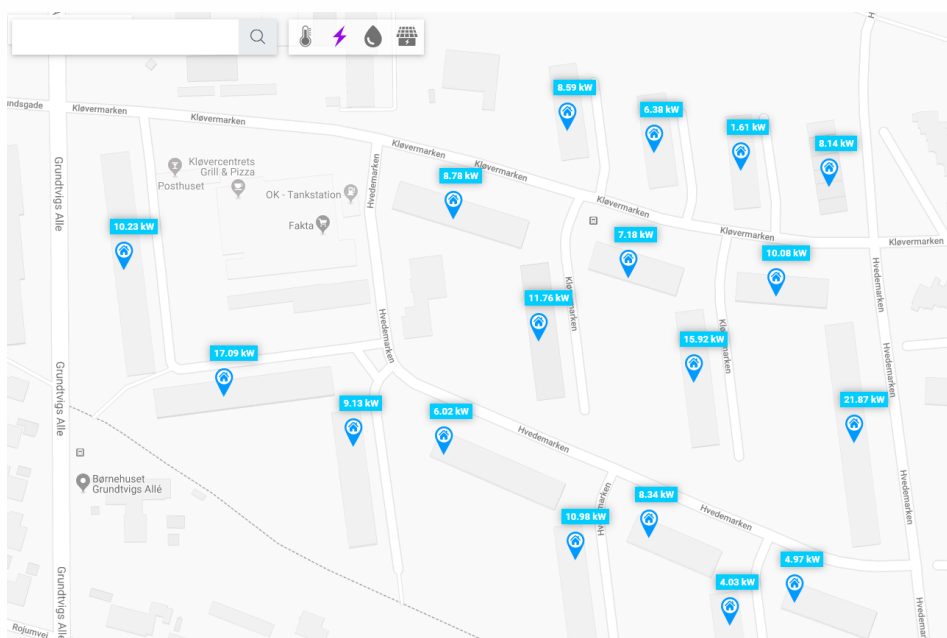
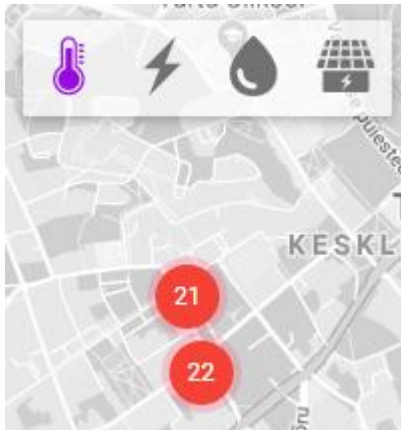


Figure 8 Smart building map

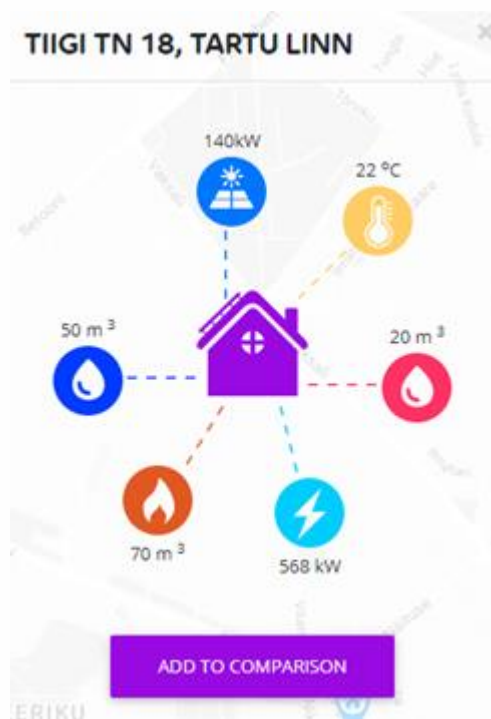


To see the other energy consumption, click on desired energy icon on the filter bar at top of the screen.



**Figure 9 Switching between data layers**

You can select only one filter at the time. To see all consumption data and building address at the same time, click on the circled number on the map. A pop-up box will now appear on the left side of the screen with all the data that is available for that building.



**Figure 10 Smart building data overview**

To see average daily, weekly, monthly and etc. data, move your mouse over the desired energy icon.

If required you can compare energy consumption between buildings. To add a building to comparison, click on the “Add to comparison” button in the pop-up box.



To see compared buildings data, click on the “Compare” button at top of the screen. Energy consumption graph will now appear in the pop-up box.

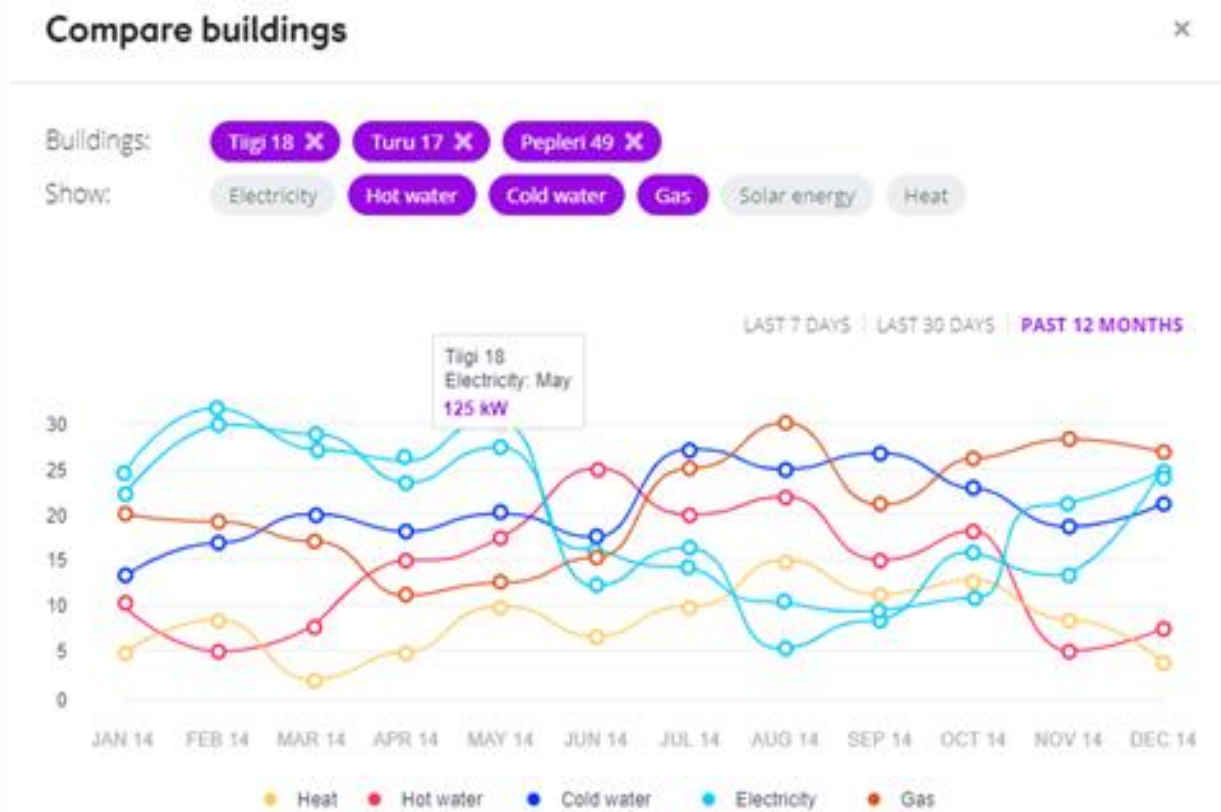


Figure 11 Comparing the buildings energy consumption

You can filter what consumption data you want to see on the graph by selecting energy filters from the Show row.

To remove the building from comparison, click on the building name.

### Search bar

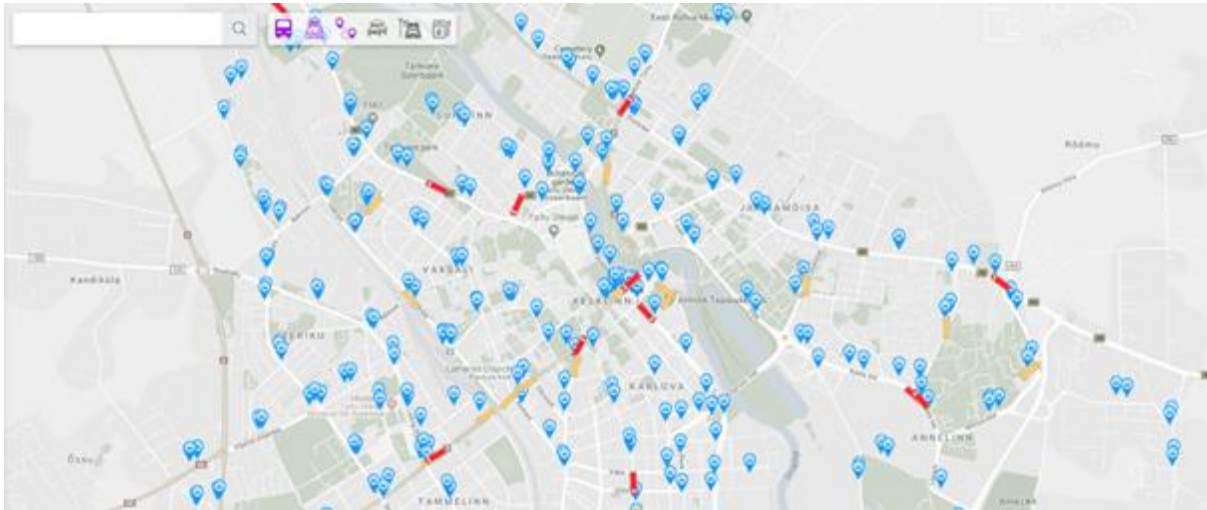
You can use the „Search bar“ to search for the desired building consumption data. Start to enter the building address and then choose it from the pop-up box. Consumption data will now appear on the left side of the screen in the pop-up box.

### Zoom in/out

To zoom the map in or out, scroll with your mouse or use „+“ and „-“ buttons in the lower right-hand corner of the map.

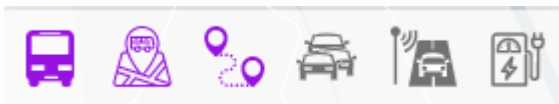
## Mobility map

By default, this page shows Tartu bus stops, routes and real-time buses movements on the map.



**Figure 12 Mobility map**

You can filter the data you want to see on the map by selecting filters from the “Filter bar” at top of the screen. You can select one or more filters at the same time. Purple icons show selected filters.



**Figure 13 Switching between data layers**

You can choose between the following filters:

- Show buses
- Show bus stops
- Show bus routes
- Show traffic
- Show traffic monitoring

## Tracking the buses

To track buses' movements in real-time, click on the “Show buses” icon on the “Filter bar” at top of the screen. Bus icons will now appear on the map.

Red bus icons show moving buses, yellow bus icons present stopped buses.



Figure 14 Bus tracking

To see the bus route, move your mouse over the bus icon. Route name will now appear above the bus icon.

To see the bus schedule, click on the bus icon. On the left side of the screen, a pop-up box will now appear with the bus schedule, starting from the current bus location.

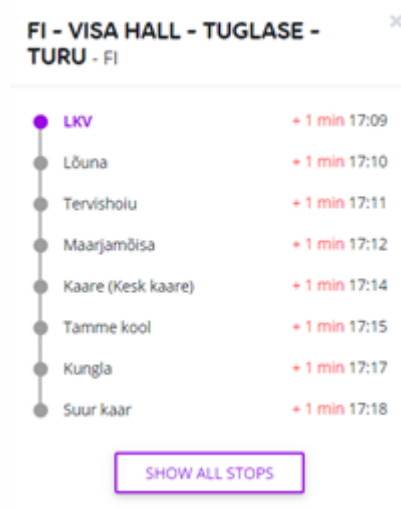


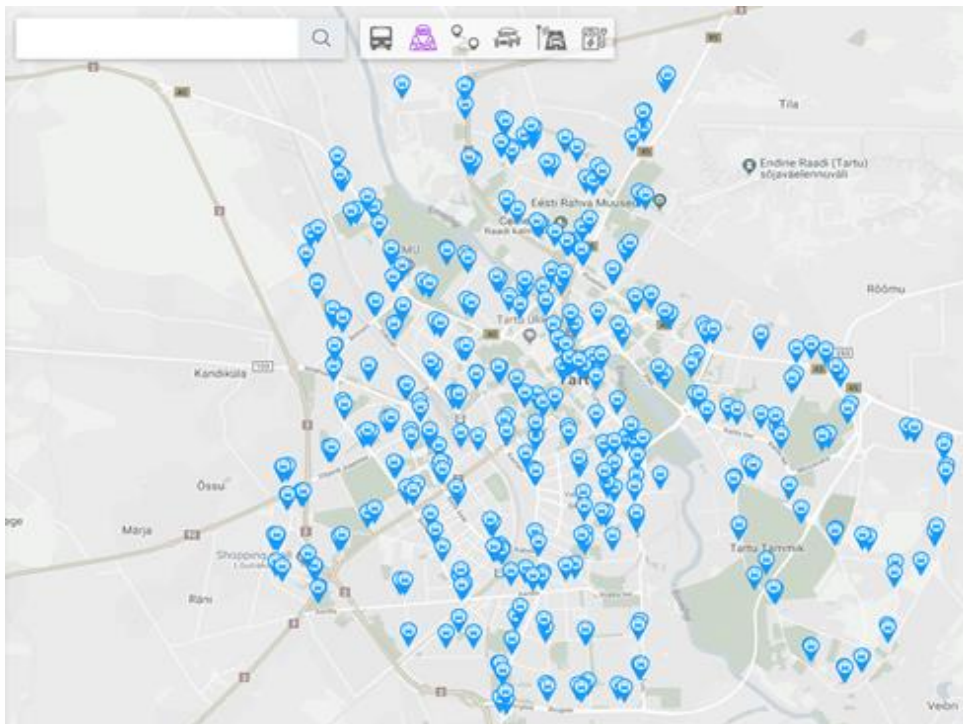
Figure 15 Bus schedule

If required, select „Show all stops“ to view the whole route schedule.

Minutes with „+“ or „-“ sign displayed next to the bus times show how many minutes the bus delays or comes ahead of the schedule. For example, „+1 min“ means, that the bus has been delayed by 1 minute.

## Bus stops

To see all bus stops on Tartu map click on the “Show buses” icon. Bus stop icons will now appear on the map.



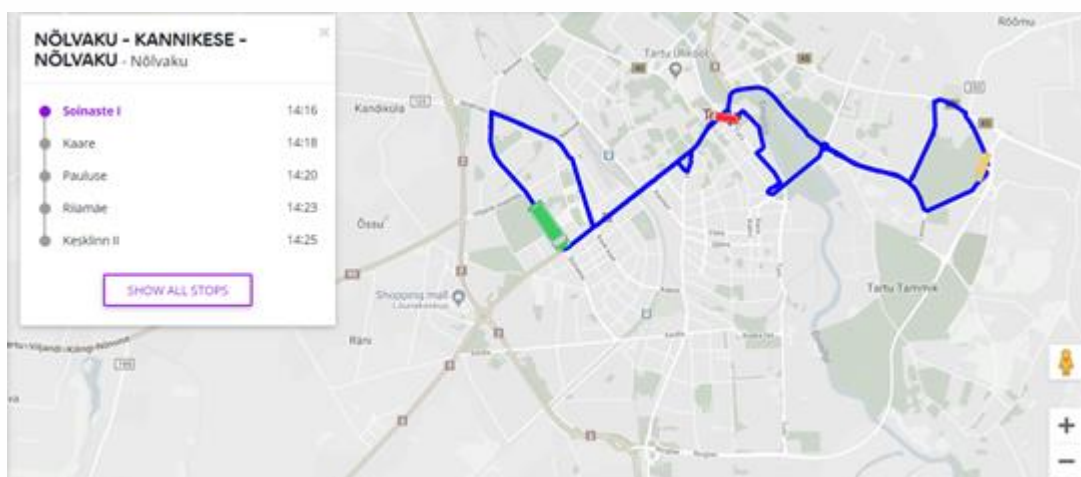
**Figure 16 Bus stops**

To see bus stop name, move your mouse over the “Bus stop” icon.

To see specific bus stop schedules, click on the bus stop icon. A pop-up box with routes and times will now appear on the left side of the screen.

## Bus routes

This filter could be used only with „Show bus“ stops or „Show buses“ filters. To see the desired bus route on the map click on the bus icon on the map.

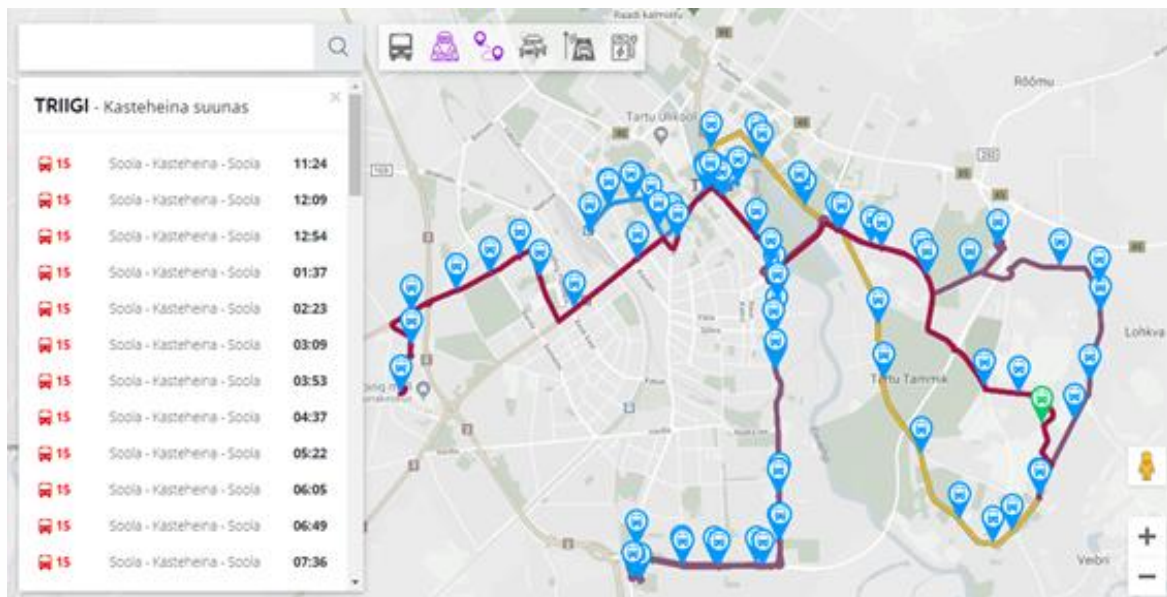


**Figure 17 Bus routes**



The bus route will now appear on the map and bus stops will appear in the pop-up box in the top left-hand corner.

To see all bus routes that make stops on your bus stop, click on the required bus stop icon.

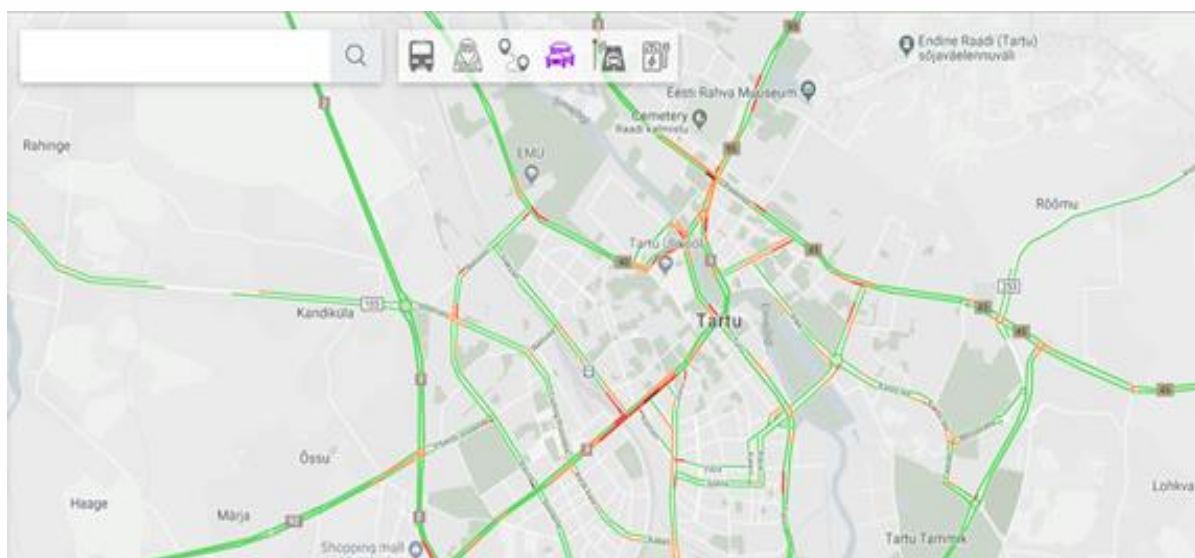


**Figure 18 Bus stop connections**

To see only needed bus route move your mouse over bus name in the pop-up box.

Traffic from Google Maps'

To see traffic conditions click on the "Show traffic" icon.

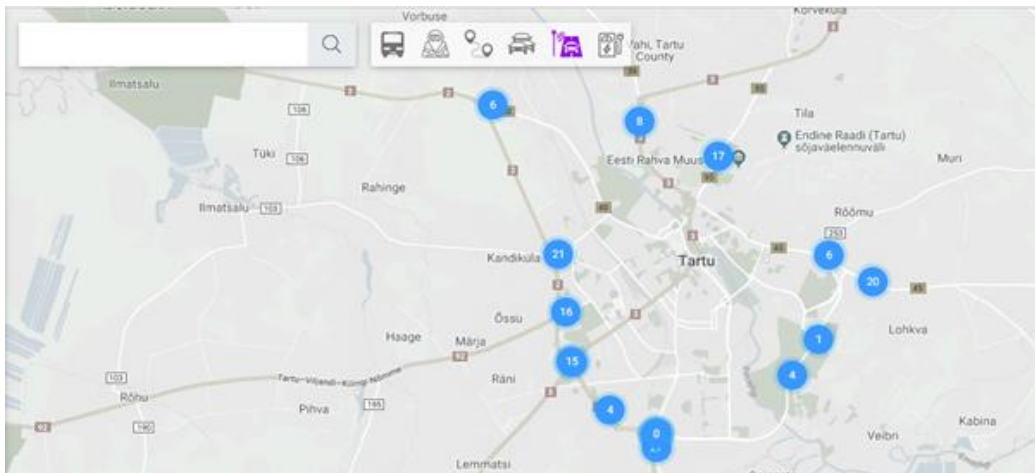


**Figure 19 Traffic overview**

The color on the map shows you the speed of traffic on the road. Green lines show there are no traffic delays. Orange lines show a medium amount of traffic. Red lines show traffic delays. The darker the red the slower the speed of traffic on the road.

### Traffic monitoring by the city

To see the usage of roads select the „Show traffic monitoring“ filter. Circled numbers will now appear on the map.



**Figure 20 Traffic monitoring**

These numbers show the average amount of vehicles pass through AVC controller per minute.

### Lights

This page shows a heat map that represents the streetlight illuminance in Tartu.



**Figure 21 Street lighting heat map**

Different colors on the map show different illuminance level. Red shows a higher level of illuminance, green shows lower level.

To monitor streetlight illuminance changes in past 24h, click on the “Play” button on playback bar.



**Figure 22 Street lighting playback**

## Weather

This page shows the seven-day weather forecast in Tartu. In the top left-hand corner, you will see **the** current temperature, wind, and precipitation. To see other day weather details click on the desired day icon.



Figure 23 Weather forecast

## Peoples' heatmap

This page shows a heat map that represents people location. The more people are in one point the darker the red displays on the map.

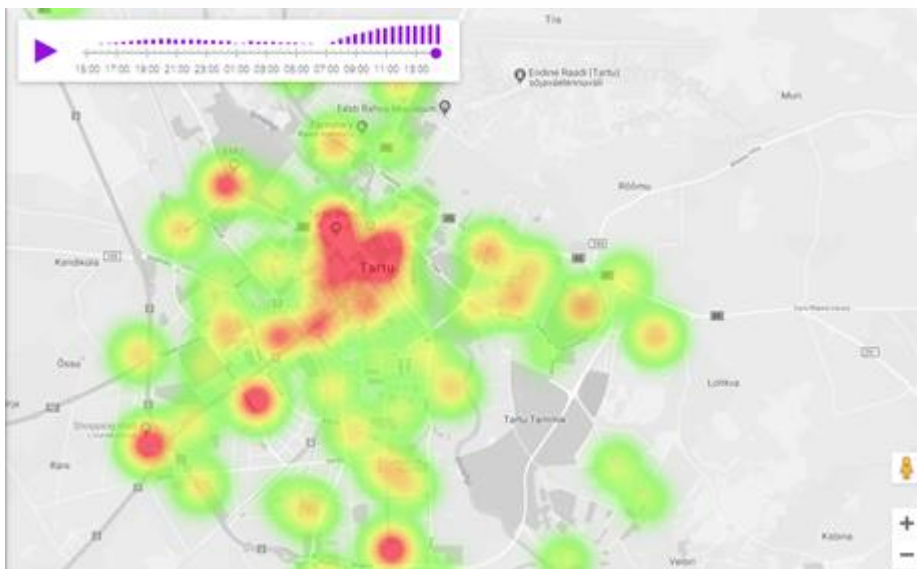


Figure 24 People location heat map

To see how people moved around in the city for past 24h, click on the “Play” button on playback bar.



Figure 25 People location playback

## 5.2. My Data Portal

This part of the portal is secured and holds more detailed data than the previous open data part. To see your data you have to be logged in the system. To log in the system select a login method, enter the required information and click on the „Log in“ button.

Accessing the system for the first time you will be asked whether you wished to connect to the services. Connected services will appear on “My services” page.

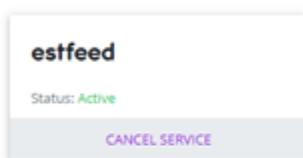
### My Services

This page shows services you are connected to. You can cancel any service by clicking on the “Cancel Service” button below the specific service name.

You can delete your City Portal account and data by clicking on the “Delete my account” button. After deletion, you will be offered to save a Restore token, so you could restore your account in the future.

To restore previously deleted accounts’ data, click on the “Restore my data” button, then enter the Restore token and click on the “Restore” button in the pop-up box.

### MY SERVICES



### YOUR CITY PORTAL INFORMATION

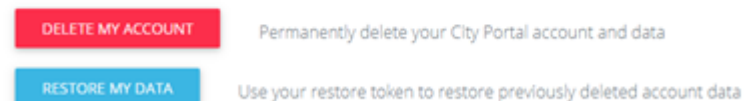


Figure 26 My services and deleting my account



## My Data Sources

After logging in you'll be taken to the „Sources“ page. This page shows your data groups or data groups shared with you.

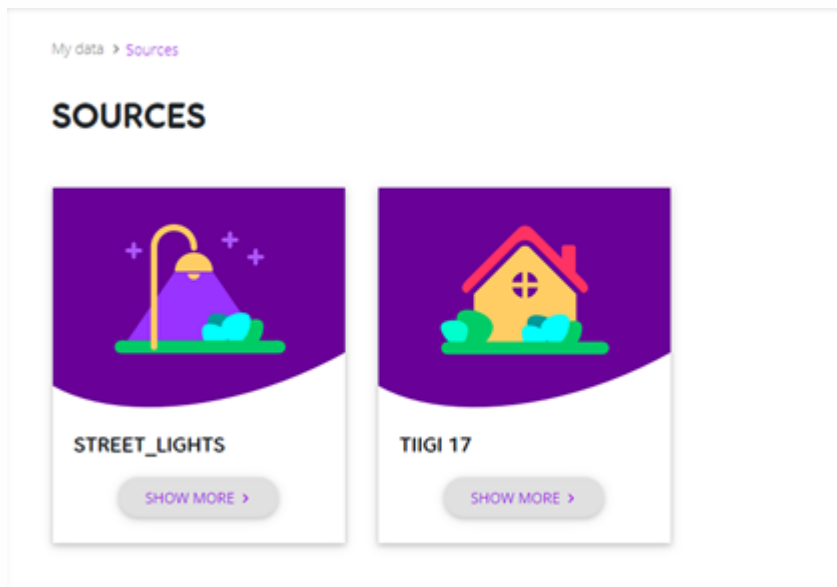


Figure 27 My data sources

To see specific data points list of data click on the „Show more“ button. The data point current value and graph will now appear on the page.



Figure 28 Datapoint graph

To see and analyze the data of another period, click on the calendar icon and select the start and end dates. Specific period data will now appear on the graph.

## List of data points

To see datapoint data sources click on the “Data sources” button in the top right-hand corner

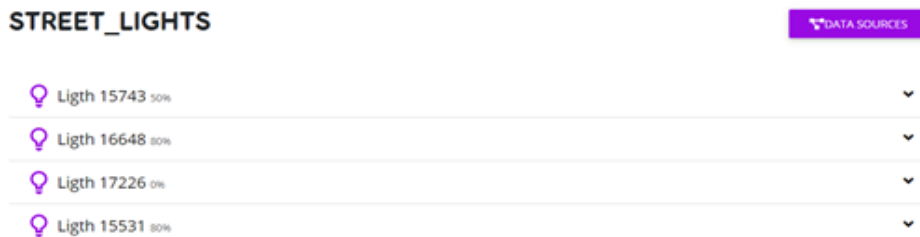


Figure 29 Data sources

You'll be taken to the data sources page. This page shows a list of datapoints ownership shared with you.

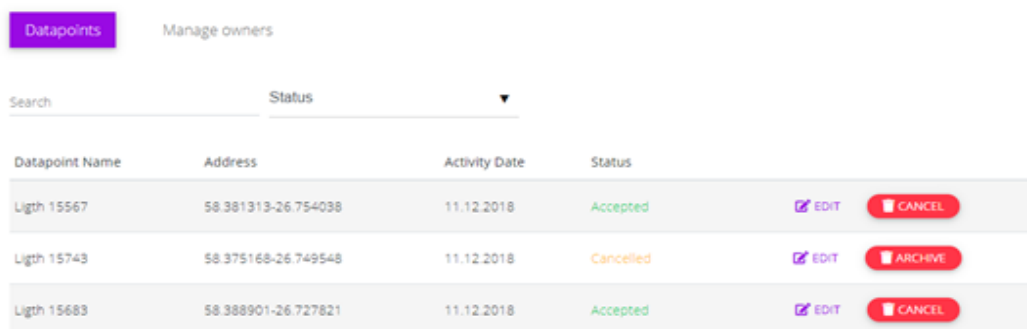
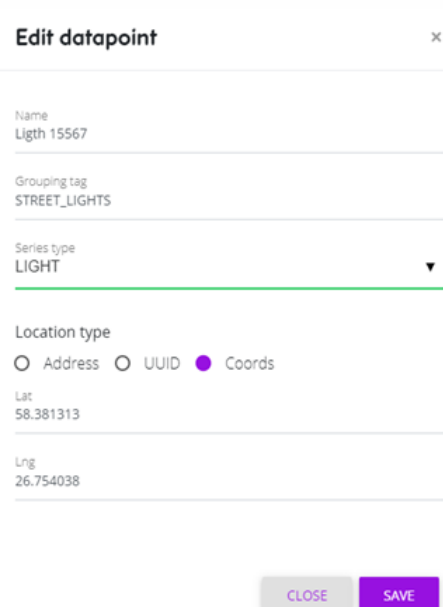


Figure 30 Datapoint list

To cancel specific data ownership click on the “Cancel” button.



**Edit datapoint** x

Name  
Ligth 15567

Grouping tag  
STREET\_LIGHTS

Series type  
LIGHT

Location type  
☐ Address ☐ UUID ☒ Coords

Lat  
58.381313

Lng  
26.754038

CLOSE SAVE

To edit datapoint details click on the “Edit” button. Edit datapoint form will now appear in the pop-up box. To save changes click on the “Save” button at the bottom of the pop-up box.

Figure 31 Edit datapoint

### Sharing my data

To see users you shared specific data before or to share specific data with other user click on the “Share” button. A pop-up box will now appear on the top of the screen. If the data was shared before you’ll see user details in the pop-up box.

To end data sharing click on the “End” button next to the user details in the pop-up box.

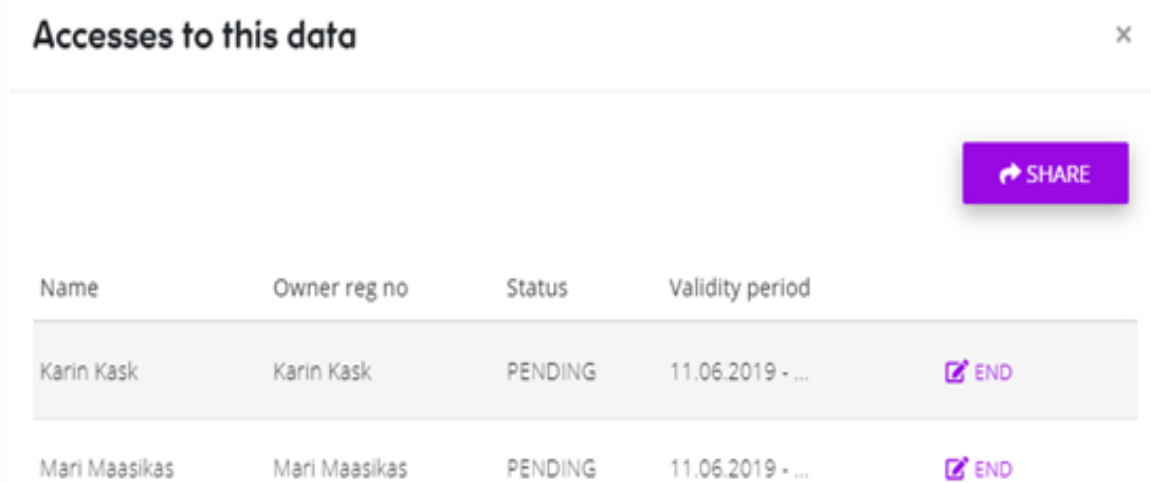


Figure 32 Access rights to the data

To share specific data click on the “Share” button in the pop-up box, then enter personal identification or registration code and click on the “Share” button.

To start to accept shared data user has to log in the system and accept pending requests by clicking on the bell icon in the top right-hand corner.

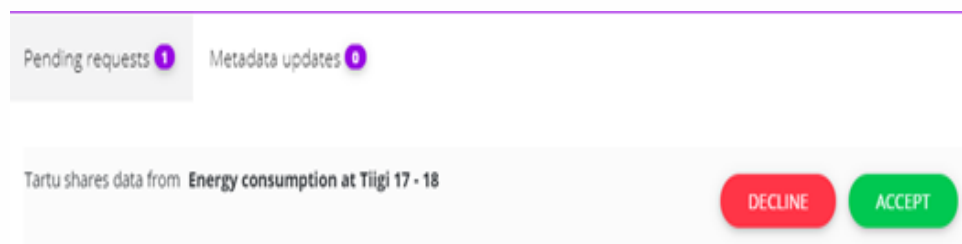


Figure 33 Pending requests

After accepting requests shared datapoint data will appear on users „My data“ page. User will be able only to monitor data. Datapoint owner can monitor and edit datapoint details.

## Delegations

This page shows all the users who have the rights to see and edit all your data.

### GIVEN DELEGATIONS

[+ ADD DELEGATION](#)

<b>Pipi Piksukk</b> 37280213000 Status: Active	<b>Mari Maasikas</b> 425345234545 Status: Canceled	<b>Mari Maasikas</b> 425345234545 Status: Suspended
<b>Mari Maasikas</b> 425345234545 Status: Suspended		

Figure 34 Delegations to represent you with your data

To add new delegation click on the „Add delegation“ button in the top right-hand corner, then enter user personal identification or company registry code.

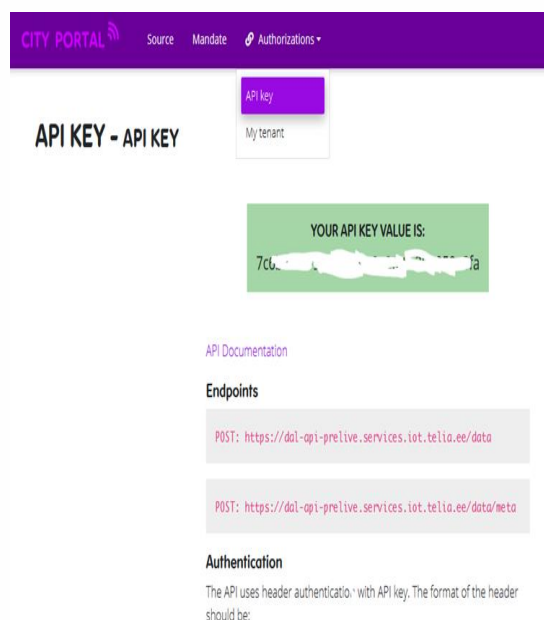
To cancel delegation move your mouse over the specific user name and click on the „Cancel delegation“ button.

## 5.3. DAL Data Mapping Tool

This tool is designed to describe already connected data or to connect new data sources. Also, ownership of data will be defined in this module.

Below is a little more technical description of how to use the tool.

### Sending data to CIOP



Log in to DAL, select “API Key” as the source of data. Now, the **API key** value should be visible (As shown in Fig. 36). The API key is used to authenticate requests to the DAL HTTP API.

Figure 35 API Key value in the DAL web applicationz

With the API key, you can make HTTP POST requests with your data to the **/data** URL endpoint. The request should include the API key in the “X-Auth-Token” header, Content-Type: application/JSON. Note: If no object with the corresponding *deviceId* previously exists, it will be created.

### Mapping data to a person, using the web interface

After sending measurement values for a new device, the new devices and their data series will appear under “Sources Mapping” (See Fig. 38):

Now, the owner of the series and other descriptive metadata values should be defined. This is done either using the web interface or the HTTP API (described later below). Using the web interface for details, *Bulk Edit* is a handy feature.

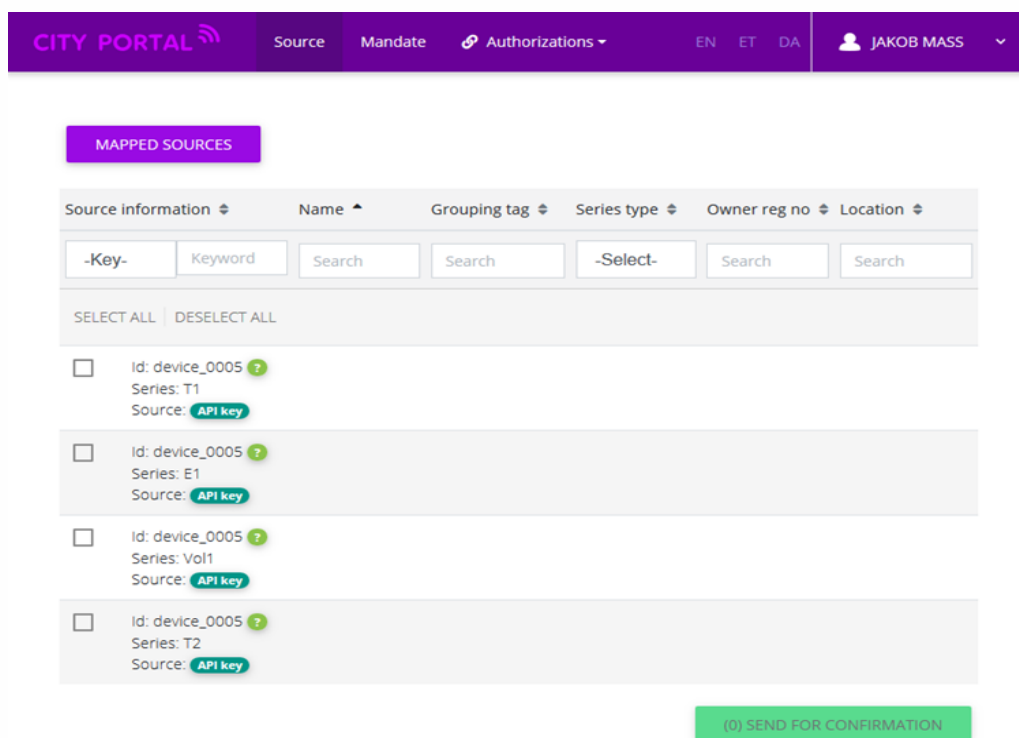


Figure 36 Setting owner and metadata values under Sources Mapping

After entering the values, the “Send for confirmation” button should be clicked. Now, the assigned owner of the data must confirm that they accept the newly forwarded data. Log into the *City Portal* application as the person who was set as the owner of the data. Notifications regarding the requests should appear (Fig. 39).

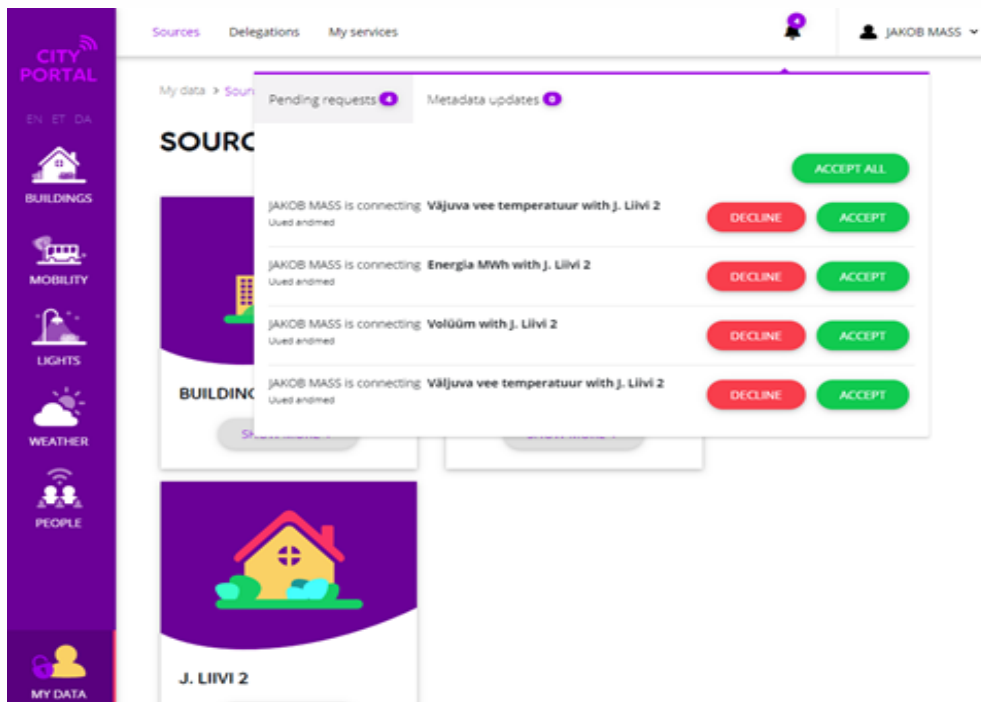


Figure 37 New pending requests notification in the City Portal application

After the new data owner has accepted the series, any new values sent by the device will appear in the City Portal application (Fig. 39). The visualizations make use of the previously set meta-fields.

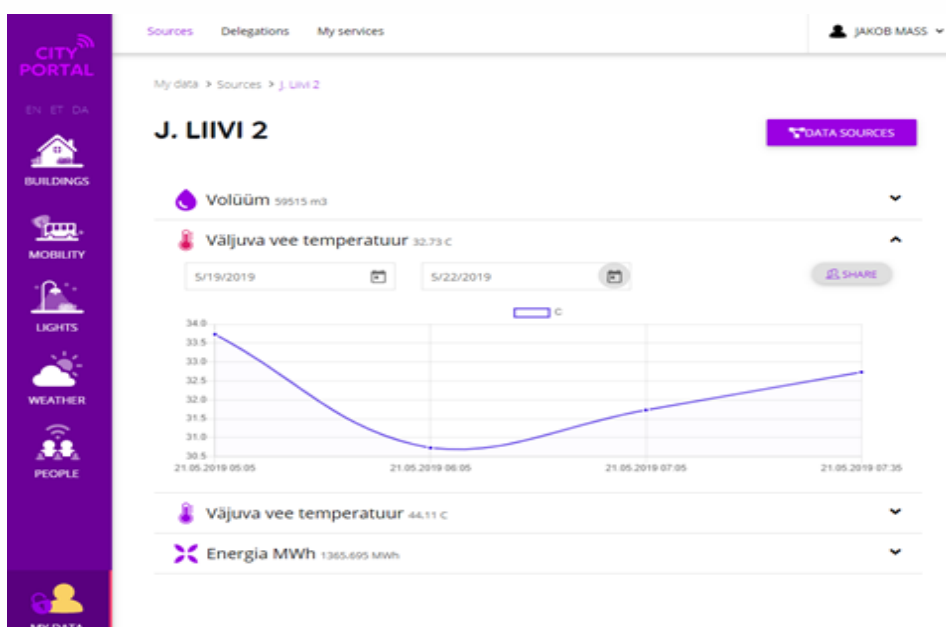


Figure 38 Graph visualization of data in City Portal

## Mapping data to a person, using the DAL HTTP REST API

The “dataSourceId” and “deviceId” values identify the data series. To set an owner to the series, the personRegistrationNumber (and personCountryCode) meta fields must be set. Additionally, the other metafields should be set with appropriate values (such as the address/UUID). The HTTP request must include the X-Auth-Token header with the API key value and Content-Type, Accept: headers with the value application/JSON

The confirmation request must include the ID of the mapping and an “assignerComment” – the message which will be displayed to the new owner in the City Portal web application.

## 5.4. KPI reporting tool

Performance Indicators (PIs) are necessary for evaluating the impact of project interventions in Tartu. Key Performance Indicators (KPIs) are the most important ones of PI's. Such KPIs for Tartu lighthouse city are listed in D7.9 for seven protocols (energy assessment, ICT, mobility, social acceptance, citizen engagement, economic performance) (see also D7.3) and for city impacts measurement (see also D7.4). Some of the indicators can be calculated automatically, as well as the data collected for the calculation of these indicators.

A prerequisite for calculating indicators is data collection. Data is collected using various methods. Most of the automatically collected data concerns energy assessment, ICT, mobility and urban platform for citizen engagement. The data come from building meters and indoor system sensors and ICT platform and system. An indicative list of automatically calculable KPIs is provided in Table 4, more details and exact formulas are presented in D7.9.

Many data sources for Tartu KPI's and PI's are connected, and data is stored already. The rest of the Data will be collected from 1st of August 2019. KPI reporting tool will be developed in cooperation with Sonderborg under task 5.7 (Sonderborg CIOP).

This module is important to note under Tartu ICT description because this will be the first service to work over multiple cities CIOP's and presents a digital single market use-case.

Protocol	Performance Indicators
Energy assessment	<ol style="list-style-type: none"> <li>1) Energy demand;</li> <li>2) Delivered energy (for buildings);</li> <li>3) Primary energy (for buildings);</li> <li>4) CO2 equivalent (for buildings);</li> <li>5) Peak load and load profile of electricity demand;</li> <li>6) Peak load and load profile of thermal (heating/cooling) energy demand;</li> <li>7) Degree of congruence of calculated annual final energy demand and monitored consumption;</li> <li>8) Degree of energetic self-supply;</li> <li>9) Share of renewable energy;</li> <li>10) Efficiency;</li> <li>11) Internal air temperature;</li> <li>12) Heat quantity for set point achievement.</li> </ol>
ICT	<ol style="list-style-type: none"> <li>1) Response time</li> <li>2) Scalability</li> <li>3) Extensibility;</li> <li>4) Storage capacity;</li> <li>5) Hours of maintenance;</li> <li>6) Non-expected hours offline;</li> <li>7) # of HEMS connected;</li> <li>8) # of BEMS connected;</li> <li>9) # of EV connected;</li> <li>10) # of mobility equipment connected;</li> <li>11) The total amount of data generated;</li> <li>12) Recharging points equipment connected;</li> <li>13) Smart lighting equipment connected;</li> <li>14) Number of services developed;</li> <li>15) Types of services;</li> <li>16) Percentage of dwellings connected;</li> <li>17) Percentage of buildings connected;</li> <li>18) Open-Data sets available.</li> </ol>
Mobility	<ol style="list-style-type: none"> <li>1) Average occupancy (EVs, in Tartu case electric bikes);</li> <li>2) Accuracy of timekeeping for the public bus;</li> <li>3) Total number of recharges per year (EV);</li> <li>4) Total kWh recharged in the EV charging stations (EV).</li> </ol>
Citizen engagement	<ol style="list-style-type: none"> <li>1) Number of citizens (registered users) using web application;</li> <li>2) Number of visits (daily/monthly) (in the web application);</li> <li>3) Increase of new visitors in the web application;</li> <li>4) Time spent on the web;</li> <li>5) Number of Apps developed in the framework of SmartEnCity;</li> <li>6) Number of mobile app downloads;</li> <li>7) Number of active users of Apps;</li> <li>8) Number of active users of Apps in the category of citizens;</li> <li>9) Quality of services/added-value services.</li> </ol>
Economic performance	<ol style="list-style-type: none"> <li>1) Benefits by uptake savings (€): Annual mileage of EVs (electric bikes) (km), Electricity uptakes for mobility (kWh)</li> </ol>
City indicators	<ol style="list-style-type: none"> <li>1) Energy savings due to district renovation (Energy Assessment</li> </ol>



	Protocol); 2) Increase of renewable energy usage (Energy Assessment Protocol); 3) Increase of renewable energy production (Energy Assessment Protocol); 4) Total kWh recharged in the EV charging stations (Mobility Protocol).
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Table 4 List of Performance Indicators

## 5.5. Energy Manager

One of the Values Adding Services on top of CIOP will be Energy Manager, co-designed by TREA and PLAN with a digitalization help from Telia. This tool is meant for citizens and businesses to see and compare their energy consumption and to get recommendations for improvement in their energy consumption behavior.

This tool will be built under task T5.7 – Sonderborg ICT cross-action and will be ready in July 2020. This module is important to note under Tartu ICT description because this will be one of the first services to work over multiple cities CIOP's and presents a digital single market use-case.

## 6. Conclusions, deviations, and outputs for other WPs

As predicted at the beginning of the CIOP implementation phase, most of the delays and/or kickbacks have been on a human and agreement side – not on technical implementation. Thus, there were no deviations to the planned work.

The implementation of Tartu CIOP directly feeds into the Sonderborg LH demo actions as the same technology will be also implemented as Sonderborgs' CIOP.

All in all, the planning and launch of the systems have been successful. In Tartu, the CIOP is functional and in the demo houses, the smart home systems are currently being installed (as of July 2019).

## 7. References

Tartu City Portal:

<https://tarktatu.telia.ee/en/>

Data mapping tool:

<https://datamaping.iot.telia.ee/en/login/login>

Sonderborg City Portal development site, as it is not yet available in public environment:

<https://sonderborg-prelive.services.iot.telia.ee/en/>