TOWARDS SMART ZERO CO_2 CITIES ACROSS EUROPE

VITORIA-GASTEIZ ✣ TARTU ✣ SONDERBORG

Deliverable 4.5: Street lighting

WP 4, Task 4.5

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[1] PU = Public

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Abbreviations and Acronyms

Table 1: Abbreviations and Acronyms

Abbreviation	
TAR	Tartu City Government
CTEL	Cityntel OÜ
ET	Telia Eesti AS
CIOP	City open information platform
Tartu	Tartu City

0 Publishable Summary

This deliverable “Smart street lighting” describes the deployment of smart street lighting Tartu Lighthouse City (LHC) implemented in the Tartu pilot area. Tartu has made a long-term commitment towards developing a smart city environment, acknowledging that smart solutions are mainly related to the fast growth of ICTs.

Smart city goals for deployment of smart street lighting is to rise energy efficiency and to reduce carbon emissions and socio-economic costs. To achieve these goals, the newest technology and ICT solutions should be used.

The main result of task 4.5 is the energy efficient public lighting with intelligent control system.
The information from the installed sensors also serves a wider meaning in addition to lighting control, as it is possible to develop different services for residents in the future based on this information (N: based on the information of the environmental sensors, it is possible to design a running track with the cleanest air, etc.).

The implementation of public smart street lighting went according to plan. The leading partners in this deployment were the TAR and CTEL. Task of TAR was to procure and install energy efficient luminaires and CTEL provided controllers for luminaires, sensors and developed the control system.

The installation of luminaires was completed in December 2017. Sensors were installed in the second part of 2018 and the intelligent control system is in continuous development.

1 Introduction

SmartEnCity's main objective is to develop a highly adaptable and replicable systemic approach towards urban transition into sustainable, smart and resource-efficient cities in Europe. This will be achieved through the integrated planning and implementation of measures aimed at improving energy efficiency in main consuming sectors in cities, while increasing their supply of renewable energy and demonstrating the benefits.

This should be achieved by a number of Europe-wide replicable strategies aimed at:

Reducing energy demand through the use of innovative technologies in building retrofitting, sustainable and clean transport systems and intelligent control ICT; as well as raising awareness of all involved stakeholders.

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. 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.

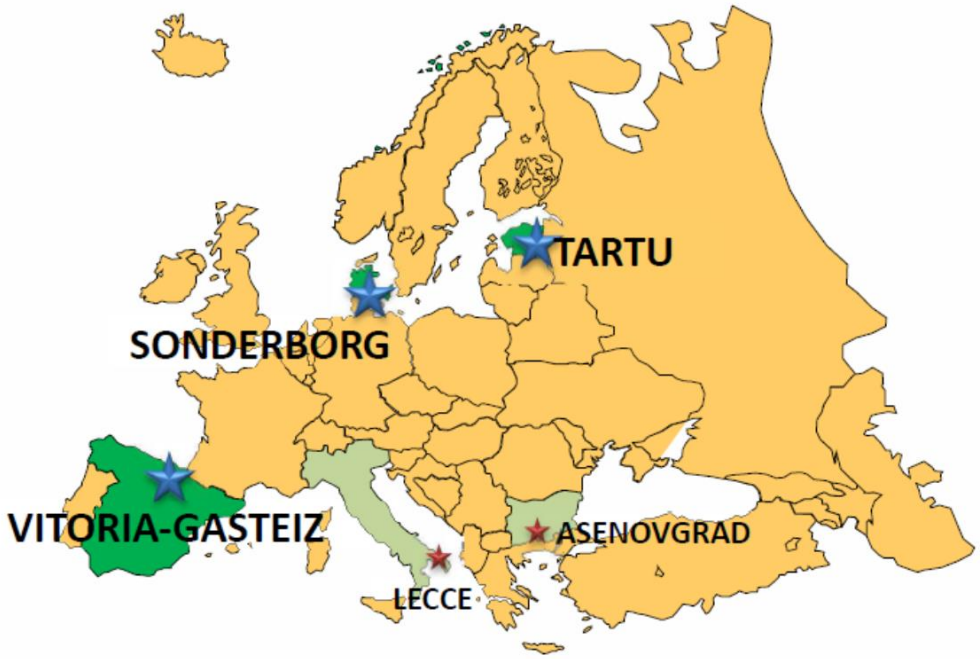

Figure 1 Partner cities of the SmartEnCity project

1.1 Purpose and target group

The purpose of this deliverable is to document the details and processes of deployment of smart street lighting system. The details include a description of the implemented measures and lessons learned in course of the implementation of the smart street lighting in Tartu. Target groups include municipalities, NGOs, and activist groups working for sustainable living environment and carbon free future.

1.2 Contributions of partners

The following Table 2 depicts the main contributions from participant partners in the development of this deliverable.

Participant short name	Contributions
TAR	General content
CTEL	Particular content (sensors and control system)
ET	Particular content (CIOP)

Table 2: Contribution of partners

1.3 Relation to other activities in the project

The following Table 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
D4.1	This deliverable provides the overall description of the current state of the lighthouse city area and will provide a comparison in the future after demo actions have been implemented.
D4.2	Integrated Planning report. This deliverable consists detailed management procedures and deployment developed for implementing the demo actions.

D4.7	ICT- Smart City Information platform. This deliverable connects all the demo actions into an ICT platform so data may easily be extracted for evaluation and replication purposes as well as for analyses of impact and development of new services.
D7.8	This deliverable provides the overall description of the KPI's and therefore the measurements to be implemented in smart street lighting.
T7.1	Evaluation plan. This task provides an evaluation plan for assessing the performance of the intervention.

Table 3: Relation to other activities in the project

2 Objectives and expected Impact

2.1 Objective

This deliverable has multiple objectives. The main objective is the implementation of smart street lighting in Tartu LH pilot area. The subobjective is to provide lessons learned to other cities and municipalities interested in deployment of smart street lighting.

2.2 Expected Impact

The features provided by the technology provide a clear business advantage, improving the rate of adoption of the smart street light control technology, thereby resulting in reduced power consumption, carbon footprint and light pollution.

On the wider level, the proposed smart street light control solution has the potential to change the market dramatically, allowing municipalities to start saving right from the moment of the solutions without having to worry about the payback period. Furthermore, as savings are instant, it will also reduce the payback period of the LED street luminaire, which will lead to much wider market uptake of saving energy in street light installations. The lifetime of these LED lights is expected to reach 100,000 hours in a few years. During the entire lifetime of the lighting systems, the smart control paradigm will save an additional 42% of energy (reducing an equal amount of carbon emissions compared to the same street lights working on a static regime).

Expected annual reduction of costs on electricity from smart street lighting in Tartu LH pilot area was 16 648 €/year and reduction of carbon emissions (CO2) was 164 t/year. Expected energy efficiency (energy saving) was 138 729 kWh in year.

The successful deployment of the smart street lighting solution will enable other smart city innovations based on the same technology and principles, such as smart parking and smart waste management.

3 Overall Approach

The SEAP of Tartu City states that Tartu has made a long-term commitment towards developing a smart city environment, acknowledging that smart solutions are mainly related to the fast growth of ICTs. In these lines, SEAP identifies the following goal: - Renovating street lighting, whereas the consumed electricity is 100% produced from renewable sources and the system is controlled intelligently.

The smart street light control solution that will be implemented in Tartu is simple and fast to deploy also on a large scale. The unique combination of field-proven wireless technology, which has been previously applied in security and smart city applications, and smart energy management enables massive and low-cost smart street lighting installations for reducing energy consumption. The aim is to bring intelligence and data processing to the device level and build networks of locally collaborating self-aware devices – sensors and luminaire controllers – which enable to take into account local weather and traffic conditions and adjust street light operation based on this without any central server data processing.

4 Task 4.5 Smart street lighting system with intelligent controlling

The framework

Tartu has been a pioneer in the development of street lighting among Estonian cities. Tartu was one of the first who had larger amounts of mercury luminaires exchanged for sodium luminaires and similarly one of the first who installed of LED luminaires in larger volumes. Now Tartu is the first city developing smart street lighting solution. Reduction of costs on energy and energy efficiency is a cross-cutting issue in the city's development strategy and development documents.

The deployment of smart street lighting in Tartu LH pilot area was a voluminous and diverse process where other project partners also played an important role: CTEL (sensors and control system) and ET (data collection and CIOP). All engaged partners also contributed to the development of technical requirements. Specific issues (light calculations, technical aspects of luminaires) were also assisted by external experts.

The tendering process was a responsibility of TAR. The whole deployment process lasted 28 months.

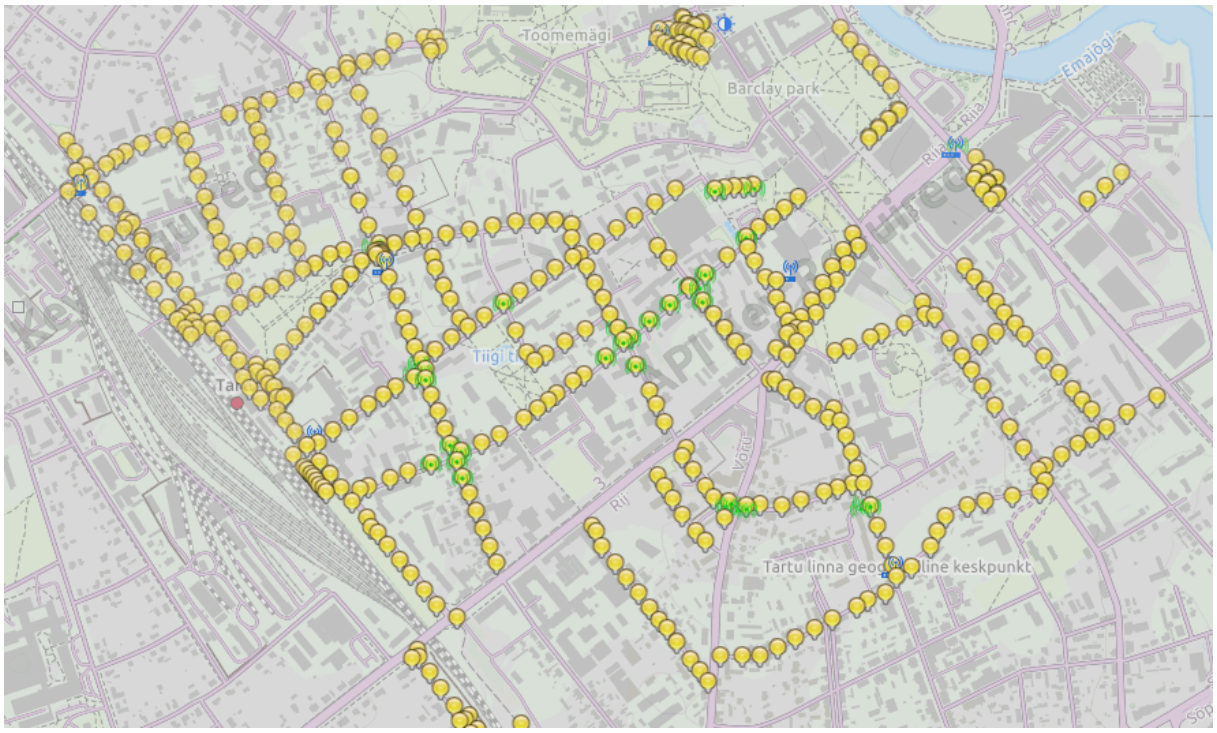

Figure 2: Installations in Tartu LH pilot area (Tartu lighting management system)

The LED luminaires

Modern LED luminaires are characteristic because of their high luminous efficiency, long life time, reliability and high color rendering index. Maintenance-free exploitation, high quality of production and possibility of easy lighting control makes LED luminaires a highly recommended choice. LED lighting provides incredible energy efficiency without sacrificing light quality.

The LED lighting allows to achieve significant energy savings right after installation and, combined with a smart control system, increases your savings even further.

The lifetime of LED lights is expected to reach 100,000 hours in a few years. Deployment of LED lighting consists several benefits:

- No need for engineering personnel for deployment and maintenance;
- Dynamic control of luminaires based on real-time local situational information;
- Real-time feedback from luminaire on operation;
- Accurate power consumption measurement;
- Very reliable operation;
- Future proof - easy to add other devices providing Smart City Services into the same network;
- Reducing the energy consumption and carbon footprint of street lighting installations.

As a result of task T4.5 there was installed altogether 322 LED-luminaires in Tartu LH pilot area from company Vizulo.

Figure 3: Vizulo luminaires installed in Tartu LH pilot area

Procurement was initiated in March 2017 and all the works was finished in-time in December 2017. Installation work was carried out by company Leonhard Weiss Energy AS.

Figure 4: Installation in Tartu LH pilot area

The sensors and controllers

322 streetlight controllers were produced and installed in Tartu for this project. Controllers were produced by CTEL and installed into luminaires by the luminaire producer (Vizulo). Necessary software developments were mostly made by CTEL employees. The controllers communicate with each other in a flat self-configurable mesh network. According to the rules saved in each controller, they can dim the streetlight and switch it on and off. Rules can be based on the specific time, sunset and sunrise time and data from sensors. Some problems with the controller software occurred after installation of the luminaires but Cityntel was able to fix the bugs and update the software.

Figure 5: smart controller

Eight sensor units were developed and produced in cooperation with Thinnect OÜ. First two of them were added to the system at the beginning of 2018. Later in 2018 other sensor units were installed. During the testing and deployment of the sensors several problems occured and that has caused delays in the final installation. Sensors measure ambient temperature, air pressure, relative humidity, particles, CO2, NO2, traffic intensity, road temperature and noise. Motion sensors and part of noise- and camera based sensors are installed separately.

Figure 6: sensors from pilot area

Component	Quantity
PIR movement detector	**30**
Movement detector with camera	**6**
Light reflection sensor	**10**
Noise sensor	**10**
Environmental sensor	**5**

Table 4: Sensors in Tartu LH pilot area

The control system

The solution developed by Cityntel is based on a wireless mesh technology. Smart controllers, capable of in-network and in- device decision-making, are installed in every street light and rely on wireless communication for communicating information between the controllers and sensors. Unlike competing solutions, where all control commands are sent from a server or network controller, this smart control solution requires no permanent server connectivity as operational rules are stored directly in the luminaire controller, improving greatly the resilience of the solution. The features provided by the technology provide a clear business advantage, improving the rate of adoption of the smart street light control technology, thereby resulting in reduced power consumption, carbon footprint and light pollution. Web based user interface Lumoflex was developed based on the experience from previous projects of CTEL. Software developments were made by CTEL in cooperation with company Thinnect. User interface enables to manage the streetlights and sensors, create groups and rules, receive alarms and manage users. API for third party applications was developed by CTEL. The City Portal developed by Telia uses API for receiving streetlight and sensor data from Lumoflex central management UI.

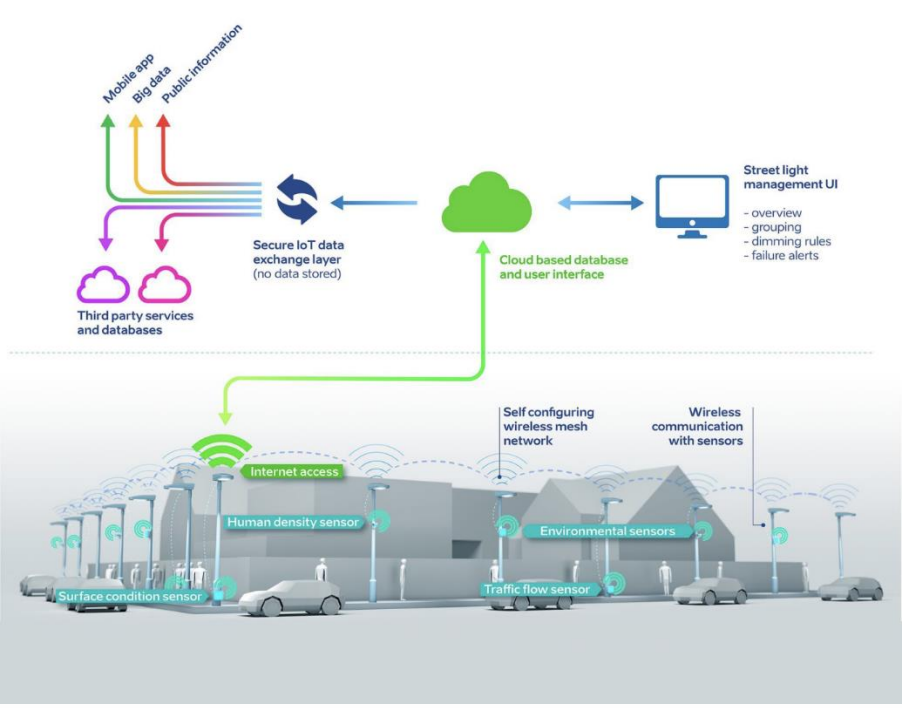

Figure 7: The control system

Monitoring and evaluation

The monitoring and evaluation of the smart street lighting deployment is done by the TAR in cooperation with ET and CTEL. Data of the performance of the smart street lighting is directed into CIOP. The main indicator reflecting the system performance is - energy consumption.

On the City Information Platform will be presented some visualization for public. Specialists will have access to the all dataset gathered from the system for monitoring and analysis.

Energy efficiency

Smart lighting has already provided significant energy savings in the first year. With further development of the management system, savings are likely to increase even further. Considering the rapid development of LED technology in the last decade, it can be quite certain that in the future it will be possible to achieve greater energy savings under the same prerequisites than in the present project.

Consumption of HPS (2017)	196673
Nominal consumption (kWh)	71480
Real consumption (including dimming) (kWh) 2018	54364
Saving from dimming (kWh)	17116
Total saving (kWh) (HPS vs. Dimmed LED)	142309
Saving (%)	**73**

Table 5: Energy consumption of street lighting in Tartu LH pilot area

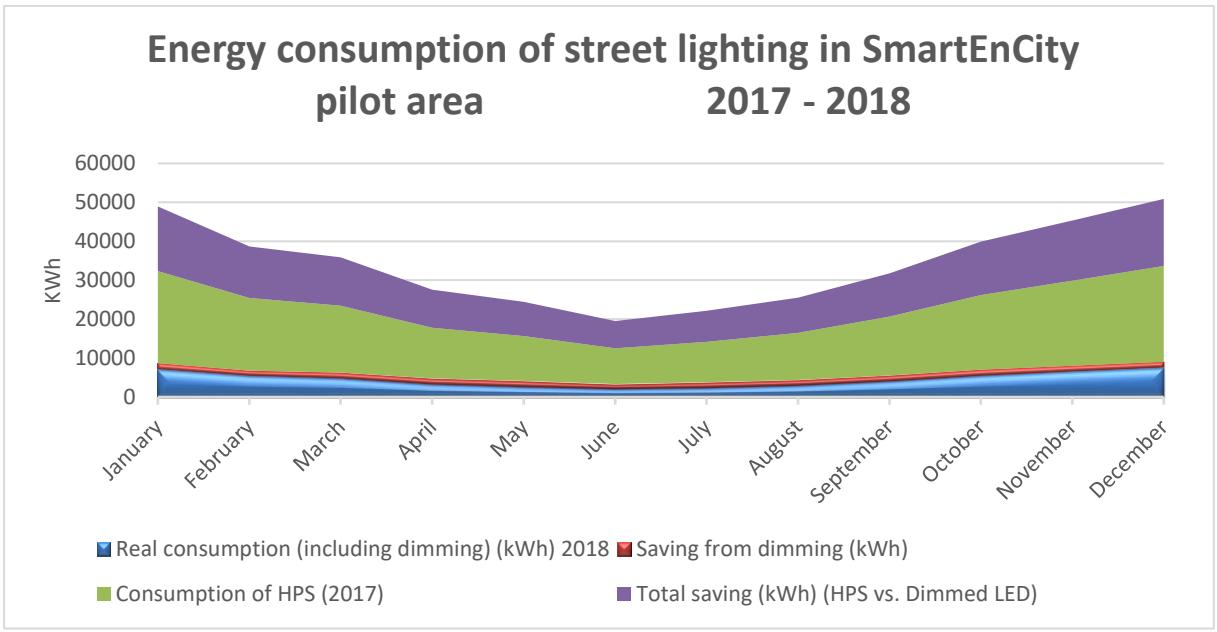

Figure 8: Energy consumption of street lighting in Tartu LH pilot area

5 Lessons Learned

Deployment of smart street lighting was in itself a complicated and time-consuming process. The main problems were related to the technical characteristics of the luminaires, controllers and sensors. As technology in this field develops very quickly, there must always be a very good lighting expert in the team, or it must be possible to find a competent external expert. Preliminary work - making light calculations and drafting technical specifications is crucial. Thorough preparation allows to save time in the procurement process and achieve the desired result. The technical requirements for luminaires must be fairly precise and sufficiently rigorous. Current experiences show that overly flexible requirements bring financially affordable but technically very low-quality luminaire offers. The situation is similar with controllers and sensors. On the market, the supply is high and often very low quality sensors or electronic components are offered from which sensors to produce. In the case of the Tartu project, there were for example problems with microphones in production of noise sensors, where microphones had to be replaced because they were of poor quality.