



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

Deliverable 4.7: Gas buses purchased and  
 in operation is commissioned and deployed

WP4, Task 4.6

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<sup>1</sup> PU = Public

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#### D4.7 Gas buses purchased and in operation is commissioned and deployed

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## Abbreviations and Acronyms

Abbreviation/Acronym	Description
SmartEnCity	Towards Smart Zero CO2 Cities across Europe
Gas buses	CNG buses
CNG	Compressed Natural Gas
Biogas	Biomethane produced from RES
RES	Renewable Energy Sources
SEC	SmartEnCity
WP	Work package
TAR	Tartu City Government

**Table 1: Abbreviations and Acronyms**

## 0 Publishable Summary

The new gas buses started operation in Tartu city bus lines on 1<sup>st</sup> of July of 2019. In total 64 new buses, manufactured in the Scania factory, started travelling along the routes, equipped with air conditioning, low bottoms and running on an environmentally friendly source of fuel. There are two types of buses: normal buses (12 m in length, 27 seats, and standing room for 52) and articulated buses (18 m in length, 41 seats and standing room for 96).

As of 1<sup>st</sup> of July 2019, the City of Tartu switched over to a new bus route network, which differs significantly from the recent network in terms of itineraries, the number of lines, as well as the frequency of departures. New bus line network consists 13 regular bus lines (formerly 26 lines) along with two night lines. Company AS GoBus is operating new gas buses.

The total annual mileage of city buses is 4,400,000 kilometers in Tartu and about 13,000,000 journeys were made on Tartu buses during the year of 2018.

The new bus line network will raise the service level of public transport in Tartu - shortening bus intervals and increasing the speed of connections. The fastest connections make it possible to increase the attractiveness of public transport and bring drivers of private cars to use the public transport. This fact, combined with the reduced environmental impact of gas buses, will allow the maximum environmental benefits of public transport reorganization to be achieved. Expected reduction of CO<sub>2</sub> emissions from reorganizing of public transport system is around 5280 tons in year.



Figure 1: New gas buses

# 1 Introduction

Tartu, with its population of 100,000 is the second largest city in Estonia. Lying 185 kilometers south of Tallinn, Tartu is also the center of South-Estonia. Tartu is known as a green, innovative and environment-friendly city. The slogan of Tartu is "The City of Good Thoughts". Tartu is a city of education and well known for the University of Tartu founded in 1632.



**Figure 2: Location of Tartu**

The aim of the transport policy of Estonia and Tartu is to ensure accessible, convenient, safe and sustainable mobility for people and businesses. High-quality infrastructure and a well-functioning transport system are essential for the functioning of everyday life.

High quality and fast public transport is the key to success in organizing urban mobility.

## 1.1 Purpose and target group

The purpose of this deliverable is to document the details and processes made by TAR related to implement gas buses in Tartu within the SmarEnCity project. The details include a description of the technical details process and also first results and lessons learned so far.

Target group include other partners of SEC project but also target groups interested in implementation of new gas buses.

## 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	Overall & general content

**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.

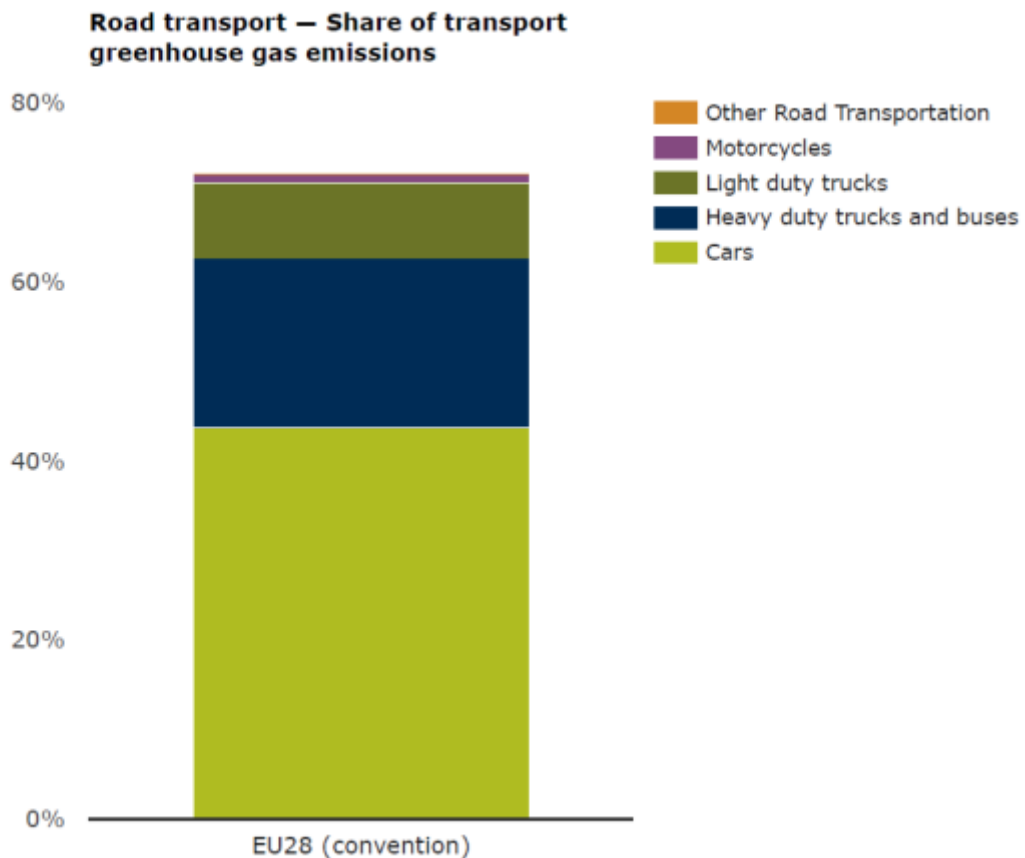
Deliverable Number	Contributions
D4.1	This deliverable provides the overall description of the current state of the lighthouse city area and will provide a comparison in future after demo actions have been implemented
D4.11	This deliverable connects all demo actions into ICT platform. Data will be easily used for evaluation and replication purposes
D4.13	This deliverable summarizes all demo actions in the Tartu Lighthouse project.
D7.8	This deliverable provides the overall description of the KPI's and therefore the measurements to be implemented in DHC

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



## 2 Objectives and expected Impact

Across Europe transport accounts for about 20 % of all greenhouse gas emissions, nearly half of it is related to passenger transport. To reduce the carbon footprint of mobility, public transport has to be strengthened, especially in rural and suburban regions that represent bottlenecks in public transport networks.



**Figure 3: Emissions from transport sector EU**

A significant part of the growth of daily traffic flows in cities is caused by private vehicles from urban sprawl areas. The situation is similar in Tartu, where according to the last 2018 mobility study, car traffic in the city is growing by 1.5% a year, thanks to urban sprawl. In order to break this trend and shape a sustainable urban environment, it is necessary to redesign public transport to meet the needs of both urban and suburban populations and to minimize environmental impact of public transport system.

To meet the challenges of the era, the city of Tartu decided to use in the public public transport system only gas buses for next 10 years and to re-organize the public bus network.

All activities related to this deliverable are 100% financed by the City of Tartu.

## 2.1 Objective

The main objective of this deliverable is to implement environmentally friendly public transport solution where gas buses in combination with re-designed public transport network will reduce CHG emissions from transport sector and make the city more liveable place. The further goal is to achieve zero carbon urban environment.

## 2.2 Expected Impact

The expected impact of deliverable is multiple. Main impact is a reduction of CO<sup>2</sup> emissions, but there are several side impacts, which are significant in terms of city environment and sustainability – cleaner city environment, reduction of private car traffic, change of movement patterns of citizens, better health of citizens etc.

The reduction of usage of fossil fuels and thus reduction of CO<sup>2</sup> emissions in transport system is the main expected impact. The estimated annual reduction of usage of diesel fuel is at minimum 2 000 000 liters and reduction of CO<sup>2</sup> emissions is accordingly 5280 tons.

Calculation of reduction of CO<sup>2</sup> emissions was made based on next methodology:

*1 liter of diesel weighs 835 grammes. Diesel consist for 86,2% of carbon, or 720 grammes of carbon per liter diesel. In order to combust this carbon to CO<sub>2</sub>, 1920 grammes of oxygen is needed. The sum is then 720 + 1920 = 2640 grammes of CO<sub>2</sub>/liter diesel.*

The reorganization of public transport is expected to have a significant positive impact on the reduction of passenger car traffic in the city. The exact extent of this impact is currently difficult to predict. According to the last 2018 traffic survey, the modal share of passenger cars was approximately 52% of all mobility in the city.



### 3 Overall Approach

Ambition of TAR in SEC 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.

The mobility actions of Tartu are aligned with its current strategy aiming to develop environmentally friendly urban transportation. The City of Tartu has set a goal to decrease environmental waste from transport and to have a more efficient use of natural resources and city space. As such, the further development of both light and public transportation modes is considered a priority. From the perspective of transport, more environmentally friendly fuels or types of movement should be chosen as to achieve the desired air pollution decrease. In other words, in order to decrease the negative environmental impact of the transportation system it is necessary to facilitate the use of alternative motor vehicle fuels in city transport.

The City of Tartu participated in the Baltic Biogas Bus project (2010-2015) and as part of the project, five new gas buses were taken into use in Tartu in 2011. The results of the biogas bus feasibility and cost benefit analysis shows that biogas buses are profitable in terms of the environment, but also economically. Based on this knowledge was decided in the preparatory phase of SmartEnCity project that for next period will be required only gas buses on Tartu public bus lines.

Procurement for bus service for period 2019-2029 was started already in 2016. The contract was signed with a new carrier in January of 2018. One of the important conditions of the procurement was that the carrier must bring 64 new gas buses to the bus lines.

Changing the public transport system in Tartu (new buses, new bus line network, updated ticketing system) required a lot of engagement of citizens. There was carried out several public gatherings where citizens have been informed about the benefits of gas buses, how the use of gas buses will affect their living environment (less noise, less particulates, less GHG emissions etc.) and what is impact from changes in bus line network. Gathered feedback from citizens was valuable especially in the planning phase.



## Task 4.7 / Gas buses purchased and in operation is commissioned and deployed

As of 1 July 2019, the City of Tartu switched over to a new gas buses and new bus route network. The new network differs significantly from the recent network in terms of itineraries, the number of lines, as well as the frequency of departures. In total 13 bus lines will begin to travel along the route, along with two night lines. New gas buses will begin serving the routes, with AS GoBus providing service on the route network.

### The buses

In total 64 new gas buses, manufactured in the Scania factory, equipped with air conditioning, low floors and running on an environmentally friendly source of fuel. There are two types of buses: normal buses (12 m in length, 27 seats, and standing room for 52) and articulated buses (18 m in length, 41 seats and standing room for 96).

### **General requirements on gas buses**

- Must comply with the requirements for the vehicles of category M3 laid down in Directive 2007/46 / EC of the European Parliament and of the Council and the amendments and supplements to this Directive.
- Must have valid EC type-approvals of individual directives and EC type-approval in force.
- Must be suitable for use in northern climates - i.e. buses must start and be operational even with outside temperatures of -30°C;
- Shall be provided with a kneeling knee-length unit, which can be used either by the bus driver in automatic mode, when the bus is lowered by opening the doors of the side, and has an automatic restoration function of the knees when the doors are closed, or the bus driver manually activates the kneeling function and has automatic knee restoration when the doors are closed.
- Buses must be designed with a uniform and correctly executed color scheme, color codes: red Pantone 485 / RAL 3028 and white Pantone 0 / RAL 9016, as specified in Annex 1 of the Technical Specification and labeled (marking means explanatory signs for passengers entering and leaving the bus and the garage number). The marking will be specified after the conclusion of the contract.



To fulfil the contract, the carrier needed to have at least 64 buses as follows:

- 45 normal buses (all low-level, LF);

The number of passenger positions must be at least 75 (7 positions per square meter of free floor space), including seats 25 to 35;

The length of the bus is between 11 500 mm and 12 500 mm;

Doors: at least three double-open two-way (2 + 2 + 2);

- 19 articulated buses (all low-floor, LF);

The number of passenger positions must be at least 136 (7 positions per free floor area per square meter), including seats 35 to 45;

The bus length is between 17 500 mm and 18 750 mm.

Articulated buses must have at least three doors (2 + 2 + 2).

### Engine and fuel system

Buses must use H-group methane gas (CNG) or other fuels other than petrol or diesel or the latest hybrid;

The bus engines must comply at least with the exhaust gas requirements (Euro VI) laid down in Regulation (EC) No 595/2009 of the European Parliament and of the Council and the amendments to that Regulation;

Bus gas cylinders must comply with the ECE-R 110 rule for CNG-3 or CNG-4 and have a valid certificate.

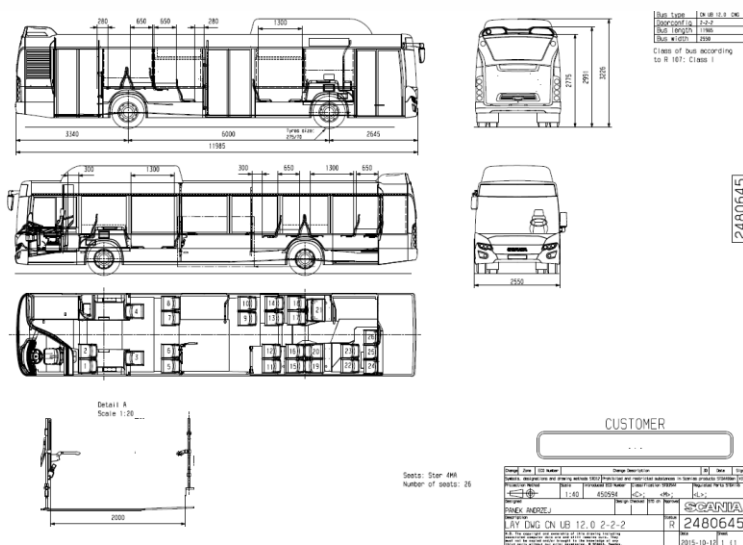


Figure 4: Scania gas bus

Public transport service provider GoBus AS constructed a new filling station in Tartu (Ringtee 25) for gas buses. New filling station have slow-filling equipment for 42 buses for overnight filling and 3 units of equipment for fast filling. The filling station was constructed by company Nordic Gas Solution.



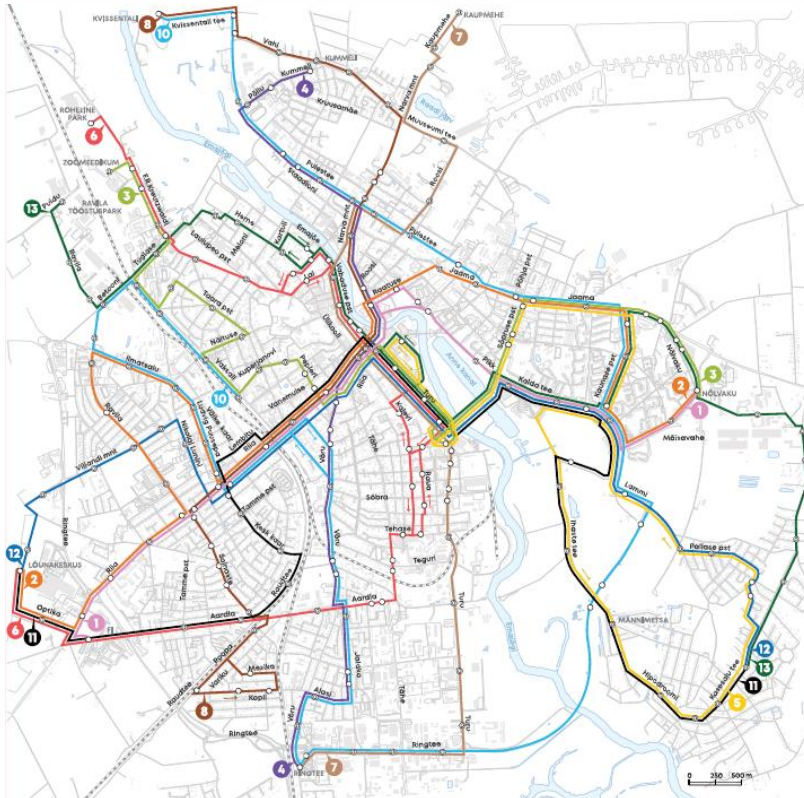
**Figure 5: New filling station**

### **Bus network**

The new route network differs significantly from the existing route network in terms of itineraries, the number of lines, as well as the frequency of departures. The new route network has fewer total routes, although these routes are more direct, better connected to one each other and operate at more frequent intervals. Timetables with a uniform frequency of service ensures that buses serving the same routes will not arrive simultaneously at the same stop. An important principle in the new route network is also the reduction in the number of circular routes and their replacement with pendulum routes, which leads to a simpler route network. The routes travel in both directions along the same itinerary, and are therefore better understood by users. Taking into consideration feedback collected from residents of Tartu, an entirely new circular route (No. 9/9a) was created alongside the pendulum routes, which passes through all of the most important points of interest.

#### D4.7 Gas buses purchased and in operation is commissioned and deployed

The new bus line network was created in close cooperation with finish company WSP Finland. In course of the process more than 1 000 comments and proposals from citizens were gathered.



**Figure 6: New bus line network**

All of the new gas buses have also new smart validators enabling to pay for a ride using contactless bank card, bus card or QR-code.



**Figure 7: New validator**





Tartu is taking a great leap forward this year when it comes to the organisation of its public transportation. We took three very big steps at one time: we developed a new route network, brought environmentally friendly gas buses onto the routes, and started the Smart Bike Share project. As a result, the air in the city will become cleaner and residents of Tartu will use less private cars.

### **Monitoring**

Deliverable “Gas buses purchased and in operation is commissioned and deployed” will be monitored within the project during the period 01.08.2019 – 31.07.2021. Monitoring will be carried out by TAR with help of smart city platform (CIOP) developed within the project by company Telia Eesti AS. GPS data from buses will be analysed and based on this information will be defined accuracy of time-keeping of buses and mileage of buses. GPS data of buses and fuel consumption data of buses will be used to monitor the environmental impact of buses. The CO<sub>2</sub> savings will be calculated in comparison to diesel and the calculation methodology is described in section 2.



## 4 Recent and former lessons learned

The experience gained from the previous procurement period regarding the use of gas buses and optimization of the bus network formed the basis for the reorganization of the public transport system in Tartu.

The introduction of gas buses was once rather risky as neither municipalities nor public transport service providers had experience in operating and using gas buses. There were also no filling stations of compressed gas available at this time. The risk taken by Tartu paid off and, as it has become clear over time, gas buses justify themselves. Thus, in preparing for the new procurement period, it was decided that within the framework of the SmartEnCity project only gas buses will be introduced in Tartu in next period.

In the case of gas buses, it is very important to have the necessary fueling infrastructure in place. It is more complex and time-consuming to build gas filling station than filling station for liquid fuels. The necessary requirements must be reflected in the procurement document.

In connection with the re-designing of the bus network, we experienced the importance of involving high-level experts/professionals into process. We also experienced how important it is for the citizens to be involved in such processes. In the planning phase was used about 20 different data-layers (mobile positioning data, data from ticketing system, POI's, schools, workplaces, living places etc.) to identify movement patterns of citizens and create efficient public transport network in Tartu. At last we got for same amount of money a public transport system with much higher quality and significantly lower environmental impact in comparison to existing system.

