TOWARDS SMART ZERO CO_2 CITIES ACROSS EUROPE

VITORIA-GASTEIZ ✣ TARTU ✣ SONDERBORG

Deliverable 5.4: 38 biogas-buses in operation, being part of the measurement and evaluation program

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[1] PU = Public

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Table of content:

Table of Tables:

Table of Figures:

Abbreviations and Acronyms

Abbreviation/Acronym	Description
CNG	Compressed Natural Gas
D	Deliverable
EV	Electrical Vehicle
PPP	Public Private Partnership
SmartEnCity	Towards Smart Zero CO_2 Cities across Europe
WP	Work package
SONF	Sonderborg Forsyning
VG	Vikingegaarden

Table 1: Abbreviations and Acronyms

0 Publishable Summary

The objective of switching from conventional diesel buses to biomethane buses in Sonderborg Municipality, Denmark was mainly to reduce the carbon emissions, although also sulfur emissions, NO_x and PM pollutants are significantly reduced. The reduction of carbon emissions from public transit is part of the ambitious and prominent goal of the Sonderborg area becoming carbon neutral by 2029.

The implementation of public transit zero emission biomethane buses went according to plan. Although, including the preparatory work leading up to the successful implementation was ongoing for more than 3 years and necessitated at least one committed traffic planner at the municipality as well as an attentive and positive city council.

Not only was it necessary to launch a tender for 44 biomethane buses, a separate tender was launched to construct a biomethane fueling station for the buses since there were no existing facilities in the municipality. Furthermore, the research and planning team discovered the benefits to adding a small fueling station at the terminal stop furthest away from the main fueling station to avoid empty drives to refuel.

The leading partners in this transformation were the municipal council and the private sector biomethane producing company Nature Energy as well as Umove, a private sector bus operating company that won the tender. The SmartEnCity partners had less prominent roles, yet conducted important work in the process; ProjectZero was a leading partner in opening up the discussion and possibility for alternative fuel vehicles and assisted with informative research and lessons learned from elsewhere. SONF collaborated and supported the process with project management resources and an educational and informative video for the general public regarding the benefits of the biomethane buses.

The fueling station was completed in May 2017 after less than 6 months of construction. The biomethane buses started operating on June 25th as planned, approximately 10 months after the announcement of the winner of the tender. The contract for Umove to operate the buses is 10 years with the possibility of extending for another 2 years.

Figure 1: Biomethane bus refueling

1 Introduction

The SmartEnCity project has a wide variety of demo actions, of which one of the focus areas is Smart Mobility. The smart mobility actions aim to explore and implement transportation solutions for the 21st century; the various solutions across the three lighthouse cities focus on zero and low emission transit. In Sonderborg the smart mobility demo actions include the implementation of the biomethane buses, and intelligent EV chargers.

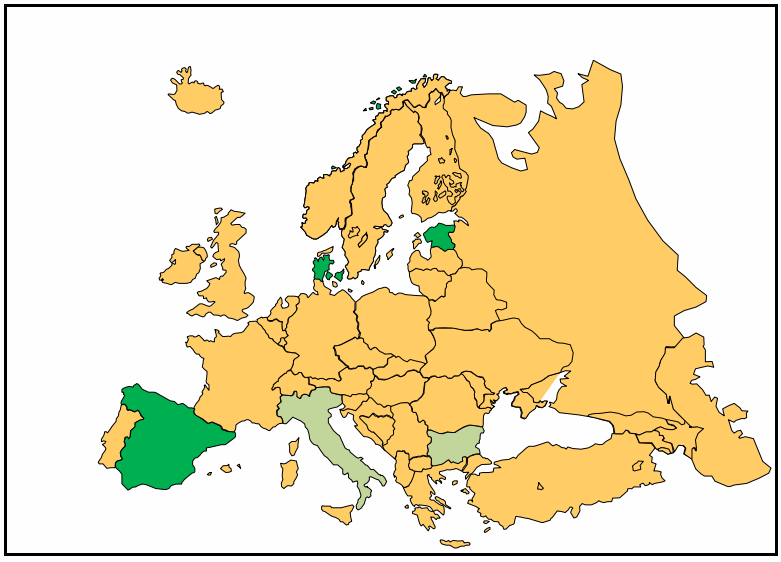

Figure 2: Lighthouse and Follower Cities in SmartEnCity

Sonderborg Municipality aims at becoming carbon neutral by 2029. To address all carbon emitting activities in the municipality resources have been committed to create long term viable development plans. These plans include energy efficiency in buildings, zero emissions transport, and green district heating.

Besides becoming carbon neutral, one of the key factors to assess initiatives is the number of green jobs created. Therefore, several strategic plans exist for the municipality, and with the support from the majority of political parties, so the strategies are implemented across election periods. Among the most noticeable strategies for the area are the general ones; Masterplan 2029, Roadmap 2010-2015, Roadmap 2020, and the topic specific ones; Strategic Energy Plan, and Strategic Energy Plan for Green Transportation.

A crucial part of achieving the 2029 goal is to address the 27% of carbon emissions stemming from transport.[2] The ProjectZero secretariat acts as a catalyst to research, launch and track the progress towards carbon neutrality.

[2] Strategisk energiplan for grøn transport 2016

1.1 Purpose and target group

The purpose of this deliverable is to document the details and processes of substituting conventional diesel fueled buses with biomethane buses. The details include a description of the political processes, and lessons learned up to the implementation of the buses.

Target groups include municipalities, NGOs, lobbying and activist groups working for carbon free public transit and others interested in changing to alternative fuel 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
SONF	Overall & general content
ZERO	Contributions and support

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
D5.1	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.
D5.7	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.

Table 3: Relation to other activities in the project

2 Objectives and Expected Impact

Smart mobility is part of the Sonderborg Lighthouse Demonstrator tasks in the SmartEnCity project, and switching from diesel buses to biomethane buses is a significant activity within this task.

2.1 Objective

The objectives of this deliverable was twofold; 1) the implementation of biomethane buses, and 2) a summarizing documentation of the resources going into this change to provide lessons learned to other cities and municipalities interested in zero carbon public transit.

2.2 Expected Impact

The reduction of an annual one million liters of diesel is expected to reduce the municipality's share of carbon emissions from transportation with 2,660 ton of CO_2. Furthermore the municipality is decoupling development from fossil fuel consumption which supports achieving carbon neutrality by 2029, an ambitious but realistic goal for the area.

Improved service for customers now include USB charging, space for either four bicycles, two strollers or two wheelchairs, ramps for easy access and kneeling of the bus during entering and exiting. Not only are these services aimed at improving quality of life for residents in the area, but also to encourage the switch from driving cars to take public transit which additionally would reduce carbon emissions from the reduced number of cars on the road.

As a bonus of implementing zero emission biomethane buses an increase in green permanent jobs are imminent due to a biogas production facility being constructed in the municipality. The national company supplying the biomethane gas for the bus fueling station is building a production facility so the biomethane will be locally sourced. The number of temporary jobs in the construction phase is estimated at 450 and the permanent jobs at the facility, including drivers between the facility and the farmers, are estimated at 25. Since the production and consumption of the fuel occurs locally it is anticipated that more money will remain in the region.

3 Overall Approach

In 2007 a Public-Private Partnership (PPP) called ProjectZero was created by collaborative efforts of Sonderborg Municipality, The Bitten & Mads Clausen Fond, The Nordea Fond and Dong Energy[3]

> "The public-private partnership – ProjectZero – was created to inspire and drive Sonderborg´s transition to a ZERO carbon community by 2029, based on improved energy efficiency, conversion of energy sources into renewables and by creating participation of all stakeholders to reach the ambitious goal: CO_2-neutral growth and sustainable urban development."[4]

The ProjectZero secretariat acts as a local catalyst and driver in order to achieve the Sonderborg ProjectZero vision together with local and external stakeholders.

Biomethane buses in the Sonderborg area

In 2014 the administration of the Sonderborg municipality started to prepare the planning process for the new public transit buses that had to be launched in mid-2017. Due to the ProjectZero vision and the fact that the municipality as administrative body acts as a role model the administration decided to investigate new carbon neutral technologies as alternative for the diesel driven buses. During a research phase the idea to have biogas buses grew. This was also supported by a presentation given by the CEO of the large Norwegian transit company TideBus that already had some experiences with CNG, electrical and hydrogen buses. Finally the administration decided to incorporate a statement about carbon neutrality in the tendering materials. The city council decided in September 2014 that the next tendering for the public transport services had to be published with an obligation about the fuel of the buses which either had to be biomethane or electricity. Furthermore a new filling facility had to be established close to the Sonderborg city center.

Further investigations showed that biomethane would be the best solution for public transportation in Sonderborg due to their cost and mileage effectiveness. These findings were also confirmed by a comparison by the Danish consultant Teknologisk Institut which showed that biomethane buses are the best choice considering costs, carbon emissions, NO_x emissions and technological maturity.[5]

Once the municipality had made the political decision to pursue zero emission public transit vehicles a tender was launched for biomethane bus transportation covering the entire municipality. The tender was successful and the winner announced in September 2016. The biomethane buses started operating on June 25th 2017 according to plan and will run for at least 10 years with the possibility of extending the contract another 1+1 years.

Although unrelated to this deliverable, the municipality was able to attract a national gas utility to start investigating sites for biogas production facilities in the municipality so that the biomethane would eventually come from locally sourced raw materials. Until such facility exists the biomethane buses buy certifications for the amount of biomethane consumed from the national grid.

[3] http://www.projectzero.dk/da-DK/TopPages/Om-ProjectZero/Hvem-st%C3%A5r-bag-ProjectZero.aspx, accessed 23.11.2017,09:48
[4] http://brightgreenbusiness.com/en-GB/TopPages/About-ProjectZero-2.aspx, assed 23.11.2017, 09:51
[5] Rådgivning i forbindelse med udbud af kollektiv trafik 2017, Teknologisk Institut, 2016

The successful implementation of this deliverable has been based on close collaboration between ProjectZero, the municipality and SONF. The municipality handled the technical and hands on work involved, SONF handled some publicity related items and coordination with the biomethane production company and ProjectZero initiated the contact with the biomethane production company and acted as project catalyst until all decisions had been made at the administrative and political level.

4 Task 5.6 / 38 biogas buses in operation

The framework

The process of switching from conventional diesel buses to alternative fuel buses took 3+ years. The process necessitated close collaboration between several local and regional partners. In Denmark the public transit system is regulated in such a way that municipalities cannot run tenders directly for public transit services. The regional bus transit agency SydTrafik is responsible for all tenders regarding public bus transit.

After the municipal council at the end of 2014 decided to pursue biomethane buses in the next lease period, the specifications had to be developed. Between a national consultancy company and the municipal employees specifications were agreed upon. The specifications included; all 38+6 buses had to be the same design, space for four bicycles, a minimum of 650km per charge, USB charging at all seats, and that buses "kneel" when passengers enter or exit the bus. This information was passed on to the tendering department at SydTrafik which completed the tender process, with municipal involvement at the end of the process. The winning bid was chosen based on a combination of quality and price.

The added cost of operating biomethane buses is €470,000 annually. The politicians in Sonderborg judged the added value from the buses to be higher than the added cost. Among the added value are; zero emissions towards the 2029 carbon neutrality goal, immediate pollution reduction for the citizens walking the streets, and noise reduction.

The buses

The tendering materials for the new buses were launched in December 2015. The tendering included the shift of all existing diesel buses within the Sonderborg municipality to biomethane driven CNG buses.

The buses are equipped with national integrated ticketing system – Rejsekortet enabling comfortable and affordable use of other regional and national public transport services. The ticketing system have additional benefits – statistic data from ticketing system shows off the usage of public transport services (routes, times) and is used for better planning of public transport services.

The lease contract with the operator is 10 years starting 25th June 2017 with the possibility to extend 1+1 year. This was a necessary step to allow for a reasonable write off of the buses.

A video was produced for a dual purpose; to educate the public about the change to biomethane buses and the associated benefits, and to run a publicity campaign to encourage more individuals to take public transit. The video showcases the possibilities for bringing bikes, wheelchairs or strollers onboard, USB charging and the kneeling bus during entering and exiting. The video has had 207 views on Youtube between October 17th, 2017 and January 5th 2018; the video may be viewed here https://www.youtube.com/watch?v=h9U8UKjSrC0 .

The biomethane buses are CNG buses, however, certificates for biomethane production equaling the amount of natural gas used in the buses are being purchased.

Figure 3: Biomethane buses parked for the night

The fueling station

A separate tender was launched for the filling facility and the purchase of approximately 1 million Nm^3 biomethane annually[6] because there was no biomethane fueling station in Sonderborg municipality. This slow-fill fueling station was designed to include 50 fueling points despite the current number of buses included in the biomethane bus tender was 44. Of the 50 fueling points 48 are slow fill and two are fast-fill. That means that if an emergency arises two buses at a time can be filled in 15 minutes. The slow fill fueling points fill the 44 buses concurrently in 8 hours, usually overnight. It was made a condition in the bus tender that any operator of the buses must use this fueling station to ensure the financial viability of the fueling station.

The fueling station was constructed to the following specifications. If all 38+6 buses start fueling they will be fully fueled after 8 hours. However, due to varying schedules and timetables the buses rarely all start fueling at the same time which means most buses are fully fueled in less than 8 hours. The compressors of the filling station are directly connected to the natural gas grid (4 bar) so there is no need for any storage.

The bill from CNG consumed is passed on to the bus operator Umove. A national gas utility company is the biggest shareholder of biogas production plants within Denmark and is the supplier of CNG to the fueling station.

[6] https://emdesk.eu/shared/595f3950311d7-cdd78b6efb693e13db41f52e85bf282f
https://EMDESK.eu/shared/595f390210a92-b12aacd88f3347e37641e364e50f6bc5

The municipality is responsible for purchasing biomethane certificates equal to the amount of CNG used at the filling station to ensure the biomethane off-set since CNG and biomethane are combined in the national grid.

Furthermore there is a bus washing station, a garage and an employee building with changing facilities, tables and chairs, coffeemaker, and an office.

The building phase of the new filling station started in the beginning of 2017 and was finished in early summer 2017.

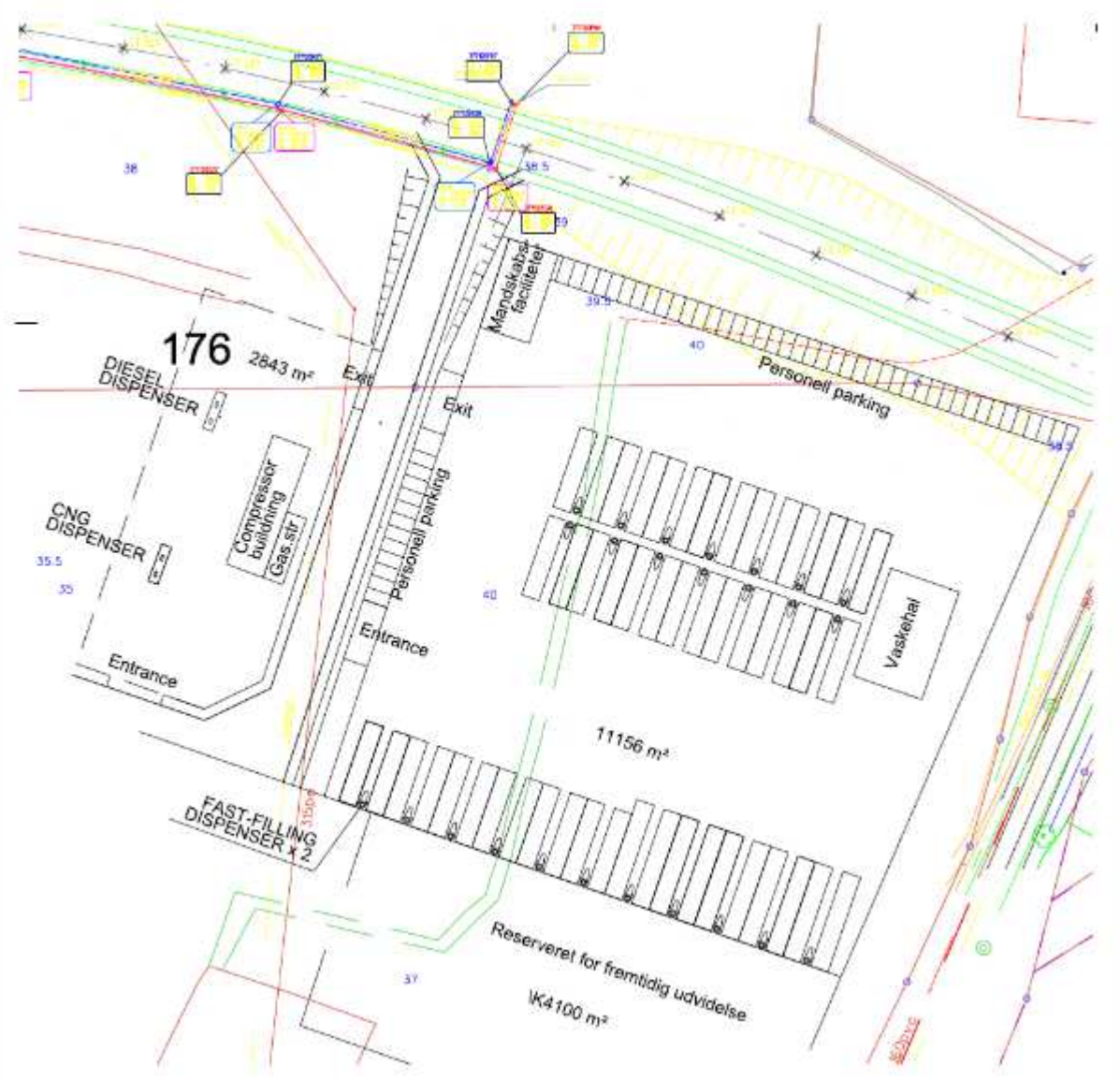

Figure 4: Schematic overview of the new gas filling facility[7]

[7] https://www.sydtrafik.dk/Files/-sydtrafik2013/Topmenu/Udbud/Sydtrafik_9._udbud/9-udbud-pakkebesprivelse-pakke-937-v18032016.pdf, accessed 27.11.2017, 10:40

Monitoring and evaluation

The monitoring and evaluation of the buses is done by the municipality. Statistics regarding number of passengers, travel distance, popular routes, and age groups are collected through the digital ticketing system “Rejsekortet” which is the prevalent mode of payment for public transit in Denmark. The mechanical monitoring and biomethane consumption is done by the bus operator Umove and includes engine, performance, maintenance of the chassis and interior.

The data collected will be made available for the SmartEnCity project. The initial plan had included VG to install dataloggers, however this out not to be feasible due to insurance/warranty issues. The data collected and made available to the project include passenger info and travel patterns, technical performance, kilometers driven, repairs and maintenance.

Figure 5: SmartEnCity delegation on a fieldtrip in October 2017 investigating the new biomethane buses

5 Lessons Learned

Throughout the process leading up to the biomethane buses several actions have proven crucial for the successful implementation; ambition, commitment and long term planning.

Firstly, a clear, ambitious goal for the Sonderborg area followed up by factual numbers and statistics were the guiding principles. Through the ProjectZero vision and secretariat the ambitious goal of carbon neutrality in 2029 was established and widely packed by politicians, businesses and individuals. The research and documentation of how much carbon emissions stemmed from various sectors including the public bus transit system supported decision makers in targeting the largest emitters and thus launch a tender for the replacement of diesel fueled buses.

Secondly, the political commitment from the municipal council, backed with data from the local traffic planners has been invaluable since the biomethane buses have a total annual added cost of €470,000. The political commitment ensures the widespread communication of the benefits achieved through this added cost.

Thirdly, the importance of long term planning must be emphasized, especially when first switching from diesel fueled to, for example, biomethane because of the extensive research necessary. The topics researched included the costs of establishing a refueling station, range of biomethane buses and of the average daily routes for each bus, delivery time from the manufacturer, as well as the process time through the political system to obtain the necessary approvals.