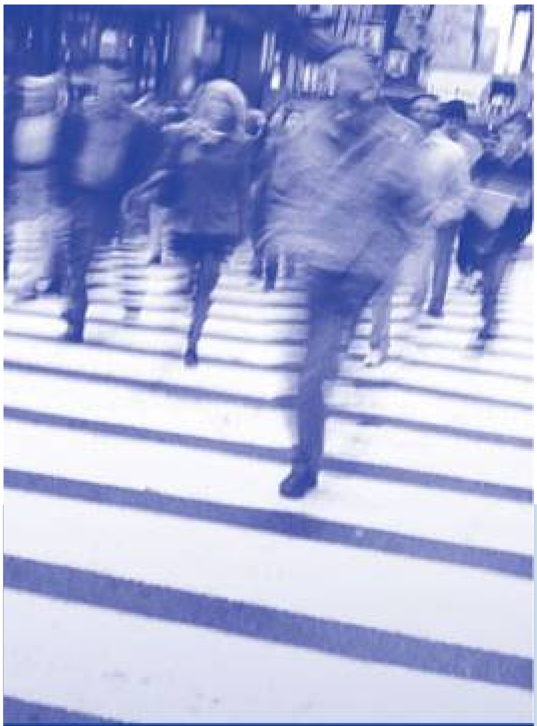

ECCENTRIC

Replication Package : Clean Vehicle Technologies

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2020 CIVITAS Cleaner and better transport in cities ECCENTRIC

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Abstract

CIVITAS ECCENTRIC work package 7 comprises seven measures aiming to increase the efficiency and to reduce environmental impact of urban freight in Madrid, Munich, Ruse, Stockholm, and Turku.

The report summarizes specific experiences, lessons, and recommendations of demonstration measures of WP7 cluster focused on Clean Vehicle technologies, which includes two measures that target different approaches towards low carbon logistics and test different technologies for heavy duty freight vehicles. The report aims to maximize the replication potential of the measures, describing critical challenges and success factors to consider.

Project Partners

Organisation	Country	Abbreviation
Ayuntamiento de Madrid	Spain	AYTOMADRID
Grupo de Estudios y Alternativas 21 SL	Spain	GEA21
Consorcio Regional de Transportes de Madrid	Spain	CRTM
Empresa Municipal de Transportes de Madrid SA	Spain	EMT
Universidad Politécnica de Madrid	Spain	UPM
Avia Ingenieria y Diseño SL	Spain	AVIA
FM Logistic Corporate	Spain	FM LOGISTIC
Stockholms Stad	Sweden	STO
Kungliga Tekniska Hoegskolan	Sweden	KTH
Flexidrive Sverige AB	Sweden	FLEXI
Carshare Ventures BV	Sweden	CARSHARE
Ubigo Innovation AB	Sweden	UBIGO
Mobility Motors Sweden AB	Sweden	MM
Cykelconsulterna Sverige AB	Sweden	CYKEL
Gomore APS	Sweden	GOMORE
Landeshauptstadt Muenchen	Germany	LHM
Münchner Verkehrsgellschaft mbH	Germany	MVG
Domagkpark Genossenschaft EF	Germany	DOMAGK
Green City EV	Germany	GC
Green City Projekt GMBH	Germany	GCP

Technische Universitaet Muenchen	Germany	TUM
City of Turku	Finland	TUR
Varsinais-Suomen Liito	Finland	VSL
Turun Kaupunkiliikenne OY	Finland	TUKL
Western Systems OY	Finland	WS
Turun Ammattikorekeakoulu OY	Finland	TUAS
Gasum Biovakka OY	Finland	GASUM
Obshtina Ruse	Bulgaria	RUSEMUN
Club Sustainable Development of Civil Society Association	Bulgaria	CSDCS
ICLEI European Secretariat GMBH	Germany	ICLEI
FM Logistic Iberica SL	Spain	FMLOG

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Dissemination Level: PC = Project Coordinator, SM=Site Manager, TC=Technical Coordinator, EM=Evaluation Manager.

Table of Contents

List of Figures

List of Tables

List of Acronyms

BEV	Battery Electric Vehicle
CO_2	Carbon Dioxide
D	Deliverable
EC	European Commission
EFV	Electric Freight Vehicle
EV	Electric Vehicle
FCEV	Fuell Cell Electric Vehicle
GHG	Greenhouse Gas Emissions
ICE	Internal Combustion Vehicles
LBG	Liquefied Biogas
LEV	Light Electric Vehicle
MIT	Motorised Individual Transport
ML	Measure Leader
NGO	Non-Governmental Organization
NOx	Nitrogen Oxides
PHEV	Plug-in Hybrid Electric Vehicle
TCO	Total Cost of Ownership
UVAR	Urban Vehicle Access Regulation
WPL	Work Package Leader

Executive Summary

Demonstrate and test innovative solutions for cleaner and better urban freight in urban centres has been identified as a main need that remains unresolved even in cities that have developed a comprehensive set of actions and policies on sustainable mobility. The freight companies face challenges of availability, affordability and performance to integrate clean vehicle technologies in their fleets as city centres show an increasing conflict in public space use, the tolerance for noise and pollution leads to more demanding requisites and, at the same time, digitalization is inducing a disruptive change in customer behaviour through e-commerce.

This document summarises and integrates the main findings and conclusions of the two measures of the ECCENTRIC Work Package 7 “Towards better and cleaner urban freight logistics” that are focused on Clean Vehicle Technologies (Cluster 2). It is intended to provide key information for the replication and upscaling of the measures tested, which are focused on heavy duty vehicles, a range where a lack of commercially available environmentally friendly freight vehicles have been identified. Technologies tested in trucks operating in real-life logistics conditions (BEV in Madrid, LBG in Turku and PHEV in Stockholm, this last one included in measure STO 7.4 of cluster 1) are aligned with the recommendations of the European integrated perspective for urban logistics regarding clean vehicles.

This report (D.7.5) is part of the Replication package produced as a result of the work carried out in the ECCENTRIC WP7, in which reports D.7.4 - Efficient Supply Chains, which also includes measures related to the uptake of clean freight vehicles, and D.7.6 - Innovative policy tools for freight logistics are also included.

1. Introduction

1.1. Purpose of this document and target group

In CIVITAS ECCENTRIC, five cities (Turku, Stockholm, Ruse, Munich, and Madrid) have implemented in total 51 innovative sustainable urban mobility measures. The measures were addressing a variety on urban mobility challenges, organized in different thematic clusters. This document is intended to equip practitioners and decision makers with the information needed if they want to replicate measures of the thematic cluster “Clean Vehicle Technologies” or aspects of these measures, considering always the local context to achieve a feasible and reliable transfer of experiences.

This document is tailored following the practical needs of project developers and planners / technical staff from cities to develop innovative measures, to consider potential barriers and to be able to select the appropriate solutions to match their contexts. This document provides evidence that particular measures have been successfully implemented in a city and have a good replicability potential.

2. Summary of the Cluster: Clean Vehicle Technologies

In the last decade European cities have made significant steps forward in the delivery of sustainable urban mobility policies, proving that major impacts in terms of congestion and reduced emissions can be achieved through ambitious measures.

At the same time, peripheral districts remain largely unaddressed, with the effects of flagship projects being rarely transferred to these areas. Recent or future urban growth processes are posing additional pressure to peri-central areas. The main common challenges are to relieve central areas through clean and efficient urban logistics, as well as to increase the attractiveness and sustainable mobility of suburban districts.

The cities of Madrid, Stockholm, Munich, Turku and Ruse, in the framework of the CIVITAS ECCENTRIC consortium, have identified urban freight as one of the main needs that remains unresolved even in cities that have developed a comprehensive set of actions and policies on sustainable mobility and, therefore, a thematic work package has been specifically directed towards demonstrating and testing innovative solutions for cleaner and better urban freight in urban centres.

The freight companies face important challenges to incorporate clean vehicles to meet the increasing environmental standards as city centres show emerging conflicts in public space use, the tolerance for noise and pollution leads to more demanding requisites and, at the same time, digitalization is inducing a disruptive change in customer behaviour through e-commerce.

The CIVITAS ECCENTRIC measures dedicated to tackle the specific challenges of clean vehicle technology for urban freight in the city centre cover a variety of potential approaches to develop and analyse economically viable and environmentally sound technologies for commercial medium and heavy duty trucks to be used in urban goods delivery operations, thus reducing energy consumption, emissions and noise.

The UE Communications “A European Strategy for Low-Emission Mobility” and “Europe on the Move”, COM (2017)-283 and COM (2016)-502, respectively, highlight the importance and challenges represented by freight transport, that is expected to grow by 60 per cent, in achieving sustainable mobility systems and how the success in the shift to low-emission mobility will very much depend on how cities address urban logistics issues.

Table 1 Measures of WP7- Cluster 2 – Clean Vehicle Technologies

Measure	City	Partner(s)
MAD 7.6 – Prototype for an ultra-low emission cargo vehicle	MADRID	AYTOMAD / AVIA / FMLOGISTIC / UPM
TUR 7.7 – Introduce biogas for heavy duty freight vehicles	TURKU	GASUM / TUR / TUAS

The CIVITAS ECCENTRIC project has applied as a global framework the six central topics recommended by the European Commission to tackle freight challenges. The six topics are the subject of a non-binding guidance series primarily aimed at public authorities such as municipalities, developed by the European Commission's Directorate General for Mobility and Transport (EC Study on urban logistics – The integrated perspective, DG MOVE 2018) and are the following:

- Use of Information and communication technologies
- Treatment of logistics activities in Urban Vehicle Access Regulation schemes
- Engagement of stakeholders when implementing urban freight transport policies
- Logistics schemes for E-commerce
- The use of Environmentally Friendly Freight Vehicles
- Indicators and data collection methods for urban freight distribution

These guidance documents cover the use of environmentally friendly freight vehicles, providing advice to the local policy makers on urban logistics. They have been used during the ECCENTRIC project for defining an overarching analysis of the measures and other info exchange:

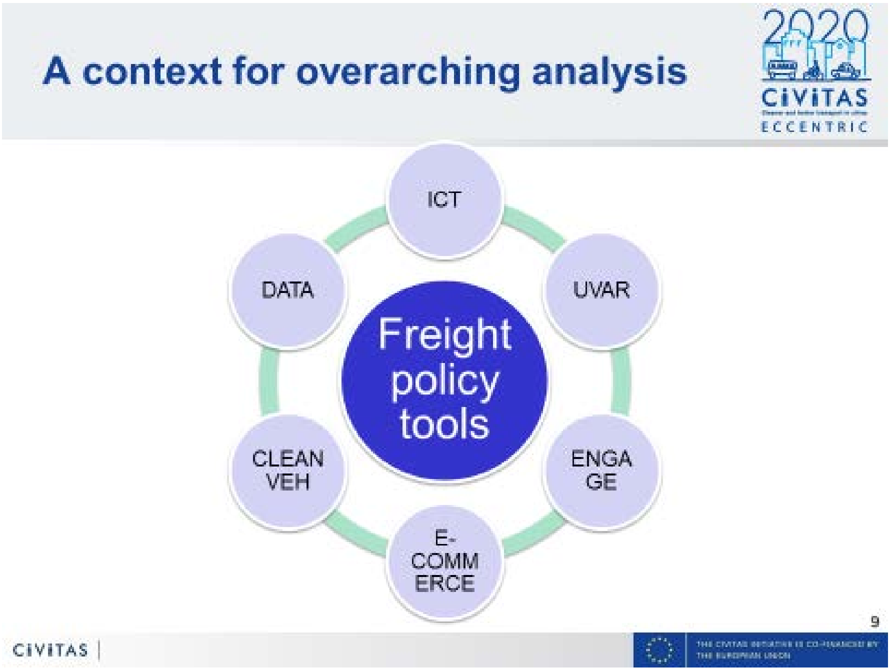

Figure 1: Clean Vehicles as main element of the EC integrated perspective

3. From ECCENTRIC cities to replication in other places

When talking about clean freight vehicles there is a wide scope in terms of size, type, and traction technology. Considering the type and size of vehicles, different available clean vehicles as mopeds, cargo bikes, e-scooters, quadricycles or light and heavy-duty vehicles currently play an important role in cutting emissions for the last mile delivery. As mentioned in the European Environment Agency report ""The first and last mile — The key to sustainable urban transport", other innovative vehicles not yet implemented in real life setting, as autonomous vehicles but also drones and robots, could be also considered."

Within the CIVITAS ECCENTRIC project, the WP7 cluster on "Clean vehicle technologies" has targeted heavy duty vehicles because clean trucks have been considered as one of the main technological unresolved challenges in achieving a low emissions urban freight. In this regard, the European non-binding guidance document on urban logistics says about the environmentally friendly freight vehicles that in "the segment of heavier vehicles, such as classes N2 and N3, the internal combustion engine vehicles remain the single viable solution as the battery electric vehicles are limited in terms of load capacity and range".

Nevertheless, other light vehicles and vans have been part of the demonstration measures in different work packages and the results included in the corresponding deliverable could provide useful information for other cities interested in replication:

- MUC 7.3: Combining Cargo-Bike-Delivery with a flexible package system.
- STO 4.9: Offering test fleets of e-bikes and e-freight bikes.
- STO 6.1 Offering EV-test fleets to selected target groups.
- MUC 6.3 Electric lightweight vehicles for car sharing and logistics.

Regarding technologies, the ones that have been tested for heavy duty trucks within the scope of WP7 have been the fully electric truck in Madrid, the plug-in hybrid electric vehicle in Stockholm and the biomethane fuelled vehicle in Turku. Two of them included in the cluster of Clean Vehicle Technologies and the third one in the cluster of Efficient Supply Chains in this same work package, due to the combination of night delivery regulation in Stockholm (Measure STO 7.4: Night delivery with clean and silent vehicles)

Figure 2: **ECCENTRIC heavy freight vehicles in real life operation in Madrid, Turku and Stockholm**

The technologies tested are the ones that are on the edge of market maturity, so they are likely to present better conditions for upscaling and replication. Furthermore, they are aligned with the concept of Environmentally Friendly Freight Vehicle adopted in the CE study of logistics (The Integrated Perspective) as the alternatives to be considered as technological transition towards the reduction of greenhouse gas emissions and other pollutants.

The vehicles have been specifically designed or modified for the CIVITAS ECCENTRIC project bearing in mind that they must be operated in real life conditions as part of current urban supply chains. The Figure 3 shows those vehicles running in current logistics activities.

The information for evaluating the replication potential, i.e. the main drivers and barriers and policy recommendations that can have a positive impact in the progressive uptake of clean freight, is included in clause 4 for both measures included in this cluster. Other useful information can be found in other ECCENTRIC Replication Package deliverables from WP7, WP6 and WP4.

4. Example measures

4.1. Measure MAD 7.6 – Prototype for an ultra-low emission cargo vehicle

Introduction

Within this measure, the Climate Change Department of Madrid City Council cooperated with a vehicle manufacturer Avia Ingenieria y Diseño SL (AVIA) in order to develop a prototype of a clean Electric Cargo Vehicle adapted to the specific needs of Madrid´s urban freight operators, following the study on freight distribution developed by UPM, the research partner in measure MAD 7.1 . The aim is to test the prototype under real operation conditions to fine-tune its design and performance as well as to promote the further uptake and commercialisation of the improved vehicle by other stakeholders.

The general objective is the contribution in cutting air pollutants and GHG emissions, since freight road traffic and last mile logistic are, after passenger cars, the most pollutant fleet of the city.

A new sustainable mobility approach is now adopted as part of Madrid City Council Agenda. The Air Quality and Climate Change Plan (Plan A) and the new Madrid 360º Strategy have set among their goals fostering new and sustainable patterns on urban freight distribution paying attention to innovation on logistic processes happening in within the city (e.g. consolidation centers) and to the renovation of the freight fleet fostering the use of clean vehicles. New regulations on mobility as the new Sustainable Mobility Ordinance, the new Zero Emissions Zone (implementing access restrictions to freight vehicles regarding weight and environmental performance) or the On Street Parking Service fare scheme are aligned with the strategic goals on urban freight sustainability. All these policies support private stakeholders in the up taking process of clean vehicles.

Implementation

The whole implementation process is specifically focused on the design and manufacturing of an electric truck suitable for most of the last mile deliveries happening within the city. The measure, coordinated by Madrid City Council, is being developed by four public and private stakeholders:

- AVIA, an engineering company specialized in clean trucks manufacturing.
- FM Logistic, a logistic operator with a big share of freight deliveries within Madrid that will test the prototype in real conditions providing deliveries under the frame of the Measure 7.1 Consolidation Centre.
- Madrid Polytechnic University UPM, a public research institution specialized in Air Quality and modeling the impact of traffic in Madrid air quality.
- Madrid City Council, Energy and Climate Change Service.

The time frame of the measure has followed the 4 stages planned: Research & Planning, Procurement & implementation, Demonstration & Monitoring and Conclusions and Recommendations. The actions taken during the development of the measure are described below:

Planning and research

An analysis of the 'Study on freight distribution in Madrid' (in cooperation with MAD 7.1) was conducted by UPM, focused on existing Freight distribution models taking place in the city and most common vehicle typologies used in every distribution model. The aim is to identify freight vehicle typologies not offered by car manufacturers. UPM study and analysis includes a Survey Scheme focused on freight operators and vehicle typologies and clean vehicles use perspective. Analysis includes traffic regulations, traffic restrictions, municipal plans on freight, etc. to evaluate the best technological solution.

The factors taken into account for the design of the prototype are the following: AVIA Ingenieria owns their own workshops and a team specialized in designing, retrofitting and manufacturing clean vehicles; the electric truck prototype has been designed and manufactured according to European Regulations on Technical type approval of motor vehicles and batteries; Madrid Municipal regulations on traffic access for freight vehicles, in terms of weight and pollutant and GHG emissions, have been considered in the design phase.

It is important to remark that there has been a particularly important change in the design phase. At the beginning it was expected to design and manufacture a hybrid truck powered by electricity and compressed natural gas (CNG). During the first stages of the project all partners involved took the decision of manufacturing an electric prototype due to several facts (new regulations on freight urban traffic, innovative approach, reduction on prices of the electric components of the vehicle, etc.)

Procurement and implementation

Design project.

- Definition of main characteristics of the electric vehicle: Following conclusions of the previous phase, set main characteristics of the vehicle (size, load capacity, gross vehicle weight, low emission technology).
- Definition of engine and energy storage system main features: based on a previous analysis of geographic conditions of the working area of vehicles (maximum slope, etc.) and analysis of freight operator needs (electric range) using data logger system in currently used freight vehicles.
- Design phase - design and integration of components in the chosen chassis.
- Procurement and vehicle assembly - A new 12 tones chassis provided by a popular truck manufactured was procured by AVIA Ingeniería. In parallel, the most important elements for the electrification of the truck (as the battery train and the electric engine) were procured and assembled. The truck was assembled by the third quarter of 2019, after solving several problems regarding technical issues on the manufacturing process and delays on the

supply of electric components. As part of the procurement and ensemble process, it is important to highlight that FM Logistic has provided the cargo box of the prototype considering their final customers' needs.

- By December 2019, the vehicle was running. Once the functional safety test finished it was ready to face all the administrative permits, according to European regulations on vehicle harmonization and national regulations on freight transport, needed for the electric truck prototype to be working on street on the delivery of goods.
- A trial and durability test has been carried out before starting the demonstration phase. The idea of this test was to have an initial data of the vehicle performance prior to be functioning on the street under real operational conditions. After finishing this works since March 2020, the vehicle is ready to start the real condition tests.

Some of the main features of the vehicle are:

- Range: 80 km
- Maximum speed: 90 km/h
- Maximum weight: 12 ton, with an estimated load capacity over 8 ton.

The electric truck prototype will be mainly recharged at the FM Logistic warehouse using a standard wall box charger (16 A 3 phases) and will include standard connectors to take advantage of public charging networks.

Figure 3: Bodybuilding and main components of the electric truck prototype

<u>Demonstration and monitoring</u>

The most important works during this phase are:

- Evaluation of the performance of the electric vehicle under real conditions. The vehicle is going to be tested by FM Logistic under real conditions using the consolidation centre designed for the measure MAD 7.1.
- Monitoring and assessment of impacts derived from the use of the electric vehicle comparing it´s performance with a conventional one.

Figure 4: ECCENTRIC electric truck prototype running on the road

Communication and exploitation

The communication strategy focused on future marketability and upscaling started in June 2019, once the prototype was assembled and operational, but still not officially allowed to be driving on road, was launched in the ELECTRIC VEHICLE SHOW MADRID (VEM 2019) and the National Workshop associated to this event, with the presence of the Environment and Mobility Councillor of Madrid City Council.

Figure 5: Dissemination activities for marketability and upscaling

After finishing the previous phase, the strategy of communication was focused on these 2 main issues:

- Dissemination of conclusions and lessons learnt.
- Definition of a business case for urban clean deliveries with other logistic operators working in Madrid. Upscaling with different potential customers.

Business model and contractual partnerships

The 12-ton Electric Truck is owned by AVIA Ingeniería, the engineering company in charge of the design and manufacturing of the vehicle. The prototype is going to be tested by FM Logistic, under their green brand "CITY LOGin", under the frame of the measure MAD 7.1 Consolidation Center, focused on the improvement of their last mile operations within the city. AVIA Ingeniería, and FM Logistic have signed a leasing contract that enables FM Logistic (CITYLOGin) to use the prototype daily as a regular vehicle of their freight fleet. The European financing through ECCENTRIC project has reached 430.000 €.

Formal relationship between the public authority and the industry partner

Madrid City Council has supported AVIA Ingeniería, in the planning and design phase conducting previous studies focused on the analysis of the freight sector of the city and coordinating the research ('Survey among city freight operators') developed by Polytechnic University of Madrid UPM with the goal of identifying clean vehicle typologies not offered currently by vehicle manufacturers.

Madrid City Council has also offered support in the procurement and implementation Stage assuming part of the cost of the administrative authorization, according to European Regulations on new vehicles commercialization, required to get the Circulation Permit.

Under the frame of the communication and exploitation phase, the City Council has supported AVIA Ingeniería, offering the possibility of being represented in events organized by the City Council such as the Madrid´s electric vehicle exhibition VEM (2018 and 2019 edition) and technical workshops on urban sustainable mobility.

Critical challenges and success factors

At the beginning of the project, three critical issues to solve during the first steps of the development that would have had a big influence on the future implementation and replicability were identified:

1 – Vehicle configuration.

Initially defined back in 2015 the project proposed to the EU as an "Ultra-low emissions vehicle". This could cover the several configuration of hybrid transmissions that the industry was developing in that moment, considering a range from mild hybrids to full hybrids, and from parallel configuration, to the serial one. Therefore, the first question faced was to identify what was to be the "Ultra-low "definition when the project would be finished in 2020. Considering the evolution of the technologies, and basically the advance in battery storage for vehicle traction, the decision was to consider a full electric vehicle as the final solution for this kind of vehicles inside the cities. Clearly the "ultra-low "emission vehicle in 2020 was a pure electric one, taking the challenge to "zero" emissions vehicle.

2 – Vehicle application.

It is essential to define the main purpose of city logistics considering the different parameters involved in the possibilities for such a vehicle. In this case it has been designed for last mile operations in the inner city. Large trailers were initially ruled out, given that despite their large size, and therefore potential to influence emissions, their number is very small, and their use is very restricted. The vans, below 3.5-ton, is a very specific market and there were already commercially available options produced by large manufacturers. Finally, it was decided that “medium size” trucks and their various applications constitute a need where the market was not providing suitable products. A survey was conducted among the different companies that operate these types of vehicles in the city of Madrid, thus obtaining a target configuration in terms of load capacity, size, and range.

3 - Vehicle base for the prototype.

Choosing the starting frame vehicle for the prototype was also an important decision. The possibility of manufacturing a complete vehicle was ruled out from the beginning, since in other projects carried out by AVIA Ingeniería, it had already been proven that for the small productions we were talking about, this was economically unfeasible. Considering the option of transforming an existing vehicle, it was decided to use a new vehicle as a base. Despite the higher initial costs and more difficult administrative type approval processes, bearing in mind future upscaling and marketability of the prototype, starting with a new vehicle chassis will allow to offer a competitive product and lowered the subsequent manufacturing costs in a possible short series.

Lessons learned from implementation/replicability and recommendations

There are some gaps in terms of legislation regarding electric commercial vehicles and their specific needs. Some of them related to the local regulations for driving and business models. In this case, problems with the current regulations in Spain related to the commercial operation of vehicles for delivery have been found because a specific “transport authorisation” is required in Spain to make this type of business, and the application of a prototype vehicle for this is still not considered in the regulation. It causes some delays till to achieve all permissions to operate the electric vehicle prototype and get real conditions data.

With the actual technology and market scale for these vehicles, the prices are much higher that the equivalent internal combustion engine versions, making exceedingly difficult to find a business model that could be economically feasible. For policy makers at local and national level, it could be the time to move the attention and incentives from the electric passenger cars, as this is by now, and focus on the commercial vehicles, as a great opportunity to reduce the inner city emissions.

4.2. Measure TUR 7.7 – Introduce biogas for heavy duty freight vehicles

Introduction

The city of Turku with the cooperation of Gasum Ltd. aims at promoting the use of biogas for heavy duty freight vehicles. The strategic framework is the implementation of a network of biogas filling stations along the main roads in Finland, to promote the Liquefied biogas (LBG) especially for cargo companies. The CIVITAS ECCENTRIC measure has allowed to test the first heavy freight vehicles using LBG as an energy source in real life conditions. By using renewable energy instead of fossil fuels, it is possible to reduce current emissions (CO2, NOx, and PM).

Gasum Ltd. has replaced two diesel trucks with two LBG trucks and have used them in the company's own waste and organic fertilizer logistics. One LBG truck (Scania) runs between the Turku Wastewater Treatment Plant and Gasum's biogas production plant transporting sludge that will be processed to biogas. The other truck (Iveco) delivers nutrition residue from biogas plant to local farmers.

Implementation

This measure has proceeded according to initial plans to a large extent. The measure was well pre-planned and hence the procurement process started early in the project.

Research and planning**:**

The research and planning phase of this measure commenced in September 2016 and was completed in April 2017. The phase included the following activities:

- The preparation of the truck procurement documentation by Gasum Ltd. The city of Turku prepared the tender documentation for gas vehicles.
- Market discussions were conducted with stakeholders and truck vendors. At the same time, the city of Turku prepared for the documentations for gas vehicle tendering.

Procurement and implementation:

The procurement was completed in August 2017. The first step was to secure LBG distribution for the trucks. This was done by opening a public filling station in Turku that supplies both CBG and LBG, thus enabling the initial growth of the number of biogas vehicles in the Turku area. This station was not a part of CIVITAS ECCENTRIC project and would have been opened regardless.

The phase included the following activities:

- Gasum Ltd evaluated the tenders and did some tests, after which the truck providers were chosen in August 2017. The choice was made for a Scania LBG truck and Iveco LBG/CBG-hybrid truck. Both trucks have less horsepower than the diesel versions that they replaced, and they are 2-axis models instead of 3-axis. This is because at the time of the procurement, there were no high power 3-axis LBG trucks available on the market.
- The city of Turku tendered for four gas vehicles, one to be used at the environmental department and three at the social department.

Figure 6: Heavy duty vehicle fuelled by liquefied biogas (LBG) from wastewater sludge

Demonstration and monitoring:

The demonstration and monitoring phase started in September 2017. As explained earlier, one LBG truck (Scania) started running a route between the Turku Wastewater Treatment Plant and Gasum's biogas production plant transporting sludge that is processed to biogas. The other truck (Iveco) started delivering nutrition waste from biogas plant to local farmers. However, once the weather conditions worsened by the arrival of winter, it turned out that the 2-axis model was not suitable for the operating environment of the Iveco truck. The route in question has a lot of back roads in rural areas and the traction was not good enough. Also, because of less horsepower, the nutrition liquid container could not be operated in full capacity. Therefore, accelerating and braking would put the liquid in motion and cause steering problems. This truck was then transferred to Freja Logistics Ltd and has since been operating on standard roads with solid loads solving the aforementioned challenges

Conclusions and dissemination:

Most of the data has so far been collected and analysed linked with LBG trucks. Along the implementation process, different events on biogas directed at the greater public and stakeholder forums on alternative fuels in South-West Finland have been organised by the city of Turku.

Business model and contractual partnerships

The procurement of the LBG trucks is financed by CIVITAS ECCENTRIC. Both trucks were initially operated by Gasum but after encountering safety concerns due to route (it turned out that the 2-axis model was not suitable for the operating environment of the Iveco truck) one was transferred to Freja logistics and is operated on standard roads with solid loads solving the aforementioned challenges. The fuelling stations are key enabling factors not included in the business model.

The Iveco truck operated by Freja Ltd on varying routes drove a total of 95,500 km in 2019. The Scania truck drove a regular route of 16 km in one direction 5-6 times a day, 5 days a week. The total yearly mileage with the two trucks amounts to 137,100 km. If these routes were driven with EURO VI model diesel trucks, the CO2 emissions would reach an amount of up to 87.7t/year. The operating costs of the biogas trucks are somewhat lower than the costs of operating a new diesel truck of the same size. The main difference comes out from the energy price as no major costs are incurred from different engine technology.

Figure 7: LBG trucks and associated fuelling station

Critical challenges and success factors

There has been a significant increase in the use of biogas as transportation fuel during the project, so the concurrent process of widening the filling station network has been a success factor and prime promoter of sales of CBG/LBG. However, in the Turku area it is likely that project influence, via the measure promotional activities, has contributed both to the regional and national momentum for more extensive use of biogas in heavy freight traffic. This is also demonstrated by the fact that gas as vehicle fuel was one of the procurement criteria for Turku City fleet acquisition during 2017-2019. This has resulted in the procurement of 15 new gas vehicles for the city fleet, to add to the previous four gas vehicles in the fleet. It can be stated without hesitation that the promotional activities of the project together with the widening of the gas filling station network have contributed to the procurements.

From the communication perspective, the utilisation of sewage sludge has clearly brought an image benefit for the measure. The measure has provided a fine opportunity for showcasing biogas use in heavy traffic and served effectively in promoting biogas as a viable option for passenger cars. During the project, the number of biogas vehicles (passenger cars) has risen significantly. It has been estimated that the only real limiting factor for increasing the share of biogas among transportation fuels in the long term is its production capacity.

Lessons learned from implementation/replicability and recommendations

Although the usage of LBG does not represent technical challenges, as the same engines can use bio-based fuel without any large technical changes, the potential impact and scalability of the this type of measures is constrained by external factors because the LBG filling infrastructure is still quite limited. In fact, the different consideration of environmental benefits of gas as alternative fuel will determine the development of the vehicular gas filling network through Europe (CNG city centre/LNG highway corridors). Regarding technical issues, one of the potential barriers identified during the planning phase is that currently the motors in LBG trucks have less horsepower than their diesel counterparts, thus reducing their competitiveness.

The measure has led to extremely specific outputs.

- LBG/CBG trucks have proven a viable and cost-efficient alternative in heavy traffic.
- The city of Turku has succeeded in promoting biogas vehicles among their own fleet.
- The use of biogas as transportation fuel has increased as alternative to fossil fuels.

It is essential the support of policy makers to promote the replacement of fossil fuels in Heavy Duty Vehicles by prioritising low carbon deliveries in public tenders and supporting the construction of LGB filling station infrastructure by providing good locations. An emerging challenge is that biogas could be somewhat overshadowed by the strong focus on the electrification of city fleets. To have more push for biogas promotion in the city, a stronger formulation of policy on use of biogas as a traffic fuel in city operations would be needed.

Regarding the implementation of “Waste to Energy” pathways from a municipal or regional perspective, despite the obvious benefits in terms of environment GHG emissions and circular economy approach, the biogas production and treatment to produce biomethane at local level could be a technical and economic challenge when other options for organic waste and wastewater treatment are already implemented.

5. Conclusions

The uptake of clean vehicles in freight fleets faces several challenges that jeopardize their widespread application for urban logistics, mainly in the range of heavy-duty vehicles. Throughout CIVITAS ECCENTRIC project different clean technologies for freight trucks have been tested and operated in real life conditions and the following barriers have been identified:

- Commercially available options adapted to logistics. For the purposes of the project it has been necessary to adapt internal combustion engine (ICE) models or directly create a prototype.
- Higher investment costs, although operating costs are usually lower than ICEs, so the total cost of ownership could be advantageous.
- Limited performance characteristics (autonomy, horsepower, loading capacity…) compared to equivalent ICEs vehicles
- Specific fuelling/charging stations

Therefore, the push for more environmentally friendly transport in city freight fleets needs to be coupled with parallel actions to become a feasible choice for logistic companies and municipalities in their efforts to reach their transport-related climate targets. Public administration, from European level to municipalities, should thus work to create the suitable conditions for establishing a positive environment to the required fleet renovation and reduce the environmental and traffic impact of the last mile delivery. Four lines could be identified according to their nature and application:

- Planning measures to be developed in the city, e.g., fuelling/charging infrastructure, consolidations or logistic hubs, strategic land use in close collaboration and partnership with stakeholders (see Deliverable 7.6 - Innovative policy tools in freight).
- Communication and awareness measures to promote environmentally friendly freight vehicles and achieve a strong engagement of all the stakeholders.
- Legal and regulatory measures in freight operations that could influence in the behaviour of stakeholder by enabling certain selected activities in specific conditions (low emissions zones, load/unload zones, off-peak deliveries, etc.).
- Fiscal measures and economic incentives to benefit clean vehicles in the impact of taxes and fees and to cover extra-costs of clean vehicles.

6. Sources /References

1. "Study on urban logistics - The integrated perspective". European Commission, Directorate-General for Mobility and Transport. Dec. 2017.
2. NBGD 2: Treatment of logistics activities in Urban Vehicle Access Regulation Schemes.
3. NBGD 4: Logistics schemes for E-commerce
4. "The first and last mile — The key to sustainable urban transport". Transport and environment report 2019 European Environment Agency, EEA Report 18/2019
5. CIVITAS ECCENTRIC project; Deliverable 7.5 "Clean vehicle technologies"
6. CIVITAS ECCENTRIC project; Deliverable 7.6 "Innovative policy tools for freight logistics"
7. CIVITAS ECCENTRIC 'Study on freight distribution in Madrid' (UPM, 2017)
8. Nationally funded project in Finland "New solutions in city logistics" will provide valuable new information about the possibilities of LBG as a source of fuel in urban environments especially in the first/last mile context.
9. In Turku, however, an investigation into the potential use of biogas as transportation fuel was initiated by the city, Åbo Akademi University and some companies already in 2010. The primary goal of the investigation was to find a sustainable public transport solution based on use of biogas.