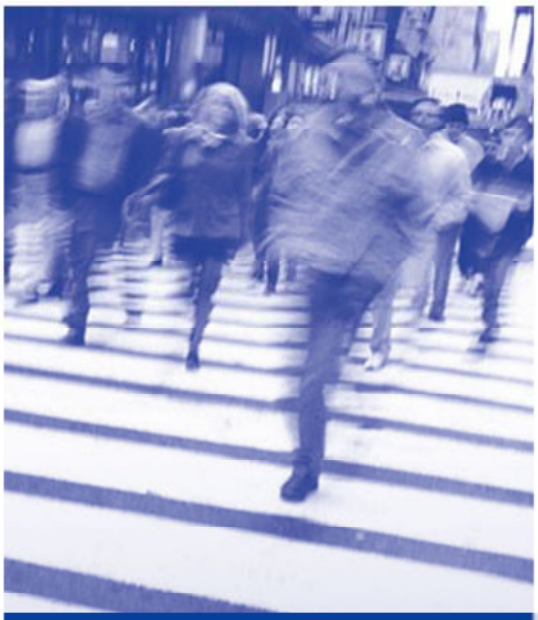

CiViTAS
Cleaner and better transport in cities

AALBORG

Aalborg

T1.2 T1.3
Biofuel Delivery Service, and supply in Aalborg

Aalborg Kommune
April 2011

THE CIVITAS INITIATIVE
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Project Name	ARCHIMEDES (Achieving Real Change with Innovative Transport Measure Demonstrating Energy Savings)
Start date of the Project	15/09/2008
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Measure:	M1 Biofuels in Aalborg
Task:	Task 1.2, 1.3
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Contents

1. Introduction

1.1 Background CIVITAS

CIVITAS - cleaner and better transport in cities - stands for CIty-VITAlity-Sustainability. With the CIVITAS Initiative, the EC aims to generate a decisive breakthrough by supporting and evaluating the implementation of ambitious integrated sustainable urban transport strategies that should make a real difference for the welfare of the European citizen.

CIVITAS I started in early 2002 (within the 5th Framework Research Programme);
CIVITAS II started in early 2005 (within the 6th Framework Research Programme) and
CIVITAS PLUS started in late 2008 (within the 7th Framework Research Programme).

The objective of CIVITAS-Plus is to test and increase the understanding of the frameworks, processes and packaging required to successfully introduce bold, integrated and innovative strategies for clean and sustainable urban transport that address concerns related to energy-efficiency, transport policy and road safety, alternative fuels and the environment.

Within CIVITAS I (2002-2006) there were 19 cities clustered in 4 demonstration projects, within CIVITAS II (2005-2009) 17 cities in 4 demonstration projects, whilst within CIVITAS PLUS (2008-2012) 25 cities in 5 demonstration projects are taking part. These demonstration cities all over Europe are funded by the European Commission.

Objectives:

to promote and implement sustainable, clean and (energy) efficient urban transport measures
to implement integrated packages of technology and policy measures in the field of energy and transport in 8 categories of measures
to build up critical mass and markets for innovation

Horizontal projects support the CIVITAS demonstration projects & cities by:

Cross-site evaluation and Europe wide dissemination in co-operation with the demonstration projects
The organisation of the annual meeting of CIVITAS Forum members
Providing the Secretariat for the Political Advisory Committee (PAC)
Development of policy recommendations for a long-term multiplier effect of CIVITAS

Key elements of CIVITAS

CIVITAS is co-ordinated by cities: it is a programme “of cities for cities”
Cities are in the heart of local public private partnerships
Political commitment is a basic requirement
Cities are living ‘Laboratories' for learning and evaluating

1.2 Background ARCHIMEDES

ARCHIMEDES is an integrating project, bringing together 6 European cities to address problems and opportunities for creating environmentally sustainable, safe and energy efficient transport systems in medium sized urban areas.

The objective of ARCHIMEDES is to introduce innovative, integrated and ambitious strategies for clean, energy-efficient, sustainable urban transport to achieve significant impacts in the policy fields of energy, transport, and environmental sustainability. An ambitious blend of policy tools and measures will increase energy-efficiency in transport, provide safer and more convenient travel for all, using a higher share of clean engine technology and fuels, resulting in an enhanced urban environment (including reduced noise and air pollution). Visible and measurable impacts will result from significantly sized measures in specific innovation areas. Demonstrations of innovative transport technologies, policy measures and partnership working, combined with targeted research, will verify the best frameworks, processes and packaging required to successfully transfer the strategies to other cities.

1.3 Participant Cities

The ARCHIMEDES project focuses on activities in specific innovation areas of each city, known as the ARCHIMEDES corridor or zone (depending on shape and geography). These innovation areas extend to the peri-urban fringe and the administrative boundaries of regional authorities and neighbouring administrations.

The two Learning cities, to which experience and best-practice will be transferred, are Monza (Italy) and Ústí nad Labem (Czech Republic). The strategy for the project is to ensure that the tools and measures developed have the widest application throughout Europe, tested via the Learning Cities' activities and interaction with the Lead City partners.

1.3.1 Leading City Innovation Areas

- The four Leading cities in the ARCHIMEDES project are:
- Aalborg (Denmark);
- Brighton & Hove (UK);
- Donostia-San Sebastián (Spain); and
- Iasi (Romania).

Together the Lead Cities in ARCHIMEDES cover different geographic parts of Europe. They have the full support of the relevant political representatives for the project, and are well able to implement the innovative range of demonstration activities.

The Lead Cities are joined in their local projects by a small number of key partners that show a high level of commitment to the project objectives of energy-efficient urban transportation. In all cases the public transport company features as a partner in the proposed project.

2. Aalborg

The City of Aalborg, with extensive experience of European cooperation and having previously participated in CIVITAS I (VIVALDI) as a 'follower' city, is coordinating the consortium and ensures high quality management of the project. The City has the regional public transport authority (NT) as a local partner, and framework agreements with various stakeholder organisations.

Aalborg operates in a corridor implementing eight different categories of measures ranging from changing fuels in vehicles to promoting and marketing the use of soft measures. The city of Aalborg has successfully developed similar tools and measures through various initiatives, like the CIVITAS-VIVALDI and MIDAS projects. In ARCHIMEDES, Aalborg aims to

build on this work, tackling innovative subjects and combining with what has been learned from other cities in Europe. The result is an increased understanding and experience, in order to then share with other Leading cities and Learning cities.

Aalborg has recently expanded its size by the inclusion of neighbouring municipalities outside the peri-urban fringe. The Municipality of Aalborg has a population of some 194,149, and the urban area a population of some 121,540. The ARCHIMEDES corridor runs from the city centre to the eastern urban areas of the municipality and forms an ideal trial area for demonstrating how to deal with traffic and mobility issues in inner urban areas and outskirts of the municipality. University faculties are situated at 3 sites in the corridor (including the main university site). The area covers about 53 square kilometres, which is approximately 5 % of the total area of the municipality of Aalborg. The innovation corridor includes different aspects of transport in the urban environment, including schools, public transport, commuting, goods distribution and traffic safety. The implementation of measures and tools fit into the framework of the urban transport Plan adopted by the Municipality.

Figure 1: The Archimedes corridor in Aalborg

3. Background to the Deliverable

The main project aim of CIVITAS ARCHIMEDES Measure 1, which contains the three demonstration tasks regarding biofuels, is to demonstrate the use of biofuels at the individual fleet level, using first generation biofuels in an innovative manner, and lay the foundations for maximising the opportunities for take-up of second generation biofuels.

Providing fuel consumption remains constant, an average 15% substitution of diesel with CO_2 neutral biofuels in the delivery services in the CIVITAS corridor is expected to lead to 210 tonnes less CO_2 being emitted annually.

This deliverable is the result of merging what were originally planned as two separate deliverables T1.2 and T1.3. The purpose of merging the deliverables is to create better visibility of the lessons learned during implementation of the closely related tasks. Task 1.3 which concerns the implementation of biofuel supply is hence supporting task 1.2, since the success of the implementation of the trial is dependent on the supply of fuel.

3.1 Summary Description of Tasks

This deliverable concerns two different tasks, described as follows:

- Through Task 1.2 50 postal service vehicles in Aalborg will be operated on a minimum of 10% biodiesel and an expected annual average of 15%. The demonstration project was started the 1st of April 2011. The Postal Service will report on fuel consumption and impacts on vehicle reliability. The link to task 11.1.1 will enable the assessment of environmental impacts.

- The second task, (task no. 1.3), is to establish a fuelling station to ensure the supply of bio-diesel to the demonstration fleet.

4. Bio-fuels in Aalborg

4.1 Description of Work Done

This deliverable covers two tasks as described above. The tasks concern the demonstration of biodiesel in 50 postal service vehicles (including 5 HGVs) operating in and around the City of Aalborg. The second task is to ensure the supply of biodiesel for the vehicles. Since biodiesel in the percentages being demonstrated is not available on the open market in Denmark, special arrangements have had to be set up, including a new fuelling station at the local Postal Service depot.

4.1.1 Initiating the Planning Process

The planning process of implementing biodiesel in the fleet mentioned above was initiated during the preparation of the of the CIVITAS ARCHIMEDES project with informal discussions between the Postal Service, oil supplying companies and the City of Aalborg.

At the beginning of the CIVITAS ARCHIMEDES project two working groups were set up to deal with the tasks.

The first working group consisted of:
- The ARCHIMEDES secretariat in Aalborg
- The Postal Service

The second working group consisted of:
- The ARCHIMEDES secretariat in Aalborg
- Oil Supplying Company

The second working group was closed in spring 2010, when the Postal Service took over communication with oil supplier about the establishment of the fuelling station and biodiesel supply. Project management was then carried out in the first working group. The working group has been considering best suitable solutions for the fuelling station, and based on the results from Task 11.1.1 (Study of impact using 1G and 2G biofuels in Public Transport and Delivery Service vehicles [reported in ARCHIMEDES Deliverable R1.1]), the product and share of biodiesel to be used were selected.

4.1.2 Study of Impact Using 1st Generation and 2nd Generation Biofuels

This section includes the main conclusions from Task 11.1.1 (Study of impact using 1G and 2G biofuels in Public Transport and Delivery Service vehicles).[1]

Only about 2.500 m^3 of Tallow Methyl Ester TME based B10, B15 and B30 (blends containing 10%, 15% and 30% respectively of biodiesel mixed with conventional diesel) has successfully been used in Denmark so far.

The cold temperature properties of biodiesel are very different from conventional (fossil) diesel. Tallow biodiesel, especially, typically requires heated tank installations for handling in pure form (B100). The problem is reduced when mixing with ordinary diesel or with additives. The B5Next project has shown that it is possible to produce a tallow-based B5 that is usable under the same conditions as standard Danish winter diesel. B10 and B15 should be limited to approximately -10℃, whereas B30 should not be r elied on during winter. Low temperature stability is not consistently dependent on base fuel cold properties. It is absolutely necessary to measure cold weather properties in the ready mixture, not only in the base components. While B10 and B15 TME can be derived from domestic diesel qualities, B30 TME requires a special low density base-diesel to comply with the density requirement of the Fuel Quality Directive.[2] This makes B30 significantly more expensive.

Biodiesel might need heating before the admixing process with diesel to ensure a homogenous product. Tallow biodiesel requires heating at approximately 25 ºC during mixing; otherwise a deposition in the finished mix could result.

The need for two-stage mixing could arise in the case of long transport distances where, for example, due to the cold temperature properties, neat TME must be diluted to B50 before transportation.

A diesel engine is an internal combustion engine with a high compression ratio that brings about a fuel dilution of the engine lubricating oil – especially in the engine warm-up period – because the fuel seeps down past the piston and dilutes the engine oil[3]. Biodiesel has been shown, according to various international experiences, to increase this dilution. When using B30 or lower blends, however, this deterioration of engine oils is not expected to have any consequences for the engine if service intervals are adapted according to the manufacturer's specifications. Typically this means that engine oil has to be changed twice as often.

In the Biodiesel DK project; analyses of the motor oil in the vehicles have regularly been made – partly to protect against engine failure and partly to test possible engine oil change intervals. No critical fuel/oil dilution has been detected.

[1] Please notice, that this section describes 'best knowledge' at the time of finishing deliverable R1.1 in January 2010. As new knowledge is generated, reservations are changed.

[2] Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC (Text with EEA relevance). Source: http://eur-lex.europa.eu/

[3] Especially as an effect of some motor models injecting extra fuel as part of automatic cleaning of the CRT particulate filter

Fuels like B10 and B15 TME are not likely to damage factory mounted or retrofit exhaust after treatment equipment.

Because the pure biodiesel has a lower volumetric energy content, the higher the blend the lower the overall energy content. Power and torque can be expected to drop in proportion to the volumetric energy content in the fuel. This was not, however, noticed by most drivers for the blends in question. Laboratory tests indicated a slight improvement of engine thermal efficiency. Emissions of CO, HC and PM decreased while NO_X was slightly increased.

The cost of TME is not the only cost issue. Also to be considered is the cost of extra service, base diesel price and fuel logistics. An increase in consumption due to lower volumetric energy content may also be expected.

Approval of new tank installations is a time consuming process. The two pilot projects that for the past year have worked with centralised admixture have spent seven and ten months respectively on the design and completion of the mixing plants.

Special requirements on equipment, pumps, gaskets, coating etc. are often the result of rubber materials that lack compatibility with B100 biodiesel. The problem is not so predominant for concentrations below B30 and can therefore often be neglected in the vehicle when using a lower admixture. However, the mixing plants that are in contact with B100 must have the appropriate hose and gasket material.

For biodiesel it is particularly important to consider the storage and mixing temperatures which for tallow biodiesel, in particular, is a critical parameter. Therefore it is even more important that the mixing takes place under controlled conditions. On the other hand the ready-mixed B10 or B15 will be rather unproblematic to transport and could be transported by ship if needed.

According to the recent life-cycle analysis study from the Technical University of Denmark 2nd generation tallow-based biodiesel is the only engine fuel which gives without a doubt a positive CO_2 displacement in the overall Danish energy system. This is a very important reason for choosing this fuel.

According to tests carried out by DTI, blended fuel produced by DAKA in Denmark has practically no negative environmental impacts compared to standard diesel.

Experiences from field tests show no need for conversion of vehicle engines. Standard vehicles can be used with little or no modification; the most significant change might be use of different rubber seals or hoses.

Local production of tallow-based 2nd generation biodiesel was established in 2008 and the plant is already prepared for up scaling. Potentially it will be able to deliver 5% of all diesel in Denmark.

The experiences from other projects so far are good and the fuel from DAKA - or equivalent fuel from other suppliers - was therefore recommended for large scale demonstration.

Based on the conclusions and recommendations from task 11.1.1, the ARCHIMEDES demonstration tasks 1.1 and 1.2 will include 2nd generation biofuels made from animal fat.

4.1.3 Implementing Biodiesel in the Postal Service Fleet

Implementation of higher blends of biofuels requires a fleet that can be monitored through the project. Implementing biodiesel among regular cars in the city by offering biodiesel at regular fuelling stations is thereby not an option. The postal service in Aalborg has been seen as a good partner in demonstrating biodiesel in a delivery service fleet.

The City of Aalborg and Post Danmark (The National Postal Service) in Aalborg have worked together for several years prior to the CIVITAS ARCHIMEDES project. This has among other places been visible in the case project: “How to make the goods transportation more efficient in Aalborg?” which was ongoing at the beginning of the millennium, focusing on cooperation on delivery of goods in the city centre under the following bullets:

- In cooperation, Transport companies, shopkeepers and local authorities tried to find solutions for reasonable delivery times.
- All experiments were based on voluntary basis.
- Transport coordination between transport companies
- Two men in one vehicle – faster delivery of the goods in the city centre.
- Establishing passing places/ loading zones in the pedestrian areas

Based on the experiences on making goods distribution more efficient, it was a logical next step to make the fleets cleaner. Also through CIVITAS ARCHIMEDES Measure: Efficient Goods Distribution in Aalborg / Environmental Zone in Aalborg, the focus is on cleaner vehicles through restriction on trucks and buses, which are now obliged to fulfil the EURO IV norm or having particulate filter installed before entering the city centre. (For more information please refer to CIVITAS ARCHIMEDES Deliverable T63.1, May 2009.)

The following bullets have been the main issues during the process of implementing biodiesel in the fleet of the Postal Service.

1. How to set up supply of biodiesel (Specifically addressed in section 4.1.4)
2. The blend of biodiesel
3. Engines, maintenance and vehicles

1. How to set up supply of biodiesel
This issue is specifically addressed in section 4.1.4

2. The blend of biodiesel
Deciding which blend of biodiesel to use has been an important issue from the beginning of the project. The objective of the measure is to demonstrate a high blend; however, it has also been important not to compromise operation of the vehicles. The project group, with assistance from a consultant from the Danish Technological Institute, has continuously followed the results from other biodiesel projects to see how far the demonstration in the ARCHIMEDES project should go. In the end the decision was made based on this assistance and on the recommendations in deliverable R1.1.

Originally a blend of at least 10 % was planned. However, as time went by and more results from other projects became available, a plan for the blend was set up, stating that in the winter period, a blend of 10 % should be used, in spring and autumn, 15 % should be used, and in the summer a blend of 20 % should be used.

Even though results from other projects started to show that higher blends might be used without problems, even during winter, regard for safe operation and the project budget also

had to be taken into consideration. The ARCHIMEDES project is financing the additional costs for the Postal Service to be operating on biodiesel.

3. Vehicles, engines and maintenance

The original objective of the measure was to operate 50 vehicles, including 5 HGVs on biodiesel. However, as time progressed, it became difficult to find 50 vehicles, operating in Aalborg, and specifically in the ARCHIMEDES corridor.

The Postal Service has been hit hard by the financial crisis, and by structural changes transferring more and more mail to the Internet, and parcels, due to liberalisation of the market, to competing companies. As a consequence the Postal Services have been forced to cut down on activities, including numbers of employees and vehicles. This meant that during the planning process only 30 vehicles seemed to be available for the project. However, more types of vehicles were included as the project, progressed, ending up with a project consisting of 48 vehicles – but with the risk that some of the vehicles might be removed during the project period.

Another concern, which has been present all the way through the project, has been the uncertainty of what will happen to the engines, when the vehicles are operated on biodiesel. When doing the original project description, it was expected that some kind of modification of the engines were required because the properties of biodiesel make it harsh to the engines - a 100% solution could dissolve rubber seals and hoses. However, the preparatory research showed that this should not be necessary as for blends below B50 this should not be a problem.

Even a B10 or B20 will dissolve any impurity on the walls of the vehicle tank etc. As a consequence it is necessary to clean / change fuel filters after using biofuel for some time, to avoid engine stop. But once the tank has been cleaned by the biofuel, this problem is over.

Also the risk of “rotten” fuels has been discussed, since biodiesel is more exposed to engage with bacteria than conventional diesel. This will result in the development of large particles that will eventually stop for the fuel being delivered to the engine. However, this is not considered as a risk with the blends used.

Dilution of the engine lubricating oil by the fuel can occur because fuel can seep down past the piston, so mixing with the engine oil. This is especially an effect of some vehicle models injecting extra fuel as part of automatic cleaning of the CRT particulate filter. Ordinary diesel in the engine oil will evaporate and disappear but the bio-component is more stable and can build up leading to an attenuation of the engine oil and thus to a deterioration of the oil’s lubrication capacity.

Experiences seem to show, however, that no significant deterioration of engine oils is likely to occur when using B30 or lower blends. To be safe service intervals can be adapted. In previous projects engine oil has been changed up to twice as often as required by the engine manufacturer for using ordinary diesel. The budget of the project is taking into account that it could be necessary to change engine oil twice as often as usual. After the first change of oil, the oil will be analysed and the need for changes will be decided.

A B10 or higher blend is outside the legal diesel fuel standard (EN 590) and therefore the ordinary engine warranty no longer applies, unless some special agreement is made. The experience from Aalborg is that some car manufactures are not willing to sustain warranty if fuel standard is not complied with, while other manufacturers are willing to accept a very high blend.

To avoid any problems caused by the use of biofuels to the engines - and as a substitution for engine warranty - a special insurance has been taken out on the vehicles in the project.

4.1.4 Fuelling Stations

The postal service has been responsible for negotiating with the biodiesel supplier, and the postal service has also been responsible for setting up a fuelling station that could facilitate the use of biodiesel. The ARCHIMEDES Project has contributed to the costs for the construction of the fuelling station.

The process of ensuring fuel supply started at the end of 2009, and more solutions were considered on how to secure the supply. The solutions discussed in the working group were as follows:

- Using an existing tank at a functioning fuelling station located near the Postal Service
- Using an existing tank at a closed fuelling station located near the Postal Service
- Setting up a temporary tank at the Postal Service in Aalborg
- Setting up a new fuelling station at the Postal Service in Aalborg

The idea of using a spare tank at an existing, functioning fuelling station had to be dropped because of legal problems with distributing a fuel not complying with the fuel standard from a station open for ordinary users.

Next the area was investigated to see if there were any existing fuelling stations near the Postal Service that were not in use. One particular station was interesting, located only some 500 metres from the Postal Service. However, this fuelling station was about to be demolished, and no guarantee could issued that the tank could be available to the end of the project. Therefore the station could not be used. No other feasible alternative locations were found.

The next consideration was to set up a temporary tank. However, the amount of diesel that is expected to be used, combined with the environmental requirements set up by the authorities, made this solution unfeasible as well. After ruling out the alternatives it was agreed that the work would focus on setting up a new fuelling station at the Postal Service centre in Aalborg.

The preparation of the fuelling station was ongoing for some time after the final decision of placing the fuelling station at Postal Service centre. Setting up an installation that could be potentially dangerous in terms of fire or environmental pollution requires permissions from different authorities. Even though fuelling tanks are established all the time, getting the building permission turned out to be a long and confusing process. No comprehensive list of the requirements seemed to exist, and the requirements seemed to evolve during the process. In spite of the fact that all relevant stakeholders were included at a fairly early stage of the process, including the oil supplier, the producer of the fuelling station, the planning control unit at the city of Aalborg and the environmental department and even though a professional consultant specialised in oil installations was hired, it was not possible to keep a sense of perspective and the process took a long time.

Even though the application process was started in due time the process ended up slightly delayed according to the schedule.

The extensive challenge of getting a new fuelling station established was a very important lesson in this project, and this should be considered by others who want to exploit the lessons learned by this.

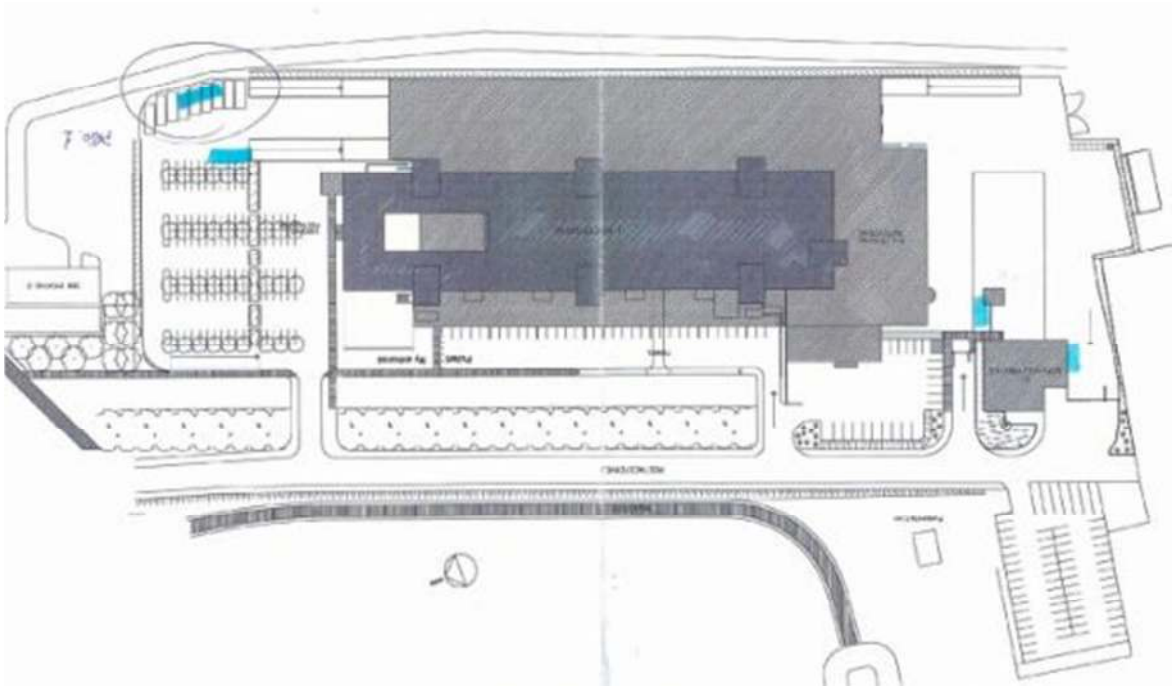


Figure 2 The proposed locations for the fuelling station with a ring around the preferred location

Due to the delay the station was not established before an unusually early and long-lasting winter came to Aalborg and the frost made it impossible to construct the fuelling station. The fuelling station was eventually finished in March 2011 after some days without temperatures below zero. The fuelling station was the only outstanding issue delaying the process of implementing biodiesel in the Postal Service fleet.

Figure 3 The bio-fuel tank at Post Danmark (Danish Postal Service)

In contrast to the installation established for public transport, where the ordinary diesel and the bio component (50% solution) are kept in separate tanks – with the bio component heated to secure viscosity,- and first mixed to required blend in the pump, at the Postal Service's depot the biodiesel is already in the right blend when arriving at the fuelling station. This makes only one tank necessary and - due to the 'low' bend, B10-B20 - the need for heating the tank does not exist.

4.1.5 Operating in a Cold Climate

Figure 4 The difference between 100% AFME on the 1st of October 2010 (5 – 10 Co) and the 20th of November 2010 (-5 – 0 Co). It is the same container displayed. Note the difference in transparency.

As the temperature decreases the AFME-product coagulates, almost similar to pig fat or butter in the refrigerator, but to a lesser degree thanks to refining and additives. Figure 3 shows this effect for 100% AFME; it indicates that the climate is an important issue to deal with, while implementing biodiesel blends in the two fleets in Aalborg.

To avoid any problems – since the postal service relies on a fully operating fleet – and yet to demonstrate a new and innovative technology, the following decisions have been made:

- For the Postal Service it has been chosen that the blend will change from 10% in the winter to 20% in summer periods, still exceeding the general national targets of 5.75 % in 2012, which could be substituted by use of a 3.75% 2G. as AFME.
- If safe operation of the Postal Service is endangered due to biodiesel problems caused by temperature decreases, the Postal Service are allowed to pause the demonstration, using standard diesel. However, this has to be documented. As a reference, it can be stated that even though temperatures have been down to -18 degrees at short periods this winter, use of B10 has given no problems for the buses in task 1.1.

4.1.6 Benefiting the Environment

The main objective for implementing biodiesel in the postal fleet is to reduce dependence on fossil fuel and to reduce the emission of CO_2, since test results shows that other emission reductions are not really significant in comparison with traditional diesel products.

1st generation biodiesel produced from rapeseed oil or sunflowers are leading to a typical reduction of between 45% and 58%. However, Life Cycle Assessments of biodiesel from vegetable or animal waste products normally lead to a typical CO_2 (equivalent) reduction of 88%.The difference in reduction and the ethical questions of using farm land to grow crops for biodiesel production have been important elements in the choice of the product.

Providing fuel consumption remains unchanged, an average 15% substitution of diesel with CO_2 neutral biofuels in the delivery services is expected to lead to 210 tonnes less CO_2 being emitted annually. The emissions will be further assessed through the project.

4.2 Specification of Biodiesel Products

Daka™ Biodiesel

Analysis	Unit	Limit values Lower	Upper	Analytical method
Ester content	% (m/m)	96,5	-	EN 14103
Density at 15°C	kg/m³	860	900	EN ISO 3675 EN ISO 12185
Kinematic viscosity at 40°C	mm²/s	3,5	5,0	EN ISO 3104
Flash point	°C	120	-	Per EN ISO 3679
Sulphur	mg/kg	-	10	Per EN ISO 20846 Per EN ISO 20884
Coke residue (at 10% distillation residue)	% (m/m)	-	0,3	EN ISO 10370
Cetane number	-	51,0	-	EN ISO 5165
Sulphate ash	% (m/m)	-	0,02	ISO 3987
Water	mg/kg	-	500	EN ISO 12937
Grime	mg/kg	-	24	EN 12662
Corrosion of copper (3 hours at 50 °C)	Degree of corrosion	Class 1	Class 1	En ISO 2160
Oxidation stability at 110 50 °C)	Hours	6	-	EN 14112
Acid value	mg KOH/g	-	0,5	EN 14104
Iodine value	g iodine/100g	-	120	EN 14111
Linoleic acid methyl ester	% (m/m)	-	12	EN 14103
Polyunsaturated fatty acid methyl esters (>= 4 double bonds)	% (m/m)	-	1	
Methanol	% (m/m)	-	0,2	EN 14110
Monoglycerides	% (m/m)	-	0,8	EN 14105
Diglycerides	% (m/m)	-	0,2	
Triglycerides	% (m/m)	-	0,2	
Free glycerine	% (m/m)	-	0,02	EN 14105 EN 14106
Total glycerine	% (m/m)	-	0,25	EN 14105
Sodium + potassium	mg/kg	-	5	EN 14108 EN 14109
Calcium + magnesium	mg/kg	-	5	Per EN 14538
Phosphorus	mg/kg	-	10	EN 14107

Figure 5 Data sheet for bio diesel component. source: http://www.daka.dk

4.2.1 About Biodiesel

The following text is the description of the biodiesel product from DAKA, copied from the website: www.daka.dk:

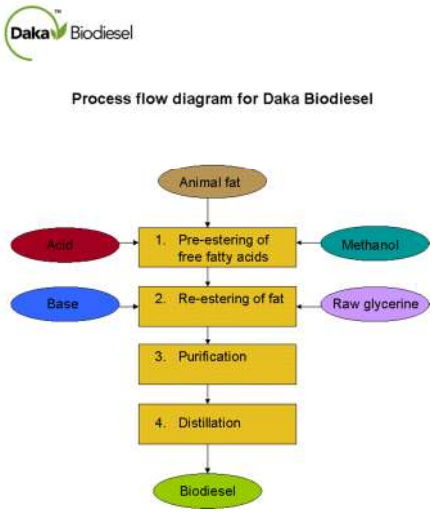
From www.daka.dk

Biodiesel consists of fatty acid methyl esters (FAME) created as the result of a reaction between an alcohol and oils/fats of vegetable or animal origin.

Methanol (wood alcohol) is usually the alcohol of choice, but ethanol may also be used.

The conversion process releases glycerine, a by-product of the biodiesel production process.

Process flow diagram for biodiesel.



Biodiesel may be used both as a CO2 neutral fuel in diesel engines, and as a bio fuel oil. The European diesel standard, EN 590, generally allows up to 5% biodiesel to be added, while a number of passenger cars, lorries and buses may run on 100% biodiesel with a few minor adjustments.

The structure of all oils/fats is principally the same, regardless of whether they are of vegetable or animal origin. They consist largely of triglycerides, and only the proportion of individual fatty acids differs. It is especially the content of unsaturated fatty acids in relation to the

saturated fatty acids that is important for the product. As the following table shows, palm oil and animal fat contain almost the same level of unsaturated fatty acids, while the level is far higher in rapeseed oil and soy bean oil.

	Animal fat	**Rapeseed oil**	**Palm oil**
Palmitic acid (16:0)	24	4	42
Palmitoleic oil (16:1)	4	0	0
Stearic acid (18:0)	16	2	4
Oleic acid (18:1)	43	60	43
Linoleic Acid (18:2)	11	20	10
Linolenic acid (18:3)	1	10	0
Other	1	4	1

A high level of unsaturated fatty acids lowers the congealing point, not just for the oil/fat, but also for the resulting FAME. This is especially significant in connection with the use of pure biodiesel, while it is less important as regards admixtures.

Daka Biodiesel will primarily be produced using refined animal fat extracted from slaughterhouse by-products and dead animals from primary agriculture. Other by-products in the form of used cooking oil and other oils unsuitable for food production may also be used in the production process.

Denmark has a large animal production, and we must ensure that the by-products that are not of sufficient quality to end up on the dinner table are put to the best possible use.

For some people, the use of dead animals from agriculture will be controversial. These raw materials, however, are no different from those that reach the slaughterhouse. Traditional fossil fuels also stem from dead plants and animals, but we do not believe that we should wait 100 million years before the present by-products from agriculture can be recycled!

4.3 Communication

4.3.1 Opening Event

When, at last, the fuelling station was established an opening event which involved cutting a red tape was held, combined with a small workshop for mid-level managers, where the managing director for the biofuel factory presented the bio product and answered questions.

The Alderman from the Technical and Environment department in the City of Aalborg and the local manager from Post Danmark participated, and they did the red tape cutting.

Figure 6 The Alderman cuts the red tape on the first tap

Figure 7 First refuelling on bio fuel

4.3.2 Media Coverage

Due to a question of right timing it was decided not to hold a big press effort at the launch, but to postpone the campaign for a while and then couple the press effort with a campaign where the post vehicles were decorated with biodiesel streamers, making the measure visible in the streets.

On the day of the opening the delivery services launched an article in the internal newspaper for their employees.

NYHEDSPOSTEN

8. APRIL 2011
22. ÅRGANG. NR 6

POST

POST DANMARKS MEDARBEJDERBLAD
POST DANMARK ER EN DEL AF POSTEN NORDEN

Grønnere kørsel i Nordjylland

Biodiesel i tanken på ca. 45 postbiler skal være med til at skabe bæredygtig trafik i Aalborg

GENFØDT SOM BRÆNDSTOF Postbiler, der tanker ved Rustenborg i Postområde Nordjylland, skal til og med 2012 teste kørsel med biodiesel, der er udvundet af selvdøde dyr. Her er Flemming Jørgensen ved at hælde ny energi på sin lastbil.

Af Torben Korgaard

De lokale postbiler i Aalborg er ved at blive mere grønne end gule. Et særligt tankanlæg på Rustenborg er netop blevet indviet for at kunne levere de miljøvenlige dråber. Resten af året og i hele 2012 vil der blive tanket biodiesel i et blandingsforhold, som alt efter årstiden vil variere fra 10 til 20 pct. mod de hidtidige højst 5 pct.

I tilfældet her er biodieselen udvundet af selvdøde dyr, og selvom det kan lyde en kende makabert, er det ifølge Marianne Holmgaard, chef for Postområde Nordjylland, et rigtig godt argument for at kaste sig ud i forsøget.

Fra ord til handling

- Her kører vi på rent affald. Der går altså ikke noget fra nogen. Med vores vognpark er vi en stor spiller, og ved på den her måde at sætte handling bag ordene kan vi skubbe lidt til bevidstheden med at tænke grønt. Desuden passer det fint til Posten Nordens vision om at ville være kundernes miljørigtige valg.

Forsøget med biodiesel i de lokale pakke- og kassetømmerbiler er blot det seneste af en række tiltag under EU-projektet Archimedes, der i samarbejde med Aalborg Kommune har stået på gennem flere år. Formålet er at afprøve alternative brændstoffer for at begrænse udledningen af det skadelige CO2.

Postbilerne kan tåle det nye brændstof uden særlige forarstatninger. Et ekstra serviceeftersyn og et skift af oliefilteret skal der imidlertid til. Miljødiesel koster ca. en krone ekstra pr. liter, men de ekstra udgifter dækkes gennem EU-projektet.

Figure 8 Article in the internal newspaper at Post Danmark. 'Greener driving in North Denmark'

As the internal newspaper has national coverage, the news was found by the national radio and they did a web news and a small TV spot.

Figure 9 Web article from national Television.

The level of press coverage is satisfactory given that it was decided to postpone the campaign.

4.3.3 Biodiesel Controversies

Dead animals and the use of food are controversial topics in relation to biofuels. Also in Denmark this has been discussed. The discussion related to the use of food has not been present in Aalborg, since 2nd generation biofuel was chosen as the product very early in the planning phase.

Instead discussions have been focused on the smell of the biodiesel product. People have been worried of the aspect of using dead animals because they know how dead animals smell. This is not the case with the chosen product in Aalborg since the fat used for the diesel is refined and thereby the smell disappears. It would not be possible to run on unrefined animal fat.

Another raised question has been if it is disgusting or unethical to use slaughterhouse waste. DAKA, the producer of biodiesel states on its website the following, in the section for frequently asked questions:

> **"Isn't it disgusting/unethical to use slaughterhouse waste and dead animals to make biofuel?"**
>
> "No. In fact, we firmly believe it would be unethical not to make use of this resource. Slaughterhouse waste used to be turned into feedstuffs, but that's no longer possible. That doesn't mean we should simply dispose of the waste products in landfill sites. Fossil fuels come from dead animals and plants too, but we don't think we should bury slaughterhouse waste in the ground and wait 100 million years for it to turn into oil – especially not since we can do it in just two days!"
>
> www.daka.dk

4.4 Problems Identified

Various challenges have been experienced during the implementation of biodiesel process. The challenges have all been addressed earlier in this report. The main challenges are listed below:

Technical issues, biodiesel has different properties to standard diesel: As described above, the AFME-product coagulates at a higher temperature than standard diesel. This is an important challenge in a cold climate such as the Danish climate in Northern Europe. A strategy on how to deal with the temperature has been important to ensure reliable operation of the postal service vehicles. The strategy has been for the project partners to be willing to pause the demonstration project if the temperature dropped dramatically. The strategy has not been tested for the delivery services yet, as operation has just started in Spring 2011, but the Public Transport services have used B10 during the whole winter as part of ARCHIMEDES task 1.1 even though temperatures have been down to -18 degrees during the nights.

Also biodiesel, as ordinary diesel can blend with the oil of the motor during operation, but in contrast with ordinary diesel, biodiesel does not evaporate, and in the long run changes the properties of the engine oil, and can cause trouble for the engine while operating. This means that more frequent oil changing is sometimes recommended.

Engine manufacturers can also be concerned about the warranties of the engines because the blend does not comply with EN590. Therefore a special insurance has been made for the project.

Fuelling facilities: Due to challenges in getting permission for setting up the fuelling station, the process was unfortunately slightly delayed according to the schedule. This in spite of the fact that all relevant stakeholders were included at a fairly early stage of the process, including the oil supplier, the producer of the fuelling station, the planning control unit at the city of Aalborg and the environmental department. The long process of setting up a special fuelling station should be taken into account.

4.5 Future Plans

A press and awareness campaign will be launched this May 2011.

The demonstration project will be ongoing until the end of the ARCHIMEDES project with a mix of B10 – B15 and B20 over the year.

Data collection is ongoing and the numbers will be evaluated by Danish Technological Institute in accordance with the evaluation plan for measure 1, Biofuels in Aalborg.

On 15th and 16th of June 2011, the City of Aalborg will participate in the conference “Clean Vehicles, Clean Fuels, Cleaner Cities” in Donostia San Sebastian, presenting the preliminary results of the demonstration, especially focussing on the challenges related to the cold climate of Denmark.