

**CiViTAS**  
Cleaner and better transport in cities

**MIMOSA**

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## Measure Evaluation Results

### TAL 1.1 Alternative Fuels

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## Executive Summary

The measure was originally planned as an implementation for real life testing of bio-diesel and bio-ethanol on Tallinn Bus Company (TBC) buses, and learning and gaining knowledge in practice. In the inception phase of the measure it was downscaled to “RTD only” and two main studies were carried out in the scope of the measure. The objective of the measure was changed to identifying the potential and conditions required for using environmentally friendly bio-fuels in the bus fleet in Tallinn and with the long-term vision to reduce fossil fuel dependency and pollutant emissions. The measure was realised in the following stages:

**Stage1: Study on legislative aspects of implementing alternative fuels** (December 2009 – March 2010) This study was conducted by the Tallinn University of Technology (TUT) and focused firstly on current available European documentations on bio-fuels, secondly on current national legislation frame and development plans for renewable and bio-fuels and thirdly on problematic cases due to legal issues in renewable and bio-fuels.

**Stage 2: Study on technical, socio-economic and environmental aspects of implementing alternative fuels** (December 2011 – March 2012) The study was conducted by the Stockholm Environmental Institute Tallinn Centre (SEI) and focused on technical, socio-economic and environmental impacts of bio-diesel, bio-ethanol and diesel-electric hybrid technologies.

**Stage 3: Spreading the knowledge among stakeholders** (March 2012 – June 2012) –Two workshops were organised for presenting and discussing the results of the studies with stakeholders (fuel suppliers, environmental experts, etc.).

The impact evaluation was based on interviews conducted with participants of the workshops. Their own estimation on their awareness before and after reading the studies was asked for and their awareness of the different aspects of alternative fuels was the only indicator for evaluating the measure. **The key-result** extracted from the evaluation was the raising of awareness among stakeholders: A rise of 67% among interviewed stakeholders was observed.

From the process evaluation some barriers and drivers were identified during the measure realisation. **The most important barrier** encountered during the measure was the low rate of expert participation in the earliest phase to define the concept and frame of the measure. The initial idea was to implement a pilot project to test the use of alternative fuels on buses. Nevertheless, this concept was abandoned due to the lack of resources available and low understanding that the testing would not provide much useful knowledge while requiring a large amount of resources. The focus of the measure was on research. This measure’s deviation required time to define the new objectives of the measure which caused a delay in the realisation. **The most important driver** encountered during the measure was the constructive partnership agreement between project partners. The TBC, TUT and SEI worked in close collaboration and shared a common understanding of the topic which contributed to reaching relevant outcomes from the conducted studies.

From the entire realisation process of the measure **some recommendations** can be addressed to cities which are aiming at conducting studies on legal and technology issues in the field of alternative fuel. Firstly, the results achieved in the studies are relevant and useful for all Estonian cities which can profit from the first research conducted in the context of Tallinn. Nevertheless, European cities should adapt their research in accordance with their own national legal frame. Secondly, measures implemented in the frame of a project such as MIMOSA should involve a wide range of experts, organisations, institutions and citizens in

order to make use of the available knowledge resources therefore defining common objectives for community development and increasing the level of results achieved. Thirdly, it appeared crucial during the realisation process to focus first efforts on conducting deep research into the field of alternative fuels prior to any implementation. Indeed to shift from fossil to alternative fuel requires deep understanding of the environmental, economic and legal issues to ensure a successful implementation. It is therefore highly recommended to invest time and effort in a proper preliminary study.

## A Introduction

### A1 Objectives

The measure objectives are:

- (A) High level / longer term:
  - Improvement of quality of life;
  - Reduction of transport related pollution;
- (B) Strategic level:
  - Promote the usage of environmentally friendly alternative fuels in Tallinn PT bus fleet;
  - Create conditions for the use of environmentally friendly bio-fuels in bus fleet (to reduce transport sector's dependency on fossil-fuels and fight against climate warming process);
  - Promote the reduction of pollution emission in the target area;
- (C) Measure level:
  - (1) To learn from other European cities which have implemented bio-fuels;
  - (2) To clarify the conditions and perspectives for further use of biodiesel or ethanol powered buses in Tallinn PT fleet;
  - (3) To raise the knowledge regarding bio-fuels among transport managers and technicians;
  - (4) To address decision makers and stakeholders to demonstrate the advantages of bio-fuels for the PT fleet in Tallinn.
  - (5) To draw conclusions, give recommendations and specify state and local level transport development plans.
  - (6) To draw conclusions, give recommendations and specify state and local level transport development plans that are now rather general in this respect.
- (D) The expected outputs are:
  - (1) Knowledge of Estonian legislation and the need for amendments;
  - (2) Knowledge of requirements for infrastructure and bio-fuel powered bus fleet, also for maintenance of infrastructure and bio-fuel powered bus fleet
  - (3) Knowledge of the requirements for storing and handling the bio-fuels;
  - (4) Knowledge of requirements for maintenance and technical personnel for bio-fuel powered bus fleet and infrastructure
  - (5) Knowledge of bio-fuel powered bus fleet and infrastructure procurement possibilities and terms
  - (6) Knowledge of bio-fuels, supply possibilities and terms;
  - (7) Knowledge of potential environmental impact of bio-fuel powered buses based on experience of European cities;
  - (8) Knowledge of the risks and obstacles of implementation of bio-fuels in Tallinn PT bus fleet based on experience of European cities;
  - (9) Awareness regarding bio-fuels and implementation of bio-fuels powered buses within transport managers has increased by 50%;

## A2 Description

The measure was originally planned for actually testing bio-diesel and bio-ethanol on Tallinn Bus Company (TBC) buses and finding out the knowledge in practice. In the inception phase of the measure it was downscaled to “research only” to find out all aspects of implementing alternative fuels before actually going to implement them. The measure was directed to bio-diesel and bio-ethanol only.

After the downscaling the main goals of the measure were to perform studies to find out possibilities and aspects of implementing biofuels in TBC and to spread the knowledge obtained with the studies among stakeholders in this field. The measure consisted of two studies. The first was conducted by the Tallinn University of Technology and was concentrated on different aspects of legislation on Estonian and European level. The second study was conducted by the Stockholm Environmental Institute Tallinn Centre (SEI) and was aimed at technical, socio-economic and environmental impacts of alternative fuels.

The results of the studies were presented to a selection of stakeholders of the measure in two workshops together with discussion of the results. The selection consisted of representatives from different levels of TBC management, representatives of the Tallinn city government, the Environmental and Transportation departments of Tallinn city, the Ministry of Economic Affairs and Communications, the Ministry of the Environment, the Enterprise Estonia foundation, Estonian Development Fund, [Estonian Renewable Energy Association](#), Association of Estonian Cities, a bus and truck manufacturer and a bio-energy company.

## B Measure Implementation

### B1 Innovative Aspects

The innovative aspect of the measure on national level is that there will be made **use of new technology** - Bio-fuel powered vehicles for PT fleet have not been used in bigger scale in Tallinn nor in Estonia before. The City of Tallinn sees an opportunity to prepare for the future through implementation of clean and energy efficient vehicles.

### B2 Research and Technology Development

As already mentioned in the description (A2) the main goal of the measure was to find out possibilities and aspects for implementing bio-fuels. Two studies were conducted to find legal, technical and environmental aspects of implementing bio-fuels.

The first study made by Tallinn University of Technology (TUT) in 2010 was aimed at legislation. It consisted of:

- study on different types of fuel, advantages and disadvantages;
- legal expertise on the implementation of bio-fuels in the Estonian legal environment with references to European legislation,
- study on actual legislation regulating bio-fuels and implementation of bio-fuels;
- study on actual legislative risks and problems of implementation bio-fuels in Tallinn and Estonia;

The main conclusions from the study were:

- There are no direct legal restrictions foreseen preventing implementation of bio-fuels and there is no direct need for amendments in legislation
- However, there are risks of legal problems as can be seen from previous verdicts of European Court of Justice and changes on national and municipal level practices which make long term investments into the technology risky.

A presentation with conclusions from the first study can be obtained from the TBC home page:

[http://www.tak.ee/public/files/Tiit\\_Metsvahi\\_TTU\\_Seadusandlus\\_alternatiivkytuste\\_kasutusel\\_MIMOSA\\_210612.pdf](http://www.tak.ee/public/files/Tiit_Metsvahi_TTU_Seadusandlus_alternatiivkytuste_kasutusel_MIMOSA_210612.pdf)

The second part of the study conducted by the Stockholm Environmental Institute Tallinn centre (SEI) continued with analysing different aspects connected to alternative fuels: technical, socio-economic and environmental. The aspects analysed were:

- Comparison of environmental impact of different technology based buses (diesel, bio-diesel, bio-ethanol, diesel-electric hybrid);
- Calculation of emissions and external costs of different technology based buses;
- Economical, technical and political experiences of bio-fuel implementation in neighbouring regions;
- Requirements on alternative fuels;
- Knowledge collection about implementation possibilities and requirements on bio-fuels, bio-fuel based fleet and infrastructure in Estonia;
- Risks and barriers with implementation of bio fuels in Tallinn public transport.

Besides bio-diesel and bio-ethanol, diesel-electric hybrid buses were also analysed for comparison.

The main conclusions from the study were:

- Based on experiences of Nordic countries all types of bio-fuels analysed can be used in Tallinn climate;
- Not all types and generations of bio fuels give positive results in terms of total emissions, production of a fuel can be a big contributor to total amount of emissions and should always be included in the emission estimation.
- The local harmful emission reduction effect of bio-ethanol and bio diesel is relatively low compared to the new EURO VI engine emission standard buses;
- The cost of saved global emissions (CO<sub>2</sub>) with bio-ethanol and bio diesel is too high to be a feasible method for emission reduction;
- TBC could be the effective testing ground for new technologies and creating critical mass of users of the new technologies to reduce transport related pollution in Tallinn;
- Other measures have to be undertaken to reduce transport related environmental impact because public transport is only minor part of it.

The second study was conducted between December 2011 and May 2012. Report of the study (in Estonian, with summary in English) can be obtained from the TBC home page:

[http://www.tak.ee/public/files/SEI\\_uuring\\_TAKkytused\\_Lopparuanne\\_SEI2012%281%29.pdf](http://www.tak.ee/public/files/SEI_uuring_TAKkytused_Lopparuanne_SEI2012%281%29.pdf)

### B3 Situation before CIVITAS

EU Member states have agreed that by the year 2020 biofuels will form 10% of all fuels in use and the emission of greenhouse gases will be decreased by 20% in respect of the year 1990. The Estonian Ministry of Economic Affairs and Communications adopted „Public Transport Development Programme for 2006-2010” states that by December 31, 2007 proposals for making PT energy efficient will be worked out and deployment of biofuel powered vehicles will be encouraged.

According to the biofuel feasibility study initiated by the Ministry of Economic Affairs and Communications, bio-ethanol and bio-diesel were the two most potential alternative fuels that suit to Estonian transport sector. For this reason the bio-gas was not planned as an alternative for studying in the second part of the study in the scope of the MIMOSA measure. Implementation of bio-ethanol and bio-diesel needed to be studied in terms of production, sales and supply to end-users. Lack of knowledge on bio-fuels in general was an obstacle to overcome because it has been one of the reasons for not implementing them in transport sector. In addition to import knowhow, there was a need to assess risks, fulfil gaps in legislation and construct specific infrastructure. There was lack of information on bio-ethanol/bio-diesel supply possibilities, cost and on how biofuels will suit Estonian climatic conditions.

Bio-fuels have been only marginally tested in public transport of Tallinn: the public fleet was relying entirely on fossil fuels and electricity that was mainly produced from fossil oil shale.

TBC average fuel consumption was approximately 10 million litres a year and the use of fossil diesel fuel had a negative impact on the environment. Considering economic and environmental aspects there was an urgent need to find alternatives to the fuel currently used.

## B4 Actual Implementation of the Measure

The measure was implemented in the following stages:

**Stage 1: Study on legislative aspects of implementing alternative fuels** (December 2009 – March 2010) – the study was conducted by TUT. The legislative aspects analysed were: 1) Documentation issued by European Parliament and European Council on renewable and bio-fuels; 2) National level legislation and development plans on renewable and bio-fuels; 3) Cases of legislative problems with renewable and bio-fuels;

**Stage 2: Study on technical, socio-economical and environmental aspects of implementing alternative fuels** (December 2011 – March 2012) – the study was conducted by the SEI.

**Stage 3: Spreading the knowledge among stakeholders** (March 2012 – June 2012) – two workshops were organized for presenting and discussing the results of the studies with stakeholders.

## B5 Inter-Relationships with Other Measures

The measure is indirectly related to the bio-gas (CNG) bus project in the city of Tartu. The EU project website is <http://www.balticbiogasbus.eu>. Some conclusions from the project were used in the second study of the measure.

## C Impact Evaluation Findings

### C1 Measurement Methodology

The only realistic impact of the measure was to raise the awareness of the stakeholders connected to the measure on alternative fuels. All other possible impacts based on the change of awareness were out of time frame of the measure and could therefore not be evaluated.

#### C1.1 Impacts and Indicators

TABLE C1.1.1: Indicators.

No.	Evaluation	Evaluation sub-category	Impact	Indicator	Description	Data /units
15	Society	Acceptance	Awareness	Awareness level	Degree to which the awareness on alternative fuels has changed	Index, qualitative, collected, survey

Detailed description of the indicator methodologies:

**Indicator 15 (Society, awareness)** – The indicator was based on survey questions where the participating stakeholders of the workshops were asked about their estimation on their awareness of different aspects of different alternative fuel types before and after the workshops where the results of the studies were presented. The workshops were held in March 2012 and June 2012. The fuel types were: bio-diesel, bio-ethanol, bio-gas and diesel-electric hybrid. The aspects to consider were: legislative, technical, environmental and socio-economic. The question was asked in a matrix form and the participants evaluated their knowledge before and after and on different aspects on a scale of 1 to 5. The sample size of the survey was 14 persons (9 with technical/transportation background, 5 with environmental background) which comprised representatives from different levels of TBC management, representatives of the Tallinn city government, the Environmental and Transportation departments of Tallinn city, the Ministry of Economic Affairs and Communications, the Ministry of the Environment, the Enterprise Estonia foundation, Estonian Development Fund, [Estonian Renewable Energy Association](#), Association of Estonian Cities, a bus and truck manufacturer and a bio-energy company.

Except for rise in awareness of stakeholders all the other objectives listed in the A1 (D) are measurable in a scale of YES of NO.

The following table C1.1.2 list the indicators that were stated originally in the Local Evaluation Plan but were omitted after the measure was changed into the “research only” measure.

**TABLE C1.1.2: List of potential effects that were not assessed**

Impacts category	Indicator	How does it impact	Why it was not accessed
Economy	Benefits	Usage of alternative fuels would probably have resulted in socio-economical benefits	The measure was changed to “research only” in the inception phase
Economy	Costs	Usage of alternative fuels would have resulted in additional costs for implementation and probably higher running costs	The measure was changed to “research only” in the inception phase
Energy	Energy consumption	The usage of alternative fuel would probably have resulted in change of energy consumption	The measure was changed to “research only” in the inception phase
Environment	Emissions	The usage of alternative fuels would probably have resulted in lower emissions	The measure was changed to “research only” in the inception phase

## C1.2 Establishing a Baseline

The baseline was formed retrospectively by asking the participants about their own estimation on their knowledge of different aspects before seeing the results of the studies.

## C1.3 Building the Business-As-Usual Scenario

The BAU scenario was based on the fact that there have been no similar studies on different types of alternative fuels during the MIMOSA project. Thus without the measure 1.1 the specific knowledge on implementation and impact of alternative fuels would have been constant.

## C2 Measure Results

### C2.1 Economy

Not applicable

### C2.2 Energy

Not applicable

### C2.3 Environment

Not applicable

## C2.4 Transport

Not applicable

## C2.5 Society

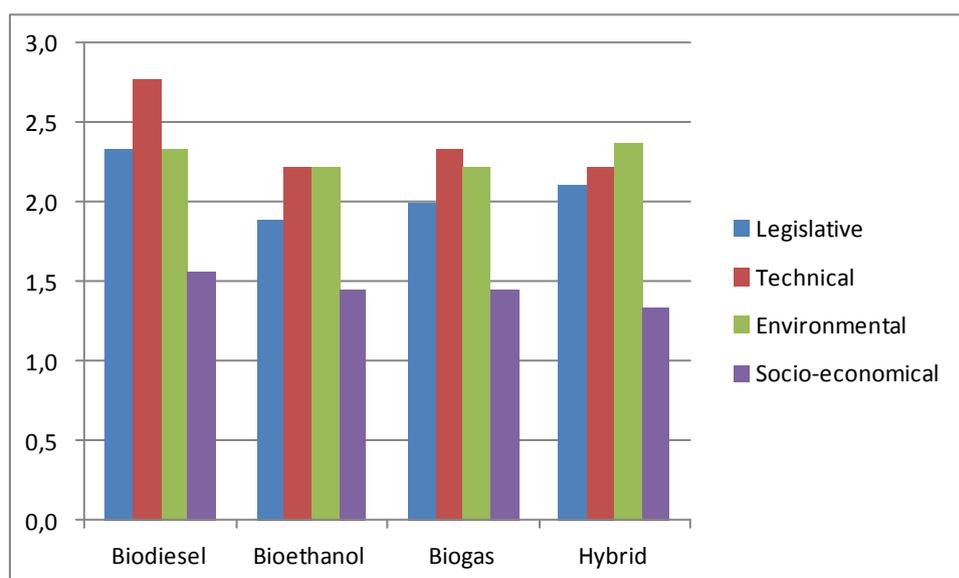
**Awareness.** The awareness of the stakeholders (their own estimation before and after seeing presentations of the studies and discussing the results on the workshop) was measured in a scale 1 to 5. The left side of the tables C2.5.1 to C2.5.4 and also the figure C2.5.1 to figure C2.5.4 present the average answers from the participants on different aspects of different fuels. The cells in the tables are shaded from green to red according to the values (green-higher, red-lower) Tables on the right present the spread of the answers (standard deviation), shaded from red to green (red-higher, green lower). The tables are separate for participants from organisations from a technical/transportation background and from an environmental background.

The tables C2.5.5 to C2.5.6 and figure C2.5.5 to figure C2.5.6 present change (%) in the awareness as a result of the studies and workshops.

**TABLE C2.5.1: Awareness on different aspects before the studies, stakeholders with technical/transportation background**

	Awareness				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	2,3	1,9	2,0	2,1	0,7	0,8	0,7	1,1
Technical	2,8	2,2	2,3	2,2	0,8	1,0	0,9	1,0
Environmental	2,3	2,2	2,2	2,4	1,2	1,2	1,2	1,1
Socio-economical	1,6	1,4	1,4	1,3	0,7	0,7	0,7	0,5

**FIGURE C2.5.1: Awareness on different aspects before the studies, stakeholders with technical/transportation background**



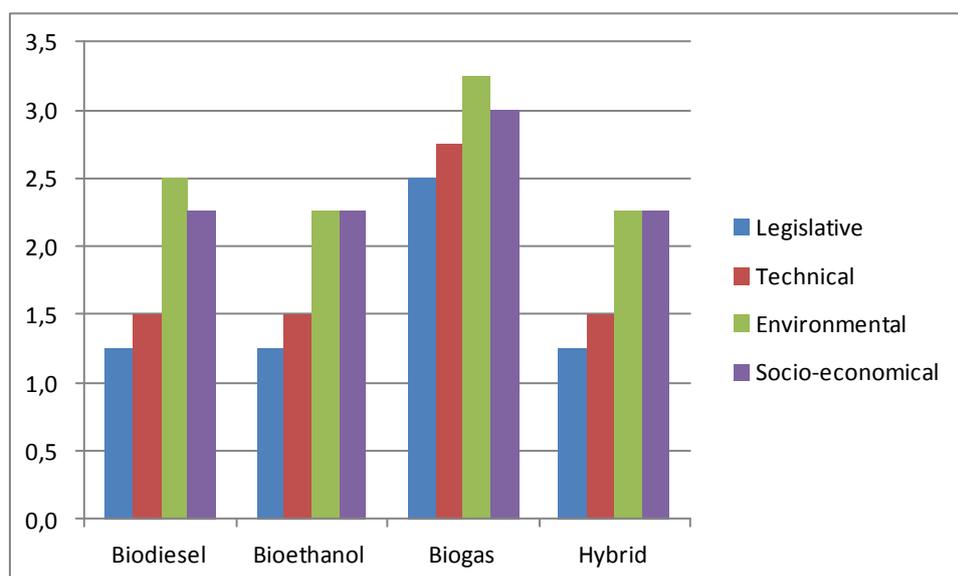
Comments on the awareness of the stakeholders with technical/transportation background before the studies:

- The awareness on socio-economical aspects is lower than other aspects, the answers are relatively similar;
- The awareness on technical and environmental aspects is higher but the answers are wider spread in case of environmental aspects;
- The awareness on biodiesel is higher than on other fuels, the spread of awareness is slightly higher on the hybrid technology
- 

**TABLE C2.5.2: Awareness on different aspects before the studies, stakeholders with environmental background**

	Awareness				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	1,3	1,3	2,5	1,3	0,5	0,5	1,9	0,5
Technical	1,5	1,5	2,8	1,5	0,6	0,6	1,5	0,6
Environmental	2,5	2,3	3,3	2,3	1,0	1,3	1,5	1,3
Socio-economical	2,3	2,3	3,0	2,3	1,3	1,3	1,8	1,3

**FIGURE C2.5.2: Awareness on different aspects before the studies, stakeholders with environmental background**

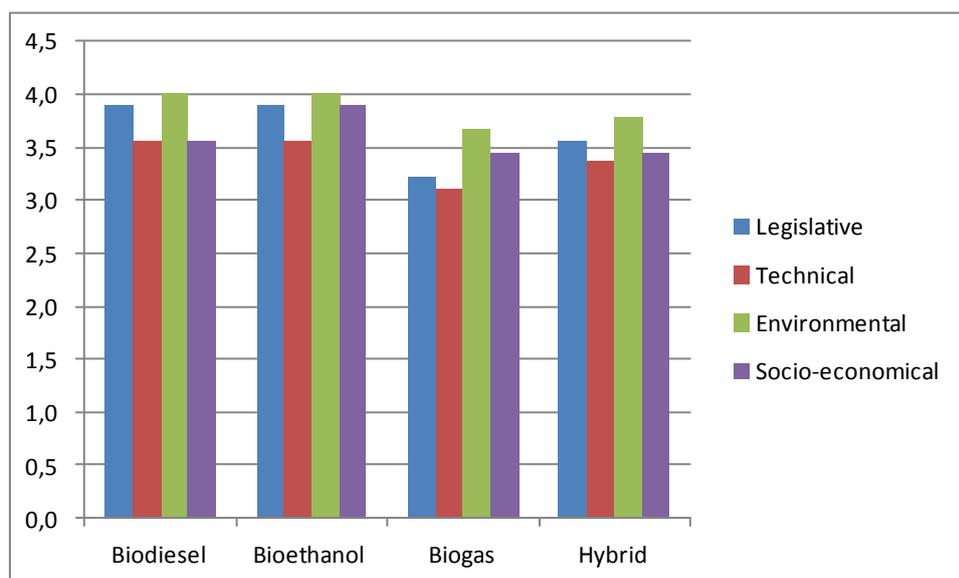


Comments on the awareness of the stakeholders with environmental background before the studies:

- The awareness on legislative and technical aspects is lower than other aspects, the answers are relatively similar;
- Since the sample was small (5), answers from one biogas-aware participant (he is actually expert in this field) brought up the awareness numbers on biogas and the standard deviation figures show that the spread of the answers is considerably higher for the same reason;

**TABLE C2.5.3: Awareness on different aspects after the studies, stakeholders with technical/transportation background**

	Awareness				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	3,9	3,9	3,2	3,6	0,9	0,8	1,1	1,0
Technical	3,6	3,6	3,1	3,4	0,5	0,7	0,6	0,7
Environmental	4,0	4,0	3,7	3,8	0,5	0,7	1,0	0,8
Socio-economical	3,6	3,9	3,4	3,4	1,1	1,1	0,9	1,2

**FIGURE C2.5.3: Awareness on different aspects after the studies, stakeholders with technical/transportation background**

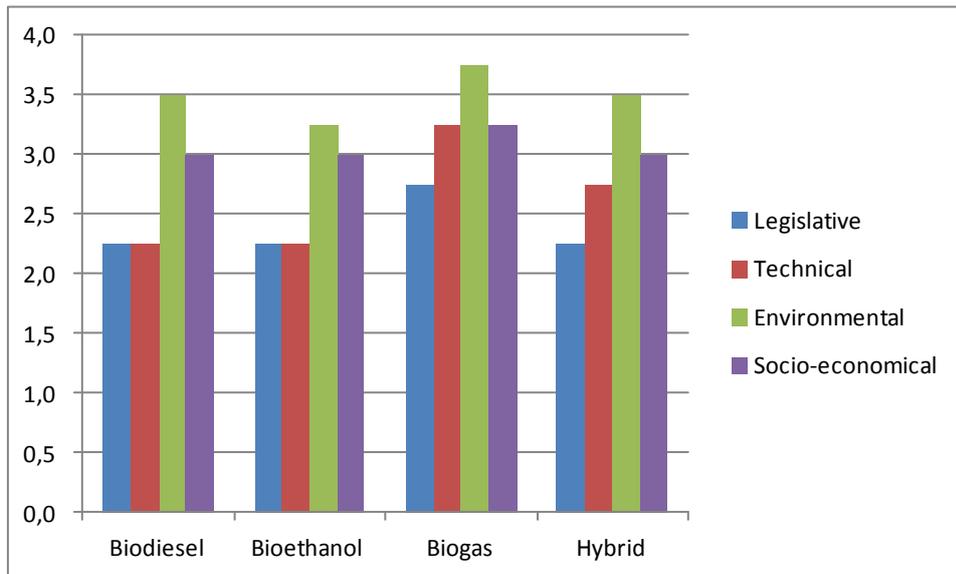
Comments on the awareness of the stakeholders with technical/transportation background after the studies:

- The awareness on biodiesel and bioethanol is higher than awareness on biogas and hybrid technology. The lowest awareness on biogas is logical, because biogas was not subject of the study, only some results from the Tartu biogas bus project were presented;
- The awareness on technical aspects is lowest, awareness on environmental aspects is highest, in both cases with low standard deviation of the answers

**TABLE C2.5.4: Awareness on different aspects after the studies, stakeholders with environmental background**

	Awareness				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	2,3	2,3	2,8	2,3	0,5	0,5	1,7	1,0
Technical	2,3	2,3	3,3	2,8	1,0	1,0	1,3	0,5
Environmental	3,5	3,3	3,8	3,5	0,6	1,0	1,0	0,6
Socio-economical	3,0	3,0	3,3	3,0	1,2	1,2	1,5	1,2

**FIGURE C2.5.4: Awareness on different aspects after the studies, stakeholders with environmental background**



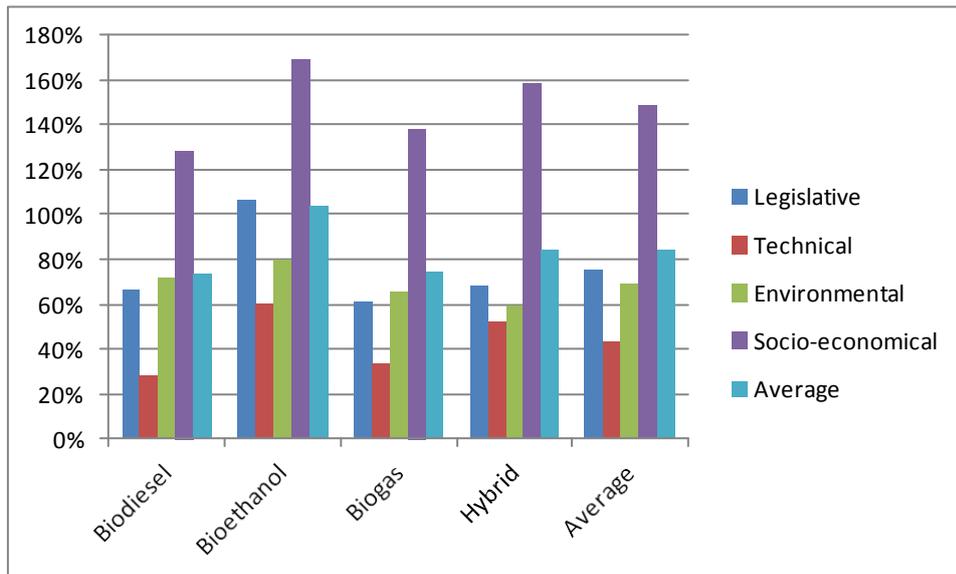
Comments on the awareness of the stakeholders with technical/transportation background after the studies:

- The awareness on environmental aspects is highest after the studies;
- The awareness on legislative and technical aspects remained lower than on environmental and socio-economical aspects after the studies;
- The more varying results on biogas are again explainable by the on bio-gas expert in the sample

**TABLE C2.5.5: Change in awareness on different aspects after the studies, stakeholders with technical/transportation background**

	Awareness				
	Biodiesel	Bioethanol	Biogas	Hybrid	Average
Legislative	67%	106%	61%	68%	<b>76%</b>
Technical	28%	60%	33%	52%	<b>43%</b>
Environmental	71%	80%	65%	59%	<b>69%</b>
Socio-economical	129%	169%	138%	158%	<b>149%</b>
Average	<b>74%</b>	<b>104%</b>	<b>74%</b>	<b>84%</b>	<b>84%</b>

**FIGURE C2.5.5: Change in awareness on different aspects after the studies, stakeholders with technical/transportation background**



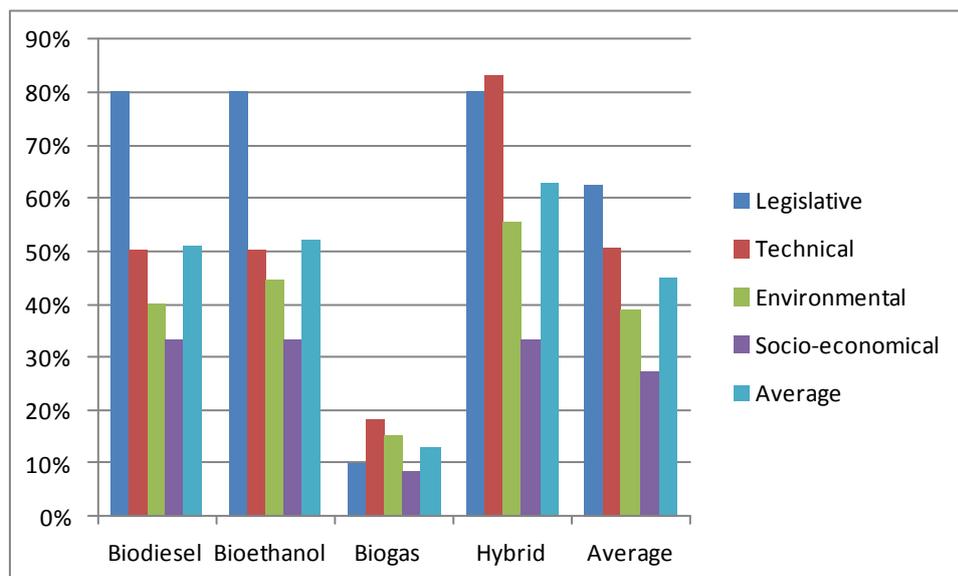
Comments on the change of the awareness of the stakeholders with technical/transportation background after the studies:

- The change in awareness was highest on the socio-economical aspects. The second study brought out clearly that the cost of emission reduction with biodiesel and bioethanol is not feasible;
- The change in awareness was highest on bioethanol. This could partly be explained with initial lower awareness than other fuels
- The change in awareness was lowest on technical aspects since the presentation on neither of studies was concentrated on detailed technical aspects of alternative fuel;

**TABLE C2.5.6: Change in awareness on different aspects after the studies, stakeholders with environmental background**

	Awareness				
	Biodiesel	Bioethanol	Biogas	Hybrid	Average
Legislative	80%	80%	10%	80%	63%
Technical	50%	50%	18%	83%	50%
Environmental	40%	44%	15%	56%	39%
Socio-economical	33%	33%	8%	33%	27%
Average	51%	52%	13%	63%	45%

**FIGURE C2.5.6: Change in awareness on different aspects after the studies, stakeholders with environmental background**



Comments on the change of the awareness of the stakeholders with environmental background after the studies:

- The change in the awareness was highest on the legislative aspects;
- The change was lowest on the socio-economical aspects;
- The low change in the awareness on biogas was again caused by the presence of a biogas expert in the small sample so the initial awareness values were already high;

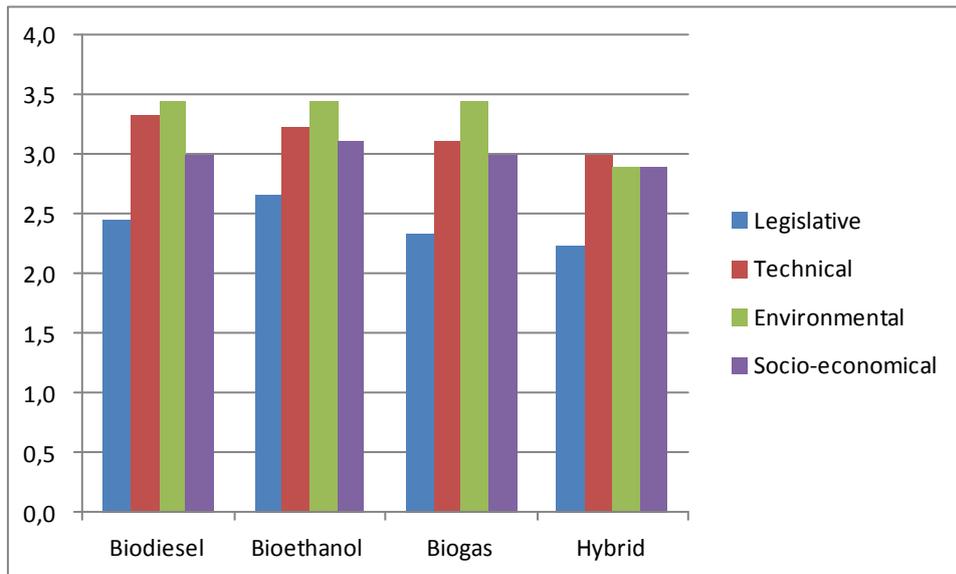
**Importance of factors.** The importance of different factors with different fuels was similarly to the awareness asked before and after the workshops. It can be considered as an indicative check of the participants own estimation on their awareness on different aspects of alternative fuels.

The left sides of the tables C2.5.7 to C2.5.10 and the figure C2.5.7 to figure C2.5.10 present the results of the survey in a scale of 1-5 together with standard deviations on the right side of the tables. The tables 2.5.11 to 2.5.12 and figure C2.5.11 to figure C2.5.12 present the change (%) in the understanding of importance as a result of the studies and workshops.

**TABLE C2.5.7: Importance of different aspects before the studies, stakeholders with technical/transportation background**

	Importance of different aspects				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	2,4	2,7	2,3	2,2	1,1	1,3	1,2	1,1
Technical	3,3	3,2	3,1	3,0	1,0	1,2	0,9	1,3
Environmental	3,4	3,4	3,4	2,9	0,9	1,2	1,0	1,3
Socio-economical	3,0	3,1	3,0	2,9	1,4	1,5	1,5	1,5

**FIGURE C2.5.7: Importance of different aspects before the studies, stakeholders with technical/transportation background**

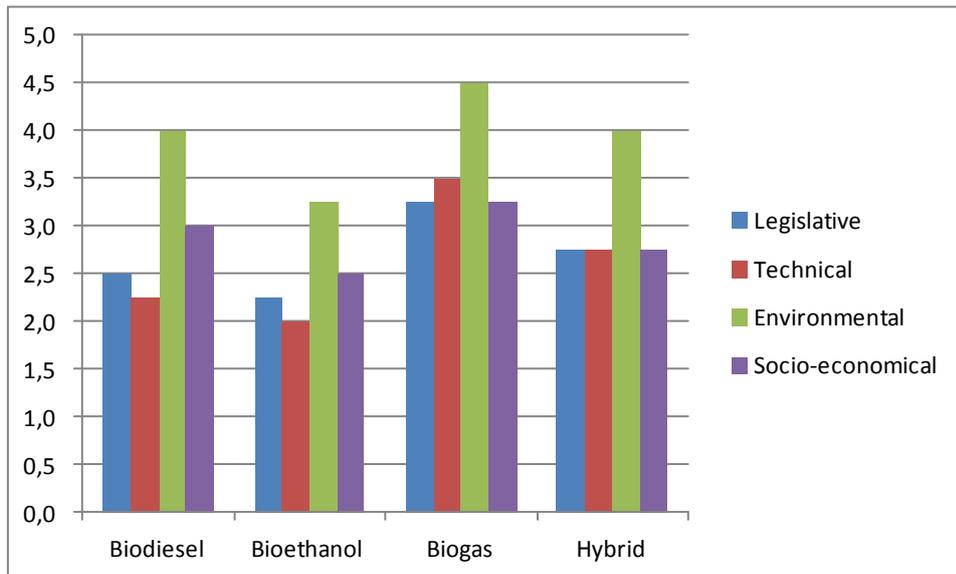


Comments on the understanding of the importance of different aspects of the stakeholders with technical/transportation background before the studies:

- The importance of the environmental aspects is considered to be higher than other aspects with biofuels;
- The importance of the legislative aspects is considered to have lowest importance with all fuels;
- The spread in the answers about importance of socio-economical aspects is the highest

**TABLE C2.5.8: Importance of different aspects before the studies, stakeholders with environmental background**

	Importance of different aspects				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	2,5	2,3	3,3	2,8	0,6	1,0	1,3	0,5
Technical	2,3	2,0	3,5	2,8	1,3	1,4	1,7	1,5
Environmental	4,0	3,3	4,5	4,0	0,8	1,7	0,6	0,8
Socio-economical	3,0	2,5	3,3	2,8	1,2	1,3	1,5	1,0

**FIGURE C2.5.8: Importance of different aspects before the studies, stakeholders with environmental background**

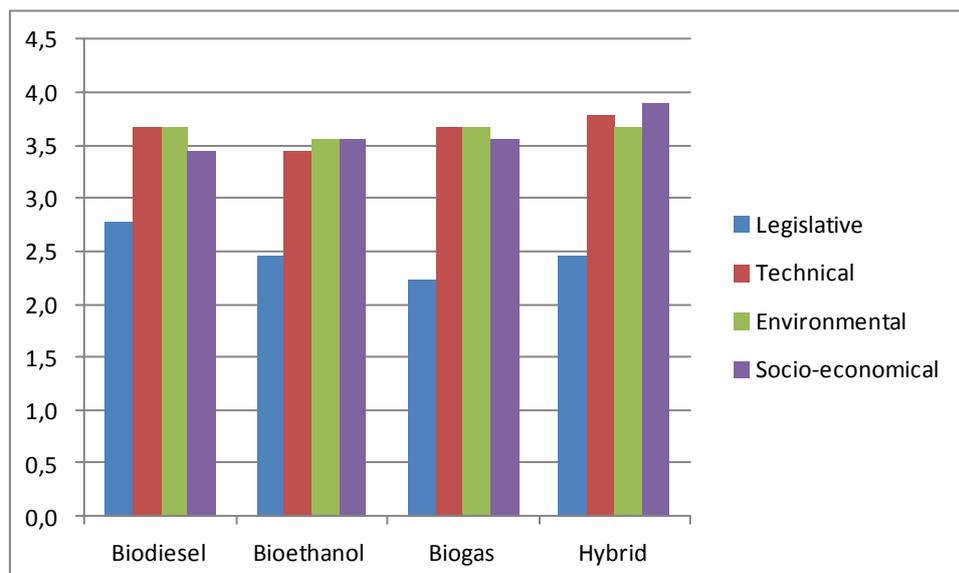
Comments on the understanding of importance of different aspects of the stakeholders with environmental background before the studies:

- The importance of the environmental aspects is higher than other aspects;
- The importance of legislative aspects is higher than other aspects;
- The environmental aspect of biogas has the highest importance;
- The higher importance of all aspects in case of biogas is again influenced by the presence of a biogas expert in the sample;

**TABLE C2.5.9: Importance of different aspects after the studies, stakeholders with technical/transportation background**

	Importance of different aspects				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	2,8	2,4	2,2	2,4	1,1	1,0	1,1	1,0
Technical	3,7	3,4	3,7	3,8	0,9	0,9	0,7	0,8
Environmental	3,7	3,6	3,7	3,7	0,7	0,9	0,7	0,5
Socio-economical	3,4	3,6	3,6	3,9	1,2	1,2	1,1	0,9

**FIGURE C2.5.9: Importance of different aspects after the studies, stakeholders with technical/transportation background**



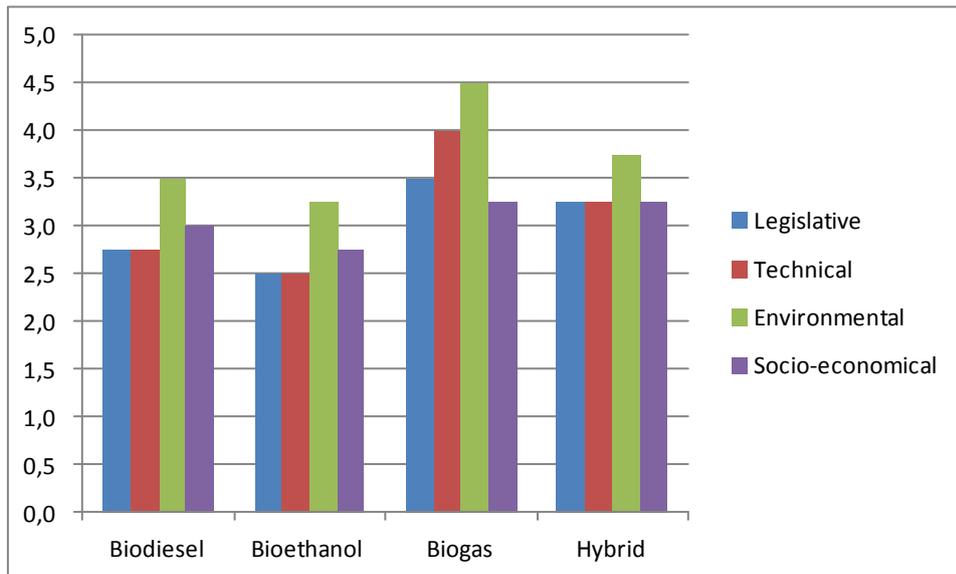
Comments on the understanding of importance of different aspects of the stakeholders with technical/transportation background after the studies:

- The importance of technical, environmental and socio-economical have practically the same high importance with all different file types
- Only the importance of legislative aspects have lower importance with all different file types;
- The socio-economic aspect of a hybrid technology has the highest importance;
- The very small variation in importance of the different aspects in case of different fuels is an indicator that the results of the table C2.5.9 should probably be taken with caution. For example there are no important legislative aspects compared to the other fuels, socio-economical aspects are negative (very high cost) in case of biodiesel and bioethanol, etc but these results are not reflected in the table. All this was explained in the reports of the studies and presented on workshops. The result indicates either misunderstanding of the question or reduced willingness to answer repeating questions in a matrix form after several hours workshop.

**TABLE C2.5.10: Importance of different aspects after the studies, stakeholders with environmental background**

	Importance of different aspects				Standard deviation			
	Biodiesel	Bioethanol	Biogas	Hybrid	Biodiesel	Bioethanol	Biogas	Hybrid
Legislative	2,8	2,5	3,5	3,3	1,0	1,3	1,3	1,0
Technical	2,8	2,5	4,0	3,3	1,0	1,3	0,8	1,0
Environmental	3,5	3,3	4,5	3,8	1,3	1,5	0,6	1,3
Socio-economical	3,0	2,8	3,3	3,3	0,8	1,0	1,7	1,0

**FIGURE C2.5.10: Importance of different aspects after the studies, stakeholders with environmental background**



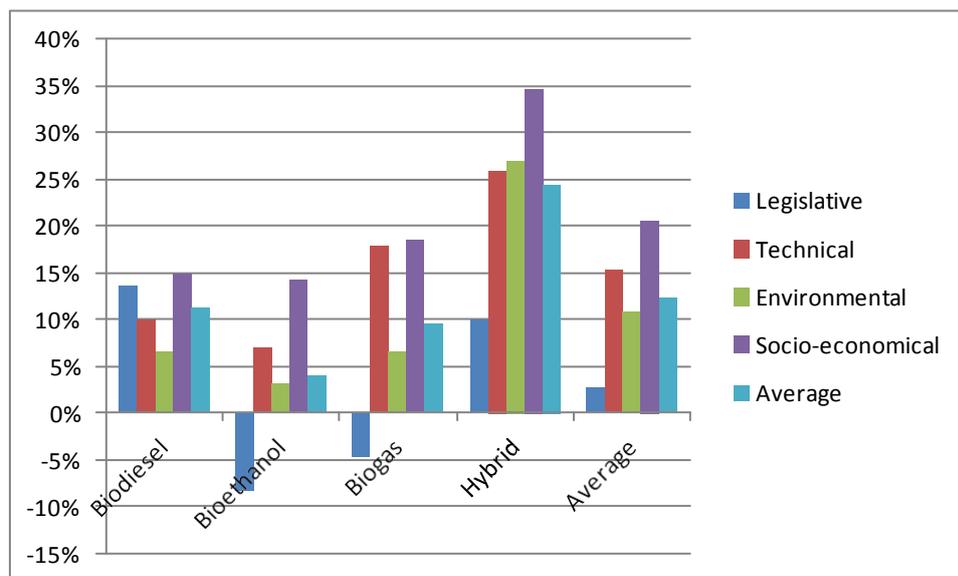
Comments on the understanding of importance of different aspects of the stakeholders with technical/transportation background after the studies:

- The importance of environmental aspects is highest after the studies;
- The importance of all aspects is highest in case of biogas. This is again probably caused by the fact that there was a biogas expert among this sample;
- The importance of all aspects is lowest in case of bioethanol;
- The environmental aspect of biogas has the highest importance;
- The positions of importance of different fuels could be interpreted as this samples preference of alternative fuels, which is in accordance with the results of the second study.

**TABLE C2.5.11: Change in importance of different aspects after the studies, stakeholders with technical/transportation background**

	Importance of different aspects				
	Biodiesel	Bioethanol	Biogas	Hybrid	Average
Legislative	14%	-8%	-5%	10%	3%
Technical	10%	7%	18%	26%	15%
Environmental	6%	3%	6%	27%	11%
Socio-economical	15%	14%	19%	35%	21%
Average	11%	4%	10%	24%	12%

**FIGURE C2.5.11: Change in importance of different aspects after the studies, stakeholders with technical/transportation background**



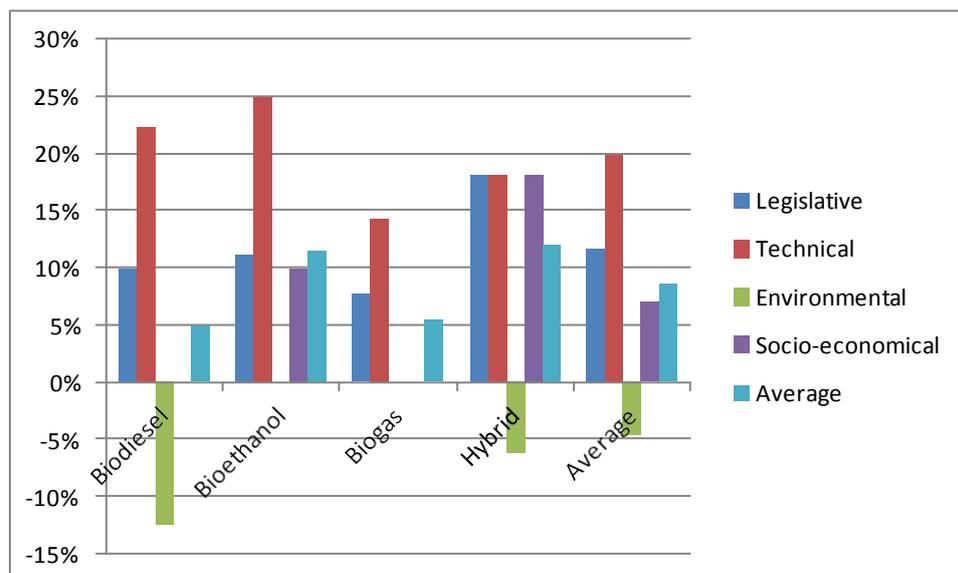
Comments on the change of understanding of importance of different aspects of the stakeholders with technical/transportation background after the studies:

- The highest rise of importance of socio-economic aspect reflects the outcome of the second study where the importance of cost of reducing emissions was clearly brought out;
- The change in understanding of importance was most raised for hybrid technology. This can be reflection of the conclusion of the second study, where the hybrid technology turned out to be a more feasible alternative fuel than biogas and biodiesel;
- The understanding of the importance of the legislative aspect has even dropped in case of bioethanol and biogas while the importance was still raised in case of biodiesel and hybrid. This is not fully in accordance with the studies, where the problems with legislation were brought out for biodiesel and bioethanol;

**TABLE C2.5.12: Change in importance of different aspects after the studies, stakeholders with environmental background**

	Importance of different aspects				
	Biodiesel	Bioethanol	Biogas	Hybrid	Average
Legislative	10%	11%	8%	18%	<b>12%</b>
Technical	22%	25%	14%	18%	<b>20%</b>
Environmental	-13%	0%	0%	-6%	<b>-5%</b>
Socio-economical	0%	10%	0%	18%	<b>7%</b>
Average	<b>5%</b>	<b>12%</b>	<b>5%</b>	<b>12%</b>	<b>9%</b>

**FIGURE C2.5.12: Change in importance of different aspects after the studies, stakeholders with environmental background**



Comments on the change of understanding of importance of different aspects of the stakeholders with environmental background after the studies:

- The understanding of importance of technical aspects was raised most;
- The understanding of importance of most aspects of hybrid technology was raised most;
- The understanding of importance of environmental aspects has dropped. Generally this is in accordance with the results of the second study, that the local harmful emissions of biodiesel and bioethanol are on comparable level with emissions of new EURO V and VI standard buses. Only the balances of changes between fuel types are questionable;
- The change of importance was lowest on the socio-economical aspects;

The average of the survey results is presented in table C2.5.13.

**TABLE C2.5.13: Change in awareness of the stakeholders**

Indicator	Before (date)	B-a-U (date)	After (date)	Difference: After – Before	Difference: After – B-a-U
Society, awareness	2,4 March 2012	2,4 June 2012	4,0 June 2012	67%	67%

The evaluation results reflect well the general feeling and discussions with the stakeholders which were participating the workshops. The general knowledge on alternative fuels was very different from the actual study results and the results were generally accepted as comprehensible, acceptable and useful among the stakeholders. While the exact percentage of the knowledge increase has little knowledge the potential impact of the measure was at the time of the workshops clearly positive.

The other objectives listed in the chapter A1 (D) were implemented as follows:

- (1) Knowledge of Estonian legislation and the need for amendments – **achieved**, the topic was covered by the first study;
- (2) Knowledge of requirements for infrastructure and bio-fuel powered bus fleet, also for maintenance of infrastructure and bio-fuel powered bus fleet – **not achieved**, was not important/achievable after downscaling of the measure. Only some elements of the topic were briefly covered by the second study.
- (3) Knowledge of the requirements for storing and handling the bio-fuels - **not achieved**, was not important/achievable after downscaling of the measure.
- (4) Knowledge of requirements for maintenance and technical personnel for bio-fuel powered bus fleet and infrastructure - **not achieved**, was not important/achievable after downscaling of the measure. Only some elements of the topic were briefly covered by the second study.
- (5) Knowledge of bio-fuel powered bus fleet and infrastructure procurement possibilities and terms - **not achieved**, was not important/achievable after downscaling of the measure.
- (6) Knowledge of bio-fuels, supply possibilities and terms - **achieved**, the topic was covered by the second study;
- (7) Knowledge of potential environmental impact of bio-fuel powered buses based on experience of European cities - **achieved**, the topic was covered by the second study;
- (8) Knowledge of the risks and obstacles of implementing bio-fuels in Tallinn PT bus fleet based on experience of European cities - **achieved**, the topic was covered by both of the studies;

### C3 Achievement of Quantifiable Targets and Objectives

No.	Target	Rating
1	Knowledge regarding bio-fuels within transport managers has increased by 50%	➤➤
<b>NA = Not Assessed O = Not Achieved ➤ = Substantially achieved (at least 50%)</b> <b>➤➤ = Achieved in full ➤➤➤ = Exceeded</b>		

The overall target of raising the knowledge of alternative fuels among stakeholders was achieved with the measure, it has increased by 50%. The debates on the workshops supported the numerical results that the knowledge among stakeholders on alternative fuels was raised as a result of the measure activities.

### C4 Up-Scaling of Results

The measure could be up-scaled in two different directions:

- Widening the circle of stakeholders to other public transport companies in Tallinn, other cities in Estonia, other transportation companies etc would increase the impact of the measure. The findings from the studies have been unexpected even for transportation and environmental specialists and are therefore important to take to the wider public.

- The study should have been widened to bio-gas as well. In the planning and inception phase of the measure (2008-2009) the bio-gas was not realistic alternative to be considered but in the later years the development of this type of fuel has been fast and the second study (beginning of 2012) should have taken this into account. As there was a pilot study with 10 new bio-gas buses in the second largest Estonian city Tartu from 2011 the omission of bio-gas was compensated with knowledge gained from this pilot.

## C5 Appraisal of Evaluation Approach

Setting such numerical target for awareness on a very specific topic on limited stakeholders always creates a challenge for evaluation of the measure impact and the evaluation results should be taken as a general indicator only. After reading a report of a study, seeing presentation of a summary of the study and participating discussions on the topic probably no-one would answer that their knowledge on the topic has decreased. Since the results of the studies were somewhat surprising even for the experts carrying out the studies, the results of the stakeholder survey on the awareness “before” seem to be somewhat overestimated. To find the actual amount of knowledge change would require arranging at least two exams to stakeholders on the topic, which is not realistically practicable approach. However the survey brought also out the differences in knowledge of different stakeholder groups and their opinion on importance of different aspects with different fuels that supported the validity of the survey.

## C6 Summary of Evaluation Results

The key results are as follows:

- **Raising the knowledge on alternative fuels** – the knowledge of the participating stakeholders was raised by 67% as a result of the measure activities: studies and workshops.

## C7 Future Activities Relating to the Measure

The results of the studies on alternative fuels have been made available for the general public. No further activities have been planned as of August 2012.

## D Process Evaluation Findings

### D1 Deviations from the Original Plan

There was one crucial deviation from the original plan: **Cancelling the implementation of alternative fuels**. Originally, 6 buses and necessary infrastructure were considered to be rented for testing both bio-ethanol and bio-diesel. The cancellation was decided already in the inception phase of the measure before starting with the studies. There were several reasons leading to this decision:

- Insufficient planning when selecting measures for Tallinn. The measure was not planned thoroughly as it turned out in the inception phase.
- Negative experiences from CIVITAS 2 project. Even with mild winter temperatures of southern Europe other cities experienced difficulties with using bio fuels.
- High cost of renting and testing alternative fuels compared to possible knowledge obtainable. The unit costs are very high for renting only 5 buses and building temporary infrastructure together with all logistics connected. Also some personnel would have to be trained or employed (not likely to be available in Estonia) temporarily. At the same time there is knowledge available from Nordic countries based on bigger scale implementation in similar climate conditions.
- Costly evaluation of testing. If the implementation were to be evaluated properly it would have required many high level technical measurements for evaluation.
- Too short testing period for evaluation. The possible testing period would have been short in the scope of the MIMOSA project, realistically 1 year. Thus it would have been difficult to evaluate the influence of actual weather conditions of that year on the outcome.

### D2 Barriers and Drivers

#### D2.1 Barriers

##### Overall barriers

- Insufficient planning of the measure when selecting MIMOSA measures for Tallinn. The selection of measures had no wider expert participation and thus had to be reconsidered in the inception phase. This caused delays in implementation since it took time to achieve clear understanding of the new objectives of the measure and actions to implement.

##### Preparation phase

- Tallinn decided to downsize the measure and implement it with smaller resources as a “soft measure”. This effectively cancelled the possibility to achieve the original objectives of actually physically testing the usage of alternative fuels while being the right decision looking at it afterwards.
- Because of limited resources in Tallinn Bus Company, priority and urgency of Tallinn MIMOSA measures 2.3 and 6.1, the measure 1.1 was decided to have lower priority and thus was delayed by approximately 4 months.

## **Implementation phase**

- Difficulties in estimating possible barriers for implementing alternative fuels, examples of other European countries were not directly transferable. As a result the study on possibilities for implementing the alternative fuels is general at times, and does not give conclusive answers. The topic itself is a barrier since there is practically no past information or experience on this topic in Estonia and the experience from other countries is not directly transferable to Estonian conditions.

## **D2.2 Drivers**

### **Overall Drivers**

- Constructive partnership with project partners. It affected the outcome of studies, which is in accordance with all partners understanding. It was a relatively good understanding of the topic and objectives between TBC, TUT and SEI throughout the process. This made possible the final outcome in a form of useful and usable knowledge.
- The Tallinn Traffic Development Plan for 2005-2014 states that Tallinn traffic management service has to ensure environmentally friendly and sustainable traffic. According to the biofuel feasibility study initiated by the Ministry of Economic Affairs and Communications, bioethanol and biodiesel are potential bio-fuels for Estonian transport sector.

## **D2.3 Activities**

### **Preparation phase**

- Additional specialists were included in study on legislation, possibilities, risks and perspectives of implementing bio fuels in Tallinn. Originally the plans for the measure were different but as it was changed to “research only” measure, additional specialist was used by the TUT team to rise the quality of the study results.

## **D3 Participation**

### **D3.1 Measure Partners**

- **Tallinn Bus Company** – leading partner of the measure, responsible for preparation and implementation of the measure.
- **Department of transportation of Tallinn City** – Tallinn City is the owner of the TBC, principle participant.
- **Tallinn University of Technology** – , Principle participant. Responsible for consulting the other project partners, conducting the first part of the study on legislative aspects of implementing alternative fuels, presenting the results and performing evaluation.
- **Stockholm Environmental Institute Tallinn centre** - Principle participant. Responsible for conducting the second part of the study on technical, socio-economical and environmental aspects of implementing alternative fuels and presenting the results.

## D3.2 Stakeholders

- **City departments** - Managers and specialists in the Environmental and Transportation departments. The knowledge is important for them for future strategic decisions on municipal level.
- **Ministries** - Managers and specialists in the Ministry of Economic Affairs and Communications, Ministry of the Environment. The knowledge is important for them for future strategic decisions on national level.
- **Transportation companies** - Public transport and goods transport companies. The knowledge from the measure gives them important information for future plans.
- **Fuel manufacturers and suppliers** - Local and foreign companies dealing with production and distribution of fuels. The knowledge from the measure gives them important information for future plans and possibility to share their own knowledge and information contributed to the workshops.
- **Vehicle manufacturers** - Bus and goods transport vehicles producers. The knowledge from the measure gives them information for future development plans and possibility to share their own knowledge and information contributed to the workshops.
- **Knowledge institutions** – Universities and institutes dealing with logistics, transportation and environmental topics. The knowledge from the measure gives them important information for future studies and for sharing with students as future specialists and managers in these fields.

Representatives of all listed stakeholders were also present in the two workshops held in March and June 2012.

## D4 Recommendations

### D4.1 Recommendations: Measure Replication

- The measure with its results is transferable to other Estonian cities but the situation is different with other countries. A study on possibilities and estimated results of using alternative fuels can be performed in any city and is important prerequisite to any physical implementation of fuels.
- The main positive lesson from the measure was that based on studies only, it was possible to practically cancel out the usage of bio-diesel and bio-ethanol in Tallinn currently, because their cost is too high compared to their effect on emission reduction. The knowledge was obtained with considerably less effort and resources than with physical implementing of the fuels.
- The negative lesson of the measure is that planning and selecting measures for implementation and piloting is a very important phase of any measure or project. Down-scaling the implementation of alternative fuels to “research only” already in the inception phase is an example that the planning of the measure was not done well – nothing unexpected was the cause for the change, just reconsideration. The planning should be done in possibly wider circle of experts and community to put effort and resources into projects and measures that would be useful for the society.
- For other cities the main recommendation would be that before implementing anything physically it is good reason to take time for a proper study and consider all aspects that

can be estimated without implementing. It is possible to find similar experiences in other cities and countries and try to find elements that are similar and transferable.

#### **D4.2 Recommendations: Process (Related to Barrier-, Driver- and Action Fields)**

- The European Commission has a good reason to address the selecting and planning phase of any project or measure similar to CIVITAS MIMOSA. How are the measures selected in cities, is the selection done by a limited number of officials or by a wider circle of experts and representatives of the community. Additional effort put into the planning phase would save time and resources later in other phases. Evaluation possibilities should be more important criterion when selecting measures; evaluation experts should be always included selecting measures and projects.
- The number of measures per city or per partner should be in accordance with the available resources in the organisation, including qualified backup. This applies also to the evaluation team. The backup helps to mitigate the situation in the case of changes in the organisation, the need for additional resources to the measure or if other measures with higher priority take up more resources than planned.

## RTD Fact Sheet Template

<b>TAL 1.1. Alternative fuels</b>	
<b>Reference Measure</b>	1.1 Alternative fuels
<b>Date of Submission</b>	26/06/2012
<b>Date of Review (ISIS)</b>	18/10/2011
<b>Date of Approval</b>	08/2012
<b>Author(s)</b>	Marek Rannala
<b>Editor(s)</b>	Loredana Marmora (by ISIS)

### Context and Purpose

Tallinn Bus Company (TBC) average fuel consumption is ca 10 million litres a year and the use of fossil diesel fuel has negative impact on environment. Considering economic and environmental aspects there is an urgent need to find alternatives to the currently used fuel. European Commission (EC) has set target to have 10% of fuel used in engines to be of biological origin, the share of bio-fuel used for all motor vehicles in Estonia is currently 0%. As bio-fuel powered vehicles for Public Transport (PT) fleet in Tallinn have been used only marginally in past, it is necessary to survey and investigate prospects, potential and sustainability of bio-fuel implementation on bigger scale. The measure is intended mainly for internal use in Tallinn Bus Company.

In the early phase of the project it was decided not to implement the measure physically but to concentrate instead on finding out possibilities for implementing bio-fuels inside the scope of the measure.

### Description of RTD Activity

The decision of not physically implementing the fuels was made in the inception phase of the measure. It was decided to conduct a research to create knowledge on legal, technical and other aspects of using Bio-fuels. The first part of the research made by Tallinn University of Technology (TUT) in 2010 was aimed at legislation. The research consisted of:

- study on different types of fuel, advantages and disadvantages;
- legal expertise on the implementation of bio-fuels in the Estonian legal environment with references to European legislation,
- study on actual legislation regulating bio-fuels and implementation of bio-fuels;
- study on actual legislative risks and problems of implementation bio-fuels in Tallinn and Estonia;

The second part of the research conducted by the Stockholm Environmental Institute Tallinn centre (SEI) continued with evaluation of possible impacts connected to alternative fuels: technical, socio-economical and environmental. Besides bio-diesel and bio-ethanol, diesel-electric hybrid buses were also analyzed for comparison. The second study was conducted between December 2011 and March 2012.

### Outputs and Results

Conclusions from the research of TUT:

- there are several suitable types of alternative fuels for using in Tallinn PT (most of them bio-fuels), each with own advantages and disadvantages in local climate;
- there is comprehensive amount of Estonian regulations for implementing alternative fuels;
- there are no legal restrictions foreseen preventing implementation of alternative fuels and there is no direct need for amendments in legislation;

- it is important to check the vehicle manufacturer's terms of guarantee before implementing alternative fuels;
- it is important to avoid rise of cost for PT service because of alternative fuels.

Conclusions from the research of SEI:

- liquid biofuels do not have excise exemption in Estonia and the principles of fuel taxation are currently changing in EU;
- the effect of biodiesel and bioethanol on the air quality is comparable with the results of fossil diesel on EURO6 technology based buses;
- environmental and social impacts (including indirect impacts) of biodiesel and bioethanol are not always lower than with fossil fuels;
- currently there is no production nor sales of sustainably produced alternative fuels in Estonia;
- the cost of reducing CO<sub>2</sub> emission of PT with studied alternative fuel types is very high and is higher than the achievable reduction effect;

Preliminary results from the SEI study were discussed on a workshop with stakeholders from the TBC, TUT, Tallinn Transportation and Environmental departments. The final results and the study from TUT were presented on 21.06.2012 on a workshop with widened range of stakeholders, including deputy mayors, municipal officials and representatives from the Ministry of Economic Affairs and Communications and the Ministry of the Environment.

## Resulting Decision-making

As it was decided not to physically implement the alternative fuels in the scope of the measure, the research did not influence any decisions in the scope of the measure. However it will certainly affect future decisions on implementing alternative fuels in Tallinn PT.

## Lessons Learnt

The main insights from the first part of the research came from the European examples in the field. There might be no direct obstructions to implementing alternative fuels but problems may arise in some time after implementation. The main concern is relative legal instability in this field which does not support making long-term strategic decisions. The research brought out a case example from European Court in Germany (Plantanol GmbH & Co. KG Versus Hauptzollamt Darmstadt, 10.09.2009), where bio-fuel was mixed with fossil fuel by the local company and European regulations turned out to be contradictory in interpretation of how this kind of mixture or parts of the mixture should be taxed.

The second study brought understanding that the technological approach (using bio-fuels) to reduce the environmental impact of PT is not the most efficient. The emission reduction effect for air quality is similar with newer technology (EURO5 and EURO6) buses and the effect for global CO<sub>2</sub> emissions has very high cost. PT is only a minor emission contributor compared to the whole transportation system and therefore the whole system (including the whole mobility range and land use planning) should be addressed for improving the situation and other possible measures should be compared with PT alternative fuels for impact economic efficiency. The PT operating costs would be 60% higher with biodiesel and 50% higher with bioethanol and 10% higher with diesel-electric hybrid bus and fossil diesel. For partial implementation of bio-fuels in the whole transportation PT has an important role to play: testing and creating a critical mass of users. A prerequisite for using bio-fuels was found to be starting of large scale alternative fuel production in Estonia.

## Cost-effectiveness

The effect of the RTD activity was evaluated with a survey with stakeholders on two workshops asking their awareness and attitudes before and after the introduction of the study results. The results of the survey are presented in the Measure results template.

## Dissemination and Exploitation

Dissemination of the RTD activity results consisted of 2 workshops aimed at local (Estonian) stakeholders who can benefit from the research. The results are also used for specifying state and local level transport development plans.