The BEST experiences with Bioethanol Cars

– BEST WP1 Cars Final report

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BEST deals with the introduction and market penetration of bioethanol as a vehicle fuel, and the introduction and wider use of flexible fuel vehicles and bioethanol cars on the market.

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# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>7</td>
</tr>
<tr>
<td>Summary</td>
<td>9</td>
</tr>
<tr>
<td>Introduction</td>
<td>11</td>
</tr>
<tr>
<td>The BEST objectives: WP1 Cars</td>
<td>13</td>
</tr>
<tr>
<td>What are flexifuel vehicles and E85?</td>
<td>13</td>
</tr>
<tr>
<td>What can flexifuel vehicles and E85 offer?</td>
<td>13</td>
</tr>
<tr>
<td>Implementation of WP1 tasks 1-2</td>
<td>14</td>
</tr>
<tr>
<td>Task 1 – city/regional car fleets</td>
<td>14</td>
</tr>
<tr>
<td>Task 2 - private car fleets</td>
<td>15</td>
</tr>
<tr>
<td>Assessing market development during BEST</td>
<td>16</td>
</tr>
<tr>
<td>The “S-Curve”</td>
<td>16</td>
</tr>
<tr>
<td>State of market before BEST</td>
<td>17</td>
</tr>
<tr>
<td>European policies influencing BEST</td>
<td>18</td>
</tr>
<tr>
<td>BEST targets for WP1</td>
<td>18</td>
</tr>
<tr>
<td>Observed market developments</td>
<td>19</td>
</tr>
<tr>
<td>Total number of FFVs in the EU</td>
<td>19</td>
</tr>
<tr>
<td>Total number of FFVs at BEST sites</td>
<td>22</td>
</tr>
<tr>
<td>Case studies: developments at the sites</td>
<td>23</td>
</tr>
<tr>
<td>Case study: incentives in Stockholm</td>
<td>23</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>23</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>23</td>
</tr>
<tr>
<td>Assessing market development in Stockholm</td>
<td>25</td>
</tr>
<tr>
<td>Conclusions on the Stockholm experience</td>
<td>28</td>
</tr>
<tr>
<td>Biofuel Region: change is possible!</td>
<td>29</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>29</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>30</td>
</tr>
<tr>
<td>Rotterdam: sales grow in the absence of major incentives</td>
<td>31</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>31</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>31</td>
</tr>
<tr>
<td>Madrid: searching for long terms solutions to improve air quality</td>
<td>32</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>32</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>33</td>
</tr>
<tr>
<td>Basque Country: bioethanol central to regional energy planning</td>
<td>34</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>34</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>34</td>
</tr>
<tr>
<td>Brandenburg: local economic development a key priority</td>
<td>37</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>37</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>37</td>
</tr>
<tr>
<td>La Spezia: fuel prices restrict progress</td>
<td>38</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>38</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>39</td>
</tr>
<tr>
<td>Nanyang: a good start in China</td>
<td>39</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>39</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>40</td>
</tr>
<tr>
<td>Somerset: small steps in challenging circumstances</td>
<td>41</td>
</tr>
<tr>
<td>Situation prior to BEST</td>
<td>41</td>
</tr>
<tr>
<td>Activities during BEST</td>
<td>41</td>
</tr>
<tr>
<td>São Paulo, Brazil</td>
<td>43</td>
</tr>
<tr>
<td>Attitudes: drivers and fleet managers</td>
<td>44</td>
</tr>
<tr>
<td>Drivers report positive experiences</td>
<td>44</td>
</tr>
<tr>
<td>Fleet managers</td>
<td>45</td>
</tr>
<tr>
<td>Conclusions and recommendations</td>
<td>46</td>
</tr>
<tr>
<td>The BEST manufacturers’ perspective</td>
<td>47</td>
</tr>
<tr>
<td>Economic issues</td>
<td>48</td>
</tr>
<tr>
<td>Vehicle costs</td>
<td>48</td>
</tr>
</tbody>
</table>
Preface

The project BEST, Bioethanol for Sustainable Transport, focuses on the introduction and market penetration of bioethanol as a vehicle fuel, and the introduction and wider use of bioethanol cars and buses.

During the project more than 77,000 bioethanol cars and 138 bioethanol buses have been introduced, demonstrated and evaluated. Fuel stations for E85 and ED95 fuel have opened. Low blends with petrol and diesel have been developed and tested.

Through BEST, the participating cities and regions aimed to prepare a market breakthrough for bioethanol vehicles and bioethanol. Another objective was to inspire others to follow. During the project several incentives promoting bioethanol cars and buses and bioethanol fuels have been introduced locally and in some cases at the national level. Some of the sites faced barriers to the introduction of bioethanol in the beginning of the project and in certain locations these are still not solved. The barriers have mainly been taxation and regulation issues.

The participating cities/regions are: Biofuel Region (SE), Brandenburg (DE), Somerset(UK), Rotterdam (NL), Basque Country and Madrid (ES), La Spezia (IT) Nanyang (China) São Paulo (Brazil) Co-ordinating City is Stockholm (SE).

The project is co-financed by the European Commission within the 6th framework; Sustainable Energy Systems/Alternative Motor Fuels: Biofuel Cities.

The project started in January 2006 and will continue to the end of 2009.

The work in the BEST project is split into 9 work-packages (WPs):

- WP1 - Cars
- WP2 - Buses
- WP3 - Low Blends
- WP4 - Distribution
- WP5 - Incentives
- WP6 - Coordination
- WP7 - Marketing and Dissemination
- WP8 – Transfer of knowledge
- WP9 - Evaluation

This report gives detailed information about all the work conducted within WP1 - Cars in the BEST project. Similar reports are compiled for all WPs except WP6. In the end of the project a Policy Report summarizing the results from the whole project will be published. Please refer to www.best-europe.org to find all reports from the project.

This report was written by Eva Sunnerstedt, WP1 Coordinator for the City of Stockholm and Paul Fenton, WSP Analys & Strategi in Stockholm.

Stockholm in November 2009.

Gustaf Landahl     Eva Sunnerstedt
BEST Co-ordinator    BEST Stockholm
Environment and Health Administration    Environment and Health Administration
City of Stockholm    City of Stockholm
Summary

This report highlights “The BEST experiences with Bioethanol Cars”. The report contains the results of WP1 Cars, which comprised six tasks focusing on:

1&2 introduction of bioethanol cars to city/regional and private car fleets
3 conversion of conventional vehicles to run on bioethanol
4 use of test fleets
5 testing of bioethanol electric hybrid vehicles
6 training of car dealers and service staff.

The results of these tasks have been analysed, in contrast to the original objectives of BEST and with reference to the contextual factors that affected the implementation of the tasks. This includes assessment of observed market developments, user attitudes, problems and opportunities that enable or hinder introduction of bioethanol cars, economic factors, and sustainability. The major findings are:

- Flexifuel vehicles and E85 can contribute towards a diversified fuel mix and help the EU meet its targets for alternative fuels. In the short-medium term, flexifuel vehicles can ease the transition to a cleaner vehicle fleet.
- Flexifuel vehicles and bioethanol fuels work very well at all sites and are appreciated by fleet managers and drivers.
- Flexifuel vehicles are energy efficient. Manufacturers tend to state that the fuel consumption therefore is 30-40% higher when driving on E85. However, within the BEST project flexifuel vehicles consume less fuel than previously thought – in the best case only 1.14 times more E85 than petrol was necessary. The evaluations carried out within the BEST project suggest that the energy efficiency of running on E85 may be between 1-26% higher than running on petrol. This is considered to be an important area for future research.
- Fuel price determines whether consumers fuel use bioethanol or fossil fuels – a competitive price per kilometre for bioethanol compared to fossil fuels is essential to market development
- It is possible for a city to influence the market spread of clean cars.
- Conventional petrol cars can be converted to flexifuel vehicles without impact on performance. Swedish legislation for this process could be transferred to other Member States.
- Conversion of diesel cars to run on ED95 is possible but requires further research and development to overcome start problems and corrosion of some components.
- Sustainable transport fuels are needed – standards and certification for biofuels are being developed and well-to-wheel analysis of all fuels is important to advance knowledge
- Initial results suggest Hybrid Electric Vehicles running on bioethanol blends such as E25 offer significant potential to reduce fuel consumption and emissions.
- Effective training of sales and maintenance staff can ease market introduction.
- Safety is a key issue – regulations can be developed at an early stage for technical safety issues such as fuel management, leakages, etc.

During 2008, almost 79,000 flexifuel vehicles were sold in the EU, contributing to a total fleet of over 170,000 flexifuel vehicles. Vehicles operating at the BEST sites represent approximately 45 % of this total. By June 2009, a total of 77,000 flexifuel cars have been introduced at nine BEST sites, far exceeding the project’s original aim to introduce 10,000 cars. Over 1,700 E85 pumps are in operation in BEST countries and over 2,200 in the EU.

Recommendations to policy-makers and guidance to other cities interesting in working with flexifuel cars are also presented in the report, as well as reference materials including clean vehicle definitions, safety requirements and a summary of conversion legislation.
Introduction

The purpose of the BEST project is to initiate a lasting development of bioethanol fuel all over Europe and to demonstrate the prerequisites for a market breakthrough for bioethanol-fuelled vehicles. Therefore, the BEST sites work for the introduction of vehicles and distribution lines combined with targeted information campaigns. This work is followed-up by studies on, for example, effects of different kinds of local, regional and national incentives.

This report investigates the activities, results and impacts of Work Package 1 of the BEST project. WP1-Cars. WP1 Cars aimed for wide-scale demonstration of flexifuel cars from at least two vehicle manufacturers in municipal fleets and on the city markets.

The report is structured in the following way:

- Description of flexifuel vehicles (FFVs) and the reasons for starting BEST.
- Analysis of the implementation of WP1-Cars tasks 1-2. These tasks concerned: Introduction of flexifuel vehicles to (1) city/regional car fleets and (2) private car fleets.
- Description of market development theory informing BEST and the state of the market prior to the project.
- Overview of observed market developments during BEST in the EU and detailed case studies on sites participating in WP1-Cars.
- Results of driver and fleet managers surveys.
- Assessment of economic issues linked to flexifuel vehicles and E85, such as vehicle costs, fuel prices and energy consumption, taxation of fuel and incentives.
- Analysis of technical results from tasks 1-2.
- Analysis of the implementation of WP1-Cars tasks 3-6. These tasks concerned: (3) conversion of conventional cars to run on bioethanol; experiences from (4) the BEST Test fleets and with (5) electric hybrid FFV cars; (6) Training of car dealers and service staff.
- Problems and opportunities highlighted by WP1-Cars.
- Discussion of sustainability issues linked to use of bioethanol in BEST.
- Conclusions and Recommendations.

Throughout the report, the achievements of WP1-Cars are assessed in comparison to the original objectives of BEST, as well as in terms of the contribution the project made (e.g. reduction of greenhouse gases).

The report also includes assessment of whether flexifuel vehicles are a viable transport solution with potential for future development, and which issues – such as costs, taxes, incentives, standards, sustainability – must be considered when formulating policies for flexifuel vehicles and bioethanol.
The BEST objectives: WP1 Cars

The BEST project aimed to study market development of bioethanol in different locations by facilitating introduction of vehicles and infrastructure, carrying out support measures such as training and dissemination, and conducting thorough analysis of bioethanol performance as a fuel, both from technical and environmental perspectives.

What are flexifuel vehicles and E85?

The main focus of WP1 Cars was the introduction of flexifuel vehicles running on E85.

**Flexifuel vehicles** are cars with an internal combustion engine that is designed to run on petrol plus an alternative fuel such as bioethanol. Bioethanol is more corrosive than petrol, so non-corrosive materials are introduced to some components of the engine. Fuel injection and spark timing is adjusted automatically by electronic sensors, meaning the cars can burn any blend of bioethanol and petrol – meaning the cars are “flexible”.

**E85** is a fuel blend used by flexifuel cars. E85 is a fuel blend of 85% anhydrous bioethanol and 15% petrol, which is used primarily for ignition. During winter, colder countries may use winter blends, increasing the volume of petrol, to maintain the fuel’s performance at extreme temperatures. This has no significant effect on vehicle performance as the vehicle is “flexible”, but slightly increases emissions of both controlled emissions and carbon dioxide compared to driving in summer (due to the higher petrol content).

Bioethanol has lower energy content than petrol and manufacturers of FFVs usually inform consumers that the cars consume up to 30-40% more fuel than conventional petrol cars. However, the measurements and evaluations carried out within the BEST project suggest that this is an overstatement and that the actual consumption rate of FFVs is lower – in the best case only 1.14 times more E85 than petrol was required. Moreover, the evaluations carried out within the BEST project suggest that the energy efficiency of running on E85 may be between 1-26% higher than running on petrol. This represents a significant finding, further described in this report in the section on “Technical Performance of the BEST cars”.

Distribution of E85 can take place at dedicated fuel pumps or so-called “flexifuel pumps”, which utilise two tanks (one for petrol, one for E85) to supply petrol, E85 or different blends of bioethanol such as E10. Issues relating to filling stations are discussed at different points throughout this report. For example, requirements that filling stations offer alternative fuels have been shown to be an effective instrument. Regulations and safety issues are also presented in the report and as Appendices.

What can flexifuel vehicles and E85 offer?

Flexifuel vehicles running on E85 can make a significant contribution towards the achievement of EU climate targets whilst supporting economic development in agriculture. Energy security and the resilience of transportation and the economy will be increased by diversifying the range of fuels on offer in the EU.

E85 is a liquid fuel that can be used in dedicated or converted flexifuel vehicles, making it an ideal fuel type for a transport system based on the supply of liquid fuels. As flexifuel vehicles can operate on blend of bioethanol and petrol, they are appropriate during the transition to a new transport system as users can change their fuel choice according to the availability of fuel.

Depending on how bioethanol is produced, use of E85 in converted vehicles can significantly reduce emissions of carbon dioxide (CO2). Nitrogen oxide emissions (NOx) will decrease and emissions of carbon monoxide (CO) and hydrocarbons (HC) will be dramatically reduced, as 70% of CO and HC emissions from bioethanol are non-fossil. Moreover, hydrocarbon (HC) emissions from bioethanol are less dangerous than HC emissions from fossil fuels, as emitted gas comprises non-combusted alcohol.
Implementation of WP1 tasks 1-2

There were six tasks in WP1-Cars, each involving different sites. The City of Stockholm was responsible for coordinating activities within these tasks and facilitating cooperation between partners. Tasks 1 and 2 concerned the introduction of flexifuel vehicles to city/regional and private car fleets.

The objectives, implementation and outcomes are described in the following sections. This includes a description of market theory informing BEST and the state of the market prior to the project, as well as an assessment of project results and case studies on each site. The results of driver and fleet manager evaluations and information on economic factors relating to FFVs and E85 are included.

Technical results linked to tasks 1 and 2 are assessed prior to the presentation of activities and results of tasks 3-6.

Task 1 – city/regional car fleets

Participating sites: Stockholm, Biofuel Region, Rotterdam, Somerset, Basque Country, Nanyang, Madrid, La Spezia

Objectives: This task aimed to stimulate public procurement of FFVs, enabling progressive replacement of conventional vehicles at the eight participating sites. These sites have demonstrated FFVs under different conditions (climate, traffic, topography, etc) and for different types of activity (private transport, public transport, waste collection, home service, etc). This has enabled comparisons of technical performance, practical use and user acceptance to be made.

Information, education and training of personnel have taken place to ensure that high percentages of bioethanol are fuelled in the vehicles. Saab and Ford have offered vehicles to each site at a discounted price, in order to accelerate demonstration and market penetration of the flexifuel vehicles.

Implementation: implementation of the task has at times been challenging, not least because public bodies are complex organisations and political decisions may be required to stimulate action. Inter-departmental relations may also slow or limit introductions of new technologies or methods, as might uncertainty over the requirements or stipulations of public procurement legislation. Divergence between local and national targets, as was observed in Nanyang, can also impede the speed of introduction.

Outcomes: Notwithstanding these difficulties, eight BEST sites succeeded in purchasing a total of 1,005 FFVs for use in publicly-owned fleets during months 1-42. 202 of these vehicles received funding from the EU and 803 were purchased without EU support. These fleets are using FFVs under different conditions, demonstrating their potential for wider utility, both within the site and if transferred to other locations.

The vehicles also play an important role in spreading knowledge about FFVs to society and building confidence in the technology. It is perhaps no coincidence that the sites with the largest numbers of publicly-operated FFVs are also the sites with the largest numbers of privately operated FFVs.

This shows that the public and private markets interact and overlap. Infrastructure developments are required by and benefit both groups, meaning it is essential to address the issue of filling stations in parallel with attempts to introduce cars to public and private fleets. Publicly-owned vehicles may enter the private market in resale.

Information on factors such as fuel consumption, displacement of fossil fuels, emissions, maintenance, etc, can be found in the section “Technical performance of the BEST cars”.

14
**Task 2 - private car fleets**

**Participating sites:** Stockholm, Biofuel Region, Rotterdam, Somerset, Madrid, La Spezia, Brandenburg

**Objectives:** This task aimed to stimulate procurement of FFVs by private fleets and private individuals. Company cars account for a significant proportion of the resale market, meaning the purchasing decisions of companies impact directly upon the overall composition of fleets in cities and nations.

**Implementation:** FFVs have been demonstrated in private company fleets at several sites. Evaluation of mileage, bioethanol fuel consumption and driver attitudes have taken place. Consumer feedback has been gathered where possible. As in Task 1, Saab and Ford have offered vehicles to each site at a discounted price, in order to accelerate demonstration and market penetration of the flexifuel vehicles.

By June 2009, at least 76,200 FFVs had been purchased for use in private fleets and private individuals at five BEST sites and the original targets for the project have been comfortably surpassed. However, sales activity has been concentrated in four sites: Rotterdam, Madrid, Biofuel Region and Stockholm, where Ford and Saab focused their activities and a partial market breakthrough has been achieved. In these locations, different combinations of incentives, infrastructure developments and other factors helped to stimulate FFV sales. The price of fuel has been shown to be a key driver of E85 fuel and car sales.

The lack of activity at other sites testifies to the complexity of this process and suggests that influencing purchasing decisions may be partly dependent on other factors. For example, if doubts exist about fuel cost or there are no guarantees about fuel supply, private companies are unlikely to invest.

In such circumstances, action by public bodies may be required to build confidence among private purchasers and inspire them to follow suit. This may include introduction of incentives to stimulate the market, though it is worth noting that the largest private fleets in BEST are located at those sites where significant public purchases of FFVs took place in the very early stages. Joint procurement is another tool that can be used, though it has not been specifically addressed within BEST.

**Outcomes:** Overall, the achievements in task 2 have been outstanding. The BEST project aimed for a total of demonstration of 10,000 FFVs – in this task alone, over 77,000 vehicles have been demonstrated. Again, this highlights the potential of FFVs to other actors in the sites and beyond and contributes towards growing confidence in E85 and FFVs.

Information on factors such as fuel consumption, displacement of fossil fuels, emissions, maintenance, etc, can be found in the section “Technical performance of the BEST cars”.

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Information on results and lessons learnt in Tasks 1-2 is contained in the following sections on market development, case studies, user analysis, economic issues and technical performance. Following this, detailed analysis of Tasks 3-6 is included in the report.
Assessing market development during BEST

In order to assess market development during the implementation of the BEST project, various illustrations showing models for introductions of new technologies were proposed. These development models have informed the project and provide interesting points of reference when studying the results of BEST.

The “S-Curve”

The S-curve describes the development of markets for many new technologies, including computers and mobile phones. When new technologies are first introduced to the market, most consumers are reluctant to purchase them. The product is considered too unusual, or unproven. The market is dominated by so-called “early adopters” which are buyers with a special interest in new technologies or in the particular qualities of a specific technology (such as lower environmental impact).

Over time, as the volume of products in the market increases, new suppliers enter the market and the technology continues to develop. Market barriers including high purchase price, missing information or perceived shortcomings in quality diminish and demand increases, prompting producers to add new models to the market.

When the new product has reached wider availability and the market has reached a so-called “acceptance level” or critical mass, mainstream consumers begin to be interested in it. Having reached this level of wider acceptance, market share begins to increase rapidly until it reaches a maximum penetration and is considered a mature product offering.

As the BEST project aimed to study market development, it is important to assess whether development up an “S-Curve” can be observed at BEST sites, or whether other processes are underway. Three alternative models of market development are proposed as variants on the “S-Curve” – the market with “extended diffusion time”, the “undersized” market and the “instable” market.

In Figure 2, the “S-Curve” is shown in model a) “successful development”. After a slow start, sales of the technology accelerate rapidly until it achieves a stable and self-sustaining share of the market. In
model b) “extended diffusion time”, achieving a functional market is harder than in model a). The same result is achieved, albeit with a longer initial phase. Nonetheless, the introduction of the new technology does eventually succeed.

In contrast, model c) “undersized” shows a market which promised to develop fully but fails to maximise its potential market share. This could occur for any number of reasons, but model c) is at least partially successful, compared to model d) “instable”. This market begins to develop but, no sooner than growth develops than it tails off. The market may then collapse, may be subject to peaks and troughs, but it is unclear whether it will ever fully develop.

It should be stated that these models are not predictive, but can be used to identify target groups of particular policies or initiatives. A thorough analysis of these models can be found in the report “Promoting Clean Cars” (D5.12). This report attempts to analyse developments in Stockholm and Sweden and draw general conclusions about the contribution of different incentives introduced.

**State of market before BEST**

Prior to BEST, a total of around 7,000 flexifuel (FFV) cars had been sold in Europe and almost all of these vehicles had been purchased in Sweden. However – as shown in Figure 3 below - in 2005 there were a total of 195.7 million passenger cars in operation in the EU15, plus a further 28.6 million other vehicles in the EU15 vehicle fleet. 7,000 flexifuel vehicles represented, quite literally, a drop in the ocean!
Elsewhere, a self-sustaining market was established in Brazil over the three decades since the Brazilian Government launched its PROALCOOL programme in 1975. A large proportion of the 24 million vehicles operating in Brazil are FFVs. Brazil is currently the seventh largest automotive producer on the world market, producing close to 3 million vehicles in 2007 (4.1% world production). Almost 2.4 million of these vehicles were cars produced by ten manufacturers, including an astonishing 1,719,667 flexifuel vehicles – 71.9% of all cars produced in Brazil in 2007!

1,975,518 cars were registered in Brazil in 2007 and 90.6% of these were flexifuel vehicles. Of these 1,780,876 FFVs, 655,440 were registered in the State of São Paulo, where the BEST site is located. São Paulo is a major production and sales hub for the car industry. 11 out of 27 car production facilities in Brazil are based in the State of São Paulo, accounting for 43.7% of assembled cars in 2007. Almost 28% of car dealers in Brazil are located in the State of São Paulo.

**European policies influencing BEST**

On the policy level, the European Commission had supported technical development of alternative fuels for transport through a range of programmes, such as THERMIE and GROWTH&ENERGIE. Development, testing and introduction of dedicated and flexifuel biofuel vehicles took place, but limited progress had been made in developing and establishing functioning markets.

The Biofuel Directive (2003/30/EC) established targets for the large-scale introduction of biofuels in the EU, rising from 2% in 2005 to 5.75% in 2010 and 20% for alternative fuels in 2020. Increasing the production and consumption of sustainable biofuels will represent a major contribution towards EU climate targets. It was clear that, to achieve this goal, use of high-blend biofuels must be scaled up, and the BEST project was established as a mechanism to introduce and demonstrate clean vehicles and fuels.

The proposal for the Renewable Energy Directive includes proposed regulations or criteria for what fuel shall be interpreted as a biofuel that can be included in the targets for the directive. This work together with the media debate in Europe, regarding the fuel versus fuel and the discussion of the actual sustainability of biofuels, has been very influencing on BEST.

**BEST targets for WP1**

WP1 Cars aimed to demonstrate 10,000 flexifuel cars from at least two vehicle manufacturers in municipal fleets and on the city markets at nine sites, thereby aiming to more than double the existing EU FFV fleet. 164 of these vehicles would receive EU funding. A further seven vehicles would be demonstrated – (funded) 3 converted petrol vehicles, 1 converted diesel vehicle and (non-funded) three hybrid electric vehicles.
Observed market developments

When BEST was launched, there were around 7,000 flexifuel vehicles operating in Europe and most of these had been purchased in Sweden. The sites were at different stages of development. Regarding bioethanol, certain sites had experience with different blends and operated flexifuel vehicles in city and private fleets, whereas others were making their first attempts to introduce both vehicles and fuels. Several sites had detailed clean vehicle strategies whilst others entered BEST with a strong interest and a need to take the first steps.

Therefore, from day one, the needs and aspirations of sites have been different. The differing starting points of the sites were reflected in the objectives and targets set by the project. Detailed information outlining the baseline conditions at each site can be found in the BEST Sustainability report (D9.11 and D.9.15).

Total number of FFVs in the EU

During 2008, almost 79,000 flexifuel vehicles were sold in the EU, contributing to a total fleet of over 170,000 registered flexifuel vehicles. Vehicles operating at the BEST sites represent approximately 45 % of this total. A total of 77,000 flexifuel cars have been introduced at nine BEST sites, far exceeding the project’s original aim to introduce 10,000 cars.

Table 1 shows the breakdown of FFV sales in the EU during 2008. Almost 75 % of FFV sales took place in Sweden, reflecting the pattern within BEST and emphasizing the speed of market development in the country, which perhaps is a consequence of the more advanced state of the Swedish market prior to BEST. The countries with the next largest totals for FFV sales were Germany,
the Netherlands, France and Ireland respectively. This data was provided by General Motors from internal MIS database and may contain inaccuracies or discrepancies. However, the overall trends indicated by the data appear similar to those observed by the BEST partners.

Across Europe, the market for FFVs and high blend bioethanol fuels is growing. Table 1 also shows the total number of installed E85 pumps and FFVs in operation. Considering the fact that, when the BEST project was launched, several of these countries had neither installed E85 distribution capacity nor operational FFVs, it is tempting to draw the conclusion that the project has directly influenced these developments.

This may be an overstatement, as a wide range of other factors – such as EU and national biofuel directives – have influenced the trend, but there is an element of truth in the assumption. By demonstrating FFVs on a large scale and by spreading information about the qualities of bioethanol, BEST has undoubtedly boosted market development in the EU, directly in the participating sites and their countries and indirectly in Europe as a whole.

For example, BEST has inspired the development of emerging markets for FFVs and E85 in France and Ireland. France adopted strategies from Swedish and is committed to E85 production, which offers significant economic opportunities to the French agricultural sector. Likewise, Ireland is also interested in local production and has adopted many of the approaches recommended by BEST.

As the market for FFVs has grown, the range of manufacturers offering models on the EU market has expanded. When BEST launched, the only FFV model available (outside of Sweden) was the Ford Focus. Today, a wide range of manufacturers offer a great number of models on the EU market. However, the availability of these brands varies considerably within the EU.

Moreover, there are a range of further FFV models available on the Brazilian and US markets that are unavailable in the EU due to company strategies and other factors, such as import regulations. As the FFV market grows, it is likely that more of these models will become available in the EU.
<table>
<thead>
<tr>
<th>Country</th>
<th>FFV units sold in 2008&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Approx. FFV fleet size&lt;sup&gt;2&lt;/sup&gt;</th>
<th>No of E85 pumps (April 2009)&lt;sup&gt;3&lt;/sup&gt;</th>
<th>Available FFV brands&lt;sup&gt;4&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>503</td>
<td>13</td>
<td></td>
<td>Ford, Renault, Saab, Volvo</td>
</tr>
<tr>
<td>Belgium &amp; Luxembourg</td>
<td>198</td>
<td>3</td>
<td></td>
<td>Saab, Volvo</td>
</tr>
<tr>
<td>Denmark</td>
<td>82</td>
<td></td>
<td></td>
<td>Ford, Saab</td>
</tr>
<tr>
<td>Estonia</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>3 178</td>
<td>7,000</td>
<td>305</td>
<td>Cadillac, Citroen, Dacia, Ford, Hummer, Jeep, Lotus, Peugeot, Renault, Saab, Volvo</td>
</tr>
<tr>
<td>Germany</td>
<td>5 694</td>
<td>10,000</td>
<td>255</td>
<td>Ford, Saab, Skoda, Volvo</td>
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<tr>
<td>Hungary</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>2 730</td>
<td>7,000</td>
<td>31</td>
<td>Citroen, Ford, Renault, Saab, Volvo</td>
</tr>
<tr>
<td>Italy</td>
<td>96</td>
<td>150</td>
<td>1</td>
<td>Ford, Saab, Volvo</td>
</tr>
<tr>
<td>Latvia</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>3 679</td>
<td>6,000</td>
<td>29</td>
<td>Cadillac, Chrysler, Citroen, Dodge, Ford, Hummer, Mitsubishi, Peugeot, Saab, Volvo</td>
</tr>
<tr>
<td>Norway</td>
<td>452</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>1 546</td>
<td>4,500</td>
<td>15</td>
<td>Citroen, Ford, Peugeot, Renault, Saab, Volvo</td>
</tr>
<tr>
<td>Sweden</td>
<td>59 066</td>
<td>130,000</td>
<td>1440</td>
<td>Audi, Cadillac, Chevrolet (NAV), Chrysler, Citroen, Dacia, Ford, GM (NAV), Mitsubishi, Nissan, Peugeot, Renault, Saab, Seat, Skoda, Volvo VW</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1 191</td>
<td>5,000</td>
<td>62</td>
<td>Cadillac, Chevrolet (NAV), Chrysler, Citroen, Ford, GM (NAV), Renault, Saab, Volvo</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>452</td>
<td>2,000</td>
<td>21</td>
<td>Citroen, Ford, Renault, Saab, Volvo</td>
</tr>
<tr>
<td><strong>Total Europe</strong></td>
<td><strong>78 901</strong></td>
<td><strong>2,000</strong></td>
<td><strong>21</strong></td>
<td><strong>Audi, Cadillac, Chevrolet (NAV), Chrysler, Citroen, Dacia, Dodge, Ford, GM (NAV), Hummer, Jeep, Lotus, Mitsubishi, Nissan, Peugeot, Renault, Saab, Seat, Skoda, Volvo VW</strong></td>
</tr>
</tbody>
</table>

Table 1: Sales of FFVs in 2008 by country and as a percentage of the EU total; FFV fleet sizes and number of E85 pumps in operation in selected countries. Source: GM internal database and information provided by Ford and Saab for D1.4. Number of ethanol vehicles (E85) sold and prognosis for the coming year, Swedish search engine of E85 filling stations in Europe - [http://www.korridor.se/aryan/acadiane/E85/stationsadmin/stations_search.phtml](http://www.korridor.se/aryan/acadiane/E85/stationsadmin/stations_search.phtml)

<sup>1</sup> Based in information from a GM internal database and BEST D1.04. Number of ethanol vehicles sold and prognosis for coming year, (2009).
<sup>2</sup> Compilation by BEST WP1 leader Eva Sunnerstedt with input from BEST sites and several national stakeholders
<sup>3</sup> [www.korridor.se/aryan/acadiane/E85/stationsadmin/stations_search.phtml](http://www.korridor.se/aryan/acadiane/E85/stationsadmin/stations_search.phtml)
<sup>4</sup> Compilation by BEST WP1 leader Eva Sunnerstedt with input from BEST sites and several national stakeholders
Total number of FFVs at BEST sites

At the site level, the achievements are substantial but vary in scale, as each site started with different levels of development and had different expectations and objectives.

As Figure 5 shows, by June 2009, the nine sites had succeeded in introducing a total of over 77,000 flexifuel vehicles far exceeding the project’s original aim to introduce 10,000 cars. A total of 205 vehicles received EU funding during months 1-36 (202 public, 3 private). At four sites – Stockholm, Biofuel Region, Rotterdam and Madrid – there are signs that flexifuel vehicles have partially or fully penetrated the market.

![M48 targets vs. total FFVs introduced M1-42 per site](image)

Figure 5: This figure shows the number of flexifuel vehicles in operation per site as of 30 June 2009 (blue) compared with the objectives at the beginning of BEST (yellow). For Rotterdam the original goal was 955 FFV in Rotterdam region and a spin off effect to the private market of 2 000 in the whole Netherlands. By June 2009, there were 7,270 FFVs in operation in the Rotterdam Region.
Case studies: developments at the sites

In this section, case studies providing more detailed analysis of experiences at selected sites are presented. The purpose of these case studies is to tell the story of how BEST evolved on the ground – what obstacles were encountered and which opportunities arose; how project teams handled different kinds of issues; and which lessons have been learnt as an outcome of participation in BEST.

Case study: incentives in Stockholm

Situation prior to BEST

The Stockholm County in Sweden includes 26 municipalities with a total population of 1.9 million inhabitants. The Environment and Health Administration of the City of Stockholm leads Clean Vehicles in Stockholm and is responsible for coordination of BEST.

As a consequence of previous attempts to introduce clean vehicles and alternative fuels, Stockholm had already established a small market for flexifuel cars. By 2006, Stockholm had the world’s largest bioethanol bus fleet, with around 250 buses. Moreover, a survey indicated that 77% of consumers believed it was easy to purchase clean cars and 28% said they were prepared to buy clean vehicles.

Prior to BEST in year 2005 a total number of 7 000 FFVs has been sold in Europe and almost all of these vehicles had been purchased in Sweden. In 2006, after one year of BEST, a total of 317,798 registered cars were present in the City of Stockholm, of which 6,837 were FFVs. A total of 838,717 vehicles were recorded in the Stockholm County, including 21,400 FFVs. The City of Stockholm set targets to increase the share of clean vehicles in these fleets and a range of incentives were offered.

Stockholm aimed to introduce 100 funded FFVs and 4000 non-funded FFVs within BEST.

<table>
<thead>
<tr>
<th>Clean Vehicles in Stockholm has four aims:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 100% clean vehicles in the city-owned fleet by 2010.</td>
</tr>
<tr>
<td>2) 35% of all new cars sold in Stockholm shall be clean vehicles by 2010.</td>
</tr>
<tr>
<td>3) 8% of fuel consumed in the Stockholm Region shall be renewable by 2010.</td>
</tr>
<tr>
<td>4) 10% of all heavy vehicles shall be clean by 2014.</td>
</tr>
</tbody>
</table>

Box 1: Objectives of Clean Vehicles in Stockholm.

Activities during BEST

Since BEST was launched, a dramatic change has taken place in Stockholm - a developing market in bioethanol and flexifuel vehicles has emerged. Since 2005, there has been a significant increase in sales of alternatively fuelled vehicles. Growth in sales coincides with the launch of various initiatives and introduction of incentives aimed at stimulating use of clean vehicles.

Bioethanol has been tremendously successful because it is a liquid fuel and there are low additional costs for vehicles. Larger filling stations are obliged to offer alternative fuels and, as a liquid fuel which can be easily installed for a fraction of the cost compared to other alternatives (e.g. up to one tenth of the cost of biogas pumps), bioethanol has emerged as the industry choice.

For most of the project period, the price of E85 per kilometre has been competitive and in these periods, sales of E85 have increased dramatically. This has inspired manufacturers, who have released a growing list of FFV models onto the Swedish market. As of April 2009, there were over 30 FFV models on sale. As shown in figure 6 below, the launch of the Ford Focus in 2001 and the Saab Bio-Power model in 2005, together with the Ordinance of Government Purchase - which compelled public bodies to purchase clean vehicles where possible – appears to have stimulated this trend.
Figure 6: Incentives and new Clean Vehicle registrations in Sweden 1994-2004 annual data, October 2004-October 2009 monthly data. Source: Environment and Health Administration, City of Stockholm, Data from General Agents, Statistics Sweden and BilSweden. A large version is included as an Appendix.
The subsequent growth of the flexifuel market can be attributed to a successful combination of policy measures and incentives, extended infrastructure increasing access to fuel supplies, and increasing awareness of the advantages of driving flexifuel vehicles. Influential incentives have included free residential parking in the City of Stockholm (from May 2005) and exemption from congestion charges from January 2006 (on a temporary basis) and August 2007 (on a permanent basis). Moreover, subsidies of €850 (SEK 10,000) were offered by the national government to private buyers of clean cars.

By the end of 2008, almost 40% of all cars sold in Stockholm were clean vehicles (alternatively fuelled vehicles, hybrid electric vehicles or low-CO\textsubscript{2} petrol and diesel vehicles), and the majority of these cars were FFVs. This level was maintained during 2009, despite the removal of the clean vehicle rebate and clean vehicles’ exemption from the congestion charge. In comparison to other European cities, Stockholm has achieved remarkable developments. The experience of Stockholm clearly shows that it is possible for a city to influence the market spread of clean cars.

Assessing market development in Stockholm
The market for flexifuel vehicles resembles the “successful development” model described in ‘Assessing market development during BEST’. After flexifuel vehicles became available, growth in sales has occurred quite rapidly and sales of flexifuel vehicles are close to 20,000 vehicles per year in Stockholm County.
The growth in the clean vehicle market has led to a rapid increase in the Stockholm County clean vehicle fleet, as shown in Figure 9 below.

A similar pattern is evident on the national level. The growth in sales of clean vehicles – and especially flexifuel cars – is reflected by the increased range of consumer choice, as the range of clean car models has increased and diversified amongst brands. The next figure shows that over 90 clean...
vehicle models are now on the Swedish market, with bioethanol and conventional fuel-efficient vehicles accounting for the majority.

Figure 10: Number of clean car models on the Swedish market. Source: Konsumentverket

Consequently, the increasing sale and use of clean vehicles has led to a rapid extension of infrastructure for alternative fuels. The number of filling stations providing E85 or gas has increased dramatically, from below 200 in 2005 to 1300 in 2008. This represents around one third of all filling stations in Sweden. The increase is partly a consequence of the changing market and partly a result of a renewable fuel obligation, introduced in 2006, which compelled filling stations above a certain size to provide alternatives to fossil fuels.
The renewable fuel obligation has the effect of meeting and stimulating demand. This, when combined with the rising number of flexifuel vehicles in Sweden, has led to a rapid increase in sales of E85. However, Figure 12 below makes it clear that increasing ownership of FFVs will not automatically increase E85 sales. In the last month of this chart, November 2008, the price of petrol per kilometre was less than that of E85, causing a dramatic depreciation in E85 sales.

Figure 12: The renewable fuel obligation meets and stimulates demand. This, combined with the rising number of flexifuel vehicles in Sweden, has led to a rapid increase in sales of E85. However, an increased FFV fleet does not automatically increase E85 sales are still intimately linked to price in relation to the price of petrol. For example, a dramatic depreciation in E85 sales occurred in November 2008 when the price of petrol per kilometre was less than that of E85. Sources: BilSweden and The Swedish Transport Agency.

Conclusions on the Stockholm experience
The combination of the Clean Vehicles in Stockholm programme and Government policies have resulted in a more rapid market development than may have otherwise been expected. Monetary incentives have been an important driving force in the latter stages of market development.

An important privilege for drivers of alternatively fuelled vehicles is the exemption from congestion charges in Stockholm. Statistical analyses show that this exemption increased clean vehicle sales in Stockholm County by 23% in 2008.

A recent survey of clean car buyers in the City of Stockholm found that households reported their own environmental impact as the most influential factor when choosing a clean car, with lower operating costs and exemption from congestion charges being highly significant factors.

Company car drivers responded that the lower employee benefit tax assigned to a clean company car is the most influential factor for choosing a clean vehicle. Environmental performance and exemption from congestion charges were highly influential factors for company car drivers. Lower tax, operating costs and exemption from the congestion charge are effective incentives because they offer recurring benefits to drivers choosing clean cars.
Purchase price subsidies are a one time reward affecting capital costs and can have positive and negative side effects. Purchase price subsidies were reported positively by the Swedish media which helped raise awareness about clean cars. At the same time, subsidies require significant amounts of public funds which put pressure on the public budget. Worse, car dealers tended to increase prices by the value of the subsidy.

However, the Swedish clean vehicle subsidy seems to have affected company purchases adversely by capitalising the value of the premium as lower second hand values on low-CO$_2$ cars. Purchase price subsidies reduce capital costs and are suitable in limited cases. Thus, paying subsidies to selected target groups will reduce the risk of market wide side-effects and puts less pressure on public funds.

By the end of 2008 the share of clean vehicles in the Swedish vehicle stock was approximately 5% and 8% in Stockholm. Clean vehicles represent an ever-increasing share of the total vehicle fleet in Sweden and, by October 2008, had developed a market share of 40% of new vehicle sales in Sweden. The majority of these vehicles are FFVs and the market share for clean vehicles has been sustained throughout 2009, despite removal of key incentives and lower fossil fuel prices.

The market share of 5% in Sweden and 8% in Stockholm is significant, where cars in general are kept for a longer time and used for more years than in the United States or most EU Member States. However, the market is far from self-sustaining and our best estimate is that the market for clean cars in Stockholm, and perhaps also in Sweden, has reached the developing market phase or manifests a partial market breakthrough.

Our understanding of the complex dynamic interactions between markets is still at a very early stage and needs to be developed in order to use the S-curve for predictions about when markets reach self-sustaining growth. Nevertheless, the S-curve concept can help policymakers identify target groups and craft incentives appropriate to each type.

The experience of Stockholm clearly shows that it is possible for a city to influence the market spread of clean cars. It is important that the city leads by example, but achieving effects beyond municipal administrations requires co-operation with strategic public and private partners and constructive dialogue with national government authorities. There is a need to work systematically and to have a long run commitment. It is essential to consider what role the municipality can play in influencing supply of both clean vehicles and fuels. It is also important to adapt policies to changing circumstances.

Biofuel Region: change is possible!

Situation prior to BEST

Biofuel Region (BFR) is located in Sweden and includes two counties, Västerbotten and Västernorrland, in which 500,700 people reside across 77,100 km$^2$ territory. 18 out of 22 municipalities in these counties are members of Biofuel Region, together with seven small-medium enterprises and three universities. The National Road Authority and the two County Administration Boards are also affiliated members of the BFR.

No statistics are available from the period prior to BEST. However, at the beginning of 2006 a total of 242,541 cars were registered in BFR, of which 119,551 were in Västerbotten and 122,990 in Västernorrland. Of these, a very small proportion used biofuels – 1,539 cars in BFR, of which 786 were in Västerbotten and 753 in Västernorrland.

BFR had good conditions for market development. Clean vehicles and alternative fuels were increasing their market share in Sweden and a range of national incentives and instruments were being used. Moreover, many actors in BFR were committed to developing local production of sustainable energy sources to boost economic development.
BFR aimed to introduce 2500 non-funded FFVs within BEST.

**Activities during BEST**

Within the BEST project, activities in Biofuel Region focused on three spheres – public actors, private actors in general as well as taxi companies and drivers. An additional task, the conversion of a conventional diesel car to run on ED95, was added during the project and is discussed in Task 3.

Activities within the public sphere focused primarily on introducing FFVs to the fleets of the BFR member municipalities. The Biofuel Region is an organisation comprising 18 member municipalities in Northern Sweden. The members represent 18 of the 22 municipalities in the Västerbotten County.

Private sector activities focused on ‘VIP’ companies with high environmental profiles or commitments, evidence of environmental management systems, etc. The taxi community was given special focus, with taxi companies, drivers, and major customers procuring taxi services the target of communications.

With the exception of the taxi community, where a lack of demand from buyers of taxi services has impeded introduction of FFVs to the sector, results in Biofuel Region have exceeded expectations. The original target of introducing 2500 non-funded FFVs was met early in the project and now more than 5000 FFVs operate in the region.

This development mirrors national trends in Sweden, where incentives and regulations have helped boost uptake of FFVs. However, on the county level, the Biofuel Region shows much stronger results than its neighbouring counties, suggesting that the information campaigns and work within BEST have contributed towards faster market development than may otherwise have been the case.

![Figures 13 (left) and 14 (right) show clean cars as a percentage of total car sales in the different municipalities of Västerbotten during 2007 and 2008. The graphs clearly show large increase in sales of clean cars both in the regional as a whole and in each municipality (Bjurholm was the only municipality to witness a decline).](image)

The problems encountered in Biofuel Region are those common to all sites – the price of E85 compared to fossil fuels directly impacts on consumption and demand for FFVs; and the debate regarding sustainability of biofuels has sometimes been unfair or unhelpful, even if it is essential for future development of sustainable fuels.

In the case of Biofuel Region, negative media has also contrasted starkly with events on the ground, with large numbers of FFVs being sold. Nonetheless, time and effort has been spent on informing citizens of the issue. A notable consequence is that consumers must still be convinced *why* they should buy FFVs and E85 – for many, it is a purely economic decision without broader implications.

A final problem experienced in Biofuel Region relates to fuel supply. In an attempt to ensure supply of alternative fuels, Sweden introduced legislation obliging fuel stations to offer alternatives. For many independent or smaller fuel stations, this places a large financial strain on their businesses. In a rural,
sparsely populated area like Biofuel Region, this can mean that fuel stations close and consumers must travel further to purchase fuel. Biofuels are often blamed for this, resulting in a consumer backlash.

Despite this, E85 is available at around 35-45% of fuel stations in the Biofuel Region, compared to 25-26% in Sweden nationally and far above the European average. The BEST project directly contributed to this development, supporting introduction of 75 pumps in the region, and from 2004-2007, fuel stations installing pumps for E85 were offered 10,000-20,000 litres of free fuel as an incentive.

The experience of the Biofuel Region is positive. Change is possible and there is no need to wait a decade for large-scale introduction of alternative fuels. Bioethanol is a good substitute for fossil fuels and may represent a viable replacement for diesel fuel in heavy transports and cars.

Rotterdam: sales grow in the absence of major incentives

**Situation prior to BEST**

Around 1.1 million people live in the Rotterdam region. Industry and logistics contribute towards significant air quality problems and emissions of greenhouse gases. These problems are enhanced by the region’s location, at the centre of Europe’s industrial heartland.

Rotterdam has ambitious plans to reduce CO$_2$ emission by 50% before 2025, via reuse of waste heat from industry, carbon capture and sequestration and projects directed towards use of clean vehicles and fuels.

The BEST project aimed to contribute towards the strategic climate and environmental goals and the introduction of biofuels to the Netherlands. At the beginning of the project, there were no FFVs in the Netherlands. After twelve months of the BEST project, 35 flexifuel vehicles were in use in the Rotterdam region, but the total number of vehicles operating at the site was approximately 500,000.

Rotterdam aimed to introduce 19 funded FFVs and 2936 non-funded FFVs within BEST.

**Activities during BEST**

For many years, air quality has been a significant problem in the Netherlands and especially the industrial and logistics hub of Rotterdam. Several years ago, the Rotterdam Region - comprising 16 municipalities and the City of Rotterdam - started a project with the objective of achieving sales of 30,000 clean vehicles (all technology types) to private users by the end of 2010. When invited to join the BEST project, the City of Rotterdam saw an opportunity to stimulate the market for FFVs and E85 whilst learning from peers and benefiting from European exchange.

Since joining BEST, Rotterdam has witnessed the birth of a developing market for FFVs in the Netherlands. There were no FFVs in operation when BEST was launched, but by June 2009, there were over 7,200 FFVs in the Netherlands. This is an excellent achievement. Nonetheless, Rotterdam has encountered obstacles along the way and challenges have been dealt with pragmatically.

The failure of the national government to implement a commitment to rescind excise taxes on E85 has been an obstacle which has proven more difficult to overcome. As in several other BEST sites, a great deal of time and effort has been devoted to raising awareness about the potential of bioethanol as a transport fuel. Rotterdam formed a national working group for E85 issues in the Netherlands in which Ford and other stakeholders are participating. The group was adopted by the national working group on Sustainable Energy issues, which is currently chaired by Shell.

This group and local politicians in Rotterdam have informed the national government about the importance of the tax issue. At the policy-making level, all national ministries - with the exception of the Finance Ministry - agree that the excise on E85 should be removed. Nevertheless, the issue has not been resolved.
The refusal of the national government to implement its own commitment on excise appears to contradict some of its own initiatives. For example, the Ministry of Transport introduced a subsidy in 2008 which led to the installation of 69 E85 pumps and 31 natural gas pumps in the Netherlands. Prior to this initiative, there were only a few E85 pumps in the country. In January 2009, a further € 1.8 million subsidy was announced. 13 of the pumps will be in the Rotterdam region.

The City and Region of Rotterdam have also introduced local measures to support market development, such as local subsidy arrangements for fuel pumps and awareness-raising campaigns. This work is possible because of the high level of political engagement from the politicians in Rotterdam (Rotterdam City Hall’s fleet of Chryslers was exchanged for 12 FFV Volvos!).

Nonetheless, both the rising sales of FFVs and expansion of E85 infrastructure appear at odds with the national excise policy. Moreover, it should be noted that E85 sales are not increasing in line with FFV sales. One reason for this is that Ford has been offering an incentive for purchases of Focus model FFVs, whereby the customer receives a higher performance FFV model for the same price as a lower performance conventional model and, more recently, the FFV versions have become cheaper than the petrol versions.

This makes the purchase of an FFV a purely economic choice. Customers may have little or no awareness that the car they own is an FFV, depending on their knowledge and the information provided to them. As long as the price of E85 is higher than the price of petrol, this is unlikely to change.

On the other hand, rising sales of FFVs has led to a diversification in the range of models available to consumers. The Ford Focus was the first FFV model available in the Netherlands, but now models from BEST partner Saab, as well as French manufacturers, Volvo and Mitsubishi are available. This means that, with decisive government action to reduce the price of E85, a large group of users could immediately switch to E85.

In sum, the BEST project has made a market develop for FFVs and E85 in the Rotterdam Region and the Netherlands as a whole. Moreover, the development of this market has influenced and supported other markets for clean vehicles, leading to a slow diversification of the vehicle fleet and fuel supply.

The intense media debate on the sustainability of biofuels was perceived in positive terms by Rotterdam, since this logically leads to scrutiny over all forms of fuels and products. Increasing the sustainability of biofuels can help stimulate increased sustainability in other sectors too.

Despite these positive developments, the dominance of the tax issue has constrained the potential level of impact, particularly when it comes to reducing greenhouse gas emissions. Removing excise would make an immediate contribution and encourage more of the approximately 6000 FFV owners and future FFV owners to switch to E85. This could make a significant contribution to air quality in the Netherlands.

Madrid: searching for long terms solutions to improve air quality

Situation prior to BEST
Madrid has a population of 5,022,289 in a territory of 605.8 km². The city has encountered serious problems with air quality and increased CO₂ emissions from rising transports. Activities within BEST are handled by the Directorate-General for Sustainability and Agenda 21 in the City of Madrid, but apply to the entire Madrid Region.

Prior to BEST, the city operated 392 biodiesel buses and aimed to introduce bioethanol as a complementary measure. Of 276,633 vehicles registered in the city at the start of 2006, none were flexifuel vehicles and there was no reference project for use of E85 in transport in Spain.

Madrid aimed to introduce 25 funded and 15 non-funded FFVs within BEST.
Activities during BEST
When BEST was launched, there was quiet optimism that with a committed vehicle manufacturer and production of bioethanol in the Basque Country, Madrid had the right ingredients for a successful market introduction of FFVs and E85. Time has proven that achieving a market introduction is more complicated than previously thought and is not solely dependent on having what appear to be the “right” pre-requisites.

Madrid has had a consistent and strong ally in Ford Spain, who manufacture FFVs in Valencia and have only sold FFV Focuses on the Spanish market. However, Abengoa – the Spanish company producing bioethanol – focused on the export and additives markets and did not have the correct permits to supply E85 in Spain. As a result, BP would supply E85 to Madrid in the early stages of the project. Later, Abengoa supplied E85 to Madrid, before a local company, Bioetanol de la Mancha became the distributor in Madrid.

Another issue specific to the Spanish market is the high percentage of diesel vehicles in operation. This means that sales of conventional petrol vehicles – and consequently the fleet size – are limited. Thus, even though Madrid has had a favourable situation with FFVs entering the market on a gradual basis (as Ford and Volvo sell only FFVs for certain models), the scale of this transformation is limited and there has been uncertainty over supply of E85.

Madrid has used public procurement as a tool to drive market development. An E85 fuel pump was installed and the Municipality purchased 5 FFVs in 2006 and subsequently hired a further 20 FFVs on four-year leases. All of these vehicles were Ford Focuses, although a Saab was also leased on a two-year contract to serve a Councillor. This contract ends in November 2009 and will not be renewed due to costs. Despite good cooperation between the Environment and Economy departments on the procurements, the aim of leasing Volvo FFVs for all Councillors was not achieved.

Procurement was also used to introduce FFVs to cleaning service fleets. Clean vehicles were awarded extra points in evaluation of tenders and the current service provider has procured 15 FFVs, 10 of which are manufactured by Ford and 5 by Renault. An E85 fuel pump was also installed as part of the contract. The public transport company of Madrid also decided to purchase ED95 buses.

Tax was the only major issue outside of the municipal scope and in the early stages of the project, bioethanol was taxed as alcohol in Spain, increasing the cost of fuel. This issue had to be resolved at the national level. Another major obstacle has been the length of time it takes to gain permission for and install fuel pumps, considering that the municipal fleet pump involved in BEST project was the first E85 pump opened in Spain. Besides, the City Council has promoted the opening in 2008 of the first public E-85 pump in Madrid Region. The Regional Government authorises inspection at filling stations and has been careful to approve new pumps in what it considers a test phase.

Likewise, fuel distributors have been unable or unwilling to install fuel pumps for biodiesel and bioethanol due to limited space at existing urban filling stations or concerns about the market size. It
took four years before the first public E85 pump opened at a Shell filling station in Madrid in November 2008. New filling stations are obliged to offer alternative fuels (bioethanol and biodiesel). However, whilst the price per litre of bioethanol is lower than that of petrol, the price per km is higher, meaning E85 is uneconomic.

BEST has helped Madrid learn about bioethanol and lay the foundations for future work. Greater cooperation and more strategic coordination between the different levels of Government in Spain would help accelerate the transition to clean vehicles and alternative fuels in Spain. In particular, greater efforts to reduce dependence on diesel are required, as diesel is increasingly scarce, will become increasingly expensive and has negative impacts upon local air quality. Madrid considers biodiesel a poor substitute, but a more fundamental shift amongst fuel distributors and vehicle manufacturers is required if the general public are to purchase alternative vehicles and fuels.

The debate over sustainability of biofuels has not deterred municipal politicians in Madrid about the need for a transition to clean vehicles and fuels. However, the debate – combined with the price of E85 compared to other options – has complicated the picture and made it unclear how to progress in the future. Madrid will continue with E85 whilst exploring use of hybrid vehicles and vehicles running on biogas from local waste facilities, in combination with natural gas, in municipal fleets.

### Basque Country: bioethanol central to regional energy planning

#### Situation prior to BEST

The Autonomous Community of the Basque Country (Euskadi) comprises the territories of Bizkaia, Gipuzkoa and Araba, covering an area of 7,234 km² with a population of 2,140,908.

In 2003, the Basque Government launched the Basque Energy Plan, which included the target of achieving biofuels for 11.9% of energy used in transport. This target was more than double the EU target and would equate to replacement of 177,000 tep/year with biofuels by 2010. The Plan also focused on increasing production of biodiesel and bioethanol to 270,000 tonnes/year by 2010.

The BEST project is based within the Basque Energy Board (EVE), which makes it unique within the BEST partners as the main driver lays on industry issues. Prior to the BEST project there were no registered flexifuel vehicles in the Basque Country but at the beginning of 2006 there were a total of 117,586 conventional cars.

The Basque Country aimed to introduce 200 non-funded FFVs within BEST.

#### Activities during BEST

The ambitious targets laid out in the Basque Energy Plan provided the framework and context for the BEST project. At the beginning of the project, there were no flexifuel vehicles and no bioethanol filling stations in the Basque Country. The project team and stakeholders had to learn quickly about the wide range of issues linked to bioethanol production, supply and consumption.

In the early stages of the project, EVE relied heavily on Swedish technical information and expertise from Scania and SEKAB, to build momentum and understanding. BEST provided an excellent platform for exchange and the Basque Country was able to learn from other sites. For example, EVE took two groups – politicians and technical staff – on “lighthouse tours” to Sweden.

These tours helped consolidate and advance the project, by inspiring staff about the potential of bioethanol. Seeing is believing - the experience of the tours helped to generate trust and confidence in bioethanol on the local level. There is now unanimous cross-party political support for the use of biofuels in the Basque Country and, even if the 11.9% target is not met by 2010, a long-term commitment to biofuels is assured.
EVE works with municipalities on biofuels production, distribution and consumption issues. In BEST, activities initially focused on filling stations, to develop a supply network for biofuels across the Basque Provinces. However, this was not straightforward, as the majority of filling stations in the Basque Country were controlled by oil companies or franchisees. Companies with strong market positions in cities such as Bilbao were not prepared to diversify their supply of fuels beyond conventional diesel and petrol fuels.

As a consequence, EVE worked with independent fuel distributors to install E85 pumps at filling stations. The BEST sites have found that independent fuel distributors are often more willing to install fuel pumps for alternative fuels, if guarantees can be made about the volume of sales. In the Basque Country, EVE offered to meet installation costs for the new pumps by up to 100% - and even this was not enough to convince some distributors to offer E85!

Providing guarantees of sales was difficult, as there are only a small number of FFVs in the Basque Country and most of these operate within municipal fleets. Nonetheless, a technical solution was found in the form of the flexifuel pump. The flexifuel pump enables fuel distributors to install an E85 tank at the forecourt but then offer a range of fuel blends – E5, E10 and E85 – from the same pump. This technical solution helped ease financial concerns about installing E85 pumps. E10 has proven surprisingly popular amongst consumers.

Ironically, several fuel distributors were concerned about the perceived price volatility of E85. In fact, during BEST, the price of E85 was relatively stable in the Basque Country whereas the price of petrol changed frequently.

Working with the independent fuel distributors was a first step, enabling E85 to get on the market. However, the site reports that often consumers perceive independent fuel distributors to be of inferior quality, meaning E85 risks becoming seen as a low quality fuel if it is only available in these filling stations. Therefore, wider distribution is needed and this implies that a filling station obligation, similar to that implemented in Sweden, should be introduced.

Increasing the number of E85 pumps should provide the foundations for increased sales of FFVs in the Basque Country. By June 2009, there were 8 E85 pumps – half of all E85 pumps in Spain – out of a total of over 250 fuel stations in the Basque Country. A further 2 E85 pumps will be installed by the end of 2009, contributing towards a total of 35 biofuel pumps (there are also 25 biodiesel pumps) in the Basque Country. EVE aims to achieve 60 pumps, most selling both biodiesel and bioethanol, in the near future.
Increased vehicle sales would provide an incentive for more manufacturers to enter the market. At present, only Ford, Saab, Volvo and Renault offer models in the Basque market. To date, most FFVs operating in the region are owned by municipalities and institutions. However, there is still a tendency to procure diesel vehicles, as diesel is perceived as a fuel that is less vulnerable to price fluctuations. E85 is more energy efficient than petrol cars, however, it is associated with higher fuel consumption especially when comparing to a diesel car (diesel 6 litres/100 km compared to E85 11 litres/100 km).

In the long term, as diesel becomes scarce, the basis for such assumptions is likely to change. However, fuel distributors are currently topping up diesel with biodiesel to cover for shortages in supply. A consequence of this – and the high numbers of diesel cars in Spanish car fleets – is that fuel distributors have been more interested in supplying biodiesel than bioethanol.

EVE considers participation in the BEST project as an important step along the path to achieving a sustainable energy mix in the Basque Country. In the coming years, work with public procurement will be intensified and a steering group comprising all relevant stakeholders will be formed to promote use of bioethanol. EVE will also attempt to highlight the Basque experience to other Spanish regions by providing study visits similar to the “Lighthouse tours” they took part in during BEST.
Brandenburg: local economic development a key priority

Situation prior to BEST

The Bundesland of Brandenburg lies in the east of Germany, on the border with Poland. Brandenburg has a population of 2.5 million inhabitants. In the south of Brandenburg, four counties and the university city of Cottbus form the “Innovative Energy Region”, with 650,000 inhabitants.

In its Energy Strategy 2020, Brandenburg aims to achieve a 20% share for renewable energy sources by 2020. Brandenburg is the largest producer of electricity in eastern Germany and is a leading producer of renewable energy, being the country’s largest producer of biodiesel and bioethanol (180,000 tonnes, rye-based). As a result, developing an efficient and sustainable biomass-based economy is a strategic objective for Brandenburg. A network of industrial companies (Brandenburg BBpro.e.V) was established to represent biofuels issues prior to BEST.

When Brandenburg joined BEST, the Ministry of Rural Development, Environment and Consumer Protection seemed on the verge of extending its subsidy programme for natural gas filling stations to bioethanol stations. There were also a number of FFVs in operation in eastern Germany, as citizens preferred petrol vehicles to more expensive diesel alternatives and Ford supplied on FFV models on the market.

Brandenburg participated in BEST during 2007-8. Brandenburg exceeded its target of introducing 80 non-funded FFVs within BEST.

Activities during BEST

Brandenburg joined BEST in 2007 and in contrast to the other sites, focused primarily on introducing FFVs and E85 to private fleets. The circumstances appeared to be right for market development – there was no tax on bioethanol until 2015 and national incentives reducing the price of E85; a small but growing fleet of FFVs in the region; and local production of bioethanol.

Participation in BEST aimed to expand sales of FFVs and the fuel supply network, spreading knowledge and bringing down costs of production and for consumers. In particular, increasing production and consumption of bioethanol offered the potential to boost local agricultural and economic development in a relatively deprived region.

Brandenburg is the largest producer of agricultural products in eastern Germany. Rye grown in the region can be used to produce bioethanol and a fuel producer moved its production plant to the region, taking advantage of national funds that provide grants covering up to 45% of investment costs of new facilities in eastern Germany. This producer then signed agreements with local farmers to purchase 650,000 tonnes of rye at a fixed price for bioethanol production.

However, several problems arose. The Ministry of Rural Development, Environment and Consumer Protection learnt that its subsidy programme for natural gas filing stations could be extended to E85, but only at publicly-owned fuel stations. This meant private filling stations could not access the funds. Moreover, the Ministry was inconsistent in its handling of the issue (e.g. holding meetings but not following up on them) and reflected a lack of sensitivity to the market in policy.

These problems were exacerbated by a complex permitting process based in the Water Protection departments of local administrations, which were often unfamiliar with bioethanol. As a consequence, results varied across Brandenburg, with filling station owners spending a lot of time in discussion with Water Protection officers. It took one year to introduce an E85 fuel pump in Cottbus. The local bioethanol producer faced similar struggles in identifying refineries prepared to accept bioethanol and faced production problems when the price of corn rose dramatically in 2007.

The debate on the sustainability of biofuels did not help accelerate these processes, adding new levels of complexity and uncertainty. This led to a certain amount of passivity from staff in public
authorities, who did not support or prevent the region’s work with biofuels from developing. The absence of clear signals from the administration increased uncertainty further.

Nonetheless, sales of FFVs were occurring at sites in Brandenburg and other parts of eastern Germany. East German consumers prefer petrol to diesel vehicles (diesel accounts for just 8% of the market) and Ford sells FFVs for the same price as conventional vehicles, though local dealers were at times not as enthusiastic as Ford Germany about encouraging sales of FFVs.

The Brandenburg story highlights the need for cooperation between public authorities, producers and retailers, and the need for decisive leadership at the local/regional level. The rise in commodity prices and sustainability debate in 2007-8 stalled several actions (e.g. municipal procurement of an FFV), but more common initiatives and approaches may have accelerated market introduction of FFVs and E85 in Brandenburg. A large number of stakeholder meetings, presentations and events were held as part of BEST, in an attempt to stimulate such cooperation.

By the end of 2008, there were a total of 9,735 Ford FFVs in Germany, of which 1,863 were in eastern Germany. There are now six filling stations offering E85 in Brandenburg, six in Berlin and a total of approximately 250 in Germany, mostly situated in the west and northwest of the country.

To a large extent, the market introduction of FFVs and E85 in Brandenburg has suffered from unfortunate timing. The site benefited from having tax exemption on E85, local production of bioethanol and the availability of FFVs for the same price as conventional petrol vehicles. However, long administrative processes delayed the opening of new filling stations during a time when (due to the price of petrol) many consumers were demanding E85. Unfortunately, the oil price has collapsed since then, meaning that even if new fuel pumps are installed, there is no guarantee of E85 sales as the East German market is extremely price sensitive.

Photos 4 and 5: Launch of E85 filling station and presentation of fuel pumps at public events. Brandenburg has actively promoted its activities. Fuel station launches can be a good way to attract attention from local and national media. Source: Site

La Spezia: fuel prices restrict progress

Situation prior to BEST

La Spezia in the Liguria region of Italy has an area of 881 km² with a population of 215,137. BEST activities in La Spezia are led by the Province of La Spezia’s Mobility and Transport division and the public transport company ATC, which is mainly owned by the Municipality and the Province of La Spezia.
116,640 cars were registered in La Spezia at the start of 2006, but none of these were flexifuel vehicles. The municipal and provincial administrations made the introduction of biofuels a strategic priority, as part of their commitment to fight climate change and promote sustainable development. Transport has been targeted via the Provincial and Urban Strategic Plans for Mobility.

La Spezia aimed to introduce 10 funded FFVs within BEST.

**Activities during BEST**

Through their participation in BEST, the Municipality and Province of La Spezia have introduced 10 funded FFVs to their public fleet, meeting their objective at the start of the project. These vehicles have experienced no technical problems and drivers have reported positive experiences with bioethanol.

Nonetheless, the target of introducing 90 non-funded FFVs in La Spezia has not been met. Despite the best efforts of the project partners, it has proven impossible to stimulate purchasing of FFVs because the fuel price is considerably higher per litre when compared to fossil fuels. Moreover, bioethanol pays the same excise duty per litre fuel as fossil fuels (this actually means a higher excise duty than fossil fuels in terms of energy units) and consumers receive no tax reductions or incentives.

With high prices, there is no demand for bioethanol and therefore no chance of encouraging fuel distribution or consumers to purchase FFVs. The Municipality and Province have continued to operate their FFVs in difficult circumstances, but other municipalities are reluctant to adopt FFVs and E85 since they increase costs in a period of budget cuts. It is politically unrealistic to innovate.

As a consequence, the Province and Municipality of La Spezia have called for policy changes at the national level. Amending policy is not a straightforward process in Italy. Legislation is being discussed but experience from the biodiesel industry (biodiesel has an excise reduction) suggest that bioethanol is perhaps two years into a five year process.

It is interesting to note that FFVs are being driven in Northern Italy near the Swiss border, as consumers can purchase E85 in Switzerland for prices that are lower than those for fossil fuels in Italy. This is because Switzerland has introduced various exemptions and incentives to stimulate sales of E85.

The Municipality and Province of La Spezia are extremely interested in exploiting environmental technologies and as such remain committed to bioethanol. Buses running on ED95 have been introduced in La Spezia. However, price is a key determinant of policy. La Spezia is proud to have introduced FFVs and E85 to the public fleet, but disappointed that factors beyond their control have restricted further achievement.

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**Nanyang: a good start in China**

**Situation prior to BEST**

Nanyang is located in the southwest of the Henan province in China and is a famous historical and cultural city, as well as a ‘China Excellent Tourism’ City. Thirteen counties are under the jurisdiction of Nanyang City, which covers an area of 26,600 km² where 10.5 million people reside.

At the end of 2005, there were no flexifuel vehicles amongst Nanyang’s registered vehicle fleet of 75,000. The introduction of bioethanol in Nanyang was a part of the city’s ‘Recycle Economy Framework’ and part of a wider drive in China to reduce dependency on fossil fuels in transport fuels.

Nanyang aimed to introduce 10 funded FFVs within BEST.
Activities during BEST

To meet rising energy demand, combat climate change and boost rural economies, China began in 2001 to introduce an E10 bioethanol blend to transport fuels. Nanyang was one of the first cities to demonstrate E10, partly because the city has a history of bioethanol production and partly because Nanyang is situated in Henan Province, which produces around 10% of all food products in China. By October 2003, all fuel stations in the City of Nanyang supplied E10 and all petrol vehicles (except those operated by the military) were using E10.

Participation in BEST provided Nanyang with the opportunity to be the pioneer of high blend bioethanol demonstration in China. To date, ten flexifuel vehicles are operating in Nanyang and even though this is much less than anticipated, the demonstration attracts interest from the Central Government and fuel and automobile industries.

The road to implementation has not been smooth. There were no FFVs on the Chinese market and Nanyang contacted various FFV manufacturers about the possibility of launching their models in China. However, there were many hurdles to overcome before an FFV could be driven in Nanyang.

For example, Ford China had no plans to set up an FFV production line in China but could import FFVs from other markets. The same was true of other manufacturers. This would increase the costs of FFVs, as Nanyang would have to pay more than the FFV sale price in the EU and the 3C authorisation from the Government (needed because there were no FFVs sales in China) and an import tax of around 47% of the total FFV price.

Strict customs policies meant the 3C authorisation and import duty were not waived. Eventually, after extensive negotiations, the Chinese company Dongfeng agreed to provide FFVs to Nanyang by retrofitting conventional vehicles to run on high blends of bioethanol. Moreover, Nanyang planned to use FFVs in the public taxi fleet, but at present the existing taxis have not reached their life expectancy and cannot be replaced.

In China, the fuel price is controlled by the Central Government and the market price of bioethanol is the same as that of petrol. Nanyang has discussed this issue with national authorities such as the National Development and Reform Commission. The City invited key officials to the 2006 and 2008 World Biofuels Symposiums, which were organised by Tsinghua University, in the hope of raising the level of knowledge and awareness of officials. However, there is currently no price reduction or tax exemption for biofuels, meaning local incentives – such as free parking for FFVs – are the only type of incentives to purchase FFVs and use bioethanol.

Food security is and will always be the most important issue for the Government of China. The debate on “food versus fuel” had an impact on the attitudes of certain government authorities, fuel and automobile suppliers, and other stakeholders. This may have impeded progress towards reductions or exemptions from import duties and fuel taxes and certainly slowed the overall rate of progress for BEST in Nanyang.

Nonetheless, climate change, energy security and rural development are also critical issues for China. China is a large country with 34 provinces, of which 10 now use E10 in their fuel supply (partly or wholly). Successful experiences in these 10 provinces mean E10 will be developed further, though infrastructure and vehicles will have to be prepared for this transition. High blends remain low on the Central Government’s list of priorities.

On the provincial level, a large drive towards biofuels can be observed. Henan Province – where Nanyang is located - is China’s most populous province, with over 100 million inhabitants. Around 80% of these residents work in agriculture and the province is keen exploit the potential of biofuels for rural economic development and to improve the local environment. This means that, in spite of the many challenges faced by Nanyang in the BEST project, the local government continues to support and work for use of FFVs using high blend bioethanol.
Somerset: small steps in challenging circumstances

Situation prior to BEST

Interest in flexifuel vehicles and E85 emerged in Somerset when the local grain company Wessex Grain – who had been supplying wheat to Abengoa for bioethanol production – declared their interest in developing a bioethanol production plant in Somerset. Their interest coincided with Somerset Council’s plan to increase bioenergy in local energy production and for transport.

The possibility of locally-produced bioethanol contributing to regional economic development proved attractive to many in Somerset and a coalition of actors was formed, including Wessex Grain, the public water company and Ford – who were keen to launch their Focus FFV model in the UK. The Ford Focus was already the UK’s largest selling vehicle, creating an enormous sense of expectation.

Somerset aimed to introduce 46 non-funded FFVs within BEST.

Activities during BEST

Around this time, Somerset joined the BEST project and immediately began introducing FFVs to public fleets. BEST was valuable because the project set out targets and deliverables against which Somerset’s achievements could be measured. During the first year of the project, all targets were met: 10 vehicles were procured by the County fleet, 15 by the local police and others by actors including the UK Environment Agency, Wessex Water and Wessex Grain. 5 fuel pumps for E85 were installed.

Unfortunately, at this point the unexpected occurred. All plans had assumed that as the oil price rose, bioethanol would become more competitive. Instead, the price of raw materials including wheat rose, meaning E85 cost 25% more per kilometre than petrol. In this context, it proved impossible to sell more FFVs. The project team focused on raising awareness of the potential of bioethanol, in the hope of achieving new legislation providing fuel price parity with petrol per pence/km.

The project team spent much of the first two years of BEST discussing with members of the British and European Parliaments, meeting the British Transport Minister and holding events to highlight their case. As in the Netherlands, this approach was unsuccessful, resulting in stagnation. Unlike the Netherlands, consumers did not purchase FFVs in large numbers – Ford state that around 150 - 250 FFVs are sold per year in the UK – and only one retailer sells high blend bioethanol in the UK. Should a vehicle manufacturer decide to make FFVs their standard product (or available at the same price as conventional vehicles, as in the Netherlands), this situation could be expected to change quite quickly.
Moreover, as the project lost momentum, the global debate on “food versus fuel” focused attention on the sustainability of biofuels and in a broader sense, on justice and equity issues in global trade. In Britain, media coverage of this issue was particularly hostile and a bitter atmosphere quickly formed, in which Somerset’s work became the subject of ferocious criticism. Supportive local politicians found that it was no longer possible to introduce local incentive systems, since even if they introduced such measures there was virtually no chance of consumers purchasing E85.

As a result, in Somerset the BEST project team was unable to make progress beyond their early achievements. Efforts now focused on identifying other UK local governments with an interest in alternative fuels and clean vehicles. By this time, local governments were obliged by new regulations to conduct performance assessments to reduce CO2 emissions. As many local governments also operate fleets, the BEST team recognised the potential synergy between these regulations and the project.

Photo 8 and 9: The introduction of FFVs in Somerset has brought a large interest from people both within and outside the Somerset County. Source: Site

Contact with Nottingham and Reading was established and led to introduction of FFVs and buses in both cities. A national conference with actors including the Renewable Fuels Agency, Local Government Association and British Sugar, was held in Somerset on the issue of how to quantify CO2 savings from biofuels and how local governments can implement biofuel policies.

There are no clear results from this period, but evidence suggests a changing tide. The Low Carbon Vehicle Partnership has commissioned a report on “Market Opportunities for High Blend Biofuels” which will be published in 2009. This report highlights the experiences of the BEST project and will propose potential measures to assist introduction of FFVs and biofuelled buses and trucks in the UK.

The UK government seems increasingly concerned about the potential impacts of “Peak Oil” and has instructed councils to conduct contingency planning exercises on the issue. Moreover, in January 2009 the government ignored the findings of the Gallagher Review (which proposed revising down biofuels targets to 3% of the fuel mix) and imposed a 3.5% target, rising to 10% in 2020. Such a target could be attainable if high blend bioethanol is introduced on a large scale. In response to critics, the government has linked these introductions to sustainability certification schemes.

This assumption is based on the following. The Renewable Energy Directive states that all Member States need to have a 10% share of energy consumption in transport consisting of renewable energy by 2020. Bioethanol contains 67.5% of the energy per litre of petrol (21.2 MJ/litre compared to 31.4 MJ/l). A 10% blend by volume is the maximum allowed by the Fuel Quality Directive and this corresponds to 6.75% energy.

Biodiesel contains 92.1-93.8% of the energy content per litre of diesel (33MJ/l compared to 35.2-35-8 MJ/l). A 7% blend by volume is allowed by the Fuel Quality Directive, corresponding to 6.4-6.6% energy.
Whilst the team has encountered serious obstacles – few of which were within their control or could be planned for – the overall contribution of the BEST project has been good and the opportunity to cooperate with European colleagues who face similar challenges has been appreciated.

**São Paulo, Brazil**

The State of São Paulo in Brazil extends over an area of 248,800 km² and has a population of around 40 million. This represents 21.5% of the Brazilian population, making São Paulo the most populous country subdivision in the Western Hemisphere. The city of São Paulo has 11 million inhabitants.

The State has extensive experience with bioethanol and flexifuel vehicles. The production of bioethanol began over 30 years ago, enabling Brazil to be able to produce its own energy for transportation, generating economic, social and environmental benefits. 90.6% of cars registered in Brazil in 2007 were FFVS. Of these 1,780,878 cars, 655,540 were registered in the State of São Paulo.

São Paulo’s participation in the BEST project involves demonstration of hybrid electric vehicles (HEV) and buses running on bioethanol blends. The experiences and results of this demonstration are presented in the report on “Task 5 - electric hybrid FFV cars” in this report.

Photo 10: Petrol and ethanol fuel pump in São Paulo. Source: Site

Thus, the allowances set in the Fuel Quality Directive allow up to 6.75% renewable substitution of fossil fuels using low blends and the proportion decreases as the volume of diesel increases. The remaining 3.3% of energy consumption must be met with high blends of some form. Possibilities include large volumes of B20; use of B50 and B100 in old trucks and buses; biogas (which is counted twice); electrical vehicles (counted 2.5 times); or future synthetic diesel. There are significant obstacles to all of these choices but it is likely most or all will be employed in some form.

This leaves E85 and ED95 as potential high blends that offer the potential to replace both petrol and diesel.
Attitudes: drivers and fleet managers

Drivers report positive experiences

The “Report on driver attitudes towards flexifuel vehicles” (Deliverable No 1.14) provides detailed description and analysis of results from two consecutive surveys conducted within the BEST project. These surveys took place in spring 2007 and autumn 2008 and illustrate the impact of the project on driver attitudes. A similar survey was carried out in autumn 2008 by the City of Stockholm and provided similar results, reinforcing the findings of the BEST studies.

The first survey was carried out at seven of the BEST sites and the second at nine sites. Both surveys were directed at private bioethanol car owners and drivers of bioethanol cars within city and commercial fleets. The sample sizes and numbers of respondents varied considerably between sites, reflecting differences regarding the extent to which bioethanol has been introduced and the means and ways to identify users of bioethanol cars in different locations. Around two thirds of respondents came from Sweden.

The surveys contained questions about the reasons for purchasing and driving a bioethanol car, filling stations, perception of differences between bioethanol cars and “conventional” cars, attitudes towards and satisfaction with bioethanol cars, and sources of information regarding bioethanol vehicles. When looking at the background data assembled for all sites together, the results from both surveys are quite similar. However, the results revealed significant changes at the site level.

- In both surveys most of the respondents (70%) were men. Over 40% worked in public service and around 70% drove a car owned by their employer.

Key results regarding attitudes, perceptions and behaviour are as follows:

- In 2007, half the owners of private bioethanol cars stated their reason for purchasing a bioethanol car was concern for the environment, but by 2008, this number had fallen to 44%. The number stating economic advantages were the primary reason for purchasing a bioethanol car rose from 23% in 2007 to 38% in 2008.

- Company policy was the primary reason for drivers of company owned cars to drive a bioethanol car. The factor grew in importance over time (43% in 2007; 61% in 2008).

![Figure 15: Reasons for driving a bioethanol car - total. Source: BEST Deliverable 1.14.](image-url)
A majority of the respondents changed opinion on bioethanol cars since they started driving them. In both 2007 and 2008, around half of the respondents had become more positive and around 11% had become more negative.

In both surveys, three quarters of the drivers were generally satisfied with their experience driving a bioethanol car. 82% of the respondents would recommend bioethanol cars to others.

The share of respondents who found the number of fuelling stations for bioethanol appropriate has almost doubled from 22% in 2007 to 40% in 2008.

The most satisfied users were in the Swedish sites and Brandenburg, with the Swedish users also being the most satisfied with the number of filling stations and most satisfied over time. The least positive were Rotterdam, Madrid and Somerset where the number of filling stations appears to inhibit growth.

The most important sources of information about bioethanol were identified in both surveys as media, followed by colleagues/acquaintances and car dealers and manufacturers. Additional comments to the survey indicate concerns about food vs. fuel and awareness of other alternative energy sources, suggesting strong media influence over certain actors.

About half of the respondents in 2008 were of the opinion that it was economically better to drive a bioethanol car than a petrol car; a fifth thought it was uneconomic. Almost 40% said that a bioethanol car is more economic than a diesel car and about a quarter think the opposite. A third of the respondents thought driving a hybrid electric car was more economic than using bioethanol. These results are clearly linked to the price of E85 compared to fossil fuels when the survey was conducted, at which time the price of oil was extremely high, making the per kilometre price of bioethanol very competitive. Subsequent depreciation of the oil price makes it likely that a follow-up survey would present quite different results on this issue.

**Fleet managers**

It is interesting to compare this information with the results of the fleet manager survey, which are analysed in detail in the “Report on survey of fleet operators’ attitudes towards bioethanol vehicles and fuel” (Deliverable 9.25).

This report presents the results of a survey that investigated fleet operators’ attitudes towards bioethanol fuel and bioethanol vehicles and their role in the market-breakthrough of bioethanol and bioethanol vehicles (cars and buses) in Europe, using as the BEST project as a case study. The survey
aimed to complement previous research - conducted on fleet demand for alternative fuel vehicles in public and private fleets in the USA - by adding an insight into the perceptions of European fleets.

A questionnaire survey was sent to 274 fleet operators at seven BEST sites that already had some flexifuel vehicles (FFVs) and buses in their fleet. 58 responses were received from fleet managers with different levels of experiences with bioethanol vehicles (ranging from one to four years) and different fleet sizes.

The results of the survey show that participating organizations were initially influenced by environmental considerations and issues such as their “green” image and social corporate responsibility when purchasing their first bioethanol vehicles. The companies reported that their overall experience with bioethanol vehicles has been positive and the vehicles are perceived as having good environmental performance and reliability. Fleet managers reported that the vehicles gained the approval of drivers and mechanics.

Nonetheless, issues such as fuel cost, access to refuelling infrastructure, range on full tank and capital/operating costs cause concern to fleet operators. Considerations about future bioethanol prices and availability significantly influenced future purchase decisions. Organizations that were satisfied with the current environmental performance of bioethanol vehicles were more likely to purchase more bioethanol vehicles in the future. On the other hand, concerns or doubts about the safety of bioethanol affected negatively future purchase decisions.

The results suggest that key factors influencing procurement include the emission performance of vehicles, reliability, the type of services the vehicles provide and the fleet manager’s length of experience. Another influential factor is the type and quality of information (positive or negative) the fleet manager is exposed to. Many of fleet operators had been exposed to positive information about bioethanol and more than half perceived this information to be useful.

Fleet operators in the sample were mostly highly-educated and seemed to be relatively knowledgeable and informed about bioethanol. A significant proportion claimed to have invested substantial time and effort in searching for information regarding bioethanol. The significant effect of information and knowledge on perceptions underlines the potential to facilitate market penetration for bioethanol and other alternative fuels through the provision of quality accurate information.

Conclusions and recommendations

Within BEST, studies of attitudes of drivers and fleet managers have been undertaken at most sites. The results the surveys broadly correlate. The majority of drivers stated that they drove a bioethanol car because of either their employer’s company policy or their personal concern for the environment. The fleet manager survey shows that environment is a key stimulus for company policy, meaning that the debate as to whether bioethanol offers environmental benefits and contributes towards reduction of greenhouse gas emissions becomes critical to the further development of the market.

In both surveys, users reported positive experiences with FFVs and satisfaction with the overall performance of the vehicles and fuel. Notwithstanding this, the price of fuel and access to refuelling infrastructure were cited by respondents in both surveys as major concerns. Experience in BEST sites suggests that a combination of regulatory measures and incentives can help to assuage these fears and create favourable conditions for market development.

Provision of quality accurate information about the climate and environmental impacts of bioethanol is essential, as information strongly influences drivers and fleet managers. However, information alone is insufficient to stimulate market development. Drivers and fleet managers harbour real and persistent concerns about infrastructure and fuel price and creative combinations of regulations and incentives will be needed to maximise the potential for market development in Europe.
The BEST manufacturers’ perspective

Ford and Saab are partners in BEST. Both manufacturers express a strong belief in the FFV technology for today and in the future. Both companies are planning to produce more FFV models and observe slightly increasing interest from buyers. However, whilst their interest in FFVs is primarily related to environmental concerns, both manufacturers aim to sell large volumes of cars and make money. There has to be growing interest from consumers if FFVs are going to stay in production.

BEST has taught the car industry that if an introduction of FFVs is going to be successful, the most important aspects are strong political interest and support for bioethanol. Currently, the levels of political interest are very different in different EU Member States and this is the key factor explaining why FFV sales have increased fast in some countries and not increased at all in others. Political support is essential!

Secondly, the operating cost of E85 must be equal to the operating cost of petrol if you want to make sure that the vehicles are to be filled with E85. If the E85 operating cost is in favour of petrol, it is even better. If the price of E85 is too high, it is very hard to attract a large interest for buyers and then the interest from the car industry is also low.

Through the BEST projects, FFV cars have been introduced in more countries and also faster than originally planned. This introduction was in most cases linked to the opening of filling stations. The dialogues with all other stakeholders have been very valuable and fruitful. Strong markets develop when all stakeholders act together in the same direction. The initial Light House Tours were very good starting points for BEST and were a very good kick-start of new markets for the car industry.

The car industry did not foresee the very strong media debate about food versus fuel and the negative, sometimes inaccurate picture about ethanol as a fuel that was shown frequently in media. During this period, it was important and beneficial that all stakeholders in BEST acted together, i.e. by finding and sharing information. This work was done differently in different sites but the overall experience was very positive and is important to keep alive after BEST. Even though a lot of progress was made in BEST with these issues, the manufacturers feel more work could be done in this area.

Ford and Saab both have plans to introduce more FFV models and believe FFVs are here to stay. They also see new developments like ethanol electric hybrid cars in the future. The FFV technique as it today will have difficulties handling Euro 5 and Euro 6 for cold starts and short term development needs do be done in this field. In some countries, both Ford and Saab only sell FFV versions of some models as the interest is high and it is more effective to only have one version of the same car.

When working with independent dealers, one need to realise that it is harder to attract true interest from them as long as a car sell in low volumes. In BEST this dilemma was underestimated when it came to the handling of the test fleets. For more information, read the section on “Test fleets” in this report.
Economic issues

Vehicle costs

Purchase prices for alternatively fuelled vehicles are higher than prices of conventional vehicles. The Swedish National Tax Board has published data on the additional purchase price of alternatively fuelled vehicles since 2002, see table 2. (There is no corresponding price premium for low-CO\textsubscript{2} cars.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Hybrid/electric</th>
<th>Biogas/Natural gas</th>
<th>FFV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>5,715</td>
<td>3333</td>
<td>476</td>
</tr>
<tr>
<td>2003</td>
<td>5,715</td>
<td>4,476</td>
<td>476</td>
</tr>
<tr>
<td>2004</td>
<td>6,095</td>
<td>4,476</td>
<td>476</td>
</tr>
<tr>
<td>2005</td>
<td>6,000</td>
<td>2,857</td>
<td>619</td>
</tr>
<tr>
<td>2006</td>
<td>6,000</td>
<td>2,857</td>
<td>619</td>
</tr>
<tr>
<td>2007</td>
<td>6,857</td>
<td>2,857</td>
<td>1,143</td>
</tr>
<tr>
<td>2008</td>
<td>6,857</td>
<td>2,857</td>
<td>952</td>
</tr>
</tbody>
</table>

Table 2: Additional purchase price of alternatively fuelled vehicles in € (VAT included, based on conversion €1 = 10.5 SEK). Source: National Tax Board, Sweden. This data is used to calculate the tax reduction on clean company cars.

The alternatively fuelled vehicles available on the Swedish market have a purchase price premium of about 30% for hybrid cars, 10% for biogas cars, and 5% for a bioethanol FFV. The additional cost of FFVs has risen over time as an increased range of models becomes available on the market (only medium-sized cars were offered in 2002).

Second hand markets started to develop in the early 2000s, but price estimates were difficult because the base for comparisons was still very small. It was possible to draw conclusions only about battery electric cars, electric hybrids and biogas vehicles. The battery cars had lost 40% more in value than a comparable conventional vehicle; electric hybrids were valued 8% less and biogas vehicles 10% less than a comparable conventional car.\textsuperscript{6}

In 2006 there was no difference in value loss between a conventional Ford Focus and FFV Ford Focus. In January 2008 buyers were prepared to pay slightly more for a second hand Ford Focus FFV than a second hand Ford Focus petrol car, see table 3. Although this is based on a limited owner survey, it does indicate that FFV-owners are no longer disadvantaged in the second hand market in Sweden.

<table>
<thead>
<tr>
<th>Model</th>
<th>2004</th>
<th>2006</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toyota Corolla</td>
<td>75%</td>
<td>83%\textsuperscript{*}</td>
<td>-</td>
</tr>
<tr>
<td>Toyota Prius (electric hybrid)</td>
<td>50%</td>
<td>75%\textsuperscript{*}</td>
<td>71%</td>
</tr>
<tr>
<td>Volvo petrol</td>
<td>63%</td>
<td>64%</td>
<td>67%</td>
</tr>
<tr>
<td>Volvo Bi-fuel (biomethane)</td>
<td>55%</td>
<td>57%</td>
<td>63%</td>
</tr>
<tr>
<td>Ford Focus petrol</td>
<td>-</td>
<td>71%</td>
<td>70%</td>
</tr>
<tr>
<td>Ford Focus FFV (bioethanol/petrol)</td>
<td>60%</td>
<td>71%</td>
<td>72%</td>
</tr>
</tbody>
</table>

Table 3: Percent retained value after three years compared to purchase price. Note the comparison concerns a Toyota Corolla that has been driven 15,000 km less than the Prius. Source: Trendsetter 2006, Clean Vehicles in Stockholm 2006 and Clean Vehicles in Stockholm 2008.

Fuel price and energy consumption

The majority of new vehicles introduced in BEST are FFV passenger cars capable of running on petrol and bioethanol blends up to E85. BEST carried out a detailed assessment of the technical performance of 93 FFVs across 11 different models – predominantly from Ford and Saab but also including Volvo.

These vehicles were operated at all sites, sometimes by individuals and sometimes in car pools (multiple users). A wide range of users included home service for elderly and disabled, and fire inspectors in Stockholm; the Mayor of La Spezia; the Mayor, Alderman and Councillors of Rotterdam; the municipal waste service in Madrid; Somerset County Council, and Avon and Somerset Constabulary. In total over 2,164,263 km worth of vehicle performance was assessed during the BEST FFV study.

Bioethanol has lower energy content than petrol, and manufacturers of FFVs usually inform customers that the cars consume up to 30-40 % more fuel than conventional petrol cars. Based on the different energy content and a hypothesis that FFVs utilise the energy in petrol and E85 with equal efficiency it can be assumed that FFV cars consume 1.41 times more E85 than unblended petrol on a volume basis.

Preliminary results from the on-road use of FFVs allowed a breakdown of occasions when the various FFVs were driving on pure E85 or pure petrol. For the periods that the vehicles were running on E85, the FFVs consumed an average of between 8.57 to 14.7 litres per 100 km compared to when they were running on petrol when they consumed an average of between 8.57 to 13.4 litres per 100 km.

These averages are based on a range of results from a number of different sites, with wide variations in data for fuel consumption and the number of vehicles in each sample. The variations can be partly explained by contextual factors – different model cars, different driving styles, the distance travelled and type of journey (city traffic or highway), fuel supply (E85 was not available at all sites at all times), refuelling choice, etc.

The evaluations carried out within the BEST project suggest that the energy efficiency of running on E85 may be between 1-26% higher than running on petrol. This resulted in significant lower E85 consumption than anticipated – in the best case only 1.14 times more E85 than petrol was necessary (instead of the theoretically assumed 1.41). This is considered to be an important area for future research.

It is worth noting that E85 has a higher octane value (approx.104) than petrol (95). If engines could be adapted to this higher octane value in the future, increases in energy efficiency could be obtained and the fuel/energy consumption of bioethanol cars could be further reduced.

[Clarification]

Energy efficiency of cars

Fuel consumption of cars is often confused with energy efficiency.

Bioethanol has lower energy content per litre than petrol:

Petrol 32 MJ per litre
Petrol with 5% low-blended bioethanol 31.5 MJ per litre
Bioethanol 21 MJ per litre
E85 (85% bioethanol) 22.7 MJ per litre

Thus, E85 contains 71% of the energy than that of, petrol (22.7/32=0.709). As a result, the fuel consumption measured as litre per kilometre is higher when driving on E85, and more frequent refuelling is required. If the energy in E85 and petrol are utilised equally efficiently in the car, 1.41 times more E85 would be required (32/22.7=1.41).

7 Draft of BEST D9.26. BEST Final Evaluation Report (to be published end 2009),
8 Directive 2009/28/EC on the Promotion of the Use of Energy from Renewable Sources.
BEST experiences show that FFVs are more energy efficient and do not consume as much E85 as theoretically anticipated.

To reduce climate impact from vehicles it is necessary to

- improve energy efficiency (engine development),
- reduce energy consumption (smaller cars, etc.)
- to fuel with renewable fuels.

**Stockholm**

The relative price of E85 needs to be sufficiently lower than petrol to make E85 a preferred option in Sweden. Therefore, “petrol equivalent” prices are more useful when comparing bioethanol and petrol prices. The red lines in Figure 17 show petrol equivalent prices of E85 calculated to reflect higher fuel consumption (assumed to be 30-40%). In 2005 and during the time period April 2006-October 2008 the petrol equivalent price of E85 was less than petrol.

![Figure 17: The price of petrol (lead free 95 octane) and the price of E85, monthly averages Source: Statoil](image)

Developing more energy efficient vehicles that are optimised to run on bioethanol may be one way to improve the competitiveness of E85. However, in the short term, removal of excise taxes or introduction of incentives that stimulate use of E85 may be necessary to ensure that E85 can retain price parity with petrol. Several BEST sites have spent a considerable amount of time working at the national and European levels for the introduction of such measures, to little or no effect.

It has been shown in several BEST sites that though local measures are no substitute for national action, they can help stimulate behavioural change. Incentives for production and consumption of sustainable biofuels could be considered as a mechanism to support further development of the bioethanol market. It is clear that, when the price of bioethanol per km is higher than that of petrol, most consumers fill up with the fossil fuel. Carbon dioxide emissions must be reduced now, meaning urgent measures to guarantee price parity for sustainable biofuels are required if Europe is to meaningfully reduce emissions from its road transport sector.
Rotterdam

Rotterdam is dealing with high E85 prices. The awareness-raising actions taken within the BEST project and on an individual basis, together with the national working group E85, did not have any positive results yet. The National Government is not willing to remove the excise taxes on E85, nor are they willing to introduce any other incentives that stimulate the use of E85.

The first pump holder offering E85 in Rotterdam (Argos Oil) has retained the price of 1.91 € per litre since 2006, despite selling low volumes of fuel. Since the second quarter of 2008, another pump holder (Tam Oil) is offering E85 for more or less the same price as regular petrol. This price reduction is only volume-based and does not reflect the higher fuel consumption when using E85 in a flexifuel vehicle.

Tam Oil can afford this price reduction on a temporary basis, as a result of their cooperation with an E85 producer and Volvo. In the long term, nationwide tax reductions or other national incentives are needed in order to stimulate the use of E85 in Rotterdam and the Netherlands.

![Figure 18: The price of petrol (lead free 95 octane) and the price of E85 in the Netherlands, Source: CBS, Tam Oil, Argos Oil.](image)

Taxation and regulation

A wide range of tax and regulatory instruments are used to stimulate use of flexifuel vehicles. These include instruments targeted at the cost of fuel, the purchase price of vehicles, and the ongoing costs of maintaining and operating vehicles. The BEST sites conclude that incentives on taxes and excise reduction to achieve competitive bioethanol prices have the strongest potential to achieve a market breakthrough.

However, such agreements require national coordination and impact directly on the national treasury. During BEST, Germany, Sweden and Spain took sufficient national excise measurements to make bioethanol competitive at the pump, whereas the UK, Italy and the Netherlands did not. The
Incentives: lessons learned

BEST attempted to develop direct contact with key decision makers and stakeholders to stimulate the development of effective incentives and implement, study and evaluate the use of these incentives. Sites concentrated on incentives relevant to their own local context (e.g. sites with local production addressed production incentives). A wide range of incentives were developed, including motor tax rebate, local purchase grants, free parking and access to restricted areas.

There was extensive focus on green procurement and in certain sites, direct financial incentives were offered by the national government (Sweden); regional government (Basque Country); and companies (Ford Netherlands). Only Sweden has achieved a national definition of a clean vehicle, which helps guide consumers and producers alike, though Rotterdam and Madrid make use of their own definitions. Distribution incentives focus on the extra costs of installing pumps to supply bioethanol. In Sweden, this is mandatory for larger service stations.

The BEST sites conclude that incentives on taxes and excise reduction to achieve competitive bioethanol prices have the strongest potential to achieve a market breakthrough, but that this requires national coordination and impacts directly on national treasuries. See BEST report D 5.14 Report Incentives - Incentives to promote Bioethanol in Europe and abroad. It is because costs of service, maintenance and fuel consumption are – alongside safety, comfort and performance - several of the most important factors for costumers when buying new cars.

Cooperation with stakeholders and political support are both essential to introduce effective incentives. Incentives must be adapted to reflect the different market stages. Clear signals will help key stakeholders – such as local agricultural producers or fuel suppliers – embrace clean vehicles and fuels. Further elaboration of these points, as well as information on the use of incentives at the different sites and analysis of measures, is included in D5.14 “Incentives to promote Bioethanol in Europe and abroad”.

experiences of the different sites and analysis of measures is included in D5.14 “Incentives to promote Bioethanol in Europe and abroad”.

52
Technical performance of the BEST cars

As part of the work in BEST, more detailed assessment of the performance of FFVs has been made. Fuel consumption was monitored in 83 flexifuel cars (76 Ford Focus FFVs and 7 Saab Biopower), and on an aggregated level the project monitored 167 cars (151 Ford Focus FFVs, 12 Saabs and 4 Volvos). These vehicles were operated by all BEST partners, sometimes by individuals and sometimes in car pools (multiple users). A wide range of users include the police in Somerset; home service for elderly and disabled, and fire inspectors in Stockholm; the Mayor of La Spezia; the Alderman and Councillors of Rotterdam; and the municipal waste company in Madrid.

FFVs are more efficient on the road than in the media

FFVs require change of oil between 1.5-2 times as often as petrol cars, depending on the manufacturer. The regular reporting on maintenance shows that no extra unscheduled maintenance was required by FFVs compared to conventional cars. Moreover, as described previously, BEST results indicate that FFVs use less E85 than assumed and are more energy efficient than petrol cars.

Emissions impact of FFVs in BEST

Based on the results of the technical assessment of closely monitored vehicles and BEST’s analysis of bioethanol supply chains, preliminary calculations for the CO2 impact per vehicle were made. The impact depends on variables such as vehicle fuel economy and life cycle emissions from supply chains, as well as the reported contributions of the different supply chains to total bioethanol sales at sites. The highest performing bioethanol used in BEST was produced from sugarcane in Brazil. The lowest performance came from Spanish wheat-based bioethanol produced in natural gas fuelled plants.9

The preliminary calculations suggest potential life cycle reductions of collective greenhouse gases of between 7 and 152 tonnes of CO2 equivalent, with the cars running purely on E85. The potential saving of 7 tonnes was based on bioethanol from the Spanish wheat, whereas a potential saving of 152 tonnes can be made if the bioethanol is supplied from Brazilian sugarcane.

By 2008, more than 67,500 flexifuel vehicles had been purchased at BEST sites. This corresponds to approximately 0.04% of the total European petrol car fleet and a potential reduction of between 6,500-142,200 tonnes of GHG emissions, assuming that all the vehicles run on E85 containing bioethanol from Spanish and Brazilian supply chains, respectively. This corresponds to approximately 0.01% of the total GHG emissions from transport in 2008. Since the vast majority of FFVs are used in countries using Brazilian sugarcane bioethanol in E85, the upper limit is more realistic.

Based on the above supply chains, and assuming that the closely monitored FFVs are representative of the EU fleet structure and driving habits, BEST found that:

If 10% of the EU petrol passenger car fleet is substituted by FFVs driving on E85 only by 2020, GHG emissions from the transport sector will potentially be reduced by 0.1- 3.4% in 2020.

If 50% of the EU petrol passenger car fleet is substituted by FFVs driving on the best E85 only by 2030, GHG emissions from the transport sector will potentially be reduced by up to 16% in 2030.


Please note that all projections for the future and for the 67,500 FFVs in BEST sites, assume that the FFVs use E85 only. Experience from Sweden shows that in 2008, the average Swedish FFV user

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fuelled E85 to 90 %. The figures thus represent the maximum possible GHG savings, rather than the actual. On the other hand, with better performing bioethanol in the future (in accordance with the Renewable Energy Directive) the potential greenhouse gas savings could be even bigger.

Implementation of WP1-Cars tasks 3-6

There were six tasks in WP1-Cars, each involving different sites. The City of Stockholm was responsible for coordinating activities within these tasks and facilitating cooperation between partners. Tasks 3-6 concerned:

3. Conversion of conventional vehicles to run on E85 and ED95
4. Test fleets
5. Hybrid electric vehicles using E25
6. Training of car dealers and service staff

The objectives, implementation and outcomes of these tasks are described in the following section.

Task 3 – conversion of conventional vehicles

**Participating sites:** Stockholm, Biofuel Region

**Objectives:** the task focused on conversion of three conventional petrol cars to run on bioethanol and evaluated the impact of conversion upon fuel economy, regulated emissions, greenhouse gas emissions, maintenance requirements and safety. Conversion of a conventional diesel car to run on ED95 was also attempted within the task.

BSR Sweden AB has converted conventional vehicles, representing different engine families, to Dedicated Fuel cars or flexifuel cars running on different fuel blends. The purpose of this task was to demonstrate that conversion of conventional fossil-fuelled vehicles to bioethanol could take place and met relevant standards for safety and emissions.

**Implementation - Conversion of petrol cars:** BSR has tested conversions and applied for certification for three Saab models (Saab 9.5 series, 2.3 litres turbo 2004 model; Saab 9.5 series 2.0 litres turbo 150 and 185 horsepower models), comparing performance with petrol and E85. The former was converted and tested for the BEST project, as was an Opel Signum and Chevrolet Colorado. The vehicles have also been tested for E10 for scientific reasons within BEST the E10 tests are, however, not included in the certification process.

**Outcomes - Conversion of petrol cars:** results show that conversions of conventional vehicles to run on E85 can make a significant contribution towards reduction of greenhouse gases and other emissions from the road transport sector. Analysis of hydrocarbons, aldehydes and fuel evaporation has also taken place – results are available in the report D1.20 “Emissions and experiences with E85 converted cars in the BEST project”.

Most emissions occur during the ignition phase, particularly for cold starts. This is because bioethanol lights less easily than petrol at cold temperatures, meaning more fuel is burnt during ignition. This increases CO and HC emissions. NOx emissions are generally low during the whole test cycle.

For all fuels - the catalyser does not begin immediately after ignition but must warm up. This means that, for around 10 seconds, HC, NOx and CO emissions pass through the catalyser (as the proportion of unburned fuel passing through the catalyser is high). After around one minute, the catalyser is fully operational.

Regulated emissions are measured from starting the engine, meaning bioethanol has high emissions of HC and CO. Once the catalyser is fully operational, HC and CO emissions reduce dramatically (the same is true for all fuel types). Moreover, bioethanol burns more efficiently than petrol and therefore, during the full cycle of an emissions test, maintains total emissions of HC and CO that are far below the statutory requirements.
During operation, lowering the fuel temperature of E85 will help to reduce NOx emissions but will cause a rise in HC and CO emissions. The rise in HC and CO emissions is explained by the fact that bioethanol has lower energy content per litre of volume compared to petrol and consequently fuel consumption is increased by 20-30%. An increase of 5% in engine power is permitted by the Swedish conversion regulation, although larger power increases could be achieved.

From a technical perspective, the BEST tests have uncovered no significant problems. There are differences in property between petrol and bioethanol and certain engine components may have to be changed in order to operate efficiently with E85. In particular, specific components may corrode or rust if exposed to bioethanol.

Nonetheless, providing conversion is carried out in accordance with the certification process and provided normal maintenance takes place thereafter, there is no evidence to suggest conversion to E85 will cause deterioration or declining performance. Conversions are guaranteed for five years or to 80,000 km. Outside of BEST, a Volvo test car has been driven for over 250,000 km after conversion to E85 without evidence of technical problems.

A conversion kit costs between €860-€1350 (9900-16000 SEK) and, since the regulatory process was finalised, over 200 kits have been sold. This number is significantly lower than expected. Sales of both E85 and conversion kits have been impacted by the global financial crisis and the sharp drop in oil prices in late-2008, which has placed bioethanol at a competitive disadvantage.

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**Box 2: Team Green Rally raised the profile of E85.**

By introducing a converted E85 rally car to competitive racing in Sweden, BSR have transformed the sport, winning the Swedish Sports Association’s 2007 environmental prize as a result.

When BEST began in 2005, 2 rally cars used E85, but now over 85% of Swedish rally cars use the fuel and motor sport’s governing body, the FIA, is considering making E85 the international standard for rally cars.

The high profile presence of Team Green Rally and BSR’s participation in BEST has undoubtedly helped to increase interest in E85 in Sweden and support market development.
Implementation - Conversion of diesel cars: BSR have demonstrated within BEST the world’s first conversion of a diesel car to run on ED95. The conversion requires increased compression for ignition and an altered fuel injection system. The test has revealed significant potential but some technical hurdles must be overcome before the conversion of diesel cars to run on ED95 can occur on a large scale.

As the conversion is an innovation, no specific regulations exist governing the technique. However, legal conversions can take place under the same conditions as E85 conversions. This means conversions can take place if the converted vehicle meets the requirements of an equivalent diesel car. Once the conversion technique has been perfected, it will be possible to rapidly introduce this process to the market.

Outcomes - Conversion of diesel cars

In addition to the conversion of petrol cars to run on E85, a Saab 9.3 diesel car was converted to run on ED95. The diesel engine is more energy efficient than the otto engine and therefore less consumption of fuel and less CO2 emissions are achieved when operating a diesel engine. There is a large fleet of existing diesel cars in Europe and the world in tackling a problem with diesel shortage. When refining oil you always get both petrol and diesel – currently the request for petrol is decreasing but the request for diesel is increasing. All of this calls for an interest to convert diesel cars to ED95. An ED95 powered diesel car has the opportunity to become a very clean and energy efficient vehicle. With the large fleet of existing conventional diesel cars in Europe the market and environmental benefits for conversions to ED95 are very large.

The conversion process began in winter 2008 with an assessment of the conventional diesel vehicle, in order to investigate the types of hardware and raw materials used in the vehicle’s components, such as the engine, fuel tank, pumps, fuel lines and injector. This information was combined with a study of Scania’s ED95 diesel engines and information from SEKAB on the properties of ED95, to develop a blueprint for mechanical conversion of the car.

Following this, the engine was removed from the car and reconstructed, enabling an increase in compression ratio by converting the combustion chamber. This is essential for the engine to start and function, because ED95 is harder to ignite than diesel. In a conventional diesel vehicle, fuel is compressed at a ratio of approximately 18:1 for ignition, but in the converted vehicle for ED95 this must be increased to 24:1-28:1.

Following the technical evaluation, BSR chose a compression ratio of around 24:1. The reconstruction of the engine was complex, not least because a range of components – such as pistons – needed to be replaced or altered as a result of the conversion. However, these components were difficult to source and had to be specially manufactured. Furthermore, after the mechanical reconstruction of the engine was complete, changes to software were required to adapt the vehicle for ignition.

However, once testing of the vehicle began, it became obvious that a consistent and controllable timing of the actual compression ignition represented a challenge. It was not easy to start the engine directly and time lags rose from between 10-30 seconds, causing increased emissions and making the converted vehicle impractical for users.

Software was adapted in an attempt to improve the performance of the car, sadly with limited success regardless what start sequence modifications were used. This suggested that the problems were mechanical.

BSR decided to make further amendments to the engine to find out if the start problem was related to the compression ratio and problems in igniting the fuel. New pistons were ordered to increase the compression ratio, but took several months to be delivered. Once these components arrived, the engine was rebuilt and software calibrated to the new compression ratio.

During the reconstruction, significant corrosion was observed on several components, but it was assumed that this was due to the fact that the vehicle had not been started or driven often during the development time and the wait for new components. Investigations revealed extensive corrosion to
several components, such as the injector, turbo aggregate, filters and exhaust. Despite the higher compression ratio, this problem reoccurred and despite intensive work to identify the cause, where almost all the engine’s outer components were replaced, the start problem has not been resolved.

In order to test all possibilities with the start problem, BSR restored the original compression ratio of 24:1 and built the engine again. Unfortunately, this did not help and BSR observed that key components such as the injector were aggressively corroded by the fuel. It is assumed that this is the main cause of the start problem.

Despite this, it should be pointed out that the car and engine have operated smoothly and driven approximately 2000 km under different driving conditions.

Planned emissions tested were delayed whilst components were replaced, but another round of testing showed a repeat of this rapid corrosion. Preliminary emissions results indicated that use of ED95 in converted diesel cars may offer significant potential to reduce a wide range of emissions. Together with Biofuel Region, the decision was made to postpone NEDC tests at AVL-MTC because the start problem was unresolved and seriously compromised CO and HC values (current regulations do not take account of the fact that in ED95, CO comprises mainly non-fossil CO and that HC is primarily alcohol emissions).

However, the tests within BEST have demonstrated that conversion of diesel cars to run on ED95 using today’s fuel and components is not viable. If conversion of diesel engines to run of ED95 is to occur on a large scale, a range of components must be adapted so that they do not corrode when using ED95. Alternatively, the properties of the fuel must be changed in order to make it less corrosive. The fact that Scania have adapted diesel bus engines to run on ED95 suggests this is possible but information is restricted due to commercial secrecy.

With further testing of this new technique, development of new components and/or changes to the properties of ED95, and the establishment of a certification system for conversions, it may soon be possible to speculate about the potential environmental benefits of large-scale bioethanol conversions for diesel. The BEST experience shows that investments in research and development for these technologies must be scaled up.

**Legislation and certification:** In 2005, the Swedish Road Administration began work to establish a regulatory process for E85 conversions. Legislation regulating the conversion of conventional vehicles to run on bioethanol came into force in Sweden on 1 July 2008, permitting conversion of conventional
vehicles to E85 under strict conditions. Certified conversion kits must fulfil the following requirements:

- Be supplied by approved companies (e.g. BSR) and be adapted to each motor family;
- Approved companies must have certified quality management systems and are subjected to annual tests;
- Converted cars must meet NEDC emission requirements for both petrol and E85. Car manufacturers currently have to prove petrol cars meet Euro 4 standards only for petrol, even if they have FFV function (no proof for E85 is required), but from 2009 Euro V standards will demand fulfilment of emission standards for both petrol and E85.
- On Board Diagnostics (OBD) cannot be impacted by the conversion;
- Power increases are limited to maximum 5%;
- The converting company must issue a certificate confirming all materials that come into contact with the fuel are suitable and take over the manufacturer’s guarantee for meeting exhaust regimes;
- A new vehicle inspection (MOT) must be carried out.

The establishment of this certification process took much longer than expected, meaning a delay in the implementation of the tasks. During the first year of the project, three cars were selected for testing and one Saab was converted and tested for emissions. However, conversion of the remaining two was held up until the legislation was finalised, so that the converted BEST cars comply with the new legislation.

This should not be interpreted in a negative way. On the contrary, the delay indicates formal recognition by the Swedish Government of the potential of bioethanol conversions, and establishes a legal framework regulating the activity. The conversions carried out within BEST comply with these regulations and demonstrate their potential utility in other countries.

This may result in the spread of bioethanol conversions across Europe. A similar process has already taken place with regard to conversions of vehicles from petrol to natural gas. A certification process was approved in Italy and thereafter spread to other countries, such as France, Germany and the Netherlands.

**Lessons learnt & contribution to EU policy-making:** three petrol cars were converted to run on bioethanol with no adverse side-effects in terms of performance or emissions. A diesel car was also converted but there is a need for further research and testing of this technique.

The EU has a higher proportion of diesel vehicles than Sweden, but the potential for conversion of petrol vehicles is enormous. BSR have learnt that Turbo models are easier to convert and use bioethanol more efficiently, meaning markets with large numbers of Turbo vehicles – such as Germany – are likely to be ideal locations for rapid introduction of conversion kits.

A regulatory framework and certification process have now been established in Sweden and use of conversion kits in five motor families has been approved. The approach taken and standards used by Sweden can be transferred to other EU Member States, in the same way that Italy’s regulatory process for conversion to natural gas has been adopted by other countries.

**Recommendations to policy:** The Swedish legislation could be amended to increase use of conversion kits. For example, the current regulations approve alternative fuels for single fuel or flexifuel vehicles but not for bi-fuel cars. The cost of bi-fuel conversions are the same as for single fuel conversions but much less than flexifuel conversions. Likewise, the requirement in the Swedish legislation that power increases are limited to a maximum 5% seems to act as a disincentive to improve efficiency (E85 has a higher octane grade than petrol and in optimised engines, fuel consumption can be reduced).
The regulations could also take account of the fact that 70% of CO emissions from E85 are non-fossil and a high proportion of HC is released in the form of unburnt alcohol. When factoring in increased fuel consumption when running on E85, the present regulations make it difficult for converted vehicles to comply with emission requirements, despite the difference in composition of CO and HC emissions compared to petrol. Some degree of differentiation is needed.

Definition of vehicles presents a similar problem. In the Swedish legislation, vehicles built after 1993 are defined as new vehicles when converted, meaning they must meet latest emission standards and performance must be guaranteed for 5 years or 80,000 km. In practice, this means older vehicles built between 1993 and 2002 may be hard or impossible to retrofit, because even if E85 delivers substantial improvements, the gap between old performance and new standards is too large.

Providing support and incentives for E85 conversions would significantly support the roll-out of the technology and contribute towards reductions of greenhouse gases and local air emissions. It is estimated that up to 500,000 vehicles (one eighth of the national fleet) could be converted to meet clean vehicle criteria in Sweden.

**Task 4 - test fleets**

**Participating sites:** Stockholm, Biofuel Region, Rotterdam, Somerset, Basque Country, Nanyang, Madrid, La Spezia, Brandenburg

**Objectives:** Through Ford and Saab, test fleets of flexifuel cars were established at the different BEST sites. The test fleets were established to increase knowledge of FFVs and inspire purchasing of the cars (not to conduct technical evaluation of performance). The aim was to encourage public bodies and companies to adopt flexifuel cars in their fleets. Test cars were offered at no charge for short periods (several days) from local Ford and Saab dealers, so that users could experience flexifuel cars and make informed decisions about the vehicles.

**Implementation:** With the exception of China and Sweden, test fleets were established at each of the BEST sites during the first twelve months of the project. Ford and Saab both supplied 1-2 vehicles per site or country. The vehicles were made available at local Ford and Saab dealers.

Ford Focus FFV demo cars have been available on request in Rome (covers La Spezia); Madrid (covers Basque Country); Rotterdam; Somerset; and Cottbus. In Stockholm, BFR and São Paulo demo Ford Focus FFVs are part of the standard offer. No Ford demo cars available in Nanyang or China.

Saab BioPower 9-5 demo cars have been available on request in Rome (covers La Spezia); Madrid (covers Basque Country); Amsterdam (covers Rotterdam); National Saab Representative UK (covers Somerset); Berlin (covers Cottbus); and Shanghai (not funded through BEST). In Stockholm, BFR and São Paulo demo Saab BioPower cars are part of the standard offer.

The Nanyang test fleet was established with Dongfeng cars (a Chinese automaker) late in the second year of the project, after the regulatory issues relating to supply of E85 in China (described in the Nanyang Case Study in this report) had been overcome. In Sweden, FFVs are an important part of normal product palettes and therefore specific test fleets were not required within BEST. However, test fleets with various kinds of clean vehicles have been implemented and used in the past, with positive responses and effects on the development of the clean vehicle market in Stockholm.

A majority of the test cars were tested by municipal public bodies and private companies. Many of the companies testing the vehicles had environmental connections or interest and to a certain extent, an interest in the bioethanol business could be observed amongst participants. Some tests were made by taxi drivers, private persons, representatives from NGOs and other vehicle manufacturers. Journalists and politicians also test drove the vehicles. In addition to their use as test cars for public bodies and private companies, the cars were also used during BEST events and seminars to demonstrate the vehicles.
The test fleets were marketed differently at different sites. In the case of Ford, the cars were placed on display at a local Ford dealership at most sites. However, for Saab and for Ford in La Spezia and the Basque Country, the test cars were placed in the national capital cities – Rome and Madrid, respectively. The sites conducted marketing of the test fleets locally through local websites, newsletters and local and national bioethanol events, seminars, workshops, conferences and exhibitions. During most of these events, test cars were displayed and shorter test drives were made possible for interested parties. It was usually possible to sign up for longer test periods at these events.

The managers of the test fleets were instructed to present each person that tested a car with a questionnaire, so that the driver’s opinion of the car would be recorded. A follow up was planned to see if the test drive actually lead to a purchase.

**Outcomes:** The impact of the test fleets was mixed. In the months that followed establishment of the test fleets, fleets were used less than expected by Ford and Saab. The initial absence of E85 filling stations in some locations was one reason for low usage. Another important factor was that the cooperation between sites and retailers differed according to location. This relationship is critical and can take time to develop, as both parties learn how to cooperate with each other in a mutually beneficial way.

Later it became clear that fleet managers had failed to distribute and collect the questionnaires from all drivers testing the vehicles. An investigation into low response rates shows that the test fleets had been well-used, but the response rate of questionnaires was low.

Those who did use the fleets and responded to the questionnaires reported very positive experiences. Many of the drivers were first-time users of flexifuel cars and the survey results indicate that the approach increased their confidence and interest in the vehicles. Saab report purchases of flexifuel cars in the UK, Spain and Germany by test fleet users.

Test drivers reported no significant problems with flexifuel technology and were satisfied with driving performance, noise, braking and acceleration, although increased fuel consumption was cited as a negative factor. Most drivers suggested they were prepared to pay a marginal extra cost (1%) to purchase flexifuel vehicles and 0-5% additional running costs.

A similar pattern was evident in China. The test fleet comprised two cars, operated by Tianguan Group, and any organisations or individuals interested in conducting a test drive could do so. The first vehicle was available for test drives from December 2007 and the second from March 2008.

Following test drives, 41 of 47 test drivers from five Chinese provinces answered questionnaires on flexifuel vehicles. Most drivers were satisfied with the performance and functionality of flexifuel vehicles but one third expressed concern at the rate of fuel consumption. However, few of the drivers seemed interested in purchasing flexifuel vehicles, irrespective of the vehicle price. The project team attributes this to lack of fuel infrastructure.

In Rotterdam, the city themselves organised a test fleet which was mainly used for internal testing (though some external tests took place). These cars were managed by city employees and local evaluation shows that these cars were very important in convincing city fleet managers to adopt flexifuel cars in their fleets, as well as in raising awareness of flexifuel cars and bioethanol as a fuel in Rotterdam.
Photos 12 and 13: an FFV test car from Dongfeng in Nanyang. Source: Site

**Recommendations:** BEST has found that test fleets can influence purchasing decisions in public bodies and private companies and that test cars are very important when it comes to marketing and information - seeing is believing.

Experiences from BEST show that including test cars at an early stage in campaign events can increase awareness and generate media attention. However, it seems difficult to initially engage car dealers when the car sells in very low volumes. In the future, stricter routines could be applied to ensure a high response rate to questionnaires. Methods such as direct interviews could be used to obtain higher response rates. In addition, one should carefully consider who should manage a test fleet, especially in the developmental stage when very few sales can be expected and therefore the dealers’ interest is low.

Further information on the test fleets and the results of the surveys can be found in D1.09 “Report on the experiences from the NanYang test fleet”, D1.10 “Report on experiences from the Ford test fleets” and D1.11 “Report on the experiences from the Saab test fleets”

**Task 5 - electric hybrid FFV cars**

**Participating sites:** São Paulo

**Objectives:** this task aimed to evaluate the pollutant emissions and fuel consumption of an experimental fleet of three hybrid electric vehicles (HEVs) during demonstrations in the city of São Paulo, when using an E25 blend (25% anhydrous bioethanol, 75% petrol). In Brazil all petrol has an ethanol low blend of 22 – 25 %. All vehicles, hybrids as well as others need to be able to use this standard low blended petrol fuel if they are to operate in the country.

The task involved investigating application of new dedicated testing methodologies for HEVs, identifying barriers to the deployment of HEVS, technical issues relating to HEV technology, promotion of government incentives to support the technology and stimulation of research, production and marketing for HEVs.

**Implementation:** Toyota do Brasil has completed the initial maintenance of the fleet and provided a dedicated training course to the drivers in November 2008. Furthermore, the detailed methodologies for emission tests and vehicle field tests have been finalised. The correction coefficients of the batteries have been defined in order to make test results of the three different HEV fully comparable.

According to the Brazilian Standard ABNT NBR 14008, emission and fuel consumption test of vehicles must comply with a standardized driving cycle. Tests are usually performed after 80,000
km of on-road operation, and emission limits to be respected are established by the Brazilian “Motor Vehicles Air Pollution Control Program” (PROCONVE).

The measurements within the BEST demonstration activities were performed after 40,000 km of on-road operation and the emission test results were compared to the limits set by PROCONVE. Three driving cycles in urban and overland traffic were defined by PETROBRAS, BR, TOYOTA and FUSP, namely two driving cycles in São Paulo and one cycle in Rio de Janeiro.

**Outcomes:** Three HEVs were tested as part of BEST in urban and rural conditions. A 2002 Prius was driven in 32 tests for almost 20,000km, consuming 6.75 litres per 100km. A 2005 Prius was driven in 7 tests for over 4,000km, consuming 5.7 litres per 100km, suggesting that the more modern vehicle achieves better performance. A third 2002 Prius was also tested, but no data was available on these tests as of October 2009.

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<th>Fuel (litres)</th>
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<tr>
<td>2002 Prius</td>
<td>32 tests</td>
<td>1303.8</td>
<td>19327,3</td>
<td>14.8</td>
</tr>
<tr>
<td>2005 Prius</td>
<td>7 tests</td>
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<td>4207.5</td>
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The results indicate that HEVs compare favourably with other vehicles and offer significant potential for further development. Important lessons have been learnt. The dedicated emission and fuel consumption tests for the HEVs indicate that, in addition to the correction of battery coefficients, modification to the serial-production electronic fuel injection system of the Toyota Prius petrol engine is required.

As shown in Figure 18, correcting the battery coefficients appears to have a positive effect on emissions (g/km) and increase range (km/litre). The same is true of the battery load – emissions are reduced and range increases if the battery is close to maximum charge (shown in Figure 19). When the battery is low, more E25 is used. As E25 contains three-quarters volume petrol, this causes a rise in carbon dioxide emissions.
Figure 18: Non-corrected and corrected emission and fuel consumption figures. The brown bars indicate various emissions and kilometres per litre when the battery coefficients have not been corrected, the blue bar indicating the performance after correction of battery coefficients.

Figure 19: Emission and fuel consumption at different conditions of battery charge. The brown bars indicate various emissions and kilometres per litre when the battery is fully charged, with the blue bars indicating the same results when the battery is on a minimum charge.
As shown in Figure 20, the HEV also has a significant impact on other air emissions and easily meet air quality standards in Brazil, the USA and the EU.

![Graph showing emission and fuel consumption](image)

**Figure 20:** The corrected emission and fuel consumption figures (sky blue) are compared with established emission limits of Brazil (purple), USA (brown) and Europe (yellow). The first results of the HEV demonstration are significantly below the indicated limits.

More information on technical aspects, testing methodologies, driving cycles, etc. is included in the “Report on Experiences of HEV Demonstration in São Paulo, October 2009”.

**Recommendations:** Within the fleet implementation, substantial delays were caused by obligatory bureaucratic procedures. It was necessary to negotiate an agreement between the local project partner CENBIO/IEE/FUSP and the major stakeholders Toyota do Brasil, PETROBRAS and the fuel distributor BR (subsidiary of PETROBRAS).

Due to the fact that every single modification to the agreement had to be analyzed and accepted by the legal departments of all partners, the overall negotiation process was very complicated and time-consuming. The participation of two PETROBRAS departments increased the complexity. Further delays were caused by the unexpected replacement of directors who had already signed the agreement. The official agreement was essential to provide the legal and regulatory base for licensing and insurance of the HEV vehicles.

Future projects must establish legally binding agreements between the various partners at a much earlier stage. This work can be complicated and labour-intensive. If delays occur, these are likely to generate further delays, as personnel, legislation and other circumstances change.

The following pictures show the Prius HEV during the process of conditioning of the battery prior to emission and fuel consumption tests.
Photo 14: Prius HEV owned by Petrobras during the conditioning of the battery. Source: Petrobras, 2008.

Photo 15: Prius HEV owned by Petrobras during the conditioning of the battery. Source: Petrobras, 2008.
Photo 16: Electronic devices to measure the charge level of the battery. Source: Petrobras, 2008.

Photo 17: Electronic devices to measure the charge level of the battery. Source: Petrobras, 2008
Task 6 - Training of car dealers and service staff

**Participating sites:** Stockholm

**Objectives:** Generating knowledge about flexifuel technology and bioethanol fuels and training staff to provide quality sales and maintenance service helps to increase consumer confidence and assist market development for FFVS. In this task, Saab and Ford developed training material and arranged courses at BEST sites to educate local Saab and Ford dealers and service staff about bioethanol technology and requirements for distribution and service of flexifuel vehicles.

**Implementation:** for the successful introduction of a new car concept, it is essential that personnel at all dealers are trained to sell the new cars. This is especially important to companies that do not sell directly to customers, but make use of dealers. As a key link in the chain between manufacturer and consumer, dealers have the power to recommend particular vehicles and influence customer choice. If dealers and sales personnel have sufficient knowledge of flexifuel technology, they may be more likely to recommend flexifuel vehicles. Likewise, service staff must be trained to maintain and repair flexifuel cars.

Ford dealers are independent enterprises, with cooperation based on agreements. Dealers have to prove that they carried out a certain number of trainings each year. However, what type of training the dealer chooses to undertake is up to them and Ford has no means of enforcing training in a specific topic area. That said, Ford has used competitions to encourage training in flexifuel vehicles.
During the first months of the BEST project, training material for Ford and Saab sales and service staff members was developed on a European basis and improved and adjusted by the different markets. Locally-adapted materials included country-specific information on issues including taxation, incentives, filling stations, etc. Ford made particular use of these materials in Sweden.

Outcomes: a specific problem was identified early on in the project. Early-adopters of FFVs tend to know a great deal about the technology and therefore can be perceived as “problem” customers by dealers who perhaps have only superficial awareness. This can damage the relationship between dealer and buyer. Over time, as the dealer becomes more familiar with FFV technology, this problem is corrected but the problem can be to a large extent avoided with early training of dealers.

Training activities were carried out on an ongoing basis throughout the project by Saab and Ford. Training of Ford service staff focused on the technical differences between flexifuel vehicles and conventional vehicles. Personnel were shown how to maintain and repair flexifuel vehicles; trainings covering the environmental and safety issues relating to bioethanol were also carried out.

Training of Ford sales personnel focused on increasing awareness of environmental issues and the implications of using bioethanol fuels. Moreover, the technical differences between flexifuel cars and conventional vehicles were highlighted, in particular issues regarding fuel consumption and pricing. In mid-2007, the emergence of the “food versus fuel” debate prompted Ford to adjust training materials, giving extra emphasis to sustainability issues.

The most important training materials have been identified as special flexifuel booklets, question and answer pamphlets, presentations, articles in dealer magazines and interactive materials, including a DVD and online information, including online tests. Materials were made available to personnel at all dealers, with each dealer’s management responsible for implementing training. A large amount of information materials were distributed to staff and customers, informing them about flexifuel cars.

Ford declares itself happy with the training programme and results in all BEST sites. In particular, Ford learnt that whilst training dealers on technical innovations is important, it is also critical to train staff on environmental and social impacts of the new technology. The training model demonstrated in BEST will be used for future introductions of new vehicle technologies.

Further information on the activities carried out by Ford is available in D1.07 “Ford Training of car dealers and service staff by Ford” and by Saab in D1.8. Report on the experiences of training car dealers and service staff by Saab.
Problems and opportunities

Fuel standards and safety

There is currently no standard for E85, creating two problems which directly impact upon efficient use of E85 as a vehicle fuel.

First, there are variations in the form of E85 used in different EU States – these may include the feedstock used, production processes, properties, blend, etc. This makes it difficult to assess life cycle sustainability and contributes towards variations in functionality. Vehicle manufacturers report that different forms of bioethanol impact machinery in different ways and at different speeds. Therefore, technical solutions also vary.

This lack of uniformity in fuel type contributes towards the second problem – that cars are not optimised for E85 but make use of conventional technologies that are adjusted to permit use of E85. This means there is some scope for further efficiency improvements, through optimisation of FFVs and single fuel cars using E85. However, this is at least partly dependent on the introduction of an E85 fuel standard. Without the latter, manufacturers and consumers can use uncertainty and variable performance as justifications to avoid production or purchase of E85 fuel or vehicles.

Another problem relates to the classification of alcohol in different countries. Bioethanol is sometimes classified as a fuel, sometimes as a chemical (due to the additive in the fuel) and sometimes as a food product. This affects the taxation placed on the fuel and the extent to which use is permitted in different circumstances. E85 and ED95 must be approved by national authorities to permit sales. Related to permitting, procedures and regulations for safe handling of the fuel are required. The BEST sites have found that once these procedures are established, safety risks are manageable. The fuel can be handled in the same way as other fuels. However, in the start-up phase, local governments may need help develop and formalise safety procedures and regulations in their country.

For more information see the BEST final report from WP4 Distribution of ethanol fuel.

Filling stations

BEST sites have shared the experience of a “catch 22” moment in their implementation of tasks. E85 filling stations are unlikely to be constructed if few cars operate on bioethanol; consumers will not purchase bioethanol cars if they cannot access fuel supplies; and few manufacturers will deliver a product to a market without consumers. By bringing together manufacturers and consumers, the BEST project aimed to overcome this “first-mover” problem.

The sites have delivered mixed results, for a wide variety of reasons. In Sweden, national legislation obliges filling stations of a certain size to install alternative fuel pumps. This has had a profound effect on the market as it signalled to consumers that their access to alternative fuel supplies would be increased across the country. Other sites have encountered problems in this area, described in the “Case Studies” earlier in this report.

A general conclusion of the project is that strategies to introduce alternative fuels and clean vehicles must be integrated and address the issue of filling stations in parallel to and in synergy with other issues, such as local production of fuel or sales of vehicles.

For more information see The BEST experiences with distribution of bioethanol for vehicles (2009).

Governments as facilitators

In Sweden, the Netherlands and Spain, BEST has contributed towards the stimulation of the bioethanol car market and increased demand for E85. The successful development of the bioethanol
market in Sweden is perhaps the best example of this. Moreover, the overall impact of BEST has been to raise awareness of E85 as a viable transport fuel in Europe.

However, it is important to recognise that BEST is only one part of a complex chain, of actors, decisions, regulations, etc. The BEST project has at times benefited and at times been held back by decisions (or lack of decisions) from different levels of government. Governments can facilitate the development of functioning markets, but must send the right signals to all stakeholders.

In Sweden, positive and recurring Government actions have helped boost E85 sales, whereas in other countries, problems with technicalities or contradictory recommendations have hindered the development of bioethanol markets. Related issues include taxation, incentives, standards, safety and data.

For more information see BEST report D.5.14 Report Incentives - Incentives to promote Bioethanol in Europe and abroad.

**Recording sales of FFVs**

In contrast to other BEST countries, FFV vehicles are not recognised in the national car register in Germany, creating a “chicken and egg” situation where fuel suppliers lack information about consumer behaviour and the potential size of the market for E85 and policy-makers gain no insight into which incentives or policy changes are required to stimulate uptake of bioethanol.

As policy-makers cannot see a market for FFVs and E85 in the data they receive, they may be inclined to think that a market does not exist. Such an assumption – although based upon the available data – would be misleading and inaccurate. A large group of potential E85 users may exist, but the system would be unaware of their presence.

Moreover, this risk is enhanced when the price of bioethanol is higher than that of petrol per kilometre. The experiences of BEST show that price is a key determinant of E85 sales and therefore, if petrol is cheaper than E85 per kilometre, there will lower sales of E85 – irrespective of the number of flexifuel vehicles. If the only observed trend is negative (low E85 sales), policy-makers may jump to the wrong conclusion and think that consumers do not want E85 and that, as a result, there is no need to provide incentives for FFVs and/or E85.

This illustrates another problem, that non-recognition of FFVs in the national car register makes it harder to offer incentives to both FFVs and E85 fuel and to monitor and evaluate the impact of incentives after their introduction. Non-recognition of FFVs hinders development of E85 fuel supply infrastructure, as fuel suppliers have no data on market potential and therefore no strong incentive to introduce bioethanol fuels.

Incentives have proven themselves to be an important factor in stimulating and enabling market change. Therefore, restricting the scope and potential of incentives directly impedes introduction of FFVs and E85.

The vagaries of data collection should not be allowed to dictate or misdirect policy on such a critical matter. Recognition of FFVs in national car registers is an essential step to enable understanding of markets and to develop appropriate mechanisms to stimulate increased use of E85. This will have positive impacts for the environment and economy in the EU.

**Performance and reliability**

The flexifuel vehicles demonstrated within BEST have performed consistently. The regular reporting on maintenance shows that no extra unscheduled maintenance was required by FFVs compared to conventional cars. There have been no reports of major problems with performance or reliability at any of the sites, nor were such problems reported in the driver or fleet manager surveys.

The major inconvenience of FFVs is increased fuel consumption compared to a conventional vehicle. FFVs use 20-30% more fuel in volume when running on E85 compared to when run on petrol, because
bioethanol has lower energy content per litre than petrol. However, E85 has a higher octane value (approximately 104) than petrol, meaning the fuel burns more efficiently.

At present, FFVs are essentially modified conventional vehicles. If engines could be adapted to this higher octane value and optimised to run on bioethanol (instead of on petrol or diesel), fuel consumption from bioethanol cars could be reduced in the future.
Sustainability

The BEST project’s objective is to demonstrate the use of bioethanol as a transport fuel. Since the project began, global consumption of bioethanol has increased, leading to debate regarding the sustainability of bioethanol production and the extent to which bioethanol can substitute fossil fuels in the fuel mix.

In particular, the indirect impacts of land use change have been analysed by reports including the Searchinger et al (2008) paper and the subsequent Gallagher Report in the UK. The findings of these reports have been the focus of intense media debate and often misinterpretation.

A certain amount of public unease about biofuels has emerged, perhaps as a consequence of these reports and related media reports. Whilst aspects of this may reflect a lack of knowledge or in some cases, knee-jerk reactions or special interests, the uncertainty regarding the sustainability of biofuels must be resolved if fuels like bioethanol are to achieve wider market penetration.

As part of the BEST project, WP9 has carried out reviews of the socio-economic and environmental impacts of biofuels. Broad sustainability assessments are covered in deliverables D9.11 and D9.15 “Sustainability Report” and D9.18 “Report on Sustainability Assessment”, which presents an update on the current debate surrounding the sustainability of biofuels.

The Sustainability Assessment is focused on assurance and certification systems being developed in the EU and around the world. Specific environmental impacts of bioethanol are considered in D9.14 “Review of fuel ethanol impacts on local air quality” and D9.21 “Report on life cycle greenhouse gas impacts of ethanol supply chains at BEST sites”.

The sustainability assessment provides a unique opportunity to examine and implement several aspects of a sustainability framework and test the possibility for certification to be applied in Europe in response to the growing demand resulting from the implementation of the Biofuel Directive 2003/30/EC. The BEST sustainability assessment contributes to improved understanding of key considerations needed to form policies appropriate for market development of biofuels in Europe.

The certification and verification systems ongoing in Europe and worldwide are already influencing the policy in Member States and the EU commission regarding the sustainable production and use of biofuels. Although the main criticism for the UK Renewable Transport Fuel Obligation system is the lack of reward or penalties for non-compliance, the main concerns lay on the current reporting methodologies that do not adequately reflect the actual impacts of increased production of biofuels.

Tools and methodologies to meet the new demands with the awareness of the social, economic and environmental impacts for all transport fuels need to evolve and mature as the market continues to develop not only in Europe but also worldwide. This will contribute towards the development of a level playing field for all transport fuels in which life cycle costs are accurately represented. The BEST project sustainability assessment of these issues contributes towards better understanding of these complex issues.

In addition to D9.11 and D9.15 “Sustainability Report” and D9.18 “Report on Sustainability Assessment, several other sustainability studies were concluded in BEST. D4.11 “Report on the consequences and sustainability of the long-term production and supply of ethanol from cellulose (from forest residues and crops/wheat) in the participating cities/sites and in some regional markets in Europe” was prepared by Umeå University in Sweden as part of WP4.

The environment impacts of bioethanol were assessed in D9.10 and D9.14, with D9.21 reporting on “Life cycle greenhouse gas impacts of ethanol supply chains at BEST sites.” “Progress on Sustainability” was reported in D9.23.
**Box 3: Verified sustainable ethanol**

SEKAB is a municipal-owned company that set its own criteria for sustainable bioethanol, which was independently verified. Sales of the world’s first verified sustainable bioethanol (E85 and ED95) began on the Swedish market in August 2008. The product is produced in Brazil and a total of 58 million litres of E85 were sold in the first three months.

Link:  [www.hallbaretanol.se](http://www.hallbaretanol.se)

Conclusions

**FFVs are a viable transport solution**

The vehicles introduced in BEST have worked very well at all sites and have been appreciated by drivers and fleet managers, demonstrating that flexifuel vehicles running on E85 can play a key role in the transition to a non-fossil fuel transport system.

New techniques to convert conventional vehicles to run on bioethanol and a hybrid electric vehicle running on E25 have been demonstrated. The price of bioethanol per kilometre compared to fossil fuels remains a key determinant of levels of E85 consumption, as petrol contains higher energy content than bioethanol and as a result, cars running on bioethanol consume more fuel. However, within BEST flexifuel vehicles consumed less fuel than previously thought.

Sustainability is a key concern for all transport fuels. Standards and certification for sustainable biofuels are being developed and well-to-wheel analysis of all fuels is needed. Likewise, safety is an important issue that must be taken seriously. Procedures for handling and storage of bioethanol must be in place – or developed – to ensure safety and accident avoidance.

**Contribution of clean vehicles procured within BEST**

The vehicles procured within the BEST project have contributed substantially to raise awareness of flexifuel vehicles and trust in the technology. Developing markets have emerged in several sites, with increased availability of clean vehicles and fuels changing patterns of behaviour.

This has had impact beyond the project sites, with other cities and countries (such as Ireland and France) deciding to implement clean vehicle and fuel policies and seeking to follow the BEST example. A soon-to-be-released report in the United Kingdom will highlight BEST as the template for large-scale introduction of high blend bioethanol in the UK and the project was nominated for awards including the Sustainable Energy Europe Campaign Award for 2009.

Moreover, results from WP1 have demonstrated that users are satisfied with the performance and reliability of flexifuel vehicles, although the higher rates of fuel consumption are a recurring concern. A critical issue in all countries is the price of bioethanol compared to petrol. This issue must urgently be addressed if the EU is to develop a strong and sustainable market for bioethanol fuels and flexifuel vehicles.

Conversion of conventional petrol vehicles to run on bioethanol has been proven to be technically possible at a reasonable cost and meet or exceed emission standards. A certification process for conversions has been established in Sweden. The technique and regulatory process can be easily transferred to other EU states, in the same way Italian legislation on conversion of vehicles to run on natural gas has been adopted in other countries. Moreover, a diesel vehicle has been converted to run on E95. With more research and testing, technical hurdles may be overcome, enabling this technique to be applied on a larger scale.

Hybrid electric vehicles running on E25 have been tested in Brazil and demonstrated positive initial results. It is hoped that HEVs tailored to use bioethanol blends will soon become widely available. This, together with the conversion techniques, represents a significant contribution towards technological development from the BEST project.

Test fleets were established at each site and helped introduce potential users to flexifuel vehicles. The test fleets highlight the important contribution of vehicle manufacturers Ford and Saab to the project. The cooperation between the various actors in the consortium was effective and the input and assistance from industry was greatly appreciated. The BEST project helped different actors come to better understanding of their peers and facilitated great opportunities for learning and exchange.
The regular reporting on maintenance shows that no extra unscheduled maintenance was required by FFVs compared to conventional cars. Procedures and regulations for safe handling of the fuel are required but the BEST sites have found that once these procedures are established, there is no safety risk with bioethanol. The fuel can be handled in the same way as other fuels. However, in the start-up phase, local governments may need help develop and formalise safety procedures and regulations in their country.

**Achievement of BEST objectives**

In statistical terms - from both a project perspective and at certain sites – the BEST project has been a great success. BEST originally aimed to achieve the introduction of 9,941 flexifuel vehicles but by June 2009, a total of 77,000 flexifuel vehicles had been introduced at the project sites during the project lifetime. The flexifuel vehicles introduced within BEST represent around 45% of the approximately 170,000 new flexifuel vehicles recorded in the EU car registry during 2005-2008.

This means that collectively, the BEST sites are forerunners in the EU. However, at the site level, results vary considerably within BEST. Four sites – Stockholm, Biofuel Region, Rotterdam and Madrid - appear to have achieved partial market breakthroughs for flexifuel vehicles and E85, whereas others have had more limited success. A degree of variation between the sites is natural and was anticipated. Each site began the project with different levels of development, meaning expectations and objectives varied accordingly.

Despite this, many sites have reported a general sense of frustration at missed opportunities or obstacles to further progress. In particular, failure of national governments to ensure competitive pricing for bioethanol and other alternative fuels has been cited as a recurring problem that limits the chance of increased and accelerated market penetration for flexifuel vehicles. Consumption of E85 is directly linked to its price (per kilometre) compared to fossil fuels. In contrast, there is no such correlation between ownership of a flexifuel vehicle and use of E85 fuel. In several sites, consumers have been prepared to purchase flexifuel vehicles if there is little or no additional cost. However, the majority will use the most competitively priced fuel. For example, in Rotterdam sales of flexifuel vehicles have flourished whilst E85 sales remain relatively low, as the price of E85 in the Netherlands is very high.

This means the EU fleet of flexifuel vehicles will only deliver sustained reductions of carbon dioxide emissions if E85 is cheaper or comparably priced to fossil fuels. Having said this, the increasing numbers of flexifuel vehicles in the EU must be seen as a positive development, as it creates the possibility for a rapid switch from fossil fuels to sustainable biofuels. Therefore, it is important to distinguish between the potential of flexifuel vehicles and the present reality.

**Sustainability**

Another issue that must be resolved is the debate over sustainability of biofuels. BEST has contributed to this debate with analysis, reports and awareness-raising activities. Whilst project participants welcome this debate as a natural and valid step in the development of the bioethanol market (and indeed, the markets for all goods and services), most sites expressed concern at tone of media coverage on this theme.

The sustainability debate has often been driven by parties with their own interests. Whilst the spotlight has shone brightly on biofuels, the larger and more important debates - about the sustainability of all fuels and the urgent need to increase efficiency and reduce the volume of transports whilst introducing the most sustainable fuels as a replacement for fossil fuels – have been somewhat neglected.

Political and ethical questions, rather than science, have come to dominate much of the discussion. In certain instances, this has made it hard or impossible for politicians to introduce local measures which could support the BEST project.
Definitions and standards
A clean vehicle definition is helpful as it provides a clear benchmark against which consumers and manufacturers can assess their choice of car. This can facilitate green procurement and joint procurements. Clean vehicle definitions used in Sweden, Rotterdam and Madrid are included as an Annex to this report, along with a summary of the Swedish conversion legislation and safety regulations.

Existing definitions, standards and regulations could be transferred from one country to others within the EU, creating a level playing field and reducing the administrative burden of starting from zero in each Member State. This would help to accelerate market change. Additionally, new standards are required to enable easier market access for bioethanol and more sustainable market conditions over the long-term. For example, bioethanol should be treated differently to petrol when testing vehicles. At present, there is no standard procedure for bioethanol, meaning the fuel is tested as petrol.

These regulations are indicative of the types of definitions and standards that have to be developed to introduce flexifuel vehicles and E85 to a new market.

Cost, tax and incentives
Accounting for increased fuel consumption, consumers are less likely to purchase E85 if it is more expensive than petrol, even if they own a flexifuel vehicle. In the same way, fuel suppliers are unlikely to supply a product if they feel there is no market. If there is no fuel supply and no demand, vehicle manufacturers will be less inclined to deliver flexifuel models. Thus, a degree of intervention or obligation is required to stimulate the market and enable bioethanol to establish itself as an alternative transport fuel.

The BEST project set out to overcome this “first mover” problem by simultaneously introducing vehicles, fuel supply and identifying consumers. Nonetheless, the common experience of BEST sites is that when E85 is available, the price of bioethanol compared to fossil fuels is critical to the volume of E85 sold (if you are to obtain followers outside of the public fleets).

All sites suggest that support, in the form of reduced excise or other incentives, is required to ensure price parity. Alternatively, it may not be that support for bioethanol is required, but rather that support for fossil fuels is removed or excise based on carbon dioxide emissions should be introduced.

At the city level, the BEST project has demonstrated that cities can utilise local instruments and their influence to help develop markets. Cities can act as catalysts with activities that reach beyond their municipal administrations. This requires co-operation with strategic public and private partners and constructive dialogue with government authorities. In order to achieve results there is a need to work systematically and to have a long run commitment. It is essential to include both vehicle supply and fuel infrastructure as critical components of city policies.

Monetary incentives are an important part of an overall policy to promote clean cars. The bioethanol cars in BEST have all shown to be just as reliable as conventional cars. However, different types of user groups emerge in different market phases. Therefore, when assessing the strength of incentives it is important to distinguish between different market phases.

This may mean that certain types of incentives are required to stimulate innovators whereas later in the market development process, incentives will focus on stimulating markets. Preparing the market with incentives will address the lack of vehicles, missing infrastructure and improve regulatory and tax conditions, thus enabling financial incentives to be introduced to stimulate a market that is ripe for development.
Recommendations

In December 2008, the European Parliament voted in favour of a proposed Directive for the use of energy from renewable sources. The Directive will establish an overall binding target of a 20% share of renewable energy sources in energy consumption and a 10% binding minimum target for biofuels in transport, to be achieved by each Member State.

In general, the BEST sites have observed a stronger preference in the EU for low blends than high blends. However, the BEST experiences suggest that it will only be possible to meet the 10% target and begin the journey towards achieving the levels of greenhouse gas emissions called for by scientists if high blends of biofuels, such as E85, are introduced on a larger scale.

The BEST sites recommend that:

- Politicians take the lead and endorse proactive policies to enable wider use of clean vehicles and fuels.
- Flexifuel vehicles become the standard and are obligatory for all new petrol cars sold in the EU.
- Flexifuel pumps delivering petrol and blends of bioethanol up to E85 are made standard.
- Fuel taxation should reflect greenhouse gas emissions across the lifecycle and favour alternative fuels when priced per kilometre.
- Research and development into diesel conversion and hybrid electric techniques is scaled up.
- Standards and certification processes for sustainable transport fuels are finalised and implemented.

Guidance to cities

It is possible for a city to influence the market spread of clean cars. This calls for a decisive leadership at the local/regional level. Cities need to focus on creating or promoting the supply of vehicles, fuel provision and fuel infrastructure. Cities should recognise that their clean vehicle strategy is a long run commitment. It is also important to prepare for the next stage by identifying and reducing legal barriers. In order to identify barriers it is essential to test and demonstrate vehicles in real world situations, but putting large numbers of vehicles into operation at this stage is neither feasible nor desirable at this stage.

It is not uncommon for projects to run into difficulties during the beginner stage. General difficulties include high purchase costs, technical problems, an underdeveloped refuelling network, difficulties with fuel supplies, requirements such as double inspections and tax disadvantages. Project management and project partners need strong commitment to its goals.

Policies and incentives must reflect and be adjusted to the stage of market development. In the initial stages, the city primarily needs to focus on replacing a restricted number of vehicles in its own fleet. It is useful to co-operate with other partners who test vehicles, but the choice should be limited to devoted pioneers who are prepared to cope with possible difficulties. The number of vehicles is of secondary importance until barriers have been overcome. It is much more important to co-operate with strategic partners, including other cities, fuel producers and providers. Other key partners include vehicle suppliers, service providers and test centres.

The city needs to collect information and experiences from its own fleet managers, test drivers and partners in order to identify complicating circumstances. These experiences should be documented and communicated to relevant actors at the national, regional and local levels.
Adopt a Clean Vehicle Strategy: take four steps towards large scale implementation of clean cars!

There are many possible routes towards introduction of clean vehicles and fuels – here is an example of how Stockholm has worked and how your city can follow.

1) Start with heavy vehicles operating in fleets (i.e. public transport buses, waste collection trucks). Heavy vehicles are the largest polluters in a city so large environmental benefits can be achieved. When operating in fleets they use only one filling station at the depot where they return to every evening. One filling station for ED95 at the depot is therefore enough and no widespread net of filling stations is required for this first step.

2) Introduce clean cars in the fleet of cars owned by the municipality and operated by the municipal employees in their day to day work. Make sure to get own experiences and practice as you preach. Make sure that all new cars bought or leased to the city fleet are clean – set targets for this and set strict requirements on the employees to refill with alternative fuel.

3) Inspire others to obtain followers. In this step it is important to work with information and incentives. Arrange seminars and workshops with test driving for specially identified target groups (i.e. private companies with lots of vehicles and an environmental profile). Work to obtain favourable prices for the fuel. Find, introduce and push for primarily economic incentives and secondly incentives that favour clean vehicles in other ways.

4) Start to demand clean vehicles in all kinds of procurements where vehicles are involved, i.e. taxi services, school transports, mail delivery and courier services, security services.

Box 4: Four steps to introduce clean vehicles and fuels, based on example from City of Stockholm.

In order to promote fuel distribution, there is a need to identify strategic partners, including producers, providers and retailers and to initiate co-operation. To some extent market mechanisms can help cities develop refuelling capacity. Existing infrastructure for petrol and diesel can be converted to supply liquid fuels including bioethanol and RME at a relatively small cost. Cities will need to identify existing fuel suppliers interested in committing themselves to supply alternative fuels.

BEST sites have experienced that small independent fuel distributors can become pioneers in supplying E85. These chains may have no own interests in oil fields and therefore have greater scope to supply alternative fuels, if sufficient numbers of vehicles and customers exist in the market.

Joint procurements can be a powerful tool when vehicles are missing or when the cost of existing clean vehicles is high. Buying in bulk together with other cities can raise volumes to a level at which producers can offer lower purchase or lease costs and in Sweden and Madrid this has led to the introduction of new clean cars to the market. Market research to find available vehicles among car dealers and general agents should be carried out before engaging in joint procurement.

In order to ensure sustainable production of all fuels, cities (and others) need to put demands on their suppliers when procuring fuel. Since there is a need to develop interaction between vehicle sales and fuel supply it is advisable to try to find ways to co-operate with both car producers or general agents and fuel suppliers.
References

D1.2. Annual data collection 2008 of aggregated data from each BEST site
D1.4. Number of ethanol vehicles (E85) sold and prognosis for the coming year
D1.7. Report on the experiences of training car dealers and service staff by Ford
D1.8. Report on the experiences of training car dealers and service staff by Saab
D1.9. Report on experiences from the test fleets in Nanyang
D1.10. Report on experiences from the Ford test fleets
D1.11. Report on experiences from the Saab test fleets
D1.12. Report on the experiences of HEVs on ethanol - test results and drivers experiences
D1.14. Report on drivers attitudes toward FFV based on questionnaires to drivers in all participating sites
D1.20 Emissions and experiences with E85 converted cars in the BEST project
D5.2. Promoting Clean Cars Report
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List of appendices

Appendix 1: Clean vehicle definitions – Stockholm, Rotterdam and Madrid
Appendix 2: Summary of the Swedish regulations concerning conversion of conventional vehicles to run on bioethanol
Appendix 3: Summary of relevant safety regulations from Sweden
Appendix 4: Nationally accorded green procurement procedure, The Netherlands (BEST Deliverable 5.15)
Appendix 5: Linkage between incentives and sales of FFVs.
Appendix 6: Annual data collection 2008 of aggregated data from each BEST site (BEST Deliverable 1.2).
Appendix 1 – Clean Vehicle Definitions

The Clean Vehicle Definition for the City of Stockholm

**Passenger cars with a maximum of four seats plus the driver’s seat**
This definition of clean vehicles with a maximum of four seating places in addition to the driver’s seat is in conformance with the regulation SFS 2006:1572 for state purchase and leasing of clean vehicles. This is automatically updated if/when the government updates or adjusts their definition for procurement of clean vehicles. This implies that cars with a first registration date after the new regulations come into effect are automatically assessed in accordance with the new definition.

**Petrol or diesel cars**
According to information in the Swedish Road Administration’s listing, a passenger car complying with at least Euro IV and equipped to run only on petrol or only on diesel may not exceed 120 grams per kilometre of carbon dioxide emissions in mixed driving conditions. Also in the Swedish Road Administration’s information, particle emission in passenger cars equipped with compression ignited engines must be lower than 5 milligrams per kilometre.

**Clean vehicles that can run on alternative fuels, except LPG**
Fuel consumption per 100 kilometres may not exceed 9.2 litres petrol \(^{11}\), 8.4 litres diesel or 9.7 cubic metres of gas\(^{12}\) in mixed driving conditions in cars complying with at least Euro IV and equipped with technology to run totally or partially with fuels other than petrol, diesel or LPG. The most advantageous value applies for passenger cars that can be run on two different fuels.

Should the vehicle not be approved for the specific alternative fuel, the information from the manufacturer or agent must ensure the vehicle running on that fuel will comply with at least the Euro IV requirements and, should the vehicle run on a compression ignited engine, that the particle emission is lower than 5 milligrams per kilometre (environmental class 2005PM).

The maximum levels mentioned in the first paragraph above for petrol and diesel run clean vehicles, apply for passenger cars that cannot be run on fuel mixtures in which the alternative fuel is not predominant, calculated on the fuel's energy content.

An automatic gear passenger car is considered to meet the maximum levels indicated in the first paragraph, if it’s identical with a manual gear passenger car which meets the applicable values.

For a car to be classified as environmental class Electricity, the information from the car manufacturer or agent for cars, must state the electrical energy consumption does not exceed 37 kilowatt hours per 100 kilometres.

**Passenger cars with a minimum of five seats plus the driver’s seat**

**Definition**
Passenger cars/mini-vans with a minimum of five seats in addition to the driver’s seat are considered clean if equipped with either of the following technology:

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\(^{11}\) At the moment E85 is not certified vehicle fuel. The fuel consumption requirements for ethanol cars are therefore set as for the petrol.

\(^{12}\) The most advantageous consumption value of either gas or petrol can be used in gas operated models approved for both gas and petrol fuels.
a) Passenger/mini-van run partially or entirely on electricity.

b) Passenger car/mini-van equipped with technology to operate totally or partially with fuels other than petrol, diesel or LPG.

Vehicles with compression ignited engines must meet the particle requirements for at least environmental class environmental class 2005PM according to the listings in the Swedish Road Administration.

Vehicles run on electricity (Category A) must be of environmental class Electricity or Hybrid.

Vehicles with alternative fuels (Category B) must be able to run on a fuel mixture in which the alternative fuel is predominant, calculated on the fuel’s energy content. It must be classified for at least Euro IV/environmental class 2005PM or higher. If the vehicle is not approved for the alternative fuel, the information from the manufacturer or agent must assure that the vehicle meets the requirements of at least Euro IV/environmental class 2005PM running on this fuel.

**Light trucks or buses up to 3.5 tons of total weight**

**Definition**

Transport vehicles registered as light trucks or buses are considered as clean vehicles if they are equipped with either of the following technologies:

a) Light trucks or buses which are run totally or partially on electricity.

b) Light trucks or buses equipped with technology to operate totally or partially with fuels other than petrol, diesel or LPG.

Vehicles with compression ignited engines must meet the particle requirements for at least environmental class environmental class 2005PM according to the listings in the Swedish Road Administration.

Vehicles run on electricity (Category A) must be of environmental class Electricity or Hybrid.

Vehicles with alternative fuels (Category B) must be run with a fuel mixture in which the alternative fuel is predominant calculated on the fuel’s energy content. It must be classified for at least Euro IV/environmental class 2005PM or higher. If the vehicle is not approved for the alternative fuel, the information from the manufacturer or agent must assure the vehicle meets the requirements of at least Euro IV/environmental class 2005PM running on this fuel.

**User Requirements – applicable to all the above vehicle categories**

Vehicles operated on alternative fuels must be driven on the alternative fuel at least half of the driving distances to be considered clean. The requirement applies to the yearly average value. It must run as much as possible on the fuel presented as a renewable energy source.

To drive half the driving distance, 45% of the fuel volume in cubic meters must be gas, compared with petrol calculated in litres. To drive half the driving distance on E85, 60% of the purchased fuel must be made up of E85.
The Clean Vehicle Definition for the City of Madrid

There is not a clean vehicle definition in Spain. Nevertheless there are approaches i.e in the City of Madrid that are used as a way of definition.

1- Energy classification of vehicles

The system is based on European Directive 1999/94 CE and its adoption to the national legislation (RD 837/2002). According to that, there is a classification in seven classes (from A to G) related to the relative consumption compared to other vehicles of the same category (the category is set up by size in terms of area). There is also information about CO\(_2\) emissions. The table is only valid for vehicles run on gasoline or diesel (bioethanol use by FFV is not considered).

The national organization on energy efficiency has a web site where the classification is displayed:

http://www.idae.es/Coches/portal/BaseDatos/MarcaModelo.aspx

2- CO\(_2\) emissions

There is a general trend to equal the term “clean vehicle” to those that are exempted to plate tax according to the national tax exemption rule to vehicles with CO\(_2\) emissions lower than 120 g CO\(_2\)/km.
The Clean Vehicle Definition of the City of Rotterdam (illustration)

Kind of vehicle

Emission class

Suitable for ≥ 85% biofuel

Technique

Fuel

CO₂-emission (gr/km)

Fuel consumption (/100km)

Environmental Friendly vehicle

- Light company van
  - Emission class 5
    - Suitable for ≥ 85% biofuel
    - Electric
    - Fuelcell
  - All fuels

- Heavy company van
  - Euronorm V
    - Electric
    - Hybrid
    - Fuelcell
  - All fuels

- Off-road vehicle
  - Stage IIIb
    - Hydrogen
    - All fuels

11 May 2009
Appendix 2: Summary of the Swedish regulations concerning conversion of conventional vehicles to operate on alternative fuels

Converting conventional vehicles to be able to operate on alternative fuels offers a rapid way to substantially reduce emissions of climate gasses without having to wait for a total fleet renewal.

**Problematic issues**
The main concerns for this is whether the converted vehicles will fulfil emission standards and who should be responsible for this compliance.

There are several conversion-kits for E85 available at the market, but tests performed by the Swedish Road Authority have shown that too simple a conversion may lead to higher emissions than allowed. Hence there is a need for an authorization of the conversion kits.

For conventional cars, the manufacturers are responsible for the emission performance and to bear the costs for repairing of any malfunction within 5 years or 80,000 km. However, if someone tampers with the engine or the exhaust system the manufacturers are no longer responsible for the emission standard compliance.

**Legislation concerned**
The conversion option is introduced in the Swedish legislation implementing the Directives
- 72/306/EEG on the approximation of the laws of the Member States relating to the measures to be taken against the emission of pollutants from diesel engines for use in vehicles. Amended by Directive 2005/21/EG,
- 2000/30/EG on the technical roadside inspection of the roadworthiness of commercial vehicles circulating in the Community, amended by Directive 2003/26/EG
- 2002/51/EG on the reduction of the level of pollutant emissions from two- and three-wheel motor vehicles and amending Directive 97/24/EC
- 2007/46/EG establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amended by EC regulation 1060/2008

Major changes in the original legislation allowing for conversion:
- A converted vehicle from 1994 or younger should fulfil the original emission standard for which the vehicle model was type-approved when using the new fuel, regardless of the vehicle’s actual age. A flexifuel vehicle may however use the age-compensating values laid down in the current legislation, for emissions from the original fuel (petrol/diesel)
- A converted vehicle from 1993 or older need only to fulfil the test standards set in the yearly Motor Vehicle Inspection (CO and HC at idling and 2,000 rpm)
- A conversion for ethanol vehicles should result in a single fuel vehicle or a flexifuel vehicle that automatically adapt to the fuel-mix. Bi-fuel vehicles are not allowed.
- The conversion kit manufacturer is responsible for the emission performance of the conversion kit for 5 years or 80,000 km when applied on passenger cars, and for 11 years/200,000 km for light-duty trucks. The vehicle manufacturer is responsible for the emission performance of all other parts of the vehicle
- The increase in maximum power is limited to 5%
- Procedures are specified for type-approval of conversion-kits.
Appendix 3: Summary of relevant safety regulations from Sweden

In December 2007, the Swedish Petroleum Institute issued a handbook\(^{13}\) with recommendations to member companies regarding safe handling of E85 from the fuel depot to the vehicle’s fuel tank. The report contains best practices and experiences for construction and operation of E85 installations, in accordance with related legislation on fire safety, explosive goods, environmental impacts, and so on.

The recommendations state that in most respects, the same regulations and precautions applying to petrol must be followed when handling E85. However, certain special safety measures are required due to the differences in fuel properties when bioethanol content is higher than 50% in the fuel blend. These include the following legal requirements:

- Regulations on handling of E85 from the depot to fuel tank. These are specified in the Environmental Code, Law of Fire Risk and Explosive Goods (LBE) and Law on Transport of Dangerous Goods (ADR-S).
- The Environmental Code specifies general conditions for handling of E85. Depots are categorised in three groups according to the volumes of fuel they store or handle. This affects the type of permits the depots are obliged to acquire.
- Fuel stations must apply to the local Environmental and Health Protection administration for permission to install an E85 pump. Related to this, the fuel stations must follow regulations on emission of volatile organic compounds (VOC) and fuel vapour, as well as fire safety regulations.
- Fire safety permits for handling of petrol and diesel in existing fuel stations are not automatically valid for E85 and complementary permits are required before operation of the pump can begin.
- Cistern tanks for storage of E85 and petrol must be installed in accordance with the regulations, checked every six years (twelve if they are non-corrosive). All materials must be suitable for purpose and suppliers must document that the materials are appropriate for E85.
- Rules governing the transport of dangerous goods apply to E85, which is a Class 3 fuel (same as petrol). If transported with petrol, the vehicle must display special orange and numbered signs and carry documentation on the goods, sender and receiver. The tanker must fulfil requirements specified in the ADR-S and loading/unloading regulations are stated in the LBE.

Related to these regulations is a range of other legislation, including:

- The law on provision of alternative fuels states that all fuel stations above a certain size must provide alternative fuels in at least one pump.
- Regulations specify that E85 cannot be sold from a petrol pump.
- The Seveso directive, where the risk classification of E85 is crucial. Class R11: Highly flammable (flash point less than 21° C) means that a fuel distributor may handle up to 5,000 tonnes using less extensive safety measures, while for Class R12: Extremely flammable (flash point lower than 0° C and boiling point less or equal to 35 ° C ) this limit is 10 tonnes. All tests of E85 have showed a boiling point above 35° C.

\(^{13}\) Svenska Petroleum Institute, Etanol E85 – rekommendationer till medlemsföretagen angående god praxis för säker hantering av etanol E85, December 2007.
Appendix 4: Nationally accorded green procurement procedure, The Netherlands

This appendix contains the English summary, taken from D5.15. The full document is in Dutch and can be downloaded at: http://www.senternovem.nl/duurzaaminkopen/Criteria/Vervoer/dienstautos.asp

The Ministry of Housing, Spatial Planning and the Environment (VROM), The Association of Netherlands Municipalities (VNG), The Inter Provincial Consultation (IPO) and the Association of Water Boards (UWV) has finished in May 2008 a set of criteria for sustainable procurement.

Within the Netherlands, the collective government departments (486 local authorities of which 16 in the Rotterdam Region, 13 ministries, 12 provinces and 27 water boards) annually purchase products and services totalling 30 billion euros: these vary from civil constructions (bridges, roads), environmental facilities (landscaping, parks) to small items such as PCs and pens. If procurement officers consider both social and environmental criteria during this procurement process, this creates an enormous market demand for sustainable products and services.

One of the products are public vehicles. The document “Criteria for sustainable procurement of public vehicles” describes the various policy instruments used by government procurement officers and environmental coordinators in order to purchase sustainable public vehicles.

The document contains general information on sustainable vehicles. Sustainability aspects are Climate, Air quality and Noise. Also social criteria are considered.

1: The first phase of the procurement process is the preparation phase.
   - First an organisation should consider alternatives for the new vehicle, like public transport or more efficient use of the remaining vehicles;
   - The second consideration should be to choose for a vehicle as small as possible necessary for the business-wise use;
   - The third consideration is to only choose 4x4 vehicles if this is really necessary.

2: Then the specification phase for the purchase
   - Vehicles should at least meet up to specific energy labels;
   - Vehicles should be at least Euro4;
   - Diesel vehicles must have a particulate filter (straight from factory of mounted afterwards);
   - Vehicles must have an indicator of the actual fuel use.

The aspects above are valued with a system of points. Extra points can be given to innovative vehicles with alternative propulsion and to low-noise tires.

3: In the using phase extra attention should be focussed on:
   - Training of the drivers;
   - Per kilometre compensation instead of allowing full private use of a car company;
   - Mounting a speed limit device and/or a cruise control;
   - A rewarding system for drivers with a low fuel use;
   - Appropriate maintenance.
Appendix 5: Linkage between incentives and sales of FFVs


New registrations of clean cars, Sweden

Source: Environment and Health Administration, City of Stockholm, Data from General Agents, Statistics Sweden and BilSweden.

New registrations of FFV's in BioFuel Region

- Delivery of first FFV (Ford Taurus)
- Biofuel trials receive annual exemptions from taxes
- Delivery of more FFV (Ford Taurus)
- Call for tender, FFV
- Demonstration FFV fleet with local municipalities
- Demonstration FFV fleet with local Taxi company
- Free parking in Municipal of Örnsköldsvik
- Reduction of company car assessment value
- Start-up of ethanol ambassadors in BFR
- Nation-wide procurement of FFV (Ford Focus)
- Free parking in Municipal of Umeå
- General tax reduction on biofuels
- Fuel station agreements in BFR
- Rebate 10,000
- Increased free parking corporation in BFR
- Ordinance of Government Purchase
- Saab bio-Power
- Renewable fuel obligation

Source: Biofuel Region, Data from General Agents, Statistics Sweden and BilSweden.

Development of the FFV fleet in The Netherlands

- Tamoil E85 price equal to Petrol and Volvo reduced price FFV’s
- National subsidy offering bioethanol or natural gas pumps
- Environmental bonus Ford
- First E85 pump
- Decision clean city fleet

Source: City of Rotterdam.
Appendix 6: Annual data collection 2008 of aggregated data from each BEST site

Annual data for 2008 – collection of data – ethanol car use, mileage, share of E85 use
Data from Nanyang is enclosed at the end of this report.

EVF1.1a Aggregate fuelling data for Ford Focus FFVs

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<th>Number of FFVs included in data collection</th>
<th>Total distance travelled (km)</th>
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* The prices for E85 in Spain differ between Madrid and Basque country. Basque Country was able to negotiate an agreement with the ethanol fuel supplier where E85-price should be minimum 20 % lower than petrol for the next 10 years. There is also a very small difference in taxation, where Basque ethanol is charged 2.4 ¢ less per litre.

EVF1.1b Aggregate fuelling data for Ford C-Max FFVs

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### EVF1.1c Aggregate fuelling data for Saab 9-3 Biopower FFVs

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### EVF1.1d Aggregate fuelling data for Saab 9-5 Biopower FFVs

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### EVF1.1e Aggregate fuelling data for Skoda Oktavia FFVs

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93
## EVF1.1f Aggregate fuelling data for Volkswagen Golf FFV

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## EVF1.1g Aggregate fuelling data for Volvo C30 FFV

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<th>Total E85 costs (EURO)</th>
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## EVF1.1h Aggregate fuelling data for Volvo V40 FFV

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## EVF1.1i Aggregate fuelling data for Volvo V50 FFV

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## EVF1.2 Purchase price data for FFVs

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**Nanyang** has purchased ethanol cars from Dongfeng, a Chinese motor company. One car stated to operate in 2007 and during 2008 a total of 10 cars have been operating.

The total distance travelled in 2008 for all these cars: 82200 km.

Total fuel ethanol used: 6911 l. (including 2007 and 2008)

Total petrol used: 1320 l. (including 2007 and 2008)

Total fuel ethanol cost: 4400 Euro.

Total petrol cost: 840 Euro.

Purchase price for the Dongfeng car is 11 250 Euro. Within which, 10 000 Euro is the fee of the car and 1 250 Euro is the refit fee.