SUSTAINABLE ENERGY IRELAND

Hybrid Electric and Battery Electric Vehicles

Measures to Stimulate Uptake

Review of worldwide experiences in the use and measures to stimulate the uptake of battery electric and hybrid electric vehicles

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Executive summary

Sustainable Energy Ireland (SEI) is interested in the potential contribution of electric vehicles – both those using battery and hybrid electric technologies – in helping Ireland to reduce emissions of carbon dioxide (CO_2) from the road transport sector. With this in mind, SEI is planning to support financially a number of demonstration projects as part of a forthcoming demonstration programme. In order to inform the development of this programme, SEI commissioned AEA Energy & Environment to undertake a study on the costs and benefits of the use of hybrid electric vehicles and battery electric vehicles in Ireland.

This document is the second report of this study. The first report provided detailed technical information on hybrid and battery vehicle technologies, battery charge and discharge efficiencies and the cost of ownership and emissions performance of electric vehicles compared to conventional petrol and diesel vehicles. This report reviews worldwide experience in encouraging the uptake of electric vehicles, discusses the policy instruments that have been used to stimulate such an uptake and makes recommendations to SEI with respect to its proposed demonstration programme.

The report is based on a review of the work of the International Energy Agency (IEA), particularly its 2002 report on "Deployment Strategies for Hybrid, Electric and Alternative Fuel Vehicles". However, in this report, the IEA's work is supplemented with updates of some of the main programmes, as well as a couple of recent developments in the UK. The main findings from the review of market introduction programmes were:

- **Follow the steps to a successful market introduction programme.** These include: the appointment of a project manager; the creation of a network of engaged stakeholders; the establishment of a refuelling/recharging infrastructure; lobbying and media activities; continuous education of the public and business; and the establishment of a market for used vehicles.
- **Target the right market segment**. Experience suggests that targeting niche markets is more likely to be beneficial than a widespread market introduction strategy. Evidence also suggests that targeting fleets, e.g. public transport, delivery vans, etc., and 'activity centres', e.g. airports, campuses, in the first instance increases the chances of success.
- **Select the right technological scope for the programme**. Successful market introduction programmes focus on technologies that either offer outstanding advantages to the users compared to existing technologies or require only minor behavioural changes from prospective users.
- **Make sure that all the stakeholders are involved**. The chances of successfully introducing a market introduction programme increase with the number of stakeholders committed to the programme. It is important to engage the vehicle industry, as well as other stakeholders by, for example, networking, public-private partnerships and leadership by example.

The review of policy measures identified the following key lessons:

- **Use a combination of supporting measures**. While stand-alone measures can be beneficial, the impact is usually greater if a package of measures, which have been tailored to the unique conditions of the country concerned, is implemented in a coordinated fashion.
- **Consistent time/resource frame.** Market introduction programmes take time to achieve their desired impact. Hence, it is important that the programme is kept in place, along with any supporting measures and the necessary funding, for long enough to allow the necessary changes to take place and to allow the market to react.
- **Monitoring and assessment of results.** The time and resources for monitoring and evaluating the impact of the programme should be included in the programme design from the outset. Monitoring and evaluation of impacts will enable the programme or its

accompanying measures to be adjusted whenever necessary throughout the operational lifetime of the programme.

- **Give priority to a "network management" to engaging interested stakeholders.** Experience with clean vehicle markets suggests that priority should be given to network management to ensure that there is a strong involvement of the stakeholders and a high public acceptance of the programme, rather than governments attempting to provide a strong steer without engaging stakeholders.
- **Necessary but complementary role of financial incentives.** Financial incentives are expensive and, while they are sometimes a necessary precondition for success, they are not a guarantee of success. Incentives can play an important complementary role, particularly where there is a chance that the supported technology becomes self-sufficient in the future.

Given the review of other programmes, the report makes a number of recommendations to SEI:

- Options for large demonstration programmes might be **public fleets in cities** or **public transport in cities**.
- Smaller projects could focus on **delivery vans in cities**, **public transport in smaller tourist areas**, **buses and other mid-size vehicles at airports** or **taxi fleets in large cities**.
- At a later stage of the market introduction programme, i.e. once the initial phase has been successful and public awareness of and support for electric vehicles has increased, private fleets or private vehicles could be targeted.

Based on the findings of the first report of the study, the best options for each vehicle category are:

- **Passenger cars**: switching to battery electric cars, as they are the best option in terms of CO_2 emission reduction, or to hybrid cars, the second best option in terms of CO_2. Both vehicle categories are available in Ireland today.
- **Vans***:* switching to hybrid vans would be the most cost-effective option both in terms of CO_2 emissions and costs.
- **Minibuses and full-sized buses**: switching to hybrid minibuses or full-sized buses would be the most appropriate option at the present time.

Supporting measures for the Irish demonstration programme might include:

- **Subsidies for vehicle purchase or conversion**, to help overcome the cost differentials between electric and conventional vehicles.
- **Subsidies for investment in infrastructure**.
- **Common procurement platforms** have been proven to be a useful mechanism to centralise the purchase of the vehicles and develop relations with the vehicle industry.
- **Public-private partnerships and voluntary agreements** to engage stakeholders and obtain their buy-in to the programme.
- **Regular communication and education** about the demonstration programme aimed at both stakeholders and the public more generally.
- **Evaluation** of the programme should occur regularly, e.g. every year, as it is an important mechanism to monitor progress and, where necessary, to adapt the measures (particularly the level of the subsidies) to take account of technological developments and the development of the market.
- **International collaboration** has a potential role to play, particularly given that the UK, where vehicles drive on the same side of the road as in Ireland, is also developing programmes for low carbon vehicles.

Additionally, it is important that wider policy supports, rather than provides obstacles to, the development of a market for electric vehicles. Hence, the following policy frameworks could be reviewed:

- **Taxation system**. Ireland's taxation system as it applies to passenger cars is already being reviewed with a view to amending this to reflect better a car's environmental impact, e.g. its emissions of CO_2. The taxation of other vehicles, or other aspects of the taxation system that impact on travel, e.g. taxes related to the use of company cars and or cars used for business, could encourage or provide a barrier to the development of a market for electric vehicles. These might include:
    - Registration/purchase taxes
    - Circulation taxes
    - Fuel taxes
    - Subsidies
    - Taxation of benefit in kind
    - In use and parking charge

- **Existing standards and regulations** that have been set up with other technologies, in this case conventional transport vehicles and fuels, in mind have the potential to provide potential barriers to the introduction and use of electric vehicles.

While the instruments above have the potential to reduce CO_2 emissions, their design is fundamental to whether this will in fact be achieved. Hence, each instrument needs to be designed to take account of national and local circumstances.

Table of contents

1 Introduction 7
1.1 Scope of this project and report 7
2 Review of worldwide experiences of market introduction programmes 8
2.1 Introduction 8
2.2 Case studies of market introduction programmes 9
2.2.1 UK – Powershift Programme (1996 – 2005) 9
2.2.2 UK Low Carbon Vehicle Innovation Platform (2007 onwards) 10
2.2.3 UK Low Carbon Vehicle Procurement Programme (2007 onwards) 11
2.2.4 European ZEUS programme (1996-1999) 12
2.2.5 European ELCIDIS programme (1998-2002) 13
2.2.6 European CIVITAS programme (2002-2005) 14
2.2.7 European CIVITAS II programme (2005 onwards) 15
2.2.8 US California ZEV programme (1990-present) 16
2.2.9 US Clean Cities Programme (1993-present) 16
2.2.10 Japan Clean Energy Vehicle Diffusion Plan (1998-2010) 17
2.3 Key Lessons from market introduction programmes 18
3 Review of measures to stimulate the uptake of hybrid and battery electric vehicles 22
3.1 Introduction 22
3.2 Review of main policy instruments 23
3.3 Key lessons for governmental measures 29
4 Recommendations 30
4.1 Recommendations for the proposed demonstration programme 30
4.1.1 User groups to target 30
4.1.2 Vehicle categories to target 31
4.1.3 Supporting measures 31
4.2 Recommendations for clean vehicle policy 32

1 Introduction

Under the Kyoto Protocol, Ireland has agreed to limit its national greenhouse gas emissions, including those of carbon dioxide (CO_2), during the period 2008 to 2012 to a maximum of 13% above 1990 levels. Ireland's CO_2 emissions peaked in 2001 at 31% above 1990 levels. The National Climate Change Strategy for Ireland showed that transport is a fast growing source of greenhouse gas emissions. Due to the predicted continuing rise in CO_2 emissions from road transport, there is a need to take action to reduce emissions from this sector if Ireland is to meet its Kyoto commitment.

One of the measures that would be of potential interest is increasing the use of hybrid electric vehicles (HEVs) and/or battery electric vehicles (BEVs). These options have the advantage of reducing average vehicle energy consumption, and hence reducing CO_2 emissions. We understand that, in 2008, Sustainable Energy Ireland is planning to support financially a limited demonstration programme, which will fund a number of separate demonstration projects. In addition, it is anticipated that the Irish passenger car tax system – including both the vehicle registration tax and annual motor tax – will be altered so that the tax system is linked to a car's CO_2 emissions.

1.1 Scope of this project and report

In order to inform the details of its demonstration programme and accompanying work, Sustainable Energy Ireland commissioned AEA Energy & Environment to undertake a study on the costs and benefits of the use of hybrid electric vehicles and battery electric vehicles in Ireland. As part of this study a number of reports and documents are being produced. Report 1 has provided information on hybrid and battery vehicle technologies, battery charge and discharge efficiencies and the cost of ownership and emissions performance compared to conventional petrol and diesel vehicles. This document, Report 2:

- Reviews experience from elsewhere in the world, in relation to encouraging the uptake of alternatively fuelled vehicles;
- Discusses the policy instruments that have been used to stimulate such uptake; and
- Makes recommendations as to what Ireland might do in relation to its proposed programme.

Different countries around the world are at different stages in the development of the market, promotion, incentivisation and use of hybrid electric vehicles (HEVs) and battery electric vehicles (BEVs) in their vehicle fleets. Much can be gained in reviewing the experiences of those countries where deployment of these vehicles has been most extensive.

Section 2 of this report provides an overview of the size and type of programmes that have been in operation worldwide to promote the use of battery electric and hybrid electric vehicles and comments on their results. A list of the programmes as well as basic information about them is provided in Annex I. Due to the large number of programmes that have been in operation, we focus on a selection of the most relevant and successful of these for which information was available. Finally, section 2 identifies the key lessons from the programmes in terms of "how to design a successful electric vehicle market programme".

Section 3 of this report then reviews the type of measures, which might be necessary to stimulate the widespread uptake of battery electric and hybrid electric vehicles. We describe the five categories of instruments that the governments usually use in their strategies to promote clean vehicles and we analyse their strengths and weaknesses. Then we summarise the key lessons that governments should keep in mind while designing and implementing these measures.

Section 4 of this report concludes by giving mores specific recommendations to SEI based on the lessons from the experiences in other countries.

2 Review of worldwide experiences of market introduction programmes

2.1 Introduction

Programmes that aim to accelerate the development or increase the market share of alternative vehicles can be found in a lot of countries all over the world. These programmes are initiated by different stakeholders, who had various motives to start such a programme. This section will describe the different approaches of these existing programmes, to analyse the reasons for their success or failure and to identify promising strategies for the market introduction of HEVs and BEVs. However, it is very important to keep in mind that a properly designed programme is formed by the framework conditions in the nation or region. Therefore it is evident that a successful programme cannot be translated into another country with just the same success.

A primary source for the work carried out for this task is Annex VIII/XXI of the International Energy Agency (IEA) Hybrid and Electric Vehicle Implementing Agreement. In 2002, this working group published a detailed study entitled "Deployment Strategies for Hybrid, Electric and Alternative Fuel Vehicles"[1], which provides details of deployment and market support programmes that have been introduced in various countries around the world to support the market introduction of all of these types of vehicles. Information was collected on 95 programmes in 18 countries. From this wide range of programmes, case studies have been selected which can be regarded as "typical" strategies of government administrations and stakeholders.

Since the publication of the 2002 report, the IEA has produced a number of annual reports and newsletters, which have updated stakeholders with amongst other things recent sales figures for alternatively fuelled vehicles.[2] These have also provided some useful updates to the programmes, but nothing as comprehensive as the 2002 report has been undertaken since. The IEA is currently planning to undertake a new study *Market deployment of hybrid & electric vehicles: lessons learned*, which will include an annex on the role of the EV and HEV manufacturers in the past 15 to 20 years. The aim of this work will be to identify the weaknesses of the decisions, design, dependency on technologies automakers are not familiar with (batteries, specific electronics etc.) that happened within the "car industry".

Given that the IEA report is now five years old, an attempt has been made to seek updates on the programmes mentioned in the report. Supplementary research has been undertaken to identify programmes that support the uptake of hybrid-electric and/or battery-electric vehicles that are currently in place, or that were more recently undertaken in a selection of countries. On the one hand, information about the programmes analysed in the IEA report have been updated with the latest information available (see table in Annex I). On the other hand, some programmes that were not covered by the IEA report have been analysed in this report: the European CIVITAS programme and the European ELCIDIS programme. For some on-going programmes, information on outcomes may not yet be published, in which case web links have been provided so that the reader may follow-up completed projects as they occur.

In Section 2.2, we present detailed information for a selection of the case studies in the IEA report. Additionally, we have also included details of some new demonstration and deployment programmes that are not included in the IEA report. The programmes reviewed represent a good coverage of various criteria, including the following:

[1] http://www.ieahev.org/pdfs/annex_8_final_report.pdf
[2] http://www.ieahev.org/

- Scope of the programme (local regional or national)
- Initiators of the programme (government, industry, NGOs etc.)
- Framework conditions (environmental, economic, social etc.)
- Programme strategies (mandates, voluntary approaches, financial and non-financial incentives, etc.).

The selected programmes covered in section 2.2 are:

- UK Powershift Programme
- UK Low Carbon Vehicle Innovation Platform[3]
- UK Low Carbon Vehicle Procurement Programme[4]
- EU Zero Emission Vehicles in Urban Society (ZERO) programme
- EU ELCIDIS programme
- EU CIVITAS programme
- US Clean Cities Programme
- California Zero Emission Vehicle Programme
- Japan Clean Energy Vehicle Diffusion Plan

Additional information about other interesting programmes for HEVs and BEVs has been compiled in a table to be found in Annex I of this report.

Section 2.3 summarises the key lessons from the programmes described in section 2.2 and identifies the main factors for a successful hybrid-electric and/or battery-electric vehicle market introduction programme.

2.2 Case studies of market introduction programmes

2.2.1 UK – Powershift Programme (1996 – 2005)

The Powershift programme[5] is one of the largest programmes so far undertaken in the UK, to promote alternatively fuelled vehicles. It was managed by the Energy Saving Trust (EST) and had a budget of approximately £10 million per year (€15 million). Its aim was to help develop a sustainable market for clean fuel vehicles in the UK with a focus on liquefied petroleum gas (LPG), compressed natural gas (CNG) and electric vehicles (EVs). The programme set out a four-stage plan to support the use of clean vehicles. This included:

- Demonstrating through pilot projects;
- Stimulation of the supply of clean fuel vehicles and to establish a refuelling structure;
- Targeting of non-depot based fleets around the refuelling structure and increasing the supply of clean vehicles; and
- Establishment of a wide supply of refuelling points and supply of clean vehicles to enable these fuels to become an option for the private motorist.

The intention was that as the purchase of new clean vehicles became a mainstream market option and the costs came down, that Powershift grant support could be refocused on further policy objectives.

[3] This is a new programme. The UK Technology Strategy Board is currently running a competition to award funding for projects under this programme
[4] This programme will not start until mid-2008
[5] See following link:
http://www.dft.gov.uk/consultations/archive/2002/fdpp/thefuturedirectionofthepower1587?page=2#a1004

A package of measures was deployed to support the market introduction of EVs under Powershift. These included:

- Subsidies for vehicle purchase: 50% of the premium cost of the vehicle and 50% of the cost of leasing batteries for a period of up to 3 years.
- Subsidies for installation of refuelling stations
- Buyer's guide to help fleet managers in their purchasing decisions
- Continuous revision of support criteria
- Demonstration projects to attract manufacturers initially
- Common procurement: creation of purchasing consortium to buy 350 vehicles worth •20 million for 30 fleets (public and private sector)
- Private-private partnerships: long-term fuel supply contracts between suppliers and fleet operators (10 years)
- Exit strategy: plans to gradually cut back funding as price of vehicle falls
- Powershift also encouraged operators of electric vehicles to purchase electricity from renewable sources, to minimise greenhouse gas emissions. Organisations who did so were entitled to offset their electricity bill against the climate change levy (CCL). (The CCL is a tax on the use of energy in industry, commerce and the public sector.)

Market surveys of the EV market suggest that EVs had been successful in a number of niche areas where travel is on a fixed route or within a certain area. These include milk delivery, pool cars and parking enforcement vehicles. Promising trials of electric bus and delivery van applications have also occurred. The Powershift programme suggests that the longer-term market for electric vehicles will be affected by both technical and non-technical issues.

- Technical issues include:
    - Limited performance and range – restricting electric vehicles to niche applications; and
    - Competition from the introduction of cleaner conventional and hybrid vehicles.
- Non-technical issues include:
    - Vehicle availability – few manufacturers currently produce electric vehicles;
    - High capital cost of electric vehicles (in some cases); and
    - Public perception about electric vehicles.

The scheme eventually ran into problems, as it did not comply fully with European Commission rules on state aid. EST now manages grants for alternatively fuelled vehicles and infrastructure.[6] One project undertaken with EST grants was the introduction of an electric bus in Lincoln. It has proved very popular with residents and tourists alike. In its first year of operation the bus carried 85,000 passengers around the steep city route.

2.2.2 UK Low Carbon Vehicle Innovation Platform (2007 onwards)

In the UK, there is currently a range of sources of existing and potential funding for research, development and demonstration (R, D&D) into low carbon transport technologies.[7] However, the UK Government decided that there was a case for an expansion of the scale of support for R, D&D activities in a range of low carbon technologies, including those relevant to the transport sector. Especially relevant in this context is the new Low Carbon Vehicle Innovation Platform (LCVIP)[8], which brings together key stakeholders in the UK automotive sector and provides new funding for UK industry-led demonstration and collaborative R&D projects focussed on nearer and further from market technologies where the UK has or can develop world leading expertise. In conjunction with the Technology Strategy Board (TSB), the Department for Transport (DfT) and the Engineering and Physical Sciences Research Council (EPSRC) are financing and developing the new platform to provide critical coordination and up to £20 million (€30 million) of support from 2008/09 onwards. The funding is part of the UK Government's Low Carbon Transport Innovation Strategy (LCTIS), which was launched in May 2007[9], and will be available to support low carbon vehicle technologies with the clear potential to be commercially viable in the short term. Projects funded under the LCVIP that are relevant to passenger cars, light commercial vehicles, heavy goods vehicles, buses and taxis are all

[6] http://www.energysavingtrust.org.uk/fleet/

eligible for support. The funding will be made available through competition bids managed by the Technology Strategy Board.

The first competition opened on 21 September 2007. It focuses on bringing forward relatively near market low carbon vehicle technologies, whether for private or public service vehicles, that could be viable candidates for commercialisation or fleet procurement initiatives over the next five to seven years. There are no specific constraints on the vehicle categories and technologies that can be proposed in this competition, as long as the vehicles concerned are road-based. Similarly all relevant in-vehicle technology options are eligible, including retrofitting. Any niche vehicle applications would need to clearly demonstrate the applicability of the technology to wider vehicle markets. Similarly proposals in technology areas generally considered to be further from market would need to demonstrate convincing and credible evidence of a viable route to market within a five to seven year timeframe. The UK Government see the LCVIP competition as complementary to the new DfT Low Carbon Vehicle Procurement Programme (see below section 2.2.3), through the support it will provide for relevant R, D&D work which can subsequently be incorporated into new vehicles.

2.2.3 UK Low Carbon Vehicle Procurement Programme (2007 onwards)

In May 2007, the UK Government announced in the Energy White Paper funding to develop a new programme of financial support for the public procurement of lower carbon vehicles: the Low Carbon Vehicle Procurement Programme.[10] The objective of the government in developing this new programme is to utilise public procurement to help accelerate the market introduction of lower carbon vehicles in the UK. An initial £20 million (€30 million) has been allocated to the programme, with further funding dependent on demonstrating that a viable model for the programme can be developed. Moving successfully from the demonstration to the commercial phase of technology development is one of the most challenging elements of the innovation process. Reducing risks at this stage can therefore help increase the rate at which new technology options can be brought to market. Governments can play an important role in this area through interventions focussed on public procurement and creation of niche markets for lower carbon vehicles. These interventions can be effective as, by increasing the visibility and certainty of an early market for a new lower carbon model – subject to the attainment of cost and performance criteria – they have the potential to reduce the initial risks faced by companies when considering whether to introduce a new technology to the marketplace.

Consultations about the design of this new programme were held between August and September 2007. DfT is expected to advise Ministers in the early autumn and the first procurement is expected to start from 2008/9. The discussion paper suggests that the objectives of the programme may best be met by developing a programme which:

- Supports the procurement of vehicles with carbon emissions that are lower than those of comparable vehicles widely available in existing commercial markets.
- Is predominantly focussed on seeking to develop a smaller number of larger scale procurements that will help to accelerate the market introduction of technologies and vehicles that are relatively close to market and have realistic prospects for achieving wider commercialisation in the relatively near future. This objective may well need to be achieved in stages with smaller procurements prior to the commencement of larger exercises. A smaller proportion of programme funds might be reserved for supporting the demonstration of more radical longer-term technology options.
- Is focussed on vehicle types and sectors where the introduction of new lower carbon vehicles has the potential for significant positive impacts on our wider domestic and international carbon reduction objectives.
- Maximises the opportunities for wider innovation and learning benefits from fleet procurements and demonstrations.
- Is compliant with relevant EU procurement and state aid legislation.

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[7] http://www.dft.gov.uk/pgr/scienceresearch/technology/lctis/lowcarbontis?page=11
[8] http://www.berr.gov.uk/files/file41443.pdf
[9] http://www.dft.gov.uk/pgr/scienceresearch/technology/lctis/
[10] http://www.dft.gov.uk/pgr/scienceresearch/technology/lcvpprogramme

- Is managed on behalf of DfT by an external contractor/organisation on the basis of a broad contract covering the day-to-day management and operation of the programme and the provision of appropriate support to participating public sector organisations.

Public sector organisations that may potentially participate in the new programme include central government departments and their agencies, local authorities and county councils, law enforcement organisations (police and prison services) and National Health Service organisations. Today, it is estimated that the UK public sector vehicle fleet comprises roughly 100,000 heavy duty vehicles and at least 200,000 light duty vehicles, with around half of light duty vehicles leased and half owned. The majority of light duty vehicles are passenger cars, vans or mini-buses. Heavy-duty vehicles cover a broader range of more disparate vehicle types. Around 13,000 new heavy duty and 75,000 new light duty vehicles are either purchased or leased by UK public sector organisations each year. These figures are estimates and are subject to considerable uncertainty. However they are indicative of the broad scale of public procurement of vehicles and indicate that there is a potential scope to conduct procurements of relatively significant scale for lower carbon vehicles.

2.2.4 European ZEUS programme (1996-1999)

One of the largest clean transport programmes to be undertaken in Europe in recent years is the Zero Emission Vehicles in Urban Society programme (ZEUS).[11] It focuses on how cities can help overcome the market obstacles that restrain zero and low emission mobility. The programme involved the efforts of cities in 8 countries and ran for three years from 1996. It was co-funded by member states and the European Commission. The programme involved a number of measures including battery electric vehicles. The cities involved were:

- Stockholm, Sweden
- Athens, Greece
- Copenhagen, Denmark
- Helsinki, Finland
- London/Coventry, UK
- Luxembourg
- Palermo, Italy and
- Bremen, Germany

As discussed in Report 1, low emission vehicles generally cost more than their conventional counterparts with battery electric vehicles (BEVs) often being the most expensive. The ZEUS programme showed that bulk purchasing of vehicles from manufacturers could greatly help reduce prices for alternative fuelled vehicles. This has helped open up a market for BEVs in Europe with vehicles being available in markets where they had not been previously.

The aim of the programme was to demonstrate the actions that cities can take to promote zero and low emission vehicles. The partner cities have benefited from the experience gained in the other cities. In three years, the ZEUS programme achieved:

- Over 1,000 alternative fuelled vehicles and 600 new city bikes in operation;
- New infrastructure for alternative fuels and electric charging in place. For example, most cities participating in ZEUS had a battery-charging infrastructure in place in which an hour of charging provided approximately 10 kilometres of travel; and
- Public awareness of sustainability issues.

[11] Final report of the programme available at: http://stockholm.se/pages/352574/Zeus-FinalReport.pdf

Examples of successful experiences:

- In Sweden, the ZEUS programme was successfully implemented in Stockholm. It resulted in the introduction of about 70 electric vehicles and 20 electric mopeds, especially used by city companies and public authorities.
- As part of the ZEUS programme, Palermo offered a comprehensive electric car-sharing scheme with 13 locations selected near major transport stations with individuals able to book automatically from remote locations. The vehicles also had permission to drive in bus lanes whilst photovoltaic cells at one of the sites ensured some of the electricity was delivered carbon free. The study however highlighted that due to the need for re-charging, car sharing relying on BEVs may need more vehicles and locations to serve the same user needs as with conventional cars. However, there was positive feedback from BEV users, with the quietness especially recognised as a key benefit.

2.2.5 European ELCIDIS programme (1998-2002)

The European programme Electric Vehicle City Distribution (ELCIDIS) took place between 1998 and 2002 and involved six cities.[12] The cities involved were:

- Rotterdam, Netherlands
- Stockholm, Sweden
- La Rochelle, France
- Erlangen, Germany
- Regione Lombardia, Italy and
- Stavanger, Norway.

The overall objective of the programme was to improve the "visibility" of hybrid and battery electric vans for goods delivery in cities, to show their environmental benefits and to promote the use of these vehicles. Overall, the ELCIDIS programme achieved the following:

- In the six cities, the participating transport companies deployed a total of 39 electric and 16 hybrid vehicles;
- The programme showed that HEVs and BEVs could be used in urban areas successfully.

The experiences with the hybrid and BEVs differed. To begin with there was a lack of interest on the part of manufacturers to construct a hybrid van. Eventually a manufacturer was contracted as the supplier. However, as it was a new design, there were inevitable technical problems including charger breakdown and engine mode switch malfunction. In addition, proper support service from the manufacturer was lacking. It should also be noted that the hybrid vans could not carry loads as heavy as regular diesel vehicles. Whilst this did not pose any problems for participating companies since weight restrictions were unimportant, it may be relevant for other applications where heavier loads are involved.

The outcomes with the electric vans were more positive. The experience of the Citroen Berlingo electric vans was interesting. Overall those electric vans were very reliable with two of the vehicles not showing any technical problems throughout the project. The only technical problem related to the electric box, which regulated the battery system. The property management company who tested the van were generally happy with its function except the limited driving range.

Overall the programme managers felt that the project succeeded in verifying the principal merits of using HEVs and BEVs in urban areas and it proved that there were no major objections to the use of HEVs and BEVs in urban areas. For example, company managers welcomed the positive publicity that the vehicles brought.

[12] Final report of the programme available at: http://www.elcidis.org/elcidisfinal.pdf

2.2.6 European CIVITAS programme (2002-2005)

The European Initiative CIVITAS (CIty-VITAlity-Sustainability)[13] aims to help cities achieve a more sustainable, clean and energy efficient urban transport system by implementing and evaluating an ambitious, integrated set of technology and policy-based measures. CIVITAS I was launched in early 2002 and ran to 2005 (within the European Commission 5th Framework Research Programme) and 19 cities participated. The CIVITAS initiative is co-financed by the European Union. They provided 50 million Euros of funding for CIVITAS I.

The programme has identified eight measures as the basic building blocks of an integrated strategy. The aim is that each CIVITAS city chooses an appropriate set of measures and combines them to form integrated solutions for clean urban transport in cities. The most common measure introduced was clean fuels and vehicles. A common stimulus for interest in this measure included general concerns regarding climate change and fuel security as a result of rising fossil fuel prices.

Some barriers to the measures' implementation and success were:

- The limited performance of the clean vehicles in relation to traditional ones;
- Technical problems with vehicles, fuels or refuelling stations;
- The low public appeal of the scheme, including difficulties in user familiarity with new technologies and the perception of the technologies as being unproven and costly;
- High cost differentials between cleaner vehicles and conventional vehicles and also high maintenance and fuel prices;
- The need for new refuelling infrastructures;
- The low interest of car dealers to "launch" clean vehicles and consequent lack of clean fuel car models, delays by suppliers delivering vehicles, long vehicle registration processes and vehicle depreciation (limited, or no second-hand market for these types of vehicles).

The results of some examples of CIVITAS I projects involving BEV and HEVs are outlined below.

Rotterdam, The Netherlands
A large number of HEV buses were introduced into the municipal fleet. Fuel consumption of new hybrid buses was improved relative to conventional fuelled counterparts and reduced emissions of both NO_x and PM were achieved. The planned introduction of seven electric vehicles for urban distribution was poorly implemented as only two EVs were introduced due to technical problems. This highlighted the potential barriers in attempting to introduce these vehicles to private users. Problems were also reported with the introduction of electric bikes where only half of the 100 proposed were introduced. This was due to poor information provision and public relations.

Lille, France
The activities were managed under an Urban Mobility plan and this involved the gradual replacement of the entire bus fleet in Lille with clean vehicles. Another project was the conversion of Lille's heterogeneous fleet of 120 vehicles to natural gas and electric vehicles. In the end 84 CNG and two electric vehicles were purchased. Maintenance costs for the EVs were higher than conventional vehicles due to higher battery costs. Overall operating costs from the introduction of all the various measures (not just EVs) were deemed competitive. Four electric scooters and 23 bicycles were introduced as part of the initiative.

Rome, Italy
Over the four years in which the CIVITAS programme operated in Rome, 19 measures were implemented including the adoption of clean vehicles and fuels. For instance, 46 electric buses were introduced. Legislation and regulations were found to be both the main drivers and barriers to the introduction of clean vehicles. The buses were found to be technically reliable. In addition, 398 electric scooters were introduced with suitable recharging points, which were well received by both

[13] http://www.civitas-initiative.org/main.phtml?lan=en

tourist services and the general public. Part of the success of this project may have been the use of an awareness strategy (contrast to Rotterdam).

Bristol, UK
The aims of the programme were to clean up existing diesel vehicles and to introduce new clean fuel buses. Consequently the work followed two implementation paths towards cleaner bus fleets – new hybrid diesel electric buses and retrofitting older vehicles with exhaust treatment equipment. Five battery-powered Reva G-Wizz electric cars and a hybrid vehicle (Toyota Prius) were introduced into the council's municipal fleets. Bristol successfully introduced three new electric recharging facilities for the municipal fleet in early 2004.

Göteborg, Sweden
The City of Göteborg aimed at increasing the number of clean vehicles both in the city as a whole and within the municipal fleet. This was achieved by working with more active information strategies such as communication directed towards special target groups, well-directed incentives and demands on procurement. The total number of clean vehicles increased during the project period by roughly 3,000, which was twice as many as predicted.

Stockholm, Sweden
In Stockholm, two projects are particularly relevant for this review. A first project was introduced that aimed at demonstrating that clean heavy vehicles (buses and lorries) could replace conventional diesel vehicles in an efficient way. A second project was to accelerate the take up of clean vehicles within private companies and in the municipal fleet. This project was successful and more than 3000 clean vehicles were introduced during the project. The successful introduction of clean (biogas) waste collection vehicles in Stockholm city centre has now led to a decision to use only clean waste trucks in the whole municipality.

2.2.7 European CIVITAS II programme (2005 onwards)

In 2005, the CIVITAS Initiative was extended to encompass 17 new cities. This initiative is known as CIVITAS II. The overall budget with partner organisations is more than 300 million Euros for both initiatives. It should be noted that these projects are ongoing and thus full evaluation of the projects is not due until completion in 2009.

Under CIVITAS II, two of the projects are of particular relevance to this study and will be briefly reviewed here. These are the CIVITAS SUCCESS and the CIVITAS CARAVEL projects.

CIVITAS SUCCESS[14]
Under CIVITAS SUCCESS (Smaller Urban Communities in CIVITAS for Environmentally Sustainable Solutions), 12 hybrid buses using biofuels are being implemented in the 3 participating cities of La Rochelle, Preston and Ploiesti. The first hybrid bus in La Rochelle was due to be operational by September 2006[1] (to coincide with European Mobility Week 2006) with a second minibus due to come into use from November 2006. Both vehicles were to run between the city centre and the Park and Ride. It has not been possible to obtain information on the status of this implementation.

In La Rochelle there is a further aim to develop a Hybrid Taxi fleet with two hybrid vehicles exchanged for conventionally fuelled vehicles each year. To achieve this the project will assist taxi drivers and managers to procure the hybrid vehicles by persuading car manufacturers to offer special incentives. In addition, promotional activities will be directed at the public and taxi drivers. Outcomes expected from the CIVITAS project include guidance on the procurement and operation of clean vehicle technologies in the urban setting.

[14] http://www.civitas-initiative.org/project_sheet?lan=en&id=4

CIVITAS CARAVEL[15]
Air pollution reduction in the cities of Burgos, Genoa, Stuttgart and Krakow is one of the aims of the Caravel project. To help achieve this, the focus is on the use of clean municipal vehicle fleets. This will include the purchase of car-sharing vehicles with hybrid engines.

The CIVITAS CARAVEL project is intending to introduce 30 hybrid cars for car sharing and electric buses and freight vans in Genoa. The successful trial application in Genoa of electric vans serving inner-city shops (from a goods distribution centre) will be substantially extended in terms of size, area, service quality and technology. Krakow is intending on adopting a similar approach. Burgos will allow access only to clean vehicles and aims to reduce the total number of delivery vehicles.

2.2.8 US California ZEV programme (1990-present)

In order to reduce the harmful emissions of the transport sector, the Californian Air Resources Board (ARB) introduced the Zero emission vehicles (ZEV) programme in 1990.[16]

There is a package of supporting measures under the ZEV programme, which comprise the following:

- Mandates: originally there was an obligation for the largest vehicle manufacturers to sell a minimum number of ZEVs (2% of sold new vehicle fleet from 1998 to 2000, 5% in 2002/3, 10% from 2003). However, the original targets were relaxed in 1996 and 1998, because the level of battery technology was not sufficient to warrant widespread introduction of BEVs. The 10% mandate was allowed to include partial credits for other clean vehicles.
- Voluntary agreements between the ARB and the largest auto manufacturers
- Awareness and information activities
- A 'try before you buy' scheme: short-term leasing programme for public fleets
- Vehicle purchase subsidies
- Tax incentives: reduced licence fees
- Infrastructure subsidies: up to 90% of the installation charges for EV chargers
- Green fleet initiatives to influence public and private purchasing
- Setting standards: standardisation of the EV recharging equipment.

The ZEV programme has been deemed successful in helping develop cleaner vehicle technologies. For example advances in electric drive-train components and battery storage have made the development of hybrid vehicles possible. Two categories of partial ZEVs are now allowed under the mandate, one that encourages advanced, near-ZEV technologies such as clean hybrid-electric cars or methanol fuel cells, and one that encourages the production of very clean gasoline-powered cars.

2.2.9 US Clean Cities Programme (1993-present)

The Clean Cities Programme[17] is one of the largest clean vehicle programmes, to date, in the US. Initiated in 1993 in response to the 1992 Energy Policy Act (EPAct), Clean Cities aims to support local decisions and concerned fleets to fulfil the requirements of the EPAct regarding the obligation to purchase alternative fuel vehicles. It was designed as an umbrella programme to achieve the objectives of the EPAct. Clean Cities is run through the US Department of Energy's FreedomCAR & Vehicle Technologies Programme under which R&D funding of Hybrid and Electric Propulsion will be around $50 million for 2007. Much of this funding is targeting the technical aspects rather than deployment activities, which is the focus of Clean Cities.

[15] http://www.civitas-initiative.org/project_sheet?lan=en&id=3
[16] http://www.arb.ca.gov/msprog/zevprog/zevprog.htm
[17] http://www.eere.energy.gov/cleancities/

The package of supporting measures under the Clean Cities Programme comprise the following:

- Public-private partnerships: locally based government/industry partnerships, more than 80 volunteer, community-based coalitions, which develop public/private partnerships to promote clean vehicles
- Informational and educational activities for local businesses and governments
- Networking: sharing information and experience within the members of the Clean Cities network
- Up-scaling of local projects: clean corridor concept to ensure that refuelling facilities for alternative fuels are available for regional transit and across the country.

Since its inception in 1993, Clean Cities has grown to almost 90 coalitions and 4,800 stakeholders across the country, put close to 1 million alternative fuel vehicles (AFVs) on the road, and displaced approximately 1 billion gallons of gasoline. In 2004 alone, Clean Cities displaced 237 million gallons of gasoline through the use of AFVs, engine idle reduction technologies, fuel economy measures, and hybrid vehicles. In addition to its US activities, the programme has established International partnerships to facilitate knowledge sharing. Current international partners[18] include India, Peru and Indonesia as well as the European CIVITAS programme discussed above.

Examples of successful applications of HEV and BEV under the Clean Cities programme include the following:

- Budget EV Rental Cars[19] offers electric vehicles for rent at Los Angeles International Airport. Electric recharging stations are available to electric-vehicle renters through a partnership with the LA Department of Water and Power. The rental fleet includes 20 electric vehicles that are being offered for rental at rates as low as $44 per day. Charging is free at the 100 electric charging stations.
- As part of Santa Monica's Sustainable City Program, the city's fleet department was asked to operate 75% of its vehicles on alternative fuels by 2000. As of the autumn of 1999, alternative fuel vehicles (AFVs) comprised about half the city's 962-vehicle fleet and will be 62% alternatively fuelled. Santa Monica's alternative fuel infrastructure is already in place including eight EV charging stations. The city is currently developing a training manual for its EV operators to improve EV use.
- The US Postal Service maintains the largest federal fleet with approximately 208,000 vehicles. In 1999, Ford Motor Company, in partnership with Baker Electromotive of Rome, NY, received the single largest electric vehicle (EV) order in U.S. history. The USPS announced its purchase of 500 electric mail delivery vehicles based on the Ford Ranger EV, with the option of ordering a total of 6,000 units. Production of the 500 electric mail delivery vehicles began in the fall of 2000 and continued through the following year. Vehicle affordability was a vital aspect of this project. Incentive dollars from New York State, Washington D.C. metropolitan area, California, the federal government, and various utilities helped make it a reality.

2.2.10 Japan Clean Energy Vehicle Diffusion Plan (1998-2010)

In 1998, the Japanese government set a target for the diffusion of clean energy vehicles in 2010, in light of the targeted reduction of CO_2 emissions based on the Kyoto protocol. This programme was managed by the Japanese Ministry for Economy, Trade and Industry (METI) and the Ministry for Land, Infrastructure and Transport. The target for clean energy vehicles was 3.65 million units in the overall vehicle fleet in operation by 2010 (including about 100,000 electric vehicles and 2 million hybrid vehicles). Special target numbers for each large prefecture were also set (e.g. Tokyo 40,000 EVs). This corresponds to a reduction of approximately 0.6 million tons of CO_2 emissions. Further, the aim is for 210,000 units of advanced battery equipped vehicles, such as fuel cell vehicles, to be in operation by 2010, reducing 0.3 million tons of CO_2 emissions. The target was revised in July 2001 at the board of investigation of natural resources and energy, reducing the number of electric vehicles and increasing the number of hybrid and fuel cell vehicles. Of fuel cell vehicles, the METI also set targets of

[18] http://www.eere.energy.gov/cleancities/pdfs/41126.pdf
[19] http://www.evrental.com/

about 50,000 units for 2010 and about 5,000,000 units for 2020. A budget of about US$100 million per year was invested in this programme.

Incentives have been introduced to help ensure that these targets are reached. These include:

- Electric and hybrid electric vehicles can receive a purchase subsidy of up to 50% of the incremental cost of a vehicle;
- Subsidy for the establishment of clean energy vehicle refuelling facilities;
- Funding demonstration for low-pollution vehicles including car-sharing and station car;
- Discount on the automobile tax;
- Business tax credit – purchase of clean energy vehicles for business use and; establishment of fuelling facilities for CNG and methanol vehicles.

Other interesting smaller projects in Japan:

Kyoto public car project
The Kyoto public car project was initiated in December 2000. Funded by the Ministry of Economy, Trade and Industry (METI), 35 electric vehicles were available for free for the public[20]. The average daily use per vehicle was 2.1 times and the mean distance travelled 15 km. An automated (internet) reservation and transaction rental system worked well though it was felt that improvements could be made to the system, for example information on vehicle availability. A second phase of the experiment introduced fee charging whereby the vehicle could be rented at a cost of 17 yen per minute. Unsurprisingly, fee charging reduced vehicle use. The project was terminated in 2002 without being taken to the commercial stage.

CEV sharing corporation
The CEV sharing corporation was established in Yokohoma in 2002[20]. 80 companies share 24 electric vehicles for business use at an operating rate of about 20%. The cost of using electric vehicles in this car-sharing scheme is less than one-tenth of a conventional vehicle.

2.3 Key Lessons from market introduction programmes

This section summarizes the key lessons from the introduction programmes that we described before in terms of "how to design a successful electric vehicle market introduction programme?"

The main key success factors are:

- Follow the steps to a successful market introduction programme;
- Target the right market segment;
- Select the adequate technological scope for the programme;
- Make sure that you involve all the stakeholders;

Steps to a successful market introduction programme

Fleet tests and pilot/demonstration projects often form the first step of a market introduction programme. The rationale of a demonstration project is to demonstrate the benefits of alternative vehicle technologies to the public and to trigger a demand for these technologies in the market. The aim of a fleet test or a pilot project is to test the performance of a new technology under 'real' framework conditions. The result of the fleet test or the pilot project confirms whether a technology is marketable or not. Additionally, they help to identify possible barriers for the market introduction. Therefore, those projects are usually prerequisites for a successful market introduction programme.

[20] http://www.evaap.org/pdf/EVdemo.pdf

Experiences from the existing programmes show that some factors are crucial in achieving successful up-scaling of fleet tests and pilot and demo projects to wider market introduction programmes. These factors include:

- Project manager;
- Stakeholder involvement and network creation;
- Establish a refuelling infrastructure;
- Lobbying activities and media;
- Continuous public and business education;
- Establish market for used clean vehicles;

Research and development activities should be carried out and stimulated during the whole course of a market introduction programme. These activities are necessary in order to support the continuous improvement of the technology and by that to enable clean vehicles to become competitive with conventional vehicles. In many programmes R&D activities are financially supported by the national governments, but in some cases these are supported by other stakeholders, such as fuel suppliers or the vehicle industry.

Target the right market segment

A successful market introduction programme always relies on a proper selection of the market segment to target. The selection of the appropriate market segment depends firstly on the ability of alternative vehicles to compete with conventional vehicles; and secondly on the extent of behavioural change required on the part of users in order to be able to use the alternative vehicles. The experiences from existing programmes show two types of possible market introduction strategies:

- **Widespread market introduction strategy** targets a large variety of vehicle users at the same time. These can only be successful for vehicles that can compete with the existing conventional vehicles and require no or only minor behavioural changes from the users, e.g. LPG, biofuels. This strategy has proved not to be successful for BEV so far, and successful for HEV only under specific conditions.
- **Niche market strategy** targets a limited and well-identified user group. This is the strategy that many actors are currently following in the field of electric vehicles. It will only be successful if the targeted user groups are pockets of users whose preferences are already compatible with the characteristics of the new technology. It requires that the technology have some specific advantages over the conventional technology for these users. Possible niche markets for EVs may be: city cars, public transport (buses, taxis, etc.), shared cars, self-service systems for short-time and short-range vehicle rental, delivery vans and service vehicles (post, utilities, messengers, etc.), cycles, scooters, mopeds and motorcycles.

In terms of targeting **initial user groups**, the experiences show that in the initial phase of a market introduction programme for EVs fleets and 'activity centres' are often targeted as first user group. In other words:

- Most market introduction programmes try to target vehicle **fleets** as the initial market for different reasons: large mileage/year, mileage mostly in urban area, high vehicle turnover, few decision makers, fixed daily routes. However, fleet operators are usually reluctant to purchase alternative vehicles with a high capital cost and of which they have no, or limited, past experience. Therefore, most programmes target at first governmental and public sector fleets rather than private fleets. Another popular fleet often targeted in the initial phase of market introduction programmes are public transport vehicles, particularly buses and taxis.

- To avoid spreading too few resources across too many types of projects, some programmes start to target **'activity centres'** like airports, national parks, campuses, tourist resorts, etc. The advantage is that the variety of vehicle types at service in these centres opens up many interesting possible applications for alternative vehicles at a lower cost and with a high visibility. However, because these vehicles are often owned by a variety of different entities it is recommended to design the programme with all the decision makers of the entities of an activity centre simultaneously.

Eventually the overall aim of all market introduction programmes should be to reach the private vehicle purchasers; hence focussing on fleets and activity centres should be seen as an initial step. However today most market introduction programmes are just in this initial phase, and this is particularly true for BEVs and HEVs.

Technological scope of the programme

The success of a programme depends also on the relevance of its technological scope. The technological scope of a programme can be focused on the promotion of a single technology/fuel type or it can aim to deploy several types of clean technologies/fuels. Programmes with a broad technological approach are the most ambitious ones, especially if they cover a large geographical scope, but not often the most successful ones. The choice of the vehicle technology is crucial for the success of the programme. So far, only technologies that either offer outstanding advantages to the users or require only minor behavioural changes have been successfully introduced. Therefore, it is crucial for a market introduction programme to focus on marketable technologies with a high level of acceptance by potential users to be successful.

Involvement of the stakeholders

There are likely to be many stakeholders involved in the process of bringing new vehicles into the market: governments (local, regional, national, intergovernmental), NGOs, fuel suppliers, vehicle industry, vehicle users, research centres, and media. All of them play different roles and act differently, some being active and some passive or even counteractive. When introducing a new vehicle or technology to the market it must offer advantages or at least no disadvantages to all the relevant stakeholders. Ignoring this factor may limit the effectiveness of subsequent measures.

The role of main stakeholders in the market introduction programmes for BEVs and HEVs is:

- **Governments** naturally play a central role in clean vehicles market introduction programmes since they have the power and the resources to mobilize a variety of instruments (see section 3 of this report). National governments are usually responsible for legislation, taxation schemes and R&D funding. However, local governments often play a more central role for the promotion of clean vehicles for several reasons:
    - They are the closest to the people and therefore they can easily act as legislator and facilitators to develop programmes at the local level;
    - The environmental problems are intensified in the cities;
    - The majority of the fleet vehicles are found in the cities; and
    - They are usually big fleet owners themselves and so they can set a good example.

  This explains why the large majority of the programmes introduced so far are managed by cities or other local authorities.

- So far the **vehicle industry** has not played any dominant role in the promotion of clean vehicles and being able to engage these to provide sufficient numbers of alternative vehicles to procure vehicles has often been an issue for the programme initiators. However some car manufacturers are creating partnerships with fuel suppliers to overcome this 'chicken and egg' problem. Manufacturers of heavy vehicles traditionally have close contacts with the fleet owners. They can therefore play a significant role in introducing clean vehicles on the market. The supporting industries (e.g. producers of batteries, charging stations, etc) have a more proactive strategy in favour of the development of clean vehicles, as their future is

dependent on the increased use of their products. Finally, local retailers and maintenance providers play a key role in the market introduction of clean vehicles since their engagement or reluctance in selling and servicing these vehicles is often crucial for the purchaser's decision.

- **Fuel suppliers** are the driving forces behind several market introduction programmes for alternative fuels since they want to create new market for their products. This is also true for electricity suppliers and the promotion of BEVs and HEVs. Many big electricity utility companies are very active in promoting and increasing the use of electricity vehicles. In many programmes utility companies have provided charging facilities and have subsidised the electricity.
- **Vehicle users** and user associations strongly influence the market diffusion rate of alternative vehicles since most buyers when faced with new technologies will first seek to learn how others have experienced it. Big fleet owners (e.g. bus companies, national post agencies, leasing firms, taxi companies, public utilities, etc.) are therefore often the main partners in the introduction of new programmes.

In general the chances of successfully introducing a market introduction programme increases with the number of stakeholders committed to the programme. It is especially important to get the existing car industry on board. There are a variety of strategies for the involvement of additional stakeholders: persuasion, networking, mandates, voluntary agreements, public-private partnerships and leadership by example.

Finally, several programmes demonstrated that the high cost of investing in clean vehicles can be significantly reduced by buying the vehicles in bulk together with all the stakeholders of the programme (common procurement; see below).

3 Review of measures to stimulate the uptake of hybrid and battery electric vehicles

3.1 Introduction

This section will provide a review of the types of measures that might be necessary to stimulate widespread market uptake of hybrid and battery electric vehicles. The review will be strongly linked to the work carried out in Section 2 on the experiences of other countries in their deployment programmes. Like Section 2, much of the information for this section has been obtained from the IEA report "Deployment Strategies for Hybrid, Electric and Alternative Fuel Vehicles", which includes guidance on how to design, develop, and implement programmes to stimulate the uptake of HEVs, BEVs, and other alternatively-fuelled vehicles. A caveat to the following is that success of measures in one programme cannot necessarily be translated to success in another. The local conditions from programme to programme vary and as such programmes may have to be adapted to suit the new programme. Furthermore, a key finding of the CIVITAS programme is that a combination of measures often provides enhanced returns compared to the impacts of single measures introduced on their own.

In order to enter the vehicle market successfully, clean vehicles must offer advantages – or at least no disadvantages – to all relevant stakeholders. Since clean vehicles usually cannot offer advantages to all relevant stakeholders under existing framework conditions, supporting measures that aim to change these framework conditions are necessary. These measures aim at overcoming the main barriers to the development of clean vehicles on the market:

- Lack of marketable technology
- High cost
- Lack of supporting infrastructure
- Conservative attitudes and value leading to lack of social acceptance

There is a wide variety of supporting measures available to change the framework conditions of the vehicle market in favour of clean vehicles and to overcome these barriers. They can be regrouped in five categories of instruments that the governments (or other stakeholders) use in their strategies to promote clean vehicles:

- Command and control instruments
- Economic instruments
  - Targeted at electric vehicles
  - Targeting transport, generally
- Procurement instruments
- Collaborative instruments
- Communication and diffusion instruments

A particular stakeholder is often best placed to introduce each of the supporting measures or instruments presented above. National and local governments can utilise all of the instruments, whereas other stakeholders have a more limited repertory of measures which they can apply: command and control only for governments; economic instruments also for other stakeholder groups; communication instruments for all stakeholders. However the implementation of most measures can be effectively supported and enforced or hindered by other stakeholder groups.

3.2 Review of main policy instruments

Command and control instruments

Command and control instruments are usually the prerogative of public authorities. Traditionally, they represent the core of the government's strategy that is then complemented by other types of instruments. Examples of command and control instruments are presented below:

- **Standards** are one type of command and control instrument that are necessary to promote clean vehicles in several ways: for quality and safety, for technical design and to reform inappropriate existing standards and regulations, which have not been designed with cleaner vehicles in mind. Standards set the minimum rules that the stakeholders (particularly vehicle manufacturers and fuel suppliers) must follow when introducing clean vehicles on the market. However governments must be prepared to adapt the standards regularly as new technologies become available on the market. Environmental standards may typically be included in the licensing procedures for the different categories of vehicles.

- **Vehicle emission regulations** have become gradually stricter in most countries during the past decades, mostly due to European regulations. It is important to stress that these regulations only relate to emissions of air quality pollutants and not to emissions of CO_2. The European Commission is currently in the process of developing proposals to regulate emissions of CO_2 from passenger cars. European regulations relating to air pollutant emissions from vehicles have stimulated the development of cleaner conventional vehicles but have had no significant effect on the market introduction of electric vehicles. One approach would be to force manufacturers to develop cleaner technologies through the imposition of very tough focused medium or long-term CO_2 emission standards.

- **Mandates** are the typical instruments used by the governments to force targeted stakeholders to modify their behaviour. Two types of mandates are popular to promote clean vehicles: mandates for procurement of clean vehicles, which require a certain number of clean vehicles to be incorporated into a fleet; or mandates for the selling of clean vehicles, which forces vehicle retailers to sell a fixed percentage of clean vehicles per year for instance.

- **Exemption of clean vehicles from certain restrictive regulations** is also used in several countries. These exemptions offer advantages regarding the access to certain areas to clean vehicles: express and bus lanes, restricted zones, restricted parking zones, etc. However, these incentives are usually viewed as short term only, because as clean vehicles become more popular they will not be sustainable anymore, unless the terms of the regulation are modified regularly over time.

Economic instruments (targeted at hybrid and battery electric vehicles)

Economic instruments, targeted at hybrid and battery electric vehicles, help address the "cost" barrier to the development of these clean vehicles. They do so by supporting financially the development of the clean vehicle technologies and by giving financial incentives to potential buyers of specific types of vehicles (e.g. BEVs or HEVs).

However, the experiences presented above show clearly that financial incentives for BEVs and HEVs can be very expensive and they are not stand-alone instruments. The impact of financial incentives often does not reach the level anticipated before the programme implementation, since either the financial incentives are too small or the technology requires major behavioural changes.

Instruments include:

- **Direct investment** in R&D, in infrastructure and in demonstration projects is used in most countries to support clean vehicles. This support is typically provided by national governments or European programmes, but sometimes also by local governments or the vehicle industry.

- **Subsidies (targeted)** are also a very popular instrument to overcome the cost barrier of the clean vehicles. Subsidies are usually grants offered to targeted stakeholders under specific conditions. The design of the settings of a subsidy (budget, target, conditions, evaluation, etc) is crucial to its success, as subsidies are easily inefficient if they are not designed properly. Different types of subsidies (or grants) are popular in the transport sector: vehicle purchase and conversion subsidies; subsidies for infrastructure construction; public transport subsidies.

- **Financing schemes** are also important measures to successfully overcome the barriers of high investment cost (e.g. vehicle purchase or conversion, construction of infrastructure).

Economic instruments (targeted at transport, generally)

Economic instruments which facilitate the uptake of all lower carbon vehicles can also play an important role in encouraging the purchase and use of hybrid and battery electric power vehicles. Taxation instruments cover six key areas:

- Registration/purchase taxes
- Circulation taxes
- Fuel taxes
- Subsidies
- Taxation of benefit in kind
- In use and parking charges

In most countries, passenger cars have generally been the target of tax reform that takes into account the CO_2 emissions of vehicles, with other vehicles, e.g. light commercial and heavy duty vehicles, being targeted less frequently. There are a number of reasons why this is the case, including:

- Passenger cars generally make up the largest proportion of the vehicle fleet in a country and hence are the mode that emits the largest proportion of CO_2 emissions. Consequently, when reform begins, it is the mode that is usually targeted first.
- Energy efficiency is often more of a consideration in the purchase of commercial vehicles, e.g. vans and heavy goods vehicles, than it is for passenger cars. Hence, there are potentially higher reductions in CO_2 emissions to be gained from targeting passenger cars than vehicles used for commercial purposes.
- There is, as yet, no agreed method for measuring CO_2 emissions from heavy-duty vehicles, whereas the CO_2 emissions of passenger cars have been measured and reported for a number of years. This is partially due to the fact that passenger cars are the source of more CO_2 emissions than are commercial vehicles (as noted above). However, additionally, due to the nature of the way in which vehicles are manufactured and sold, it is far easier to measure the CO_2 emissions from a passenger than it is from a heavy-duty vehicle. The CO_2 emissions of light commercial vehicles are now measured.

Notwithstanding these issues, there are a number of different types of taxation measures, outlined below, that are available in the transport sector more generally that can contribute to reduced CO_2 emissions. However, the importance of the design of any instrument cannot be overstated. As noted below, the previous UK company car taxation scheme incentivised driving at the margins, whereas the reformed system has resulted in the use of cars emitting lower amounts of CO_2. Hence, below we set out the range of taxation measures available that may incentivise lower CO_2 emissions from the sector, but note that the benefits of these depend on the design of the instrument. For those vehicles, such as heavy-duty vehicles, where it is not possible to directly link a taxation measure to a vehicle's CO_2 emissions, a proxy to CO_2 could be chosen, but this must be chosen well if the desired effect is to be achieved. The instruments are discussed below and summarised in Table 3.1.Interactions between the instruments, and wider issues are considered at the end of the section

- **Registration/purchase taxes**

  Registration/purchase taxes are an upfront cost and so can have a strong impact on carbon emissions and on the market, if the costs are strongly differentiated according to a vehicle's emissions[21]. Political acceptability concerns can be addressed through the use of feebate and revenue neutral schemes[21].

  In Ireland, from 1 July 2008, the purchase of lower carbon vehicles will be incentivised. All new cars registered and any imported into Ireland, will be placed in one of seven tax bands with lower carbon emission cars attracting reduced VRT rates and higher carbon emission cars attracting increased VRT rates. The range will go from 100 euros a year to 2,000 (the rates will vary from 14% to 36%).

  In other countries different approaches to incentivising lower carbon vehicles through registration tax are in place[22], for example in:

  - France, the regional tax on registration certificates is increased for cars emitting more than 200gCO_2/km
  - In Cyprus, rates range from a 30% reduction for cars emitting less than 120gCO_2/km to a 20% increase for cars emitting more than 250gCO_2/km.

- **Circulation/ Motor taxes**

  Circulation charges, because they are an annual charge rather than an upfront cost, tend to have a relatively limited effect on purchase decisions. However, they have the advantage of being relatively politically acceptable, and are quite straightforward to introduce[21]. In the UK, cars registered on or after March 1,2001 are charged according to their level of CO_2 emissions. For the tax year 2007-2008 this was up to £300, with the least polluting vehicles paying no excise duty at all. Cars registered before March 1, 2001 are charged according to engine capacity.

  Annual circulation taxes based on CO_2 emissions are also in place in Luxembourg, Sweden, Cyprus and Denmark.

- **Fuel taxes**

  Increasing fuel charges, which is an indirect measure, has a limited short-term impact on carbon emissions but can affect purchasing decisions in the longer term. The measure is, however, unpopular with the public.

  In the UK, the fuel duty escalator (annual fuel duty increases above the rate of inflation) was introduced in 1993, first at an annual rate of 3% above inflation and then at 5%. It was increased to 6% in July 1997, although this was subsequently discontinued in 1999. The increase in fuel duties between 1996 and 1999 are estimated to have produced annual carbon savings of between 1 and 2.5 MtC by 2010.

- **Subsidies**

  Subsidies, through grants or in some cases rebates, can have an impact on carbon emissions, if the pricing is strongly differentiated. Subsidies can also help in developing markets. However, depending on the size of the scheme, they can be costly[21].

  In Ireland, from 1st July 2008 there will be VRT relief on series production hybrid electric vehicles and flexible fuel vehicles of up to €2,500. In Italy, a tax incentive of €800 and a two-year exemption from annual circulation tax is granted for the purchase of a new passenger car complying with the Euro 4 or Euro 5 exhaust emissions standards and emitting not more than 140 g of CO_2/km, provided a Euro 0 or Euro 1 car is scrapped simultaneously.

[21] TNO (2004) Measuring and preparing reduction measures for CO_2 emissions from N1 vehicles.
[22] ACEA (2007) Overview of CO_2 Based Motor Vehicle Taxes in the EU

The UK government has recently announced a new programme to procure innovative low-carbon vehicles for use in public sector fleets and has committed £20 million to this programme. The majority of programme funding in the initial phase will be in procurement of low carbon vans reflecting the fact that currently there is no low carbon van model available on the mass UK market. Procurement of battery electric vans and low carbon minibuses will also take place.

- **Taxation of benefit in kind and the treatment of depreciation**
  The taxation of benefit in kind and the treatment of depreciation are issues when of relevance in relation to the taxation of company cars. In the UK, prior to the relatively recent company car tax reforms, the taxable benefit in-kind relevant to the private use was calculated in a way that encouraged additional driving to avoid paying tax. Given the additional CO_2 emissions resulting from this incentive, the company car taxation was reformed so that it is calculated with reference to a car's list price and CO_2 emissions, this figure is then subject to tax and National Insurance Contributions. The charge increases from 15% of the car's price to a maximum of 35% - in 1% steps for every 5gCO_2/km. The scheme was introduced in 2002 and in 2004, average CO_2 emissions figures from company cars were around 15g/km lower than would have been the case if the reforms had not taken place. Around 60% of company car drivers who were given a choice of company car by their employers were influenced by the company car tax reform and as a result chose cars with lower CO_2 emissions figures.

  However, it is also suggested that when drivers stop having company cars they switch to cars with CO_2 emissions figures that are around 5g/km higher than the company cars that they would have otherwise have had if they had not opted out. France[22] and Belgium also has company car tax schemes that are based on CO_2.

Furthermore, the UK company car tax scheme does not cover light vans, and an increase in the purchase of light vans, has been noted since the introduction of the scheme.

- **In use and parking charges**
  Pricing policies for example adapted road pricing, congestion charging or parking charges, etc., can be used to compensate for the added costs of clean vehicles and to internalise the external costs/benefits of transport. The idea behind road pricing is to link the costs more strongly to the vehicle in use, e.g. the user pays according to the distance travelled, the type of infrastructure, or the vehicle emissions. In the UK, in London proposals to increase the current £8 charge to £25 for the highest carbon vehicles and take away charges for the least polluting vehicles. The majority of vehicles would continue to pay the same £8 charge[23].

  Offering preferential parking charges for clean vehicles can be a contribution to compensating users for the added cost of such vehicles. In London a number of local authorities are considering relating residents parking charges to a car's CO_2 emissions. This was led by the London Borough of Richmond, which, in 2007, introduced a £300 fee for an annual residents' parking permit, for Band G cars (i.e. those emitting high CO_2 emissions), which compares to the charge of £100. At the other end of the scale, those cars emitting low amounts of CO_2 pay no parking fee[24].

[23] AEA Energy & Environment *et al* (2007) *Combined Impact Assessment of Proposed Emissions Related Congestion Charging* for Transport for London; see http://www.tfl.gov.uk/assets/downloads/ERCC-Impact-Assessment.pdf
[24] *ibid*

Table 3.1 Impacts of taxation on different sectors

	Private		Sole Trader			Company			
Vehicle Category	Private car	Private van	Company car	Public Service vehicle	Taxi	Company car	Other fleet car (e.g. rental leasing co.)	Light Commercial Vehicle	Public Service Vehicle Minibus/ bus
Registration/Purchase (lower carbon incentivised)	+++ ***		+++ ***		+++ ***	+++ ***	+++ ***		
Subsidies – purchase	+ **	+ **	+ **		+ **	+ **	+ **	+ **	
Potential Future Fiscal Measures									
Subsidies (including purchase and rebate)	+ *	+ *	+ *	+ *	+ *	+ *	+ *	+ *	+ *
Subsidies – research and development	+ ***	+ ***	+ ***	+ ***	+ ***	+ ***	+ ***	+ ***	+ ***
Circulation/ motor taxes	+ *	+ *	+ *		+ *	+ *	+ *	+ *	
Fuel taxes	+ *	+ *	+ *	+ *	+ *	+ *	+ *	+ *	+ *
Taxation of benefit in kind / and treatment of depreciation	++ *		++ *			++ *		++ *	
In use and parking charges[1]	+++ *	+++ *	+++ *		+++ *	+++ *	+++ *	+++ *	

+CO_2 reduction

* impact on market development

[1] takes into account reduced mileage

Interaction Between Instruments
The instruments, have, so far, been considered independently. However, there are clearly linkages between the above instruments which would result in lower carbon vehicles being further incentivised. Linkages can include:

- Substitutability where instrument A has a similar impact to instrument B, and can replace, but not add to it
- Complementarity: the combined effect of measures A and B is greater than either alone, but less than their sum
- Addivity: the combined effect of measures A and B is equal to the sum of their individual effects
- Synergy: the combined effect of measures A and B is greater than the sum of their individual effects

For example fuel taxes and subsidies for research and development are likely to be synergistic measures, while subsidies for purchase and fuel taxes will involve complementarity or addivity.

In undertaking analysis of the different measures it will also be important to 'group' them and assess the potential combined impacts.

Wider issues
Wider issues must also be taken into consideration when examining the above instruments. For example, organisations can re-imburse employees fuel costs and if driving for business purposes makes up a considerable percentage of fuel use then the impact of an instrument such as a fuel tax on an employees vehicle purchase will reduce. The same problem arises if a company were to pay parking or in use charges. Steps to address these issues, therefore, need to be considered alongside the implementation of instruments.

Procurement instruments

Another very effective way of increasing the number of clean vehicles on the market is for the governments (or whichever stakeholder of the programme) to purchase clean vehicles directly.

- **Green procurement** aims to achieve immediate air quality improvements and to boost the market by increasing the demand for clean vehicles. There are both voluntary and mandatory approaches to encourage green procurement.

- **Leadership by example**, i.e. the use of clean vehicles by the initiators of the programme and the spread of their experiences is an effective measure to promote clean vehicles. This is particularly true considering that fleet managers generally have a 'wait and see' attitude to new technologies hoping someone else will assume the risk of being the first. They are more willing to purchase a clean vehicle if it has proven itself productive for another fleet.

- **Common procurement** has been used successfully in a number of cases. When a large number of users form purchasing consortia, their negotiating power can be greatly enhanced. Genuine economies of scale can be achieved. However, to assure a positive impact of common procurement it is critical that local retailers are involved early in the process to help build a strong local buyer/supplier relationship.

Collaborative instruments

As opposed to traditional command and control instruments, collaborative instruments are used more and more in policy-making. They rely on the idea that beyond its steering role a state should exert a more collaborative or managing role in the society and on the markets. Taking into account the given fact that the current vehicle market is dominated by a few big players and the state usually does not have the resources to steer the action of those big players, it is more realistic for the governments to take the role of a facilitator, network manager and moderator. A large range of

collaborative instruments is available to the governments to play an important role in the promotion of clean vehicles by co-ordinating the actions of the other stakeholders.

- **Certification and labels** are common instruments used by governments in collaboration with the stakeholders to improve the transparency and the diffusion of information on the markets.

- **Voluntary agreements** are a modern trend for public authorities to try to forge alliances with manufacturers on a voluntary basis. To be effective those voluntary agreements must be backed by the prospect of regulations if the targets are not met.

- **Public-private partnerships** and **private-private partnerships** are more and more common instruments to achieve specific policy objectives in a flexible and voluntary way that provides advantages for all partners. For instance: quality partnerships between local authorities and public transport operators; partnerships of fuel suppliers and fleet owners; or partnerships of vehicle users and vehicle dealers, etc.

Communication and diffusion instruments

Communication and diffusion instruments are available to all stakeholders to inform and educate the public about clean vehicles. They are often seen as weak but crucial instruments for the success of a programme, especially in the field of clean vehicles where there is usually a lack of quality information about the technologies.

- **External information and awareness campaigns** are used continuously to communicate about the objectives, the strategy and the results of the programme. This is absolutely necessary for the success of the programme.

- **Marketing activities** for clean vehicles should not be problem-centred but they should position clean vehicles as modern technologies that have much to offer for the individuals. In other words, marketing activities should focus their message on positive and not negative images of clean vehicles.

- **Vehicle buyers' guides and vehicle labelling** provide accessible information about the performance (including economic and ecologic performances), the safety and the advantages of clean vehicles. They must be consumer-friendly, and include easily accessible information that helps customers in comparing different vehicle models.

- **Internal information** and continuous education activities among the stakeholders of the programme are just as important but often neglected by the programme managers. It helps to keep all people informed and directly involved in the programme.

- **Education and training packages** for vehicle sales/retail personnel and mechanics are essential in order to establish both a sound pre-sales service and a good after-sales service.

- **Persuasion and lobbying activities** are also important measures within every market introduction programme. They aim at getting additional partners committed to the programme in order to achieve more favourable framework conditions for clean vehicles.

3.3 Key lessons for governmental measures

Combination of supporting measures
Each measure may be introduced as a stand-alone measure. However the effect is greater if several measures are implemented as a package that is tailored to the unique framework conditions of the country concerned. The measures must be introduced in a co-ordinated manner as a 'bundle of measures'. Since every 'bundle' is tailored according to the specific framework conditions of a country it is not possible to give a general recipe for a promising combination of measures. But it is useful to have a look at the different approaches that existing market introduction programmes have taken.

Consistent time/resource frame
It is important to remember that the successful outcome of a clean vehicle programme is attained gradually and cannot be forced in an untimely manner. It is therefore essential that the programme be scheduled for a long period to bring along changes of the framework conditions and allow the market to react. Measures must be in place long enough and funded at a consistent level in order to form a reliable base for the developmental plans of industries and vehicle users. Therefore, measures should be carried out with continuity and they may be necessary for quite a long period.

Monitoring and assessment of results
One noticeable result of the analysis of existing introduction programmes is the fact that there is a striking lack of independent, policy-oriented evaluations open to the public. Such evaluations would facilitate learning from the programme's successes and failures. Ideally, the design for monitoring and evaluation should already be included in the design of the programme. In addition, continuous monitoring facilitates the assessment of the programme so that the measures can be adjusted whenever necessary throughout the operational time of the programme.

Priority to network management
The analysis of the existing programmes shows that most programmes start with the assumption of a strong steering state and networking is mostly seen as a complementary measure. However transport is a policy field where the opposition against governmental measures is very high and it is a market dominated by a few big players. In this context, governments cannot steer the clean vehicles market by themselves, but they can give positive impetus. The argument is not that the strong state concept does not work (it does assuming that the necessary resources are available), but that in the specific conditions of the clean vehicle market, priority should be given to a network management approach to ensure strong involvement of the stakeholders and high public acceptance of the programme.

Necessary but complementary role of financial incentives
Experience shows that financial incentives are very expensive and not a stand-alone instrument to promote the market introduction of clean vehicles. In other words, financial incentives are sometimes a necessary precondition for success, but not a guarantee. In addition, subsidies are an appropriate instrument only if there is a chance that the supported technology becomes self-sufficient in the future (marketable and high public acceptance). Therefore, financial incentives can play an important but only complementary role.

4 Recommendations

As noted in the introduction to this report, SEI is planning to initiate a demonstration programme for HEVs and BEVs in Ireland. This section presents recommendations to SEI about how to design a successful demonstration programme for HEVs and BEVs (section 4.1) and the considerations that might be given to reviewing the existing policy framework in order to ensure that obstacles to the introduction and use of EVs are minimised (section 4.2).

4.1 Recommendations for the proposed demonstration programme

This section sets out a number of recommendations as what this demonstration programme might contain. These are set out below.

4.1.1 User groups to target

It is clear from the examples presented above that focusing on **niche markets** in the early stage of the market introduction programmes, as opposed to a widespread, unfocussed market strategy, is potentially the most successful approach. The best niche user group to choose would be one that is easy to target and highly visible. The best options might be:

- Fleets that travel mostly in urban areas and that have fixed usage patterns, as this facilitates the siting of, and access to, recharging infrastructure.
- Public fleets because they are easier to target than private fleets at an early stage of the demonstration programme.
- Public transport because of its high visibility and fixed usage patterns based in urban areas.
- Specific activity centres, such as airports or tourist areas, because of their high visibility and clearly delimited area.

Hence, possible options for SEI for the first demonstration programmes might be:

1. **Public fleets** in cities: municipal vehicles, police vehicles, city agencies' vehicles, etc. This option targets mainly passenger car and van vehicles categories (e.g. the UK Low Carbon Vehicle Procurement Programme, ZEUS Stockholm project, CIVITAS Rotterdam, Bristol and Gőteborg programmes).
2. **Public transport** in large cities. This option targets mainly minibuses and full sized buses (e.g. the CIVITAS Rome, Lille, Bristol, Stockholm programmes).

Options for additional smaller projects might be:

1. **Delivery vans** in cities (e.g. ELCIDIS programme).
2. Public transport in smaller **tourist areas** (e.g. car free tourism resort programme in Germany).
3. Buses and other mid-size vehicles at **airports.**
4. **Taxi fleets** in large cities.

At a later stage of the introduction programme, private fleets or private vehicles could be targeted, but only when the initial demonstration programmes have been successful and public support for HEVs and BEVs has increased.

4.1.2 Vehicle categories to target

Based on the results from Report 1, which reviewed the available vehicle categories and models in Ireland, we can make some recommendations on the best options in terms of vehicle categories:

- **Passenger cars**: switching to BEVs (best option in terms of CO_2 emission reduction) or to HEVs (second best option in terms of CO_2). Both vehicle categories are available in Ireland today.
- **Vans**: switching to hybrid electric vans would be the most cost-effective option both in terms of CO_2 emissions and costs.
- **Minibuses and full-sized buses**: switching to hybrid minibuses or full-sized buses is the most appropriate option at the present time. Battery electric buses would be better in terms of CO_2 emissions, but there is a lack of availability on the Irish market.

4.1.3 Supporting measures

To be successful, market introduction programmes should rely on a range of measures that must be coordinated. It is also important that while designing the details of these measures that the targeted user groups and vehicle categories are kept in mind at all times in order to ensure that the measures being developed are the most appropriate. Examples of measures that might be at the core of the Irish demonstration programme are:

- **Subsidies for vehicle purchase or conversion.** Given the cost differentials between EVs and conventional vehicles, granting subsidies to potential buyers of HEVs or BEVs is a measure worth considering in the introduction of a demonstration programme. Subsidies could potentially cover between 50 to 100% of the additional cost, depending on the budget of the programme. When determining the level of subsidy, these additional costs could be taken to include only the investment costs or might be taken to include investment costs as well as any additional maintenance costs for a period up to 3 years (e.g. UK Powershift Programme).
- **Subsidies for investment in infrastructure**. New investments in refuelling infrastructure (e.g. electric charging stations) are crucial for the success of a demonstration programme. Allocating subsidies to fund investments in such infrastructure could also be a central element of a demonstration programme. These subsidies can either be direct investments in recharging infrastructure, or subsidies to other stakeholders (e.g. fuel suppliers) to build the necessary infrastructure. This approach has been taken in the UK through the Energy Saving Trust's Refuelling and Recharging Infrastructure Programme, which provides funding for the construction of recharging infrastructure.
- **Common procurement**. Common procurement platforms have been proven to be a useful mechanism at the programme level (or city level) for each category of vehicle (cars, vans, minibuses and full-sized buses) in order to centralise the purchase of the vehicles. Purchasing consortia have proved to be very efficient in other countries and they also facilitate the relations with the vehicle industry. Hence, the demonstration programme could encourage the setting up of such arrangements.
- **Public-private partnerships and voluntary agreements**. Another key lesson was the need to engage stakeholders and obtain their buy-in to the programme, so the use of mandates or other mandatory instruments would probably not be beneficial at this point. However, the development of partnerships with the relevant public bodies and the different industries involved (e.g. vehicle manufacturers, vehicle maintenance services, fuel suppliers) at an early stage of the programme should be a major factor in the programme. Voluntary agreements or partnerships would need to operate for a long period to be really successful (typically 10 years). It is also important to involve other stakeholders, in fact as many as possible, such as user groups, in the programme in order to ensure the active and positive collaboration of them all in the programme (e.g. US Clean Cities Programme).
- **Communication and education**. Experiences in other countries show that public awareness and support to HEVs and BEVs is crucial for the success of a programme (e.g. CIVITAS Rome and Gőteborg programmes). We therefore recommend communicating the objectives, results and outcomes of the demonstration programme on a regular basis. Communication

needs not only to be directed at the stakeholders of the programme (i.e. internal information campaigns) but also to the public in general (i.e. external information campaigns). Part of this communication needs to cover information about the latest developments in EV technologies.

- **Evaluation**. Finally, the regular evaluation, e.g. every year, of a programme is an important mechanism to monitor progress and, where necessary, to adapt the measures (particularly the level of the subsidies) to take account of developments in the technologies and the development of the market in order, for example, to avoid subsidies overcompensating buyers. A regular evaluation will also provide the information for meaningful internal and external information campaigns. To be objective and ensure credibility, the evaluation should be undertaken by an external organisation that is not involved in the programme. The design of the evaluation procedures should be decided early on while the programme itself is being developed.
- **International collaboration**. Given that the findings of the review underline the need to build networks, engage stakeholders and develop markets, and additionally that the UK, is also developing programmes for low carbon vehicles, there is the potential for Ireland to work closely with the UK on their related programmes. This is particularly relevant as the UK and Ireland are in a minority of countries in the EU that drive on the left.

4.2 Recommendations for clean vehicle policy

In order to stimulate the uptake of electric vehicles in Ireland, and also more clean vehicles in general, the broader policy framework must also be favourable to the introduction and use of such vehicles. Action to ensure that the policy framework supports the demonstration programme will be outside the scope of the programme, itself, but is potentially important if the introduction of cleaner vehicles is to be supported and encouraged. Similarly, a review of Ireland's wider policy framework that might identify any obstacles to the introduction of EVs in the country is outside the scope of this project.

Policy areas, which should be part of a wider policy review to ensure that obstacles to the introduction of EVs in Ireland are minimised, include:

Taxation: The impact of the new Vehicle Registration Tax on vehicle purchases and overall carbon emissions needs to be closely monitored. Other aspects of the taxation system also have the potential to either encourage or inhibit the use of EVs, such as the taxation of the use of company cars and or cars used for business, e.g. the treatment of benefit in kind. While these are briefly discussed in Section 3 a more detailed review of these taxation systems and their potential to support and encourage the introduction of EVs in Ireland may be useful. An assessment of measures that could stimulate uptake of EVs in public service vehicles is also necessary.

Standards and regulations. Another barrier to new technologies might be caused by the existing regulatory framework that has been set up with other technologies, in this case conventional transport vehicles and fuels, in mind. This could relate to, for example, health and safety standards or planning requirements relating either to the vehicles, themselves, or the refuelling infrastructure. Consequently, a review of existing regulations and standards that might impact on, either EVs or their recharging infrastructure, could be undertaken to identify any potential barriers to the introduction and use of EVs in Ireland.

Annex I

Information about additional interesting HEV and BEV programmes

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
Austria	EV Promotion in Vienna	1995 - ….	1782 electric passenger and light duty vehicles (425 in 2001)	500,000 Euro (1995-2001)	Objective: To support the deployment of electric vehicles by subsidies (20% of purchase price) only for citizens of Vienna
Switzerland	Large Scale Test with Lightweight EVs and Partner Communes	1996-2001	EVs	ca. 22 million US$ (Swiss Federal Office of Energy, Canton of Ticino, EV buyers)	Objective: to demonstrate the effects of a wide use of electric vehicles in a defined area, subsidizing of EV purchases. Subsidies not enough motivation to change to EVs, consumers need additional benefits. Supply chain doesn't work.
Germany	ProKom	1990 -…	15 electric passenger cars, 34 electric vans, mini buses, inclusion of hybrids planned	ca. 3.7 million US$	Objective: to promote the use of EVs by communal authorities. Application niches in municipal fleets identified, but still no wide acceptance by communal fleet managers

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
	Car Free Tourism resorts	1998-2003	30 electric bicycles, 51 electric scooters, 3 lightweight EVs, 7 EVs, 8 electric vans	8 million Euro (German Ministries of Transport, Environment, Economics & Labour, Province of Salzburg, cities of Bad Hofgastein and Werfenweng, EU)	Objective: to demonstrate the use of electric vehicles in tourism resorts. Vehicles accepted by tourists and local business. The substitution of about 100 vehicles with internal combustion engines by electric vehicles led to substantial reduction of air pollution, noise and CO_2 emissions proved by an EC funded study. Purchasing e-vehicles is supported with subsidies. http://www.smile-europe.org/locxpdb/front/show.php?lang=en&lxp_id=120
	e-mobile Rugen	1992-1996	60 EVs (minibuses, vans and private cars)	30 million US$ (Ministry of Science, car and battery manufacturers	Objective: test of advanced battery technologies. Some of the advanced battery types showed problems but an increased range was achieved compared with lead-acid battery types
European Union	Zero and Low Emission Vehicles in Urban Society (ZEUS)	1996-2000	>1000 zero and low emission passenger vehicles, buses, trucks, 225+150 EVs	50 million Euro (5.5 million from EU)	Objective: to show how cities, by forming purchasing consortia, can trigger a market for alternatively fuelled vehicles. Some suppliers reduced prices. Some problems resulted from local retailers not being motivated to or trained in selling and maintaining vehicles
Finland	EVD-Post	1997-2000	16 EVs	1 million US$ (EC 40%)	Objective: to show the viability of electric vehicles in postal fleets. Battery type was exchanged. Project serves for decision making concerning the use of EVs in postal fleets

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
	MOBILE	1993-1998	EVs, CNG, LPG	101 million FIM (23.3 million US$)	Objective: Framework programme with 75 single projects aiming at research, demonstration and testing of alternative fuels.
France	Praxitele	1997-1998	50 EVs with telematic systems	EDF, CGFTE (transport service), Renault	Objective: providing of publicly available EVs for rental, testing the user acceptance. A report by Shaheen et al (1998) suggested the Praxitele programme had started well. 50 Renault electric vehicles are rented and driven between 5 'Praxiparcs' located near transit stations and office blocks. AT the time of the report there were over 200 users with plans to expand to over 1000. There were also plans to operate a similar system in Paris with 2000 cars in the year 2000. http://www-rocq.inria.fr/praxitele/welcome-angl.html plus see Shaheen et al's review http://www.uctc.net/papers/467.pdf pg 9
Italy	ATAF Florence	1996-….	26 electric minibuses, 50 CNG buses	N/A	Objective: use of advanced technologies in public transport in the city of Florence. Success dependent on additional non-technical measures. http://ec.europa.eu/environment/air/clean_bus/slides/martin.pdf
	ATENA	1997-2001	Electric, CNG, Hybrid among others	19 million US$ (Ministry of Science)	Objective: developing a simulation model to assess the impact of low emission vehicles by a measuring campaign. Benefits of telematic system proven.
	FLEETS + Terni	1996-2000	24 hybrid buses, 2 biofuel buses (comparison vehicles)	3 million US$	Objective: evaluation of the use of hybrid buses. Technical failures identified during test helped improve technology, emission reduction proven.
	Law 426/98 Objective to improve air quality	1999-….	Hybrid and EVs, CNG, LPG for fleet users in cities with >25000 inhabitants	60 million US$	Important for promoting the use of hybrid and electric vehicles – less for alternative fuels.

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
Japan	EV Sharing System	1999-….	EVs		Objective: to promote the use of electric vehicles by using it in niches where they show their specific advantages (publicly available electric vehicles with telematic system), development as commercial systems. http://www.evaap.org/pdf/EVdemo.pdf
	Low Emission Truck Introduction and Promotion Plan		Hybrid trucks amongst others	120 million US$ MLIT, Japanese Truck Association	Objective: to replace diesel trucks by clean energy vehicles, subsidies 50% of the price difference compared with similar conventional trucks, leasing 30% of usual prices are taken on by the programme.
	Clean Energy Vehicle Diffusion Plan, Japan	1998-2010	Electric vehicle (100, 000), Hybrid (2.06 million)	100 million US$/year (METI, MLIT)	Objective: by 2010 3.65 million clean energy vehicles (CNG and LPG as well as hybrid and electric) will be introduced in the overall vehicle fleet; 10% of the government fleet.
Sweden	ELCIDIS, Stockholm	1998-2002	9 Hybrid and electric vans	980, 000 Euro	Objective: to test and demonstrate electric vehicles for goods delivery in cities. http://www.elcidis.org/elcidisfinal.pdf
	EVD Post	1998-2000	Involved 5 postal organisations from Germany, Sweden, Finland, France and Belgium 59 EV employed	2.6 million Euro (40% from EU) Check	Objective: to test electric vehicles for postal delivers. The demonstration vehicles logged a total mileage of over 930,000 km. The primary energy consumption was found to be 10-25% less than a petrol/diesel vehicle of the same size. Merits of the vehicles were that they were well received by drivers and members of the public, and did not contribute to air pollution or noise. Downsides identified include lack of economic maturity expressed as high procurement costs, limited product diversity and little or no after sales support. http://www.citelec.org/evdpost/EVD-POSTFinalReport.pdf

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
	Electric Vehicles in Gotenborg	1993-1999	64 EVs	4 million US$	Objective: to introduce 1000 electric vehicles step by step. Technology – interest in electric drive technology has increased and there is an urgent need for safety and infrastructure standards Demonstrations – demonstration vehicles served both the public and private sector and in the end a growing number of vehicles were purchased without subsidies due to lower purchase price. Demonstration vehicles provided technical monitoring, data, user experience and experience regarding demonstration projects, training and evaluation Consumers are generally positive about using electric cars for work, but more reluctant to purchase them for individual use http://www.kfb.se/pdfer/R-00-27.pdf Price and limited driving range are the main barriers to market, electric vehicles are easy to drive, and are useful in many situations. Subsidies are not justified. http://www.kfb.se/pdfer/R-00-48.pdf
	Hybrid Vehicles in Field Test	1996-2001	1 hybrid pick-up, 1 hybrid van	31 million Skroner	Objective: to evaluate hybrid drivetrains in everyday experience. Battery life and monitoring system below expectations, higher consumption than expected, reliability good for 1 vehicle, less good for the 2nd vehicle.
	Technology Procurement 1	1993-2000	150 electric passenger vehicles (Renault Clio electrique)	400.000US$	Objective: coordinated procurement for electric vehicles. 150 EVs on the road. More realistic knowledge about the performance and application of EVs.
	Ethanol and Hybrid Buses in Stockholm	1990-2000	6 hybrid and 200 ethanol buses	6 million US$	Objective: test and demonstrate a large-scale introduction of ethanol and hybrid buses. Good reliability.

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
UK	Powershift	1996-2005	Electric, hybrid amongst others	16 million US$/year (Dept of Environment Transport and the Regions)	Objective: to develop a sustainable market for cleaner fuel vehicles to deliver air quality, climate change and noise benefits. Cleaner fuel vehicles above all in city fleets, infrastructure established. This programme is no longer being funded. http://www.dft.gov.uk/consultations/archive/2002/fdpp/thefuturedirectionofthepower1587
USA	Zero Emission Vehicle (ZEV) Mandate	2003-…	EVs or other low emission vehicles	California Air Resources Board	Objective: to lower the air pollution by agreements with the car industry.
	Clean Cities Programme	1993-…	3.300 EVs, hybrid and others	8 million US$ (Department of Energy)	Objective: to reduce greenhouse gases and dependence on imported oil, to improve air quality. Cities have to form coalitions. http://www.eere.energy.gov/cleancities/
	ENVVEST EV Pilot Programme	1999-2002	50 EVs plus hybrids	1 million US$/yr (City of Vandenberg, DoE, car manufacturers, utilities)	Objective: to reduce pollutants and CO_2 emissions. EVs provided for test driving, user training, maintenance infrastructure established. http://www.epa.gov/projctxl/vanden/prog00_11.pdf
	Pilot EV Loan/Lease Programme for Washington Fed. Fleets	1998-1999	EVs made available for free for 1-3 months to give fleet managers chance to test them	N/A	Objective: EVs made available for free for 1-3 months to give fleet managers the chance to test them. Additional steps for the acceptance of fleet managers must complete the programme (e.g. infrastructure, standards, subsidies…)

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
	EV Market Launch Programme	1998-…	5000 EVs		Objective: to demonstrate 5000 EVs in 11 municipalities. http://ntl.bts.gov/lib/2000/2000/2088/vol1.pdf
	Fleet Evaluation	1997-…	150 EVs	Georgia Power	Objective: to familiarise fleet customers to the use of EVs by organising events. High attendance at events but lack of vehicles meeting the demands. Incentives needed http://evworld.com/archives/interviews/floyd.html
	Field Operations Programme	1996-…	>500 EVs	50million US$ (US DoE)	Objective: to provide unbiased information on performances of alternative vehicles to fleet managers by standardized tests, cooperation with EV Loaner Programme. Field operations testing of Toyota Prius demonstrated the difficulty of accurately measuring fuel economy without physically modifying a vehicle. Variables such as driver behaviour, air conditioning and the type of driving style can result in significant energy efficiency variations. http://avt.inl.gov/pdf/hev/toyota_prius_final.pdf Background information is available at - http://avt.inl.gov/
	Southern California Edison Electric Transport Programme	1989- …	300 EVs	4-5 million US$/year	Objective: to support and integrate electric transportation in Southern California. Infrastructure established. Improvements to the EVs maximum speed acceleration, and range performance are recommended. http://66.102.9.104/search?q=cache:70qiu3K7iwQJ:www.eere.energy.gov/vehiclesandfuels/avta/pdfs/fsev/usps/us_ps_12_00.pdf+eu+electric+vehicle+postal+programme&hl=en&ct=clnk&cd=3&gl=uk

Country	Programme Title	Dates	Vehicle Type/ Number	Funding and source	Objective and Results (if known)
	Station car		Small EVs	No funding/size info	Objective: to provide electric vehicles at stations of public transport systems for commuters. http://www.american.edu/ted/electric.htm Station car programmes were launched in the mid-1990s with rail transit operators seeking to relive parking shortages at stations and avoid high cost of building more parking infrastructure. Electric utilities were also hoping to exploit niche market for EVs while Las were keen to see reduced air pollution and vehicle use. Most of the programmes have struggled with high cost and low reliability of 1st generation EVs. Even though shared us is stated goal, as of 1998 no programmes had incorporated shared use. http://www.uctc.net/papers/467.pdf

Source: Based on "IEA, Deployment strategies for Hybrid, Electric and Alternative fuel vehicles 'Annex VIII/XXI' http://www.ieahev.org/pdfs/annex_8_final_report.pdf", but extensive update of the information when data available.

Sustainable Energy Ireland
Glasnevin
Dublin 9
Ireland

t + 353 1 836 9080
f + 353 1 837 2848
e info@sei.ie
w www.sei.ie

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