TOP – NEST

Project number: RD 2011-42

Report on sustainable road transport developments in Europe

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17th October 2013

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1 Introduction

The report consists of two parts:

1. Desk research (chapters 2-4);
2. Interview results with the main EU stakeholders (chapter 5).

The desk research is based on literature review and focuses on developments in Europe for understanding the existing framework conditions of road transport, the main challenges and barriers, and mapping the main networks and technology platforms. The second part of the report includes the selection of interview partners, interview guide and summary of the results of the interviews.

The report concentrates on four types of road transport: biofuels (1st generation); hybrid vehicles, electric vehicles and new technologies like hydrogen vehicles and 2nd generation biofuels. The division is based on the development status of these technologies.

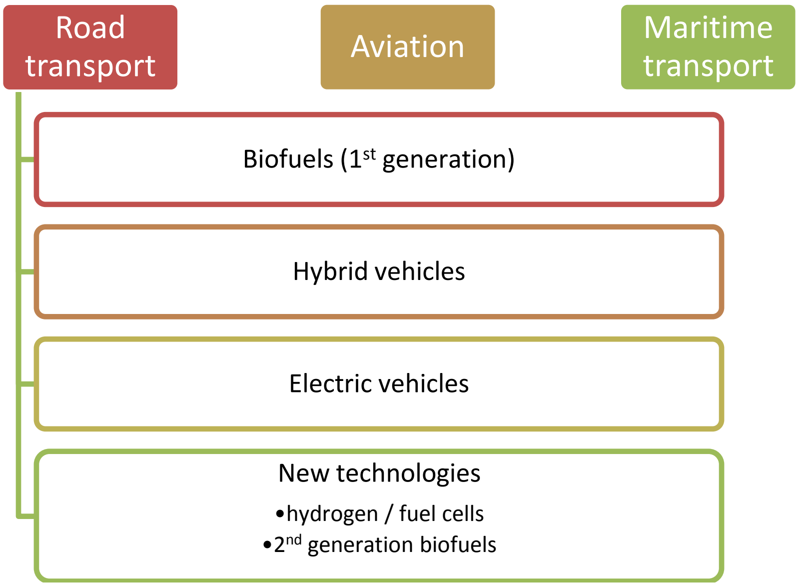

Figure 1: Division of transportation sectors

The automotive industry is a strategic sector of the European Union (EU) economy and employment (European Commission, 2012a). In the EU the transport industry directly employs around 10 million people and accounts for about 5% of gross domestic product (GDP) (European Commission, 2011d).

When looking at the current state of the industry, there exists contrasted situation. The EU market is currently at the lowest level since 1996. However, EU companies have strong positions in growing markets, such as in South America, China and others, where profits are made. Manufacturing activity in the EU, particularly for volume segments, is facing serious and structural challenges which impact its competitiveness and may put pressure towards further restructuring. Technological innovation is definitely an asset of the EU industry, in part linked to ambitious regulation, in part to a demanding and diverse customer base (European Commission, 2012a).

Transport has become more energy efficient, but EU transport still depends on oil and oil products for 96% of its energy needs (European Commission, 2011d). Moreover, transport is the second largest greenhouse gas (GHG) emission producer in the EU right after energy sector (Figure 2).

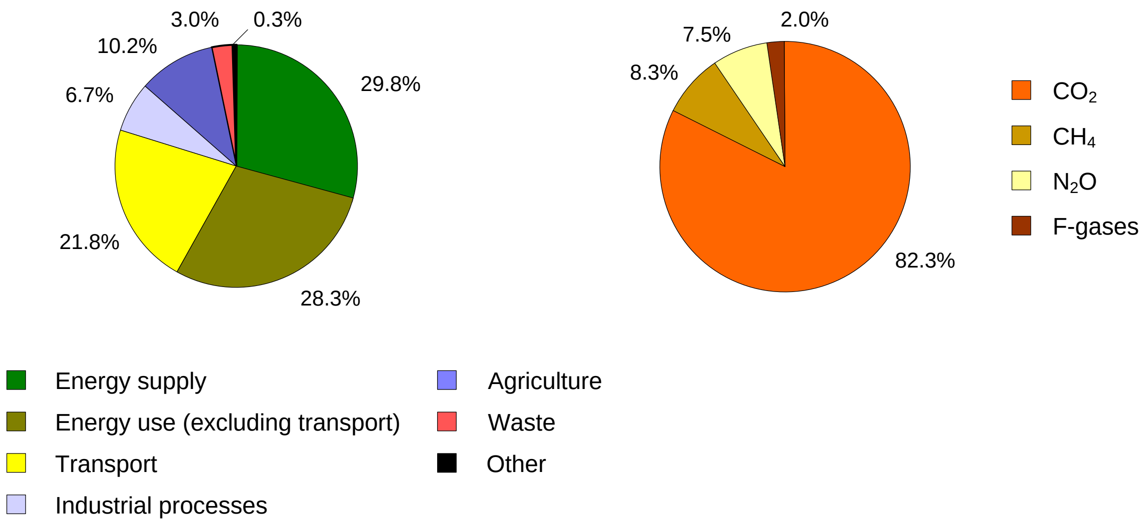

Figure 2: Share of GHG emissions by main source and gas in 2009 (EEA, 2011)

Since 2001, a lot has been achieved. But still, the transport system is not sustainable. Infrastructure takes many years to plan, build and equip. The choices that are made today will determine transport in 2050. There is needed to act on a European level to ensure the transformation of transport (European Commission, 2011d). Sustainable transport policy is driven by aspects like resource depletion, climate agreements and technology development (Dinçer & Zamfirescu, 2012). Transport has to:

- use less and cleaner energy;
  Oil will become scarcer in future decades, sourced increasingly from unstable parts of the world. Oil prices are projected to more than double between 2005 levels and 2050 (59 $/barrel in 2005). Current events show the extreme volatility of oil prices.
- better exploit a modern infrastructure;
  Infrastructure is unequally developed in the eastern and western parts of the EU. In the new Member States there are currently only around 4 800 km of motorways and no purpose-built high-speed rail lines; the conventional railway lines are often in poor condition. Moreover, freight transport activity is projected to increase, with respect to 2005, by around 40% in 2030 and by little over 80% by 2050. Passenger traffic would grow slightly less than freight transport: 34% by 2030 and 51% by 2050.
- reduce its negative impact on the environment and key natural assets like water, land and ecosystems.
  Congestion costs Europe about 1% of GDP each year. There is the need to drastically reduce world GHG emissions, with the goal of limiting climate change to 2°C. Overall, by 2050, the EU needs to reduce emissions by 80–95% below 1990 levels in order to reach this goal (European Commission, 2011c, d).

According to (Banister, 2011) sustainable mobility approach requires as well actions to reduce the overall need to travel, to encourage modal shift, to reduce trip length and to encourage greater efficiency in the transport system. Genoa car sharing case study is only one of many studies that proves that introduction of car-sharing principle in the community can deliver real fuel savings, reduced traffic and emissions. Another case study of Aalborg (in Denmark) has showed that municipalities can attract new public transport users by only offering mobile phone applications to facilitate the use of public transport.

It is obvious that more resource-efficient vehicles and cleaner fuels are unlikely to achieve on their own the necessary cuts in emissions and they would not solve the problem of congestion. They need to be accompanied by the consolidation of large volumes for transfers over long distances. This implies greater use of buses and coaches, rail and air transport for passengers and, for freight, multimodal solutions relying on waterborne and rail modes for long-hauls (European Commission, 2011d).

2 Existing framework conditions

The challenge of today is to break the transport system's dependence on oil without sacrificing its efficiency and compromising mobility. The paramount goal of European transport policy is to help establish a system that underpins European economic progress, enhances competitiveness and offers high quality mobility services while using resources more efficiently (European Commission, 2011c, d).

2.1 Transport policy goals and strategies

Creation of efficient transport sector policy is a challenge. To reach the goal – a reduction of at least 60% of GHGs by 2050 with respect to 1990[1] - first of all clear policy framework should be set. Today a number of policy documents is available on transport sector in EU. During the last four years, at least four important policy communication documents were developed and presented by European Commission (Figure 4).

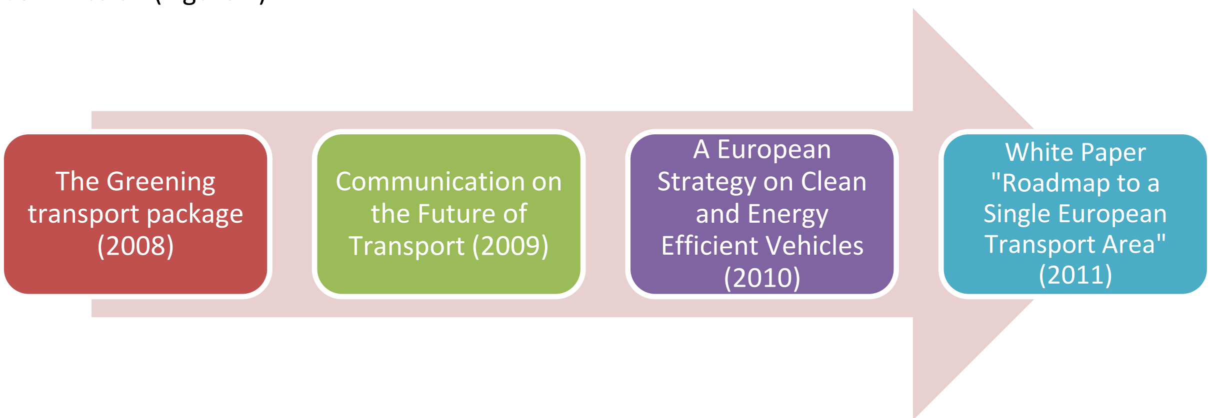

Figure 4: Policy communication documents by European Commission

Greening transport package, presented in July 2008, aims to move transport further towards sustainability. Besides an inventory of EU actions already taken to greener transport and a set of new initiatives the Commission will take in this field, the package includes three documents:

1. strategy to ensure that the prices of transport better reflect their real cost to society in terms of environmental damage and congestion;
2. proposal to enable Member States to help make this happen through more efficient and greener road tolls for lorries, and;
3. proposal for reducing noise pollution from rail freight (ACEA, 2008).

Further European Commission adopted a *Communication on the Future of Transport* on 17 June 2009. The document summarises the evaluation results of recent transport policy measures, discussion in focus groups and meetings with main stakeholders. At the same time Communication also drafts policy options to be tested and eventually included in the 2011 White Paper (European Commission, 2009).

European Strategy on Clean and Energy Efficient Vehicles is set to encourage the development and uptake of clean and energy efficient ('green') heavy- (buses and trucks) and light-duty vehicles (cars and vans) as well as two- and three-wheelers and quadric-cycles (European Commission, 2010a).

[1] Commission Communication 'A Roadmap for moving to a competitive low carbon economy in 2050', COM(2011)112

Annual state of play reports are prepared to demonstrate further progress and will contribute to the review of the strategy scheduled for 2014 (European Commission, 2011a).

The White Paper *Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system* of 28 March 2011 puts forward concrete initiatives to reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050.

The White Paper presents a variety of initiatives to reach the goal. Based on it and other literature sources, Figure 5 summarises the main elements influencing the existing framework for electric, hydrogen and biofuels road transport. These are mainly fuel availability, technologies and innovations that can deliver competitive vehicles, policy and support measures like fiscal support and market incentives and mix of different measures like awareness rising of customers.

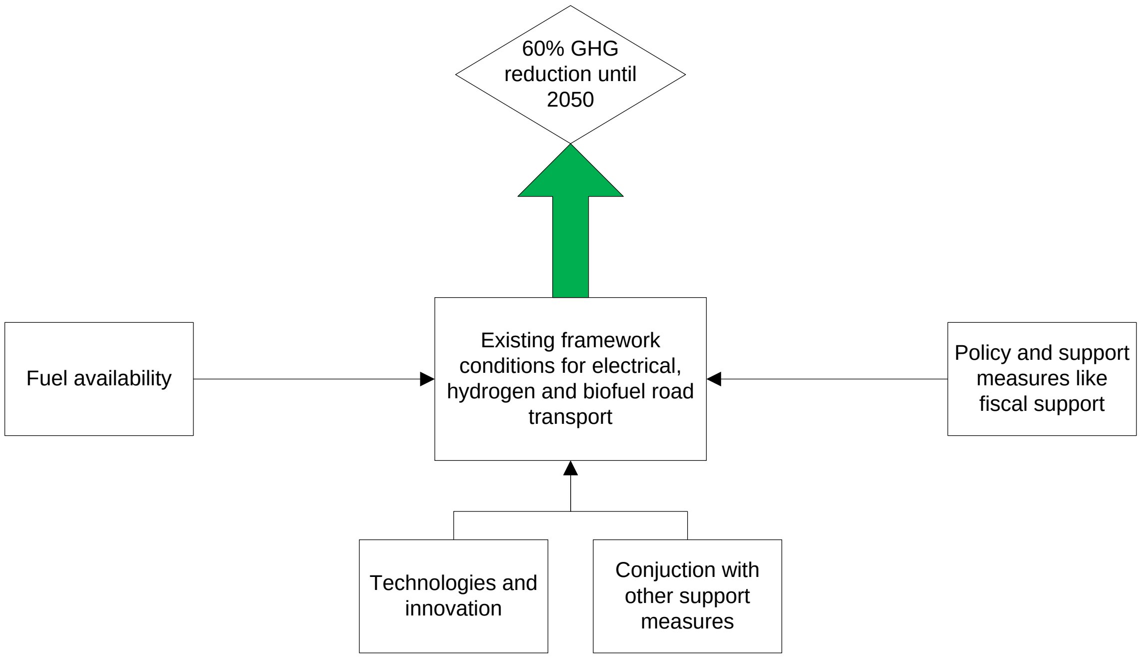

Figure 5: Main elements influencing the existing framework for electric, hydrogen and biofuels road transport

In 2011, European strategy for clean and energy efficient vehicles has benefited from synergies with several new initiatives. First of all, the implementation of the strategy is closely linked to the re-launch of the CARS 21 High-Level Group - effective as of October 2010. As foreseen in the strategy, the re-launched CARS 21 High Level Group has gathered an enlarged group of stakeholders in order to give advice on the design and the implementation of the several actions announced in the strategy. Furthermore, the Group also prepares the recommendations which go beyond the time horizon of the strategy and identifies possible follow-up actions.

Secondly, the strategy is also closely linked with a series of strategic initiatives in the fields of low-carbon economy[2], transport[3] and energy decarbonisation[4], as well as resource efficiency[5] that were

[2] A Roadmap for moving to a competitive low carbon economy in 2050, COM (2011) 112 final, 8.3.2011

[3] White Paper: Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, COM (2011) 144 final, 28.3.2011

[4] http://ec.europa.eu/energy/technology/set_plan/set_plan_en.htm

[5] Flagship initiative on a resource efficient Europe, COM(2011)21 final, 26.1.2011; Roadmap to a resource efficient Europe, COM(2011)571 final, 20.9.2011

adopted by the Commission in 2011. An important component of all of these initiatives is improvement of the sustainability and particularly environmental performance of vehicles and mobility – coherent and complementary to the concrete measures charted by the strategy for clean and energy efficient vehicles (European Commission, 2011a).

According to Alter-Motive project results, most governments (local, regional, national and supra-national level) do not have a long history in the development of policies on the field of sustainable transport. There are limited experiences to learn from. Knowledge must thus be gained from other sources including lessons learned from experiences of other governments with more and less successful policies related to the field of alternative fuels and alternative fuel technologies. Incorporating these lessons effectively can result in successful policies (Feenstra, 2010).

Alter-Motive project team tried to allocate different existing policy measures along the S-curve of technology development (see Figure 6). This gives an impression on how the measures can be allocated during the development, however to choose the measures properly one would still need to know more details about the current status of development for the respective technology (Bunzeck, Bree, & Uyterlinde, 2010). Overview of current development of technologies is presented in the next Chapter.

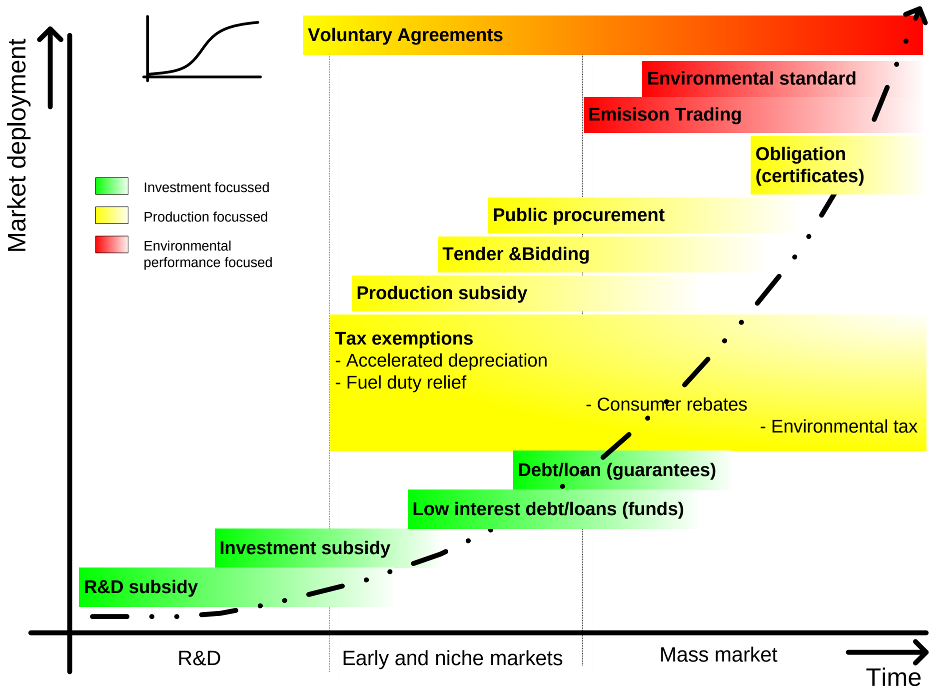

Figure 6: Policy measures along the S-curve (Bunzeck et al., 2010)

2.2 Binding legislation

There are three main directives setting targets, sustainability criteria and binding rules for road transport sector. These are:

- **Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC**. Under the Directive 2003/30/EC the EU established the goal of reaching a 5.75% share of renewable energy in the transport sector by 2010. Under the Directive 2009/28/EC this share rises to a minimum

10% in every Member State in 2020. The Directive aims to ensure the use of sustainable biofuels only, which generate a clear and net GHG saving without negative impact on biodiversity and land use.

On 17 October 2012 published proposal for amending Directives 98/70/EC and 2009/28/EC to limit the use of wood-based biofuels from 10% to 5% to meet the renewable energy targets. This means that most of the Member States will have to find other solutions to reach 10% RES target.

- **Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC.** The Directive amends a number of elements of the petrol and diesel specifications and introduces a requirement on fuel suppliers to reduce the GHG intensity of energy supplied for road transport. In addition Directive establishes sustainability criteria that must be met by biofuels if they are to count towards the GHG intensity reduction obligation.
- **Directive 2009/33/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of clean and energy-efficient road transport vehicles.** The Directive aims at a broad market introduction of environmentally-friendly vehicles. It requires that energy and environmental impacts linked to the operation of vehicles over their whole lifetime are taken into account in all purchases of road transport vehicles, as covered by the public procurement Directives and the public service Regulation.

3 Current status of three main technologies

A number of studies indicate that internal combustion engines (ICEs) for road transport will remain competitive for the foreseeable future. It is likely that even in 2050 ICEs will still make up a significant share of the transport market. ICEs are relevant not only where conventional and unconventional fossil fuel will be used but also where gaseous fuels and biofuels, including biogases, are expected to be deployed. Improvements in fuel efficiency in vehicles using ICEs will therefore still be highly relevant in reducing transport's absolute GHG emissions (even though the relative importance may be expected to decrease). For many road transport modes, there is also a trend towards the increasing electrification of vehicles, which, in the case of cars in particular, is evident in hybrid vehicles, which use both a conventional engine and an electric battery (European Commission, 2011a; Skinner, Essen, Smokers, & Hill, 2010).

Currently there are two technologies that have a mass commercialisation – 1^{st} generation biofuels and hybrid electric vehicles. Electric vehicles, full hybrid and hydrogen fuel cell vehicles are still in pre-commercialisation stage but 2^{nd} generation biofuels are in demonstration phase (Bunzeck et al., 2010). Current developments and main barriers of each of the technologies are listed in the sub-chapters below.

3.1 1^{st} generation biofuel vehicles

Over four-fifths of global production of liquid biofuels consists of ethanol. However, the share of biodiesel is rising rapidly with the emergence of new producing countries in South East Asia and faster increases in biodiesel production (compared to ethanol) in other producing countries. In 2008, the EU still produced over 50% of the world's biodiesel output, whilst Brazil and the USA together delivered 80% of ethanol production. The EU's estimated installed capacity for both biofuels exceeds its current production, and further increases in capacity are under construction (EBTP, 2010; Fonseca et al., 2010).

Commercial deployment of biofuels still depends very much on appropriate regulatory frameworks (in terms of regulation and standards for feedstock (e.g., land and waste use), biofuel production (e.g., fuel quality, sustainability, import of biofuels), distribution and vehicle compatibility (e.g., fuel standards to higher biofuel blends or regulation for new technologies), and market (e.g., exemptions from restrictive regulations)), both for existing biofuels and for innovative value chains (Group, 2011a). With the implementation of the Renewable Energy Directives having started in 2010, Member States submitted their National Renewable Energy Action Plans (NREAPs), in which biofuels are clearly expected to be the largest contributor to the target of 10% renewables in the energy consumed in transport (in 2020) (European Commission, 2011a; Group, 2011a).

Close cross-sectoral coordination between agriculture, forestry, oil industry and car manufacturers is essential in order to balance the evolution of the EU vehicle fleet and the delivery infrastructure as the penetration of biofuels grows (European Commission, 2010c).

Barrier 1: Sustainability issue

Currently dominant commercial biofuels are on the market with two principal pathways:

- Bioethanol as a blending component in petrol and in the form of ETBE (Ethyl tert-butyl ether), made from sugar-producing plants, such as sugar cane and sugar beets, or starch-producing plants like wheat and corn, and used in gasoline engines.

- Biodiesel (esters, FAME) as a blending component in diesel, made from vegetable or animal oils in the chemical form of fatty acid methyl esters and used in diesel engines (Bunzeck et al., 2010; Group, 2011a).

Sustainability is the cornerstone issue for 1st generation biofuels. First-generation biofuels that use sugar and starch crops (ethanol) and oilseed crops (biodiesel) as feedstock compete directly with demand for these crops as food or feed (Fonseca et al., 2010; Group, 2011a). Therefore, in 2010, the Commission adopted guidelines aimed at assisting Member States with the implementation of the sustainability criteria for biofuels and bioliquids. In addition, in December 2010, the Commission published a report, which analysed the additional aspect of the impact of indirect land-use change related to biofuels (and bioliquids) on greenhouse gas emissions (European Commission, 2011a). On 17 October 2012, the Commission published a proposal to limit the use of food-based biofuels from 10% to 5% to meet the RES target. This means that other solutions will have to be found.

Barrier 2: Costs

One of the main barriers for the 1st generation of biofuels is also cost. The cost competitiveness of biofuels with regard to conventional fuels remains a key barrier to deployment, although advanced technologies promise to deliver more environmental benefits per product output, better economics and higher front-end feed-stock flexibility than the current first generation processes. Demonstration projects on a relevant industrial scale are crucial, though capital intensive, to acquire feedback on cost and technical performance (Ajanovic et al., 2011; European Commission, 2010c).

The scope for cost reductions in the 1st generation of biofuels is limited, so policy measures to increase the market share of biofuels are likely to be expensive. The basic choice is which stakeholder is going to bear these costs. When tax exemptions are applied, the costs are borne by the national government and eventually all tax payers. When an obligation is applied, the costs are born by the fuel providers and fuel consumers (Ajanovic et al., 2011).

Barrier 3: Technology and infrastructure

Both generations of biofuels can be used as fuel in internal combustion engines with or without adaptations, depending on the blend and endorsement by the car manufacturer. Low-percentage blends can be used in unmodified conventional engines (Bunzeck et al., 2010; Group, 2011a). However, the freedom of movement and the integrity of the Internal Market should be ensured to avoid different biofuel blending rates to be used in different Member States (European Commission, 2012b) Blends with conventional fuels containing higher percentages of alternative fuels require dedicated engines that are offered by the automotive industry as flex-fuel or biofuel models (basically still the same car with some engine adaptations) (Bunzeck et al., 2010; Group, 2011a).

Higher blends and biogas require the adaptation of conventional vehicles and infrastructure. This leads to additional barriers, which characterise a chicken-and-egg dynamic:

- the coverage of filling stations offering the high-blend fuel or biogas;
- the availability of vehicle models that can run on high-blend fuel or biogas.

The price premium of a vehicle that runs on high-blend biofuels (flex-fuel) or biogas also adds to the dynamic, although the additional costs of a flex-fuel vehicle are moderate. For biogas, the barriers are comparable to the barriers to the introduction of compressed natural gas (CNG) (Bunzeck et al., 2010).

The existence of these additional barriers implies that additional policy measures are required to overcome this so-called ‘blend wall’. Finally, biogas vehicles tend to depreciate quickly, because there is a perception that the high combustion temperatures cause the engine to wear down quickly. Consequently, they have a low residual value, which makes them unattractive for new car buyers (Bunzeck et al., 2010).

Summary of barriers

Different barriers are more prominent in different innovation phases. Table 1 summarises how barriers and innovation phases are related for biofuels. It indicates for instance that high fuel production cost is a barrier (and is worked on) during the R&D, demonstration, and early market phases. In each of these phases, different instruments will be deployed to lower production costs. Biofuels will only be used on a large scale when they are (almost) cost competitive with conventional fuels, implying that high costs are no longer a barrier in the mass market phase (Bunzeck et al., 2010).

Table 1: Barriers for biofuels and biogas per innovation phase (Bunzeck et al., 2010)

Barrier	R&D	Demonstration	Early market	Mass market
Biogas & high biofuels blends & low biofuels blends				
High fuel production costs				
Lack of standards				
Sustainability				
Feedstock availability				
Biogas & high biofuels blends				
Filling station coverage				
Vehicle availability				
High vehicle price				
Biogas				
Low residual vehicle value				

3.2 Hybrid electric vehicles

Electric propulsion of road vehicles is used in different configurations:

- Hybrid Electric Vehicle (HEV), using a combination of an ICE and an electric motor. The battery is charged from braking energy recuperation. The external energy input comes only through the fuel for the internal combustion engine.
- Plug-in Hybrid Electric Vehicle (PHEV), using the same power train as a HEV, but with the additional option of charging the battery also by plugging to the electricity grid.
- Range-extender vehicle (REV), representing another type of HEV, with propulsion from an electric motor, and charging of the battery by plug-in to the electricity grid or by petrol fuelled ICE. When the battery is depleted, a small ICE working as generator provides the electricity for propulsion and for sustaining the battery state of charge.
- Battery Electric Vehicle (BEV), with electric propulsion only, and external energy input only through charging of the battery from the electricity grid (Group, 2011a). More in chapter 3.3.

During the last years electric vehicles gained increased interest in national and European policies and public awareness raised significantly. However, electric vehicles still represent a small niche market hardly exceeding 1% of the passenger car market today. The market share of hybrid passenger cars, the biggest electric vehicle market today, was estimated to be 1.28% in 2009. Most stakeholders assume a realistic market share for new, electrically chargeable vehicles in rage of 3 to 10% by 2020 to 2025 (Reiner, Cartalos, Evrigenis, & Viljamaa, 2010).

Hybrid configurations without the external charging possibilities do not contribute to oil substitution (Group, 2011a). Mild and full hybrid electric vehicles still rely on conventional fuel and are mainly propelled by the conventional powertrain (Zimmer, Hacker, Harthan, & Matthes, 2009). They can, however, save oil and reduce CO_2 emissions by improving the overall energy efficiency of a vehicle. Only configurations with additional external energy input in form of electricity (PHEV, Plug-in REV, and BEV) or hydrogen (HFCV) offer routes to oil substitution and full decarbonisation (Group, 2011a).

As long as batteries alone cannot meet the customers' expectations for range, reliability and price, hybrid solutions, including range extenders, could be adequate bridging technologies from ICE to battery driven power trains (Group, 2011a).

There are actually no main barriers for broader market introduction of hybrid electric vehicles (Bunzeck et al., 2010). The main advantage of the HEV is its high saving potential for fuel consumption in city traffic but disadvantage – low saving potential for interurban driving. However, one of the limiting parameters for wider use of HEV is limited availability of models and cost of battery (for full hybrid).

3.3 Electric vehicles

Today there is no electric car on the market which offers the capabilities of existing[6] ICT cars (Reiner et al., 2010). Although the long-term future of electromobility remains uncertain and depends crucially on technological and other developments, the shorter term issues seem more limited in scope and concrete. In the years until 2020, electrically chargeable vehicles are expected to gain an increasing but relatively modest market share (European Commission, 2012b). Several major original equipment manufacturers (OEMs) have announced the development and the commercialisation of electrically driven vehicles within the next years. The development activities comprise full electric and plug-in hybrid electric vehicle concepts and passenger cars as well as delivery vans. Hybrid electric and full electric delivery vehicles (vans) are under development and tested in several pilot schemes. First series-production plug-in buses have been recently introduced to the market (Reiner et al., 2010). As for electric vehicles (EVs), the current trends indicate even faster market penetration than at the time of the adoption of the EU Strategy on Clean and Energy Efficient Vehicles. Despite the macro-economic uncertainties, both vehicle manufacturers and suppliers are seriously investing in this new technology. Also the consumers are getting increasingly convinced about the merits of electric power-train and the concept of electro-mobility (European Commission, 2011a).

New concepts and new technologies need to be developed to realize efficient electric vehicles suited for both individual and public mobility and for goods distribution in urban areas (Reiner et al., 2010).

There are number of advantages for electric vehicles. The main are zero tail-pipe emissions (if energy is produced in a sustainable way), lower noise emissions and operational and fuel costs (Reiner et al., 2010; Zimmer et al., 2009).

In the same time, the successful introduction and market penetration of electrically chargeable vehicles depends on many factors such as first and maintenance cost of the vehicle, standardisation, regulation, customer acceptance, market incentive systems, electric charging infrastructure, attractiveness of alternative mobility solutions, communication and service infrastructure, vehicle energy storage system, etc (ERTRAC, 2010; European Commission, 2012b; Group, 2011b; Reiner et al., 2010).

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[6] Homologation is the process of certifying that a particular car is roadworthy and matches certain specified criteria laid out by the government for all vehicles made or imported into that country.

Barrier 1: technology ability

The technology ability is expressed in terms of range, durability, reliability, costs mainly related to battery technologies and development of an adequate charging infrastructure (Reiner et al., 2010).

According to European Commission, the EU type-approval framework for EVs was almost complete in 2011, and, in majority of cases, will become mandatory for all new cars in 2014. The only outstanding area of regulatory action concerns rechargeable energy storage systems (RESS) but work in this field has already started and concrete results will be delivered (European Commission, 2011a). In October 2011, Focus group on European Electro-mobility presented a report on Standardisation for road vehicles and associated infrastructure. One of the recommendations was establishing of CEN-CENELEC Co-ordination Group on eMobility to support coordination of standardisation activities during the critical phase of writing new standards or updating existing standards on Electro-mobility and make recommendations (Electro-mobility, 2011).

There is variety of technical issues with a need for EU-wide harmonization:

- standardization (plug, phases, data protocol);
- cross-national compatibility (recharging abroad should not be different to recharging at home);
- data protection (personal, business);
- safety requirements for recharging/discharging places;
- safety requirements while recharging/discharging the battery, e.g. short circuits;
- charging cable at the car or at the recharging station;
- technical approval body for recharging places;
- periodic inspections & maintenance of recharging places;
- liability clarification, and;
- convenient billing systems (Reiner et al., 2010).

According to (Electro-mobility, 2011), issue concerning the recharging interface on the infrastructure side, no consensus was found to select either Type 2 or Type 3 plug and socket outlet, which provide the same functions and ensure similar levels of safety. It should be noted that further discussions have taken place between electrical components manufacturers, car manufacturers and ESOs on possible technical compromises (European Commission, 2012b). Standardisation is needed especially to ensure the vehicles can be easily connected to the power network in order to recharge the energy storage system. The goal should not be just European but worldwide standards to avoid market fragmentation and to reduce overall costs. Standards and common interfaces also need to be agreed upon quickly as this would enable the European car industry to establish themselves in the market for electric vehicles (Reiner et al., 2010).

In the strategy on clean and energy-efficient vehicles, a number of specific measures were included in order to adapt the type-approval framework for electric vehicles. In particular, the Commission adopted in April 2011 a Commission Regulation which incorporates in the EU type-approval system the electric safety requirements set out in UNECE Regulation No 100. In addition, the UNECE requirements on the crash safety of vehicles have been revised in order to cover specific risks of vehicles with electric power train and they have also been incorporated in the EU type-approval system. Also, requirements for batteries in electric vehicles are being developed under the UNECE framework (in the so-called Rechargeable Energy Storage Systems or RESS group) and, once adopted, will also become mandatory for the purpose of EU type-approval of motor vehicles and their components. Mid 2012 is the envisaged date for adoption of such requirements by the relevant working group (European Commission, 2012b).

Barrier 2: electricity production from RES

Grid capacity is not considered a problem as the energy consumption of electrically chargeable vehicles is predicted to be only a fraction of the total energy consumption. However, due to the primary energy mix (fossil, nuclear, renewable) used to produce electricity the level of emissions from generating electricity for electric cars depends on the energy policy decisions at the European and national levels. The environmental benefits of electric vehicles significantly depend on what type of electricity is used for charging. Furthermore, in the long term and based on a significant volume of batteries, intelligent vehicle-to-grid solutions and load management (charging / discharging) may allow more efficient use of fluctuating energy production by 'valley-filling' and 'peak reduction'. In this sense, electric vehicles could become part of an overall energy (storage) strategy. Assuming current average European energy supply would reduce GHG emissions by more than 50% (Reiner et al., 2010).

Barrier 3: infrastructure

The 'fuelling' of electric vehicles with electric energy requires major changes of the existing energy supply infrastructure in order to enable an adequate operation of these vehicles. Charging infrastructure is considered to be a major factor in customer acceptability of electric vehicles. Due to the limited driving range and the long charging time of batteries, it will be essential to create pervasive public electric-charging infrastructure that ensures reliable charging capability. It will be difficult to make a business case for a public electric charging infrastructure because of high investment costs and high risks. If electric-power companies were to pay for the new infrastructure, the price of electricity for charging vehicles would have to rise significantly and the attractiveness of electric vehicles would decrease consequently. The installation of fast-charging infrastructure could improve the customer acceptability of electric vehicles, but create even higher investment needs. Therefore, it is expected that power companies will not invest in corresponding projects at a large scale without governmental subsidies and the perspective of a growing deployment of electric vehicles in the future (Zimmer et al., 2009).

The development of appropriate infrastructure needs a European harmonised approach (standards and norms) for the charging system of batteries used in electric vehicles as well as decisions that make sure that customer-friendly operation and billing systems are created. Without an appropriate recharging infrastructure electrically chargeable vehicles cannot successfully be introduced in the market (Reiner et al., 2010). The infrastructures needed, should be correctly developed and covered by a coordinated action of the initiatives of the following areas (see also Figure 7):

- EGCI (European Green Car Initiative), this refers to the part that is directly affecting the car manufacturer and necessary interfaces.
- EEGI (European Electricity Grid Initiative), this includes the part that affects the grid development itself.
- ESCI (European Smart City Initiative), referring to the part that directly affects city mobility, planning and growth (ERTRAC, 2012).

Figure 7: European Technological Initiatives dealing with EV development (ERTRAC, 2012)

Barrier 4: cost

Another important barrier is high initial vehicle cost (in particular for batteries). The successful market introduction of vehicles with electric driving mode is highly dependent on the availability of a battery technology that allows reliable on-board storage of electric energy. The key component for both performance characteristics and costs of an electrically chargeable vehicle is the energy storage system. Today it is expected that the energy storage system will be a lithium based battery system. However, today's costs of a Li-Ion battery system are about € 600-800/kWh. In the long-term (2020 to 2030) a price of € 150-200/kWh is regarded to be very challenging (Reiner et al., 2010).

Support should aim to lower cost through battery R&D and demonstration projects (learning by doing and volume effects). More experiences are needed regarding what coverage of charging infrastructure is really required (and will be utilized) by end-users. Consumer incentives are suitable to provide a financial relief to reduce initial high vehicle cost, either in form of tax incentives or as a direct subsidy (Ajanovic et al., 2011).

Industry needs to develop new business models but at the same time these need to be supported by corresponding public decisions of supporting the development of these models e.g. through the creation of lead markets and support for pilot projects. In general, one could distinguish four groups of key variables addressing CO_2 limits, marketing strategies of OEMs, total cost of ownership (TCO) and user acceptance of innovative drive technologies (Group, 2011b; Reiner et al., 2010).

Commercial success of electric vehicles could be fostered by new business models:

- high investment costs related to batteries could be coped through new leasing concepts;
- battery exchange stations (e.g. Better Place Project, the model of a US based start-up company) are discussed as a viable option in Israel, Australia, California, Tokyo and Denmark, and;
- vehicle-to-grid interfaces may emerge in new grid management strategies resulting in more efficient grid integration of renewable energies (Reiner et al., 2010).

Existing studies rely on theoretical assumptions but there are no standardised data on the real-world energy consumption under different driving and external conditions available. These may be gathered in the context of ongoing and announced pilot schemes all across Europe. Today there is only one country wide large-scale charging infrastructure project initiated in Denmark. Both lifetime costs and environmental impact of electric vehicles should be carefully analysed based on experiences gathered in these fleet test. A cross sectional study could take into account different dimensions (driving patterns, topography, charging cycles, long-term battery performance, ...) and result in better understanding the needs of customers and technological requirements. Such data are essential for reliable market penetration scenarios and an assessment of the environmental impact of electric vehicles. In the mid-term, data compilation between these initiatives could be facilitated by one or more of the European institutions (Reiner et al., 2010).

Table 2 summarises how barriers and innovation phases are related for electric vehicles (including hybrid electric vehicles).

Table 2: Barriers for electric vehicles per innovation phase

Barrier	R&D	Demonstration	Early market	Mass market
High capital and maintenance costs				
Lack of standards and regulation				
Lack of electric charging infrastructure				
Lack of communication and service infrastructure				
Travelling ranges				

3.4 New technologies

Although providing incentives and other amenities for particular fuels and technologies is often regarded as ‘picking winners’ from which policy makers should refrain, the risks from choosing certain innovations are outweighed by the risk of not attaining climate policy targets at all (Ajanovic et al., 2011). Therefore this chapter describes the new technologies – hydrogen and fuel cell and next generation biofuel vehicles. These technologies are under development and therefore many barriers exist.

3.4.1 Hydrogen / fuel cell vehicles

Fuel cells and hydrogen are long-term energy technology options. They can make only a limited contribution to the 2020 EU targets on GHG emissions, renewable energy and energy efficiency, but definitely can help in meeting the goal of cutting GHG emissions by over 85% by 2050 (European Commission, 2012c; Group, 2011a).

Three main technologies of fuel cells are currently developed for transport and stationary applications in Europe: Proton Exchange Membrane Technologies Fuel Cell (PEMFC), Molten Carbonate Fuel Cell (MCFC) and Solid Oxide Fuel Cell (SOFC). The two latter are focussed mainly on industrial and residential applications, while the main focus for PEMFC is automotive applications (European Commission, 2012c). European Hydrogen and Fuel Cell Technology Platform has presented a schedule for deployment strategy on hydrogen and fuel cells (see Figure 8). As it can be seen, market development for transport is foreseen in 2015-2020.

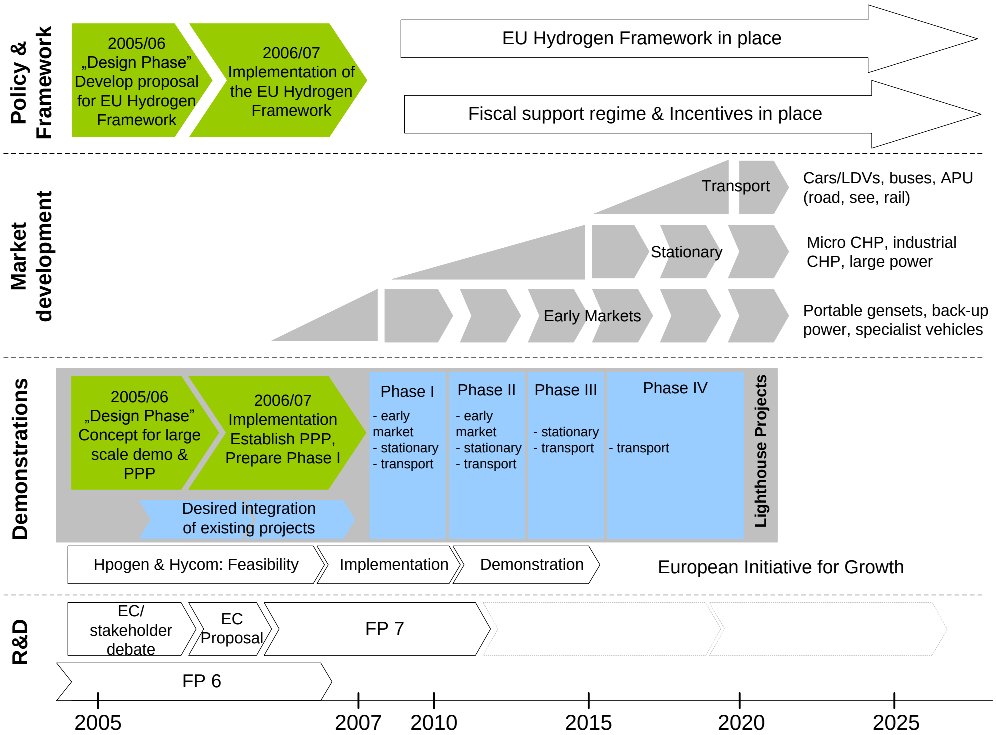

Figure 8: Schedule for development strategy on hydrogen and fuel cells (European Commission, 2012c)

As new technologies, fuel cells and hydrogen face technological, economical, institutional and societal barriers.

Technological barriers include performance and durability of fuel cells, efficiency of large volume carbon-free hydrogen production and storage safety of captured CO_2, energy density of on-board hydrogen storage and systems integration (European Commission, 2012c). Fuel cell use similar technologies in the drivetrain[7] as battery electric vehicles and thus there are many synergies in component development for the drivetrain, such as high voltage systems, E-Drives and battery technology (Reiner et al., 2010). Although harmonisation, international standards and regulations are needed to ensure safe, compatible and interchangeable technologies and systems (European Commission, 2012c).

Economical obstacles include cost of fuel cells and of hydrogen and lack of cash-flow during the first phase of deployment (European Commission, 2012c). Main barriers are the initial cost of fuel cell vehicles (consumers) and high upfront investments in infrastructure (industry) (Ajanovic et al., 2011).

The main institutional hurdles are policy and difficulties of regulatory frameworks with disruptive technologies moving from demonstration to large-scale deployment across the 'valley of death'. In order not to disturb the existing energy system, fuel cells and hydrogen technologies have to be phased-in gradually in applications where they surpass existing, as well as less disruptive, new technologies in terms of overall performance and/or lifecycle costs. Hydrogen thus has to compete with other energy carriers, electricity and biofuels, for its production from primary energy sources, increasingly renewable ones, whereas fuel cells, particularly for automotive applications face

[7] Drivetrain refers to all the components between the engine and driving wheels and including the clutch and axle, as well as the components of the driveline.

increasing competition from other zero-emission technologies such as battery electric and plug-in hybrid electric vehicles (European Commission, 2012c).

Societal barriers include public acceptance, vehicle ranges and safety perception (European Commission, 2012c).

3.4.2 2nd generation biofuel vehicles

Growing concerns of using such feed-stocks for fuel production while they are also used as food have led to increased attention for second generation biofuels. Feed-stocks for this new generation of biofuels are not associated with food production (non-food crops e.g. jatropha) or waste streams (wet waste or wood waste) and forms of lingo-cellulosic biomass. Second generation biofuels cultivation and processing is not yet as developed as the first generation (Bunzeck et al., 2010).

The potential of biofuel production from both traditional crops and energy crops is determined by the area of land, which can be made available, the yield of that land, and the use of biomass and co-products in other sectors. The production of second generation biofuels from wastes and residues is limited by the availability of these materials (Group, 2011a). Moreover, issue on land-use implications should be estimated as it depends strongly on the specific feedstock (Fonseca et al., 2010).

The costs of 2nd generation biofuels are currently too high to allow the development of an early market. Policy should for now focus on support for R&D and demonstration projects. This is currently the case at EU level; R&D results should lead to demonstration and early commercial stages. Despite of the fact that technology learning is expected to contribute to reduce the costs, some study indicate that this effect might be very limited also for routes for high energy scenarios (Ajanovic et al., 2011).

For second generation biofuels, the R&D and demonstration infrastructure and promotion instruments are still not mature. Here, the technology needs to be demonstrated at a relevant industrial scale prior to a mid-term commercialisation target. Also, more R&D and demonstration efforts should be devoted to upstream areas, such as land use, crop yields and bioenergy production. These operations are costly. A long term, coherent policy framework needs to be put into place, along with innovative financing mechanisms that pool together government, industrial and investor resources (European Commission, 2010c).

Table 3 summarises how barriers and innovation phases are related for new vehicle technologies: hydrogen and fuel cells vehicles and 2nd generation biofuel vehicles.

Table 3: Barriers for new vehicle technologies per innovation phase

Barrier	R&D	Demonstration	Early market	Mass market
Hydrogen & Fuel cells vehicles				
Performance and durability of fuel cells				
Efficiency of large volume carbon-free H_2 production				
Safety of H_2 storage				
Lack of standards				
High initial cost				

Feedstock availability for H_2 production				
Travelling ranges				
2nd generation biofuel vehicles				
Feedstock availability				
Land-use sustainability				
High production cost				

4 Transport research, technology and innovation networks in Europe

Technological innovation is one of the key competitiveness factors of the EU industry (European Commission, 2012b). It is clear that R&D has to play a major role also with respect to the increasing demand for cleaner, safer and more affordable energy technologies that are and will be necessary to achieve the ambitious climate and energy policy targets Europe has set.

In the field of clean transport systems and urban mobility, an extensive range of research, applied research and demonstration activities have been financed over recent years by both public and private sectors.

Automotive companies represent the largest private investment in R&D (around 30 billion € in 2010). Moreover, R&D in the automotive sector plays a central role for technological development in many related industrial sectors. This has enabled comparatively advanced technologies and high added value products to be developed and deployed by the EU industry and on the EU market. The technology leadership can be explained by the demanding and diverse consumer tastes in the European market. Also ambitious regulations definitely play a key role in this. The recent decade has seen significant reductions of CO_2 and pollutant emissions and improvements in vehicle safety. However, more needs to be done on those issues and several regulatory requirements decided in recent years yet have to be implemented. These developments need significant investments by manufacturers and suppliers, in addition to those needed for the cyclical development of new models, typical for the sector industry (European Commission, 2012b).

The largest public investment in transport sector is represented by the European Framework Programmes (FP). The 5th, 6th and 7th FP has supported a substantial number of research, technological development and demonstration activities between 1998 and 2012. Authors of the desk research have collected information of 160 FP projects dealing with topics of biofuels (37 projects), electric (69 projects) and hybrid (8 projects) vehicles, hydrogen & fuel cells applications (46 projects) (see Annexes I-III). In addition, research on sustainable transport related topics is supported as well under other funds and programmes such as the Competitiveness and Innovation Programme, European Structural Funds, Common Agricultural Policy funds, etc.

Besides the financial support, Framework Programmes advances research by bringing together different organisations from Europe and other parts of the world that are active in the same scientific area. Based on this trans-national cooperation the European Research Area is formed (European Commission, 2012d).

This chapter reports the main research and demonstration activities in Europe's transport sector relevant to sustainable fuel production, supply and consumption systems (see Figure 9). Within the framework of this desk research authors have foremost focused on three European research and technology network organisations:

- European Technology Platforms,
- European Industrial Initiatives, and;
- European Energy Research Alliance Programmes.

In addition, other relevant initiatives supporting development of sustainable transport systems are discussed.

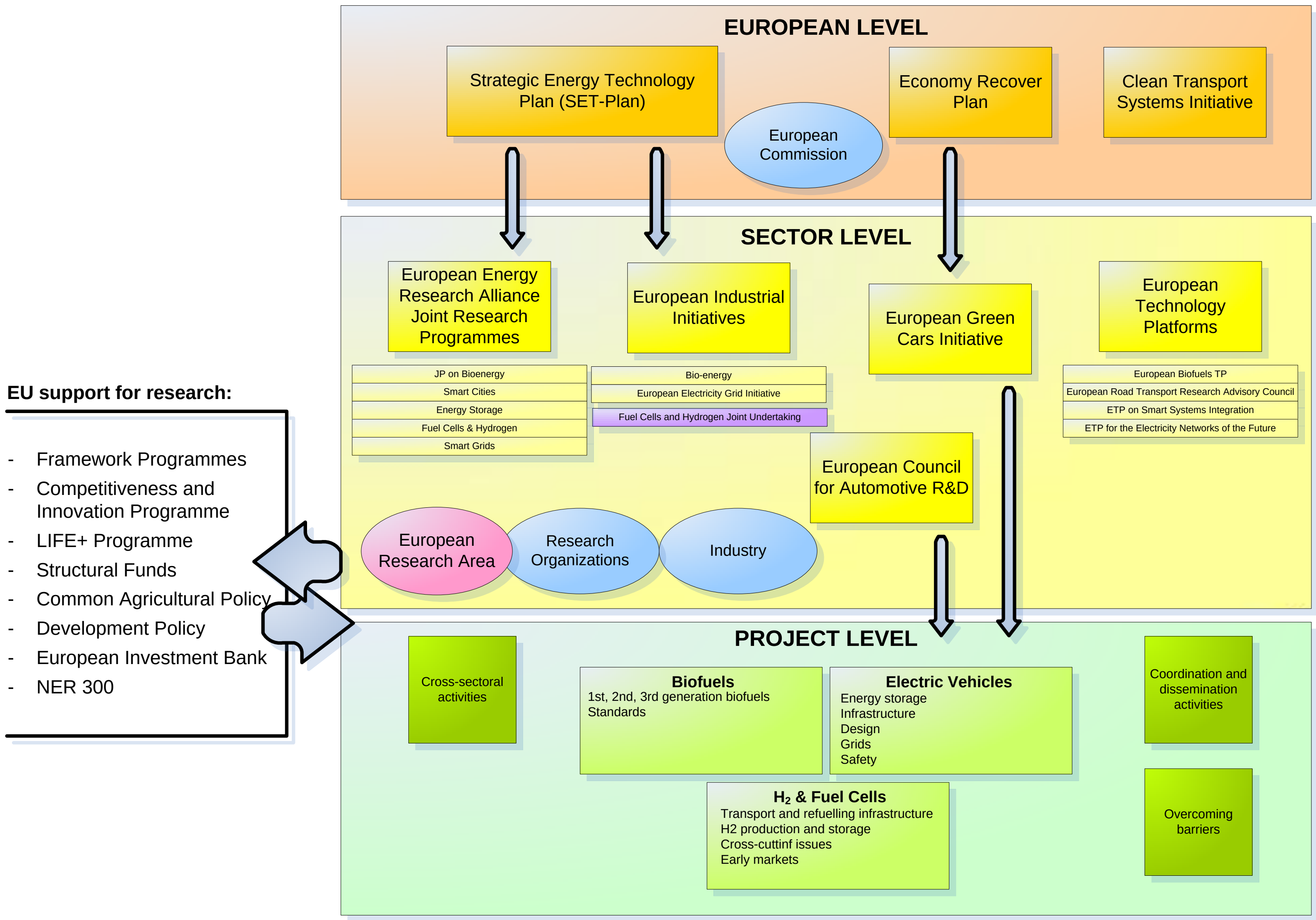

Figure 9: Transport research and technology network organizations in Europe

The technology pillar of the EU's energy and climate policy till 2050 is the *Strategic Energy Technology Plan (SET-Plan)*, adopted by the European Union in 2008. The SET-Plan establishes an energy technology policy for Europe by setting a long-term energy research, demonstration and innovation agenda for Europe. Implementation of the SET-Plan is managed under two instruments: the *European Industrial Initiatives (EIIs)* and the *European Energy Research Alliance (EERA) Programmes.*

European Industrial Initiatives, launched in 2010, brings together academia, research and industry representatives into joint large scale technology development projects to strengthen industrial energy research and innovation on technologies which is necessary for implementation of the SET-Plan. There are three EIIs whose range of interest is dedicated to transport sector:

- European Bioenergy Industrial Initiative;
- European Electricity Grids Industrial Initiative, and;
- Fuel Cells and Hydrogen Joint Technology Initiative (already implemented) (European Commission, 2010b).

In addition, to support the deployment of more efficient and new technologies according to the SET-Plan, the *European Energy Research Alliance* was launched in 2010 uniting Europe's leading energy research institutions. Currently the EERA implemented Joint Research Programmes involve more than 2 000 researchers from over 150 public research centres and universities around Europe which have associated under the European Energy Research Platform. Since its founding the EERA has launched an overall number of 13 joint programmes (JP), including five programmes relevant to development of new transport related technologies:

- JP on Smart Grids;
- JP on Bioenergy;
- JP on Smart Cities;
- JP on Energy Storage, and;
- JP on Fuel Cells and Hydrogen.

Cooperation among specific research areas and actors at European level is provided by *European Technology Platforms (ETPs)*. ETPs are industry-led stakeholder forums charged with defining research priorities and strategic directions on five technological areas:

1) energy;
2) information and communication technologies;
3) bio-based economy;
4) production and processes, and;
5) transport.

There are 36 individual technology platforms at European level. A number of them deals with topics related sustainable development of future transport systems and will be discussed in more detail further. European Technology platforms directly or partly relevant to the topic of this desk research are summarised in Table 2.

Table 2: European technology platforms

Technological area	**Technology platform (acronym)**
Energy	European Biofuels Technology Platform (Biofuels)
	European Technology Platform for the Electricity Networks of the Future (SmartGrids)
Information and communication	European Technology Platform on Smart Systems Integration (EpoSS)

Technological area	Technology platform (acronym)
technologies (ICT)	
Bio-based economy	Plants for the Future (Plants)
Transport	European Road Transport Research Advisory Council (ERTRAC)

The main work of ETPs is related to development and updating of strategic research agendas (SRA) for their particular sectors. These agendas constitute valuable input to define European research funding schemes. Contribution of wide range of industrial and public research institutions and national government representatives in the process of SRA development facilitates to create consensus and to improve alignment of investment efforts (European Commission, 2011b).

Another outcome of ETPs is the establishment of so called *National Technology Platforms (NTPs)* in many European countries. Although NTPs do not necessarily have direct link to ETPs, they address similar topics and contribute to the implementation of Europe's transport priorities at national level.
E.g., with the support of the European Road Transport Research Advisory Council (ERTRAC) 11 national road transport technology platforms have been developed in Austria, Czech Republic, Finland, Hungary, Poland, Slovenia, Spain, Sweden, the Netherlands, Turkey, and United Kingdom. The aim of these technology platforms is to allow national partners to identify their specific research policy and implementation plans for innovative transport solutions. Meanwhile, some countries are already very much forward in their SmartGrids implementation agenda. At the moment national Smart Grids associations inside Europe have been established in Austria, Slovenia, Spain, Germany, Belgium, Ireland, and Great Britain. Encouraged by the Plant ETP the Member States are now setting up as well national technology platforms or support groups of 'Plants for the Future' ETP in the individual countries across Europe. National technology platforms are currently developing in Turkey, Italy, Czech Republic, Hungary, Spain, Denmark, France, United Kingdom, and Germany

Decarbonising transport is a core theme of the European Union's future transport policy. The White Paper on Transport of 28 March 2011 sets a long-objective to cut carbon emissions in the transport sector by 60% by 2050. The *Clean Transport Systems (CTS) initiative* was initiated by the European Commission to present a consistent alternative fuel strategy and possible measures that would contribute to the achievement of the target, by accelerating the market uptake of alternative fuels and vehicles in all transport modes in the EU (Commission, 2012b).

The CTS initiative will identify the policy areas and the most urgent actions among the EU that needs to be stimulated to accelerate the use of alternative fuels and provide industry, public sector and consumers with a clear and coherent vision on the likely market developments of alternative fuels and alternatively fuelled vehicles (Commission, 2012b).

Under the CTS initiative, the European Commission is preparing to launch a comprehensive long-term alternative fuel strategy for the EU in the second half of 2012. It will cover the whole transport sector and will identify possible future actions, including legislation, in this area. The strategy will be prepared based on contributions provided by the European Expert Group in Future Transport Fuels (stakeholders) and the Joint Expert Group on Transport and Environment (Member State experts), as well as results of several public consultations, scenario modelling and implementation studies (Commission, 2012b).

The architecture of future European funding for research in clean transport is currently being prepared in the form of the following strategy papers:

- Horizon 2020 – the Framework Programme for Research and Innovation 2014-2020, and;

- Strategic Transport Technology Plan – document presenting a set of research and innovation areas (European Commission, 2011a).

4.1 Electric vehicles

Electrification of road transport is currently given high priority in EU (ERTRAC, 2012). Significant effort has been put by European policy makers and industry players not only to develop and promote new EV technologies but as well the necessary infrastructure. Due to increasing number of decentralized renewable power stations and deployment of electric transport the role of the electric grids is becoming very important to balance the energy supply and demand.

The network of organizations responsible for development of EV in Europe is illustrated in Figure 10.

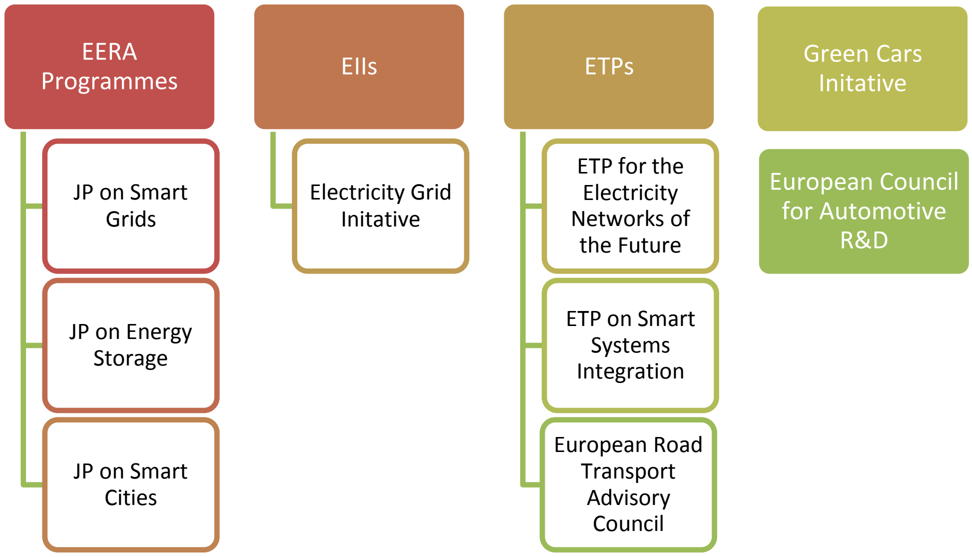

Figure 10: European network for electric vehicle R&D

Three European Technology Platforms, namely the *European Road Transport Advisory Council (ERTRAC)*, the *ETP for the Electricity Networks of the Future (SmartGrids)* and the *ETP on Smart Systems Integration (EPoSS)*, are the key European forums for identifying policy and technology research pathways for electric transport sector, as well as promoting cooperation between EU-level related initiatives. ETPs comprise a wide range of highly involved members (vehicle manufacturers, energy and fuel suppliers, research providers, EU and national bodies, cities and regions, etc.) who contribute to development of common long term visions. Strategic research agendas and deployment strategies, developed by the ETPs, identifies the key RD&D working lines for the next decades (ERTRAC, 2010; SmartGrids, 2006).

The ETPs are also one of the leading actors in *European Green Cars Initiative (GCI)*, currently the main support mechanism for EV research and development in Europe, and the *European Electricity Grid Initiative (EEGI)* – one of the European Industrial Initiatives under the SET-Plan.

The EEGI proposes a 9-year European research, development and demonstration programme to accelerate innovation and the development of the electricity networks of the future in Europe. The EEGI programme covers the period 2010-2018 and its estimated budget is 2B€. The R&D activities are organized in form of clusters, functional projects, local demonstration projects and research projects.

It is expected that results from the projects will already be available gradually starting from 2015 (Entsoe & Grids, 2010).

The European Green Cars Initiative is a part €200-billion Economic Recovery Plan presented by the European Commission in the end of 2008 to help the European economy accelerate out of the crisis and put it back on the road to recovery. Under the GCI, the financing comprises the FP7 research grants and the European Investment Bank (EIB) loans for automotive R&D in clean technologies and smart energy infrastructure. This instrument has played a key role in the recovery of the automotive industry from the crisis and is currently used by the industry to strengthen its competitive position in green' technologies (European Commission, 2011a).

The FP7 grants represent a yearly envelope of about € 100 m – matched by the industry's equal involvement. The Commission launched its first call for proposals in July 2009, which focused fully on vehicle electrification technologies. 30 projects were selected for funding with a total budget of €108 m. The second round of calls for proposals published in July 2010, with a total indicative budget of €96 m opened further research topics on trucks and logistics research, while keeping a major focus on EVs. For EVs the opened fields of research address topics like: electrical engines development and integration; safety; thermal management and innovative light-duty vehicles architectures; materials for advanced electrochemical storage solutions; battery manufacturing and information and communication technologies (ICT) for battery and onboard systems management; as well as grid integration and cooperative systems technologies. The research priorities of EVs, trucks and logistics are supported by the detailed technology roadmaps elaborated by the Advisory Group of the European Green Cars Initiative (European Commission, 2011a).

Most of the research projects that will result from the third round of calls for proposals (published in July 2011) will start during 2012 or at the beginning of 2013. The indicative budget of these calls is €108 m. The last round of calls for proposal will be published in 2012 (European Commission, 2011a).

In total more than 50 collaborative research projects have started within the European GCI since July 2009 and are included in Annex I (GCI, 2010).

Part of these projects have been initiated by the *European Council for Automotive R&D (EUCAR)* which comprises of 14 major European manufacturers of cars, trucks and buses and represents the European body for collaborative automotive and road transport R&D. List of EUCAR research and development projects related to sustainable transport systems is included in Annex II (EUCAR, 2011). These include 14 projects concerning fuels and powertrain, 8 projects working on integrated safety aspects of electric transport and 7 projects implemented for strengthening the mobility of transport sector.

Research in the field of smart grids and energy storage is carried out by three EERA Joint Research Programmes. *Joint Programmes on Smart Grids, Energy Storage and Smart Cities* unites leading European research institutions and deals with topics relevant to innovative energy storage technologies, energy management and energy systems planning, energy efficiency and integration of renewable energy sources, etc. (EERA, 2012).

Green eMotion project

The Green eMotion project, launched under the Green Cars Initiative within the FP7, is one of the largest projects aiming to enable, via demonstration, a mass deployment of electromobility in Europe. The project consortium gathers 42 partners from the automotive industry, the energy sector, municipalities as well as universities and research institutions. The aim of the project is that this large business platform will develop and demonstrate a user-friendly framework consisting of interoperable and scalable technical solutions for EVs which could be commonly accepted in Europe. The project will investigate different types of EVs and different urban mobility concepts as well as their integration in electric networks, smart grids and ICT solutions. The project has a total budget of € 41.8 m and is partly funded by the Commission's contribution of € 24.2 m.

The Green eMotion project also aims to connect with the already ongoing regional and national electromobility initiatives leveraging their results and comparing the different technology approaches to promote the best solutions for the European market. Moreover, a wider business platform will be created to enable the new actors to interact with the project consortium and to potentially develop pan-European services such as an EU Clearing House that would facilitate European billing and contribute to the development and application of standards for electromobility interfaces. With a large number of actors and locations involved, the key objective will be to demonstrate the interoperability of the entire framework together with the identification of good practices and a reference model for a sustainable rollout of EVs in Europe (European Commission, 2011a).

4.2 Biofuels

As outlined in previous chapters of this desk research, current development of biofuels is unambiguous: 1st generation biofuel production technologies are well developed and commercially widely available while 2nd and also 3rd generation biofuels require further research and technological development.

Research on transport biofuels in Europe is carried out by different organisations (see Figure 11). The core of the biofuels community in Europe is *the Biofuels Technology Platform (EBTP)* which was launched during FP6 in 2006. The EBTP unites stakeholders from industry, biomass resources providers, research and technology development organisations and NGOs in a public private partnership to contribute to the development of cost-competitive biofuels value chains, creation of healthy biofuels industry, and to accelerate the sustainable deployment of biofuels in the EU (EBTP, 2012).

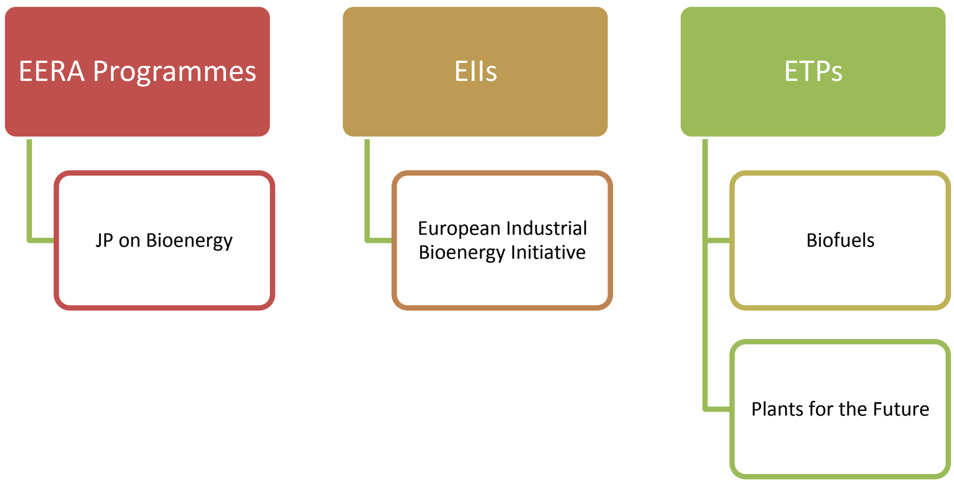

Figure 11: European network for biofuels R&D

EBTP implements different activities. During 2011, the EBTP drafted biofuels fact sheets that aim to provide the public with understandable information on innovative biofuels technologies and processes currently being developed. The fact sheets provide an overview of R&D on processing streams and indicate which technologies are being developed by companies, EC projects and other groups in Europe (EBTP, 2012).

New R&D topics have also emerged:

- upstream with algae as a potentially significant additional biofeedstock;
- midstream around the conversion technologies 'tool box' with the emergence of synthetic biology and catalytic process applications for biofuels, and;
- downstream with new end markets requesting biofuels; air, marine and rail transportation (EBTP, 2010).

In line with the recommendation of the Strategic Research Agenda and Strategy Deployment Document (2008) to accelerate efforts towards implementation, EBTP has been very active over the last years in shaping the *European Industrial Bioenergy Initiative (EIBI)* in the framework of the SET-Plan (EBTP, 2010). EIBI sustains large scale advanced bioenergy and biofuel plants, which is expected to cover about 4% of EU transportation needs by 2020. The estimated budget is €8 billion over 10 years to support 15-20 projects.

Two topics supporting EIBI were included in the FP7 call under FP7-Energy-2012-2 and FP7-ERANET-2012-RTD.

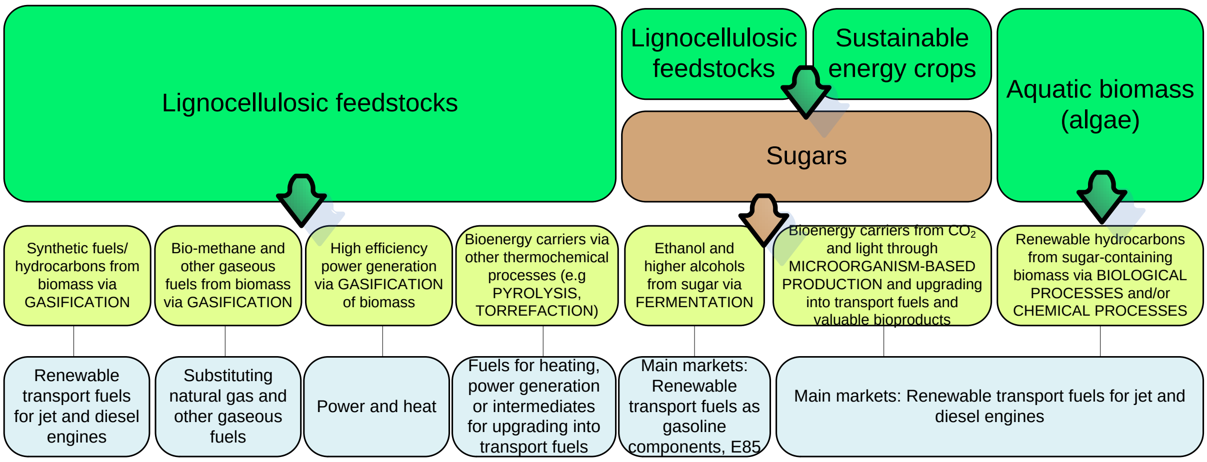

Figure 12: Seven value chains covered by EIBI

Significant input in development of next generation biofuels is expected to come from EERA *Joint Programme on Bioenergy* which is coordinated by VTT Technical Research Centre of Finland. The overall objective of this Joint Programme is to align pre-competitive research activities at EERA institutes to give a technical-scientific basis to further develop the next generation biofuels routes and to explore the possibilities for joint technology development. The EERA Bioenergy Programme will develop new technologies and improve the competiveness of next generation biofuels with four main sub-programs:

- Thermo-chemical processing;
- Sugar platform;
- Algae based biofuels, and;
- Cross cutting topics – e.g. raw material supply, energy systems, sustainability (Commission, 2012a).

Development of bioenergy, including new biofuel production technologies, goes in line with development of European plant research and innovation area. This is the work field of *Plants of the*

Future ETP. Plants for the Future ETP was initiated by the European Commission in 2003 with an aim to strengthen the European plant research and innovation area and mobilise support at different levels. The technology platform comprises of members from industry, academia and the farming community and provides a vision for the European plant sector, as well as sets out a consensus on the research needed to fulfil this vision and addresses sustainability (ETP, 2012).

Recently the Plant ETP coordinated a two years project BECOTEPS (2009-2010) which aimed to contribute to the creation of a stronger bioeconomy in Europe by 2030 by integrating and strengthening the key sectors. The Technology Platform has as well participated in the Star-COLIBRI project (2009-2010) with an aim of promoting the biorefinery concept (ETP, 2012).

4.3 Hydrogen & Fuel Cells

The *Fuel Cells and Hydrogen Joint Undertaking (FCH JU)*, launched in 2008, is one of the main instruments under which the European support for research, development and innovation in 'green' automotive technologies and transport systems is currently managed (European Commission, 2011a). The FCH JU, with the EU contribution of €470 m is a unique public private partnership led by industry supporting research, technological development and demonstration activities in fuel cell and hydrogen energy technologies in Europe. Around 45% of the available resources are being targeted to activities relevant to clean transport applications and the related infrastructure (European Commission, 2011a).

Through this Joint Undertaking four calls for proposals have been published from 2008 to 2011, with a total amount of close to €300 m, of which more than €100 m has been allocated to transport and refuelling stations applications. Some of the demonstration projects have the potential to become international references (European Commission, 2011a).

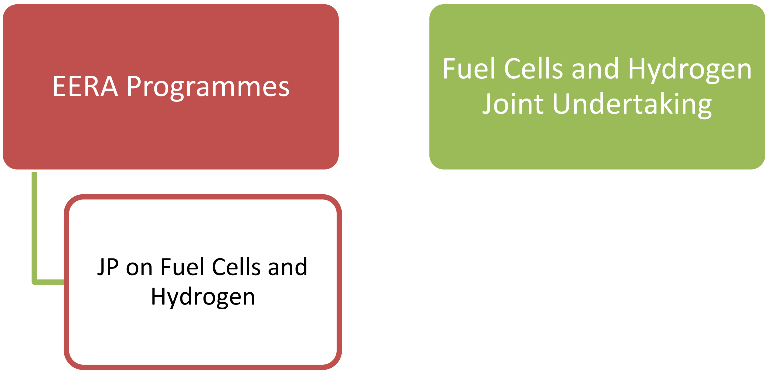

Figure 13: European network for Hydrogen and Fuel Cells R&D

Another European initiative for support of fuel cells and hydrogen technologies is the EERA *Joint Programme on Fuel Cells and Hydrogen* that aims to accelerate and harmonise long-term research on fuel cells and electrolysers in Europe. The Joint Programme, uniting 13 partners, focuses on research topics related to fuel cells, water electrolysers and non-electrochemical hydrogen production (EERA, 2012).

5 Interviews

Based on the results of the desk research, the central EU organisations were determined and chosen for interviews. This chapter includes the list of stakeholders interviewed, interview guide and the results of the interviews.

5.1 List of stakeholders interviewed

Seven qualitative interviews with leading representatives from organisations forming the European network of transport research, technology and innovation were conducted:

1. *European Biofuels Technology Platform*
2. *European Industrial Bioenergy Initiative under European Biofuels Technology Platform*
3. *European Biogas Association*
4. *Green eMotion* project
5. *European Green Cars Initiative*
6. *European Energy Research Alliance Joint Program on Hydrogen and Fuel cells*
7. *European Hydrogen Association and Hydrogen Fuel Cells and Electro-mobility in European Regions (HyER).*

Representatives were chosen in a way to cover all three main types of renewable energy road transport technologies:

(1) biofuels;
(2) electric and hybrid vehicles, and
(3) hydrogen and fuel cell vehicles.

The objective of the interviews was to analyse European level developments within the transport sector for understanding the existing framework conditions, main challenges and barriers for sustainable mobility in the Europe. Summary of organisations, experts and their functions are given in Table 3.

Table 3. Summary of organisations, experts and their functions

Organization	Interview No	Found.	Stakeholders	Mission	Interviewees
European Biofuels Technology Platform (EBTP)	I1	2006	Industry, research and academia, civil society	Contribution to the development of cost-competitive biofuels value chains; acceleration of sustainable biofuels development in the EU.	Chairman of the EBTP's Steering Committee for the past two years; responsible for overall planning and co-ordination of activities.
European Industrial Bioenergy Initiative (EIBI)	I2	2010		Support for demonstration of innovative bioenergy value chains.	Expertise in the field of bioenergy. Working at IDEA Biofuels Department since 2007; member of the EIBI and the Advisory Council of European Energy Research Alliance.
European Biogas Association (EBA)	I3	2009	National biogas associations, industry, consulting companies and research	Promotion of the deployment of sustainable biogas production and use in Europe.	Engineering background, expertise in the field of waste processing. Working at EBA and Austrian Biogas Association.
Green eMotion project	I4	2011	Industry, the energy sector,	Promotion of electro-mobility in the Europe,	Int.A – senior researcher at Siemens with long

Organization	Interview No	Found.	Stakeholders	Mission	Interviewees
			electric vehicle manufacturers, and municipalities, universities and research institutions	defining Europe-wide standards.	experience in the field of electro-mobility. Int.B – researcher at Siemens in the field of electro-mobility; background in research on renewable energy.
European Green Cars Initiative	I5	2008	European Commission and industry	Defining transport research priorities at European level, work with stakeholders involved in the field of transport research.	Holds position for four years. Previous work experience in automotive industry for European Commission; background in European studies.
European Energy Research Alliance Joint Program on Hydrogen and Fuel cells	I6	2011	Research institutions	Acceleration and harmonisation of long-term research on fuel cells in Europe.	Expertise in the field of hydrogen fuel cells. Member of several international agencies, chairman of the Italian Fuel Cells organisation, coordinator of the EERA Joint Programme on Fuel Cells and Hydrogen.
European Hydrogen Association (EHA)	I7	2000	National association members, industry	Promoting the use of hydrogen as an energy vector in Europe.	Long experience in the field of hydrogen and fuel cells. Work experience at the World Fuel Cell Council, the Italian Hydrogen Association; working at the EHA since 2006 and with the HyER partnership since 2008.

5.2 Interview guide

Interviews were used as the main method to gather data from the various actors. Interviews are considered to be a useful method for gathering data when it is important to get the subject's point of view, where it is important to describe complex interactions and to understand the situation or context in which the various processes are occurring. Some of these descriptions and interpretations are best created in dialogue between the interviewer and interviewee rather than in the more "managed" situation of the structured questionnaire (Kvale, 1996). The interviewer is a co-creator of the outcome of the interview. The semi-structured interview is designed to give the interviewee an opportunity to talk freely about topics without being steered too much by the pre-planned structure of the structured interview. The semi-structured interview also gives the interviewer the opportunity to explore unplanned themes or to "dig deeper" into particular aspects of interest, especially when it becomes evident that a particular interviewee has experience or knowledge of the theme being researched. Data were collected by interviewing all participants with semi-structured interviews.

Interview questions were prepared based on the results of the desk research. In total interview included nine questions:

1. Could you describe your position (job) in relation to renewable energy in transport? (Including relevant education and work experience in energy and/or transport. Also how many years have you been working in this position?)

2. How do you and other decision makers get your knowledge on renewable energy? How do you keep up to date on recent developments?
3. What is your opinion of European research into these technologies?
4. Do you think that research priorities or type of research funded should be changed in any way to promote renewable energy in transport?
5. Have you identified any particular barriers or difficulties to implementing renewable energy in European transport?
6. If so, do you have any suggestions for improvements? Denmark has set a clear direction towards electrification of road transport. Should other countries maybe follow Danish example and how to do it? Should national governments perhaps choose between different technologies which to support (e.g., by supporting local car manufacturers)?
7. Do you see any particular opportunities for European industry?
8. Do you think more should be done to motivate business actors, the public or academics?
9. Do you have any good examples of successful initiatives related to the development and use of renewable energy in transport?
10. Is there anything else you would like to add based on your experiences with renewable energy and transport in Europe?

5.3 Main results of the interviews

5.3.1 Getting knowledge on renewable energy, keeping up to date with recent developments

Maintaining constant contacts between the involved stakeholders are considered highly important to keep up to date with recent developments in the sector. Interview results highlight four main ways of getting knowledge in the field of sustainable transport:

- Involvement in projects and organizations (e.g., other technology platforms and initiatives);
- Personal contacts;
- Participation in field-specific events (conferences, workshops, etc.), and;
- Online information networking.

Involvement in research projects and relevant organizations plays an important role in ensuring information dissemination on recent developments among the involved stakeholders. Six out of seven organization representatives have mentioned this as one of the ways of getting knowledge on renewable energy transport applications. *"From the best research and technology institutes in Europe, we keep up to date this way. There are many experts, there. Our knowledge comes from collaboration with experts. We exchange a lot of knowledge"* /I4/.

Another way of information exchange is direct private contacts and work with stakeholders, e.g., policy makers, responsible persons within the companies and industry. Large attention is paid to keeping up to date with latest news at political level:

"We follow closely all policy developments that are relevant for implementation of hydrogen technologies. That is energy, transport, regional, and environmental policy, climate discussions" /I7/.

"…we also get a lot of information from them [politicians] about needs, interests and other work that is going on" /I4/.

Taking part in field-specific events (conferences, workshops etc.) where latest news is publicized is also often mentioned as possibility for getting knowledge on recent developments. E.g., the European Biogas Association is active in organizing annual conferences on biogas topics in member countries (Austria, Germany, France, and Italy) to delegate the knowledge. In addition, more specific knowledge is gained from both, academic papers and journals in related fields. Information networking ensured through various online channels. Information between members of associations is disseminated through websites and emails, e.g., the European Hydrogen Association communicate with its members by sending monthly updates.

5.3.2 Opinion on European research and research priorities in RES-T technologies

Opinions on European research and research priorities in renewable energy applications in the transport sector vary from interviewee to interviewee. Overall, the experts agree that much research has been done up to date allowing alternative fuel technologies (advanced biofuels, electric and hydrogen vehicles) to overcome the first phases of development towards market penetration. However, there is a discussion on research priorities. Biofuel stakeholders express an opinion that the EU Research Framework Programmes has much focused on fundamental research and development of new biofuels, *"…but now it is time to shift gear and enlarge focus from fundamental research to the actual deployment of advanced biofuels"*. This will require coordinated employment of available human resources, prioritizing and funding. They see biofuels as one of the key renewable energy options to decarbonise transport referring to still unsolved problems in the field of electric transport *"We believe that electric cars have great problem with their batteries. If they can solve it…, then it would be a very good approach. But at the moment things seem not to be, only partly and much money gets lost"* /I3/.

Investments in electric technology research have really been substantial over the past decade. As well the I4 notes that there are many projects already running (e.g., on smart charging, power, float management, etc.) and *"a lot of money is going into it already".* These research oriented projects, previously funded, have brought the electric transport to the demo phase and now the sector is trying to bring the knowledge into the field. Similarities with the future development needs of advanced biofuels can be seen here.

On the other hand, there is an opinion that basic research should not be left aside, but better balance between basic and product oriented research is needed. *"This is a big, big mistake… About one third of the research investments should be in basic research because it allows us to develop technologies"*, I6 suggests.

5.3.3 Barriers

There are several important barriers pointed out by interviewees to implementing renewable energy in European transport. The top three are regulatory framework, standardisation and financing.

One of the most crucial is the uncertain European regulatory framework and political commitment that leads also to lack of financing. *"Over the past five years, barriers for advanced biofuels in Europe have been moving from technology to policy and financing. …The issue of financing innovative biofuels pathways is crucial to ensure large scale deployment across Europe, so is a stable, long-term policy framework in which market will operate"* /I1/. Another stakeholder is even more critical and rising a general argument how far we are going to go with this issue. "*…because everybody wants to promote advanced biofuels but seriously we don't see the money anywhere. … But on the other hand, I think at some point when it comes to sustainability and the way Europe is living with it, I think at some point we are going far beyond what should be needed"* /I2/.

Different national regulations are the other obstacle. "*E.g. in Germany we cannot give public parking spaces for el-vehicles. In Spain they have a big project to encourage consumers to be el-mobile"* /I4/. Moreover there are differences sometimes also at a local level between the cities in the same country. In addition, unclear European tax legislation has been mentioned as an obstacle to promote inhabitants actually to buy cleaner cars. "*…consumer doesn't know which way will win from biofuels. Is it fuel cell, is it electric car, is it bioethanol, or something like that. So they all believe they wait until buy next cars; the car companies who build the cars they don't make, they don't put much money into the scientific work on biogas, biofuels"* /I3/.

Another difficulty at this moment is the standardisation. *"Standardisation is clearly a problem"* /I5/. However, most of the stakeholders agree that it is not a long-term problem and will be solved in few years. In respect to this also lack of infrastructure should be addressed. "*The main barrier is infrastructure. It is the old chicken and egg situation. There will not be many hydrogen cars before there are filling stations, but no one will build filling stations before there are enough hydrogen cars"* /I6/.

And this leads to an important aspect mentioned by the interviewee I7. "*I would say the main barrier right now is the numbers. We don't see them enough on the streets. We don't see enough being used by people that we trust. …we need to have more examples of those people close to us. But I know that most of the projects are looking to giving these cars to VIP. That is a great for the visibility but we are beyond the visibility right now*" /I7/.

5.3.4 Opportunities

Despite the barriers, all the interviewed stakeholders see different solutions and opportunities for the cleaner cars and also for the European industry. One of the opportunities today is the availability of the information on best practice. It is essential in order to proceed and have larger numbers of the cleaner cars on the streets. "*...first of all is to collect as much information what is going on now already in cities with clean technologies and clean power technologies in transport to see already indeed if we can measure, if we can identify best practice that have helped us towards larger numbers"* /I7/.

The good flow of information today in the work with the politicians and European Commission can improve decision making process at European level. *„We give advice to politicians and try to get them to think on a European level. If we find a good practice in one country we can recommend it and the politicians can decide if it should be implemented at a European level. We try to come up with recommendations that will work for the whole of Europe"* /I4/. However, in the meantime biofuel experts stress more and more that the technology for advanced biofuels is ready to be deployed and *„What is missing is a favourable framework to make it happen and ensure advanced biofuels play a key role in meeting the EU climate and energy 2020 targets, and beyond"* /I1/.

There are no doubts that European industry has a strong knowledge and ability. *"What we find particularly interesting in comparison with competitors and particular competitors from Asia, is the ability of the industry in Europe to cope with very complex systems"* /I5/. In the meantime, some of the interviewees note that European car industry now is already behind Japan and South Korea and European industry should larger effort to be able to compete. In order to do that interviewee I1 concludes that *„The technical know-how in Europe is very strong but the risk of Europe witnessing its technology being deployed elsewhere is real. The opportunity exists for the European industry but long term vision and political commitment are key for the industries and the investors to take an investments decision".*

European Commission will have an opportunity to evaluate the strategic plans of the Member States in regard to clean power for transport and "*…to make sure that in each country there is a verification what will work and what will not*" /I7/. And the challenge for the future at the European level is *„...to coordinate and look for synergies between all these technologies to have effective mix for every country"* /I7/.

5.3.5 Motivation

Today the funding for the research projects is enough. There is a sufficient financial support for academia and other initiatives to explore electric, hydrogen and advanced biofuels systems. However, in order to promote and proceed with the implementation of these technologies on larger scale, good business cases should be created. "*What we are really lacking to motivate business, is proper business cases. You cannot earn by having funding, you only reduce your costs. Businesses need to see that money can be made out of this technology"* /I4/.

There are different possibilities to reach that. One option is to increase the number of busses that use one or other clean technology. It can be electric, fuel cells, biogas or any other. It is a possibility to reduce the costs (more demand will allow to reduce costs) and moreover to make it evident. *"I think promoting the customers and promoting industry, you have to support few applications more specifically. And I think one of those is buses. We should go further on ensuring clean buses in cities because that is the most visible way of showing potential customers for passenger cars that this is working"* /I7/.

In order to reach larger numbers on the streets in Europe and in each country, one of the experts in regard to the German showcase project of €180 million pointed out that "*Money should be spent in a more coordinated way. If the work was structured in a more European rather than a national way, we would be able to make more out of it"* /I5/. And this leads to another conclusion "*National governments need to be willing to finance European projects and have a European rather than a national interest"* /I5/.

Meanwhile more should be done to motivate consumers. It can be done through money and economic incentives. *"In Germany the car tax is not related to the CO_2 production. This kind of system could be changed. Those who are driving older cars will have to pay more. ... Other initiatives need not be economic, e.g. the times saved in Oslo, because electric vehicles can use the bus lanes and avoid the queues. Maybe we could be more creative about finding things the consumers want" /I5/.*

Young generation is the other audience to work with. There is need for cooperation between publishing houses and different associations and stakeholders in order to improve the content of the current curricula. "*There is still little explanation, mentioning of employment opportunity, developments, links between energy and transport. ...80% will live in the cities when they will be older. ...So, something should change in another way and thinking, in education, the way how they learn"* /I7/.

5.4 Conclusions

Interviews with representatives of the European transport research and technology network highlight two common cornerstone questions to be solved in the nearest future. These are: (1) development of a stable long-term regulatory framework (including standardization and cross country regulation), and (2) funding, both at national and at European level, and combination between them. In addition, effort should be put in capacity building and awareness rising initiatives where local authorities and public bodies, as well as NGOs play a critical role.

At European level energy for transport is being produced in a variety of ways. It is hard to predict how the markets of biofuels, electric cars, and hydrogen vehicles will develop and what will be the interactions between them. However, one of the suggestions of experts is that the impact of alternative fuels on transport and energy systems should be analyzed in detail, especially taking into account experience with first generation biofuels.

Many positive examples of renewable energy applications in transport can be found in Europe demonstrating both, high technological developments and involvement of different stakeholders. Numerous projects and initiatives are going on the EU on transport bioenergy, electric cars, hydrogen, smart infrastructure, nanoelectrics and relevant topics. However, there is often a problem with these projects that despite the good results, they do not have much impact. This can partly be explained with narrow level of project implementation. E.g., for hydrogen all the implementation of different projects is still on small scale, mainly to see how the technologies are operating. The next move is to use this experience to develop larger programs. Coming from demonstration projects to larger programs is challenging mainly from the financing point of view. Another delay is related to the fact that many potentially good projects and initiatives have been launched recently and results are not achieved yet.

The findings of this study suggest that in spite of common European goals on CO_2 reduction, there is still a long way to go. The EU will need to continue harmonising policies if the scientific developments in transport are to be successfully implemented on a European scale. At a transnational level buying and selling of electricity on the European grid needs to be harmonized. At local level ways of copying success from best practice examples in European cities or regions needs to be found. Many of the European initiatives have been driven by the desire to meet CO_2 reduction targets, or to reduce costs, however several of interviewees emphasized the need for more motivational initiatives. This is not new, of course, but literature studies confirm that the idea of making sustainable transport attractive to Europeans has not been central to policy makers. These findings cannot be considered representative of the European population, however they provide an insight into the often minor deficiencies of policies, which create insurmountable barriers.

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Annex I: Research projects under the European Green Cars Initiative

No	Project Acronym	Project title
1	AMELIE	Advanced Fluorinated Materials for High Safety, Energy and Calendar Life Lithium Ion Batteries
2	APPLES	Advanced, High Performance, Polymer Lithium Batteries for Electrochemical Storage
3	ASTERICS	Ageing and Efficiency Simulation & Testing under Real World conditions for Innovative Electric Vehicle Components and Systems
4	AUTOMICS	Pragmatic Solution for Parasitic-immune Design of Electronics ICs for Automotive
5	AUTOSUPERCAP	Development of High Energy/ High Density Supercapacitors for Automotive Applications
6	AVTR	Optimal Electrical Powertrain via Adaptable Voltage and Transmission Ratio
7	CAPIRE	Coordination Action on PPP Implementation for Road-Transport Electrification
8	CASTOR	Car Multi-Propulsion Integrated Power Train
9	COSIVU	Compact, Smart and Reliable Drive Unit for Fully Electric Vehicles
10	CORE	CO^2 Reduction for Long Distance Transport
11	Deliver	Design of Electric Light Vans for Environment-Impact Reduction
12	E3Car	Nanoelectronics for an Energy Efficient Electrical Car
13	EASYBAT	Models and Generic Interfaces for EASY and Safe BATtery Integration and Swap in EV
14	eCo-FEV	Efficient Cooperative Infrastructure for Fully Electric Vehicles
15	ECOGEM	Cooperative Advanced Driver Assisted System for Green Cars
16	ECOSHELL	Development of New Light High-Performance Environmentally Benign Composites Made of Bio-Materials and Bio-Resins for Electric Car Application
17	e-Dash	Electricity Demand and Supply Harmonization for EVs
18	EFUTURE	Safe and Efficient Electrical Vehicle
19	eLCAr	E-Mobility Life Cycle Assessment Recommendations
20	ELECTROGRAPH	Graphene-based Electrodes for Application in Supercapacitors
21	ELIBAMA	European Li-Ion Battery Advanced Manufacturing for Electric Vehicles
22	E-Light	Advanced Structural Light-Weight Architectures for Electric Vehicles
23	ELVA	Advanced Electric Vehicle Architectures
24	ELVIRE	Electric Vehicle Communication to Infrastructure, Road Service and Electricity Supply
25	EMERALD	Energy ManagEment and RechArging for Efficient Electric Car Driving
26	EM-Safety	EM Safety and Hazards Mitigation by Proper EV Design
27	ESTRELIA	Energy Storage With Lowered Cost and Improved Safety and Reliability for Electrical Vehicles
28	EUROLIION	High Energy Density Li-Ion Cells for Traction
29	eVADER	Electric Vehicle Alert for Detection and Emergency Response
30	E-VECTOORC	Electric Vehicle Control of Individual Wheel Torque for On- and Off-Road Conditions
31	Evolution	Evolution
32	FastInCharge	Innovative Fast Inductive Charging Solution for Electric Vehicles
33	FUEREX	Multifuel Range Extender With High Efficiency and Ultra Low Emissions
34	FURBOT	Freight Urban RoBOTic Vehicle
35	GREENLION	Advanced Manufacturing Processes for Low Cost Greener Li-Ion Batteries
36	Green eMotion	Green eMotion
37	HELIOS	High Energy Lithium-IOn Storage Solutions
38	HEMIS	Electrical Powertrain Health Monitoring for Increased Safety of FEVs

No	Project Acronym	Project title
39	Hi-Wi	Materials and Drives for High & Wide Efficiency Electric Powertrains
40	ICT4FEV	Information and Communication Technologies for the Full Electric Vehicle
41	ID4EV	Intelligent Dynamics for Fully Electric Vehicles
42	IoE	Internet of Energy for Electric Mobility
43	JobVehElec	Raising Awareness of Job Opportunities in Vehicle Electrification
44	LABOHR	Lithium-Air Batteries with Split Oxygen Harvesting and Redox Processes
45	MAENAD	Model-based Analysis & Engineering of Novel Architectures for Dependable Electric Vehicles
46	Mobility2.0	Co-operative ITS Systems for Enhanced Electric Vehicle Mobility
47	MOTORBRAIN	Nanoelectronics for Electric Vehicle Intelligent Failsafe Powertrain
48	NECOBAUT	New Concept of Metal-Air Battery for Automotive Application based on Advanced Nanomaterials
49	OPERA4FEV	Operating Energy Rack for Full Electric Vehicle
50	OpEneR	Optimal Energy Consumption and Recovery Based on System Network
51	OPTIBODY	Optimized Structural Components and Add-ons to Improve Passive Safety in New Electric Light Trucks and Vans
52	OPTIMORE	Optimised Modular Range Extender for Every Day Customer Usage
53	OSTLER	Optimised Storage Integration for the Electric Car
54	P-MOB	Integrated Enabling Technologies for Efficient Electrical Personal Mobility
55	POLLUX	Process Oriented Electronic Control Unit for Electric Vehicles Developed on a Multi-system Real-time Embedded Platform
56	POWERFUL	POWERtrain for Future Light-Duty Vehicles
57	PowerUp	Specification, Implementation, Field Trial and Standardisation of the Vehicle-2-Grid Interface
58	SafeEV	Safe Small Electric Vehicles through Advanced Simulation Methodologies
59	SmartBatt	Smart and Safe Integration of Batteries in Electric Vehicles
60	Smart EV-VC	Smart Electric Vehicle Value Chains
61	SMART-LIC	Smart and Compact Battery Management System Module for Integration into Lithium-Ion Cell Electric Vehicles
62	SMARTOP	Self Powered Vehicle Roof for On-Board Comfort and Energy Saving
63	SMARTV2G	Smart Vehicle to Grid Interface
64	SOMABAT	Development of Novel Solid Materials for High Power Li Polymer Batteries. Recyclability of Components
65	STABLE	Stable High-capacity Lithium-Air Batteries with Long Cycle life for Electric cars
66	SuperLIB	Smart Battery Control System Based on a Charge-Equalization Circuit for an Advanced Dual-Cell Battery for Electric Vehicles
67	TelliSys	Intelligent Transport System for Innovative Intermodal Freight Transport
68	UNPLUGGED	Wireless Charging for Electric Vehicles
69	V-FEATHER	InnoVative Flexible Electric Transport
70	WIDE-MOB	Building Blocks Concepts for Efficient and Safe Multiuse Urban Electrical Vehicles
71	WINN	European Platform Driving Knowledge to Innovations in Freight Logistics

Annex II: EUCAR Research and Development projects

No	Project Acronym	Project title
1	AMELIE*	Advanced Fluorinated Materials for High Safety, Energy and Calendar Life Lithium Ion Batteries
2	CASTOR*	Car multi-propulsion integrated power train
3	DELIVER	Design of Electric Light Vans for Environment-Impact Reduction
4	E3CAR*	Nanoelectronics key enabler for Energy Efficient Electrical Car
5	e-Dash*	Electricity demand and supply harmonization for electric vehicles
6	ELIBAMA*	European Li-Ion Battery Advanced Manufacturing
7	ELVA*	Advanced Electric Vehicle Architectures
8	ELVIRE*	Electric vehicle communication to infrastructure, road services and electricity supply
9	EUROLIION*	High energy density Li-ion cells for traction
10	FUEREX*	Multi-fuel Range Extender with high efficiency and ultra low emissions
11	H2movesScandinavia	Gaining customer acceptance for electric vehicles with fuel cells in Scandinavia
12	HCV	Hybrid Commercial Vehicle
13	HELIOS*	High Energy Li-ion Storage Solutions
14	HyTRAN	Hydrogen and fuel cell technologies for road transport
15	MAENAD*	Model-based analysis & engineering of novel architectures for dependable electric vehicles
16	OPTFUEL	Optimised fuels for sustainable transport in Europe
17	POLLUX*	Process oriented electronic control units for electric vehicles developed on a multi-system real-time embedded platform
18	POWERFUL*	Powertrain of future light-duty vehicles
19	SMART FUSION	Smart Urban Freight Solutions
20	SuperLIB*	Smart battery control system based on a charge-equalization circuit for an advanced dual-cell battery for electric vehicles
21	WtW	Well-to-Wheels analysis of future automotive fuels and powertrains in the European context

* Projects related to the European Green Cars Initiative (see Annex I)

Annex III: Other research and development projects

No	Acronym	Project Title	Year	Granting	Technology/area
1	ADORE IT	Biofuels, from Dream to Mainstream	2008-2011	IEE	Biofuels
2	ALL-GAS	Industrial Scale Demonstration of Sustainable Algae Cultures for Biofuel Production	2011-2016	FP7	Biofuels
3	ALTER-MOTIVE	Deriving Effective Least-cost Policy Strategies for Alternative Automotive Concepts and Alternative Fuel	2008-2011	IEE	Alternative fuels & vehicles
4	AUTOBRANE	Automotive High Temperature Fuel Cell Membranes	2005-2009	FP6	Hydrogen & Fuel cells
5	BEAUTY	Bio-ethanol Engine for Advanced Urban Transport by Light Commercial Vehicle & Heavy Duty	2009-2011	FP7	Biofuels
6	BEE	Biomass Energy Europe	2008-2010	FP7	Biofuels
7	BEST	Bioethanol for Sustainable Transport	2006-2009	FP6	Biofuels
8	BIODIENET	Developing a Network of Actors to Stimulate Demand for Locally Produced Biodiesel from Used Cooking Oils	2007-2009	IEE	Biofuels
9	BIODIESEL CHAINS	Promoting Favourable Conditions to Establish Biodiesel Market Actions	2006-2007	IEE	Biofuels
10	BIODINA	Sustainable Community through the Production of 30000tm/yr of Biodiesel Starting from Sunflower, Rapeseed and Palm Biomass	2003-2004	FP5	Biofuels
11	BIODME	Production of DME from Biomass and Utilisation of Fuel for Transport and Industrial Use	2008-2012	FP7	Biofuels
12	Bioenergy NoE	Overcoming Barriers to Bioenergy	2004-2009	FP6	Biofuels
13	BIO-ETOH	Energy and Cost Reductions in Production of Fuel Ethanol from Biomass through Membrane Technology	2004-2007	FP6	Biofuels
14	BIOFAT	Biofuels From Algae Technologies	2011-2015	FP7	Biofuels

No	Acronym	Project Title	Year	Granting	Technology/area
15	BIOFUELTP	Biofuels Technology Platform Secretariat	2006-2009	FP6	Biofuels
16	BIOGASMAX	Biogas Market Expansion to 2020	2006-2009	FP6	Biofuels
17	BIOLYFE	Demonstrating Large-scale Bioethanol Production from Lignocellulosic Feedstocks	2010-2013	FP7	Biofuels
18	BIOLYFE	Second Generation Bioethanol Process: Demonstration Scale for the Step of Lignocellulosic Hydrolysis and Fermentation	2010-2014	FP7	Biofuels
19	BIOMAP	Development of Time-enabled Mapping and Dissemination Tool for Biofuels Projects	2008-2011	FP7	Biofuels
20	BIOMOTION	Information, Motivation and Conversion Strategies for Biofuels with Consideration of the Special Regional Structures	2007-2010	IEE	Biofuels
21	BIO-NETT	Developing Local Supply Chain Networks, Linking Bio-fuel Producers with Public Sector Users	2006-2008	IEE	Biofuels
22	BIONIC	Sustainable Biofuels in the Community	2007-2010	IEE	Biofuels
23	BIOREF-INTEG	Development of Advanced Biorefinery Schemes	2008-2010	FP7	Biofuels
24	BIOREMA	Reference Materials for Biofuel Specifications	2008-2010	FP7	Biofuels
25	BIO-SNG	Demonstration of the Production and Utilization of Synthetic Natural Gas (SNG) from Solid Biofuels	2006-2009	FP6	Biofuels
26	BIOSYNERGY	Biomass for the Market Competitive and Environmentally Friendly Synthesis of Bio-products together with the Production of Secondary Energy Carrier through the Biorefinery Approach	2007-2010	FP6	Biofuels
27	BITES	Biofuels Technologies European Showcase	2007-2009	FP6	Biofuels
28	CAB-CEP	Co-ordination Action Biofuel Cities European Partnership	2006-2009	FP6	Biofuels
29	CANE-	Conversion of Sugar Cane	2009-2011	FP7	Biofuels

No	Acronym	Project Title	Year	Granting	Technology/area
	BIOFUEL	Biomass into Ethanol			
30	CLEANENGINE	Advanced Technologies for Highly Efficient Clean Engines Working with Alternative Fuels and Lubes	2007-2009	FP6	Biofuels
31	CLEATRANS	Clean Fuels for Clean and Efficient Urban Transportation	2005-2014	FP5	Biofuels
32	CROPGEN	Renewable Energy from Crops and Agrowastes	2004-2007	FP6	Biofuels
33	CUTE	Clean Urban Transport for Europe	2001-2006	FP5	Hydrogen & Fuel cells
34	DREAMCAR	Direct Methanol Fuel Cell System for Car Applications	2001-2005	FP5	Hydrogen & Fuel cells
35	DYNAMIS	Towards Hydrogen and Electricity Production with Carbon Dioxide Capture and Storage	2006-2009	FP6	Hydrogen & Fuel cells
36	ECODIESEL	High Efficiency Biodiesel Plant with Minimum GHG Emissions for Improved Fame Production from Various Raw Materials	2008-2011	FP7	Biofuels
37	ECOTRANS	Direct Charge of Electric Vehicles from Hydro-Electric Power Plants using Fast Charging Equipment	2000-2006	EUREKA	Electric Vehicles
38	ELEGIE (IMP)	Electrical Vehicle Globally Innovative for the Environment	1992-1997	EUREKA	Electric Vehicles
39	ELOBIO	Effective and Low-disturbing Biofuel Policies	2007-2010	IEE	Biofuels
40	ENFUGEN	Enlarging Fuel Cells and Hydrogen Research Co-operation	2005-2007	FP6	Hydrogen & Fuel cells
41	FCHINSTRUCT	Preparatory Activities of the Joint Technology Initiative for Fuel Cell and Hydrogen	2007-2009	FP7	Hydrogen & Fuel cells
42	FCTEDI	Fuel Cell Testing and Dissemination	2007-2009	FP6	Hydrogen & Fuel cells
43	FCTESQA	Fuel Cell Testing, Safety, Quality Assurance	2006-2010	FP6	Hydrogen & Fuel cells
44	FIBREETOH	Lignocellulosic Waste Fibres to Ethanol	2010-2013	FP7	Biofuels
45	FLEXFUEL	Demonstration of a Flexible Plant Processing Organic Waste, Manure and/or Energycrops to Bio-ethanol and Biogas for Transport	2004-2007	FP6	Biofuels

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46	FUCHSIA	Fuel cell and hydrogen store for integration into automobiles	2001-2004	FP5	Hydrogen & Fuel cells
47	FUEL CELL BUS PROJECT	Fuel Cell Bus Project Berlin, Copenhagen, Lisbon	2000-2004	FP5	Hydrogen & Fuel cells
48	Fuel-cell - flywheel hybrid vehicle	-	2000-2001	FP5	Hydrogen & Fuel cells
49	FURIM	Further Improvement and System Integration of High Temperature Polymer Electrolyte Membrane Fuel Cells	2004-2008	FP6	Hydrogen & Fuel cells
50	G4V	Grid for Vehicles - Analysis of the Impact and Possibilities of a Mass Introduction of Electric and Plug-in Hybrid Vehicles on the Electricity Networks in Europe	2010-2011	FP7	Electric vehicles
51	GASHIGWAY	Promoting the Uptake of Gaseous Vehicle Fuels, Biogas and Natural Gas, in Europe	2009-2011	IEE	Biofuels
52	GENFC	Generic Fuel Cell Modelling Environment	2005-2008	FP6	Hydrogen & Fuel cells
53	GENHYPEM	Proton Exchange Membrane- based Electrochemical Hygrogen Generator	2005-2008	FP6	Hydrogen & Fuel cells
54	GLYFINERY	Sustainable and Integrated Production of Liquid Biofuels, Green Chemicals and Bioenergy from Glycerol in Biorefineries	2008-2012	FP7	Biofuels
55	GREEN-FUEL-CELL	SOFC Fuel Cell Fuelled by Biomass Gasification Gas	2004-2008	FP6	Hydrogen & Fuel cells
56	HARMONHY	Harmonisation of Standards and Regulations for a Sustainable Hydrogen and Fuel Cell Technology	2005-2006	FP6	Hydrogen & Fuel cells
57	HI2H2	Highly efficient, High Temperature, Hydrogen Production by Water Electrolysis	2004-2007	FP6	Hydrogen & Fuel cells
58	HOPE	High Density Power Electronics for FC- and ICE-Hybrid Electric Vehicle Powertrains	2006-2008	FP6	Hydrogen & Fuel cells
59	HYAPPROVAL	Handbook for Approval of	2005-2007	FP6	Hydrogen & Fuel

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		Hydrogen Refuelling Stations			cells
60	HYCELL-TPS	Development and Implementation of the European Hydrogen and Fuel Cell Technology Platform Secretariat	2004-2007	FP6	Hydrogen & Fuel cells
61	HYCHAIN MINI-TRANS	Deployment of Innovative Low Power Fuel Cell Vehicle Fleets To Initiate an Early Market for Hydrogen as an Alternative Fuel in Europe	2006-2011	FP6	Hydrogen & Fuel cells
62	HYFLEET: CUTE	Hydrogen for Clean Urban Transport in Europe	2006-2009	FP6	Hydrogen & Fuel cells
63	HYLIGHTS	A Coordination Action to Prepare European Hydrogen and Fuel Cell Demonstration Projects	2006-2009	FP6	Hydrogen & Fuel cells
64	HYSAFE	Safety of Hydrogen as an Energy Carrier	2004-2009	FP6	Hydrogen & Fuel cells
65	HySIC	Enhancing International Cooperation in Running FP6 Hydrogen Solid Storage Activities	2007-2008	FP6	Hydrogen & Fuel cells
66	HYSYS	Fuel Cell Hybrid Vehicle System Component Development	2005-2010	FP6	Hydrogen & Fuel cells
67	HYTHEC	High Temperature Thermochemical Cycles	2004-2007	FP6	Hydrogen & Fuel cells
68	HYVOLUTION	Non-thermal Production of Pure Hydrogen from Biomass	2006-2010	FP6	Hydrogen & Fuel cells
69	HYWAYS	European Hydrogen Energy Roadmap	2004-2007	FP6	Hydrogen & Fuel cells
70	HYWAYS-IPHE	Benchmarking of the European Hydrogen Energy Roadmap HyWays with International Partners	2006-2008	FP6	Hydrogen & Fuel cells
71	IDEAL-CELL	Innovative Dual Membrane Fuel Cell	2008-2011	FP7	Hydrogen & Fuel cells
72	INNOHYP-CA	Innovative High Temperature Routes for Hydrogen Production	2004-2006	FP6	Hydrogen & Fuel cells
73	INTESUSAL	Demonstration of Integrated and Sustainable Microalgae Cultivation with Biodiesel Validation	2011-2015	FP7	Biofuels
74	IPHE-GENIE	International Partnership for a Hydrogen Economy for Generation of New	2006-2009	FP6	Hydrogen & Fuel cells

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		Ionomer Membranes			
75	KACELLE	Kalundborg Cellulosic Ethannol Project	2009-2013	FP7	Biofuels
76	LED	Lignocellusic Ethanol Demonstration	2009-2013	FP7	Biofuels
	MADEGASCAR	Market Development for Gas Driven Cars	2007-2010	IEE	Biofuels
77	MERGE	Mobile Energy Resources in Grids of Electricity	2010-2011	FP7	Electric Vehicles
78	MOREPOWER	Compact Direct (M)ethanol Fuel Cell for Portable Application	2004-2007	FP6	Hydrogen & Fuel cells
79	NEMESIS	New Methods for Superior Integrated Hydrogen Generation System	2005-2008	FP6	Hydrogen & Fuel cells
80	NESSHY	Novel Efficient Solid Storage for Hydrogen	2006-2010	FP6	Hydrogen & Fuel cells
81	NILE	New Improvements for Ligno-cellulosic Ethanol	2005-2010	FP6	Biofuels
82	PRAZE	Personal zero emission transport for the city of the future	2000-2003	FP5	Electric Vehicles
83	PREMIA	R&D, Demonstration and Incentive Programmes Effectiveness to Facilitate and Secure Market Introduction of Alternative Motor Fuels	2004-2007	FP6	Biofuels
84	PROBIO	Integrated Promotion of the Biodiesel Chain	2007-2009	IEE	Biofuels
85	PROFUEL	On-Board Gasoline Processor For Fuel Cell Vehicle Application	2000-2003	FP5	Hydrogen & Fuel cells
86	REAL-SOFC	Realising Reliable, Durable, Energy Efficient and Cost Effective SOFC Systems	2004-2008	FP6	Hydrogen & Fuel cells
87	REFUEL	Renewable Fuels for a Sustainable Europe	2006-2008	IEE	Biofuels
88	RENEW	Renewable Fuels for Advanced Powertrains	2004-2008	FP6	Biofuels
89	ROADS2-HYCOM	Research Coordination, Assessment, Deployment and Support to HyCOM	2005-2009	FP6	Hydrogen & Fuel cells
90	SMALLINONE	Smart Membrane for Hydrogen Energy Conversion: All Fuel Cell Functionalities in One Material	2009-2012	FP7	Hydrogen & Fuel cells
91	SOFC600	Demonstration of SOFC Stack Technology for	2006-2010	FP6	Hydrogen & Fuel cells

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		Operation at 600°C			
92	STORAGE	Composite structural power storage for hybrid vehicles	2010-2012	FP7	Hybrid Vehicles
93	STORHY	Hydrogen Storage Systems for Automotive Application	2004-2008	FP6	Hydrogen & Fuel cells
94	SUBAT	Sustainable Batteries	2004-2005	FP6	Electric Vehicles
95	SUGRE	The Sustainable Green Fleets	2006-2008	IEE	Biofuels
96	SUVA	Surplus value hybrid	2001-2004	FP5	Hybrid Vehicles
97	SWEETHANOL	Sustainable Ethanol for EU	2010-2012	IEE	Biofuels
98	TBR	Waste to Recovered Fuel	2003-2012	FP5	Biofuels
99	THE REV	A thermo photovoltaic power generator for hybrid electric vehicles	2001	FP5	Hybrid Vehicles
100	TRUS	Zero Emission Public Transport for Urban Areas	2001-2013	EUREKA	Hybrid and Electric Vehicles
101	ULEVEHD	Ultra Low Emission Hybrid Vehicle Development	2002-2007	FP5	Hybrid Vehicles
102	ULEV-TAP II	Ultra low emission vehicle - transport advanced propulsion II	2002-2005	FP5	Hybrid Vehicles
103	WIDE-MOB	Building blocks concepts for efficient and safe multiuse urban electrical vehicles	2010-2013	FP7	Electric Vehicles
104	ZEOCELL	Nanostructured Electrolyte Membranes Based on Polymer-ionic Liquids-zeolite Composites for High Temperature PEM Fuel Cell	2008-2010	FP7	Hydrogen & Fuel cells
105	ZERO REGIO	Development & Demonstration of Fuel Cell Passenger Cars	2004-2009	FP6	Hydrogen & Fuel cells
106	-	Small hybrid city-car operated with biofuels or LPG	2000-2001	FP5	Hybrid Vehicles
107	-	Promotion of Pollution Control and Energy Saving by Use of Hybrid Power Systems	2000-2001	FP5	Hybrid Vehicles
108	-	Hybrid Bus Powered by Fuel Cell and Flywheel	2000-2001	FP5	Hydrogen & Fuel cells
109	-	Hydrogen Region Flanders-South Netherlands	2009-2012	Interreg-program	Hydrogen & Fuel cells
110	-	Sewage Derived Methane as a Vehicle Fuel in the City of Lille	1988-1993		Biofuels
111	-	Installation of a Production Plant for 60.000 t/y Biodiesel from Rapeseed Oil in Leer	1998		Biofuels

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112	-	Industrial Demonstration Plant for the Production of Rapeseed Methyl Ester	1995		Biofuels
113	2NDVEGOIL	2nd Generation Vegetable Oil	2008-2011	FP7	Biofuels