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COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Proposal for a Directive

on the deployment of alternative fuels infrastructure

{COM(2013) 18 final}
{SWD(2013) 6 final}

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This report commits only the Commission's services involved in its preparation and does not prejudge the final form of any decision to be taken by the Commission.

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1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

Identification

Lead DG: Directorate General for Mobility and Transport

Agenda Planning: 2012/MOVE/014

1.1. Background in the development of the legislative proposal

1. The White Paper "Roadmap to a Single European Transport Area – Towards a Competitive and Resource Efficient Transport System"[1] found that without the significant uptake of alternative fuels, we cannot achieve the targets of the Europe 2020 strategy and our climate goals for 2050. It therefore announces that the Commission will develop "*a sustainable alternative fuels strategy including also the appropriate infrastructure*" (Initiative 24) and ensure "*guidelines and standards for refuelling infrastructures*" (Initiative 26).

2. The Commission Communication[2] adopted on 24.01.2013 describes such comprehensive alternative fuels strategy, covering all modes of transport. The Impact Assessment accompanying the White Paper[3] had assessed the overall effect of the set of actions that are needed to achieve the uptake of alternative fuels. More specific impact assessments accompany the individual actions – listed in Appendix 3 – that have been or will be adopted as a follow-up.

3. This Impact Assessment report focuses on one particular element of this strategy: the deployment of appropriate infrastructure for alternative fuels, assessing whether supporting action is needed and what the merits of different options are.

1.2. Organisation and timing

4. This Impact Assessment was elaborated by DG MOVE, assisted by a Commission Inter-Service Group (ISG) created in spring 2010The ISG met on 26 April 2012 and on 10 July 2012[4]. The last IASG meeting took place on 26 July 2012. A final version incorporating the comments made during this meeting was circulated on 3 August 2012.

1.3. Consultation and expertise

5. With a view to preparing the ground for later policy developments, the Commission established the European Expert Group on Future Transport Fuels in March 2010 with the participation of all relevant stakeholders in the fields of transport and energy, and civil society. The Joint Expert Group Transport & Environment,

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1 COM(2011) 144 final

2 COM(2013) 17 final

3 SEC(2011) 358 final

4 The services involved in this group included the Secretariat-General, DG Agriculture and Rural Development, DG Budget, DG Climate Action, DG Competition, DG Communications Networks, Content and Technology, DG Economic and Financial Affairs, DG Education and Culture, DG Employment, Social Affairs and Equal Opportunities, DG Energy, DG Enlargement, DG Enterprise and Industry, DG Environment, European External Action Service, DG Health and Consumers, DG Internal Market and Services, the Joint Research Centre, the Legal Service, DG Research, DG Regional Policy, DG Trade, and DG Taxation and Customs Union.

composed of experts from the Member States for consultation purposes, was also convened by the Commission to obtain its recommendations. Finally, the CARS 21 High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union, consisting of representatives from European institutions, Member States, industry, and civil society, also delivered recommendations on "*Developing alternative fuel infrastructure*". The reports prepared by the two Expert Groups and the High Level Group are available on the Commission's website[5].

6. A Public Conference on "Future Transport Fuels" took place in the framework of the "European Union Sustainable Energy Week" on 13 April 2011. This was followed by an on-line public consultation which run between 11 August 2011 and 20 October 2011, and attracted more than 120 respondents. Finally, a targeted consultation of 124 stakeholders was carried out in November-December 2011. The summaries of the public conference and of the contributions received during the preceding public and targeted stakeholder consultations are available on the Commission website[6], and an overview is provided in Appendix 2.

7. Input from stakeholders has been taken into account both in developing the overall alternative fuels strategy set out in the Commission Communication[7] and in assessing the various options to deploy alternative fuels infrastructure.

8. As shown by the detailed assessment presented in Appendix 1 of this report, it can be concluded that the minimum standards for the consultation have been respected.

9. External expertise was used to assess the various options available, including aspects raised during the public consultation[8]. The studies have revealed large gaps in data availability, and confirmed uncertainties on future projections.

1.4. Results of the consultation of the Impact Assessment Board

10. Following the submission of a draft report to the Impact Assessment Board (IAB) on 17 August 2012, and a hearing with the IAB (which took place on 19 September 2012), the IAB sent its opinion on 21 September 2012, asking DG MOVE to resubmit the draft report. A revised version of the IA report has been sent to IAB on 12 October 2012.

11. In its opinion, the IAB made five recommendations that were addressed in the final version of the IA report in the following manner:

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5 http://ec.europa.eu/transport/urban/cts/doc/2011-01-25-future-transport-fuels-report.pdf; http://ec.europa.eu/transport/urban/cts/doc/2011-12-2nd-future-transport-fuels-report.pdf; http://ec.europa.eu/transport/urban/cts/doc/jeg_cts_report_201105.pdf; http://ec.europa.eu/enterprise/sectors/automotive/files/cars-21-final-report-2012_en.pdf

6 http://ec.europa.eu/transport/urban/events/2011_04_13_future_transport_fuels_en.htm; http://ec.europa.eu/transport/urban/consultations/doc/cts/report-on-results.pdf; http://ec.europa.eu/transport/urban/studies/doc/2012-08-cts-implementation-study.pdf

7 Idem footnote 2.

8 Two studies have been carried out by COWI sprl Belgium under two Specific Contracts. The first, "Study on Clean Transport Systems", was launched in September 2010 and explored possible contributions of various fuel-technology combinations in the transport sector to achieve the 60% GHG emissions reduction target set by the White Paper on Transport of March 2011. The second, "CTS Implementation Study on Alternative Fuels Infrastructure", was launched in October 2011. This study gathered further information on alternative fuels infrastructure, and assessed different options to develop an EU-wide alternative fuels infrastructure. The relevant reports are available at: http://ec.europa.eu/transport/urban/studies/urban_en.htm

(1) Strengthen the problem definition and the baseline scenario

12. In the revised IA report, the policy context (Section 2.1) has been extended and an appendix had been added on existing or planned initiatives at European level affecting the uptake of alternative fuels (Appendix 3). In addition, Section 2.2, 2.3 and 2.5, as well as the policy objectives in Section 3 have been revised clarifying the extent of problem, and better defining the basis of assessing the baseline developments. Finally, in Section 5, the impacts under the business-as-usual scenario have been clearly identified.

(2) Better define the policy options

13. The specific and operational policy objectives (Section 3.2 and 3.3) have been revised. Further clarification is provided on the policy options in the revised Section 4, as well as two new appendices have been added to explain the detailed pre-screening process (Appendix 7) and possible legislative formulations under each Policy Option (Appendix 8). The practical implications for implementation have been introduced in Section 5.1.1.3. Further assessment on the impact of standardization has been provided in Section 5.1.1.1.

(3) Improve the assessment of impacts and comparison of options

14. The revised version of the IA report contains a substantially extended Section 5 together with clear assessment of costs and benefits and improved presentation of the impact of the different policy options. The macroeconomic impacts, impacts on competitiveness, SMESs, functioning of the internal market have been extended, and the assessment of social and environmental impacts has been deepened.

(4) Better present stakeholders' views

15. A new appendix (Appendix 2) has been created to summarise the several rounds of stakeholder and expert consultation, and the relevant views of the stakeholders have been introduced throughout the report.

(5) Improve presentation

16. Some of the descriptive elements have been included in separate Appendices in order to shorten the report. The technical language has been simplified throughout the text, and a glossary has been included.

17. On 6 Nov 2012, the IAB issued a second opinion on the revised IA report with several recommendations which have been taken into account in the following manner:

(1) Further strengthen the problem definition and baseline scenario.

18. This recommendation has been addressed by revising Section 2.2 in order to provide additional evidence on the market and technological potential of the various alternative fuels. The uncertainties related to the projected market developments have also been explicitly stated in Section 2.2.2.

(2) Better define the policy options.

19. This recommendation has been addressed by:

- revising the description of policy options presented in Section 4.2,
- providing additional information on the estimated investment costs Member State by Member State in Section 5.1.1.2,

- revisiting the section presenting the potential sources of funding (Section 5.1.1.3).

(3) Improve the assessment of impacts and comparison of options.

20. This recommendation has been addressed by reinforcing the assessment of social impacts as well as of impacts on SMEs. An overview table of the estimated impacts has been added in Section 5.4.

2. PROBLEM DEFINITION

2.1. General context

21. Transport depends heavily on oil and oil products: for more than 95% of its needs worldwide and 96% in the European Union (EU)[9]. At the same time, more than 60% of the petroleum products used in OECD countries and about half of those used in non-OECD countries are used as transport fuels[10].

22. Oil dependency has a number of critical implications. The EU imports 84% of the oil it needs[11] at a cost of 2.1% of GDP in 2011[12]. The International Energy Agency estimated that the EU oil import bill increased in 2010 alone by $70 billion. The transport sector is very vulnerable to oil price increases with fuel typically accounting for a quarter of European hauliers direct operating costs[13]. Fuel also represents close to 7% of households' expenditure[14]. Recent projections on the price of oil are being revised upwards since, in the short term, the productive capacity fails to grow in line with demand and, in the long term, new reserves become more and more costly to extract[15]. Security of supply is an issue, since large amounts of oil are sourced from politically unstable regions of the world. Finally, fossil fuel engines used in transport are responsible for one quarter of all greenhouse gas in the EU and for high levels of local pollutants and noise in urban contexts.

23. Other regions of the world face the same challenges in relation to oil dependency of transport and seek alternative mobility solutions. This is particularly the case for the emerging economies of Asia, which have fast-growing motorisation rates. The development of alternative fuel technologies is thus a way not only to limit the drawbacks of oil use, but also to serve the demand of the fastest growing world markets.

24. Mandatory targets on the use of energy from renewable sources in transport have been in place since 2009 "to provide certainty for investors and to encourage continuous development of technologies which generate energy from all types of

9 European Commission, Directorate-General for Mobility and Transport, EU Energy and Transport in Figures, 2012, available at: http://ec.europa.eu/transport/publications/statistics/statistics_en.htm

10 Source: International Energy Agency, 2009, Transport, Energy and CO_2: Moving Towards Sustainability.

11 Source: Eurostat.

12 SEC(2011) 288 Impact Assessment accompanying document to the Communication "A Roadmap for moving to a competitive low carbon economy in 2050".

13 European Commission, Directorate-General for Energy and Transport, Road Freight Transport Vademecum 2009, available at: http://ec.europa.eu/transport/road/doc/2009_road_freight_vademecum.pdf .

14 European Environmental Agency, Expenditure on personal mobility (TERM 024) - Assessment published Jan 2011, available at: http://www.eea.europa.eu/data-and-maps/indicators/expenditure-on-personal-mobility-2/assessment

15 See for example IEA, 2011, World Energy Outlook 2010.

renewable sources"[16]. Their setting was a direct consequence of the limited progress achieved when implementing the indicative targets of Directive 2003/30/EC, and of the recognition that "a clear indication of the future level of these targets is needed now, because manufacturers will soon be building vehicles that will be on the road in 2020 and will need to run on these fuels"[17].

25. In 2010, the Europe 2020 strategy[18] called for maintaining "the lead in the market for green technologies as a means of ensuring resource efficiency throughout the economy, while removing bottlenecks in key network infrastructures, thereby boosting our industrial competitiveness"[19]. More specifically, the Flagship Initiative "Resource efficient Europe" proposed to modernise and decarbonise the transport sector thereby contributing to increased competitiveness.

26. In line with this strategy, the White Paper on Transport[20] aims at halving oil dependence of transport and sets a target of 60% greenhouse gas (GHG) emissions reduction from transport by 2050. This is to be achieved through initiatives touching upon many aspects of transport policy, but economic modelling shows that alternative fuel technologies have a central role to play. As indicated in the White Paper, halving the use of conventionally fuelled cars in urban transport by 2030 and phasing them out in cities by 2050 is an almost obliged path to achieve environmental goals without curbing mobility.

27. In its Communication "A European strategy on clean and energy efficient vehicles"[21], the Commission recognised that "At present, there is a lack of a European framework for electric mobility. Therefore, to ensure technological neutrality in practice, […] on actions needed to ensure an equivalent regulatory framework for enabling this technology." and presented a set of specific actions to be taken in the areas of vehicle type-approval, and of standardisation and infrastructure for electric charging.

28. Based on the consultation of stakeholders and expertise gathered, the Commission has identified the alternative fuels which have already shown a potential for long-term oil substitution. The Commission approach is to preserve technological neutrality by creating the conditions for an efficient market selection of these, more mature, technologies.

29. In summary, full scale deployment and commercialisation of alternative fuels is mainly hampered by (1) the high price of vehicles related to technological and production capabilities, (2) poor consumer acceptance, and (3) lack of recharging /refuelling infrastructure[22]. The root causes can be found in the existence of multiple market failures that several initiatives at national and EU level are trying to correct[23].

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16 Directive 2009/28/EC.

17 COM(2006) 848 final.

18 COM(2010) 2020 final.

19 Under Flagship Initiative "An industrial policy for the globalisation era", the Commission announced "*to improve the way in which European standard setting works to leverage European and international standards for the long-term competitiveness of European industry. This will include promoting the commercialisation and take-up of key enabling technologies*".

20 Idem footnote 1.

21 COM(2010) 186 final

22 A recent report from the OECD found that: "*The following factors may explain the slow development* [of green vehicle markets]:

30. Previous initiatives and support actions have mainly addressed fuel production, vehicle technology development, and marketing of alternative fuel vehicles. The build-up of the necessary infrastructures has been neglected.

31. Ex-post analyses of projects and policy actions have pointed out the lack of recharging/refuelling infrastructure, and the inability of market forces to fill this gap, as a fundamental barrier[24]. Technological maturity of alternative fuel vehicles and vessels has been convincingly proven in large-size European projects, but those transport means remain dis-functional without at least a basic network of re-fuelling/recharging points. Without removing the 'chicken and egg' problem between vehicles and infrastructure, all other efforts to allow efficient market choices among technologies risk to remain ineffective.

32. A market failure in the provision of recharging/refuelling infrastructure affects particularly the deployment of three alternative transport fuels: electricity, hydrogen, and natural gas (LNG and CNG). The other main alternatives to oil – biofuels and liquefied petroleum gas (LPG) – are less concerned:

- Biofuels do not require specific distribution infrastructure, as long as they are brought into market through blending into conventional fuels at a level compatible with present vehicles (< 7% for biodiesel and < 10 % for bioethanol). Problems exist, however, with uneven labelling and offer of the different fuel types across the EU. For higher levels of biofuels, the availability of sustainable resources needs to be clarified before considering specific infrastructure requirements.
- LPG is currently the most widely used alternative fuel in Europe. Its market share stands at 3% of motor fuels, and about 6 million cars in the EU are running on LPG. LPG refuelling infrastructure is well established, with some 28,000 dispensing sites in the EU, but very unevenly distributed across the EU. More homogeneous supply infrastructure could be provided by industry initiatives, without need for EU intervention.

33. The analysis of the economic features of infrastructure investments (unit costs, initial investment required, possibility of stepwise build-up) shows that LPG can expand the established infrastructure network on a sound economic basis without additional

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• *High price of AFVs (especially BEVs, due to the cost of the battery) relative to conventional ICE vehicles.*
• *Lack of refuelling/charging infrastructure, which will take many years to be built fully.*
• *Restricted driving range compared to conventional ICE vehicles, and the perceived distance needs of consumers, which often do not correspond to their regular driving habits. But, even if BEVs have enough range for daily commutes, consumers may be reluctant to pay for a vehicle that is not suitable for a trip longer than 150 km before charging.*
• *Refuelling times that are longer than what consumers are accustomed to.*"
Source: OECD, 2012, Market Development for Green Cars.

23 Concerning issues (1) and (2), at EU level, Horizon 2020 (COM (2011)809 final) is targeting suboptimal research efforts; CO_2 standards for new road vehicles try to remedy consumer myopia and 'wait and see' attitudes of carmakers in a particularly risky business environment; proposals and legislation for energy taxation and for road pricing address the presence of negative externalities; initiatives on labelling help consumers making more informed choices. An overview of related initiatives is provided in Appendix 2.

24 This was stated again prominently again at the opening of the 2012 Mondial de l'automobile, Paris: "Le démarrage [de l'électrique] est freiné par le manque d'infrastructure de recharge" (Carlos Ghosn, CEO of Renault, in Le Figaro, 27 September 2012).

public intervention; while for biofuels the infrastructure requirements are not a significant barrier to vehicle deployment.

2.2. Description and scope of the problem – Insufficient infrastructure network for electricity, hydrogen and natural gas (LNG and CNG).

34. The availability of recharging/refuelling stations is not only a technical prerequisite for the functioning of alternative fuel vehicles, but also one of the most critical components for consumer acceptance[25]. The importance of infrastructure for alternative fuels has been recognised by a large number of Member States, regional and local authorities[26]. Several initiatives have been launched to address this problem. Their detailed overview is provided in Appendix 4.

35. In this context, the network for the provision of electricity, hydrogen and natural gas (LNG for trucks and waterborne transport and CNG for road transport vehicles) is currently insufficient compared to a network that would be necessary to enable market take up of these fuels and is not likely to become available in the near future. This is further explained in Sections 2.2.1 and 2.2.2.

2.2.1. Current and near-term development of the infrastructure network for electricity, hydrogen and natural gas (LNG and CNG).

36. This section describes the current state of play of the infrastructure networks for electricity, hydrogen and natural gas (LNG and CNG), and the likely market developments in the near future as a result of on-going and announced initiatives[27].

Electricity

37. Currently, while a large part of the infrastructure needed for the deployment of electric vehicles (i.e. the electricity grid) exists, the charging points for vehicles remain to be developed. As shown on Table 1, the number of dedicated e-mobility installations, including those commissioned in 2012, can be estimated to be around 26,080 (5,830 existing and 20,250 commissioned in 2012) private and 29,800 (10,400 existing and 19,390 commissioned in 2012) public[28] Alternative Current (AC) connectors.

Table 1: Indicative number of installations per country for the AC connector[29]

Country	AC connector	Installed	Commissioned in 2012

25 "*Examining choice data from a survey of potential car buyers in Germany, we have shown in this paper that demand for alternative-fuel vehicles strongly depends on the availability of fuelling infrastructure. Consequently, a failure to significantly expand the network of stations for alternative fuels would significantly hamper the adoption of alternative-fuel vehicles in coming years.*" Source: Acthnicht et al., 2012, The impact of fuel availability on demand for alternative-fuel vehicles. Transportation Research Part D 17 (2012) pp. 262-269. Examples of other studies supporting this statement: Egbue et al, 2012, Barriers to widespread adoption of electric vehicles: Analysis of consumer attitudes and perceptions; Deloitte Development LLC, 2010, Gaining traction - A customer view of electric vehicle mass adoption in the U.S. automotive market.

26 The fact that market penetration of alternative fuels requires the build-up of the appropriate infrastructure was also recognised by the CARS 21 High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union in its recent report, available at http://ec.europa.eu/enterprise/sectors/automotive/files/cars-21-final-report-2012_en.pdf.

27 In order to ease comparison, more details on business-as-usual developments (Policy Option 1) are provided in Section 5 "Impact analysis of policy options".

28 'Public charging point' is defined as publicly accessible charging point through this Impact Assessment.

29 Source: Reproduced and updated based on data provided by EURELECTRIC, and in EURELECTRIC, March 2012, Facilitating e-mobility: EURELECTRIC views on charging infrastructure, Table 1.

		Private	Public	Private	Public
Austria[30]	Type 2	50	100	-	-
Czech Republic[31]	Type 2	5	20	-	61
Denmark[32]	Type 2	0[33]	280	-	-
Germany[34]	Type 2	385	1,750	-	97
Spain	Type 2	0	30	0	60
France[35]	Type 3	3,500	4,000	10,500	10,000
Ireland[36]	Type 2	358	202	750	1,000
Italy[37]	Type 2	233	120	8,000	2,000
Netherlands[38]	Type 2	>1,300	3,130	>1,000	>1,500
Portugal[39]	Type 2	0	525	-	675
United Kingdom[40]	Type 2	0	250	-	4,000

38. Table 1 also highlights that the majority of Member States do not have a significant number of charging points. This imbalance is even more apparent on Figure 1, Appendix 5, where publicly accessible charging points in the main European cities are displayed.

39. Moreover the infrastructure development across various Member States is highly uneven not only in terms of quantity, but also of 'quality', i.e. of technical solutions chosen. As highlighted by EURELECTRIC in its recent position paper: "*in the absence of any European agreement concerning the AC connector, European countries are either installing e-mobility infrastructure that is incompatible with other solutions (interoperability problems between Type 2 and Type 3) or are delaying investments until a European agreement is reached*". If these trends continue, the electricity charging infrastructure will continue developing in a fragmented way.

40. Based on announcements of public authorities, the current network of private and public charging points is expected to increase significantly only in France[41] with 4,400,000 points by 2020. In the rest of EU, only 600,000 points are expected to be deployed by 2020, further aggravating the already existing imbalance among Member States.

Hydrogen

41. The total number of hydrogen refuelling stations in operation in the EU is around 90 (Figure 3, Appendix 5). The stations are mainly located in Denmark, Germany, the

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30 The figures reflect efforts of Verbund.
31 The figures represent efforts of CEZ, PRE and Eon in Czech Republic.
32 The figures reflect national situation in Denmark.
33 Private locations are equipped with standardised domestic sockets ("schuko") charging in Mode 2.
34 For public, figures reflect German electricity industry efforts, private installations reflect RWE installations.
35 The figures reflect the national French roll-out plan.
36 The figures reflect the national Irish roll-out plan.
37 The figures represent Enel's installations.
38 The figures reflect the national situation in the Netherlands.
39 The figures reflect the national Portuguese situation.
40 Private installations are equipped either with a standard connector for Mode 2, or a Mode 3 charger with a tethered cable. The figures reflect the national UK situation.
41 Source: Universität Duisburg Essen, 2012, Competitiveness of EU Automotive Industry in Electric Vehicles, Draft Final Report, study contracted by DG Enterprise and Industry.

Benelux states and the United Kingdom. By 2015, the number of filling station is expected to exceed 160 with a recent announcement in Germany to complete a 50-station network[42].

LNG

42. There are currently 20 LNG terminals in the EU[43]. However for transport use, the infrastructure development is more limited: only the LNG terminal in Nynäshamn, Sweden, has small-scale LNG bunkering facilities for ships[44], while there are only around 23 LNG/L-CNG fuelling stations for road vehicles in place, mainly in Spain and in Italy[45].

43. For the near future, further 13 LNG/L-CNG stations are planned to be built in the framework of the LNG Blue Corridors project, accompanied by the deployment of a fleet of approximately 100 LNG Heavy Duty Vehicles[46].

44. Concerning waterborne transport, small-scale export/bunkering facilities at Swinoujscie (Poland), Padilski (Estonia), Klaipėda (Lithuania), Rostock (Germany), Gotherburg (Sweden), Turku and Porvoo (Finland) are planned or proposed[47]. Stakeholders indicate that a number of ports (e.g. Antwerp, Rotterdam) in the vicinity of Sulphur Emission Control Areas (SECAs) intend to provide LNG by 2015, while ports in the Mediterranean (e.g. Marseille, Barcelona) are starting to study the provision of LNG by 2017-2020[48].

CNG

1. CNG (Compressed Natural Gas) as vehicle technology is mature for the broad market, with close to 1 million vehicles on the road in Europe and around 2,800 filling stations in the EU. However, the stations are unevenly distributed across MS. In fact, more than half are located in just two MS: Germany and Italy.

2.2.2. Assessment of the current and near-term development of the infrastructure network for electricity, hydrogen and natural gas (LNG and CNG).

46. In order to establish the extent of the problem, the current and expected development of the alternative fuels infrastructure needs to be compared to a network that would

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42 The German Federal Ministry of Transport, Building and Urban Development (BMVBS) and the industry (industrial partner Daimler, Linde, Air Products, Air Liquide and Total) decided in a joint declaration to expand the hydrogen filling station network in Germany. By 2015 there should be at least 50 public filling stations for fuel cell vehicles. For the time being, 15 exist. Source: http://www.bmvbs.de/SharedDocs/DE/Pressemitteilungen/2012/125-ramsauer-wasserstofftankstellen.html

43 Source: Gas LNG Europe.

44 14 LNG terminals in Norway are organised to supply fuel to vessels, and five of those are used as bunkering stations. Source: Idem footnote 47.

45 Source: Natural & bio Gas Vehicle Association Europe (NGVA Europe).

46 LNG Blue Corridors project under the 7th Framework Programme, Sustainable Surface Transport Priority, Green Cars Initiative. The project is pending on final Commission approval.

47 Danish Maritime Authority, 2011, North European LNG Infrastructure Project.

48 As part of Priority Project 21 of the Trans-European Transport Network, the COSTA Action aims at developing framework conditions for the use of LNG for ships in the Mediterranean, Atlantic Ocean and Black Sea areas. It will result in preparing an LNG Masterplan for short sea shipping between the Mediterranean Sea and North Atlantic Ocean as well as the Deep Sea cruising in the North Atlantic Ocean towards the Azores and the Madeira Island. The implementing bodies are as follows: RINA, Grimaldi Group, Grandi Navi Veloci, Portos dos Açores, Portos da Madeira. Further information is available at: http://tentea.ec.europa.eu/en/ten-t_projects/ten-t_projects_by_country/multi_country/2011-eu-21007-s.htm

be necessary to enable market take up of these fuels. The next sections describe such minimum necessary network for vehicles powered by electricity, hydrogen and natural gas (LNG and CNG).

47. It must be noted that the uncertainties related to projections on the development of alternative fuels infrastructure and of the number of vehicles are very large. There are many factors influencing the projections, such as technology developments (learning rates, possible technology breakthroughs), the price and availability of oil, abrupt changes in national policies, in the strategies of vehicle manufacturers etc. Therefore the following section draws on a large variety of sources to establish what can be regarded as conservative projections with relatively lower uncertainty.

Electricity

48. The minimum necessary network for electric vehicles is here defined as an infrastructure network that is not only capable of servicing the existing fleet of vehicles, but ensures that alternative fuel infrastructure is available in line with:

(1) the **critical mass of production** needed for vehicle manufacturers to achieve reasonable economies of scale in the initial phases of deployment of a new technology. The International Energy Agency (IEA)[49] considers this critical mass to be in the range of 50,000 to 100,000 vehicles per year and per model, in terms of global production. The European Automobile Manufacturers' Association (ACEA) estimates a 3 to 10% market share by the mid-2020s[50], which corresponds to "*new electrically chargeable vehicle registrations of between 450,000 and 1,500,000 units by 2020 to 2025*"[51].

49 Source: IEA, 2011, Technology Roadmap, Electric and plug-in hybrid electric vehicles, available at: http://www.iea.org/papers/2011/EV_PHEV_Roadmap.pdf

50 Source: Speech by Dieter Zetsche, President ACEA, CEO Daimler on the future of electric cars at the Informal Competitiveness Council of San Sebastian, 9 February 2010 available at: http://www.acea.be/images/uploads/files/20100211_Speech_Dieter_Zetsche.pdf

51 Source: ACEA position paper on electrically chargeable vehicles, 6 Sep 2011, available at: http://www.acea.be/images/uploads/files/ACEA_on_ECVs.pdf

Table 2: Overview of global industry targets for electric vehicles and plug-in hybrid electric vehicles[52]

Car manufacturer	Announced/reported production/sales targets	Battery manufactures[53]
Daimler	10,000 in 2013[54]	Johnson Controls – Saft (JCS), Sanyo, SK Innovation, Li-Tec Battery
Fisker	50,000 in 2013[55] 85,000 in 2014-2015	A 123 Systems
Ford	10,800 in 2012 21,000 in 2013-2015	LG Chem, JCS, MAGNA E-Car Systems, Toshiba, Sanyo
General Motors	120,000 in 2012-2015[42]	LG Chem, JCS
Mitsubishi	40,000 in 2012[56] 5% in 2015 20% in 2020	GS Yuasa Corporation, Lithium Energy Japan, Toshiba
Nissan	50,000 in 2010 in Japan 150,000 in 2012 in United States 50,000 in 2013 in United Kingdom	AESC
PSA	40,000 in 2014[57]	Lithium Energy Japan, GS Yuasa, JCS
Renault	250,000 in 2013	AESC, LG Chem, SB Limotive (SBL)
Tesla	10,000 in 2013[42] 20,000 in 2014-2015	Panasonic Energy Company
Th!nk	10,000 in 2013[42] 20,000 in 2014-2015	A123 Systems, Enerdel, FZ Sonick
Volkswagen	3% in 2018[58]	Sanyo, Toshiba, SBL, Varta Microbattery

(2) the **research findings,** which centre around the projected deployment of electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs)[59] of

52 Source: Reproduced and updated based on Table 5A in IEA, 2011, Technology Roadmap, Electric and plug-in hybrid electric vehicles, available at: http://www.iea.org/papers/2011/EV_PHEV_Roadmap.pdf

53 This may contain development partners and former partnership.

54 Source: www.bloomberg.com/apps/news?pid=20601100&sid=aT_u.QS7Y4tg

55 Source: http://energy.gov/sites/prod/files/edg/news/documents/1_Million_Electric_Vehicle_Report_Final.pdf

56 "*In June 2009, the company formulated and published the "Mitsubishi Motors Group Environmental Vision 2020" as its overarching guidelines for environmental initiatives. Among the goals to be achieved by 2020 are electric-powered vehicles (EV and PHEV) accounting for 20% or more of total production volume, (new) models' CO2 emissions to be reduced by 50% in comparison from FY2005 levels as a global average.* […] [The] *"Environment Initiative Program 2015" sets interim targets for 2015 as a step along the way to achieving the 2020 targets. It calls for electric-powered vehicles to account for at least 5% of total production volume* […]." Source: www.mitsubishi-motors.com/publish/pressrelease_en/corporate/2011/news/detail0771.html

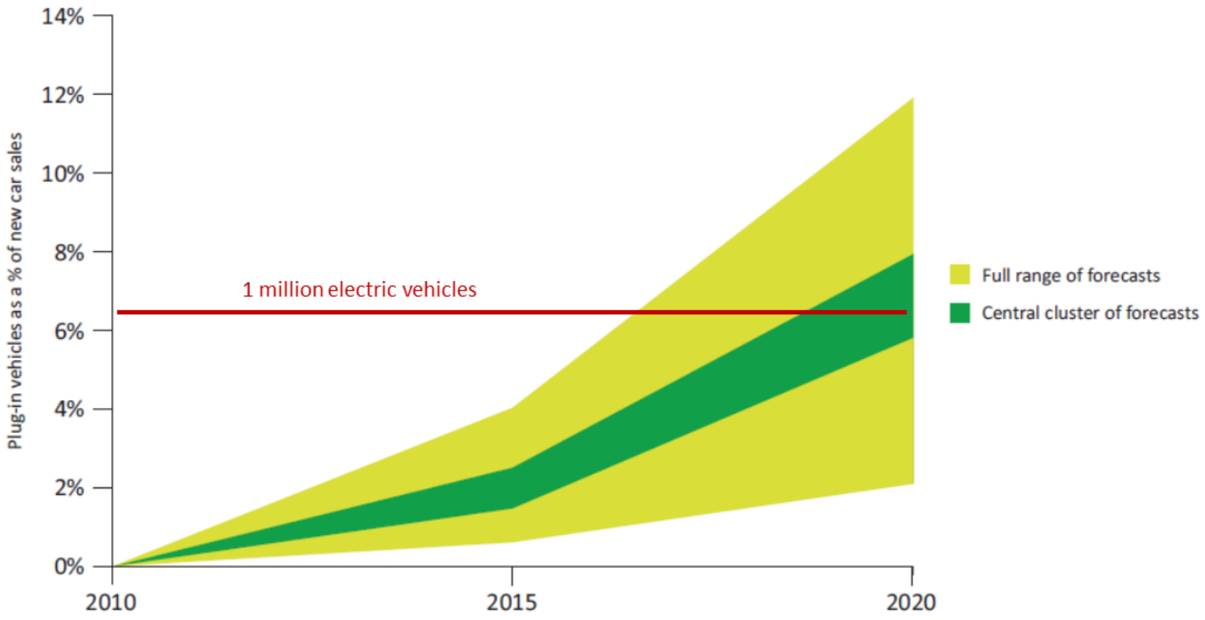
57 www.ft.com/cms/s/0/3a4324f4-4353-11e0-aef2-00144feabdc0.html#axzz1FLb87CdI

58 Estimated to be 300,000 cars. Source: http://content.usatoday.com/communities/driveon/post/2010/07/vw-sales-to-be-3-gybrid-and-electric-vehicles-by-2018/1; http://www.treehugger.com/cars/volkswagen-plans-to-sell-300000-electric-cars-a-year-by-2018.html

59 Extended-Range Electric Vehicles (E-REVs) are considered PHEVs in this report. PHEVs are considered by many as bridging technology towards full (battery-only) EVs. According to the findings of the PHEV demonstration project undertaken by Toyota in Europe, the average trip distance of PHEV users was 13.2 km, two-thirds of the trips were under 20 km, and one-third of total driving time was done in pure electric mode.

approximately 6-8% of new vehicle sales in 2020[60] (900,000 to 1,200,000 units).

Figure 1: EV and PHEV uptake forecasts for 2015 and 2020[61]



49. The above references suggest taking the benchmark number of around 4 million vehicles on the road by 2020[62] as the fleet that needs to be serviced by an adequate network. This corresponds to 1 million vehicle sales in 2020, i.e. 7% of new vehicle sales, which is the mid-point of scientific projections. This amount can be translated into the mass production of up to 20 different vehicle models.

50. Four million vehicles on the road by 2020 is less than half of what Member States announced as objective for deployment of vehicles. It can therefore be considered to be a conservative benchmark in comparison to the Member States' aim of 8-9 million EVs and PHEVs on the road by 2020 (

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60 7% is the conclusion of Universität Duisburg Essen, 2012, "Competitiveness of EU Automotive Industry in Electric Vehicles", Draft Final Report, study contracted by DG Enterprise and Industry.

61 Figure is based on selected PHEV and EV uptake forecasts by Arup-Cenex, BCG, Berger, Cheuvreux, Deutsche Bank, Frost & Sullivan and McKinsey, as shown in Department for Transport, 2011, Making the Connection, The Plug-In Vehicle Infrastructure Strategy, United Kingdom, available at: http://www.dft.gov.uk/publications/plug-in-vehicle-infrastructure-strategy/

62 The sales figure for 2020 of 1 million vehicles can be translated into an estimated stock of EVs and PHEVs in 2020 using a simple interpolation between the sales figure in 2011 of around 8,700 and the sales figure of 2020. The result of a similar exercise done by the International Energy Agency is shown on Figure 2.

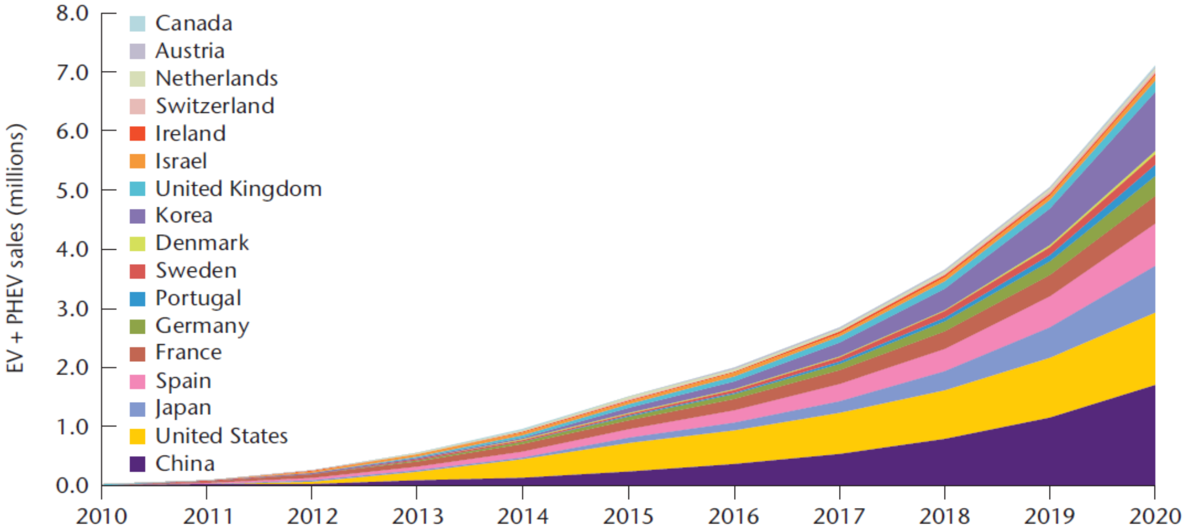
Table **3**).

Table 3: Overview of national targets and principal projections for EV and PHEVs[63]

Country	Target	Announcement/ Report date	Source
Australia	2012: first car on road 2018: mass adoption 2050: up to 65% stock	04 Jun 2009	Project Better Place Energy White Paper (referencing Garnault Report)
Australia	2020: 20% production	10 Jun 2009	Mitsubishi Australia
Canada	2018: 500,000 2020: 18,000 (EV sales in Ontario)	Jun 2008 15 Jul 2009	Government of Canada's Canadian Electric Vehicles Technology Roadmap
China	5,000,000 stock	March 2011	Electric Vehicle Initiative (EVI)
China	540,000 by 2015	8 Jul 2009	Pike Research
China	2008: 21,000,000 electric bike stock	27 Apr 2009	*The Economist*
China	2030: 20% to 30% market share	Oct 2008	McKinsey & Co.
Denmark	**2020: 200,000** **2020: 50,000**	**-**	**ENS Denmark** **EVI**
France	**2020: 2,000,000**	**March 2011**	**EVI**
Germany	**2020: 1,000,000**	**March 2011**	**EVI**
Ireland	**2020: 350,000**	**28 Apr 2009**	**Houses of the Oireachtas**
Ireland	**2020: 230,000** **2030: 40% market share**	**1 Oct 2009**	**Electricity Supply Board (ESB)**
Israel	2011: 40,000 EVs 2012: 40,000 to 100,000 EVs annually	9 Sept 2008	Project Better Place
Japan	2020: 20% market share (800,000 based on IEA estimate of 4,000,000)	March 2011	EVI
Netherlands	**2015: 20,000 stock** **2020: 200,000 stock**	**May 2011**	**Dutch Energy Agency**
New Zealand	2020: 5% market share 2040: 60% market share	11 Oct 2007	Prime Minister Helen Clark
Spain	**2020: 2,500,000**	**March 2011**	**EVI**
Sweden	**2020: 600,000**	**March 2011**	**EVI**
Switzerland	2020: 145,000	Jul 2009	Alpiq Consulting
United Kingdom	**2020: 1,200,000 stock EVs + 350,000 stock PHEVs** **2030: 3,300,000 stock EVs + 7,900,000 stock PHEVs**	**Oct 2008**	**Department for Transport "High Range" scenario**
United States	2015: 1,000,000 PHEV stock	Jan 2009	President Barak Obama
Worldwide	2015: 1,700,000	8 Jul 2009	Pike Research
Worldwide	2030: 5% to 10% market share	Oct 2008	McKinsey & Co.
Worldwide	2020: 10% market share	26 Jun 2009	Carlos Ghosn, President Renault
Europe	**2015: 250,000 EVs**	**4 Jul 2008**	**Frost & Sullivan**
Europe	**2015: 480,000 EVs**	**8 May 2009**	**Frost & Sullivan**
Nordic countries	**2020: 1,300,000**	**May 2009**	**Nordic Energy Perspectives**

63 Non-EU countries have also set targets for the deployment of EVs and PHEVs. These targets need to be taken into account to assess the likely global demand for the vehicles, and compare this to the critical mass of production globally. Source: "Individual Country Roadmaps and Announced Targets, as listed in the references." Reproduced based on Table 4 in IEA, 2011, Technology Roadmap, Electric and plug-in hybrid electric vehicles, available at: http://www.iea.org/papers/2011/EV_PHEV_Roadmap.pdf

Figure 2: National EV/PHEV sales targets, if national target year growth rates extend to 2020[64]



Source: IEA data.

51. Based on the 2nd Report of the Expert Group on Future Transport fuels[65], the number of charging points needed for servicing the benchmark 4 million vehicles can be estimated to be around 8 million points, with overwhelming majority being located at home and at the workplace, and around 1 charging point per 5 vehicles at a publicly accessible car park or on-street. These estimates take into account that the recharging network has to develop beyond the bare minimum needed for servicing the vehicles, in order to address the so-called 'range anxiety' of users[66].

52. In order to determine the minimum number of charging points required in each Member State, motorisation and urbanisation rates can be used as described in Table 4. The level of car ownership also serves as a proxy for income per capita, while the share of population residing in densely populated areas shows the potential for deployment of EVs, which will have limited operating range (< 200km) in the near-future. By comparing these numbers to Figure 2, Appendix 5 and Table 3, Appendix 4, it can be concluded that France is the only Member State that has made a firm commitment[67] to deploy a sufficient network of both private and public EV charging points.

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64 Source: Figure 6 in IEA, 2011, Technology Roadmap, Electric and plug-in hybrid electric vehicles, available at: http://www.iea.org/papers/2011/EV_PHEV_Roadmap.pdf

65 The report is available at: http://ec.europa.eu/transport/urban/cts/doc/2011-12-2nd-future-transport-fuels-report.pdf

66 Source: Wiederer et al., 2010, Policy option for electric vehicle charging infrastructure in C40 cities.

67 France has announced the deployment of 4,000,000 private and 400,000 public charging points by 2020. Source: http://www.cleanvehicle.eu/info-per-country-and-eu-policy/member-states/france/national-level/

Table 4: Minimum number of charging points in each Member State, in thousands[68]

Step 1 Step 2 Step 3

$$\frac{\text{Car stock }(MS_1)}{\text{Car stock (EU)}} * \frac{\text{Share of urban population }(MS_1)}{\text{Share of urban population (EU)}} * \text{EV stock (EU)} * 2 = \text{Number of charging points needed in } MS_1$$

	Step 1				Step 2		Step 3		
Member State	Existing stock of passenger cars	Existing car stock in each MS compared EU total	Distribution of EVs based on existing stock	Share of urban population in each MS	Share of urban population compared to EU	Distribution of EVs based on share of urban population	Scalling with the estimated number of vehicles	Number of charging points needed	Number of publicly accessible charging points needed
BE	5,276	2.20%	88	91%	1.20	105	**103**	207	21
BG	2,602	1.08%	43	62%	0.81	35	**34**	69	7
CZ	4,496	1.87%	75	67%	0.88	66	**65**	129	13
DK	2,164	0.90%	36	58%	0.76	27	**27**	54	5
DE	42,302	17.61%	704	83%	1.08	764	**752**	1,503	150
EE	553	0.23%	9	52%	0.68	6	**6**	12	1
IE	1,899	0.79%	32	27%	0.35	11	**11**	22	2
EL	5,217	2.17%	87	57%	0.75	65	**64**	128	13
ES	22,147	9.22%	369	87%	1.14	419	**412**	824	82
FR	31,709	13.20%	528	71%	0.93	493	**485**	969	97
IT	36,751	15.30%	612	80%	1.04	637	**627**	1,255	125
CY	463	0.19%	8	100%	1.31	10	**10**	20	2
LV	637	0.26%	11	62%	0.81	9	**8**	17	2
LT	1,692	0.70%	28	57%	0.75	21	**21**	41	4
LU	337	0.14%	6	100%	1.31	7	**7**	14	1
HU	2,984	1.24%	50	53%	0.70	35	**34**	68	7
MT	239	0.10%	4	100%	1.31	5	**5**	10	1
NL	7,536	3.14%	125	99%	1.30	163	**161**	321	32
AT	4,441	1.85%	74	61%	0.80	59	**58**	116	12
PL	17,240	7.17%	287	62%	0.81	234	**230**	460	46
PT	4,480	1.86%	75	64%	0.84	62	**61**	123	12
RO	4,320	1.80%	72	54%	0.71	51	**50**	101	10
SI	1,062	0.44%	18	57%	0.75	13	**13**	26	3
SK	1,669	0.69%	28	50%	0.65	18	**18**	36	4
FI	2,877	1.20%	48	57%	0.75	36	**35**	71	7
SE	4,335	1.80%	72	78%	1.02	74	**72**	145	14
UK	29,334	12.21%	488	97%	1.27	620	**611**	1,221	122
HR	1,515	0.63%	25	58%	0.76	19	**19**	38	4
EU	**240,277**	**100%**	**4,000**	**76%**	**1.00**	**4,065**	**4,000**	**8,000**	**800**
EU15	**200,805**	**84%**	**3,343**	**81%**		**3,543**	**3,486**	**6,973**	**697**
EU13	**39,472**	**16%**	**657**	**58%**		**522**	**514**	**1,027**	**103**

Hydrogen

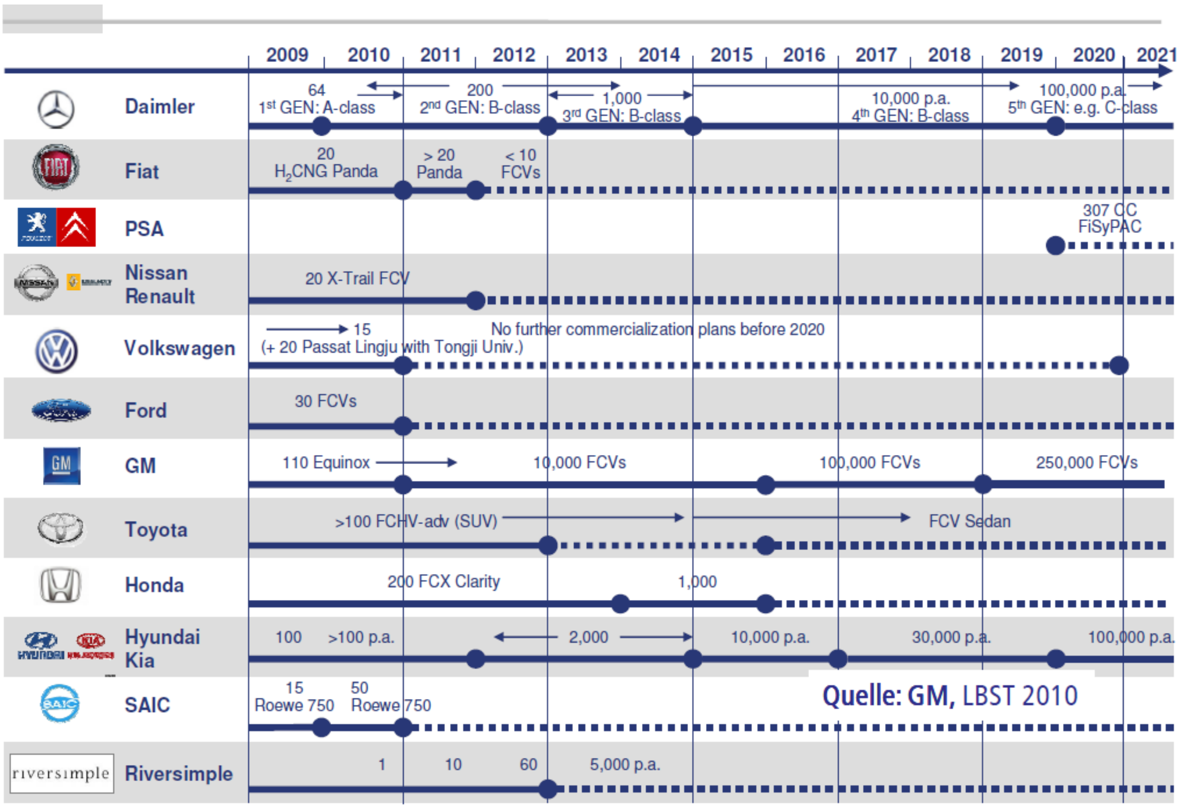
53. Higher uncertainty and lower predicted sales volumes characterise the deployment of Fuel Cell Electric Vehicles (FCEVs), particularly up to 2015, both from the side of the industry (

[68] Data on the existing stock of passenger cars and share of urban population in each Member State is sourced from Eurostat.

Figure 3) and the research community[69].

[69] For example, according to Pike Research commercial sales of FCEVs will reach 1.2 million vehicles cumulatively by 2020. Source: http://www.pikeresearch.com/newsroom/fuel-cell-vehicle-sales-to-cross-the-1-million-mark-in-2020

Figure 3: Overview of industry targets for FCEVs[70]



54. Despite these uncertainties, the United States have carried out pioneering work in the establishment of what can be considered a minimum infrastructure network for enabling the deployment of FCEVs. The U.S. National Renewable Energy Laboratory has financed a number of projects in order to identify a minimum infrastructure that could support the introduction of FCEVs. First, the location and number of hydrogen stations were determined that would make hydrogen available along the most commonly travelled interstate roads, thus making interstate and cross-country travel possible. A network of 284 hydrogen refuelling stations was proposed that would facilitate travel along 65% of the U.S. interstate highway system[71]. Second, a phased urban roll-out was established whereby the fuelling network is created on the basis of major urban centres, followed by the establishment of early corridors linking these[72].

55. In the EU, several Member States have been working on detailed plans for hydrogen infrastructure deployment. Most recently, in June 2012, Germany has announced the expansion of its refuelling network focusing on the country's metropolitan regions

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70 Source: Ludwig-Bölkow-Systemtechnik GmbH, 2011, German efforts on hydrogen for transport, available at: http://www.hydrogennet.dk/fileadmin/user_upload/PDF-filer/Aktiviteter/Afholdte_aktiviteter/Transportworkshop%20d.%201.%20dec%202011/6_Buenger.pdf

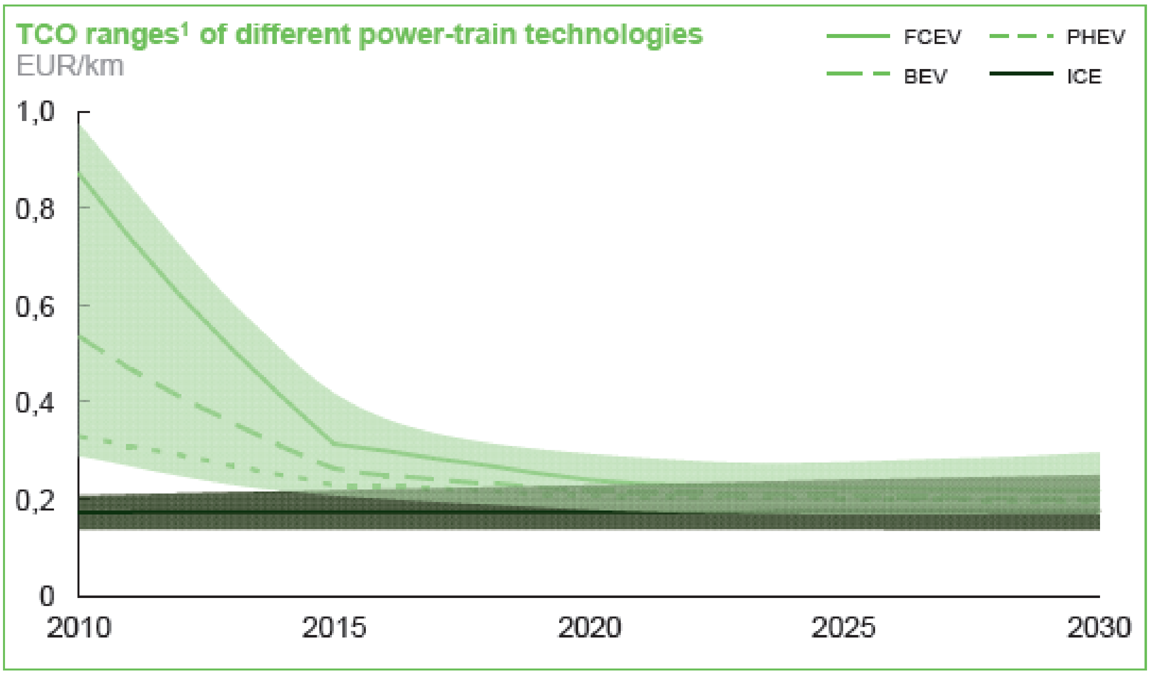
71 Source: Melendez et al, 2005, Analysis of the Hydrogen Infrastructure Needed to Enable Commercial Introduction of Hydrogen-Fueled Vehicles.

72 Source: Melendez et al, 2007, Geographically Based Hydrogen Consumer Demand and Infrastructure Analysis: Final Report.

and the creation of corridors connecting these metropolitan regions[73]. Denmark has also announced an infrastructure programme earlier this year, with the objective is to establish national coverage by 2015[74].

56. These strategies are partly motivated by industry projections that show that hydrogen fuel cell vehicles can become cost-competitive with conventional vehicles in the medium-term (Figure 4). Depending on the applicable tax regimes, the cost-competitiveness can be achieved even sooner: according to the estimates of H2 Logic[75], a FCEV vehicle in Denmark will cost around € 49,770 in 2015, while a comparable gasoline car would have a price tag of €49,583, including VAT and tax.

Figure 4: Projected development of the total cost of ownership[76]



1 Ranges based on data variance and sensitivities (fossil fuel prices varied by +/- 50%; learning rates varied by +/- 50%)

57. In line with these strategies, building on existing fuelling stations and those planned in the Member States, to link these urban clusters along main road transport corridors would create a network capable of supporting the commercialisation of hydrogen vehicles on the 2020 horizon. Subject to the uncertainties regarding technology

[73] Source: BMVBS, 2012, 50 hydrogen filling stations for Germany: Federal Ministry of Transportation and industrial partners build nationwide network of filling stations, available at: http://www.netinform.net/H2/files/pdf/50-hydrogen-filling-stations-Germany.pdf

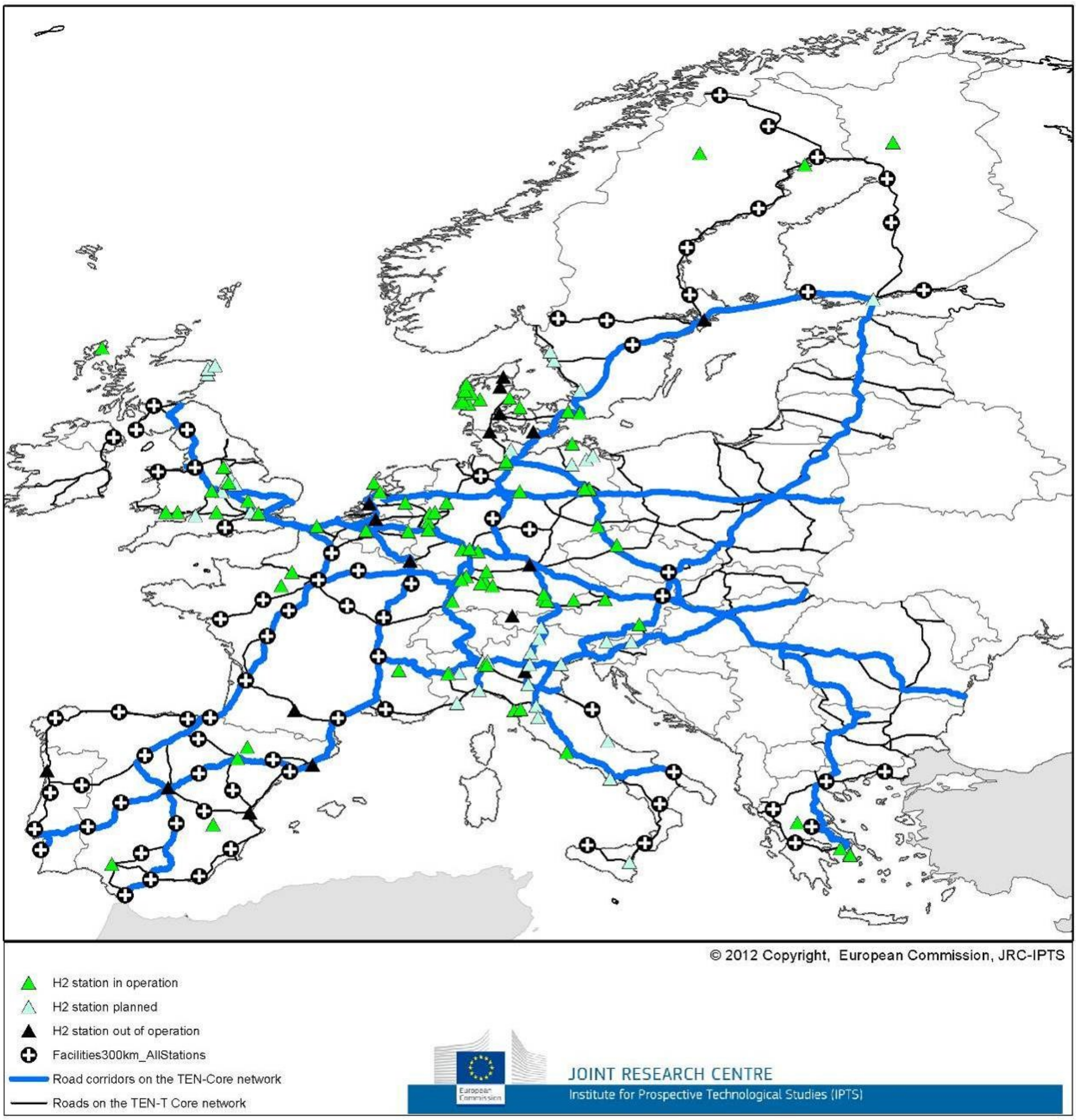
[74] Source: http://hydrogenlink.net/eng/PR-Danish-Government-launch-hydrogen-initiatives-23-03-2012.asp The Danish industry coalition analysis & roadmap on “Hydrogen for transport in Denmark onwards 2050” proposes to establish national coverage with 15 fuelling stations, achieving the maximum distance of 150 km to the nearest station. Source:http://www.hydrogennet.dk/fileadmin/user_upload/PDF-filer/Aktiviteter/Afholdte_aktiviteter/Transportworkshop%20d.%201.%20dec%202011/4_Sloth.pdf

[75] Idem footnote 74.

[76] Source: McKinsey & Company, 2010, A portfolio of power-trains for Europe: a fact-based analysis. The role of Battery Electric Vehicle, Plug-in Hybrids and Fuel Cell Electric Vehicles. Exhibit 28 "*After 2025, the TCOs of all the power-trains converge*", available at: http://ec.europa.eu/research/fch/pdf/a_portfolio_of_power_trains_for_europe_a_fact_based__analysis.pdf

development, Figure 5 shows how hydrogen fuelling stations already built or planned can provide national coverage and be connected via the proposed Trans-European Transport Network (TEN-T) Core Network[77] with the maximum distance of 300 km between stations[78]. The number of additional fuelling stations to achieve this network is 72.

Figure 5: Minimum infrastructure network for hydrogen



Natural gas (LNG and CNG)

58. The technological uncertainty related to use of LNG in waterborne and road transport is low. This being said, the take-up of LNG technology in Europe is still mainly in its

[77] COM(2011) 650 final, Proposal for a Regulation of The European Parliament and of the Council on Union guidelines for the development of the trans-European transport network.

[78] A route-based methodology rather than a strictly distance-based (Euclidean-based) approach was applied. This choice avoids the underestimation of the number of required stations as shown in Gutiérrez et al., 2008, Distance-measure impacts on the calculation of transport service areas using GIS.

planning stage[79], with the availability of LNG fuelling possibilities being very limited.

59. Despite the fact that it has been identified by industry as a main fuel option relatively recently, it is already likely to achieve significant market penetration within a decade. This is partly supported by regulatory developments, such as international requirements on the use of low-sulphur fuels in shipping by 2015 in SECAs, and globally by 2020[80]. Around 10,000 ships are currently mainly used for short sea shipping in Europe, of which around 5,000 are spending more than 50% of their time in SECAs, thus having to use mainly low sulphur marine gas oil. Stakeholder expectations are to have 500 LNG fuelled ships on order by 2015, and more than 1,000 by 2020.

60. In the inland waterways sector, more than half of the engines will need to be replaced or adapted within a decade, given their typical life cycle. The industry anticipates tightening requirements on pollutant emissions; in particular as currently only about 14% of the existing 8,500 vessels are subject to emission requirements[81].

61. For road transportation, the LNG technology in many regards is similar to CNG, and according to the estimates of one of the main producer of LNG trucks, the market penetration of LNG heavy-duty vehicles could reach more than 50,000 units per year by 2020[82]. According to industry estimates[83], the additional investment costs required for an LNG truck (€ 21,000) can be amortised within less than a year due to fuel cost savings, while for a diesel-LNG dual fuel truck (€30,000), the amortization would take less than two years.

62. CNG vehicles can play an important role in urban and medium distance transport in the mid-term 2020. According to the estimations of the main association of natural gas vehicles, a market share of 5% could be possible by 2020, with some 15 million vehicles. Sweden is leading the use of biomethane which is now accounting for 65% of all the natural gas use in some 28,000 vehicles (as of June 2010).

63. Often located in the direct vicinity of existing and planned LNG import terminals, which could be used to further distribute and provide shipping with bunker fuel, the 83 maritime ports of the TEN-T Core Network are the primary locations on a network that could enable the use of LNG in shipping. Linking these maritime ports

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79 Idem footnote 47 and 46. A number of further studies, co-financed with EU funding available for the development of the TEN-T network, analyse and refine LNG bunkering networks on a regional basis, such as LNG in Baltic ports (until December 2014), LNG infrastructure and pilot project in the North Sea (until March 2013), COSTA study on use of LNG in the Mediterranean, Atlantic Ocean and Black Sea (until April 2014).

80 "*Under the revised MARPOL Annex VI, the global sulphur cap is reduced initially to 3.50% (from the current 4.50%), effective from 1 January 2012; then progressively to 0.50 %, effective from 1 January 2020, subject to a feasibility review to be completed no later than 2018. The limits applicable in ECAs for* SO_x *and particulate matter were reduced to 1.00%, beginning on 1 July 2010 (from the original 1.50%); being further reduced to 0.10 %, effective from 1 January 2015.*" Source: IMO, available at: http://www.imo.org/ourwork/environment/pollutionprevention/airpollution/pages/air-pollution.aspx

81 Source: NEA et al, 2011, Medium and Long Term Perspectives of IWT in the European Union.

82 Source: Westport, 2011, LNG: An Immediate Fuel Alternative for Truck Transportation in Europe, available at: http://www.ngvaeurope.eu/members/presentations/Westport-Innovation-Nicholas-Sonntag.pdf

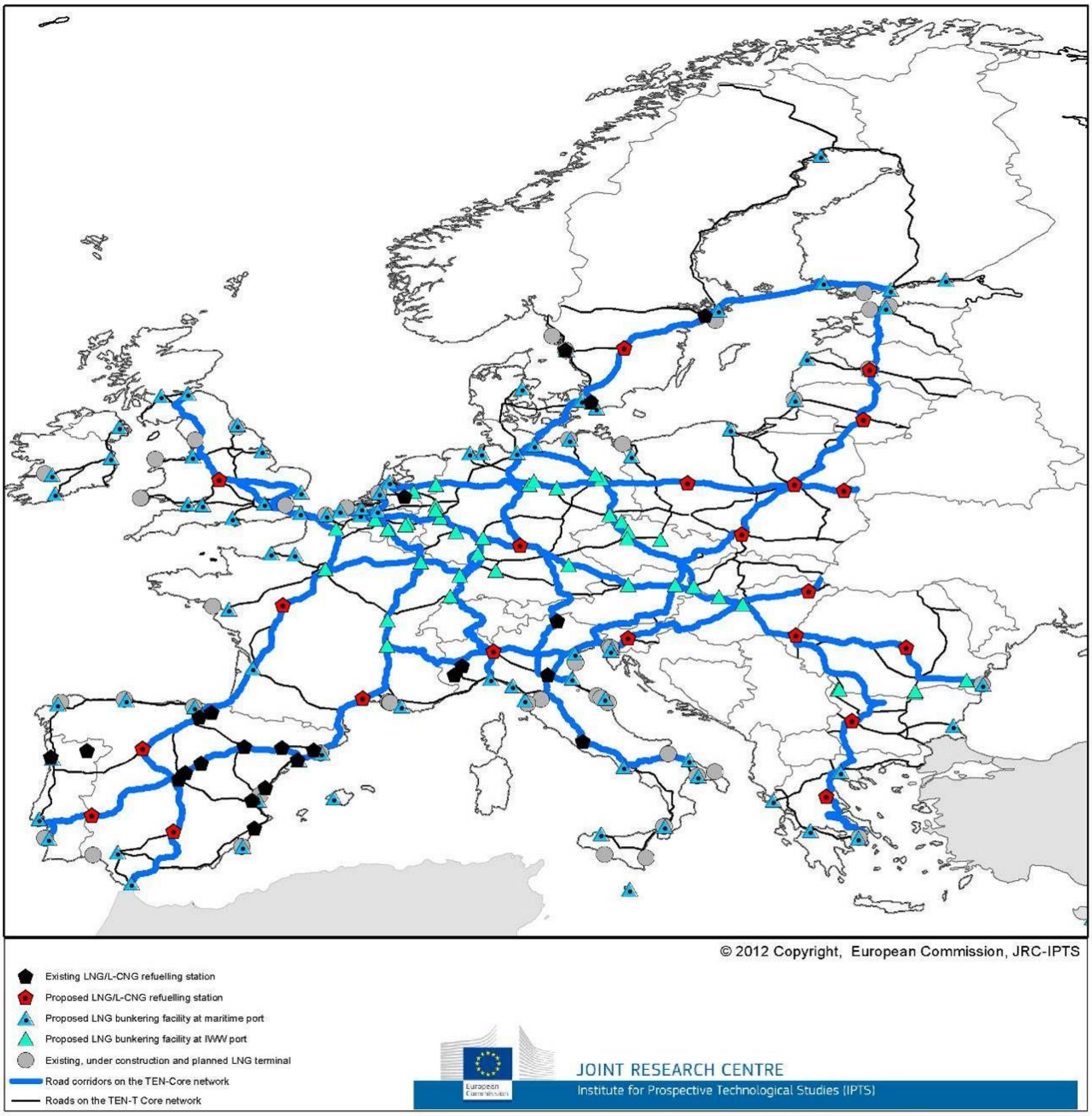
83 Source: HAM, 2012, Presentation "LNG fuel trucks experience" available at: http://www.empresaeficiente.com/uploads/workshops/docs/f83279340ba1651353cbbe1e283e7cad1e1f478d.pdf

by equipping the inland waterway and road transport corridors[84] would provide sufficient coverage for the deployment of this alternative fuel in these transport modes as well. This would require additional bunkering facilities at the 41 inland ports of the Core Network, and additionally locating 21 LNG/L-CNG fuelling stations at the maximum distance of 400 km on road (as illustrated on Figure 6)[85].

84 As identified in COM(2011) 665 final, Proposal for a Regulation of the European Parliament and of the Council establishing the Connecting Europe Facility.

85 Idem footnote 78.

Figure 6: Minimum refuelling network for LNG



Conclusion of Section 2.2

On the basis of projected market developments and in comparison with what would be necessary to allow widespread commercialisation of the corresponding vehicles, the infrastructure for electric, hydrogen, LNG for trucks and vessels and CNG for road transport vehicles is likely to remain insufficient in quantity and (in particular for electricity) in quality.

2.3. The root causes of the insufficiency of the infrastructure for alternative fuels

64. Following the above conclusion, this section analyses the underlying problem drivers that lead to an insufficient recharging/refuelling infrastructure for alternative fuels.

2.3.1. Existing recharging/recharging equipment cannot be connected and is not interoperable in all related alternative fuel vehicles/vessels

65. The technology necessary for the construction of a network for the distribution of alternative fuels is substantially mature for all types of recharging/refuelling systems, as highlighted in the Report of the Expert Group on Future Transport Fuels[86]. However, currently the standards for alternative fuels infrastructure are not common EU-wide. This is partly because voluntary standardisation has failed to deliver (e.g. plugs for electric vehicles), the application of (draft) standards is not compulsory (hydrogen) or because the standardisation work has not been completed for natural gas (LNG and CNG). The situation of the selected alternative fuels is summarised in Appendix 6.

Overall assessment

66. Stakeholders consider the issue of the lack of common standards for recharging/refuelling as the main *technical* barrier that prevents the creation of a single market as well as the reduction of costs of alternative fuels infrastructure. This problem discourages potential infrastructure investors, manufacturers of alternative fuel vehicles and vessels and consumers. Without EU-wide harmonised standards, consumers are obliged to use adaptors while investors and manufacturers face retrofit costs for adopting new recharging/refuelling systems.

67. The lack of harmonised development of alternative fuels infrastructure across the EU prevents two beneficial effects: economies of scale on the supply side and network effects on the demand side. Economies of scale can derive from reducing the unit cost of production of refuelling/recharging points by introducing alternative fuels infrastructure at a mass scale[87]. In addition, interoperability across the network due to harmonisation would allow vehicle and recharging/refuelling equipment manufacturers (e.g. for smart meters and charging devices) to sell off-the-shelf products which need not be differentiated across national markets. At the same time, network effects of harmonised alternative fuels infrastructure can be described as ‘demand-side economies of scale’. This means that consumers would obtain higher value out of the infrastructure than the price they would need to pay to access it.

68. On the other hand, network effects may cause lock-in into certain technologies and standards[88]. In such circumstances, the risk is that, at later stages of the infrastructure development, the costs of revising those standards and implementing new ones, including the cost of disutility for the public, may be excessive.

Conclusion of Section 2.3.1

The lack of common standards on alternative fuels infrastructure leads to the fragmentation of internal market against the development of a European market. Even where international

86 Idem footnote 5.

87 Source: Corts, K., 2009, Building out alternative fuel Retail Infrastructure: Government Fleet Spillovers in E85, Center for the Study of Energy Markets, University of California Energy Institute.

88 "*Network externalities can cause inertia in the development and diffusion of green cars. Barriers to entry can arise from increasing returns to scale in networks and contribute to creating a bias in the market towards existing technologies. Consumers may be reluctant to purchase an AFV* [alternative fuel vehicle] *if they are uncertain that a network of refuelling/charging infrastructure will be extended far enough to cover their needs. Instead, they will tend to favour the incumbent ICE technologies for which gasoline and diesel refuelling stations abound." Source:* Idem footnote 22.

standards exist, their implementation is voluntary, which allows EU-wide fragmentation, thereby discouraging potential infrastructure investors, car manufacturers and consumers.

2.3.2. Investment uncertainty hinders the deployment of recharging/refuelling infrastructure for electricity, hydrogen and natural gas (LNG and CNG)

69. Currently, fuelling stations for gasoline and diesel represent a mature and attractive market for investors. The lifetime of a conventional petrol station is estimated to be approximately 15 years[89], depending on the country and the location. The existing vehicle fleet running on petrol or diesel provides high utilisation rates, and this allows for a fast recovery of the initial investment with an estimated payback period of approximately 5 years.

70. On the contrary, the business case for providers of alternative fuels infrastructure for electricity, hydrogen and natural gas (LNG and CNG) is not yet established. The situation of each of these alternative fuels is summarised in Appendix 6.

Overall assessment

71. In addition to the higher costs for products at an early stage of technological development and market deployment, there are market failures that are responsible for the missing business case.

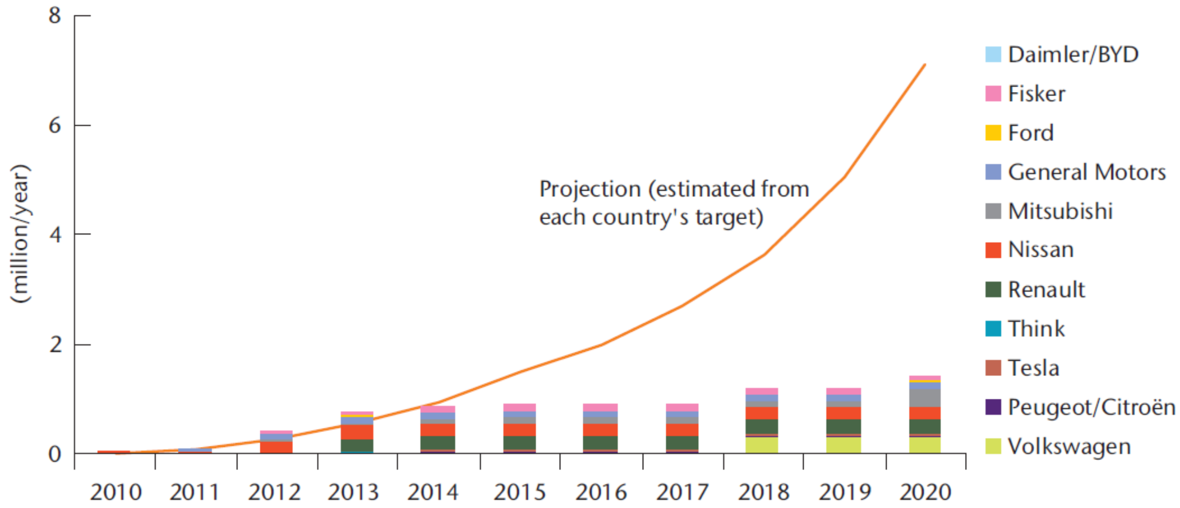
72. There is notably insufficient co-ordination among the relevant actors in a market that has strong complementarity between alternative fuels distribution and alternative fuel vehicles. This translates into a vicious circle whereby investors do not invest in alternative fuel infrastructure as there is an insufficient number of vehicles and vessels, the manufacturing industry does not offer alternative fuel vehicles and vessels at competitive prices as there is insufficient consumer demand, and consumers do not purchase the vehicles and vessels for lacking of dedicated infrastructure. This coordination failure among the complementary market actors, often referred to as the 'chicken and egg' issue, generates uncertainty about the utilisation rates of infrastructure and the length of payback periods for potential investors, and thereby hinders the deployment of recharging/refuelling infrastructure for electricty, hydrogen and natural gas (LNG and CNG).

73. Three different market participants would need to coordinate in order to exit this vicious circle: (1) the fuel supply industry (or in the case of electricity, the DSOs), which needs to invest in alternative fuels infrastructure and provide a service at a sufficient scale prior and parallel to the development of fuel demand; (2) the manufacturers of alternative fuel vehicles and vessels who need to achieve economies of scale so as to be able to supply those alternative fuel vehicles and vessels at competitive prices; (3) the final consumers, who need to be convinced about the attractiveness of alternative fuel vehicles and vessels and are likely to purchase them only if they are assured about the availability of sufficient recharging/ refuelling infrastructure[90]. Unless these actors proceed in a coordinated manner, uncertainty for investors will remain exceedingly high, and the markets will overall deliver a suboptimal solution (Figure 7).

[89] Source: Royal Dutch Shell plc, 2005, Annual Report.
[90] Idem footnote 25.

74. A good example of cooperation between different market players can be found in the many demonstration projects in which car-makers and electricity utilities have teamed-up to provide consumers with a full package of vehicle plus home charging point plus a few public charging stations. Interestingly, the number of applicants to such schemes often largely exceeds the available places, which gives evidence on the potential demand from consumers. However, the transformation of these demonstration projects into concrete business models would require greater certainty of operators on the actual deployment of a minimum sized network. Indeed, the value of a network – and therefore of the whole mobility system based on the alternative fuel – increases with the dimension of the network itself. In the stages of initial deployment, the 'system' has therefore little appeal for users and low profitability for investors. This problem can only be overcome if there is a clear commitment for sufficient investment in many geographical areas and within the same time horizon.

Figure 7: Gap between deployment targets of governments and vehicle manufacturers[91]



** Production/sale capacity levels shown here are assumed to remain constant after year of construction. In practice, capacities may rise after plants enter service.*

75. The lack of business case also results from the fact that investors may be less willing to finance open-access recharging/refuelling infrastructure for risk of 'free riding' by competitor investors[92]. 'First mover investors, and – to a smaller extent – follower investors, are confronted with high upfront costs and uncertain payback times for investments due to the low diffusion of alternative fuel vehicles and vessels and, consequently, the initially slack demand for alternative fuels. First mover' investors run the risk of losing some of their future profits to market players who will enter the market at a later stage when the demand for the marketed product consolidates, and financial viability is improved. Such a risk discourages first movers' investments.

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91 Idem footnote 49.

92 This risk has been highlighted by stakeholders promoting hydrogen: "*The main challenge to overcome for market introduction is to break through the first-mover disadvantage and to raise sufficient financial resources. Due to the high risk and amount of initial investments to enter a mature and established market, there is little economic incentive for any individual market-player to move first.*" Source: New-IG, 2011, Fuel Cell and Hydrogen technologies in Europe, Financial and technology outlook on the European sector ambition 2014-2020, available at: http://www.new-ig.eu/uploads/Modules/Publications/111026fchtechnologiesineurope-financialandtechnologyoutlook2014-2020_000.pdf

76. There can also be a 'principal-agent'-type market failure, which is manifested in the scarce interest of landlords in providing charging points for tenants/users in private dwellings and in office buildings[93].

77. Some Member States and national authorities have tried to address these problems through different measures, including on the demand side – for example by stimulating demand of vehicles through consumer incentives and public procurement. However, the different timing and scope of these initiatives has resulted in different perceptions of consumers in national markets and has not been sufficient to build up a 'critical mass' of demand and signal long-term commitment to the support of alternative fuels. Initiatives that are aimed exclusively at promoting the demand for vehicles do not appear sufficient to trigger investment in infrastructure, as underlined by representatives of automotive industry[94].

Conclusion of Section 2.3.2

In order to establish a business case for alternative fuels infrastructure, the underlying co-ordination failure among vehicle manufactures, infrastructure providers, national authorities and final users must be addressed. Initiatives that are specifically addressed at promoting infrastructure provision appear necessary to break the deadlock and elicit consumer confidence in alternative fuel technologies.

2.4. Who is affected, in what ways, and to what extent?

78. European citizens are hardly hit by high oil process, but do not feel sufficiently confident yet in switching to other technologies. Widespread availability of infrastructure, not only in some areas in a few cities, but throughout the EU, can convince consumers that these technologies are mature for deployment and it is time to invest in clean vehicles.

79. If the recharging/refuelling stations are established by market operators, the investment cost will be recovered from the users of that infrastructure. However, this will not impact substantially the operational cost of clean vehicles, for which the fuel cost will remain significantly lower than for oil products (cf. §131 and §133).

80. Public authorities, fuel suppliers and distributors, vehicle and waterborne vessel manufacturers and road and waterborne transport operators are also affected, for different reasons and to different extents, by the lack of alternative fuels infrastructure.

81. As a consequence of this insufficient infrastructure for the selected alternative fuels:

    (1) The automotive and shipbuilding industry is discouraged from producing alternative fuel vehicles and vessels.

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93 This market failure has been addressed in France, where a requirement was put in place in 2010 for new buildings (large complexes), defining an obligation for installing recharging points for EVs. Source: http://www.cleanvehicle.eu/info-per-country-and-eu-policy/member-states/france/national-level/

94 "Automaker Renault frustrated by the speed at which electric car chargers are being installed across France": Source: http://uk.reuters.com/article/2012/06/12/uk-renault-electriccars-chargers-idUKBRE85B0CJ20120612

(2) Mobility with alternative fuel vehicles and vessels running on electricity, hydrogen and natural gas (LNG and CNG) is currently constrained to few geographical areas that provide recharging/refuelling facilities.

(3) The development of a single EU market for alternative fuels in which the industry can benefit from economies of scale is jeopardised.

(4) The competitiveness of the EU industry related to alternative fuels and alternative fuel vehicles and vessels industry at the global level is limited.

2.5. Does the Union have the right to act?

82. The right for the EU to act in the field of transport is set out in Articles 90-91 of the TFEU, in Title VI, which makes provisions for the Common Transport Policy and in Articles 170-171 of the TFEU, Title XVI on the trans-European networks.

83. An EU initiative in this field would be necessary since Member States do not have the instruments to achieve pan-European coordination in terms of technical specifications of infrastructure and timing of investments. This would prevent a sufficiently even and widespread deployment of infrastructure, despite the existing and planned policy measures by Member States.

84. The value added of European action in this field derives from the trans-national nature of the identified problem. Vehicle and equipment manufacturers need to produce on a large scale for a single EU market, and they need to be able to rely on consistent developments across Member States. Similarly, consumers and transport users[95] are interested in pan-European mobility. European action can provide the requested coordination at the level of the entire EU market.

85. In addition, to comply with the principle of proportionality, the proposed action only addresses two transport modes (road and waterborne) for which the development of a minimum necessary network cannot be achieved without EU support. These sectors represent more than 80% of the modal split in freight and passenger transport[96]. In these sectors, the use of alternative fuels is functional to the reduction of oil dependence, and GHG and pollutant emissions.

Conclusion of Section 2.5

EU action is necessary to address technical, regulatory and financial barriers across the EU in order to facilitate the development of a single market for alternative fuels infrastructure and consequently for alternative fuel vehicles and vessels, so as to create the proper conditions for the various market actors to fulfil their respective functions. The EU intervention should focus on ensuring the EU-wide implementation of common standards and breaking the vicious circle of coordination failure among market actors.

3. OBJECTIVES

86. Section 2 has shown that:

(1) the existing refuelling/recharging equipment cannot be connected and is not interoperable in all related alternative fuel vehicles/vessels; and that

[95] Further details on the importance of cross-border journeys within the EU are provided in paragraph 0.
[96] Idem footnote 9.

(2) the investment uncertainty hinders the deployment of recharging/refuelling infrastructure for electricity, hydrogen and natural gas (LNG and CNG).

3.1. General policy objective

87. As part of the Climate and Renewable Energy Package of 2009, the EU has agreed on a binding targets on the share of renewable energy in the final energy use of transport (10% by 2020), and on a reduction of the greenhouse gas intensity of the energy that they supply for the road sector (-6% by 2020). The White Paper on Transport announced a reduction of 60% of CO_2 emissions by 2050 based amongst others on a significant uptake of alternative fuels.

88. The general objective of this initiative is to ensure, within the current economic climate, the provision of a sufficient infrastructure network for alternative fuels[97], contributing thereby to achieve the take-up of the alternative fuel vehicles' and vessels' market announced in the White Paper.

3.2. Specific policy objectives

89. The general objective can be translated into more specific goals:

(1) To make sure that recharging/refuelling equipment can be connected and are interoperable in all vehicles/vessels;

(2) To ensure that investment uncertainty is sufficiently reduced to break up the existing 'wait and see' attitude amongst market participants.

Table 5: Problem tree: mapping problems and objectives

General context **Last year's White Paper on Transport found that without the significant uptake of alternative fuels, we cannot achieve the targets of the Europe 2020 strategy and our climate goals for 2050. The Impact Assessment accompanying the White Paper has already described and assessed the set of Commission actions that are needed to achieve the uptake of alternative fuels. Most of these actions have been or will be accompanied by an individual Impact Assessment.**	**Context of the general objective** **As part of the Climate and Renewable Energy Package of 2009, the EU has agreed on a binding targets on the share of renewable energy in the final energy use of transport (10% by 2020), and on a reduction of the greenhouse gas intensity of the energy that they supply for the road sector (-6% by 2020). The White Paper on Transport announced a reduction of 60% of CO_2 emissions by 2050 based amongst others on a significant uptake of alternative fuels.**
Problem **Based on planned investments of Member States and, the alternative fuel infrastructure for electricity, hydrogen and natural gas (LNG and CNG) is likely to remain insufficient to enable the uptake of alternative fuels.**	**General objective** The general objective of this initiative is to ensure, within the current economic climate, the provision of a sufficient infrastructure network for alternative fuels, contributing thereby to achieve the take-up of the alternative fuel vehicles' and vessels' market announced in the White Paper.
Problem driver 1 **Existing recharging/refuelling equipment cannot be connected and is not interoperable in all related alternative fuel vehicles/vessels**	**Specific objective 1** To make sure that recharging/refuelling equipment can be connected and are interoperable in all vehicles/vessels

97 As defined in Section 0, paragraphs 0, 0, 0.

Problem driver 2	**Specific objective 2**
Investment uncertainty hinders the deployment of recharging/refuelling infrastructure for electricity, hydrogen and natural gas (LNG and CNG)	To ensure that investment uncertainty is reduced to a level breaking up the existing 'wait and see' attitude amongst market participants

3.3. Operational policy objectives

90. The following operational objectives have been defined in order to achieve the specific policy objectives set above:

(1) All recharging stations for electric vehicles, hydrogen and CNG and LNG refuelling stations for road transport vehicles, and LNG refuelling facilities for waterborne vessels can be connected, and are interoperable in all related alternative fuel vehicles/vessels.

(2) The number of recharging points for electric vehicles reaches the threshold set out in Table 1 in each MS, with at least 10% of this minimum number of recharging points being publicly accessible.

Table 6: Minimum number of electric vehicle charging points in each Member State (in thousands)

MS	Number of charging points	Number of publicly accessible charging points
BE	207	21
BG	69	7
CZ	129	13
DK	54	5
DE	1503	150
EE	12	1
IE	22	2
EL	128	13
ES	824	82
FR	969	97
IT	1255	125
CY	20	2
LV	17	2
LT	41	4
LU	14	1
HU	68	7
MT	10	1
NL	321	32
AT	116	12
PL	460	46
PT	123	12
RO	101	10
SI	26	3

SK	36	4
FI	71	7
SE	145	14
UK	1221	122
HR	38	4

(3) Existing hydrogen refuelling stations are connected via the Trans-European Transport Core Network (TEN-T) with a maximum distance of 300 km between stations by 2020.

(4) LNG refuelling facilities for waterborne vessels are available in all maritime ports of the TEN-T Core Network no later than by 2020.

(5) LNG refuelling facilities for waterborne vessels are available in all inland ports of the TEN-T Core Network, which are located on one of the corridors identified in the Regulation of the European Parliament and of the Council establishing the Connecting Europe, no later than by 2020.

(6) LNG refuelling stations for road transport vehicles are available in along the principal motorways of the TEN-T Core Network with a maximum distance of 400 km between stations by 2020. These motorways are identified as being parallel to one of the corridors identified in the Regulation of the European Parliament and of the Council establishing the Connecting Europe Facility no later than by 2020.

(7) CNG publicly accessible refuelling points are available, with maximum distances of 150 km, to allow the circulation of CNG vehicles Union-wide by 2020.

3.4. Consistency with horizontal objectives of the European Union

91. The Europe 2020 strategy, the Single Market Act and the Sustainable Development Strategy have set the scene for the transport sector. In addition, due to strong complementarities, the objectives of the European energy policy need to be taken into account.

3.4.1. Europe 2020 Strategy and Single Market Act

92. The Europe 2020 Strategy, under the flagship initiative "Resource efficient Europe", aims at supporting the shift towards a resource efficient and low carbon economy through the reduction of CO_2 emissions as well as through increased competitiveness and energy security. The specific objectives set out in section 3.2 above work towards the aim of the above-mentioned flagship. These objectives are also consistent with other objective defined in priority areas of the Europe 2020 strategy such as innovation, high employment, social and territorial cohesion.

93. The objectives listed in section 3.1 and 3.2 are also fully in line with the ambition to create a stronger, deeper and extended Single Market as set out in the Single Market Act[98].

[98] COM(2011) 206 final, Communication from the Commission "Single Market Act, Twelve levers to boost growth and strengthen confidence, "Working together to create new growth"".

3.4.2. Sustainable Development Strategy

94. The overall objective of the Sustainable Development Strategy, regarding sustainable transport is "to ensure that our transport systems meet society's economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment". The related operational objectives are:

(1) Achieving sustainable levels of transport energy use and reducing transport greenhouse gas emissions;

(2) Reducing pollutant emissions from transport to levels that minimise effects on human health and/or the environment;

(3) Reducing transport noise both at source and through mitigation measures to ensure overall exposure levels minimise impacts on health.

3.4.3. European Energy Policy

95. The European energy policy aims at providing sustainable, secure and competitive supply of energy to all consumers. The European Council of 4 February 2011 concluded that "*major efforts are needed to modernise and expand Europe's energy infrastructure and to interconnect networks across borders, in line with the priorities identified by the Commission communication on energy infrastructure*".

96. The changes to the energy system, driven by the targets to use 20% renewable energy (which translates to +/- 35% electricity from renewable energy, of which +/- 17% will be intermittent, in particular wind and solar energy), to reduce CO_2 emissions by 20%, and to reduce energy consumption by 20% by 2020, mean that generation of electricity will become more variable and less controllable, and the electricity system needs to manage this variability to ensure uninterrupted supply to consumers. Grids need to become smarter and allow consumers to participate in the energy market. EVs can contribute to this policy by providing a source of flexibility. This policy has been elaborated in the following ways:

(1) The Electricity Market Directive[99] obliges Member States to roll-out smart meters for consumers[100], and requires DSOs to take into account demand-side management when operating their system[101].

(2) The Energy Efficiency Directive[102] puts emphasis on participation of energy consumers in the energy market through demand response and participation of consumers in the balancing markets;

(3) In November 2011, the Commission has proposed a Regulation on "Guidelines for trans-European energy infrastructure"103, to enhance the investments in networks in the EU, as well as the Connecting Europe Facility as part of the EU budget for 2014-2020104, to provide EU funding for the development of networks, including smart grids and investments in ICT at distribution level.

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99 OJ L 211 14.8.2009, p.94

100 Annex I.2.

101 Article 25.7.

102 On the basis of COM(2011) 370, agreement has been reached in principle, but the final legislation still needs to be formally adopted.

103 COM(2011) 658 final.

104 COM(2011) 665 final.

4. POLICY OPTIONS

97. This section will explore alternative policy options aimed at achieving the objectives set out in Section 3.

4.1. Pre-screening of possible policy options

98. The Commission undertook an extensive consultation of stakeholders preceding this Impact Assessment. where various policy options were put forward for the alternative fuels, namely:

(1) Regarding technical specifications: no harmonisation at EU level; voluntary standardisation; and mandatory application of common standards concerning the issue of connectivity and interoperability

(2) Regarding infrastructure deployment: no EU intervention; industry self-regulation on the basis of commonly agreed methodology and indicative targets per Member State; and binding targets on Member States to solve the coordination failure.

99. To arrive to the policy options that are assessed in depth, a pre-screening of possible options was carried out on the basis of the following criteria:

(1) Consistency with general, specific and operational objectives

(2) Technology neutrality

(3) Feasibility

100. The complete description of the pre-screening process is provided in Appendix 7.

4.2. Description of policy options

101. On the basis of the pre-screening, the Commission has hence identified three policy options besides the 'no policy change' baseline scenario. These are described below, with an overview provided in Table 7.

4.2.1. Policy Option 1

(pre-screened FC4)

102. Policy Option 1 represents the future without any additional policy intervention to change current trends. Policy Option 1 refers to the 'no policy change' scenario. This policy option takes into account all current legislative and policy initiatives in the field of alternative fuels infrastructure, as well as the current and announced industry developments[105]. It also considers national announcements for the deployment of EV charging points as shown on Figure 2, Appendix 5 and Table 3, Appendix 4, and it includes the continuation of previous action programmes and incentives, such as:

(1) EU and Member States funding for RTD&D projects to promote the deployment of alternative fuels infrastructure;

(2) Allocation of state aid on individual basis for the construction of alternative fuels infrastructure;

(3) Use of existing European funding schemes (Cohesion and TEN-T funding) and of EIB loans.

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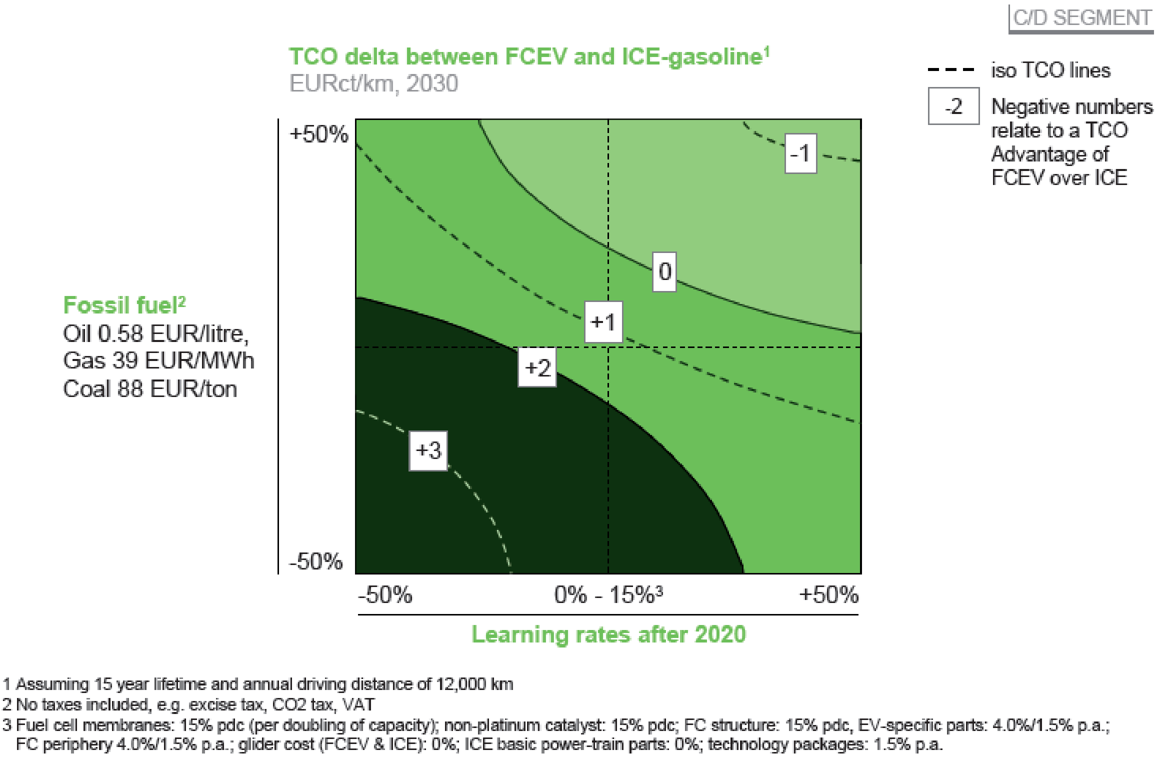
[105] Planned and proposed infrastructure to be achieved by 2015 is not considered as additional investment for the description of Policy Option 1.

103. According to economic modelling presented in Appendix 10, the oil price is foreseen to substantially increase in the coming decades. This will heavily influence future consumption trends, by incentivising a shift away from the use of oil in transportation. As demonstrated on Figure 8, with the increase of the oil price, alternative fuel technologies will become more attractive and cost-competitive with conventional technologies.

Figure 8: The influence of oil price on the cost competitiveness of FCEVs[106]



104. However, despite existing initiatives (and the resulting developments in technology) and projected increase in oil prices, the share of alternative fuels in the energy consumption of passenger cars and vans is expected to remain less than 10% by 2050 without further action on infrastructure. LNG and CNG would also not make significant inroads in road transport and the same would also happen with LNG for waterborne transport due to the lack of refuelling infrastructure.

4.2.2. Policy Option 2

(pre-screened FC16)

105. The EU will issue recommendations to ensure the application of standards developed by international and European organisations concerning alternative fuels infrastructure. At the same it will issue recommendations setting out basic criteria

106 Source: Idem footnote 76. Exhibit 12 "*All conclusions are robust to significant variations in learning rates and the cost of fossil fuels*", available at: http://ec.europa.eu/research/fch/pdf/a_portfolio_of_power_trains_for_europe_a_fact_based__analysis.pdf

and indicative targets[107] for the deployment of infrastructure for electricity, hydrogen and natural gas (LNG and CNG), addressed to Member States.

4.2.3. Policy Option 3

(pre-screened Fuel Package III)

106. The EU will set out essential or specific requirements for alternative fuels infrastructure for Member States. At the same time it will set out basic criteria for minimum infrastructure coverage, together with binding targets[108] for the technologically most mature fuel technologies (electricity, and LNG for waterborne transport), addressed to Member States. For the remaining fuels (hydrogen and natural gas (LNG and CNG) for road transport), the targets would remain indicative[109].

4.2.4. Policy Option 4

(pre-screened FC40)

107. The EU will set out essential or specific requirements for alternative fuels infrastructure for Member States. At the same time it will set out basic criteria for minimum infrastructure coverage, together with binding targets[110] for the electricity, hydrogen and natural gas (LNG and CNG) in road and LNG in waterborne transport, addressed to Member States.

4.2.5. Summary overview of policy options

108. The possible legislative formulations under the various policy options are provided in Appendix 8.

109. It should be noted that EU legislation would not specify further requirements beyond the number and the minimum technical standards for the recharging/refuelling points. Member States authorities would thus have responsibility for deciding on the regulatory framework, territorial localisation, and other implementation measures, in line with the principle of subsidiarity.

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[107] The formulation of these targets could be similar to Article 3 (1) of Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport: "(a) Member States should ensure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and, to that effect, shall set national indicative targets. […]" Source: OJ L 123 17.5.2003, p.42

[108] The formulation of these targets could be similar to Article 3(4) of Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC: "Each Member State shall ensure that the share of energy from renewable sources in all forms of transport in 2020 is at least 10 % of the final consumption of energy in transport in that Member State. […]" Source: OJ L 140 5.6.2009, p.16

[109] Idem footnote 107.

[110] Idem footnote 108.

Table 7: Detailed content of Policy Options 2, 3 and 4

Problem and drivers	General and specific objectives	Policy Option 2				Policy Option 3				Policy Option 4			
Fuels		Electricity	Hydrogen	Natural Gas		Electricity	Hydrogen	Natural Gas		Electricity	Hydrogen	Natural Gas	
Vehicle segments				LNG Vessels	LNG and CNG vehicles			LNG Vessels	LNG and CNG vehicles			LNG Vessels	LNG and CNG vehicles
Insufficient infrastructure network for selected alternative fuels	**Provide sufficient infrastructure network for alternative fuels supply enabling market take-up**												
Lack of EU-wide implementation of common standards for alternative fuel recharging and refuelling	Ensure EU-wide implementation of common standards to avoid risk of deployment of different standards and non-interoperable equipment	Recommend technical requirements for charging points	Recommend technical requirements for fuelling stations	Recommend technical requirements for fuelling stations	Recommend technical requirements for fuelling stations (LNG and CNG)	Mandate technical requirements for charging points	Mandate technical requirements for fuelling stations	Mandate technical requirements for fuelling stations	Mandate technical requirements for fuelling stations (LNG and CNG)	Mandate technical requirements for charging points	Mandate technical requirements for fuelling stations	Mandate technical requirements for fuelling stations	Mandate technical requirements for fuelling stations (LNG and CNG)
Missing business case for infrastructure providers: coordination failure among the complementary market actors ('chicken and egg' issue)	Trigger coordinated commitment at national, regional and local levels, and thereby enhance investment certainty	Recommend quantity requirements for charging points	Recommend quantity requirements for fuelling stations	Recommend quantity requirements for fuelling stations	Recommend quantity requirements for fuelling stations (LNG and CNG)	Mandate quantity requirements for charging points	Recommend quantity requirements for fuelling stations	Mandate quantity requirements for fuelling stations	Recommend quantity requirements for fuelling stations (LNG and CNG)	Mandate quantity requirements for charging points	Mandate quantity requirements for fuelling stations	Mandate quantity requirements for fuelling stations	Mandate quantity requirements for fuelling stations (LNG and CNG)

5. IMPACT ANALYSIS OF POLICY OPTIONS

110. This section provides an assessment of the economic, social and environmental impacts supported by modelling results[111], previous studies and/or by academic research where possible.

111. As highlighted in Section 3, promoting the deployment of recharging/refuelling infrastructure addresses only one of the various market failures that prevent efficient technological choices and the market up-take of alternative fuel vehicles and vessels. In other words, the Policy Options under consideration aim to provide the fulfilment of one fundamental condition for such market up-take, but cannot ensure it without the concourse of the other initiatives that are part of the overall strategy.

112. This circumstance complicates the analysis. For this reason, the assessment is based, on the one hand, on modelling results that try to quantify the 'direct' or 'stand-alone' benefits of the policy proposal, and, on the other hand, on evidence from other studies on the wider impact of the proposal, when it is seen in combination with other existing and forthcoming initiatives to promote alternative fuel vehicles.

113. The 'stand-alone' impact is assessed through modelling the effects of providing harmonised technical standards for infrastructure and of deploying a recharging/refuelling network that is denser then in a baseline projection. More specifically, the benefit of the initiative is quantified by looking at the extra utility that it brings to vehicle users[112] with respect to baseline developments.

114. In fact – since it can be argued that an equivalent monetary incentive would have to be provided to potential vehicle buyers to compensate for has more limited recharging possibilities – the model simulations implicitly compare the option of investing in infrastructure with that of providing a subsidy to vehicle buyers given a certain sales objective.

115. This approach has the advantage of providing an estimate of the benefits of additional infrastructure with respect to other possible incentive measures that have the same objective. However, it does not gauge the merits of a successful market up-take of vehicles and vessels, since it would be difficult to disentangle the effects of the numerous existing and forthcoming initiatives that pursue this same objective (CO_2 standards, energy taxation, fuel quality, road pricing, etc.).

116. Moreover, modelling is not capable quantifying the greater benefits that are associated with reaching critical mass in demand/production and the subsequent improvement in the competitive position of the European industry on global markets. However, as already demonstrated, baseline developments are unlikely to promote a deployment of alternative fuel vehicles that is in line with critical mass production and sustainable mobility scenarios.

117. That is why, in addition to modelling the direct impacts, reference is also made to the more general benefits of being able to kick-start a process of wide deployment of

[111] Modelling results build primarily on the PRIMES-TREMOVE transport model.

[112] A refuelling/recharging network has a certain utility to vehicles users. This utility is very high when the availability of infrastructure is low: without infrastructure, alternative fuel vehicles would be useless. On the other hand, the utility of infrastructure is marginally decreasing and eventually an extra charging point will not make any significant difference to the user. The relevant evidence can be found in the studies mentioned in footnote 25.

alternative fuel vehicles. These benefits are multiple, and affect the economy (lower operating cost of vehicles, lower cost of oil import, higher competitiveness of car and ship manufacturing industry), and the society (improved public health, more high value-added, high-skill jobs) and the environment (lower emissions of greenhouse gases, noise and local pollutants).

118. For the purposes of this Impact Assessment, and in order to assess the range of impacts for each Policy Option, it is assumed that:

(1) under Policy Option 2, despite the recommendation of the Commission on the application of certain standards concerning alternative fuels infrastructure, some Member States will decide to follow their own, dissimilar national rules[113];

(2) under Policy Options 3 and 4, the Commission would set out mandatory essential or specific requirements in its proposal for a Directive.

119. In order to better identify the range of likely costs and benefits of indicative and binding targets on deploying the minimum infrastructure network for electricity, hydrogen and natural gas (LNG and CNG), for the purposes of this Impact Assessment, it is assumed that:

(1) under Policy Option 2, only partial deployment of sufficient EV charging infrastructure and LNG infrastructure for vessels will take place; and there will be no deployment of hydrogen infrastructure, LNG infrastructure for trucks and CNG infrastructure for vehicles.

(2) under Policy Option 3, full deployment of sufficient EV charging infrastructure and LNG infrastructure for vessels will take place; and there will be no deployment of hydrogen infrastructure, and LNG infrastructure for trucks and CNG infrastructure for vehicles.

(3) under Policy Option 4, full deployment of sufficient infrastructure for electricity, hydrogen, LNG for trucks and vessels and CNG for road transport vehicles will be achieved.

120. The assumption on the insufficient deployment of infrastructure under Policy Option 2 needs further qualification. As already indicated, many Member States have ambitious plans for alternative fuel, in particular electric, vehicles which would go beyond the objectives of the present initiative. These plans, however, will inevitably be influenced by market developments, as an insufficient response from consumers and investors would oblige Member States to step up incentives and rely more on

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113 *"Internationally uniform standards can only be effective if there is correspondingly harmonized government regulation. Coordination processes in standardization will reach their limits if countries adopt regulations that counteract harmonization because of diverging industry policy interests. There is currently a need for action with regard to reaching agreement on a uniform charging infrastructure, which will have a significant impact on the customer uptake of electric vehicles. There is a pressing need for the harmonization of national regulations in favour of pan-European and international solutions."* Source: Second Report of the National Platform for Electromobility, published on 20 Jun 2012, is available at: http://www.bmvbs.de/cae/servlet/contentblob/86656/publicationFile/59036/electric-mobility-second-report-national-platform.pdf

public resources for the necessary infrastructure investments. There is therefore a risk that these plans are significantly revised[114].

121. As argued in Section 2.3.2 “Overall assessment”, the deadlock between the various market players needs to be removed to trigger widespread adoption of clean vehicles and vessels. This can only be done if there is a credible commitment, which Member States’ plans, voluntary industry agreements and EU recommendations might not be sufficient in providing. Indeed, market participants are aware of past non-binding initiatives in this field that failed to produce the intended result. The example of the Biofuels Directive[115] and of the 1995 strategy for reducing CO_2 emissions from light duty vehicles[116] can be quoted in this respect.

5.1. Economic impacts

122. This part assesses the economic impacts of the various policy options looking first (Section 5.1.1) at the ‘stand-alone’ costs and benefits of the deployment of infrastructure according to the methodology described in §112-119. It then assesses the macroeconomic impacts (Section 5.1.2), as well as those on competitiveness (Section 5.1.3), SMEs (Section 5.1.4), internal market (Section 5.1.5), and on consumers (Section 5.1.6), also by reference to the wider effect of this initiative as part of a strategy for alternative fuels’ developments.

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114 Highlighting the importance of public policy action, Gas Infrastructure Europe stated that "Gas infrastructure investment entails long-lead times and thus requires long-term visibility. A sound investment climate together with a stable and predictable regulatory framework is fundamental for the development of infrastructure".

115 The Biofuels Directive 2003/30/EC established a reference value of a 2% share for biofuels in petrol and diesel consumptions in 2005 and 5.75% in 2010. Member States were required to set indicative targets for 2005, taking this reference value into account. While these targets “constitute a moral commitment on behalf of Member States, there is no legal obligation for them to achieve the levels of biofuel use they have chosen to target.” Regular assessments and reports have been prepared on the EU’s progress towards its 2010 targets and on its efforts in general to develop renewable energy. The reports issued in 2007 as well as the Renewable Energy Roadmap (COM(2006) 845 final) highlighted “*the slow progress Member States were making and the likelihood that the EU as a whole would fail to reach its 2010 target. The Roadmap explained possible reasons for this, which included the merely indicative nature of the national targets and the uncertain investment environment provided by the existing legal framework*.” The Commission therefore proposed a new, more rigorous framework to drive forward the development of renewable energy and more solid, legally binding targets for 2020, as part of the Climate and Renewable Energy Package.

116 The Community strategy for reducing CO_2 emissions from light duty vehicles was based on three pillars, as proposed by the Commission in 1995, and subsequently supported by the Council and European Parliament. This structure allowed for the comprehensive integration of measures addressing both supply (voluntary commitments from the three principal automotive industry associations) and demand (labelling and taxation). In its Communication (COM(2007) 19 final) in 2007 the Commission recognised that the progress achieved so far goes some way towards the 140 g CO_2/km target by 2008/2009, but in the absence of additional measures, the EU objective of 120 g CO_2/km will not be met at a 2012 horizon. “As the voluntary agreement did not succeed, the Commission considers necessary to resort to a legislative approach and underlines that in addition to the proposed legislation urgent action should also be taken by the public authorities”. Mandatory binding CO_2 standards have been since adopted for both passenger cars (in 2009) and vans (in 2011).

5.1.1. Direct costs and benefits of technical standards and infrastructure deployment

5.1.1.1. Impacts associated with standardisation[117]

123. Academic research on different EU Member States agrees on the beneficial overall effects of standards both for companies and sectors as well as the economy. While the specific effects of standardisation for specific sectors of the economy vary according to their characteristics, studies also point out that sectors such as transport and communications services benefit more from standards. The recent Impact Assessment on European Standardisation found that "*In particular, compatibility and interface standards add economic value to goods with network externalities and facilitate the development of networks. Compatibility standards can increase direct network externalities by allowing products to work as part of a system or network. They allow each individual participant in the network to derive benefits from interacting with other participants in the network*".

124. The assessment also highlighted some of the benefits that companies and industries in the European Union derive from standardisation, such as:

125. Cost reduction or cost savings derived mainly from economies of scale, the possibility to anticipate technical requirements, the reduction of transaction costs and the possibility to access standardised components.

126. Improved market access as a result of increased competitiveness due to increased efficiency, reduced trading costs, simplified contractual agreements (because the characteristics and functionalities of the product are clear as a result of the standards) and increased quality.

127. Better relations with suppliers and clients derived from increased safety for consumers, increased trust, reduced liability risk and wider choice of suppliers for the same reasons mentioned above.

128. Optimized returns on investment resulting from the possibility to confront competing possible options for the development of a certain product or technology early in the process and to avoid investments in those that will not be widespread.

129. Concerning possible negative effects of standardisation, first of all, the impact on competition needs to be considered. Standards can have anticompetitive effects unless they are available to all potential innovators and competitors. Second, there are costs associated with retrofitting existing infrastructure. These costs are particularly relevant for electricity, where a higher number of charging points have already been deployed. For hydrogen and natural gas (LNG and CNG) infrastructure, the issue of 'stranded investments', which are not interoperable, and the need to retrofit existing fuelling stations is much less relevant due to the very early stage of their deployment.

[117] Further details of the impacts related to EVs will be provided in the specific impact assessment, led by Directorate-General Enterprise and Industry, into the legislative options and technical modalities, ensuring that practical and satisfactory solutions for the infrastructure side of the interface are implemented throughout the EU. This is in line with the conclusions of the final report of CARS 21 High-Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union. The assessment provided here draws upon the findings of the Impact Assessment accompanying the proposal for Regulation on European Standardisation (SEC(2011) 671).

130. As explained in Section 2.3.1, one of the principal issues hindering the deployment of EV charging infrastructure relates to the lack of decision on the type of socket-outlet (Type 2 or Type 3) to be deployed.

131. Under **Policy Option 1**, the amount of 'sunk' capital investment in various Member States can be calculated using the cost assumption of 520 € per private and 5,280 € per public charging point and the estimates on existing e-mobility points shown in Table 1. By the end of 2012, around 90 million € and 80 million € will have been invested in installing Type 2 sockets and Type 3 sockets, respectively. Considering announced plans of Member States for the deployment of charging infrastructure as shown on Figure 2 (and in Appendix 4), and assuming no change in the preference of Member States regarding the type of socket deployed, an additional 508 million € and 4.1 billion € would be spent by 2020 on installing Type 2 and Type 3 charging points, respectively.

132. On the other hand, the cost of ensuring interoperability of existing infrastructure could be estimated based on information concerning retrofitting costs provided by stakeholders[118]. Assuming adaptation cost of 250 € per private e-mobility point, and of 3,000 € per public charging station, requiring the use of a single type of socket from 2013 onwards could imply 45 – 50 million € total retrofitting costs for the charging infrastructure foreseen by the end of 2012.

133. **Policy Option 2** would almost certainly be sufficient to affect the choices of Member States that have not yet started significantly deploying one or other type of socket. However, it would likely prove ineffective to alter the choice of socket-outlet in many of the countries mentioned in Table 1, who are rather advanced in deployment and would face the difficult trade-off between substantial retrofitting costs (amounting to around half of their total investment costs so far) on the one hand, and lack of interoperability of their charging infrastructure on the other.

134. Under **Policy Options 3 and 4**, Member States would be required to adopt a single type of socket EU-wide, and it would correspondingly necessitate the retrofitting of existing charging points. The cost of these options would be as stated in paragraph 132, while the benefits would be that investments become 'future-proof' against issues of interoperability.

5.1.1.2. Estimated costs of infrastructure deployment

135. This section assesses the costs of deploying a minimum infrastructure network for electricity, hydrogen and natural gas (LNG and CNG) based on the unit cost of a recharging point, refuelling station and bunkering facility as provided by stakeholders, and shown in Appendix 6. The unit cost per smart private charging point can be estimated to be around 520 €; while for a publicly accessible charging point it is approximately 5,280 €. The cost of hydrogen refuelling station is 1.6 million €. The unit cost of a small-scale bunkering facility is 15 million €, the cost estimate used for LNG fuelling station is 400,000 € and the cost estimate for CNG fuelling station is 250,000 €. These costs are high-end estimates, not fully taking into account likely decreases due to learning effects (Table 8).

118 The unit cost per smart private charging point can be estimated to be around 520 €; while for a publicly accessible charging point it is approximately 5,280 €. The cost of hydrogen refuelling station is 1.6 million €. The unit cost of a small-scale bunkering facility is 15 million €, while the cost estimate used for LNG fuelling station is 400,000 €. The estimate retrofitting costs are derived in paragraph 0.

Table 8: Estimated investments costs under each Policy Option[119]

	Number of additional charging points/fuelling stations	Policy Option 2	Policy Option 3	Policy Option 4
	thousands	*Million €*		
Electricity (Total)	**8,000**	**3,984**	**7,968**	**7,968**
of 90% private	7,200	1,872	3,744	3,744
of 10% publicly accessible	800	2,112	4,224	4,224
Hydrogen	**0.077**	**-**	**-**	**123**
LNG for vessels	**0.139**	**1,140**	**2,085**	**2,085**
LNG for trucks	**0.144**	**-**	**-**	**58**
CNG for vehicles	**0.654**	**-**	**-**	**164**
Estimated investment costs of infrastructure deployment		5,124	10,053	10,398
Estimated retrofitting costs		-	45 – 50	90 –100
Estimated total investments costs		**5,124**	**10,103**	**10,498**

136. The breakdown per Member State of the estimated investment costs under Policy Option 4 is provided in

[119] Source: Idem footnote 118.

Table 9 and

Table 10. As further elaborated in Section 5.1.1.3, the choice of who will finally bear these investments costs will depend on the Member State's policy decisions among a large variety of possible measures. These policy decisions will also determine what the precise incentive mechanisms are that will ensure effective delivery of the targets.

Table 9: **Estimated investment costs of recharging points per Member State under Policy Option 4**

MS	Total charging points (thousands)	Publicly accessible charging points (thousands)	Investment cost for publicly accessible charging points (Million €)	Private charging points (thousands)	Investment cost for private charging points (Million €)	Total investment costs (Million €)
BE	207	21	109	186	97	206
BG	69	7	36	62	32	69
CZ	129	13	68	116	60	128
DK	54	5	29	49	25	54
DE	1503	150	794	1353	703	1497
EE	12	1	6	11	6	12
IE	22	2	12	20	10	22
EL	128	13	68	115	60	127
ES	824	82	435	742	386	821
FR	969	97	512	872	453	965
IT	1255	126	663	1130	587	1250
CY	20	2	11	18	9	20
LV	17	2	9	15	8	17
LT	41	4	22	37	19	41
LU	14	1	7	13	7	14
HU	68	7	36	61	32	68
MT	10	1	5	9	5	10
NL	321	32	169	289	150	320
AT	116	12	61	104	54	116
PL	460	46	243	414	215	458
PT	123	12	65	111	58	123
RO	101	10	53	91	47	101
SI	26	3	14	23	12	26
SK	36	4	19	32	17	36
FI	71	7	37	64	33	71
SE	145	15	77	131	68	144
UK	1221	122	645	1099	571	1216
Total	**8000**	**800**	**4224**	**7200**	**3744**	**7968**

Table 10: **Estimated investment costs of LNG, CNG and hydrogen refuelling stations per Member State under Policy Option 4**

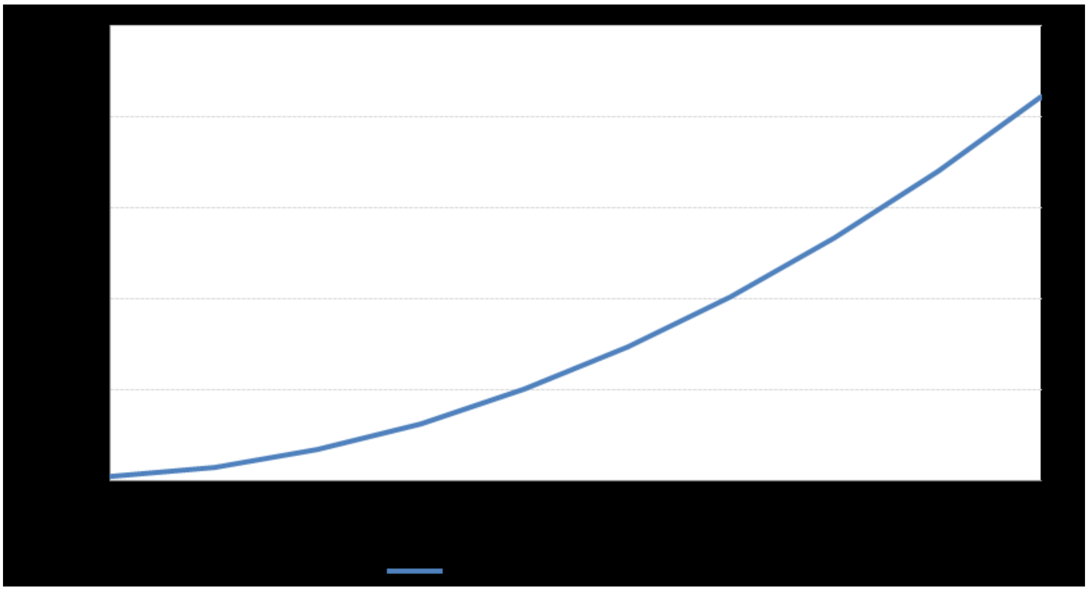
MS	Estimated number of additional LNG bunkering facility in	Estimated number of additional LNG bunkering facility in	Estimated number of additional LNG refuelling points on motorways	Estilared number of additional CNG refuelling points	Estimated number of additional hydrogen refuelling stations	Total estimated investment costs (Million €)
BE	3	6	2	10	3	143
BG	1	2	5	0	0	47
CZ	0	4	4	0	4	68
DK	2		2	20	existing>target	36
DE	5	17	25	0	existing>target	340
EE	1		0	15	0	19
IE	3		3	22	0	52
EL	4		6	40	6	82
ES	10	1	5	90	18	218
FR	7	7	18	105	19	274
IT	12	2	12	0	existing>target	215
CY	1		0	4	0	16
LV	2		4	20	0	37
LT	1		3	21	0	21
LU		1	0	0	0	15
HU		2	4	21	0	37
MT	1		0	1	0	15
NL	3	5	1	0	existing>target	120
AT		2	4	0	4	38
PL	2		15	51	0	49
PT	3		3	23	0	52
RO	2	3	6	44	0	88
SI	1		1	5	existing>target	17
SK		2	3	6	0	33
FI	3		6	60	6	72
SE	5		12	0	17	107
UK	13		0	96	existing>target	219
Total	**85**	**54**	**144**	**654**	**77**	**2,430**

137. Further analysing these costs, it is clear that investment is made most optimally if its profile is gradual and if it is more or less parallel with the vehicle uptake. In fact, using the example of electric vehicle uptake, modelling results show that initial investment costs would amount to around 20 million € in the first year, then 70 million €, and so on, gradually reaching 2.1 bn € by the final year. The net present value of the total investment in charging infrastructure would be 6.1 bn € under **Policy Option 4** (Table 11 and Figure 9).

Table 11: Illustrative investment profile parallel to vehicle uptake under Policy Option 4

	Additional cost of private charging points per year (bn €)	Additional cost of public charging points per year (bn €)	Total investment costs per year (bn €)	Discounted investment costs per year (bn €)
Unit cost	*520*	*5280*		
Discount rate		*4%*		
Year 1	0.01	0.01	0.02	0.02
Year 2	0.03	0.04	0.07	0.07
Year 3	0.08	0.09	0.17	0.16
Year 4	0.15	0.17	0.31	0.28
Year 5	0.24	0.27	0.50	0.43
Year 6	0.34	0.39	0.73	0.60
Year 7	0.47	0.54	1.01	0.80
Year 8	0.63	0.71	1.33	1.01
Year 9	0.80	0.90	1.70	1.24
Year 10	0.99	1.12	2.11	1.48
Total	**3.7**	**4.2**	**8.0**	**6.1**

Figure 9: Illustrative investment profile under Policy Option 4



138. In addition to these costs, there could be possible impacts on the electricity grid. To illustrate these impacts, it can be shown that the simultaneous charging of 100 EVs will generate a peak load of 300 kW, 2000 kW or 17500 kW depending on the recharging form, which would require the installation of 1, 4 or 35 additional transformers and, in the last case, massive distribution network reinforcement[120]. In the case of France, 2 million EVs could, if recharged simultaneously at around 19:00, generate an electricity demand equivalent to 10% of the current peak load, although their annual consumption would only represent 1-2% of total annual electricity

120 GEODE position paper on Electric Vehicles, April 2010.

consumption[121]. On average, the additional distribution grid investment needs could amount, according to estimations by Électricité Réseau Distribution France, to 1 billion € per a million EVs, assuming only less than 10% of fast charging stations.

139. At the same time, Israel Electric Company calculated in 2008 that grid reinforcement costs could go down to less than 200 million € per a million EVs, if managed recharging solutions were chosen. Hence, if infrastructure for EVs allows managed charging, the need to develop the electricity system further to meet this increasing demand will be limited and these vehicles can contribute to the flexibility of the electricity system. Furthermore, controlled charging will mean less need to build additional peak (and expensive) electricity production capacity[122].

140. For these reasons, an additional sensitivity analysis, shown on Table 12, has been carried out on how requirements on private charging points to be smart meters would affect these investment costs. By assuming varying rates (25% to 50%) of deployment of charging points capable of Mode 3 charging[123] instead of 100% as done in Table 8, and taking into account that all public charging points should be smart, the investment costs would decrease by only around 15%.

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121 Assuming no other investments in electricity storage facilities such as stationary electricity storage.

122 A more detailed assessment of the grid-related requirements for the recharging infrastructure has been carried out as part of the Grid-for-Vehicles (G4V) project (http://www.g4v.eu/index.html).

123 Mode 3 charging enables vehicle-to-grid communication.

Table 12: Sensitivity analysis on investments costs regarding smart charging under each Policy Option[124]

	Number of additional charging points/fuelling stations	Cost (high penetration of smart charging)	Cost (medium penetration of smart charging)	Cost (low estimate of smart charging)
	thousands	*million €*		
Electricity				
Total (full deployment)	**8,000**	**7,968**	**7,032**	**6,564**
of 90% private	7,200	3,744	2,808	2,340
of 10% publicly accessible	800	4,224	4,224	4,224
Total (partial deployment)	4,000	3,984	3,516	3,282
Hydrogen	**0.077**	**123**	**123**	**123**
LNG for vessels	**0.139**	**2,085**	**2,085**	**2,085**
Partial deployment	**0.076**	**1,140**	**1,140**	**1,140**
LNG for trucks	**0.144**	**58**	**58**	**58**
CNG for vehicles	**0.654**	**164**	**164**	**164**
Estimated investment costs in PO2		**5,124**	**4,656**	**4,422**
Estimated investment costs in PO3 [125]		**10,053**	**9,117**	**8,649**
Estimated investment costs in PO4 [126]		**10,505**	**9,462**	**8,994**
Cost (high estimate): All EV charging points that count towards the mandated number are capable of Mode 3 charging ("smart charging").				
Cost (medium estimate): Half of private charging points that count towards the mandated number are capable of Mode 3 charging ("smart charging").				
Cost (low estimate): 25% private charging points that count towards the mandated number are capable of Mode 3 charging ("smart charging").				

141. With respect to the interaction of LNG bunkering facilities and the existing gas infrastructure, it is assumed that there is little interaction. Only at LNG regasification terminals, which are built to feed natural gas into the transmission network and could in the future also provide refuelling services to ships, may there be an impact on the gas network. However, as quantities of LNG for shipping will be relatively small compared to the overall gas market in the EU to have an impact on the price. At the same time, they may make investments in LNG regasification terminals more profitable for project developers that do not only gasify LNG for inland consumption, but also sell LNG as a transport fuel. Therefore, it is assumed that, as

124 The unit cost per smart private charging point can be estimated to be around 520 €; while for a publicly accessible charging point it is approximately 5,280 €. The unit cost assumed per non-smart private charging point is € 260.

125 Estimated retrofitting costs to be added € 45-50 million.

126 Estimated retrofitting costs to be added € 90-100 million.

demand for LNG as fuel increases, LNG regasification terminals can satisfy the increased demand for LNG without impacting the operation of the gas network.

5.1.1.3. Source of funding for infrastructure deployment

142. The recommendation/mandate addressing problem driver 2 ("Investment uncertainty hinders the deployment of recharging/refuelling infrastructure for electricity, hydrogen and natural gas (LNG and CNG)") and calling for a minimum number of recharging/refuelling points could be implemented in various ways by Member States. While there will be no implication for the EU budget, national budgets may be affected depending on the specific measures chosen by the Member States.

143. Member States could ensure implementation and thereby compliance through a variety of measures, without necessarily involving public spending. In addition to the measures described in Appendix 9, the following examples reflect some of the initiatives already taken by national or local authorities:

144. Minimum requirements in building codes: national law could require a minimum percentage of individual parking places to be equipped with independent electric lines. The obligation could concern all new buildings and gradually extend to existing buildings, notably office and business premises[127].

145. Obligations on DSOs to build-up the recharging points required by authorities

146. Conditions for parking lots permits: the authorisation to open/operate parking lots in public venues (shopping malls, governmental facilities, airports, restaurants, cinemas, hotels, major retail outlets) could be made conditional on the installation of a minimum percentage of charging stations.

147. Schemes that certify the environmental performance of businesses could acknowledge and promote the installation of charging points open to employees/customer.

148. Joint investments between port authorities and port terminal operators for the provision of LNG terminals.

149. Building companies, concession holders, and other operators facing obligations to provide recharging/refuelling points would likely pass (part of) the costs onto consumers; however these users would still face lower operating costs for their vehicles, than those relying on conventionally fuelled cars[128] and ships.

150. Electric utilities, carmakers and mobility service providers would also have an interest in investing in charging stations. For electric utilities, in particular, electromobility does not only have the advantage of additional demand, but also the benefits of peak-load control highlighted in §139[129].

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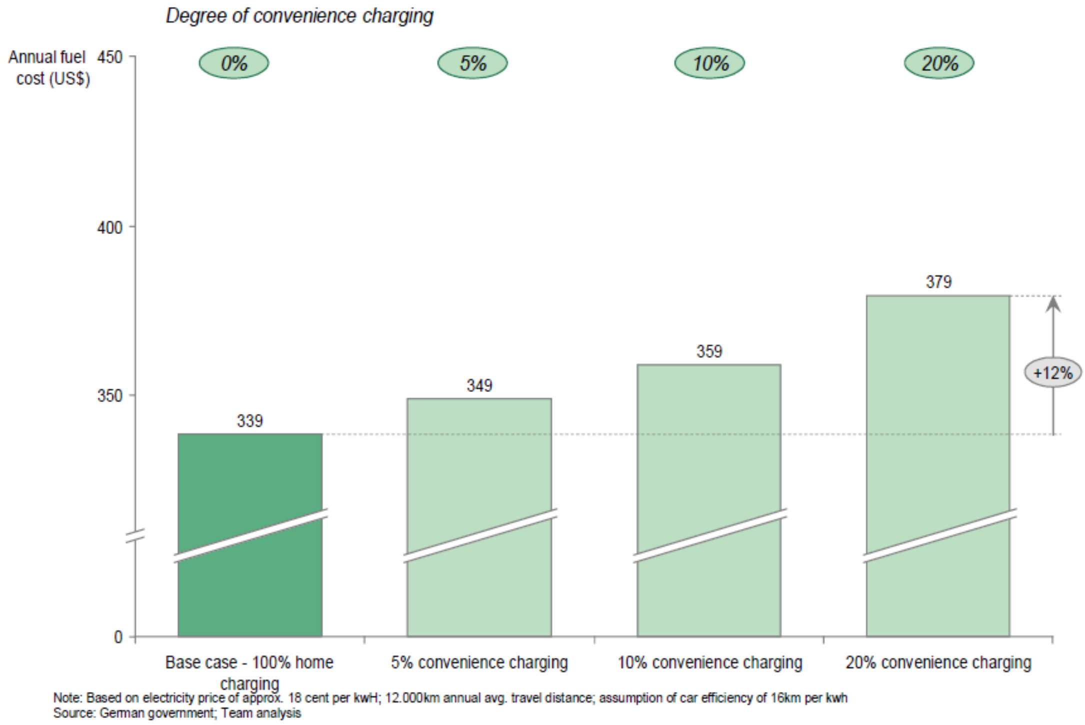
127 In France, the national target of 4.4 million charging points supported by a national law adopted in 2011. The national law (JORF n°0172 du 27 juillet 2011 Texte n°11: Décret 2011- 873 du 25 juillet 2011) requires 10% of existing individual parking to be equipped with independent electric lines to low charging points in new buildings from January 2012 and in existing buildings from January 2015.

128 See for example the calculation of energy costs on a fuel-tax parity basis provided in Figure 4.2A.7 in EUROPIA White Paper on Fuelling EU Transport, available at: http://www.europia20years.eu/uploads/Europia_White_paper/

129 Electric vehicles have the advantage of an on-board storage system and therefore the possibility to adapt their charging schedule to demand and supply conditions.

151. Partnerships for demonstration projects between utilities and vehicle manufacturers are already present in many Member States. Typically, the customer has to pay a fee for using the charging service that often exceeds the electricity cost by a mark-up, and these enable the investor to recover the cost of the installation[130]. As shown on Figure 10, the impact of these additional costs on total fuel costs is limited. Other business models foresee access to charging stations as part of a package that includes the purchase or lease of an electric vehicle, or is granted choice of an electricity provider[131].

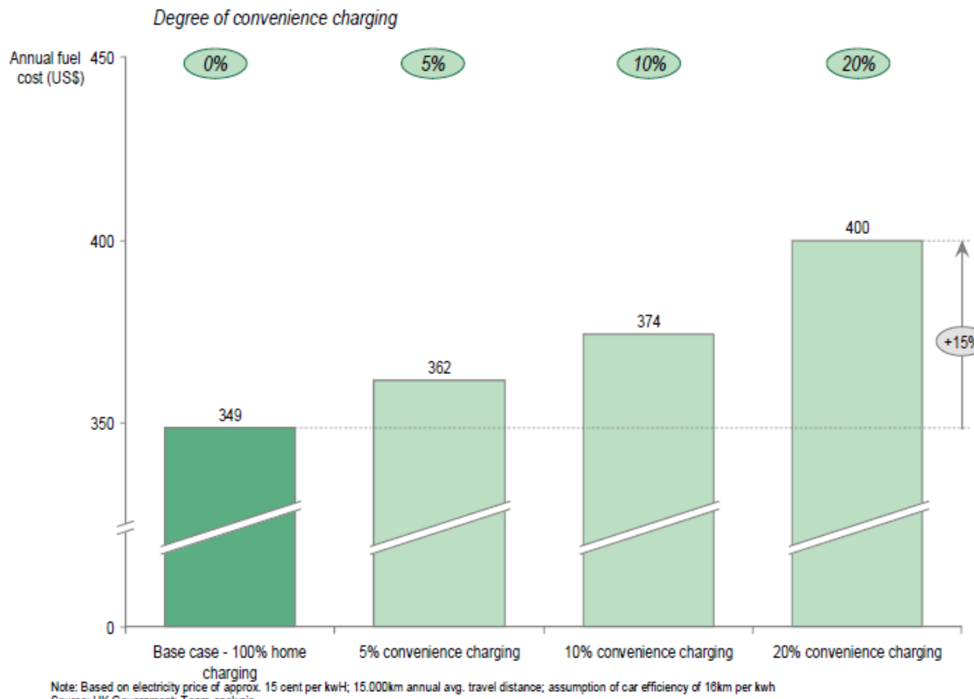
Figure 10: Impact of using public charging points applying a mark-up on electricity price on total fuel cost of end-users – example of Berlin and London[132]



130 Assuming a utilization of 205, which means that each charging station is used at least approx.. 5 hours per day, approx.. a 50% mark-up over private household electricity prices is required to achieve positive returns. Source: Idem footnote 66.

131 See for example Ecotricity UK, http://www.ecotricity.co.uk/for-the-road/frequently-asked-questions

132 Figure 3.2.2.2 in source shown in footnote 66.



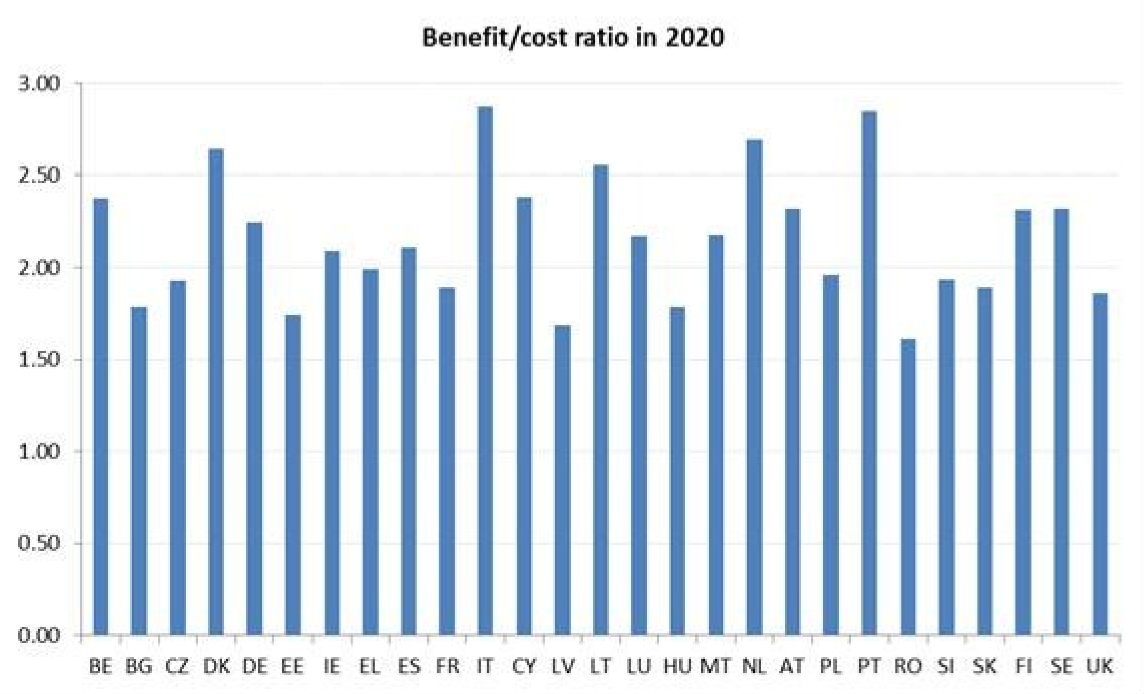
Note: Based on electricity price of approx. 15 cent per kwH; 15.000km annual avg. travel distance; assumption of car efficiency of 16km per kwh
Source: UK Government; Team analysis

5.1.1.4. Cost/benefit analysis of infrastructure deployment

152. The costs shown on Table 8 and on Table 12 need to be compared to the benefits of deploying this minimum network of alternative fuels infrastructure. For this purpose, the approach described in §120-130 and in Appendix 10 has been used.

153. The results of this cost-benefit analysis are shown on Figure 11. This limited approach does not take into account the benefits of reduced oil dependency, increased competitiveness and better functioning of the internal market. Nonetheless, even under the policy option that implies the most extensive deployment of alternatives fuels infrastructure (**Policy Option 4**), comparing the benefits of choosing deployment of infrastructure to the costs of other possible policies that can address the existing disutility of alternative fuel vehicles and vessels results in higher than 1.5 ratios in all Member States.

Figure 11: Indicative benefit-to-cost ratios across Member States[133]



5.1.2. Macroeconomic impacts

154. Under **Policy Option 1**, the pace of electrification in the transport sector is projected to remain slow: electric propulsion in road transport does not make significant inroads by 2050. As a consequence, the EU transport system would remain extremely dependent on the use of fossil fuels. Oil products would still represent 90% of the EU transport sector needs in 2030 and 89% in 2050.

155. **Policy Option 2, 3 and 4**, open up the possibility for an alternative path for the transport system with much faster deployment of alternative fuels. The main macroeconomic effect would be on reduced oil consumption and avoided fuel expenditure. The impact of this reduced fuel expenditure depends on the alternative use of these resources. Part of the savings would have to finance investment in fuel infrastructure and in the extra cost alternative fuel vehicles, which remain more expensive than the conventional models. Expenditure in infrastructure would benefit activity through the multiplier effect, whereas the expenditure for vehicles will benefit EU economy in proportion to the EU manufacturers' market share in those vehicles. Some macroeconomic effects can also be expected as a result of lower operating costs of vehicles for businesses and consumers.

156. The modelling analysis carried out for the White Paper showed that as a result of the implementation of policy measures presented, final consumption of oil by transport is expected to decrease by about 70% by 2050, relative to business-as-usual. Based on the results of economic modelling undertaken for the purposes of this Impact Assessment, described in detail in Appendix 10, avoided fuel use increases progressively over the decades 2010-2030 from about 610 million € per year in 2020 to about 2.3 bn € per year in 2030 under **Policy Option 2**, 1.7 bn € per year in 2020 to 4.6 bn € per year in 2030 under **Policy Option 3**, and 4.2 bn € per year in 2020 to 9.3 bn € per year in 2030 under **Policy Option 4**.

[133] Results of PRIMES-TREMOVE model.

157. In addition, it is possible to estimate the economic benefits of improved energy security by calculating the cost of achieving a similar improvement in energy security through the establishment of a (additional) strategic stock of oil. The Joint Research Centre estimated this cost to be about 130 € per tonne of oil equivalent (upper bound value). Based on this, the estimated aggregate energy security benefit increases gradually over the decades 2010-2030 from 150 million € per year in 2020 to 460 million € per year in 2030 under **Policy Option 2**, 410 million € per year in 2020 to 915 million € per year in 2030 under **Policy Option 3**, and 1.04 bn € per year in 2020 to 1.9 bn € per year in 2030 under **Policy Option 4**.

158. The main difference between **Policy Option 2 and 3** consists in the different probability of achieving the same results through recommendations or mandates: Policy Option 2 is considered much less effective on the basis of the arguments presented in §120-121. Similarly, the difference between **Policy Option 3 and 4** is the smaller likelihood of deployment of a hydrogen refuelling network in Policy Option 3 as well as for LNG for trucks and CNG for road ranspor vehicles: the macroeconomic impact could be significant if these technologies gains market acceptance, although this is subject to greater uncertainty than the case of electricity and LNG for vessels. The high potential gains should however be assessed against the relatively small investment costs (123 million €).

5.1.3. Impact on competitiveness

159. This section identifies the potential impacts of Policy Options 1-4 on the competitiveness of European manufacturers of alternative fuels infrastructure equipment, and of manufacturers of alternative fuel vehicles and vessels (hereinafter "manufacturers"), in terms of unit costs and pace of technological development in comparison to their global competitors.

160. The European automotive industry is a key industrial sector with a turnover of over €780 billion[134] and representing about 8% of European manufacturing value added. According to data from 2007, EU car makers hold around 27% of global market share, but there are concerns on the ability to maintain this position in new vehicle technologies[135].

161. Today the world market share of electric, LNG for vessels and trucks and hydrogen vehicles is very limited, with less than a 0.1% of vehicles sold in 2011. Regarding natural gas vehicles; in 2011 there were 15.2 million in the world, representing 1.2% of the total stock. The main markets for electric vehicles are Japan and the United States (Figure 13). However, according to projections by IEA, the sales of electric vehicles alone could reach close to 7 million per year in 2020, 17.7 million in 2025 and 33.3 million in 2030. This represents a sizeable market opportunity for car makers and manufacturers of transport equipment, in particular in the fast growing emerging markets (Figure 12).

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134 SEC(2009) 1111 final, Comission Staff Working Document, European Industry in a Changing World Updated Sectoral Overview 2009.

135 This is supported by the conclusions of a recent study "Competitiveness of EU Automotive Industry in Electric Vehicles" (idem footnote 60): "*European companies have performed well in terms of patent applications in the last few years, which is reflected in the increased public reporting and perception. However, even if this is a noticeable upward trend in Europe, it is doubtful that the European companies will catch up with the Asian companies within a few years*."

Figure 12: EV/PHEV total sales by region through 2020[136]

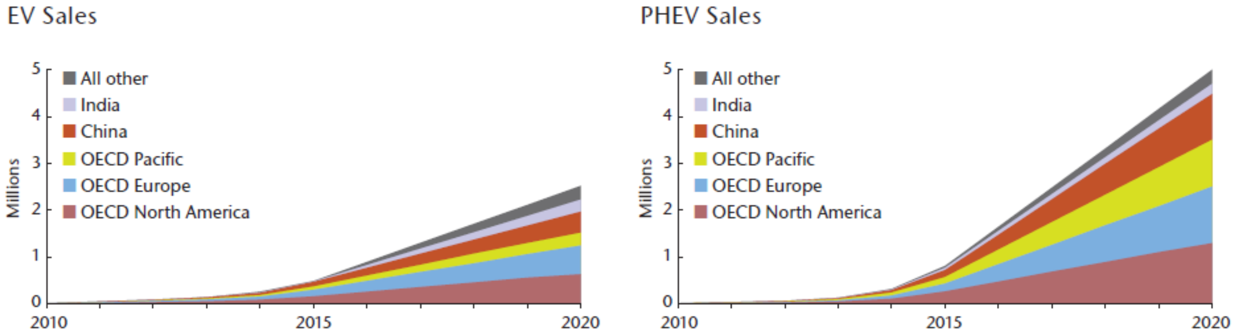
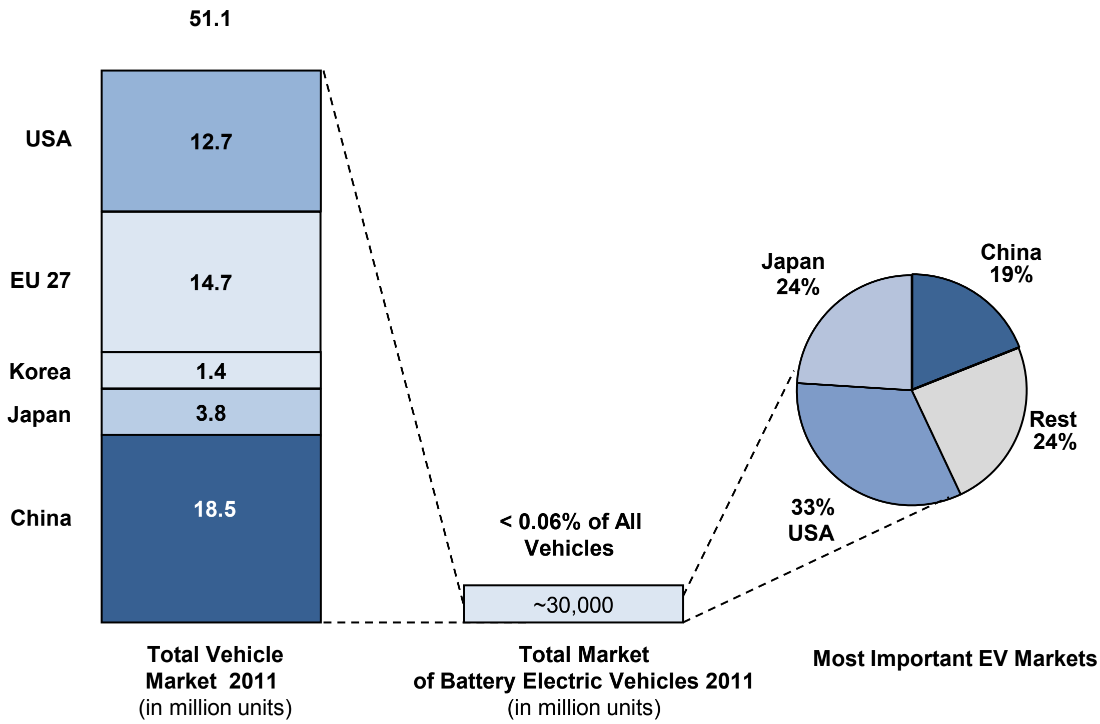


Figure 13: Current Sales of Electric Vehicles[137]



162. Under **Policy Option 1**, manufacturers will be directly affected by the lack of EU-wide application of standards and by the un-coordinated demand for their products, as they will not able to reap the benefits of mass-producing for a single European market, but would need to cater for national requirements. In particular, the learning effects and technology development associated with mass production could be negatively affected. As illustrated on Figure 14, manufacturing rates are an essential

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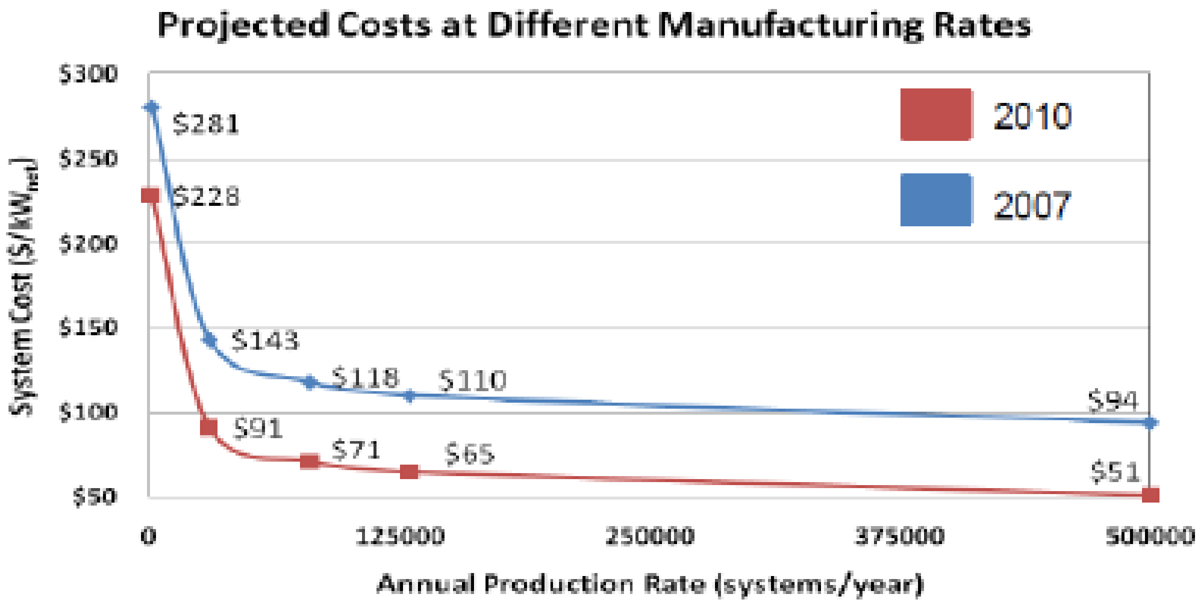
136 Source: Figure 5 in IEA, 2011, Technology Roadmap, Electric and plug-in hybrid electric vehicles, available at: http://www.iea.org/papers/2011/EV_PHEV_Roadmap.pdf

137 Idem footnote 60.

factor in achieving competitive prices of recharging/refuelling equipment, vehicles and vessels.

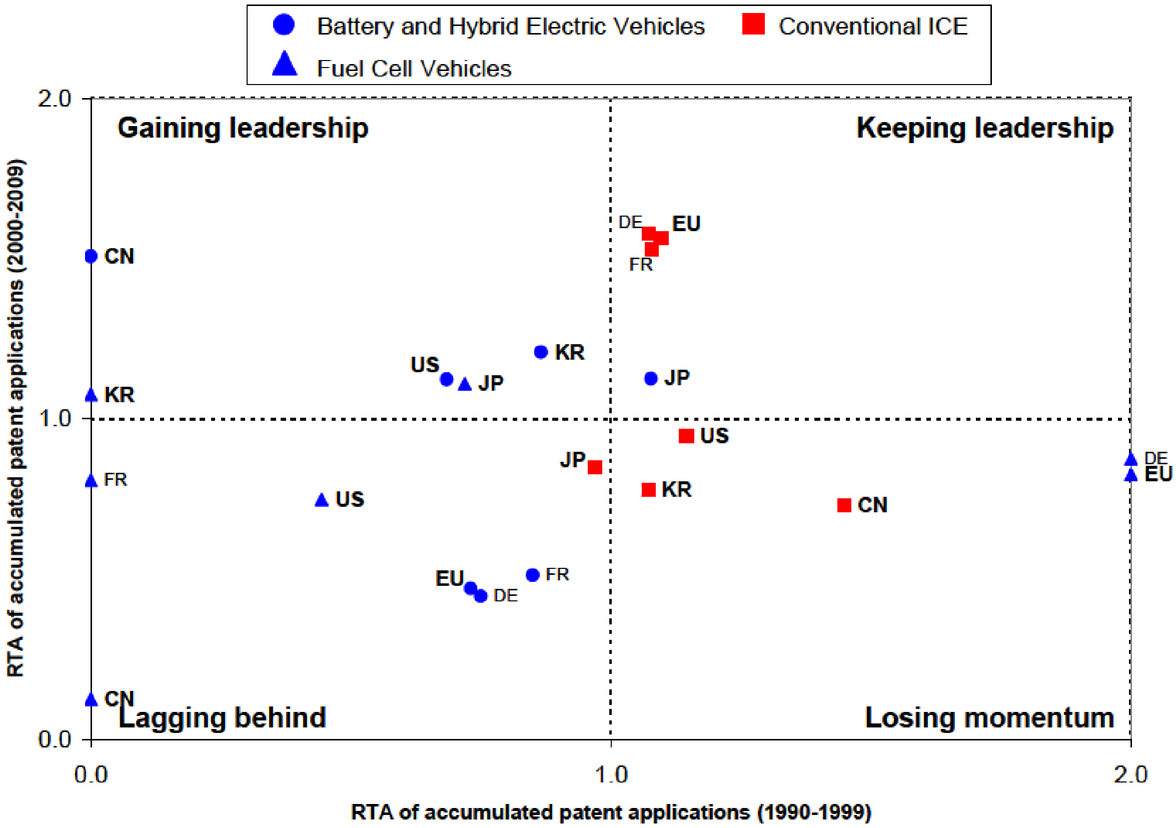
Figure 14: Impact of mass production on unit costs in the case of FCEVs[138]



163. These impacts would disadvantage European firms vis-à-vis those producers that can optimise their production processes due to their presence in large and uniform markets such as United States and Japan. The competitiveness of EU manufacturers would then likely be lower when aiming to enter these or other emerging markets. Currently, an assessment of patent applications shows a very recent catching up of European manufacturers on electric and hybrid vehicles in the EU (Figure 15).

138 Projected costs based on analysis by the United States Department of Energy. Source: United States Department of Energy, 2011, 2010 Fuel Cell Technologies – Market Report, Figure 3, available at http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/2010_market_report.pdf

Figure 15: The dynamics of the Revealed Technological Advantage Index for different technologies for selected car manufacturers[139]



164. Under **Policy Option 2**, the economies of scale that could be achieved by manufacturers would likely be higher, although not corresponding to the whole EU market for reasons explained in paragraph 133. Further benefits could be achieved under **Policy Options 3** for EVs and ships and barges capable of running on LNG and further still under **Policy Option 4**, for the manufacturers supplying FCEVs, LNG trucks and CNG road transport vehicles.

5.1.4. Impact on SMEs and micro-enterprises

165. There is generally limited quantitative evidence on the impact of deploying alternative fuels on SMEs and micro-enterprises. However, these companies dominate the road haulage and the taxi market, which suffer greatly from high oil prices. More generally, SMEs and micro-enterprises are largely present in traditional sectors of activity (retail, personal services, construction and maintenance) for which transport costs typically represent a significant share of overall costs. SMEs and micro-enterprises often have no alternative to the use of personal vehicles and LDV and contrary to large enterprises have more difficulty in optimising logistic costs and finding alternative arrangements for transport. Although the use of alternative fuel vehicles requires a larger initial investment in the vehicle, many studies show that for the high mileage typically associated with professional use, the lower operating costs allow to amortise the extra expenditure on the vehicle in a shorter time period.

139 Source: JRC-IPTS based on the EPO-esp@cenet database for 21 world car manufacturers using a keyword-based search strategy developed by Oltra and Saint Jean (2009), as shown on Figure 7 in Wiesenthal. et al, 2011, Mapping innovation in the European transport sector, available at: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/26129/1/lfna24771enn.pdf

166. A recent paper on the French EV market by the OECD/ITF[140] has found that currently:

(1) The additional consumer cost of a compact or sedan EV is around € 4000-5000 over the vehicles lifetime;

(2) The consumer saving of a compact EV van is around € 4000 compared to a conventional vehicle,

(3) and concluded that "Under these conditions, one might expect that a market already exists for BEV vans if potential buyers have confidence in the advertised driving ranges and dealer support for these vehicles."

167. From this point of view, SMEs and micro enterprises would benefit from the policy proposals since many of them could profit from the reduced operating costs of alternative fuel vehicles. **Policy Option 4** would be the most favourable, although the LNG infrastructure for ships would mainly concern large enterprises and thus provide only a small advantage to SMEs compared to **Policy Option 3**.

168. The proposals, however, do not concern SMEs and micro-enterprises only from a cost reduction perspective. Although the large car and vessels manufacturers are more directly affected, a lot of the components and assisting technologies – such as fuel cells, batteries, power electronics, gas liquefaction technologies, electrolysers for hydrogen production – come from SMEs.

169. Moreover, alternative fuel vehicles have many advantages, but do not exactly reproduce the characteristics of the conventionally powered vehicles. For this reason, their deployment will be associated with new business models and modified behaviour of users. In fact, an alternative *system* of mobility will gradually develop, characterised to a larger extent by multimodality, mobility service providers and IT technologies.

170. SMEs will have many opportunities in a transport system with such characteristics as service providers, software developers and manufacturers of equipment and components; indeed SMEs play an important role in green markets and the related areas of eco-innovation and resource efficiency[141]. Green jobs are mostly created in small and medium enterprises.

171. Whilst eco-innovation is found one of the strongest drivers for growth and value generation of SMEs, uncertain demand from the market is considered by far the largest barrier to an accelerated market uptake, as shown in a recent Eurobarometer poll carried out for DG Environment[142]. The value of the proposals, namely of **Policy Option 3 and 4**, in reducing uncertainty and helping the build-up of new markets with alternative fuel infrastructure would therefore first and foremost benefit to SMEs and create new jobs there.

5.1.5. Impact on functioning of the internal market and market development

172. Imposing technical specifications at an early stage of market development could thwart innovation and act as a barrier to entry for providers having developed

[140] International Transport Forum, 2012, Electric Vehicles Revisited – Costs, Subsidies and Prospects, Discussion Paper 2012-03, available at: http://www.internationaltransportforum.org/jtrc/DiscussionPapers/DP201203.pdf

[141] http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/index_en.htm

[142] http://ec.europa.eu/public_opinion/flash/fl_315_en.pdf

alterative solutions. In a later phase, however, the lack of technical standards could become a serious obstacle to wide acceptance of a product and the reaping of economies of scale; dissimilar national requirements could be used to limit competition[143] on the market for equipment and vehicles, by becoming a barrier to the free movement of goods.

173. In the field of recharging/refuelling infrastructure, the phase of development can be considered completed and the type of technology involved is not particularly sophisticated. Eventually, a standard is likely to be adopted, since the persistence of different technical solutions would represent a serious obstacle to pan-European mobility and would not be tolerable. This however might imply considerable stranded costs and additional expenditure for adaptation if a decision is delayed. This is the likely scenario under **Policy Option 1** (cf. §66-68).

174. Under **Policy Option 2**, the Commission would express its preference for one specific technical standard without imposing it. This is an inferior solution with respect to either **Policy Option 3-4 or Policy Option 1**: if the recommendation is followed, there would be no difference in impact with respect to a mandate, but if the recommendation is not (or only partially) followed the objective would not be reached. Moreover, by recommending a specific solution it would not facilitate any alternative agreement in the industry as theoretically possible under Policy Option 1. In any event, many voices have already been raised in favour of the establishment of standards without any decision being taken: under Policy Option 1 the deadlock is not likely to be broken within the desirable timeframe.

5.1.6. Impact on users of alternative fuel vehicles and vessels

175. The impact on households and non-business users of the various policy options is analogous to the impact on SMEs and micro-enterprises as described in §165-167. Under **Policy Option 1**, users would have more limited possibilities to switch to alternatives fuels in response to soaring gasoline and diesel prices. These alternatives are increasingly expanded under **Policy Option 2, 3 and 4**.

176. **Policy Option 3 and 4** would not only provide a more extended network, but ensure that this network covers all Member States and has the same technical specifications. This would allow wider commercialisation of vehicles with lower production costs to the benefit of users.

177. Ultimately, investors will have to recover the cost of infrastructure and will most likely do it by charging users. Accordingly, Policy Option 3 and 4 imply a 'premium' over Policy Option 1 and 2, for the availability of a wider network. The modelling exercise, however, suggests that this premium is inferior to the additional utility for the users.

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143 This issue has been *inter alia* recognised in Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the interoperability of the rail system within the Community (Recast) in its recitals: "*(7) There are major differences between the national regulations and between internal rules and technical specifications which the railways apply, since they incorporate techniques that are specific to the national industries and prescribe specific dimensions and devices and special characteristics. This situation prevents trains from being able to run without hindrance throughout the Community network. (8) Over the years, this situation has created very close links between the national railway industries and the national railways, to the detriment of the genuine opening-up of markets. In order to enhance their competitiveness at world level, these industries require an open, competitive European market*."

178. An additional advantage to users is related to cross-border mobility. A significant number of cross-border journeys, in particular with holiday purpose, take place every year in the EU. The large majority of them are undertaken using passenger cars[144]. As for road freight, the volume of intra-EU cross-border transport increased from around 1,000 billion tonne km in 1995 to over 1,500 billion tonne km in 2005[145]. Around 10,000 ships are currently used for European Short Sea Shipping. Under Policy Option 1, the possibility of using alternative fuel vehicles and vessels to undertake these trips would be severely limited due to first, the lack of harmonised standards on recharging and refuelling infrastructure; second, the lack of sufficient infrastructure.

179. The various Policy Options would impact the users involved in these cross-border trips differently: Policy Option 2 would enable seamless mobility only across Member States that follow the Commission's recommendations, while under Policy Option 3 the possibility of pan-European mobility would be ensured for all EVs and for all ships and barges using LNG. Policy Option 4 would in addition cater for the users of the main road transport corridors with LNG trucks, it would ensure enough coverage for CNG vehicles, and would also enable cross-border mobility in-between more than 15 Member States that already have hydrogen refuelling stations on their territory.

5.2. Social impacts

180. The assessment of social impacts tries to identify the possible effect of the proposal on four dimensions: employment; workers skills; social cohesion and health.

181. The direct impacts on employment would have to be estimated in the sectors related specifically to alternative fuels infrastructure. However, the main manufacturers of equipment for alternative fuels infrastructure are very large global companies (Siemens AG providing work for 360,000 employees; General Electric, employing more than 280,000 people; ABB with number of employees over 130,000; Schneider Electric, employing some 124,000 people etc), with a complex and wide portfolio of products and services. Due to these characteristics, it is very difficult to determine the number of people employed strictly in relation to the manufacturing of alternative fuels infrastructure. An overview of current employment figures is nonetheless provided in Appendix 11.

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144 Studies, such as Peeters et al, 2004, European tourism, transport and environment, estimate that the car is the most important mode of transport used for tourism within the EU; and that the total number of passenger km related to tourism can represent up to 20% of total passenger transport due to the larger distances covered by these trips. Statistics are only available however for a small number of Member States. For instance in the case of the Netherlands: "*In 2008 the Dutch made 35.9 million holidays, of which 18.4 million, or 51,3%, abroad. In 54% of the holidays abroad, the private car was used, air travel made up 34% of the total, rail 4%, and coach 5% (CBS Statline, website).*" Non-holiday cross-border trips can be estimated to be less than 1% of the trips, less than 160,000 trips a day, 77% of which made on road. Source: Pieters et al, 2012, Cross-border Car Traffic in Dutch Mobility Models, available at: http://www.ejtir.tudelft.nl/issues/2012_02/pdf/2012_02_02.pdf

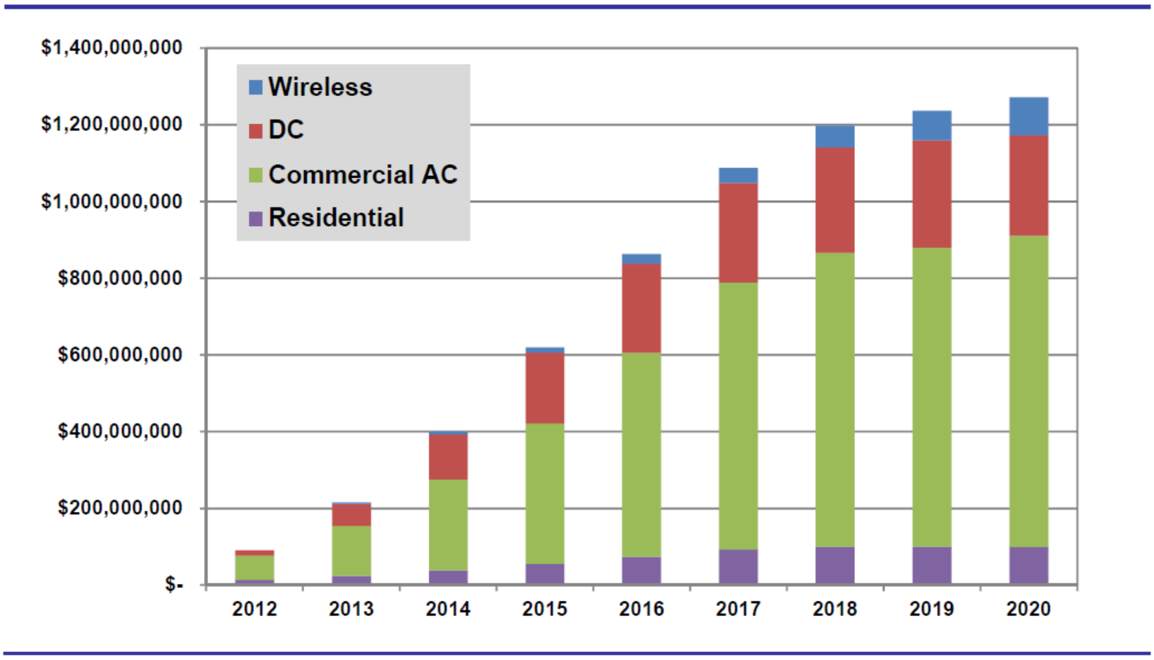
145 GHK and Technopolis, 2007, Evaluation of the Functioning of Regulation (EC) No 2679/98 of 7 December 1998 on the functioning of the Internal Market in relation to the free movement of goods among the Member States, study contarcted by DG Enterprise and Industry, available at: http://ec.europa.eu/enterprise/dg/files/evaluation/regulation_report_en.pdf

5.2.1. Impact on employment levels

182. The procurement of investment goods and services for the build-up of infrastructure for the main alternative fuels would be mostly placed in Europe, given that the EU would be a first mover in alternative fuel infrastructure investments. Most part of the direct economic impact is associated with the creation of income for the sectors directly involved in the infrastructure build-up process, as well as additional employment.

183. Additional employment, with a wide range of job qualifications, will be created for a long period of co-existence of alternative and conventional fuels, through investment into alternative fuel infrastructure sectors, in particular in the areas of construction, manufacturing, electricity, information and communication technology, advanced materials, computer applications. In electricity, e.g. additional employment would mostly come from smart meters maintenance; additional employment in the LNG and CNG supply chain with high technical skills employees. According to recent market research[146], revenues related to EV charging infrastructure alone will grow from 72 million € in 2012 to more than 1 billion € by 2020, assuming the deployment of 4.1 million charging points (Figure 16).

Figure 16: EV charging equipment revenue by segment in Europe[147]



(Source: Pike Research)

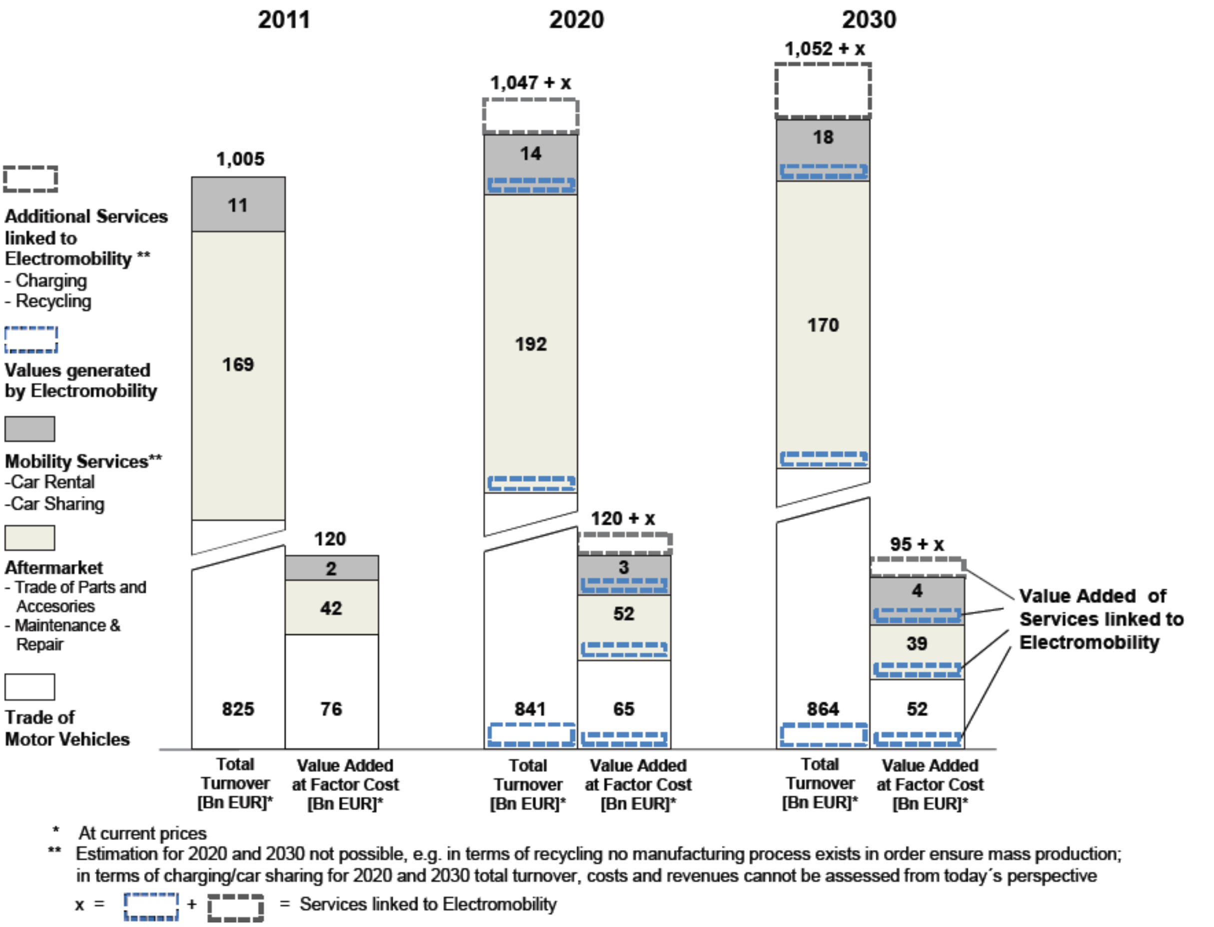
184. The wider impact on employment mirrors that of the economic impacts described in Sections 5.1.3 and 5.1.4. In sectors, such as automotive manufacturing and refining, employment will shift, on the long term, to new qualifications required by the alternative fuel technologies. This will follow the transformation of value added in the different sectors: for instance in the automotive sector, the importance of aftermarket services is foreseen to decrease while that of mobility services to

146 Pike Research, 2012, Electric Vehicle Charging Equipment in Europe.

147 Source: Chart 1.1 as provided in the Executive Summary of Pike Research, 2012, Electric Vehicle Charging Equipment in Europe.

increase (Figure 17). Several reports[148] indicate that a relatively stable core employment in the automotive industry in Europe can be expected with the deployment of EVs. The proximity of markets will be crucial in the selection of the manufacturing location for these vehicles, due to long and costly transport of batteries and finished EVs. Therefore it can be safely assumed, that the majority of vehicle assembly will concentrate in those areas which offer the greatest market demand.

Figure 17: Future shift in value added in automotive services[149]



185. The current decline of refining industry in Europe is related to improving energy efficiency in transport, and consequently less fuel consumption. A gradual market build-up for alternative fuels will, in the short term, not accelerate that development, but rather provide additional investments and employment. It will also prepare smoothly for a shift to alternative fuels, in the long term.

186. Early start of the adaptation of the job market to the new requirements with the support to the market build-up of alternative fuels will give a competitive advantage to Europe.

5.2.2. Impact on skills

187. Particularly the skills of the young professionals, which are needed in the field of R&D of the automotive companies, will need to change significantly. In the future,

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148 Fraunhofer IAO, 2012, Results of ELAB (Elektromobilität und Beschäftigung) Project.

149 Idem footnote 41.

chemists and materials scientists will have significantly higher proportions among the employees than today[150].

188. Almost all manufacturers and suppliers focus on recruiting young professionals from universities, competing for the best graduates. Regarding the access to specialists, the responses of the different experts for the purposes of a recent study[151] undertaken for the Directorate-General Enterprise and Industry, vary considerably. While the large European manufacturers do not anticipate any problems concerning the acquisition and advanced education of employees, the majority of European associations, suppliers, and public policy makers expect a shortage of skilled labour, even in the long run.

5.2.3. Impact on social cohesion

189. Affordable mobility is an important component of social cohesion; currently this is largely dependent on the use of private vehicles. Under **Policy Option 1**, personal mobility by car will encounter increasing difficulties linked to high oil price and to limits to local pollutants and greenhouse gas emissions that will inevitably become more stringent. Whereas greater use of public transport, walking and cycling is advisable, not all situations allow these alternatives.

190. Some of the less affluent parts of society will be particularly penalised by these developments: people leaving in poorly connected areas or not having the means to purchase more modern and performing vehicles. Middle income groups also spend a higher proportion of their income on transport fuel[152].

191. Alternative fuels vehicles will be initially targeted to 'early adopters'[153] which typically belong to high income groups. They will also be a relatively small number up to 2020. Accordingly, **Policy Option 2, 3** and **4**, will not have a significant direct effect on social cohesion. However, in the longer-term, a significant proportion of alternative fuels vehicles can have a dumping effect on the demand, and therefore, on

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150 "*A large spectrum of the surveyed companies plan to expand or maintain their competitive advantages while focusing on R&D and education of their employees. A German automotive premium manufacturer stated that particularly in the area of new distribution channels future competitive advantages can be expected. In this context it will be important to build up new skills and competencies, since electromobility can be associated with a change in consumer behaviour as well as mobility needs. The majority of European suppliers and manufacturers consider the development of electrical, electronic, or carbon technology skills (e.g. lightweight construction) to be most important in securing competitive advantages. Additionally, a German volume manufacturer underlined the importance of skills in relation to new business models (e.g. Connected Cars).*" Source: "Competitiveness of the EU Automotive Industry in Electric Vehicles" Final Report. December 19th of 2012. Framework Contract ENTR/2009/030 (Lot 3). Universität Duisburg Essen

151 Idem footnote 150. **Fehler! Textmarke nicht definiert.**.

152 The middle income quintiles spend a larger share of their incomes on heating and transport fuels combined, while the lower-income households do not tend to own cars (and the high-income households spend relatively less on fuel. *"Focusing on energy products consumed by households, the study shows that expenditure (and taxes) on personal transport fuels constitutes the largest category. Personal transport fuels account for the largest share of total expenditure of middle-income groups or, looking from another perspective, the expenditure of manual workers and the unemployed, followed by the non-manual workers. Conversely, the retired and inactive do not spend that much on mobility*". Source: EEA, 2011 Environmental tax reform in Europe: implications for income distribution

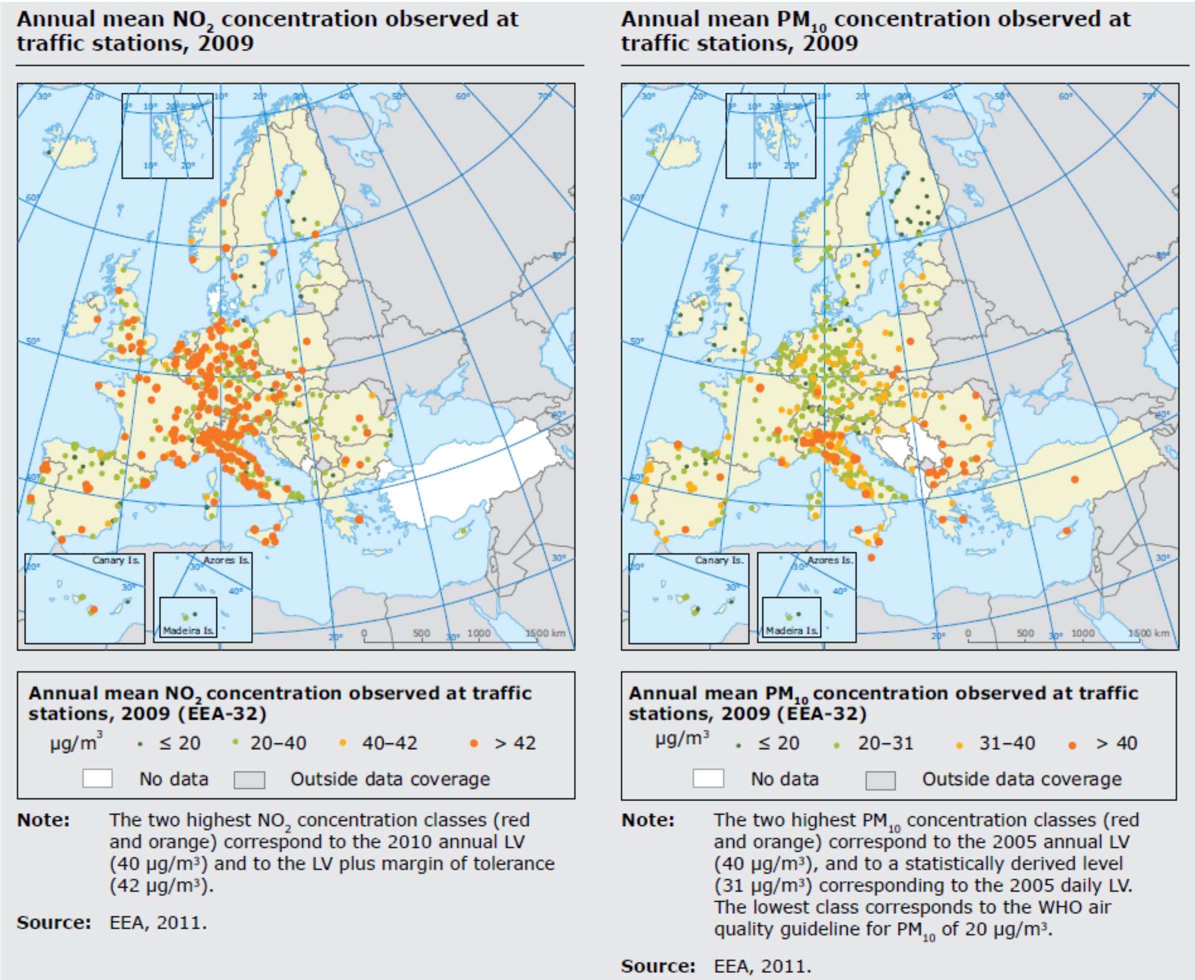
153 As shown for the United States, 'early adopter' consumers have a very distinct profile: they have a much higher-than-average household income, they tend to reside in urban or suburban areas, and nearly 90 % have garages with electricity. Their weekly mileage is low (about 160 km), and they are environmentally sensitive. Source: Deloitte, 2010, Gaining traction A customer view of electric vehicle mass adoption in the U.S. automotive market

the price of oil. Perhaps more importantly, alternative fuel vehicles will be a component of a mobility system which will demand greater complementarity between private vehicles and public transport, and any improvement in the public transport system will contribute to greater social cohesion.

5.2.4. Impact on health

192. Air and noise pollution is a persistent issue affecting the life of millions of European citizens, in particular in urban areas. Despite European legislation setting limit values for pollutants, PM_{10} and NO_2 concentrations regularly exceed those in large areas of Europe (Figure 18). The European Environmental Agency concluded that in 2011, that "*In urban areas, the exceedances of the LVs for PM_{10} and NO_2 imply exposure to concentrations levels which are expected to have adverse effects on human health*".

Figure 18: Exceedances of air quality objectives due to traffic[154]



193. Moreover, in March 2011, a joint assessment carried out by the World Health Organization (WHO) and the Commission's Joint Research Centre found that noise generated by road traffic accounts for at least 1 million healthy life years lost in the Western Europe[155]. Most recently, in June 2012, the International Agency for

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154 Source: Box.2.5 in EEA, 2011, Laying the foundations for greener transport — TERM 2011: transport indicators tracking progress towards environmental targets in Europe, available at: http://www.eea.europa.eu/publications/foundations-for-greener-transport?b_start:int=0

155 WHO/JRC, 2011, Burden of disease from environmental noise. Quantification of healthy life years lost in Europe, available at:

Research on Cancer (IARC), which is part of the WHO, classified "*diesel engine exhaust as carcinogenic to humans (Group 1), based on sufficient evidence that exposure is associated with an increased risk for lung cancer*"[156].

194. Under **Policy Option 1**, economic modelling shows that NO_x emissions and particulate matter would drop by about 20%, and by 37% by 2020, respectively. The increase in traffic would lead to a roughly 8 billion € increase of noise-related external costs by 2020. As demonstrated in detail in the following section on environmental impacts, the deployment of alternative fuel vehicles reduces further these external costs and therefore the impact on health. While **Policy Options 3 and 4** perform better in the reduction of external costs for noise than **Policy Option 2** on the 2020 horizon, the results do not vary greatly among the scenarios. On the other hand, significant differences can be seen among the scenarios for the emissions of pollutants such as NO_x and particulate matter. While under **Policy Option 4**, NOx emissions decrease by 2.8% due to the higher deployment of clean fuels such as CNG in road ransport and LNG in road transport and shipping, this reduction by 2020 is only 2.0% for **Policy Option 3** and 1.4% in **Policy Option 2**. By 2020, the reduction in particulate matter emissions follow a similar pattern to NOx emissions, declining by 2.1% in **Policy Option 4** relative to **Policy Option 1**, by 1.6% in **Policy Option 3** and 0.8% in **Policy Option 2**.

5.3. Environmental impacts

195. There are potentially large environmental benefits of deploying alternative fuels. As these benefits can only be realised if market penetration is achieved, building up sufficient infrastructure as foreseen in the Policy Options is a pre-condition. The potential impacts of deploying vehicles and vessels (on energy use, pollutant and GHG emissions and noise) are assessed below on the basis of modelling results. The full description of the modelling exercise can be found in Appendix 10.

196. Results of three scenarios, corresponding each to the respective Policy Option, are provided in comparison to **Policy Option 1**, in order to illustrate the environmental benefits of action on alternative fuel infrastructure in conjunction with policy intervention on other issues hampering the deployment of alternative fuel vehicles and vessels.

197. The modelling exercise shows that there would be significant environmental impacts in terms of reduced noise, pollutant and CO_2 emissions relative to developments under business-as-usual. Results are shown for these main environmental impacts and for oil consumption. While the focus of the exercise was 2020, modelling results are displayed for three chosen years, 2020, 2030 and 2050, on Figure 19, Figure 20 and Figure 21, respectively.

198. As a result of increased deployment of electric and fuel cell vehicles, including plug-in hybrids, already by 2020, CO_2 emissions decrease by up to 0.3% in **Policy Option 2** and 0.3% in **Policy Option 3** both compared to Policy Option 1. The reduction is marginally higher in Policy Option 3 relative to 4, due to increased emissions from LNG trucks in Policy Option 4 in the medium-run.

http://ec.europa.eu/dgs/jrc/index.cfm?id=1410&obj_id=13090&dt_code=NWS&lang=en

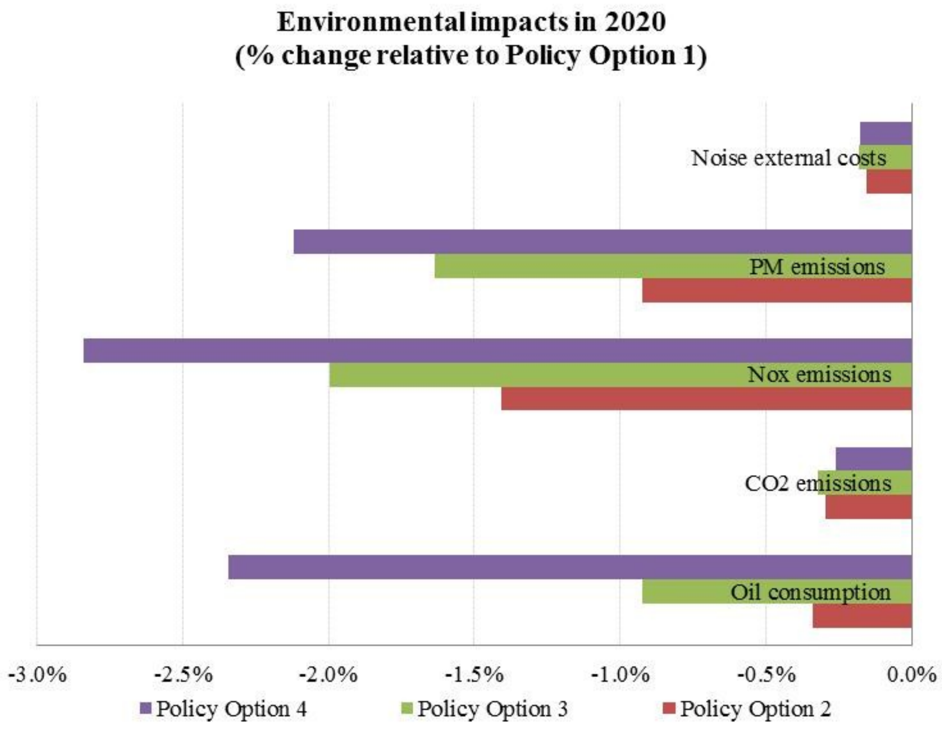
156 WHO, 2012, Press Release N° 213, available at: http://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

199. Under **Policy Option 2**, NO_x emissions decrease by 1.4% by 2020, by 2.0% in Policy Option 3, and in **Policy Option 4** by 2.8%. Particulate matter emissions follow a similar pattern to NO_x emissions. External costs for noise are reduced by about 0.2% in **Policy Options 3 and 4**, and by slightly less than 0.2% under **Policy Option 2** on the 2020 horizon.

200. Oil consumption goes down by about 2.3% by 2020 in **Policy Option 4** relative to **Policy Option 1**, reflecting the highest uptake of alternative fuels, electricity, hydrogen, natural gas (LNG and CNG) among the scenarios. Oil consumption decreases by only 0.3% by 2020 in **Policy Option 2** and about 0.9% in **Policy Option 3**.

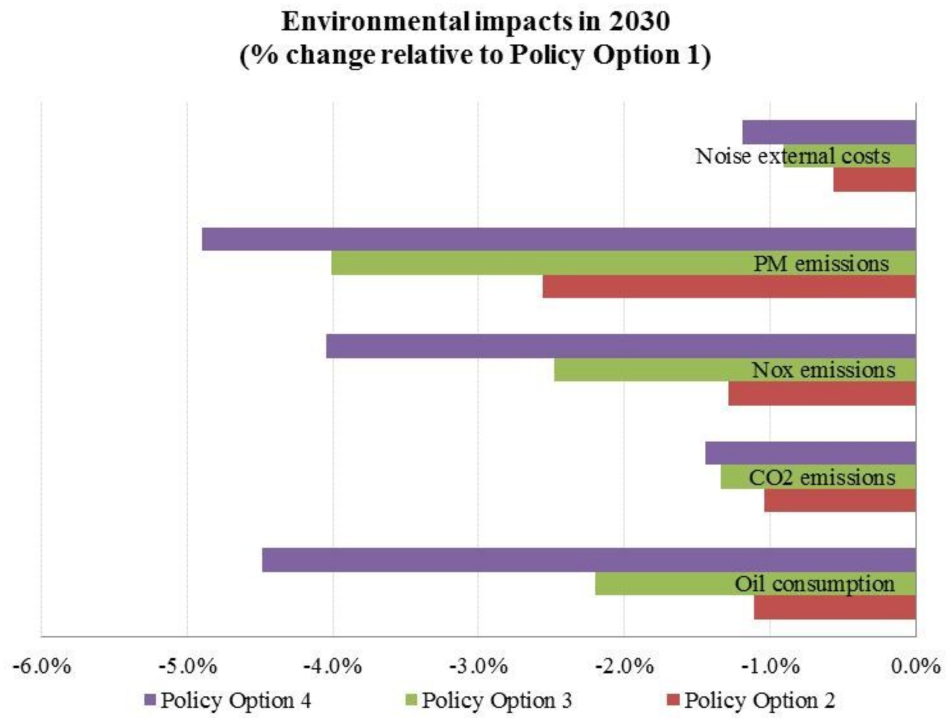
201. Similar reduction patterns among scenarios are shown for 2030 and 2050. However, **Policy Option 4** provides the highest reduction in CO_2 emission (-4.6%) by 2050 relative to **Policy Option 1**, followed by **Policy Option 3** (-3.4%) and **Policy Option 2** (-1.3%). Particulate matter emissions drop by more than 8% by 2050 in **Policy Option 4**, while NO_x emissions by about 6% under the same scenario. The reduction in oil consumption is also highest in **Policy Option 4** by 2050, at more than 8% relative to **Policy Option 1**.

Figure 19: Summary of scenario results for 2020



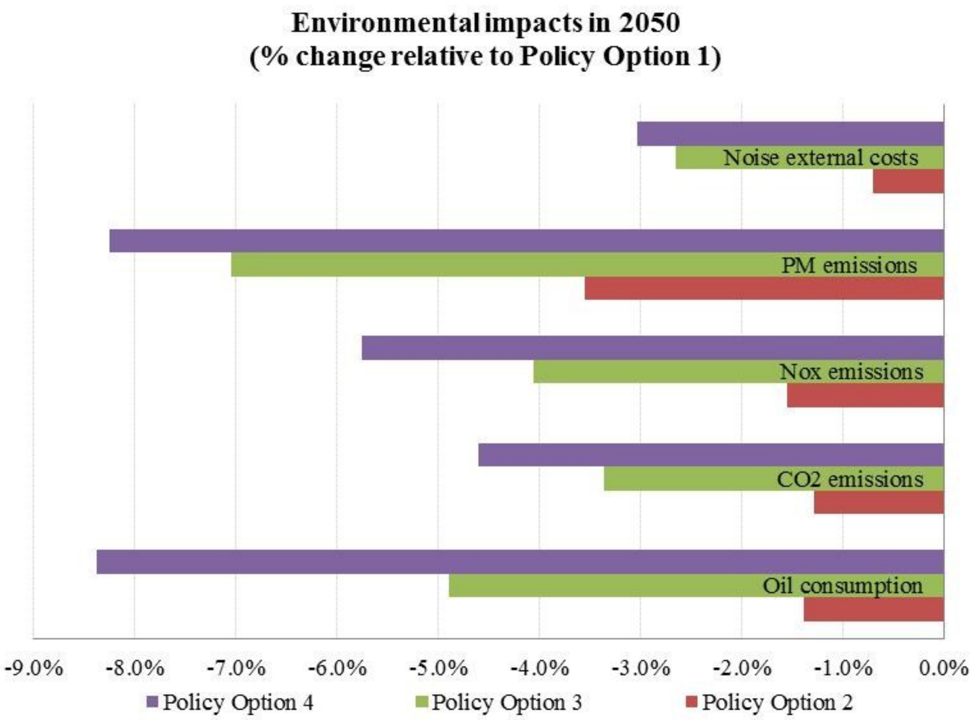
Source: PRIMES-TREMOVE transport model

Figure 20: Summary of scenario results for 2030



Source: PRIMES-TREMOVE transport model

Figure 21: Summary of scenario results for 2050



Source: PRIMES-TREMOVE transport model

5.4. Conclusions

202. This section is based on the comparison of each individual policy option, acting on both problem drivers, to Policy Option 1. The analysis of impacts shows that investing in a minimum recharging/refuelling network is the most efficient way to promote alternative fuel vehicles (Figure 10, Appendix 10). While infrastructure alone has no major direct impact, an intervention on the refuelling/recharging network can have very large and positive effect in combination with other initiatives targeted at the introduction of cleaner vehicles.

203. Under **Policy Option 4**, the benefits in terms of lower oil consumption over the lifetime of the alternative fuel cars, HDVs and vessels whose uptake would be enabled by this minimum network amount to about 84.9 bn € (with corresponding additional energy security benefit of 18.9 bn €), while lower impact on the environment can be monetised to be around 15.4 bn €. Hence, the benefits clearly outweigh the approx. 10 bn € which are needed to put in place the minimum network. Under **Policy Option 3** the corresponding numbers for avoided fuel consumption, the energy security benefits and the reduction in external costs are: 37.7 bn €, 8.3 bn € and 12.5 bn €, respectively. Under **Policy Option 2** the benefits in terms of lower oil consumption amount to 17.5 bn € (with corresponding additional energy security benefit of 3.8 bn €), while lower impact on the environment can be monetised to be around 8.9 bn €.

Table 13: Summary table of impacts

	Policy Option 2	Policy Option 3	Policy Option 4
Economic impacts			
Investment costs	-	--	---
Macroeconomic impacts	+	++	+++
Competitiveness	+	++	+++
SMEs	+	++	++
Internal market	+	++	++
Users	+	++	++
Social impacts			
Employment level	=	=/+	+/++
Skills	+	++	+++
Social cohesion	=	=	=
Health	+	++	+++
Environmental impacts	+	++	+++

Legend:
= baseline or equivalent to Policy Option 1
+ to +++ low to high improvement compared to Policy Option 1
- to - - - low to high worsening compared to Policy Option 1

6. COMPARISON OF THE OPTIONS

204. This section provides for an assessment of how the policy options will contribute to the realization of the policy objectives, as set in Section 3, in light of the following evaluation criteria:

- effectiveness – the extent to which options achieve the objectives of the proposal;
- efficiency – the extent to which objectives can be achieved at least cost;
- coherence – the extent to which policy options are likely to limit trade-offs across the economic, social, and environmental domain.

Effectiveness

205. The objectives set out in Section 3 are fully achieved under **Policy Option 4** for all alternative fuels considered in the IA. **Policy Option 3** differs only in the coverage of fuels, and the objective of enhancing investment certainty would be limited to technologically more mature fuel solutions. **Policy Option 2** has the greatest risk of not satisfactorily delivering on the specific and horizontal objectives, due to the very large margin of discretion left to Member States for implementation of the Commission's recommendations.

Efficiency

206. The least cost can be associated to **Policy Option 2**, which is however a result of lower effectiveness in the achievement of objectives. While the costs of **Policy Option 4** are higher than of **Policy Option 3**, the potential benefits can overweigh this difference, subject to the technological developments.

Coherence

207. **Policy Option 2** would likely result in lower investments at lower overall costs. This outcome would particularly penalise the environmental dimension since the development of clean vehicles would be slower. **Policy Option 3** achieves the most comprehensive limitation of trade-offs across the economic, social and environmental fields, taking into account in particular that large-scale investment is only mandated for technologies that are mature enough to deliver their economic, social and environmental benefits with high certainty. **Policy Option 4** would represent a more risky option, which can be considered to place more emphasis on the environmental dimension with respect to the economic one.

Conclusion

208. The table below summarizes the results of the comparison of policy options in terms of effectiveness, efficiency and coherence based on the assessment provided above.

Table 14: Comparison of Policy Options

	Effectiveness	Efficiency	Coherence
Policy Option 1	no	no	no
Policy Option 2	low	medium	low
Policy Option 3	medium	high	high
Policy Option 4	high	medium	medium

209. In light of the above, Policy Option 2 is discarded, since it compares unfavourably with both Policy Option 3 and Policy Option 4.

210. On the other hand, the assessment of impacts do not point to huge differences between Policy Option 3 and Policy Option 4, and indeed the two options have many elements in common, such as the measures envisaged in relation to the EU-wide implementation of common standards and the deployment of alternative fuel infrastructure for EVs. The preference is given to Policy Option 3 since it appears to better take into account the economic constraints, particularly at a time of crisis.

211. However, Policy Option 4 is not formally discarded as its suitability is mostly influenced by existing technological uncertainties and prospects that can change in the near future with technology progressing rapidly. This would increase the efficiency, which presently is rated medium.

212. The overriding necessity of giving clear signals to the markets, both industry and consumers, would rather give larger political merits to the comprehensive Policy Option 4. If chosen, such a decisive step on EU level could accelerate the market development of alternative fuels in general and ensure that investments have a larger impact on economic growth in Europe.

213. Rapid implementation of the necessary actions, with market comforting targets set for 2020, can also strongly enhance the momentum for the EU 2020 strategy.

7. MONITORING AND EVALUATION

214. The Commission would need to explore the inclusion of some monitoring and reporting requirements on the availability of alternative fuels infrastructure in the legislative proposal, building on existing reporting channels between the Statistical Offices of Member States and Eurostat and carrying out additional information collection through existing Joint Undertakings, Technology Platforms, and expert groups.

215. Internet portals launched by the Commission, such as the Clean Vehicle Portal would be used for data collection and market surveys.

216. The new European Electromobility Observatory, launched by the Commission in 2012 will aggregate data and information on the development of electricity and hydrogen as fuels across the EU and support new policy and market actions on regional and local level.

217. Member States would most likely need to provide the Commission with national plans on the build-up of alternative fuels infrastructure every two years. These reports could *inter alia* include the following information:

- Detailed sales information on alternative fuel vehicles and vessels
- Consumption of alternative fuels, including electricity, hydrogen and natural gas (LNG and CNG) for transport
- Annual progress of the number of each of the concerned alternative fuels infrastructure
- Location and density of these infrastructures

218. The Commission would submit reports on the implementation and impacts of this Directive to the European Parliament and the Council every two years. The report would assess the actions taken by individual Member States and the effects of the Directive, in particular on the market development of the alternative fuels covered by the Directive, and the need for further action.

219. The reports would also review the requirements and the dates in view of the technical, economic and market developments of the respective fuels, and propose adjustments as appropriate.

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9. GLOSSARY

- **Alternative fuels:** fuels such as electricity, hydrogen, biofuels (liquids), synthetic fuels, methane (natural gas (CNG and LNG) and biomethane) and Liquefied Petroleum Gas (LPG) which substitute, at least partly, fossil oil sources in the energy supply to transport, contribute to its decarbonisation and enhance the environmental performance of the transport sector.
- **AC:** Alternative current connector
- **ACEA:** European Automobile Manufacturers' Association
- **CARS21:** Competitive Automotive Regulatory System for the 21st century
- **CEN:** European Committee for Standardization
- **CENELEC:** European Committee for Electro-technical Standardization
- **CHIC:** Clean Hydrogen in European Cities Project
- **CNG:** Compressed Natural Gas
- **DECC**: Department of Energy and Climate Change
- **DSO:** Distribution System Operator
- **E-REV:** Extended-Range Electric Vehicles
- **ETSI:** European Telecommunications Standards Institute
- **EV:** Electric Vehicle
- **FCEV:** Fuel Cell Electric Vehicle
- **GHG:** Greenhouse Gas
- **HDV:** Heavy Duty Vehicle
- **HEV:** Hybrid electric vehicle
- **HICE:** Hydrogen Internal Combustion engine
- **HRS:** Hydrogen Refuelling Station
- **HyTEC:** Hydrogen Transport in European Cities project
- **HDV:** Heavy Duty Vehicle
- **IEA:** International Energy Agency
- **IEC:** International Electro-technical Commission
- **ISO:** international Organization for Standardization
- **IMO**: International Maritime Organization
- **LCV:** Light Commercial Vehicle
- **LDV:** Light Duty Vehicle
- **LNG:** Liquefied Natural Gas
- **LPG:** Liquefied Petroleum Gas
- **MS:** European Union's Member State

- **OCIMF:** Oil Companies International Marine Forum
- **PHEV:** Plug-in Hybrid Electric Vehicle
- **SAE:** Society of Automobile Engineers
- **SECA:** Sulphur Emission Control Area
- **SIGGTO**: Society of International Gas Tanker and Terminal Operators
- **SME:** Small and medium enterprise
- **TEN-T:** Trans-European Network for Transport
- **Type of plug 1:** Single phase vehicle coupler
- **Type of plug 2:** Type 3: Single & three phase vehicle coupler with shutters
- **Type of plug 3:** Single & three phase vehicle coupler with shutters

10. APPENDICES

Appendices 1 to 11 are provided in a separate document.