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The impact of Electrically Chargeable Vehicles on the EU economy

A literature review and assessment

Study prepared for ACEA

FTI CONSULTING

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1. Executive Summary

1.1 Electrically Chargeable Vehicles ("ECVs") include Plug-in hybrids ("PHEVs"), Battery Electric Vehicles ("BEVs") and Hydrogen Fuel-Cell Vehicles ("FCEVs"). ECVs can greatly reduce emissions associated with driving and are capable of being emission free (depending on the sources of electricity and hydrogen they use). As a result, they are expected to play a major part in the EU's decarbonisation efforts.

ECVs depend on subsidies which appear to be less comprehensive in the EU than in other key markets

1.2 Governments around the world have been trying to help overcome the still significant barriers to the widespread uptake of ECVs. These barriers include concerns over recharging and vehicle range, as well as the cost of vehicle which is still around double of comparable vehicles.

1.3 Both China and the US offer a wider range of subsidies and financial incentives to consumers and vehicle manufacturers. The US also provides financial support to infrastructure investors, while in China the government drives the roll-out of charging infrastructure. Currently, the EU only provides financial support to consumers but it has introduced the Clean Power for Transport Directive to develop national policy frameworks to drive market uptake and infrastructure development. Contrary to the US and China, the EU does not provide financial support to vehicle manufacturers.

Uptake of ECVs is slow and the EU is falling behind China

1.4 In the last decade global registrations of ECVs, led by the US, the EU and China, have increased from less than two thousand units in 2005 to over half a million by 2015. Despite accelerating growth in the last 5 years, ECV registrations still accounted for less than 1% of global car registrations in 2015.

1.5 While the US was an early leader in ECV sales, between 2012 and 2014 the EU registered larger numbers of ECVs than both the US and China. China however has seen the fastest growth in the last five years, and in 2015, for the first time, it registered more ECVs than any other country.

There is a very high degree of uncertainty around the future uptake of ECVs in the EU

1.6 We reviewed 7 relatively recent studies which provide forecasts/scenarios for the future uptake of ECVs in the EU. These studies show a very high level of uncertainty around the future market shares of ECVs in new car registrations:

(1) forecasts and scenarios range widely and the disparity increases significantly in later years. For example, the ECV market shares in 2020 range from 0% to 21%. By 2030 this range increases to 6%-43%;

(2) the most optimistic scenarios, especially from earlier studies, are in stark contrast with current, very low market shares;

(3) the most recent studies are less optimistic, with market share scenarios in 2030 ranging from 6% to 25% (compared with 6%-43% for the full sample); and

(4) the least optimistic scenarios can envisage very little ECV market development.

1.7 The large differences across the forecasts/scenarios are driven by assumptions around the evolution of battery costs, charging infrastructure roll-out and intensity of government support. All these factors have a major impact on the take-up of ECVs. For example, the influence of government support has been clearly demonstrated by the collapse of PHEV sales in the Netherlands when company car tax breaks were significantly reduced in 2016.

Studies expecting a positive impact of ECVs on EU employment and GDP rely on some critical assumptions

1.8 The macroeconomic impact on the EU of electric vehicles is likely to be significant. ECVs represent a major change in technology and infrastructure which poses a challenge to EU manufacturers whose technological leadership relates to conventional technologies.

1.9 The majority of studies assessing the impact of ECVs on the EU economy project positive impacts on GDP, employment and trade balance and negative impact on government tax receipts. However, all of these studies rely on some critical assumptions including:

(1) the EU retains its technological leadership;

(2) ECVs are at least as labour intensive as conventional vehicles; and

(3) the value-add of ECVs will be higher than the value-add of conventional technologies.

1.10 At this point, these assumptions appear optimistic. For example, the majority of the value-differential between ECVs and conventional vehicles is accounted for by the battery and in 2014, the EU produced only 6% of the world’s lithium ion batteries. Asian suppliers have also made a head-start in other components of the electric powertrains which are different from conventional technologies. Finally, many sources suggest that conventional technologies are more labour intensive than ECVs.

1.11 In contrast to those studies, a recent analysis prepared on the Future of the Automotive Industry for the German Bundestag has very different assumptions:

(1) ECVs do not have a higher value add than conventional technology; and

(2) in the ambitious ECV scenario German producers lose global market share as they "surrender" in the growth markets, in particular, in China, due to increasing competition.

1.12 In the scenario where ECVs achieve a significant market share, Germany retains a much smaller value of the global car industry than in the scenario where conventional technology continues to dominate. The impact on employment in 2030 can range from a decline of 131,000 to an increase of 267,000 depending on productivity growth, the share of import in the value of ECVs and the share of German OEMs in foreign value-add.

2. Overview of Electrically Chargeable Vehicles

Historical development of drivetrain technologies

2.1 The internal combustion engine ("ICE") is still by far the most dominant drivetrain technology used in vehicles today. However, several other technologies using different fuel sources are being developed.

2.2 The first commercially viable Alternative Fuel Vehicles ("AFVs") emerged in the wake of the oil shocks of 1960s and 1970s,[1] and are still based on combustion. They use Liquefied Natural Gas ("LNG"), Compressed Natural Gas ("CNG"), Liquefied Petroleum Gas ("LPG" or "Autogas"), Biodiesel or Ethanol, and are generally less carbon-intensive and less dependent on petrol and diesel than conventional ICEs.

2.3 Developments in battery technology and fuel cells brought about the second generation of AFVs which began to utilise electricity and are commonly referred to as Electrified Vehicles ("EVs"). Conventional hybrid vehicles ("HEVs"), which include both a conventional engine and a battery powered electric motor, were the first of these technologies to emerge commercially with the launch of the Prius in 1997. They were followed by Plug-in hybrids ("PHEVs"), Battery Electric Vehicles ("BEVs") and Hydrogen Fuel-Cell Vehicles ("FCEVs").

2.4 PHEVs, BEVs and FCEVs are together referred to as Electrically Chargeable Vehicles ("ECVs"). ECVs can greatly reduce the emissions associated with driving, with both electric and hydrogen cars capable of being emission free (depending on the sources of electricity and hydrogen they use).

Technological overview of ECVs

2.5 Electrically chargeable vehicles have three major pieces of additional technology compared with conventional vehicles: an electric motor, a battery, and regenerative brakes.

2.6 The **electric motor** is responsible for putting the electrical energy to work, accelerating the car. It can also be used to produce electricity while the vehicle is decelerating. Electric motors have some advantages over conventional combustion engines. They are more efficient in converting energy into usable power (80% conversion rate for an electrified vehicle compared with around 20% for a conventional vehicle), lower maintenance costs and lower noise levels (at low speeds).

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1 http://www.scientificamerican.com/article/natural-gas-vehicles-could-ease-energy-crisis/

2.7 The **battery** stores the electrical energy, and is generally reliant on Lithium-Ion technology ("Li-ion"). These batteries are heavy, lose maximum charge over time, and are expensive to produce. They are also less energy dense than alternative combustible fuels or hydrogen, and therefore the driving range of battery electric vehicles is usually lower than that of other types of cars. For these reasons batteries have been a major obstacle hindering the development of electric cars.

2.8 Electric vehicles generally all feature **regenerative braking**, which helps keep the battery in electric vehicles charged. In conventional cars, energy is lost as heat to the brake pads when slowing down. Regenerative brakes convert some of this energy to electricity which is then used to charge the battery.

Table 2-1: Technology behind different drivetrains

Drivetrain technology	Internal combustion engine	Electrical motor	Gear box	Exhaust system	Electrical energy source	Recharging technology	Regenerative brakes
Internal combustion engine	Yes	No	Yes, dual clutch or 8-10-speed automatic transmission	Yes	n/a	n/a	No
Plug-in hybrid	Yes	Yes	Yes	Yes	Battery	Regenerative brakes, DC current charger	Yes
Battery electric vehicle	No	Yes	Yes, but at maximum 2-speed	No	Battery	Regenerative brakes, DC current charger	Yes
Hydrogen fuel cell	No	Yes	Yes	No	Hydrogen	n/a	No

Source: Summary by FTI

Different types of ECVs

2.9 **PHEVs** are powered by an electric motor and an internal combustion engine. The battery can be charged from the grid, and the combustion engine supports the electric motor when higher operating power is required or when the battery's state of charge is low.

2.10 The electric driving range is smaller than for BEVs, as the batteries tend to have smaller capacities. The batteries can have less energy storage capacity than in a BEV because they rely less on electrical power alone to power the vehicle. The battery capacity in PHEVs is designed more for short trips in the city or commuting, for example, than for long-distance journeys.

2.11 The environmental impact of PHEVs depends on their operation mode. Running in all-electric mode results in zero exhaust emissions, but relying only on the conventional engine can lead to fuel consumption and emission levels equal to or higher than those of conventional vehicles of a similar size, because the additional batteries increase the vehicle mass. The overall environmental performance of PHEVs depends greatly on the share of renewables in the electricity generation mix.

2.12 **BEVs** are powered solely by an electric motor, using electricity stored in a battery. The battery must be regularly charged, typically by plugging in the vehicle to a charging point connected to the local electricity grid. BEVs have the highest energy efficiency and are typically able to convert around 80% or more of the energy stored in the battery into motion.

2.13 There are no exhaust emissions while driving a battery electric vehicle. The greatest benefits for the environment occur when BEVs are powered by electricity from renewable sources. However, there are fewer emissions even when electricity comes from the average mix of renewables and fossil fuels used presently in Europe (EEA, 2016a).

2.14 BEVs, however, still have somewhat limited driving ranges compared to conventional vehicles and typically need a long time to recharge the batteries. BEVs tend to have large batteries to maximise the energy storage capacity and increase driving ranges. These large batteries generally cost more than those used in hybrids. However, battery costs per kilowatt-hour (kWh) tend to be less expensive for BEVs.

2.15 **FCEVs** are also entirely propelled by electricity. In this case, the electrical energy is not stored in a large battery system, but is instead provided by a fuel cell 'stack' that uses hydrogen from an on-board tank combined with oxygen from the air. The main advantages of FCEVs over BEVs are their longer driving ranges and faster refuelling, similar to those of a conventional vehicle. Because of the current size and weight of fuel cell stacks, FCEVs are better suited for medium-sized to large vehicles and longer distances. Fuel cell stack technology is in an earlier stage of development than the technologies described above and few models of FCEVs are currently commercially available. Further technological development is needed for FCEVs to improve their durability, lower the costs and establish a hydrogen fuelling infrastructure, including standalone stations or pumps for hydrogen. Indicative electric driving range: 160–500 km.

2.16 The advantages and disadvantages of electrically chargeable vehicles are summarised in Table 2-2 below.

Table 2-2: Advantages and disadvantages of electrically chargeable vehicle models

Drivetrain technology	Bestselling model (EU, 2016)	Indicative e-driving range	Advantages	Disadvantages
Plug-in Hybrid Vehicle (PHEV)	Mitsubishi Outlander 	20-85 km	Higher efficiency Home/workplace recharging Many refuelling stations	Tech complexity
Battery Electric Vehicle (BEV)	Renault Zoe 	80-400 km	Higher efficiency Home/workplace recharging Low engine noise Zero emissions	Fewer recharging stations Long time to recharge Short driving range
Hydrogen Fuel Cell (FCEV)	Hyundai Tuscon 	160-500 km	Higher efficiency Low engine noise Zero emissions	Limited commercial availability Lacking refuelling stations Tech complexity

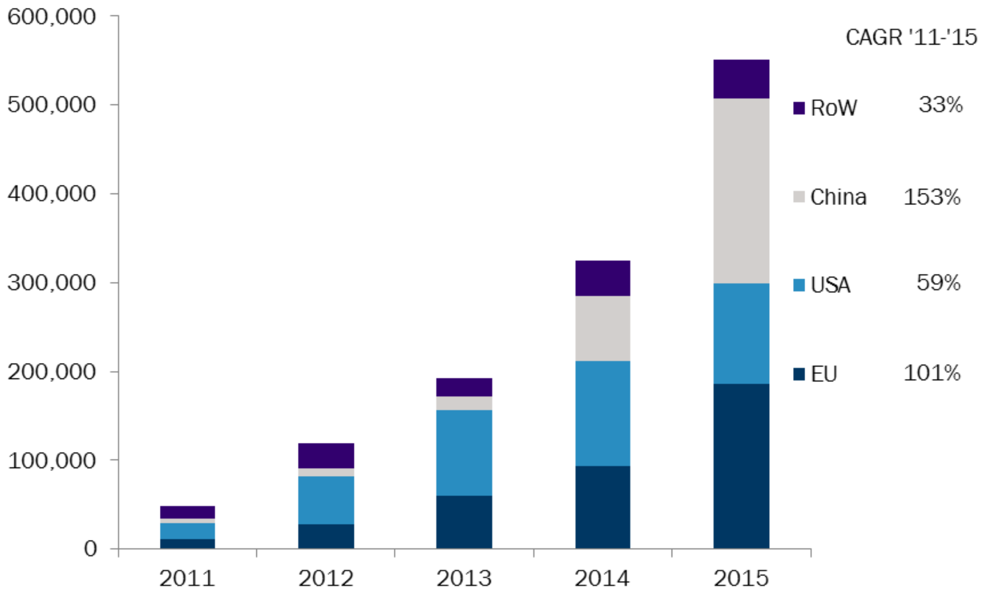
Sources: EEA, FTI analysis, ACEA, Toyota, Mitsubishi, Nissan and Hyundai.

3. ECV market development

Introduction

3.1 Over the last ten years, global registrations of ECVs, driven by the US, EU and China, have increased from less than two thousand units in 2005 to over half a million by 2015[2]. Despite accelerating growth in the last 5 years, ECV registrations still accounted for less than 1% of global car registrations in 2015. While the US was an early leader in ECV sales, between 2012 and 2014 the EU registered larger numbers of ECVs than both the US and China. This trend came to a halt in 2015 when China, for the first time, registered more ECVs than any other country.

Figure 3-1: Global registrations of ECVs



Source: International Energy Agency. (IEA) and European Alternative Fuels Observatory (EAFO). Rest of the World data is driven by Norway.

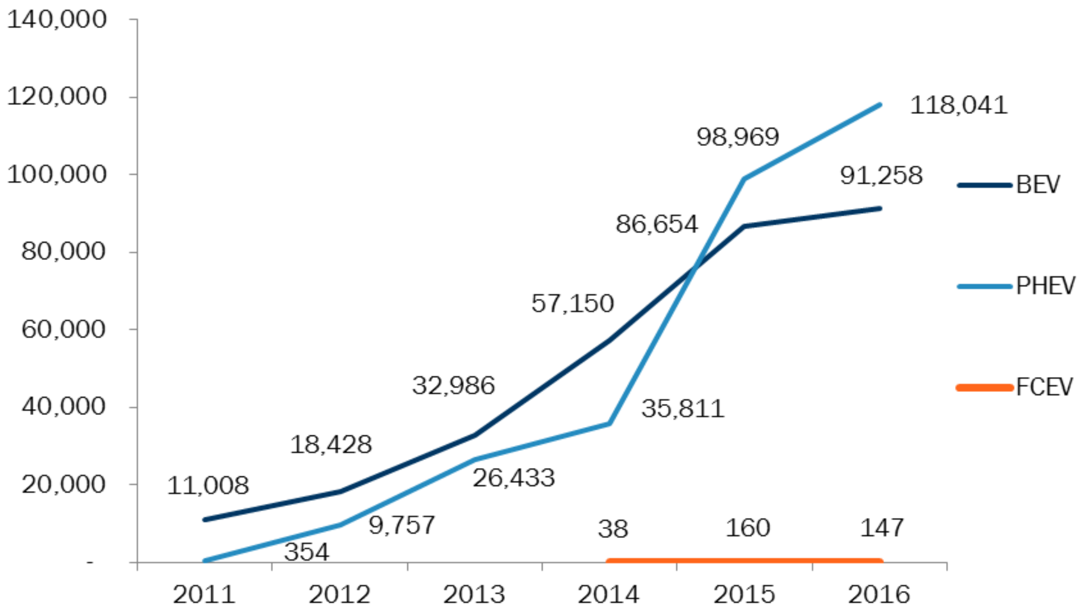
2 Global EV Outlook 2016, International Energy Agency, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

3.2 Registration of ECVs is highly concentrated; with the EU, the US and China accounting for 92% of the world's ECV registrations in 2015[3].

ECVs in the EU

3.3 In the EU, ECV registrations increased from 11,362 units (0.09% share of total registration) in 2011 to 209,446 units (1.43% share of total registration) in 2016. As shown by Figure 3-2, 2015 was the first year that the registration of plug-in hybrids surpassed that of battery electric vehicles. Plug-in hybrids continued to lead sales of ECVs in 2016.[4]

Figure 3-1: EU registrations of electric vehicles



Source: EAFO

3.4 The bestselling BEV in 2016 was the Renault Zoe, which sold over 21 thousand units and is currently priced at around €21,700[5]. The Tesla Model S is one of the more expensive ECVs on the market, selling for around €65,300. The most popular PHEV in 2016 was the Mitsubishi Outlander which sold over 21 thousand units and starts at €40,000. In comparison, few FCEVs were sold by Hundai and Toyota in 2016.

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3 Global EV Outlook 2016, International Energy Agency, https://www.iea.org/publications/freepublications/publication/Global_EV_Outlook_2016.pdf

4 http://www.eafo.eu/vehicle-statistics/m1

5 All EU car prices are quoted as the current price in Germany.

Table 3-1: EU ECV registrations by make and model, 2016

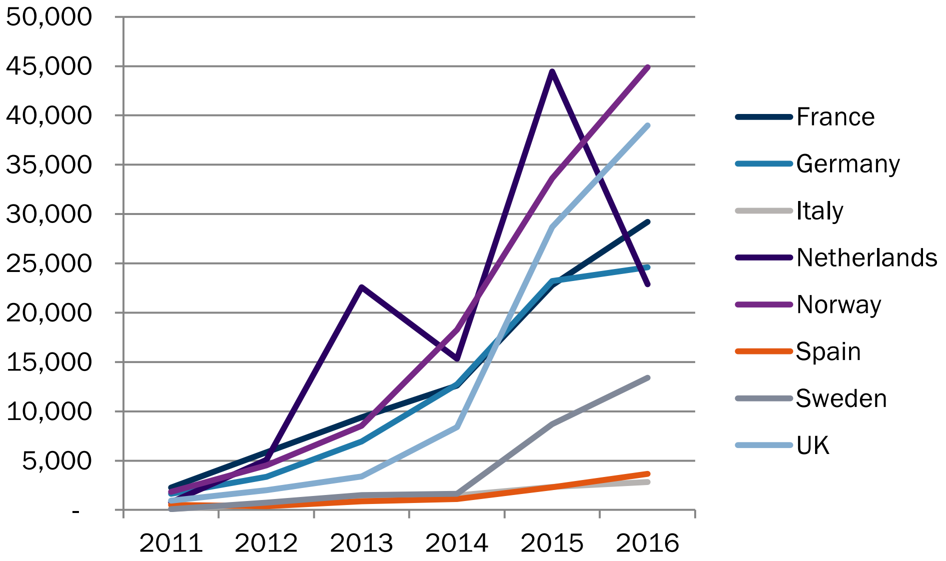
Rank	BEV			PHEV			FCEV		
	Make	**Model**	**Registrat.**	**Make**	**Model**	**Registrat.**	**Make**	**Model**	**Registrat.**
1	Renault	Zoe	21,337	Mitsubishi	Outlander	21,328	Hyundai	ix35	83
2	Nissan	Leaf	18,557	Volkswagen	Passat	13,248	Toyota	Mirai	64
3	Tesla	Model S	12,353	Volkswagen	Golf	11,351			
4	BMW	i3	9,726	Mercedes	C350e	10,231			
5	Volkswagen	e-Golf	6,666	Volvo	XC90	9,586			
6	Kia	Soul EV	4,433	BMW	330e	8,702			
7	Tesla	Model X	3,688	Audi	A3 e-Tron	6,894			
8	Mercedes	B250e	3,504	BMW	225xe	5,915			
9	Volkswagen	e-Up!	2,565	BMW	X5 40e	5,393			
10	Peugeot	iOn	1,893	BMW	i3 Rex	5,322			
Other			6,536			20,071			
Total			91,258			118,041			147

Source: eafo.eu/vehicle-statistics. Accessed on 23 February 2017.

3.5 Figure 3-3 shows combined BEV and PHEV sales in key Member States. We provide data for Norway as well which has an exceptionally high share of ECVs in new car registrations.

3.6 Following 2013, registrations grew strongly in each of the top Member States except for in the Netherlands. While in the last 6 years the Netherlands has been in the forefront of ECV sales, its sales have been volatile. It recorded steep declines in 2013, and in 2016 when BEV and PHEV sales declined by nearly 50% compared with sales in 2015.

Figure 3-3: BEV and PHEV sales in key EU Member States plus Norway, 2011-2015



Source: EAFO

3.7 Table 3-2 shows the evolution of BEV sales in the key EU Member States and in Norway. While initially BEVs have enjoyed a higher market share in the EU, the latest sales data appear mixed. In particular, BEVs appear to be losing attraction to PHEVs in Norway, the largest ECV market in Europe, despite unchanged subsidies for BEVs and PHEVs. BEVs continue to remain the preferred technology in France, potentially because French carmakers have not succeeded in launching a PHEV yet.[6]

Table 3-2: BEV sales in key EU Member States plus Norway

	2011	2012	2013	2014	2015	2016	2016 / 2015
France	2,256	5,240	8,556	10,544	17,269	21,776	26%
Germany	1,404	2,214	5,311	8,348	12,097	11,243	-7%
Italy	113	459	794	1,040	1,451	1,376	-5%
Netherlands	766	754	2,429	2,853	3,168	4,029	27%
Norway	1,837	4,181	8,201	18,086	25,792	24,224	-6%
Spain	505	326	793	1,015	1,422	2,021	42%
Sweden	72	137	391	1,188	2,978	2,945	-1%
UK	919	1,070	2,494	6,680	9,936	10,375	4%

Source: EAFO

6 AID Newsletter, Europeans are turning to PHEVs, 21 September 2016.

3.8 Table 3-3 shows the evolution of PHEV sales in the key EU Member States and in Norway. PHEVs have shown relatively consistent increases across the key Member States, accelerating in later years, except in the Netherlands where a steep decline was observed since company car tax breaks were significantly reduced in 2016.

Table 3-3: PHEV sales in key EU Member States plus Norway

	2011	2012	2013	2014	2015	2016	2016 / 2015
France	-	601	834	2,068	5,518	7,429	35%
Germany	241	1,157	1,620	4,390	11,111	13,369	20%
Italy	3	101	209	446	891	1,445	62%
Netherlands	15	4,326	20,164	12,465	41,280	18,846	-54%
Norway	1	333	323	192	7,819	20,664	164%
Spain	-	60	79	101	869	1,641	89%
Sweden	-	603	1,103	438	5,712	10,470	83%
UK	7	922	895	1,712	18,737	28,618	53%

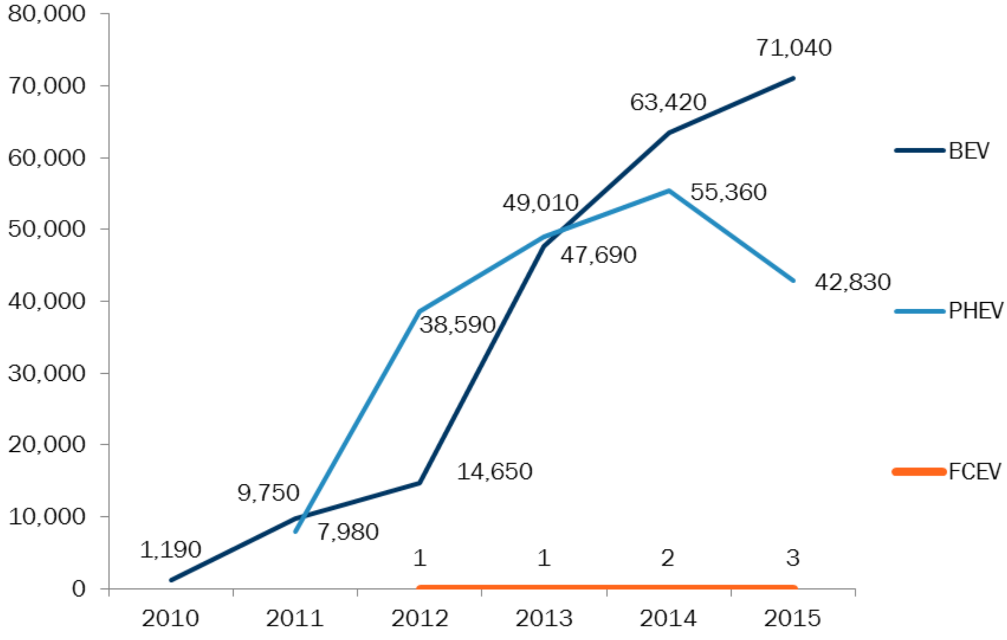
Source: EAFO

ECVs in the US

3.9 The US was the early leader in the take up of ECVs, both in terms of volume and market share. In 2011 it registered 17,730 ECVs, which constituted 0.29% of US new car registrations at the time. By the end of 2015 annual registration had reached 113,870 units and achieved a market share of 1.50%. Figure 2-4 shows the general upward trend in the market share of ECVs since 2011, with a sharp drop in PHEV registrations in 2015. This decline in registration and market share in 2015 may be a result of average US gas prices falling by about 60% in the second half of the year.[7]

7 http://www.gasbuddy.com/Charts [17/10/16]

Figure 3-4: US registrations of electric vehicles



Source: International Energy Agency. Accessed on 25 October 2016.

3.10 The US and EU's ECV markets both have a similar range of cars available. The all-time top selling BEV in the US is the Nissan Leaf, which has sold 95,384 units since it was brought to market in 2011, and starts at $29,000 (€26,000). One of the more upmarket cars available, the Tesla Model S, was the bestselling ECV in 2015. The top selling PHEV is the Chevrolet Volt, with sales of 98,558 so far and a price of $33,000 currently (€29,000).

3.11 The electric car market in the US is dominated by established car manufacturers. The top ten ranked ECV manufacturers by sales are made up almost exclusively of companies that are primarily ICE vehicle manufacturers[8]. The only notable exception to this is Tesla. Smaller start-ups are beginning to enter the market, some of whom, such as Faraday Future, are funded by Chinese investors, but are still a few years away from selling their first car.[9]

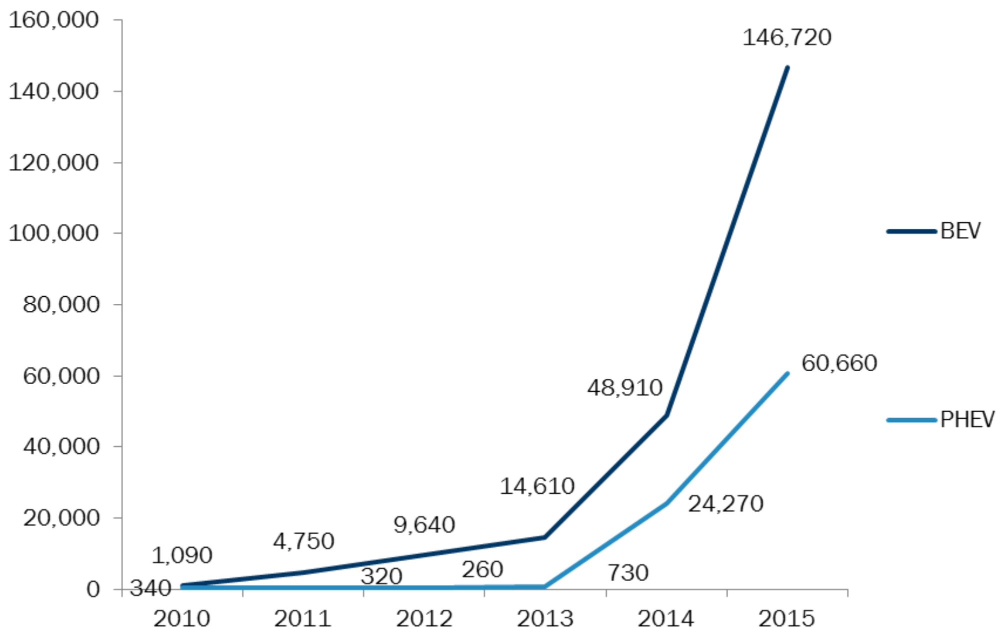
8 http://www.cheatsheet.com/automobiles/10-car-companies-that-sell-the-most-electric-vehicles.html/?a=viewall

9 http://fortune.com/2016/06/14/electric-car-startups-fueled-by-chinese-money-aim-to-catch-tesla/

China

3.12 China has seen the largest increase in ECV market share in recent years. As of 2015 it accounted for 38% of global ECV registrations, up from 11% in 2011. This is a result of registrations increasing from 5,070 to 207,380 between 2011 and 2015 and the combined market share of BEVs and PHEVs going from 0.04% to 0.98%. Figure 2-5 shows the exponential increase in registrations that China has experienced over the last few years.

Figure 3-5: China registrations of electric vehicles



Source: International Energy Agency

3.13 Production data of passenger cars and commercial vehicles show that 2016 is going to be an outstanding year for Chinese ECV production. In the first 9 months of 2016, BEV production in China increased by 118% and PHEV production by 43%. The data also show that ECV consumption is nearly completely satisfied with domestic production: there were 216,000 BEV vehicles and 73,000 PHEV vehicles sold in China in the first 9 months of 2016.

Table 3-4: ECV production in China (passenger cars and commercial vehicles)

	2015	Jan-Sep 2015	Jan - Sep 2016	Growth
BEV	290,700	105,200	229,000	118%
PHEV	88,200	51,100	73,000	43%
FCEV	-	-	-	
ECV	379,000	156,200	302,000	93%
Total PC & CV	24,503,300	17,091,600	19,422,000	14%
% ECV	1.55%	0.9%	1.6%	

Source: ACEA (China)

3.14 The Chinese ECV production is more diverse than those of the EU and the US. Manufacturers range from established makers of ICE vehicles, such as BYD Auto, to start-ups, such as WM Motor, focussing specifically on ECVs. BYD Auto, which sells cars such as the Tang and the Qin which sold 22,166 and 12,160 units respectively, posted revenues of rmb 80 billion (€11bn) in 2015[10,11]. WM Motor was founded in 2015 and has raised $1 billion in initial funding with a view to introducing its first car in 2018.

3.15 This variety of manufacturers is likely to fall in the near future as the Ministry of Industry and Information Technology (MIIT) is considering limiting the number of ECV start-ups to just ten. There are currently around 200. This is expected to be achieved by imposing stricter technology standards to try and prevent manufacturers who lack the requisite technical knowledge from entering the market.[12]

3.16 As of August 2016, only two start-ups have been granted permits to manufacture cars, with three more saying that they intend to apply. The Chinese government plans to phase out subsidies by 2020, thereby removing one of the incentives to enter the ECV market. The newspaper of the State Council says that 90% of companies currently developing ECVs will not meet the required standards within the next two years.[13]

10 http://evobsession.com/kandi-ev-1-electric-car-china-june/

11 https://www.statista.com/statistics/279209/revenue-of-byd-auto-in-china/

12 http://www.bloomberg.com/news/articles/2016-08-28/most-of-china-s-electric-car-startups-face-wipeout-by-new-rules

13 https://www.bloomberg.com/news/articles/2016-08-28/most-of-china-s-electric-car-startups-face-wipeout-by-new-rules

3.17 It is also a market dominated by domestic producers; the Tesla Model S was the bestselling non-Chinese car in 2015 but it was only 19th when ranked alongside Chinese ECVs. The most popular ECV so far in 2016 is the BYD Tang which has sold 22,166 units and has a price of rmb 300,000 (€40,000). The cheapest ECV sold in China is the BAIC E-Series EV and costs significantly less, starting at rmb 60,000 (€8,100) and selling 11,333 units in the first half of 2016.[14,15]

Incentives

3.18 Governments around the world are helping to overcome the still significant barriers to the widespread uptake of ECVs. With the price of ECVs being around double the price of comparable ICE vehicles[16], consumers are continuing to choose the latter, despite their operating costs being much higher (almost triple in some cases). These barriers are not just financial however. According to a study by the United Kingdom's Department for Transport (DfT) in 2015, respondents were deterred from buying an ECV primarily because of concerns over recharging (39%) and vehicle range (36%), with cost (27%) considered less important than both of these[17]. This indicates that more than just the price of ECVs will have to change before uptake reaches the levels many countries are aiming for.

3.19 Governments are acting to implement these changes with policies ranging from price subsidies to investment in infrastructure. They are also introducing non-financial incentives such as access to restricted traffic zones and, in China, preferential access to car license plates which are notoriously difficult to get. Progress on developing charging infrastructure is proceeding more slowly. This may be a result of the high installation costs not being seen to be justified by the still relatively low uptake in ECVs. Fast charging stations can cost up to $100,000 each and come with rigorous planning requirements.[18]

3.20 National governments seem to be becoming more ambitious however. By 2020, Croatia plans to build 164 charging stations which is equivalent to 1 every 50km, more than enough to alleviate any concerns about range, while China aims to build 4.8 million stations, which would be a 100-fold increase on its current capacity.

14 http://www.carnewschina.com/2013/05/03/beijing-auto-e-series-sedan-hits-the-chinese-car-market/

15 http://evobsession.com/kandi-ev-1-electric-car-china-june/

16 Currently, the price of a Honda Civic (petrol) is around €17,000 in Germany. The price of a comparable battery electric vehicle, the Nissan Leaf Tekna (30 kWh) is nearly €37,000

17 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/435980/public-attitudes-evehicles.pdf.pdf

18 http://cleantechnica.com/2014/05/03/ev-charging-station-infrastructure-costs/

ECV incentives in the US

3.21 The US provides incentives to consumers, manufacturers and infrastructure investors.

3.22 The federal structure of the US means that consumers have different incentives to buy ECVs in different states. The federal government offers everyone a $7,500 (€6,700) income tax credit when buying ECVs; but there are also various state level incentives in place. These range from an additional $5,000 (€4,500) tax credit to carpool lane access and reduced battery charging rates.[19] These are aimed at offsetting the cost disadvantage faced by ECV manufacturers.

3.23 The US also provides incentives to ECV manufacturers. The Advanced Technology Vehicles Manufacturing programme provides grants and direct loans to qualifying vehicle and component manufacturers. For example, Ford Motor Company is using a $5.9 billion loan to upgrade factories across Illinois, Kentucky, Michigan, Missouri, and Ohio and to introduce new technologies that will raise the fuel efficiency of more than a dozen popular vehicles. Nissan is using a $1.4 billion ATVM loan to retool their Smyrna, Tennessee, manufacturing facility and construct one of the largest advanced battery manufacturing plants in the United States. The plant will be capable of producing 200,000 advanced-technology batteries a year.[20] Borrowers pay the administrative costs related to the provision of the loan but all other costs are paid by the Government.

3.24 The US is leaving it to private providers to establish charging stations, with the federal and state governments providing tax credits, loan guarantees and cash grants. For example, Los Angeles' Department of Water and Power gives rebates of up to $4,000 per unit towards the purchase of electric vehicle charging equipment.[21]

ECV incentives in the EU

3.25 Financial incentives for the purchase of ECVs in the EU primarily take the form of purchase subsidies/rebates and tax exemptions for consumers (these range from full exemptions to partial).[22]

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19 https://www.tesla.com/support/incentives

20 https://energy.gov/lpo/services/atvm-loan-program

21 http://www.afdc.energy.gov/fuels/laws/ELEC/CA

22 Electric vehicles in Europe, European Environmental Agency (2016)

3.26 The Netherlands stands out with ECV sales representing by far the largest share of total new car sales at nearly 10%. This reflects the wide range of tax exemptions available to Dutch drivers and companies that use electric vehicles as their company cars.[23] The UK sells the second highest number of ECVs of which the majority is PHEVs. Sales have been supported by subsidies of £5,000 up to March 2016, when the level of subsidies has been reduced to £2,500-4,500.

3.27 France has the highest share of BEVs, again reflecting the relatively generous bonus under its CO2-based bonus-malus car purchasing scheme which grants a tax return of up to €6,300 for the purchase of BEVs and up to €4,000 for PHEVs. Germany has a very ambitious electro-mobility scheme that aims for a million EVs (including hybrids) on its streets by 2020.[24] However, it has only recently introduced incentives which are expected to increase demand in 2016. A summary of the different types of consumer subsidies provided in EU member states can be found in Appendix 2.

3.28 The lack of financing models for the development of charging infrastructure is considered to be one of the biggest obstacles to the widespread adoption of ECVs.[25] With the adoption of the Clean Power for Transport Directive[26], the EU has taken steps to develop national policy frameworks for the market development of alternative fuels and their infrastructure.

3.29 In the EU there are no subsidies to vehicle manufacturers (contrary to the policy approach adopted by the US and China).

ECV incentives in China

3.30 The Chinese government offers a subsidy of up to 60,000 rmb (€8,000) towards the sale price of an electric vehicle with some local governments providing further financial incentives.[27] In some Chinese cities, such as Beijing and Shanghai, ECV sales increased as a result of their preferential access to registration plates. In Beijing, 40% of plates issued each year are reserved for ECVs. This leaves for those who drive ICE vehicles, there is only a 1 in 725 chance of receiving a registration plate.

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23 http://nederlandelektrisch.nl/financial-stimulation

24 https://www.bloomberg.com/news/articles/2016-04-27/germany-planning-1-4-billion-in-incentives-for-electric-cars

25 Eurelectric, Charging Infrastructure for Electric Vehicles, July 2016.

26 Directive 2014/94/EU

27 http://www.bloomberg.com/news/articles/2013-09-17/china-renews-electric-vehicle-subsidies-without-adding-hybrids

3.31 The structure of the subsidies available to Chinese ECV manufacturers is opaque. Company accounts of BYD, which controls 80% of China's PHEV market, show that it received rmb 2.9 billion (€387 million) from the Government between 2011 and 2015. This accounts for 45% of the company's net profit over this period[28] confirming that China is taking an active interest in the development of its domestic ECV manufacturers.

3.32 Similarly, incentives provided for infrastructure investment are unclear. It appears that a key obstacle of ECV market development is the number of available charging stations and the government continues to be the main driver behind the roll out of charging infrastructure.[29]

3.33 In summary, both China and the US offer a wider range of subsidies and financial incentives to consumers and vehicle manufacturers. The US also provides financial support to infrastructure investors, while in China the government drives the roll-out of charging infrastructure. Currently, the EU only provides financial support to consumers but it has introduced the Clean Power for Transport Directive to develop national policy frameworks to drive market uptake and infrastructure development. Contrary to the US and China, the EU does not provide financial support to vehicle manufacturers.

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28 http://www.forbes.com/sites/mclifford/2016/07/26/with-a-little-help-from-its-friends-lavish-chinese-government-help-for-top-electric-car-maker-byd/#72effa771533

29 Electric vehicles in China: BYD strategies and government subsidies, Masiero et al., 2016 and http://www.china-briefing.com/news/2016/05/11/china-shifts-gears-electric-vehicles.html

4. ECV take-up projections for the EU

ECV market share forecasts for 2015

4.1 Although many studies have been written on ECVs there are fewer which forecast the market share of ECVs in new car sales or registrations. Figure 4-1 summarises the forecasts and scenarios provided by 7 studies regarding the market share of ECVs in new car registrations over time in Europe and compares them to the actual market shares achieved during 2011-2016. Several observations can be made from this chart:

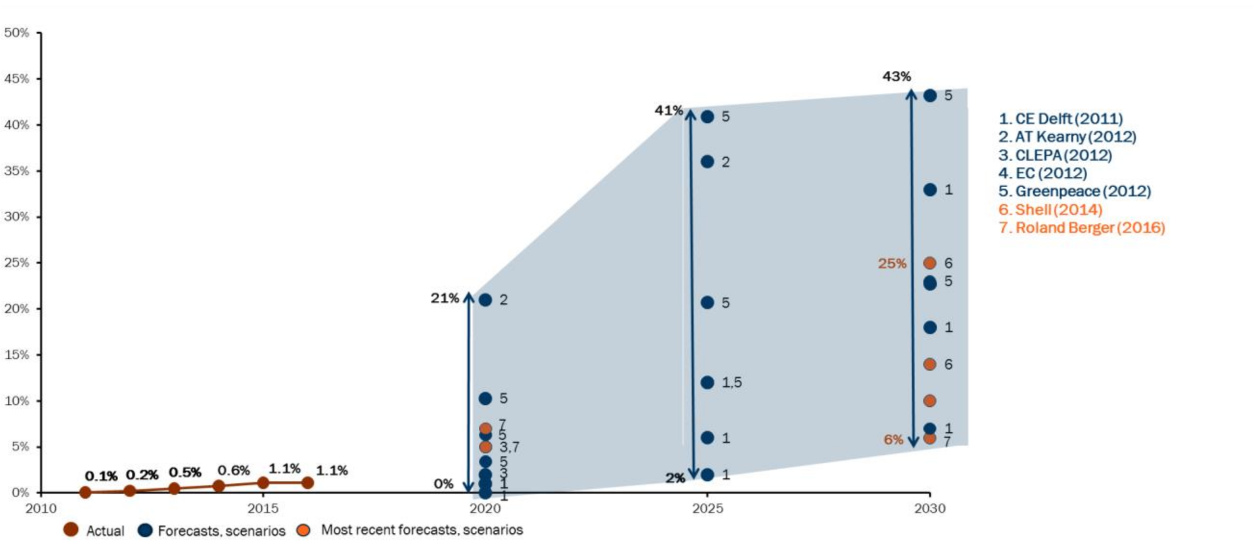
(1) forecasts and scenarios range widely and the disparity increases significantly in later years. For example, the ECV market shares in 2020 range from 0% to 21%. By 2030 this range increases to 6%-43%;

(2) the most optimistic scenarios, especially from earlier studies, are in stark contrast with current, very low market shares;

(3) the most recent studies are less optimistic, with market share scenarios in 2030 ranging from 6% to 25% (compared with 6%-43% for the full sample); and

(4) the least optimistic scenarios can envisage very limited ECV market development.

Figure 4-1: Market shares of ECVs in registrations, actual and forecast/scenario



Source: EAFO, ACEA, and the studies listed on the chart (see Appendix 1 for bibliography)

4.2 The main drivers of these differences are differing assumptions about battery costs, infrastructure development and the level of government support. Table 4-2 summarises the scenarios developed for 2030 and the assumptions that generated them.

Table 4-2: Market share scenarios for 2030, BEVs and PHEVs

Paper	Forecasts	Assumptions
CE Delft (2011)	7% - 33%	Lowest forecast relates to ICE breakthrough scenario in which ICEs reduce CO2 emissions at reasonable costs. Highest forecast relates to the ECV breakthrough scenario in which ECVs become cost competitive from 2020 onwards and fast charging is offered throughout the EU from 2025. Government subsidies are high until 2015 and are rapidly reduced afterwards as costs go down.
Greenpeace (2012)	23% - 43%	Calculates the market share of ECVs that will be required to keep emissions at a sustainable level.
Shell (2014)	14% - 25%	Germany focussed. Optimistic scenario assumes very ambitious energy and climate conservation policies and examines the potential impacts of increased electrification.
Roland Berger (2016)	6% - 10%	Key assumption is meeting existing policy requirements with the lowest GHG abatement costs. Two key scenarios mainly differ in assumptions on oil prices (€64-103 bbl) and technological improvement (battery cost €99–109 / kWh and fuel cell cost improvement).

Source: FTI analysis

5. Impact of different scenarios on the EU automotive sector value chain and macroeconomic indicators

Introduction

5.1 The macroeconomic impact on the EU of ECVs is likely to be significant. ECVs represent a major change in technology and infrastructure which poses a challenge to EU manufacturers whose technological leadership relates to conventional technologies.

5.2 BEVs present the most radical departure from conventional ICE automobile design (see section 1) and therefore a complete transition to BEVs would result in the largest change in the automotive and energy industries. The economic impact of PHEVs can be expected to be somewhat lower. In the following we describe the impacts of BEVs, the most commonly discussed technology in the economic impact literature.[30]

Mechanisms for ECVs to affect the macro-economy

5.3 A literature review by CE Delft prepared in 2012 notes that early studies on the economic impact of electric vehicles relied on an unsophisticated argument that *"EVs are more expensive hence result in more value added and additional employment"*:[31]

5.4 The mechanism through which ECVs impact the EU economy are significantly more complex. The three main channels through which they affect the economy are:

(1) the switch to new technologies;

(2) the higher prices and lower mileage costs of hybrids and ECVs; and

(3) the lower fuel consumption of hybrids and ECVs.

5.5 The **switch to new technologies** has an impact on employment in manufacturing and in the supply chain depending on how labour intensive these technologies are and whether components are manufactured in the EU or outside. ECVs require new infrastructure to be built and installed, which will have a positive impact on employment. Finally, the maintenance requirements of ECVs are also different from those of conventional technologies which also impacts employment in the EU.

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30 We have not come across any study which separately discussed the impact of FCEVs on the EU economy.

31 CE Delft, Literature review on employment impacts of GHG reduction policies for transport, 2012

5.6 The **higher prices** of new technologies are expected to lead to a fall in car purchase and a decline in the competitiveness of EU manufacturers. The impact of these factors is negative on direct employment. Higher prices also reduce real consumer disposable income available for other products which reinforces the negative impact on EU wide-employment.

5.7 **Low mileage costs** are expected to increase car usage and lead to a positive impact on indirect employment (service). They also have a positive impact on consumer disposable income leading to increased EU wide employment. Finally, they have a positive impact on the competitiveness of EU automotive manufacturers leading to increased direct employment.

5.8 **Lower fuel import** reduces employment in refining and gasoline stations but increases employment in EU electricity production (in case of a switch to ECVs).

5.9 We summarise these impacts in Table 5-1 below.

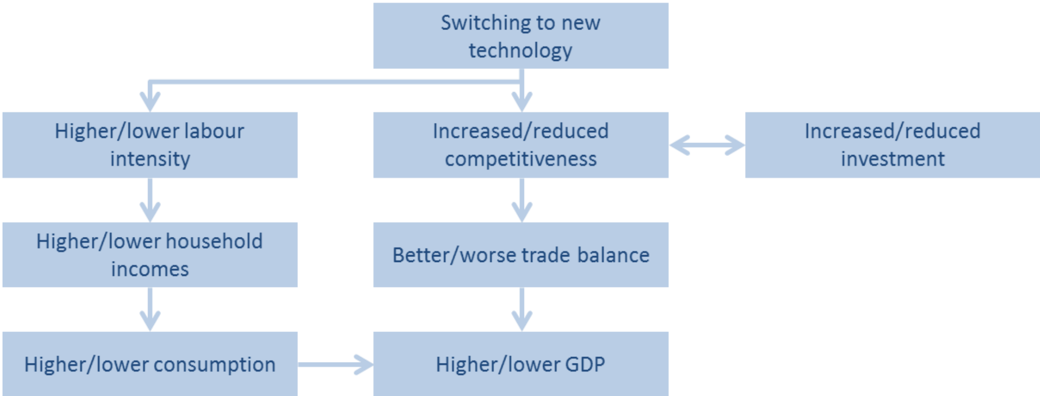
Table 5-1: Employment impacts of moving towards BEVs

Driver	Impact	Mechanisms
Technological change	Potential decrease	Higher vehicle price for BEVs may result in lower employment as BEVs may be less labour-intensive and batteries and other components may be produced out of the EU
Maintenance/ recycling	Small decrease	Maintenance costs of BEVs are expected to be lower than that of ICEs
Fuel import	Small increase	The switch to electricity from BEVs decreases employment in refining and gasoline stations which is expected to be more than offset by increased employment in the electricity generation sector
Infrastructure	Increase	There will be positive employment impact from the construction and installation/maintenance of charging infrastructure
Higher purchase costs	Decrease	Higher purchase costs are expected to lead to a fall in car purchase and to a negative impact on direct employment
Lower mileage costs	Increase	Lower mileage costs are expected to increase car usage and to a positive impact on indirect employment
Consumer spending	Unclear	If the total cost of ownership of the car is reduced consumers will be able to spend more on other goods
Innovation and competitiveness	Unclear	It is not clear whether government induced innovation will increase the competitiveness of the EU car industry. Labour market issues in the EU (aging population, lack of skilled engineers) may suggest the EU could be more competitive in less labour intensive technologies such as BEVs

Source: FTI based on CE Delft (2012)

5.10 The above can be translated into 3 main channels affecting GDP and trade balance of the EU economy. The first channel is through the switch to the new technology. Depending on whether the new technology is more or less labour intensive than the old technology there will be an impact on employment and therefore on consumer spending which will feed back into GDP. Additionally, depending on where the components will be manufactured, in or out of the EU, there will be further impacts on trade balance and GDP. This will also have an impact on the EU's attractiveness for further investment. Figure 5.1 below depicts this channel.

Figure 5-1: The impact of switching to a new technology on the EU economy



Source: FTI

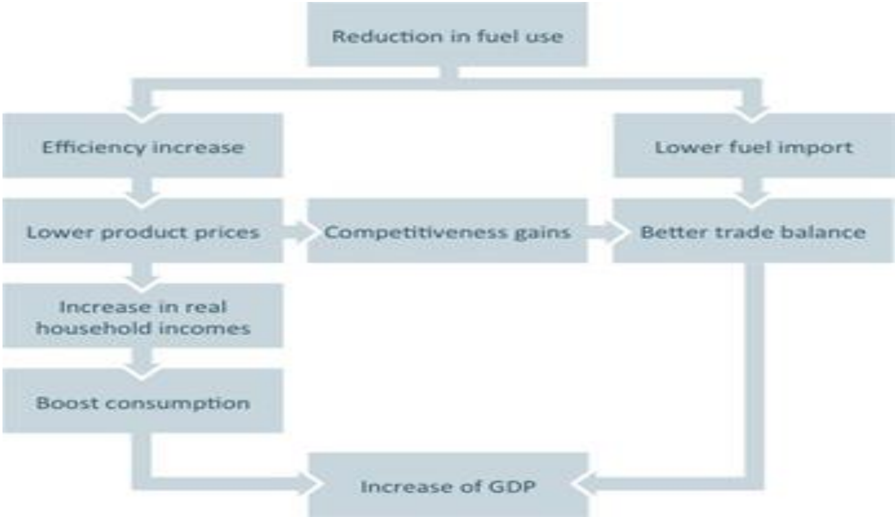
5.11 The second channel is through the higher prices of ECVs which depress GDP. Higher prices reduce consumers' real income and therefore there will be lower real spending in the overall EU economy. Additionally, higher prices are expected to have a negative impact on the competitiveness of EU manufacturers, which would have a negative impact on trade balance and on the inflow of investments. This channel is described in Figure 5-2 below.

Figure 5-2: The impact of more expensive ECVs on the EU economy

Source: CE and Ricardo –AEA, Figure 7.1

5.12 The third channel is through a reduction of fuel consumption in vehicles which has positive impacts on the wider economy. The reduction in imports of fuels improves the trade balance and boosts GDP. Additionally, the reduction in fuel costs lead to lower product prices increasing the real income of consumers and the competitiveness of EU manufacturers. Both lead to increased GDP (see figure 5-3).

Figure 5-3: Impact of reduction in fuel use on GDP and trade balance



Source: CE and Ricardo –AEA, Figure 7.2

Summary of literature on the impact of EVs on the EU macro-economy

5.13 There are many studies on the impacts of EVs on employment, GDP, trade balance and government tax receipts in different regions. The vast majority of these studies project positive impacts on GDP, employment and trade balance and negative impact on government tax receipts (see Appendix 1 for a description of the studies). However, all of these studies rely on some strong assumptions including, for instance, that in case of a switch to ECVs most of the vehicles' components will continue to be manufactured in the EU and that ECVs are as labour intensive as conventional cars.

5.14 One exception is the analysis prepared for the Bundestag in 2013[32], which shows employment impacts ranging from positive to negative depending on assumptions around productivity growth and the share of import in the value of electric vehicles.

32 Bundestag, 24 May 2013, The future of the automotive industry, 17/13672

5.15 In the following we discuss the assumptions and the results of a key economic impact study prepared by Cambridge Econometrics: Fuelling Europe's Future. This study analyses various scenarios including an ambitious ECV scenario where ECVs reach 100% market share by 2050. Table 5-2 shows that the impacts of the scenario on employment and GDP are positive. Employment increases by 660 thousand to over 1 million by 2030 and by 2 million to 2.4 million by 2050. GDP increases by €41 billion to €72 billion by 2030 and by €223 billion to €293 billion by 2050 (estimated in 2010 prices). The shortfall in tax receipts is estimated at €260 billion in 2050 (the figure is not available for 2030).

Table 5-2: Economic impact of ECVs in the EU (Cambridge Econometrics)

Scenario description	Employment	GDP(1)	Tax receipt
Ambitious ECV deployment: market share in sales of 9.5% in 2020, 80% in 2030 and 100% by 2050	1,080,000 by 2030 2,350,000 by 2050	€72 bn by 2030 €293 bn by 2050	- €260 bn in 2050

Note: (1) in 2010 prices.
Source: FTI summary of Cambridge Econometrics: Fuelling Europe's future

5.16 The key drivers and assumptions in the study are the following:

(1) Europe keeps its technology leadership (and therefore car components will be continued to be manufactured in Europe);

(2) Higher costs of technology has a negative impact on consumer and business spending however the higher costs are value to European producers and to the motor vehicle supply chain;

(3) Crude oil import was €350 billion in 2012 which would rise to €590 billion by 2030 and further still to €705 billion by 2050 based on price increases alone.[33] Most of the oil value chain is located outside of Europe and what is in Europe has low labour intensity;

(4) Reduced fuel consumption has a direct benefit to GDP from reduced imports of oil, which improves the trade balance and boosts GDP. There are indirect benefits to households and businesses, as lower business costs are passed on in the form of lower prices;

(5) Infrastructure spending is large and directs consumer spending away from other EU sectors. This negatively impacts consumers' real income however infrastructure has GDP positive impact given its much larger supply chain in Europe than those of other industries.

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33 Oil prices are based on IEA projections which, in the central case, show crude oil prices to increase from €59 per barrel in 2010 to €105 per barrel by 2030.

5.17 In contrast, in the study prepared for the Bundestag the assumptions are very different:

(1) ECVs do not have a higher value add than conventional technology; and

(2) in the ambitious ECV scenario German producers lose global market share as they "surrender" in the growth markets, in particular, in China, due to increasing competition.

5.18 The main drivers of employment and GDP impact in the scenario in which ECVs reach significant market share (more than 50% in new car sales in Germany by 2030), are productivity growth, the import share of ECV components and the domestic value added share of the cars manufactured abroad by German OEMs.[34] According to this analysis, as long as productivity growth is below the growth of value added of ECVs (assumed to be 2.7% per annum) the employment impact is positive. On the contrary, when productivity growth outpaces the growth of value creation, then the impact on employment is negative. Table 5-3 summarises these results.

Table 5-3: Employment impact of ECVs in Germany (Bundestag)

Scenario description	2020	2030
Productivity growth = 2% CAGR Import share of ECV components = 10% DE share in foreign production = 25%	138,000	267,000
Productivity growth = 2% CAGR Import share of ECV components = 50% DE share in foreign production = 10%	91,000	192,000
Productivity growth = 3% CAGR Import share of ECV components = 10% DE share in foreign production = 25%	- 31,000	- 80,000
Productivity growth = 3% CAGR Import share of ECV components = 50% DE share in foreign production = 10%	- 68,000	- 131,000

Source: FTI summary of Bundestag, 2013

5.19 In the following, we assess the key assumptions of the economic impact studies.

5.20 A key assumption in most studies related to the economic impacts of switching to ECVs is that the increased costs of ECVs will manifest themselves as economic value to EU manufacturers. This however requires that the EU transfer its technological leadership to the components of electric vehicles.

34 The analysis focusses on the impact of alternative automotive industry pathways on the German economy.

5.21 Some 26% of the EU's total R&D spending is in automobiles and parts in 2014, worth €44.7 billion.[35] The EU is also a world leader in automotive patents accounting for over 60% of patents granted globally in 2015.

Table 4-3: Patents granted in automotive sector, 2015

Nation	Patents granted	Share of world
Germany	2,058	34.3%
France	609	10.2%
Italy	268	4.5%
Sweden	221	3.7%
UK	146	2.4%
Rest of EU	501	8.4%
EU	3,803	63.4%
Japan	1,291	21.5%
US	657	11.0%
China	90	1.5%
Rest of the world	155	2.6%
World	5996	100.0%

Source: ACEA

5.22 Despite Europe's considerable leadership in automotive patents, it performs less well for patents in electric vehicle related technologies: Japan accounts for 40% of EV related patents[36,37] and is world leader in Li-ion patents.[38] There is also significant state support for EV technology in the US, China and South Korea, where governments see electric vehicles (and especially battery technology) as strategically important.[39] A transition towards ECVs may therefore challenge Europe's technological competitiveness in the automotive space.

5.23 The cost structure of ECVs is very different from that of conventional vehicles. For conventional vehicles, equipment costs make up the largest share of costs at 30-37%, and the drivetrain the second largest accounting for 22-24%. Currently the largest share of the technological costs of electric vehicles is taken up by the battery, which accounts for 35-50%. The second most expensive component is the drivetrain, including the electric motor, the inverter, transmission, and on-board charger.

35 ACEA Pocket Guide, 2016-2017

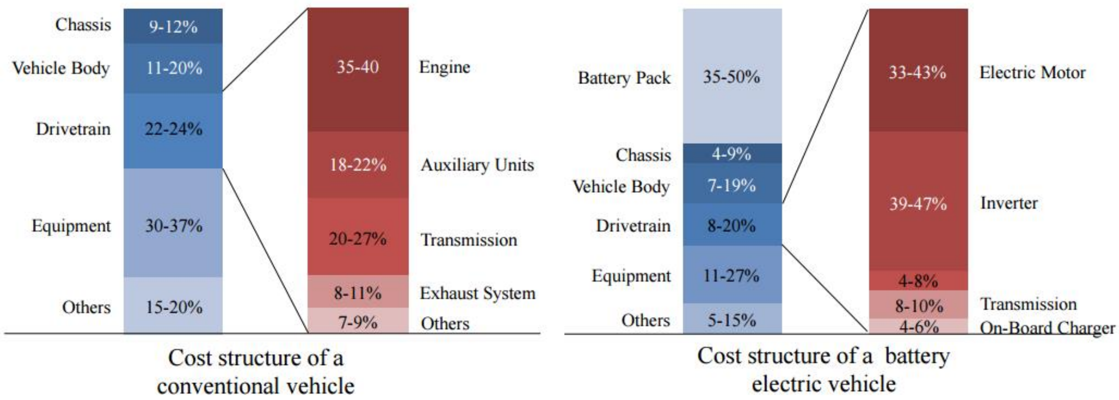
36 http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/ENV/JWPTE(2013)27/FINAL&docLanguage=En

37 OECD (2010), Innovation in Electric and Hybrid Vehicle Technologies: The Role of Prices, Standards and R&D

38 Canis (2013), Battery Manufacturing for Hybrid and Electric Vehicles: Policy Issues

39 http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=COM/TAD/ENV/JWPTE(2013)27/FINAL&docLanguage=En

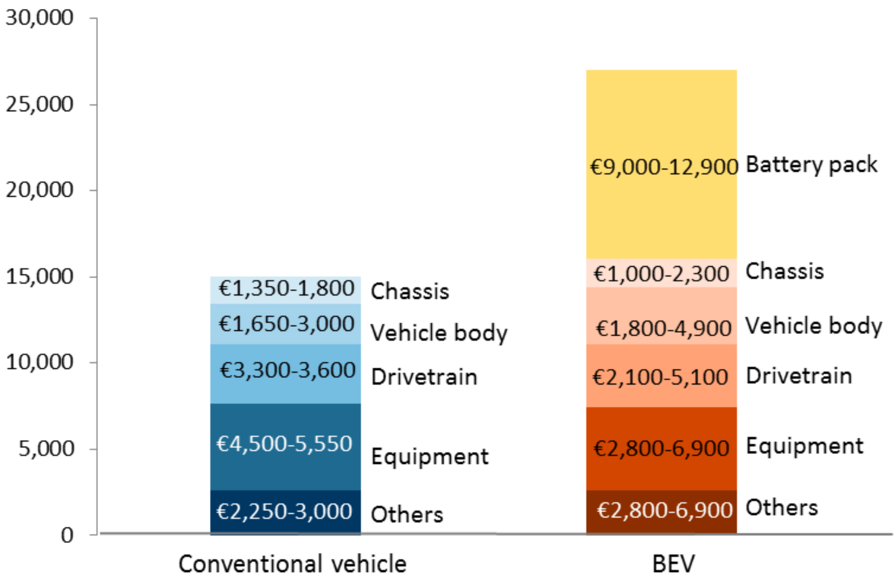
Figure 4-4: Vehicle cost breakdown, ICE versus BEV



Source: Fuchs et al (2014), An overview of costs for vehicle components, fuels and greenhouse gas emissions

5.24 Cambridge Econometrics estimates that the total manufacturing cost (excluding manufacturer and dealer margins) of a diesel ICE vehicle in 2015 is around 15,000 while that of a BEV is around €27,000. Applying the cost breakdown in Figure 4-4 to these figures we calculate that the battery pack accounts for nearly all of the €12,000 cost increase. This is shown in Figure 4-5 below.

Figure 4-5: Cost structure of ICEs vs BEVs



Source: FTI analysis based on Fuchs et al and Cambridge Econometrics data

5.25 In 2014, the EU produced only 6% of the world's lithium ion batteries, with only four countries: Japan, Korea, the US and China producing the remaining 94%.

Table 4-4: Li-ion battery production and capacity 2014, by country

Country/Region	Production (GWh)	Additional Capacity (GWh)	Total Capacity (GWh)	Share of Production
China	0.8	10.4	11.2	15%
Japan	2.0	3.8	5.8	37%
Korea	1.3	3.3	4.6	24%
United States	1.0	3.6	4.6	19%
European Union	0.3	1.0	1.3	6%
Rest of World	0.0	0.0	0.0	0%
Total	5.4	22.1	27.5	100%

Source: US Department of Energy

5.26 It is clear that on battery technology alone the EU faces significant challenges. Currently, a significant share of the value of electric vehicles leaves the EU economy. On the other hand, Transport & Environment reports[40] new battery production facilities planned by Volkswagen in Salzgitter (Germany); Samsung SDI in Hungary; and LG Chem in Wroclaw (Poland) and other plans in development.

5.27 Moreover, the batteries and electric motors require specific raw materials, which are not available in the EU (e.g. the vast majority of Lithium reserves are in Chile and Bolivia and China dominates the reserves of rare earth).

5.28 Finally, the concentration of battery production in Asia brought about a cluster of part manufacturers who specialised in developing the new electrified components and systems. The ECV supply chain in the EU has some catching up to do which also provides challenges to EU OEMs.

40 T&E, Electric vehicles in Europe, 2016

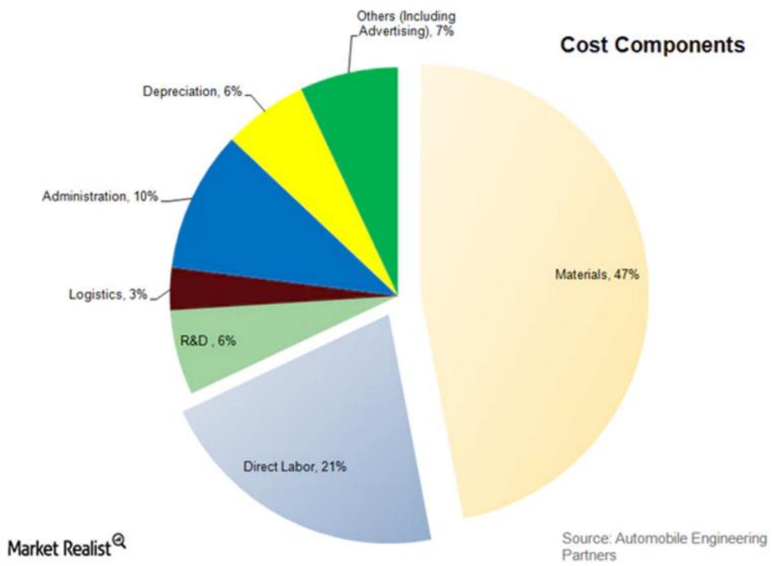
Assumption #2: Labour intensity of ECV production and maintenance

5.29 Studies estimating the impact of a switch to ECVs appear to assume that the production of an electric car is at least as labour intensive as that of a conventional vehicle. For example, Cambridge Econometrics suggests that the higher costs of ECVs create value to European producers and to the motor vehicle supply chain (e.g. to producers of fuel efficient start-stop mechanisms). Higher value-added is typically associated with employment gains.

5.30 In the EU, 3.1 million highly skilled jobs are in automotive manufacturing. Taking into account the vast supply chain, 12.2 million jobs (or 5.6% of the EU workforce) are in the automotive sector overall. These statistics highlight how an improvement or worsening in the EU's position in car manufacturing could significantly affect employment in the EU.

5.31 In a conventional vehicle material costs are estimated to be responsible for 47% of the total costs of production, and direct labour is estimated to account for 21%.

Figure 4-5: Automotive cost components of a conventional vehicle



Source: AEP, via Market Realist

5.32 There are few estimates of the labour intensity of electric vehicles. A study by Friedrich-Ebert-Stiftung in 2010 noted that then current German plants of ICE vehicles produced approximately 200 motors per employee annually. A new German plant producing electric motors (by Continental) produced 1500 motors/employee.[41]

41 Zukunft der deutschen Automobilindustrie Herausforderungen und Perspektiven für den Strukturwandel im Automobilsektor, Friedrich-Ebert-Stiftung, 2010

5.33 The Tesla Factory is the principal production facility of Tesla Motors. The plant is located in the East Industrial area of Fremont and employed around 6,000 people in June 2016.[42] On August 3, 2016, Tesla Motors announced that it was consistently producing 2,000 vehicles per week at the end of Q2 2016.[43,44] At this rate, and noting that the factory is still ramping up, the Tesla Factory is producing around 28 vehicles per employee annually.[45] (We note that the manufacturing process uses more than 160 specialist robots, including 10 of the largest robots in the world.)

5.34 The Volkswagen Wolfsburg plant produced around 815,000 vehicles and had over 73 thousand employees in 2015. Therefore, the Wolfsburg plant produced around 11 vehicles per employee during 2015, which appears to be significantly lower than Tesla's production rate calculated above.

5.35 Volkswagen has recently announced 30,000 job cuts. One of the reasons appears to be that "electronic vehicles are the future and they need less people to build them in the production process".[46]

5.36 Finally, we note that the maintenance of ECVs has also been found to be less labour intensive. According to Sia (the French society of automotive engineers), every 1 million electric vehicles in circulation destroys 1000 jobs in car maintenance.[47]

5.37 Similarly, Roland Berger expects that *"electrification will have a dramatic effect on the whole independent aftermarket value chain. Electric powertrains will consist of different technical components compared to the conventional combustion engine. An electrical powertrain will have less maintenance parts (e.g. oil filter) and less service fluids (e.g. motor oil). Also other vehicle systems, for example, the braking system, will be less used by electrical vehicles due to kinetic energy recuperation. This will have an impact on the spare parts volume, especially for high runner maintenance parts (e.g. oil filter, fluids, brake discs and pads). Parts suppliers of conventional combustion engine parts (e.g. filters, oil and engine components) will lose volumes and have to reposition or will even not exist any longer"*.[48]

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42 Campbell, Angela (2016-06-09). "Tesla Motors Inc Workers Being Contacted by UAW For Union Formation". The Country Caller. US.

43 "Tesla Second Quarter 2016 Update" *(PDF). shareholder.com. 2016-08-03.*

44 Wang, Robert Ferris, Christine (2016-08-03). "Tesla misses Wall Street targets, but logs gains in vehicle production". CNBC.

45 (2,000 vehicles * 52 weeks)/6,000 employees

46 https://www.theguardian.com/business/2016/nov/18/volkswagen-axe-30000-jobs-worldwide-diesel-emissions-scandal

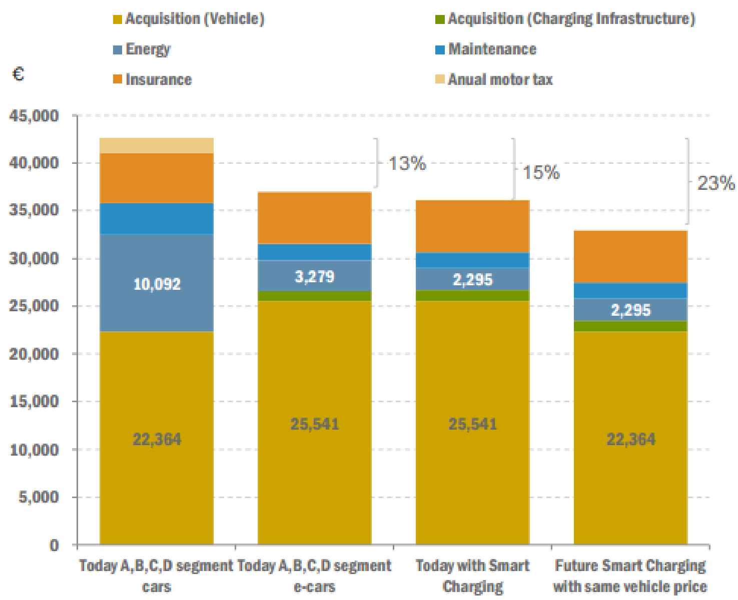
47 La voiture électrique menace les garagistes Le Figaro (Cyrille Pluyette)

48 Roland Berger, 2016, The IAM in 2030

Assumption #3: Fuel cost savings and impact on the electricity system

5.38 Fuel cost savings are clearly the main driver of economic benefits associated with the switch to ECVs. Eurelectric finds that today the fuel costs of a conventional car during its lifetime (discounted to the present) is around €10.1 thousand, while that of an ECV is around €3.3 thousand. In other words, the fuel cost of an ECV is around 33% of the fuel costs of a conventional car.[49]

Figure 4-6: Estimated total cost of ownership by Eurelectric



Source: Eurelectric

5.39 However, ECVs would also have an impact on the grid. Eurelectric finds that EVs could put a lot of stress on the electricity system which may therefore require significant investments:[50]

49 Eurelectric, 2015, Smart charging – Steering the charge, driving the change.

50 Ibid.

"[] the increased load from EVs could expose the grid to a dramatic increase in peak demand at certain times and locations. This can lead to major network overloads such as voltage drop or thermal overstress which could result in grid assets ageing or eventually can cause service interruption. In that case, heavy investments could be required to upgrade the electricity cables connecting households to transformers and the transformers themselves. Investments in the upstream grid could also be needed. These investments may burden therefore the electric mobility technology adoption at national and international scale."

5.40 While further investments in infrastructure will be expected to have a positive impact on GDP and employment, for the same reason as discussed related to charging infrastructure, it will have a negative impact on governments' budgets. In particular, Eurelectric reports calculations made in France around the investment needs per million ECVs: €200-650 million to be invested in the low voltage grid and €80 million in substations and medium voltage lines (absent smart charging).

Assumption #4: The impact of ECVs on the government budget

5.41 Studies typically focus on fuel tax returns when discussing the impact of the switch to ECVs on governments' budgets. However, governments will also need to make investments, including in charging infrastructure, in grid infrastructure and in subsidies to consumers:

(1) Fuel tax: €120-€130 billion;

(2) Charging infrastructure: €60-80 billion;

(3) Subsidies to consumers; and

(4) Grid infrastructure investment: €200-650 million / 1 million ECVs travelling to be invested in the low voltage grid and €80 million / 1 million ECVs travelling to be invested in substations and medium-voltage lines (absent smart charging).[51]

5.42 If economic activity and GDP were to increase as a result of widespread adoption of ECVs, these expenses could be offset, to some extent, by increased tax receipts.

51 Source: Eurelectric, 2015, Steering the charge, driving the change.

Appendix 1 Bibliography for Figure 4-1

A1.1 CE Delft (2011) Impacts of Electric Vehicles.

A1.2 AT Kearney (2012) Powertrain 2025.

A1.3 CLEPA (2012) Position on the revision of Regulation EC No 443/2009 setting emissions performance standards for new passenger cars and Regulation EC No 510/2011 setting emissions performance standards for new light commercial vehicles.

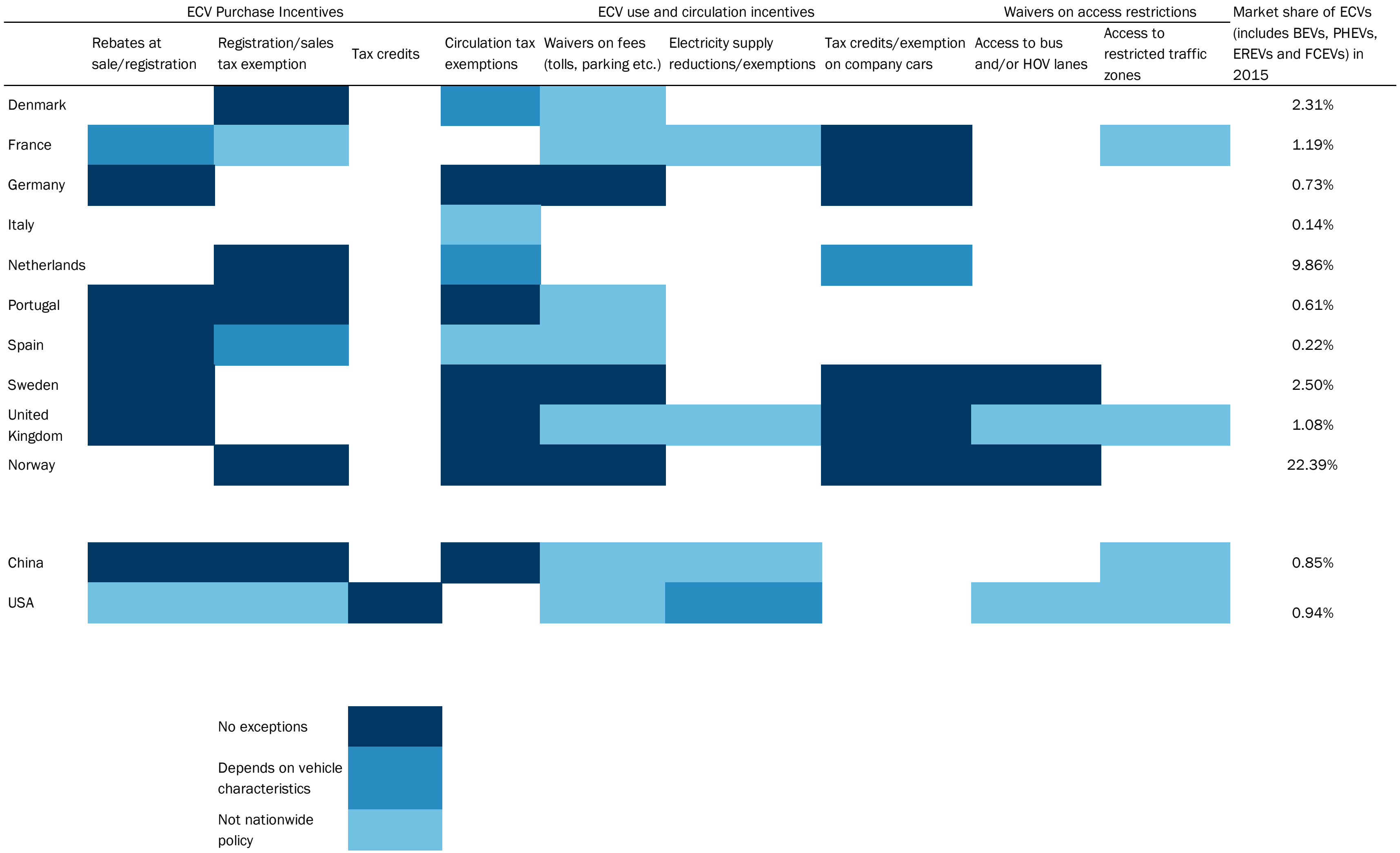
A1.4 EC (2012) Action plan for the EU automotive industry in 2020.

A1.5 Greenpiece (2012) Energy revolution.

A1.6 Shell (2014) Passenger car scenarios for Germany to 2040.

A1.7 Roland Berger (2016) Integrated fuels and vehicles roadmap 2030+.

Appendix 2 ECV subsidies to consumers in the EU, China and the US



Source: IEA, EAO, FTI analysis

Appendix 3 Summary of key studies on impact of EVs on the economy

Region	**Author (Year)**	**Title**	**Impact**
Employment impact			
Germany	Bundestag (2013)	*The future of the automotive industry*	Mixed Depending on the growth of productivity versus the growth of value creation (assumed at 2.7% p.a. in Germany) ECVs impact on employment ranges from -68,000 to 138,000 in 2030
EU	CE Delft. (2012)	*Literature Review on Employment Impacts of GHG reduction policies for transport*	Positive This literature review reports that most studies find a positive impact of EVs on employment based on a simplified theory
EU	CE Delft (2013)	*Impact of Electric Vehicles*	Positive (but benefits to Hybrid/Fuel efficient market not necessarily pure EV) 110,000 new jobs created in the EU by 2030 in production and R&D
EU	Cambridge Econometrics Ricardo-AEA (2013)	*Economic Assessment of Low Carbon Vehicles*	Positive Tech 1 Scenario[5]: European employment increase of 443,000 jobs; CPI Scenario[6]: increase of 356,000 jobs By 2050 jobs increase to 2.3m in all low-carbon scenarios examined
EU Global	EC (2011) Mckinsey & Company (2011)	*Roadmap for moving to a Competitive Low Carbon Economy* *Boost!*	Positive Net job creation to be an increase of 0.7% (~1.5million jobs) by 2020 compared to BAU. Positive 420,000 additional FTEs in global powertrain. Employment shifts from industrialised to emerging countries.
EU	Cambridge Econometrics et al. (2013)	*Fuelling Europe's Future*	Positive Between 660,000 and 1.1m net jobs could be generated by 2030. This increases to between 1.9m and 2.3m by 2050.

Region	Author (Year)	Title	Impact
GDP			
EU	EC (2011)	*Roadmap for Moving to a Competitive Low Carbon Economy*	Positive If the EU uses additional revenues from auctioning CO2 emissions and raises tax revenue from the non-ETS sector, reductions in labour costs would lead to 0.4%-0.6% increase in GDP.
EU	Cambridge Econometrics & Ricardo-AEA (2013)	*Economic Assessment of Low Carbon Vehicles*	Positive Tech 1 Scenario: increase to GDP of EUR 10bn CPI Scenario: increase of EUR 16bn
Global	Mckinsey & Company (2011)	*Boost!*	Positive Whilst ICE cars will mainly grow in emerging regions, EV markets will rapidly increase across all regions. Whilst the European, North American and Japanese market will grow 2-4% p.a., the Chinese and Indian markets will grow x3 as fast, around 9% p.a.
EU	Cambridge Econometrics et al. (2013)	*Fuelling Europe's Future*	Positive Ambitious ECV scenario: €72 billion by 2030 and €293 billion by 2050

Region	Author (Year)	Title	Impact
Tax Revenue			
EU	EC (2011)	*Impacts of Electric Vehicles – Deliverable 5***[17]**	Negative Loss of revenues (from reduction in energy, registration and circulation taxes) will amount to 13-20% of total government 2030 revenue.
EU	Cambridge Econometrics Ricardo-AEA (2013)	*Economic Assessment of Low Carbon Vehicles***[4]**	Negative Tech 1 Scenario: 2030 Negative €22 billion mainly driven by lost fuel tax receipts