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Regulation and Competitiveness of the EU Automotive Industry

FINAL REPORT

Study prepared for ACEA

CRITICAL THINKING AT THE CRITICAL TIME™

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1. Executive summary

Introduction: EU objectives in relation to decarbonisation

1.1 **Europe's 2020 strategy aims to boost growth and jobs by maintaining and supporting a strong, diversified and competitive industrial base in Europe.** The European Commission ("Commission") set targets to increase industry's share of GDP to 20% by 2020, from 15% in 2013.[1] The recent Junker plan, pledging to unlock €315 billion investment within three years, has reinforced the focus on jobs and growth in Europe.

1.2 The Commission envisages the renaissance of Europe's industry by promoting an innovative, clean technology based economy.[2] This, in the Commission's view, would not only contribute to the competitiveness of industrial sectors but would also help to achieve the objective of transforming the EU into a low carbon economy by 2050.

1.3 **The automotive industry is a key pillar of the EU economy - directly and indirectly contributing 7% to GDP and employing 5% of the labour force (nearly 13 million people).** Although its manufacturing processes are practically carbon-free, the fact that nearly 18% of the EU's total carbon emissions arise from the *use* of vehicles (passenger *and* commercial) on Europe's roads formed the basis for imposing specific measures. In comparison, the power generation sector accounts for 29% of carbon emissions.

1.4 **The effort of reducing greenhouse gas emissions was intended to be divided, cost-effectively, between different economic sectors**, considering the sectors' "technological and economic potential".[3] Accordingly, the power sector is expected to nearly completely decarbonise by 2050, manufacturing sectors are expected to reduce emissions by ~85% and the transport sector is expected to reduce emissions by ~60%.

1.5 The Commission pursues decarbonisation objectives in part via the Emission Trading Scheme (ETS) which directly regulates total emissions across power generators and manufacturing sectors by imposing a cap on emission allowances. The cap is reduced each year in line with overall emission reduction targets.

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1 European Commission Industrial revolution brings industry back to Europe http://europa.eu/rapid/press-release_IP-12-1085_en.htm?locale=en

2 European Commission For a European Industrial Renaissance http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52014DC0014

3 European Commission A sectoral perspective http://ec.europa.eu/clima/policies/roadmap/perspective/index_en.htm

1.6 Road transport emissions, on the other hand, are not directly capped but are regulated via increasingly strict average emission targets for *new* cars and vans.[4] New vehicles, however, are a small fraction of the EU's entire vehicle fleet: there were some 13 million new registrations in 2014, only about 5% of the approximately 250 million vehicles on the roads. Moreover, fleet renewal trends and vehicle use, two key drivers of emission reduction, are beyond the manufacturers' control.

The automotive sector is disproportionately affected by decarbonisation

1.7 Achievement of decarbonisation targets for the EU transport sector rests almost entirely on the progress made by the automotive industry in controlling emissions on new vehicles.[5] As a result, **the automotive sector faces higher reduction targets** than any other sector.

1.8 For example, by 2020 average emissions of new passenger cars will need to be reduced by 39% compared to their 2005 level. This compares to 10% reduction expected from other non-ETS sectors and 21% reduction expected from ETS sectors during the same timeframe.

1.9 By 2030, ETS sectors are expected to reduce emissions by 43% and non-ETS sectors by 30%. At the same time, the Commission's most stringent scenario analysed in the 2030 climate package would lead to a significantly higher, 57% reduction effort by new passenger cars.

1.10 **It is also relevant that ETS reductions are not flowing through in the way that was intended.** In the first two phases of the ETS, between 2005 and 2012, allowances significantly exceeded emissions generated by the sectors covered under the scheme. As a result of oversupply, businesses had accumulated a surplus of allowances roughly equating to a year's worth of emissions. This has weighed on carbon prices which have been significantly below the level that had been envisaged for the ETS.

1.11 Other sectors have benefited, financially, from the lack of constraints imposed by the ETS. **Automotive manufacturers have, in the meantime, made significant investments to reduce emissions from new vehicles**; average emissions of new cars declined by 22% between 2005 and 2013.

1.12 Despite this, progress in reducing overall road transport emissions has been relatively slow due to falling new car sales. The regulatory focus exclusively on new vehicles not only slows overall progress in CO2 emission reduction, it is also one of the most expensive ways to reduce CO2 emissions.

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4 Based on New European Driving Cycle (NEDC) test. For example, by 2015 average emissions by newly registered passenger cars in the EU must be below 130g CO_2/km, compared to 162g CO_2/km in 2005, and by the end of 2021 the limit will fall to 95 g CO_2/km.

5 With the exception for aviation which is regulated via the ETS.

1.13 It has been shown that globally the power sector has the largest abatement potential.[6] Moreover, empirical evidence suggests that power generators are able to pass on the carbon costs to their consumers.

1.14 **The abatement potential in the transport sector is smaller and reductions are more expensive than in other sectors.** For example, while the abatement potential in the transport sector is broadly in line with that in the steel sector, the investment required by the transport sector is roughly four times higher.

The automotive sector is already adversely affected by regulation

1.15 The automotive sector is one of the most regulated industries in the EU, and indeed elsewhere. **Regulations** relating to safety, the environment, the type approval of vehicles and taxation have already **added significantly to manufacturing costs**. The large number of new initiatives in the Commission's pipeline - including new CO2 standards for the post-2020 period - will increase manufacturing costs further.

1.16 The fact that past regulations have imposed costs on the industry has been extensively documented - by the Commission, technology consultants, universities and other commentators. Although estimates differ, it is clear that the costs are *high*.

1.17 McKinsey estimated that between 1998-2011 regulatory content and other improvements such as ESP, airbags, fuel efficiency improvement and weight reduction increased production costs by 3-4% per annum.[7] More recent environmental regulations are expected to add a further 6% to the average manufacturing costs by 2015 and 16% by 2020.[8]

1.18 Those cost increases have not been reflected in increased prices. Car prices have, over the same period, increased only in line with inflation. **The industry has not been able to pass the increasing costs onto its customers, and profitability in the EU has suffered as a result.**

1.19 The change in the industry's profits on their EU sales shows the position**. From being the most profitable region in 2007, generating €15 billion profits, the region is now in the *worst* position, showing losses in 2012.** While *some* manufacturers made profits in the EU, losses incurred by others more than offset these. In aggregate, sales within the EU generated a €1 billion net loss in 2012.

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6 McKinsey & Company, Impact of the Financial Crisis on Carbon Economics, 2010

7 McKinsey & Company, The road to 2020 and beyond, 2013

8 See calculations in Appendix 2.

Further regulation will exacerbate the problem

1.20 The sector is suffering from a multitude of competitive pressures:

- Demand is still 20% lower than it was in 2007.
- It has lost its leadership in both global sales and production.
- It continues to suffer from overcapacity - despite an increase in global sales equal to the EU's entire production.
- Its market share has not improved either in the EU or abroad.

1.21 Despite political resistance, the industry has started to shut down plants in the EU. Announced plant openings are now overwhelmingly focussed on the fast growing and profitable Asian and South-American regions. **Tighter regulation is therefore serving to reduce employment as manufacturing shifts abroad, rather than to increase employment through innovation.**

1.22 **The problem is likely to get worse**. As targets become stricter, the costs of incremental progress increase. The less expensive adjustments, such as optimised cooling and improved aerodynamics, have already been made.

1.23 The 2020 target is estimated to impose an additional €1,000-2,000 manufacturing cost per passenger car on the industry. Even calculating with the lower end of this range, these estimates translate into a fleet-wide capital cost of €13 billion.[9] Any further reduction beyond the 2020 target will require significant electrification or other alternative technologies as manufacturers run out of cost effective CO2 reduction measures for ICE technologies.

1.24 **The prospect of some kind of industrial renaissance for the EU automotive sector, driven by innovation, and fuelled by progressively tighter regulations over emissions, therefore appears increasingly unrealistic. The current reality is disinvestment and financial losses** – both potentially self-reinforcing. Tightening the regulatory environment post-2020 seems likely to compound the problem.

[9] Evercore ISI, Emission regulation. The industry's biggest challenge, 2014

2. The automotive sector is disproportionately affected by decarbonisation

Introduction

2.1 The European Commission has set ambitious greenhouse gas emission targets for the EU in the coming decades. The effort of reducing greenhouse gas emissions was intended to be divided cost effectively between different economic sectors, considering the sectors' "technological and economic potential".[10] However, the automotive sector, one of the key pillars of the EU's industry, is currently disproportionately affected by decarbonisation. Despite its higher cost of abatement the sector faces faster CO2 reduction targets which impose real burden on automotive manufacturers; in contrast to the *notional* constraints faced by many other sectors.

Background

2.2 With the overarching objective of becoming a competitive low carbon economy by 2050, the Commission aims to reduce greenhouse gas emissions by 80% by 2050 compared to 1990 levels.[11] It has also set a number of interim milestones, including a 20% reduction in emissions by 2020 and a 40% reduction in emissions by 2040.

2.3 The Commission stated that the effort of reducing greenhouse gas emissions should be divided cost effectively between different economic sectors, considering "technological and economic potential". [12] The sectors' expected contribution to decarbonisation, based on the Commissions assessment of these potentials, is reproduced below.

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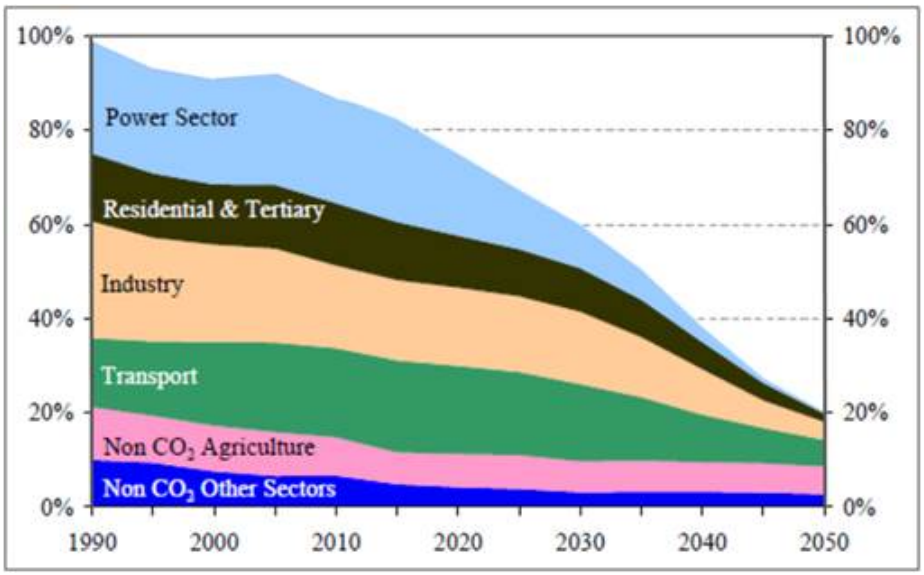
10 European Commission, A sectoral perspective, http://ec.europa.eu/clima/policies/roadmap/perspective/index_en.htm

11 European Commission, Roadmap for moving to a low-carbon economy in 2050, http://ec.europa.eu/clima/policies/roadmap/index_en.htm

12 European Commission, A sectoral perspective, http://ec.europa.eu/clima/policies/roadmap/perspective/index_en.htm

Figure 2-1: EU GHG emissions projections by sector under 80% domestic reduction target for 2050 (100% =1990)



Source: A Roadmap for moving to a competitive low carbon economy in 2050

2.4 The power generation sector is projected to make the largest contribution to decarbonisation in the coming decades. Although demand for electricity is forecast to increase, rising carbon prices are expected to drive a switch to low carbon technologies – renewables, nuclear and carbon capture and storage – leading to near complete decarbonisation of the sector by 2050.

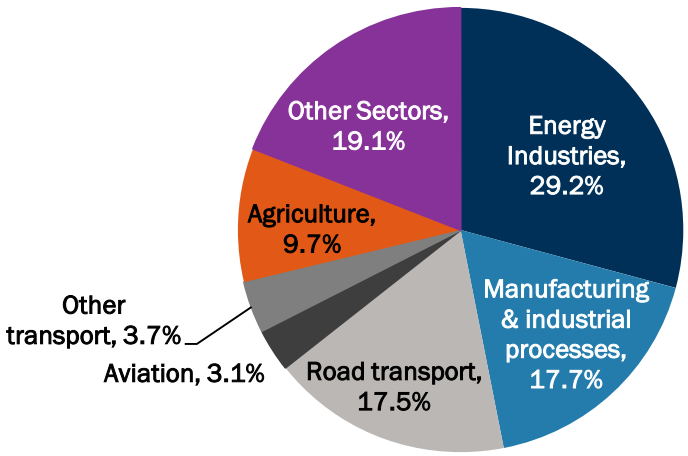
2.5 Energy intensive industries are projected to make a contribution of 83%-87% by 2050, broadly in line with the overall 2050 target. Much of the forecast improvement after 2035 is predicated on the adoption of carbon capture and storage technology for process-related emissions.

2.6 Emissions by the transportation sector are projected to decline by around 60% by 2050 relative to 1990 levels. A major driver of the anticipated decline in transport emissions is a substantial improvement in the energy efficiency of passenger cars, initially through improvements in internal combustion engines ("ICEs"), and later through the widespread uptake of rechargeable vehicles. These projections hinge on the assumption that the cost of battery technology and other barriers to increased penetration of electric cars can be overcome relatively quickly (which cannot be taken for granted). Decarbonisation for heavy duty vehicles and aviation is expected to be less pronounced, with the bulk of the reduction in transport emissions driven by the passenger vehicle segment.

Greenhouse gas emissions by sectors

The EU generated 4.8 billion tons of greenhouse gases in 2012 (including international aviation and maritime transport). Energy industries –primarily electricity and heat production – accounted for the largest share of emissions at 29.2%, while manufacturing & industrial processes represented 17.7%. The most carbon intensive industrial sectors are oil and gas, steel, chemicals and cement. Transport accounted for around a quarter of total emissions, with road transport representing 17.5% of total emissions.

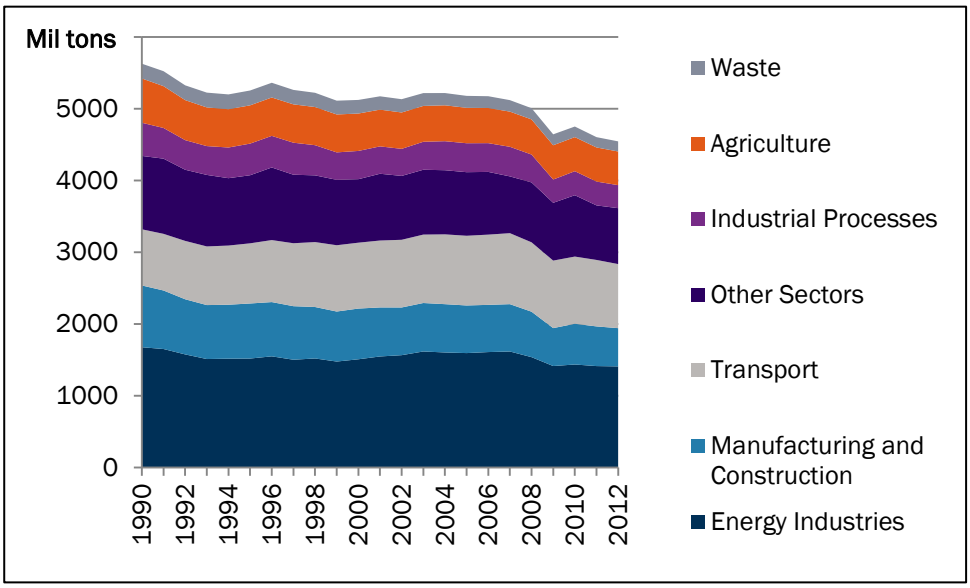
Figure 2-2: Greenhouse gas emissions by sector – EU28, 2012



Note: Includes international aviation and maritime transport
Source: EEA

2.7 Total emissions have declined significantly over recent decades. For the EU-28, emissions were already 19.2% below 1990 levels in 2012.

Figure 2-3: All greenhouse gas emissions by sector (excluding LULUCF) – EU-28



Source: EEA

Note: Transport excludes international aviation and maritime transport

Sectoral contribution to economic activity

2.8 The automotive industry is a key pillar of the EU economy. It directly contributes 2% of the EU's GDP and employs 1.5% of the EU's workforce. However, taking into account its ripple effects throughout the economy including its vast supply chain; its total contribution is closer to 7% of GDP and 5% of employment (or nearly 13 million people representing 10% of manufacturing labor force).[13] Although its manufacturing processes are practically carbon-free, the sector is held accountable for nearly 18% of the EU's total carbon emissions due to the use of cars and vans on Europe's roads.

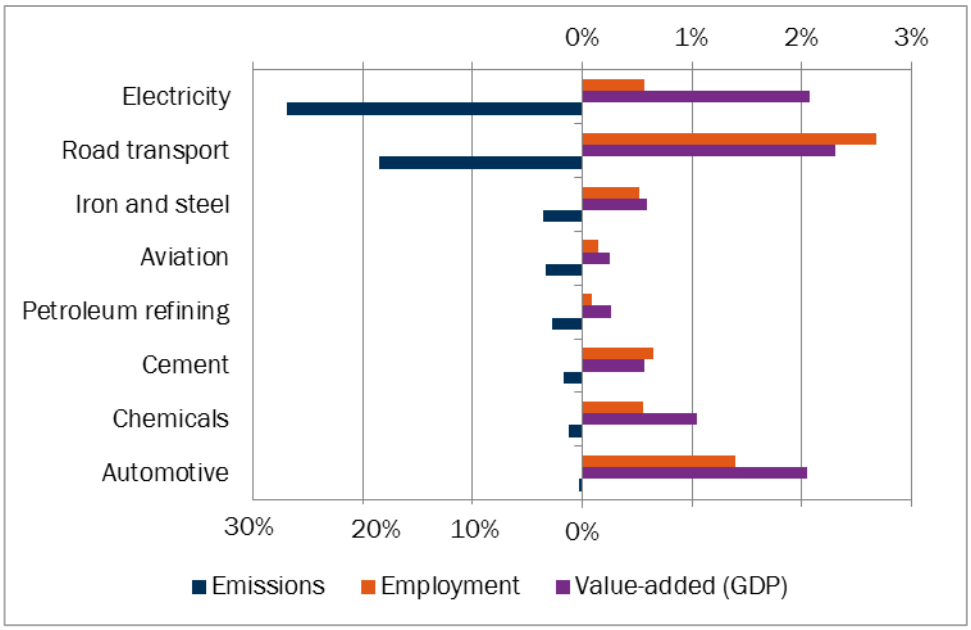
2.9 In comparison, the power generation sector's contribution to GDP is similar; however it employs less than half of the automotive workforce. It also accounts for a significantly higher share of carbon emissions (29%).

2.10 The four most carbon intensive manufacturing sectors, steel, oil refinery, chemicals and cement, jointly account for 12% of the EU's carbon emission and contribute 2.5% of GDP and 1.8% of employment.

2.11 Finally, the aviation sector, which is regulated under the ETS alongside power generators and industrial sectors, accounts for a relatively small share of GDP and employment.

[13] ACEA http://www.acea.be/automobile-industry/facts-about-the-industry

Figure 2-4: Contribution to EU greenhouse gas emissions, GDP and employment by sector, 2012



Notes: See footnote 16 for detailed description of data.[14]
Source: Eurostat, EEA

Regulations to reduce carbon emissions

2.12 Given the importance of energy intensive sectors of the economy, legislators face the duel challenge of developing regulations that achieve significant emissions abatement, while also ensuring that domestic industries remain competitive.

[14] Data exclude international aviation. GDP and employment figures exclude the UK. 'Electricity': employment and GDP figures show electricity, gas, steam and air conditioning supply; emissions figures show public electricity and heat production. 'Road Transport': employment and GDP figures show land transport and transport via pipelines; emissions figures show road transportation. 'Iron and steel': employment and GDP estimates show manufacture of basic metals (includes the activities of smelting and/or refining ferrous and non-ferrous metals. 'Petroleum refining': employment and GDP estimates show manufacture of coke and refined petroleum products. 'Cement': employment and GDP figures show manufacture of other non-metallic mineral products (includes cement, glass, tiles and other manufacturing activities related to a single substance of mineral origin). 'Automotive': employment and value-added figures show manufacture of motor vehicles, trailers, semi-trailers and of other transport equipment; emissions figure shows manufacture of motor vehicles.

2.13 There are currently two major pieces of EU-wide legislation aimed at reducing greenhouse gas emissions in the industrial sectors: the EU ETS directly caps emissions across power generators and manufacturing sectors; and within the transport sector, emissions are indirectly regulated by imposing binding emission targets for new cars and vans.

ETS

2.14 The EU ETS is the primary mechanism for reducing greenhouse gas emissions from the energy and industrial sectors. The scheme covers more than 11,000 power stations and industrial plants across the EU, and in 2012, it was also extended to cover emissions from airlines.

2.15 The ETS regulates the overall volume of greenhouse gases that can be emitted by companies covered under the scheme by imposing a cap on emission allowances. The cap is reduced each year in line with overall emission reduction targets. Companies covered by the scheme receive or buy emission allowances which they can trade, ensuring that the overall target is achieved in the most cost effective way across sectors.

2.16 To limit the impact on the competitiveness of trade exposed industries, sectors that face competition from countries with less stringent emission regulations receive a share of free allowances.

2.17 The ETS is now in its third phase which runs from 2013 to 2020. During this period the cap is reduced by 1.74% annually and there is a reduction in the proportion of allowances that are freely allocated.[15] More recently, the Commission has announced that the cap will be reduced by 2.2% between 2020 and 2030.[16] The average reduction rate during 2013 and 2030 is slightly over 2% per annum.[17]

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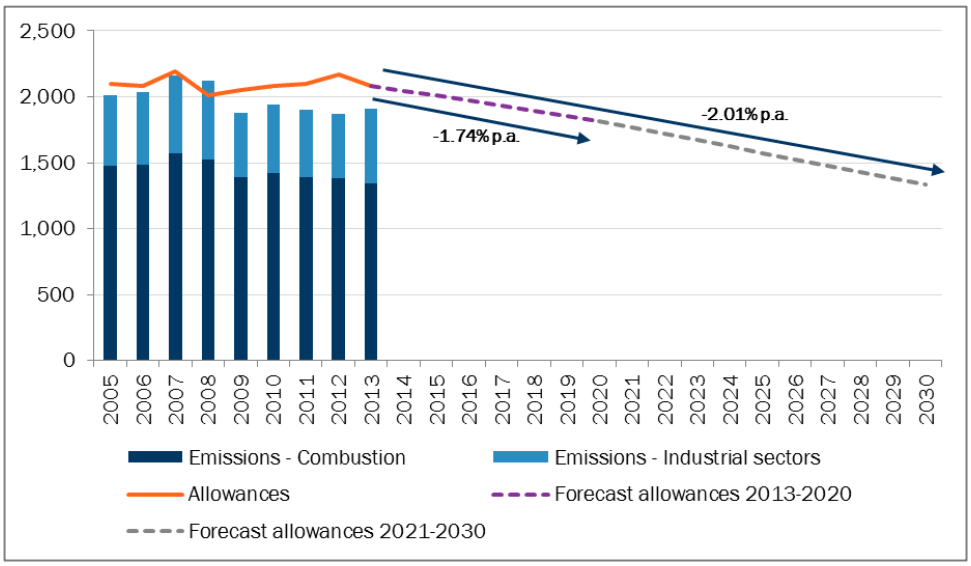
15 The cap is reduced annually by an amount equivalent to 1.74% of the average annual allowances issued during 2008-2012 (Phase 2).

16 The cap is reduced annually by an amount equivalent to 2.2% of the average annual allowances issued during 2008-2012 (Phase 2).

17 The cap is reduced annually by an amount equivalent to 2.01% of the average annual allowances issued during 2008-2012 (Phase 2).

Figure 2-5: EU ETS emissions and allowances (million ton of CO2)



Note: Reduction rates show linear annual reduction.
Source: EEA; European Commission

Regulation of road transport

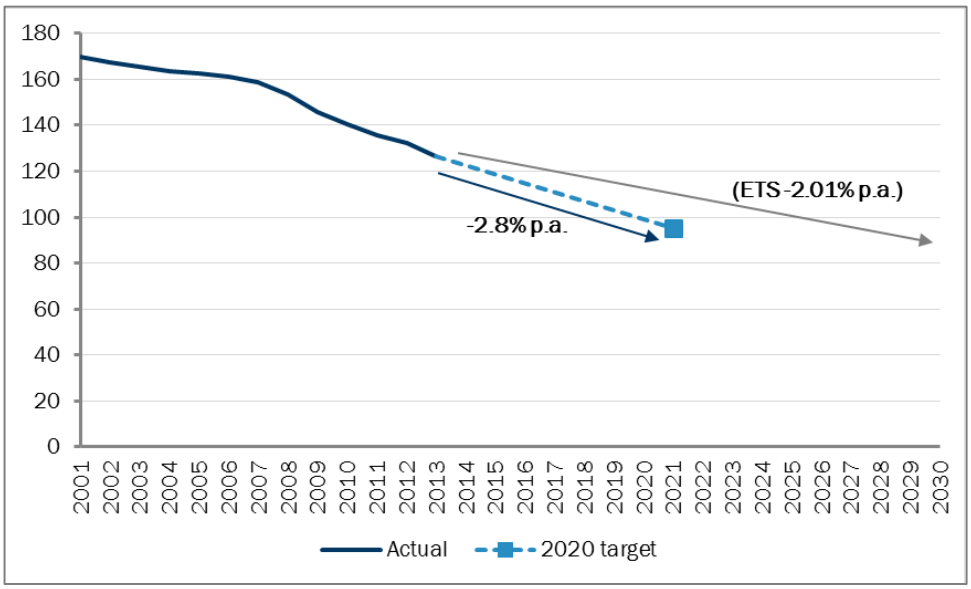
2.18 The second major piece of EU climate change legislation applies to emissions by new vehicles within the transport sector. Manufacturers of passenger cars and vans are subject to legislations that set binding targets for average CO2 emissions for new vehicles.

2.19 For example, by 2015 average emissions by newly registered passenger cars in the EU must be below 130g CO2/km, compared to 162.4g CO2/km in 2005. By the end of 2021 the limit will fall to 95g CO2/km. Similar legislation exists for new vans.

2.20 Car manufacturers have made significant progress against the CO2 targets for new vehicles. Average emissions per new car declined by 22% between 2005 and 2013. Nonetheless, manufacturers will need to reduce average emissions by a further 22% compared to 2013 to reach the 2020 target; a 39% reduction compared to 2005.[18]

[18] Due to the phasing in of the 2020 target, i.e. 95% of new passenger vehicles fleet is expected to reach the target by 2020 and 100% by 2021, we calculate with 99g CO2/km for 2020.

Figure 2-6: Actual and target emissions of new cars (g CO2/km, NEDC based)



Note: Reduction rate shows linear annual decline, comparable to ETS reduction rate calculation.
Source: European Commission, EEA, FTI calculations

2.21 Unlike the ETS, which imposes a cap on total emissions by sectors covered under the scheme, these legislations do not apply to total transport emissions. Instead, they limit average emissions per kilometre estimated by the New European Driving Cycle (NEDC) test, and only apply to new cars and vans.

2.22 However, new cars are a small fraction of the EU's entire vehicle fleet. There were some 13 million new registrations in 2014, only about 5% of the approximately 250 million vehicles on the roads. Moreover, fleet renewal trends and vehicle use, two key drivers of emission reduction, are beyond the manufacturers' control. As a result, despite significant progress in CO2 emission reduction by the automotive sector, advancement in reducing overall transport emissions has been relatively slow.

2.23 Nevertheless, today's cars with significantly reduced CO2 emissions will continuously make their way into the fleet replacing high-emitting vehicles and resulting in a year-on-year improvement in CO2 emissions, even without any further effort from the automotive industry.

The automotive sector faces faster reduction targets

2.24 As a result of regulating emissions of new vehicles the automotive sector faces significantly higher reduction targets than any other sector.

2.25 For example, by 2020 average emissions of new cars will need to be reduced by 39% (compared to 2005). This compares to 10% reduction expected from other non-ETS sectors and 21% reduction expected from ETS sectors during the same timeframe.

Table 2-1: Regulation and target reduction by sector

Sector	Overall decline 2005-2020	Annual decline 2013-2020*
Overall**	-20%	
ETS sectors	-21%	-1.74%
Energy & industry	-21%	-1.74%
Aviation***	-5%	-0.45%
Non-ETS sectors	-10%	
New cars	**-39%**	**-2.80%**

Notes: Shows linear annual decline. ** Compared to 1990; *** The aviation sector cap remains the same in each year of the 2013-2020 trading period, at 5% below the average annual level of aviation emissions in the 2004-2006 base period.*
Sources: European Commission; FTI calculations

2.26 This gap is expected to remain going forward. By 2030, ETS sectors are expected to reduce emissions by 43% and non-ETS sectors by 30%. At the same time, the Commission's most stringent scenario analysed in the 2030 climate package would lead to a significantly higher, 57% reduction effort by new passenger cars.[19]

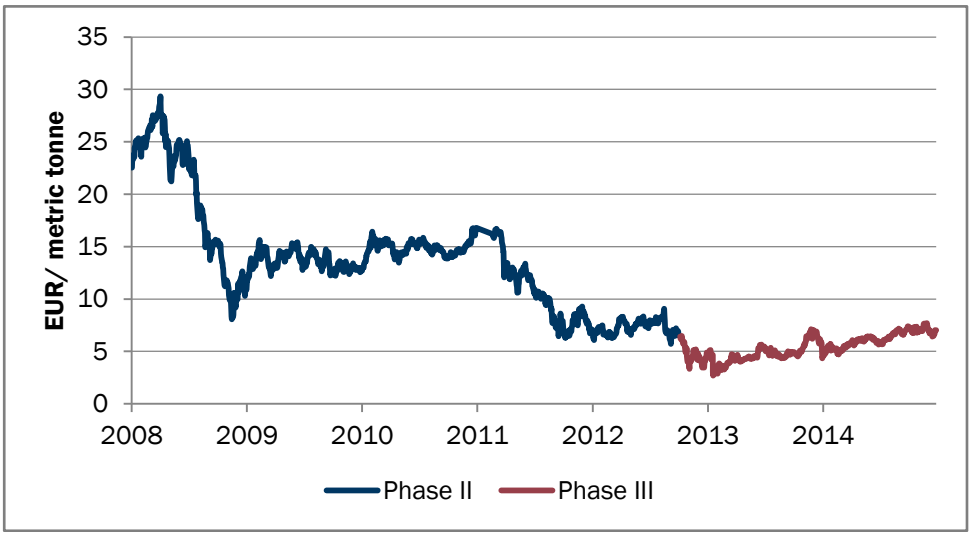
The ETS is not imposing a constraint on the sectors covered

2.27 In the first two phases of the ETS, between 2005 and 2012, allowances significantly exceeded emissions generated by the sectors covered under the scheme. This was due to a host of factors: lack of information initially to set the cap tight, cheap international credits, and most importantly, a significant decline in economic activity which resulted in subdued demand for an extended period.

[19] Compared to 2005 levels. The Commission's most stringent scenario represents a limit of 70g/km average CO2 emission for new passenger vehicles. European Commission 2030 Climate and Energy Policy framework http://ec.europa.eu/clima/policies/2030/documentation_en.htm

2.28 As a result of oversupply, businesses had accumulated a surplus of allowances and international credits corresponding to 2.1 billion tonnes of CO2, roughly equating to a year's worth of emissions. This has weighed on carbon prices, which have been significantly below the level that had been envisaged for the ETS. The carbon price momentarily approached the €30 per carbon ton "milestone" during July 2008 but then fell to its lowest level of €2.70 per carbon ton in April 2013. Since then, the price has been trending upwards and it is currently around €7 per carbon ton.

Figure 2-7: Allowance price (€)



Source: Bloomberg New Energy Finance; ICE data

2.29 The ETS is now in its third phase, which runs from 2013-2020. Among the changes in Phase 3 are the introduction of a single EU-wide cap which is reduced at an increasing pace and a reduction in the proportion of allowances that are freely allocated.[20] Nevertheless, with businesses currently holding a large surplus of allowances, carbon prices are likely to remain at low levels for the foreseeable future.

Cost of abatement is higher in the automotive industry

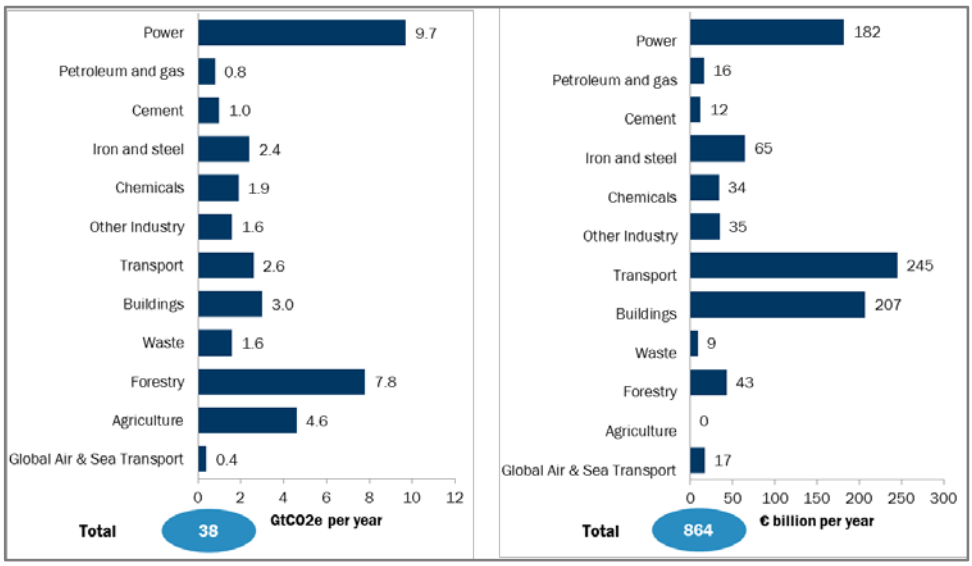
2.30 Ultimately, regulations are aimed at reducing carbon emissions in the most cost effective manner. This involves several considerations, including the scope for abatement, the potential for technological innovation, the cost of investment in new technology, and the competitive constraints faced by the sectors.

[20] The cap is reduced annually by an amount equivalent to 1.74% of the average annual allowances issued during Phase 2.

2.31 Research undertaken by McKinsey in 2010 shows that, globally, the power sector has the largest abatement potential. While abatement is relatively costly empirical evidence suggests that the power sector has been able to pass on these costs to consumers.

2.32 The abatement potential in the transport sector is relatively small compared to other sectors. Indeed, while abatement potential in the transport sector is broadly in line with that in the steel sector, the investment required to achieve the abatement potential in the transport sector is roughly four times higher.

Figure 2-8: Global CO2 reduction potential and investment requirement, 2030



Source: McKinsey Version 2.1 of the Global Greenhouse Gas Abatement Cost Curve[21]

21 McKinsey "Impact of the Financial Crisis on Carbon Economics", 2010

3. The automotive sector is already adversely affected by regulation

Automotive is one of the most regulated sectors

3.1 For decades, the EU automotive industry has faced a multitude of regulatory initiatives. According to CARS 21, the European Commission's initiative to develop recommendations for a Competitive Automotive Regulatory System for the 21st century, automotive is among the most regulated industries:

> *"the European automotive industry is one of the most regulated in its home market.[22]...The acquis communautaire concerning the type-approval of motor vehicles, is one of the most sizeable bodies of legislation in the Community, covering some 56 different directives...In addition to the large volume of Community law in this area, close to 100 regulations adopted under the auspices of the United Nations Economic Commission for Europe (UNECE) are also applicable in the Community as alternatives to the corresponding Community legislation".[23]*

3.2 Past regulations of the automotive sector relate primarily to safety, environment, type approval of vehicles and taxation. For example, the six Euro standards introduced over 1992-2014 limit various pollutant emissions of vehicles, including carbon monoxide (CO) and nitrogen oxide (NOx). EuroNCAP, the European New Car Assessment Program established in 1997, develops standards and ratings for vehicle safety, including related to occupant and pedestrian protection.

3.3 Since the automotive sector's voluntary commitments to carbon dioxide (CO2) reduction in 1998, the EU has introduced a series of standards limiting carbon dioxide emissions of passenger cars and light vehicles. Additional regulations include fuel directives, end-of-life vehicle directives, and type approval of vehicles which certifies that production samples of a design, including their systems and components, meet specified performance standards.

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22 CARS 21 "A competitive automotive regulatory system for the 21st century", p. 13

23 CARS 21 "A competitive automotive regulatory system for the 21st century", p. 21

Table 3-1: Key past regulations/legislations

Year	Area	Category	Year	Area	Category
1985	Unleaded petrol	Fuel directives	2003	Biofuels Directive	Fuel directives
1992	Euro 1	Euro Standards	2005	Euro 4	Euro Standards
1993	Sulphur content of fuels	Fuel directives	2005	ELV Type-approval	End-of-life vehicle directives
1996	Euro 2	Euro Standards	2005	Front protection systems	Pedestrian protection
1996	Air quality framework directive	Other	2006	Emissions from AC	CO2 emissions
1996	Side impact	Occupant protection	2008	Rear impact protection	EuroNCAP
1996	Frontal impact	Occupant protection	2008	Electronic Stability Control, Lane Departure Warning, etc	General safety
1997	EuroNCAP established	EuroNCAP			
1998	1998 fuel quality Directive	Fuel directives	2009	Road Safety Vehicles Regulation	Occupant protection
1998	Voluntary CO2 reduction commitments	CO2 emissions	2009	Pedestrian collision tests	EuroNCAP
1999	Consumer labelling	CO2 emissions	2009	Reduction of CO2 emissions from new passenger cars	CO2 emissions
2000	Euro 3	Euro Standards	2009	Tyre labelling & TPMS	CO2 emissions
2000	Monitoring CO2	CO2 emissions	2009	Euro 5	Euro Standards
2000	ELVs	End-of-life vehicle directives	2009	Renewable Energy Directive	Fuel directives
2001	Voluntary agreements on safer car fronts	Pedestrian protection	2012	Mass and dimensions	n/a
2001	Seatbelt reminder	EuroNCAP	2013/ 2014	Amendments to 2009 CO2 regulation	CO2 emissions
2003	Pedestrian protection	Safety	2014	Sound and silencing	n/a
2003	Child protection rating	EuroNCAP	2014	Euro 6	Euro Standards

Notes: The list is not exhaustive.

Sources: Effect of regulations and standards on vehicle prices - AEA Technology, EC website

3.4 The Commission is working on a large number of initiatives related to future regulation of the sector. These include new CO2 standards for the post-2020 period (the current targets are to be met by 2020/21), a long list of proposals related to environmental, fuel, safety, Intelligent Transport Systems (ITS), raw materials, spare parts, waste management, recycling and other areas.

Table 3-2: Regulation/legislation currently considered

No	CO2 Emissions	No	Internal Market/ITS and Safety
1	CO2 post-2020	26	Design protection
2	CO2 labelling review	27	Repair and maintenance information
3	CO2 for HDV	28	Product safety
4	World Light [Duty] Test Procedure	29	Market surveillance
5	NEDC-WLTP correlation for CO2	30	Data protection
6	Real driving emissions	31	eCall
7	Reduction of pollutant emissions	32	eCall for HDV
8	Fuel Quality Directive	33	C-ITS Platform
9	Evaporative emissions	34	Weights and Dimensions – rev. Dir 96/53
10	SULEV	35	Advanced Emergency Braking
11	Euro 7	36	Intelligent speed adaption
12	China 6 - Beijing 6 emissions standards	37	Lane Departure Warning
13	MAC efficiency test procedure	38	Pedestrian detection - Emergency Braking
14	MAC refrigerant	39	Blind Spot Detection
15	REACH review	40	Pedestrian and VRU protection
16	ELV Annex II - 8th review	41	Alcohol Interlock
17	Raw materials	42	Speed limiter, extension to LCV - M1
18	Resource efficiency	43	EDR - Event Data Recorder
19	Recyclability of motor vehicles/batteries	44	Seat Belt reminder
20	EU ETS (2009/29/EC)	45	Whole Vehicle Type Approval
21	F-Gas Regulation (842/2006) review	46	Vehicle information platform (VIP)
22	Best Environmental Mgmt Practice	47	EReg project
23	Air quality package - MCP	48	Roadworthiness test (PTI)
24	Air quality package - NEC	49	Digital tachograph
25	Environmental Footprint	50	Odometer fraud

Sources: EC website, ACEA, internet

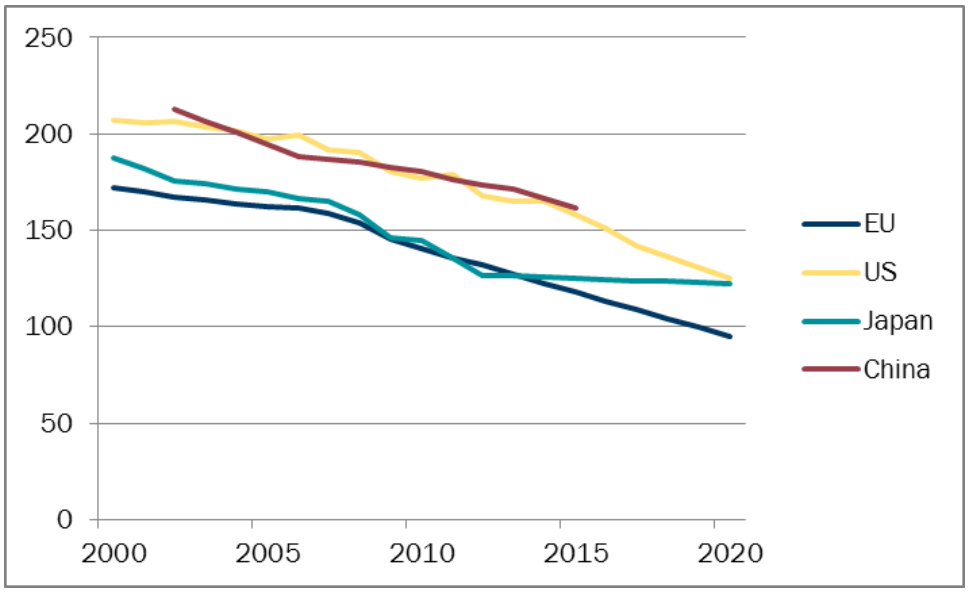
3.5 EU automotive manufacturers also face regulations abroad. Global regulations would ease the burden on manufacturers, however, these are currently set by each nation and their specifics differ considerably:

> "It is often said that motor vehicles are the most regulated consumer products and that, if this were not enough, the complexity that this introduces to the automotive business is further exacerbated by the preponderance of national rather than global regulations for a product which is more than ever global in nature."[24]

3.6 For example, the EU has set considerably stricter targets than the US, Japan and China since it started regulating CO2 emissions. For 2015 (the date of the first target) the EU set 130g/km compared to 158g/km in the US and 161g/km in China. Japan's first enacted target is for 2020, specified at 122g/km. China does not yet have an enacted target for 2020. The 2020 target for the US is 125g/km while for the EU it is 95g/km, more than 20% lower than its counterparts.

[24] Cumulative cost effect of European environmental and safety regulations on the EU Auto Industry, IHS, 2009

Figure 3-1: CO2 emissions and enacted targets for passenger cars (NEDC, gCO2/km)



Source: ICCT, FTI analysis
Note: EU 95 gCO2/km target is to be achieved by 2021, shown for 2020 for simplicity. Linear annual reduction assumed for the EU, Japan and China between last historical observation and future targets.

3.7 The lack of worldwide harmonisation of automotive regulation contributes significantly to the regulatory burden:

> "According to the Centre for Economic Policy Research, transatlantic auto regulatory divergences are equivalent to a tariff of 26%".[25]

Regulations impose significant costs that manufacturers have to absorb

3.8 Regulations impose significant costs on the automotive industry. This has been extensively documented by the Commission, technology consultants, universities and other commentators. However, estimates for specific regulations differ widely.

[25] SMMT and KPMG: The UK automotive industry and the EU, April 2014, p. 11

Table 3-3: Regulatory cost estimates

No.	Year	Regulation/*projected target*	Estimated cost /	Commentary	Source
Euro standards					
1	1992	Euro 1	£400-600	Petrol; not including fuel consumption penalty and cost of catalytic converters	Stockholm Environment Institute
2	1992	Euro 1	£350	Petrol	UK govt
3	1996	Euro 2	£250-500	Petrol	AEA Technology
4	2000	Euro 3	£210-295	Petrol	AEA Technology
5	2005	Euro 4	£210-590	Petrol	AEA Technology
6	2005	Euro 4	€470-500	Maximum compliance cost	European Commission
7	2005	Euro 1-4	£1,070-1,730	Petrol	AEA Technology
8	2005	Euro 1-4	£1,240-1,985	Diesel	AEA Technology
9	2009	Euro 5	€377-590	Diesel - reducing PM and NOx (sales-weighted average cost)	European Commission
10	2009	Euro 5	€51-105	Petrol - reducing HC and NOx (sales-weighted average cost)	European Commission
11	2009	Euro 5	€377	Diesel - relative to Euro 4	European Commission
12	2009	Euro 5	€900		ACEA
13	2009	Euro 1-5	€500-600	Price of diesel particulate filter (DPF) solutions	European Commission
14	2014	Euro 6	€213	Diesel - relative to Euro 5 - upper estimate	European Commission
15	2014	Euro 6	~€300	Cost in 2020 to meet air quality standards	AEA-Ricardo-CE
Safety					
16	2003/2005	Directives 2003/102/EC + 2005/66/EC	€27-95	Cost of amended passive safety requirements (small family car - sports car)	European Commission
17	2003/2005	Directives 2003/102/EC + 2005/66/EC	€397	Total cost including pop-up-bonnets and front spoilers - upper estimate	European Commission
18	2009	Regulation EC 661/2009	€130-250	Cost of electronic stability control (ESC)	Baum et al. (2007)
19	2009	Regulation EC 661/2009	€76	Cost of ESC if already fitted with antilock braking systems	Baum et al. (2007)
20	2011	Electronic Stability Control (ESC)	€250-340	Cost of an anti-lock braking system (€90 more for ESC)	European Commission
Type approval					
21	2013	Type approval	€5-15	Large volume passenger cars	European Commission
22	2013	Type approval	€250-300	Sport/luxury cars	European Commission
23	2013	Type approval	€50-250	Trailers/tankers	European Commission
CO2 reduction					
24	2009	Regulation 2009/443 - 130g of CO2/km (2015)	€620	Relative to 2010 baseline, reduction by 2012	TNO
25	2009	Regulation 2009/443 - 130g of CO2/km (2015)	€200	Relative to 2010 baseline (ex-post analysis)	AEA-Ricardo
26	2013	Amendment - 95g of CO2/km (2020)	<€1,000	Relative to 2010 average vehicle cost	International Council on Clean Transportation
27	2013	Amendment - 95g of CO2/km (2020)	€1,000	Relative to 2010 baseline average cost of vehicle	AEA-Ricardo-CE
28	2013	Amendment - 95g of CO2/km (2020)	>€1000	Relative to 2013 emission levels	Evercore ISI
29	2013	Amendment - 95g of CO2/km (2020)	€1,750-2,188	Based on 2020 cost curves, relative to 2009 level (high) and 130g/km (low)	TNO
30	2013	Amendment - 95g of CO2/km (2020)	€700-900	Volume OEMs, relative to 2013 emission level	Roland Berger
31	2013	Amendment - 95g of CO2/km (2020)	€1,400-1,500	Premium OEMs, relative to 2013 emission level	Roland Berger
32	2013	Amendment - 95g of CO2/km (2020)	€2,000	Relative to 2010 baseline average cost of vehicle	Institut fur Kraftfahrzeuge (IKA)
33	n/a	Global 2020 targets	$1,800-2,000	Reduction of 40% CO2 compared to 2010 level, ICE technology improvement	BCG
34	n/a	*20% weight reduction*	€250-300	Medium to large car	AEA-Ricardo
35	n/a	*20% weight reduction*	€480-890	Medium to large van	AEA-Ricardo
36	n/a	*Stop&Start technology*	€60-300	Upper estimate offers greater efficiency benefits	European Commission

Source: See Appendix 1.

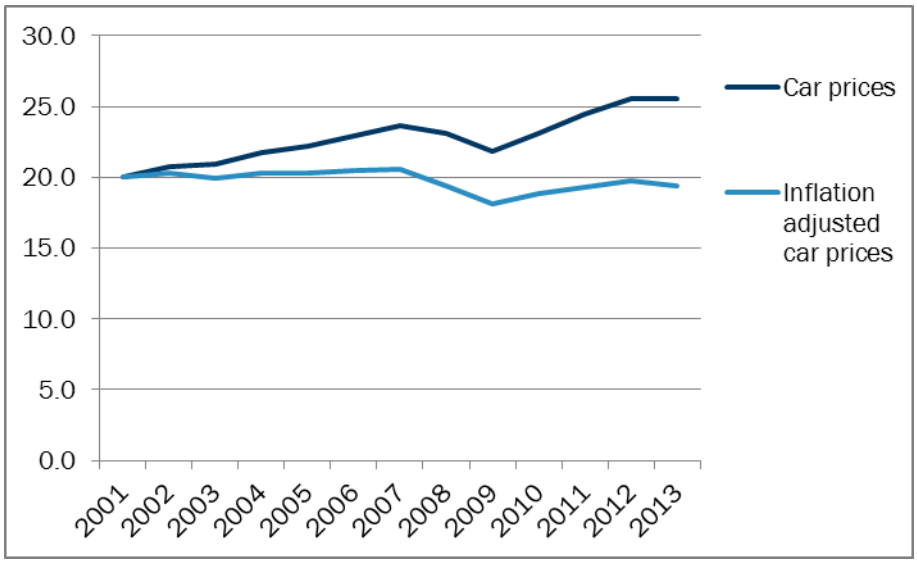
3.9 Nevertheless, it can be seen that just the environmental regulations have added a significant amount to the average manufacturing costs of passenger cars:

- the Euro 1-6 standards added €750-2,300 to the average cost of passenger cars;
- the 130g/km CO2 emission target by 2015 increases average manufacturing costs by €200-600 compared to the average cost of passenger cars in 2010;
- the 95g/km CO2 emission target by 2020 is estimated to increase average manufacturing costs by €1,000-2,000 compared to the average costs of passenger cars in 2010.

3.10 McKinsey estimated that between 1998-2011 regulatory content and other improvements such as ESP, airbags, fuel efficiency improvement and weight reduction increased production costs by 3-4% per annum.[26] More recent environmental regulations are expected to add a further 6% to the average manufacturing costs by 2015 and 16% by 2020.[27]

3.11 At the same time car prices have only increased with inflation, that is, they have been flat in real terms. Therefore, manufacturers had to absorb all cost increases as they were not able to pass them on to their customers in the form of increased prices.

Figure 3-2: EU average car prices (€ '000)



Source: ICCT EU Pocketbook 2014, Eurostat, FTI calculations

26 McKinsey "The road to 2020 and beyond", 2013, p. 10.

27 See calculations in Appendix 2.

The Commission's view of the impact of regulations

3.12 The Commission has published a series of impact estimates regarding the impact of regulatory costs on automotive manufacturers. In these it expresses its view that at worst, regulation has neutral impact on the automotive industry. For example, in its impact assessment related to the Euro 5 standard it states that as the standard applies to all manufacturers that sell vehicles on the European market it has neutral impact on the competitiveness of the EU automotive industry:

> *"neutral direct impacts"* since *"these costs will be incurred for all the car manufacturers that sell vehicles on the European market, so for the competitors of the European automotive companies as well"*[28]

3.13 In its assessment of the impact of the 2020 CO2 emission target the Commission refers to the strong global competitive positioning of the EU automotive industry concluding that it is unlikely that the regulation will change this position:

> *"the EU vehicle manufacturing industry continues to be very competitive at an international level. The implementation of the 2020 targets is unlikely to change this position"*[29]

3.14 Furthermore, the Commission has suggested that regulations could even increase the competitiveness of the EU automotive industry by encouraging innovation:

> *"The automotive industry could become more competitive in markets outside the EU with strict environmental regulation in force, through being able to produce vehicles equipped with advanced environmental technologies"*[30]

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28 European Commission http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52005SC1745&from=EN

29 European Commission http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52012SC0213

30 European Commission http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52005SC1745&from=EN

4. Further regulation will exacerbate the problem

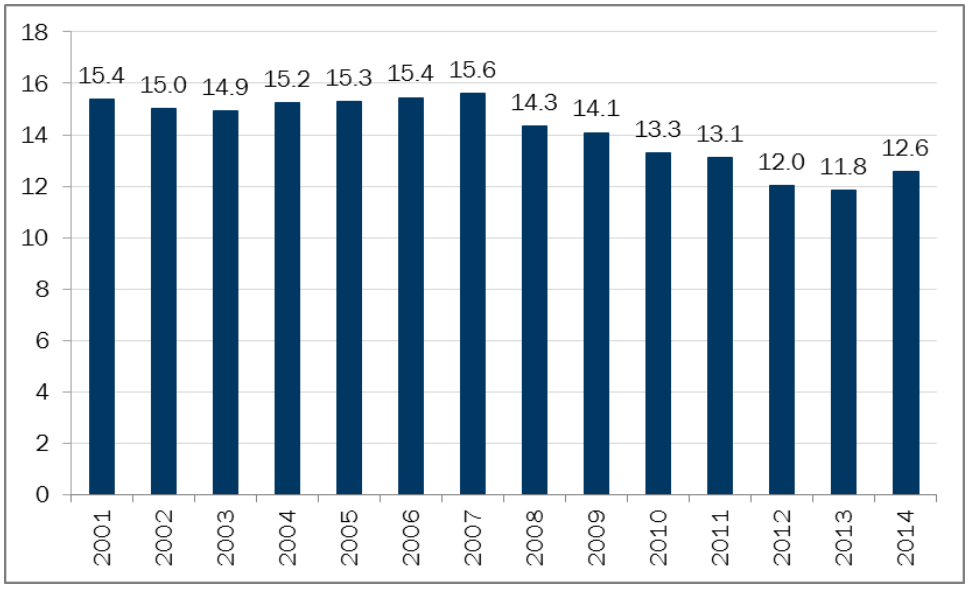
Introduction

4.1 In contrast to the Commission's view that the industry continues to be very competitive at an international level, the EU automotive sector is suffering from a multitude of competitive pressures. It has lost its global leadership in sales and production, its profits have collapsed and it is losing employment and investment. With regulatory costs progressively increasing, continued disproportionate regulatory burden will exacerbate the problem.

Background

4.2 At its peak in 2007, the automotive sector sold 15.6 million new cars in the EU. Since then, registrations have fallen continuously and have only returned to growth in 2014. With new car registrations still nearly 20% below the peak, Fiat's chief executive called recent developments the first steps from hell to purgatory.[31]

Figure 4-1: EU new passenger car registrations (million units)

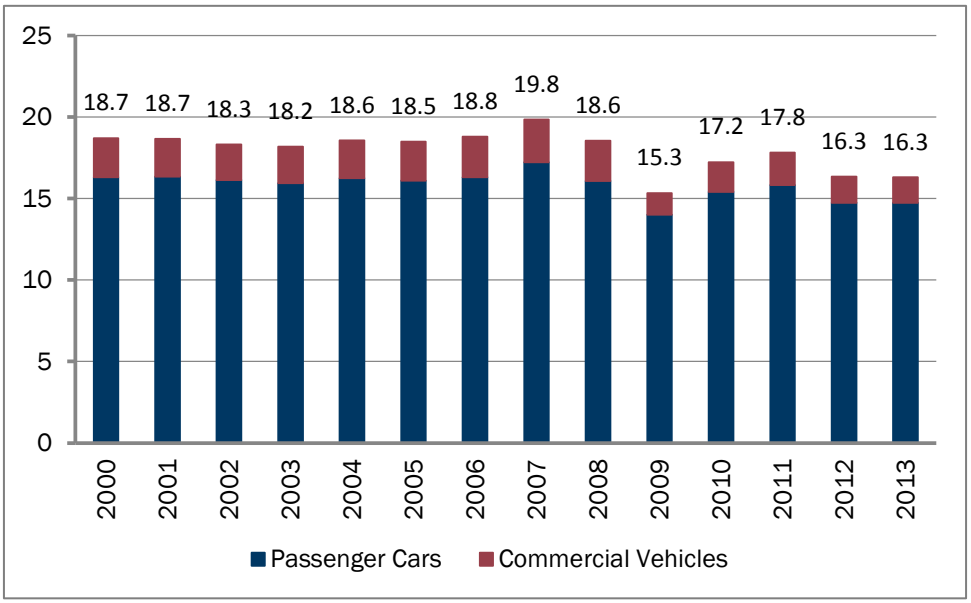


Source: ACEA

31 The Financial Times, Fiat's Marchionne sees end of European hell, 10 February 2015

4.3 Manufacturing of light vehicles shows broadly similar patterns. Between 2007 and 2009, production contracted by 23%, far more than the overall economy, highlighting the sector's vulnerability to economic fluctuations. Despite some rebounding, volumes are still far below the 19 million production rate that was maintained in the early 2000s, and even further from the 20 million units achieved in 2007.

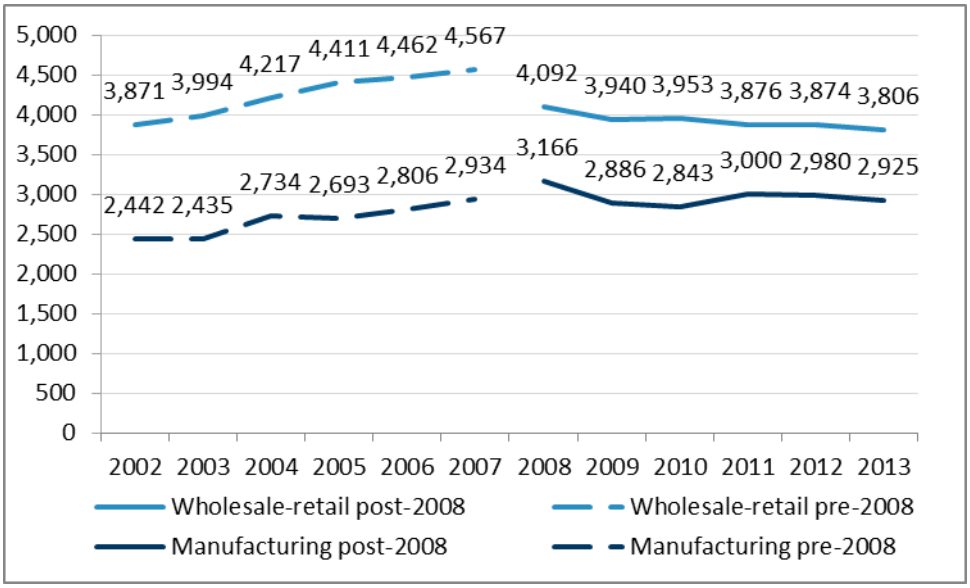
Figure 4-2: EU production: passenger cars and commercial vehicles (million units)



Source: ACEA

4.4 Albeit at a slower pace, employment in the automotive sector has also been declining in the EU since 2007. While in both manufacturing and wholesale-retail sale of vehicles employment was trending up until 2007, between 2008 and 2013 it fell by 7-8%. The slow adjustment of employment to significantly reduced production levels partly reflects the political sensitivity to shedding employment in Europe.

Figure 4-3: EU automotive employment (thousand employees)



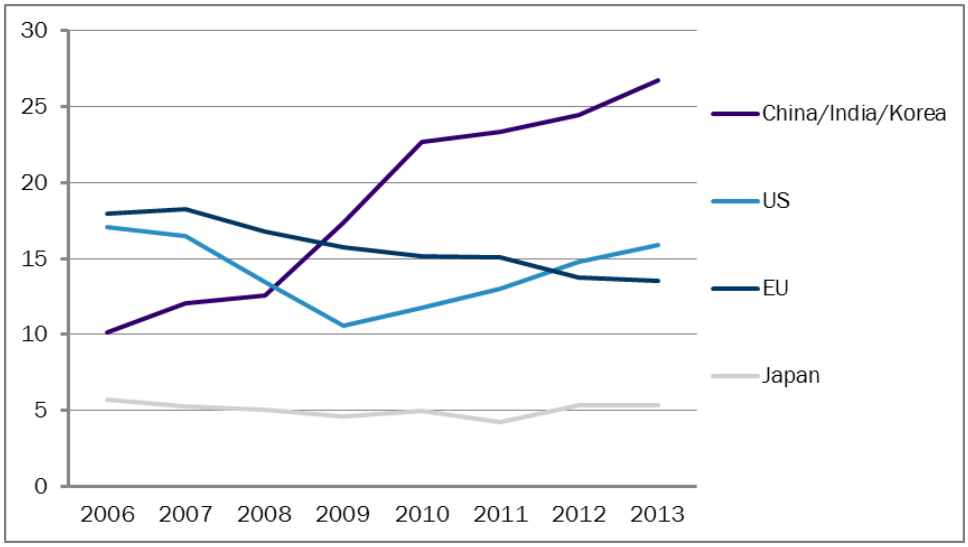
Note: Series pre- and post-2008 are not directly comparable due to reclassification of economic activities by Eurostat.[32]
Source: Eurostat Labour Force Survey

The sector is losing volumes to competitor regions and making losses as a result

4.5 Until 2008, the EU was the largest market for new vehicles. Since then it has been overtaken by the three Asian producers, China, India and Korea. By 2013 the three Asian countries combined registered twice as many vehicles as the EU. At the same time, the US, a traditionally smaller market than the EU recovered from a large drop in demand suffered during the recession and by 2013 registered 2 million more vehicles than the EU.

[32] For example, manufacturing post-2008 is a broader category than manufacturing pre-2008 as it also includes manufacture of electrical equipment for engines and vehicles, manufacture of other electrical equipment for motor vehicles, and manufacture of car seats which had not been included in the pre-2008 classification.

Figure 4-4: Global sales of motor vehicles (million units)

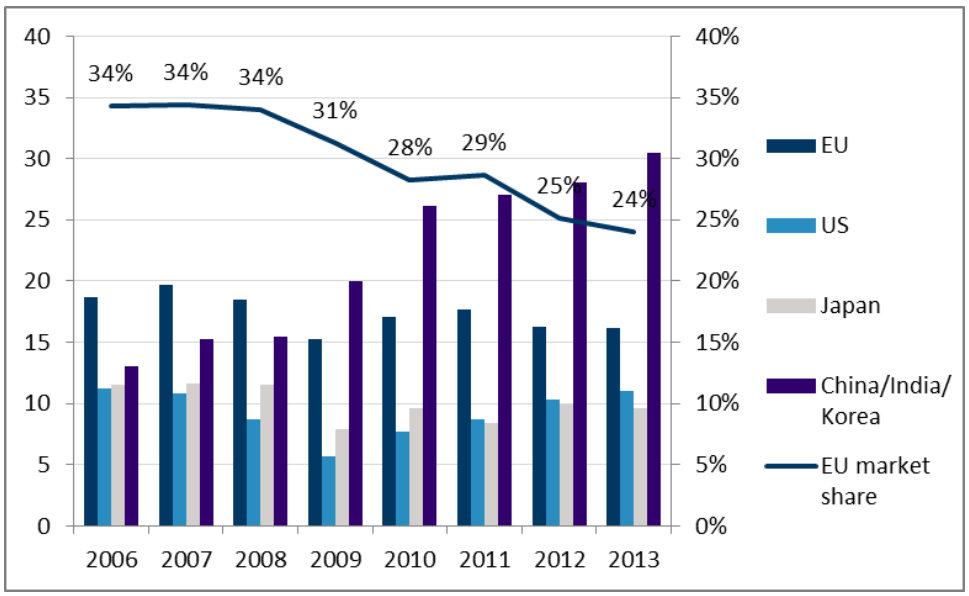


Source: OICA

4.6 Production has followed sales patterns as major OEM's moved closer to the high growth markets in Asia. While sales in Asia had a 15% annual growth rate (CAGR) between 2006 and 2013, production grew by 13% per annum. As a result, the EU's market share in the production of major vehicle manufacturing regions fell from 34% to 24% between 2006 and 2013.

4.7 The recession had a visible impact on the production of the developed regions. Between 2007 and 2009, production fell by 47% in the US, by 31% in Japan and by 22% in the EU. However, by 2013 the US had surpassed its previous peak, while the EU and Japan are still nearly 20% below the levels seen in 2007.

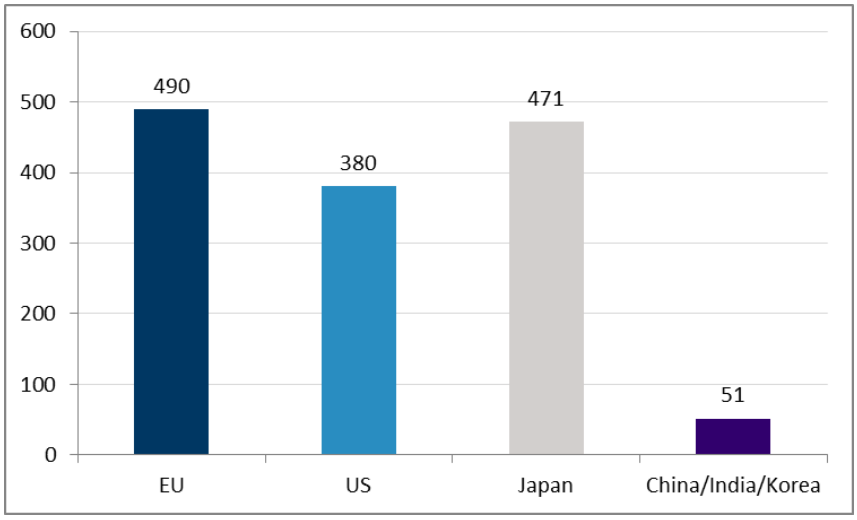
Figure 4-5: Global production of motor vehicles (million units)



Source: OICA, Eurostat

4.8 This trend can be expected to continue. Demand in the EU is unlikely to accelerate, although there has been some improvement in 2014. In fact, experts do not expect that the 17 million peak units will be ever reached again. On the other hand, the fleet in Asia is still small compared to fleets in developed markets. In 2013 the EU had 248 million passenger cars while China, India and Korea altogether had only 136 million. The difference is even more striking when population is taken into account: in 2013 the Asian markets had 51 cars per thousand people compared to 490 in the EU.

Figure 4-6: Passenger cars per thousand people



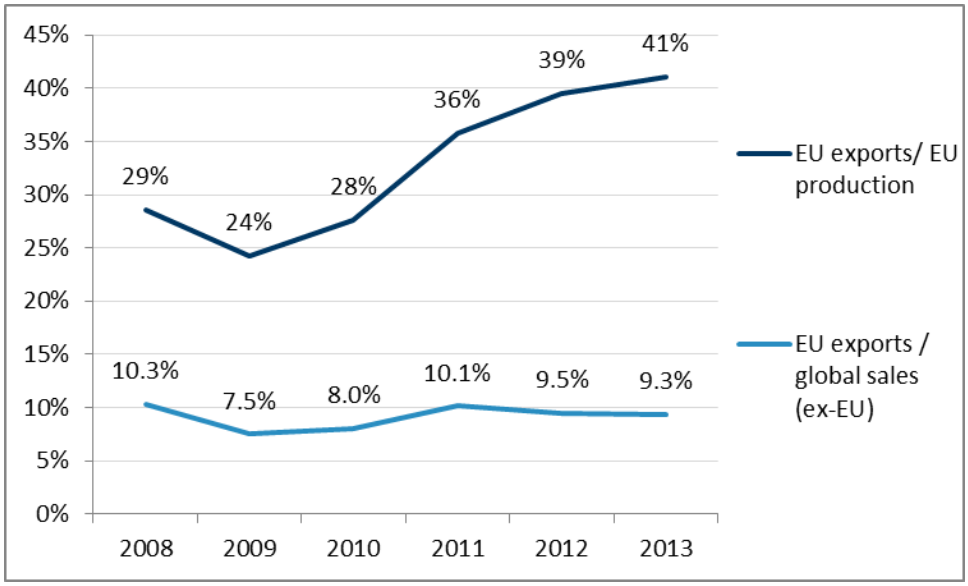
Source: OICA, World Bank

4.9 The EU has always been a net exporter of motor vehicles. In 2013 the automotive industry contributed €95 billion to the EU's trade surplus. Since the beginning of the financial crisis which dampened demand in the developed world and left the EU with significant overcapacities, EU manufacturers have aimed at increasing exports to high growth markets. Indeed, this strategy has been suggested by the Commission as an opportunity for the sector in the difficult domestic environment it is facing[33].

4.10 Between 2008 and 2013, EU exports increased from 5.3 million to 6.6 million units, at a 5% CAGR. As total EU production declined over the same period this meant a significant shift in export orientation: in 2013 the sector exported 41% of production compared to 29% in 2008. However, the market share of EU exports has not improved significantly. On the contrary, EU exports have grown significantly slower than for example sales in Asia (by 16% CAGR).

33 European Commission, Policy briefing: The EU automotive sector in a globalised market, 2012

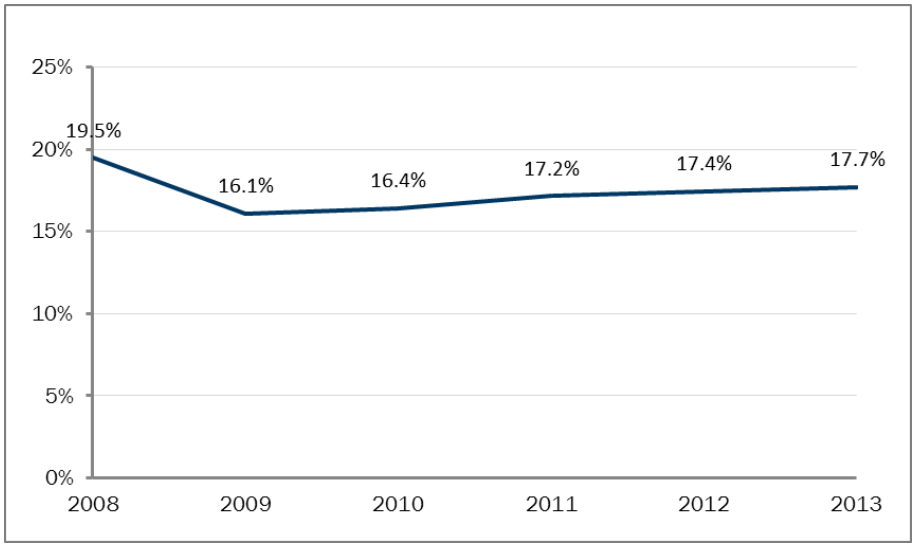
Figure 4.7: EU export as % of production and as % of sales outside the EU



Source: OICA, Eurostat, ACEA

4.11 The sector's domestic market share has also not improved in the same period. Following an initial drop in 2009, imports have been increasing gradually. Hence EU manufacturers not only compete against each other for significantly reduced domestic demand but they face further price pressures from foreign manufacturers.

Figure 4-8: EU import as percentage of sales

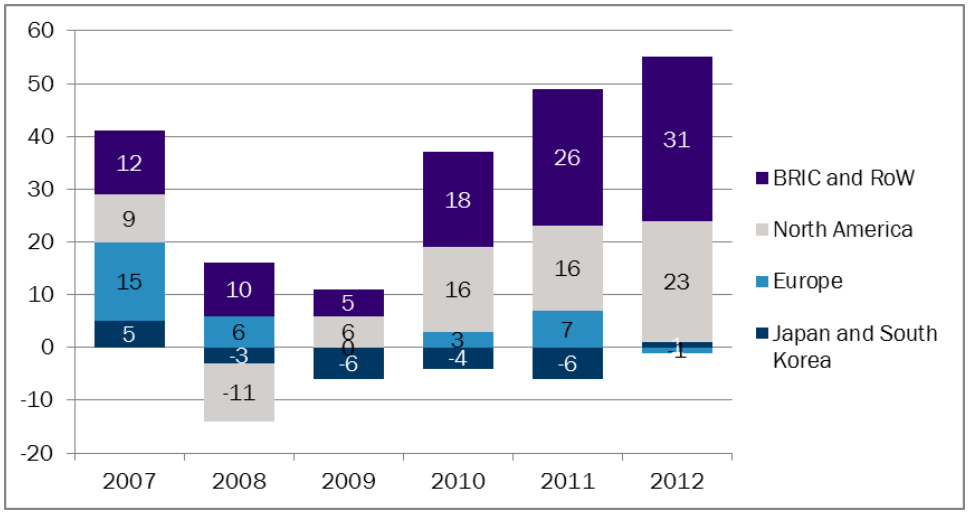


Sources: OICA. Eurostat, ACEA

4.12 From being the most profitable region with €15 billion profits on sales in 2007 the EU has slipped to the worst position, making a loss by 2012. While some manufacturers made profits in the EU, others more than offset these by making losses, which in aggregate resulted in a €1 billion net loss in 2012.

4.13 Although North America and the emerging markets have also experienced a couple of difficult years, by 2012 sales in these regions generated well over twice the profits they had made in 2007.

Figure 4.9: Global profitability (€ billions)

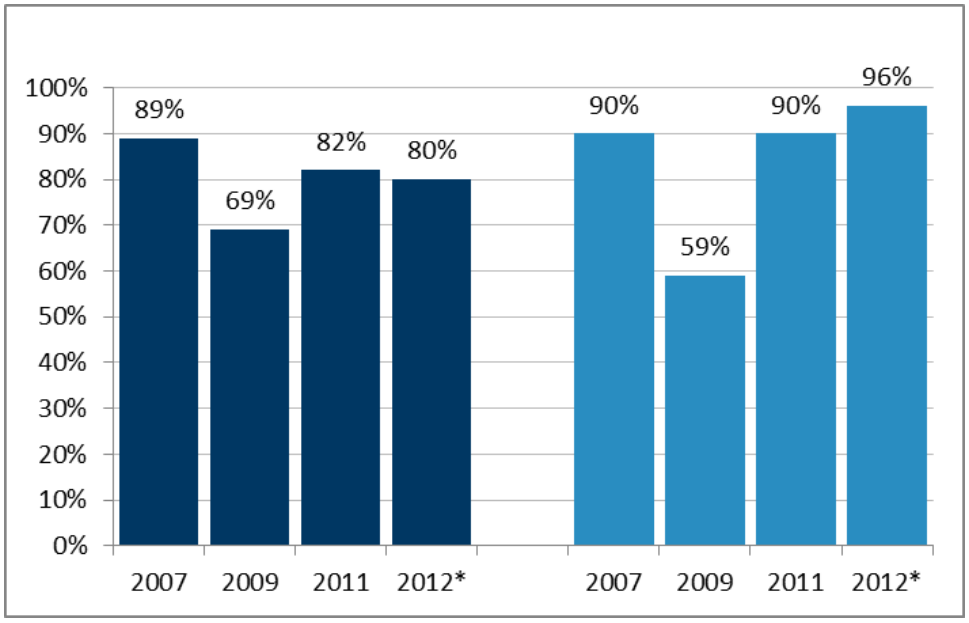


Notes: Aggregating profits and losses on sales in a given region by top 17 OEMs. Chart refers to Europe, however, OEMs confirmed that the same trend applies to the EU.
Source: McKinsey Road to 2020

4.14 Rapidly deteriorating profits in the EU are a result of increasing costs, flat prices and declining volumes. Costs in the EU are significantly higher than in Eastern Europe, let alone in the rapidly growing Asian markets. As discussed in Section 3, regulations have and continue to impose significant costs on the automotive industry.

4.15 High costs are also due to sustained overcapacities in the EU. This is a result of several factors: continuously falling demand since 2007, manufacturers' inability to fill the gap with exports and the enormous costs of and political resistance against shutting down plants and shedding employment in the EU. At the same time the US has quickly improved capacity utilisation by closing down production lines and it was also helped by the recovery of its domestic demand.

Figure 4-10: Capacity utilisation in Europe vs in the US



*Note: * Estimate. Chart refers to Europe and not the EU. The EU has substantial overcapacities but its capacity utilisation may differ from the numbers shown above.*
Source: McKinsey, The road to 2020

The sector is losing investment

4.16 Considering these trends it is not surprising that manufacturers have finally started to shut down plants in the EU and their announced plant openings are overwhelmingly focussed on the fast growing and profitable Asian and South-American markets.

Table 4-1: Recent and planned plant openings/closures

Manufacturers	Plant closures	Plant openings	
BMW		Araquari, Brazil (2014)	San Luis Potosi, Mexico (2019)
Daimler		Kecskemet, Hungary (2012) Nizhny Novgorod, Russia (2013) Decherd, US (2014)	Iracemapolis, Brazil (2016) North Charleston, US (2018)
Fiat Chrysler	Temini Imerese, Italy (2011)	Pernambuco, Brazil (2015)	Guangzhou, China (2016)
Ford	Southampton, UK (2013) (1) Dagenham, UK (2013) (2) Genk, Belgium (2014) (3) Geelong, Australia (2016) (4) Broadmeadows, Australia (2016) (5)	Chennai, India (2010) (6) Chongqing, China (2012) (7) Chongqing, China (2012) (8) Xiaolan, China (2013) (9) Chongqing, China (2014) (10)	Naberez. C., Russia (2014) (11) Yeniköy, Turkey (2014) (12) Sanand, India (2015) (13) Hangzhou, China (2015) (14) Elabuga, Russia (2015) (15)
GM	Bochum, Germany (2014)	5 plants in China (2015)	
Jaguar Land Rover		Changshu, China (2014)	Itatiaia, Brazil (2016)
PSA Peugeot Citroën	Aulnay, France (2014)	Wuhan, China (2013) Shenzhen, China (2013)	Chengdu, China (2016)
Renault		Oran, Algeria (2014) Wuhan, China (2016)	
Toyota		Guangzhou, China (2017) (16)	Guanajuato, Mexico (2019)
Volkswagen		Pune, India (2009) Dalian, China (2010) Chattanooga, US (2011) Chengdu, China (2011) Yizheng, China (2012)	Silao, Mexico (2013) 5 plants in China (2013) St. Petersburg, Russia (2013) Tianjin, China (2014)
Volvo		Chengdu, China (2013) Zhangjiakou, China (2013)	Daqing, China (2014) 1 plant in US (TBD)

Notes: (1) Stamping and Tooling operation (2) Assembly (3) Assembly (4) Assembly (5) Assembly (6) Engine Plant (7) Assembly (8) Engine plant (9) Assembly (10) Transmission plant (11) Assembly (12) Assembly (13) Assembly and engine plant (14) Assembly (15) Engine plant (16) Expanding joint venture, Guangzhou Toyota Motor Co., Ltd. (GTMC)
Sources: Company annual reports, OEMs.

The problem is likely to get worse as costs of regulations increase progressively

4.17 As shown in Table 3.3., estimates for the additional manufacturing costs of reducing CO2 emissions to 95g/km by 2020 range between €1,000-2,000 per passenger car. Even calculating with the lower end of this range, these estimates translate to a fleet-wide capital cost of around €13 billion[34], as indicated for example by Evercore ISI.[35] Compared to the €15 billion profits the industry made in the peak year and the €1 billion loss it made in 2012, absorbing €13 billion additional costs to achieve the 2020 emission target will be challenging:

> *"[] in an industry where mass OEMs generate roughly €200-300 in profit per vehicle (with the majority of EU car sales still loss making), incremental costs in excess of €1,000/car will prove challenging to absorb"*[36]

4.18 Moreover, in April 2013 the European Parliament's Environment Committee put forward indicative CO2 emission targets of between 68 g/km and 78 g/km for 2025, i.e. a target well below those of other regions to be achieved in a very short time frame:

> *"Taking the mean value of this range (73 g/km), this would constitute a further reduction of 23%, and in just four years (i.e. just shorter than one model cycle)!"*[37]

34 Approx. 13 million new car registrations *times* additional manufacturing cost of €1,000 per car.

35 Evercore ISI, Emission regulation. The industry's biggest challenge, 2014

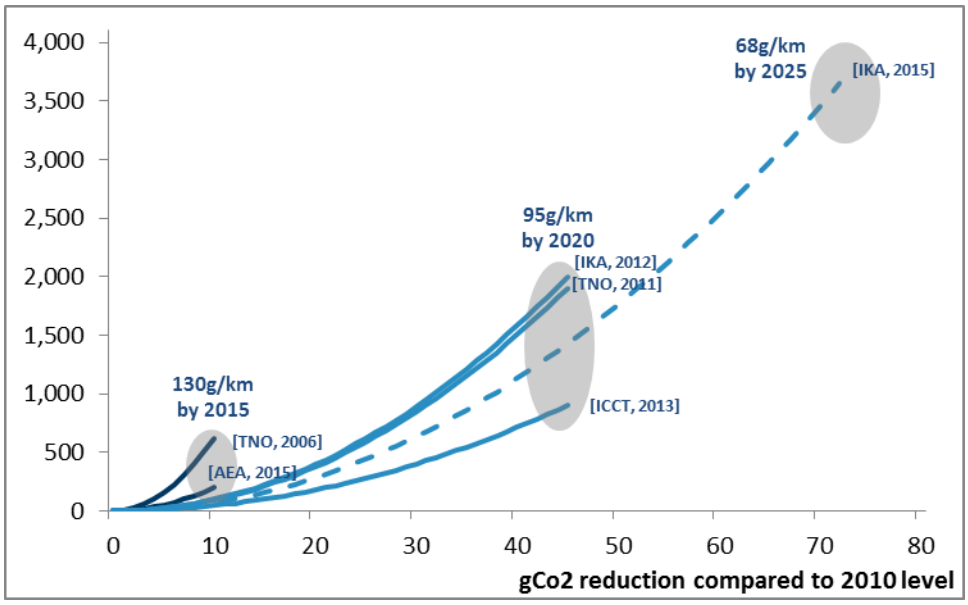
36 Evercore ISI, Emission regulation. The industry's biggest challenge, 2014

37 Deutsche Bank, CO2 emissions from cars, 2014

4.19 As targets become stricter, regulatory costs progressively increase. The less expensive adjustments, such as optimised cooling and improved aerodynamics, have already been made.

4.20 Any further reduction beyond the 2020 target will require significant electrification and/or alternative technologies as manufacturers run out of cost effective CO2 reduction measures for ICE technologies. According to IKA's most recent estimate, reducing CO2 emissions to 68g/km by 2025 would cost between €3,200-4,100 per passenger car (compared to the 2010 baseline costs).[38]

Figure 4-11: Costs estimates to achieve different CO2 reduction targets (€)



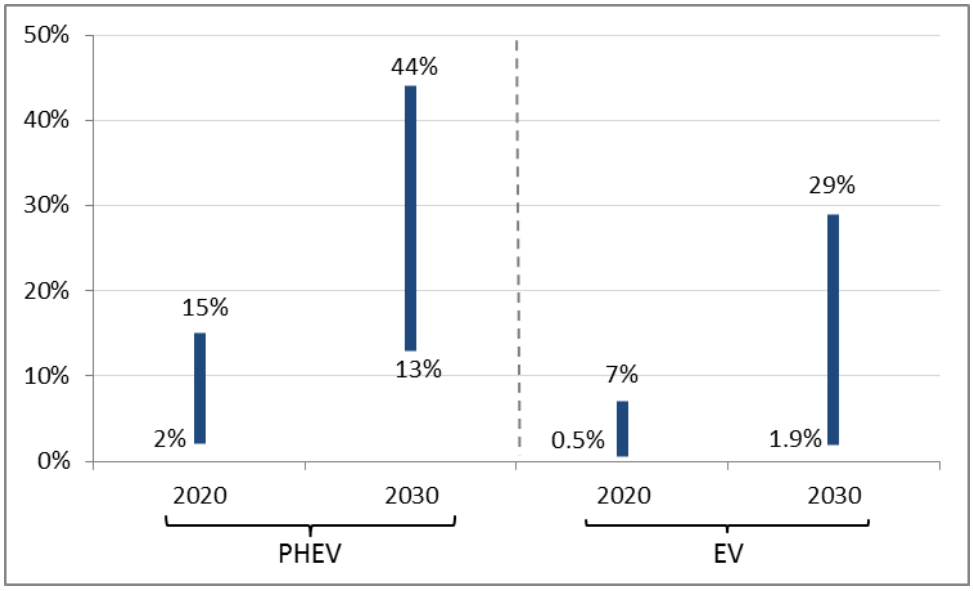
Notes: TNO (2011) uses 2020 cost curve and takes the midpoint between €1,750-2,200 estimates. IKA (2015) refers to cost optimal technology mix estimates and takes the midpoint between €3,200-4,100.
Sources: see Appendix 3.

[38] IKA, CO_2 emission reduction potential for passenger cars and light commercial vehicles post 2020, 2014

4.21 Although every OEM has brought electric vehicles to market, the take-up has been slow and has significantly lagged expectations. In 2014, 75 thousand electrically rechargeable vehicles (including battery electric vehicles and plug-in hybrids) were sold in the EU; about 0.5% of total sales. These figures are especially low when considering heavy subsidies that several countries have offered.

4.22 There is considerable uncertainty around the future take-up rates of rechargeable vehicles. AEA-Ricardo collected estimates of market shares for rechargeable vehicles developed between 2010 and 2012 and found wide ranges of forecasts. For 2020 estimates vary widely and even the most conservative forecasts appear unrealistic in light of the current market share of rechargeable vehicles. The spreads are even larger for 2030.

Figure 4-12: Estimates of market shares of rechargeable vehicles in 2020 and 2030



Source: Ricardo-AEA Powering ahead: the take-up of electric cars, 2013

Appendix 1 Sources of regulatory cost estimates

Table A1.1 Sources of estimates in Table 3.3

No.	Source
Euro standards	
1 Stockholm Environment Institute	The design of effective regulation of transport - Winston Harrington (2008)
2 UK govt	The design of effective regulation of transport - Winston Harrington (2008)
3 AEA Technology	An Evaluation of the Air Quality Strategy - AEA Technology (2004)
4 AEA Technology	An Evaluation of the Air Quality Strategy - AEA Technology (2004)
5 AEA Technology	An Evaluation of the Air Quality Strategy - AEA Technology (2004)
6 European Commission	Cumulative cost effect of European environmental and safety regulations on the EU Auto Industry - European Commission
7 AEA Technology	An Evaluation of the Air Quality Strategy - AEA Technology (2004)
8 AEA Technology	An Evaluation of the Air Quality Strategy - AEA Technology (2004)
9 European Commission	2005 Impact Assessment - European Commission
10 European Commission	2005 Impact Assessment - European Commission
11 European Commission	2006 Impact Assessment - European Commission
12 ACEA	Effect of regulations and standards on vehicle prices - AEA Technology (2011)
13 European Commission	Cumulative cost effect of European environmental and safety regulations on the EU Auto Industry - European Commission
14 European Commission	2006 Impact Assessment - European Commission
15 AEA-Ricardo-CE	An Economic Assessment of Low Carbon Vehicles - AEA-Ricardo-Cambridge Economics (2013)
Safety	
16 European Commission	2007 Impact Assessment - European Commission
17 European Commission	2007 Impact Assessment - European Commission
18 Baum et al. (2007)	An Economic Assessment of Low Carbon Vehicles - Ricardo-AEA (2013)
19 Baum et al. (2007)	An Economic Assessment of Low Carbon Vehicles - Ricardo-AEA (2013)
20 European Commission	Cumulative cost effect of European environmental and safety regulations on the EU Auto Industry - European Commission
Type approval	
21 European Commission	Fitness Check of the EU legal framework for the type-approval of motor vehicles - European Commission (2013)
22 European Commission	Fitness Check of the EU legal framework for the type-approval of motor vehicles - European Commission (2013)
23 European Commission	Fitness Check of the EU legal framework for the type-approval of motor vehicles - European Commission (2013)
CO2 reduction	
24 TNO	Review and analysis of the reduction potential and cost of technological and other measures to reduce CO2 emissions from passenger cars - TNO (2006)
25 AEA-Ricardo	Evaluation of regulations 443/2009 and 510/2011 on the reduction of CO2 emissions from light-duty vehicles - AEA-Ricardo (2014)
26 International Council on Clean Transportation	Reducing CO2 and fuel consumption from new cars: Assessing the near term technology potential in the EU (ICCT)
27 AEA-Ricardo-CE	An Economic Assessment of Low Carbon Vehicles - AEA-Ricardo-Cambridge Economics (2013)
28 Evercore ISI	Emission regulation: The industry's biggest challenge - Evercore ISI 2014
29 TNO	Support for the revision of Regulation (EC) No 443/2009 on CO2 emissions from cars - TNO (2011)
30 Roland Berger	CO2 reduction 2021 and beyond - Roland Berger (2014) Found at autonews.com
31 Roland Berger	CO2 reduction 2021 and beyond - Roland Berger (2014) Found at autonews.com
32 Institut fur Kraftfahrzeuge (IKA)	CO2 reduction potentials for passenger cars until 2020 - IKA, Institut fur Kraftfahrzeuge (2012)
33 BCG	Powering autos to 2020 BCG (2011)
34 AEA-Ricardo	Improving the understanding of the potential for weight reduction in cars and vans - Ricardo-AEA (2014)
35 AEA-Ricardo	Improving the understanding of the potential for weight reduction in cars and vans - Ricardo-AEA (2014)
36 European Commission	Cumulative cost effect of European environmental and safety regulations on the EU Auto Industry - European Commission

Appendix 2 Manufacturing costs of recent environmental regulations

A2.1 We estimate that the average manufacturing cost of passenger cars was approximately €14,400 in 2010 – based on a 60% mark-up[39] and €23,100 average car price in the EU.[40]

A2.2 The table below summarises the manufacturing cost estimates related to the Euro V and Euro VI legislations and the 2015 and 2020 CO2 emission targets.

Table A2.1 Additional manufacturing costs of recent environmental regulations

	Range	Mid-point
Euro V cost estimate	€51-900	€ 475
130g CO2/km cost estimate*	€200-620	€ 410
Additional costs to 2015		***€ 885***
Euro V cost estimate	€51-900	€ 475
Euro VI cost estimate	€213-300	€ 257
95g CO2/km cost estimate*	€1,000-2,000	€ 1,500
Additional costs to 2020		***€ 2,232***

*Note: *Additional cost to achieve target compared to manufacturing cost in 2010.*
Source: Table 3.3 in Section 3, FTI calculations

A2.3 The additional costs to 2015 represent 6% of the average manufacturing costs in 2010 and the additional costs to 2020 represent 16% of the manufacturing costs in 2010.

39 IKA, CO2 emission reduction potential for passenger cars and light commercial vehicles post 2020, 2014

40 ICCT, EU Pocketbook, 2014

Appendix 3 Sources of estimates in Figure 4.11

- TNO (2006): *Review and analysis of the reduction potential and costs of technological and other measures to reduce CO2-emissions from passenger cars*, pages 65-67. Note that data refer to CO2 reduction by 2012 (as opposed to 2015).
- AEA (2015): *Evaluation of regulations 443/2009 and 510/2011 on the reduction of CO2emissions from light-duty vehicles*, page 17.
- TNO (2011): *Support for the revision of Regulation (EC) No 443/2009 on CO2 emissions from cars,* page 14. Note that based on 2020 cost curves and mass utility parameter additional manufacturing cost of achieving 95g/km target is estimated at €2,188 compared to 2009 and €1,750 relative to 130g/km target.
- IKA (2012): *CO2 reduction potentials for passenger cars until 2020,* page 5.
- ICCT (2013): *Reducing CO2 and fuel consumption from new cars: Assessing the near term technology potential in the EU*, page 4.
- IKA (2015): *CO2 emission reduction potential for passenger cars and light commercial vehicles post 2020*, page 5. Note that a range of €3,200-4,100 increase in production costs is estimated assuming cost-optimal technology mix.