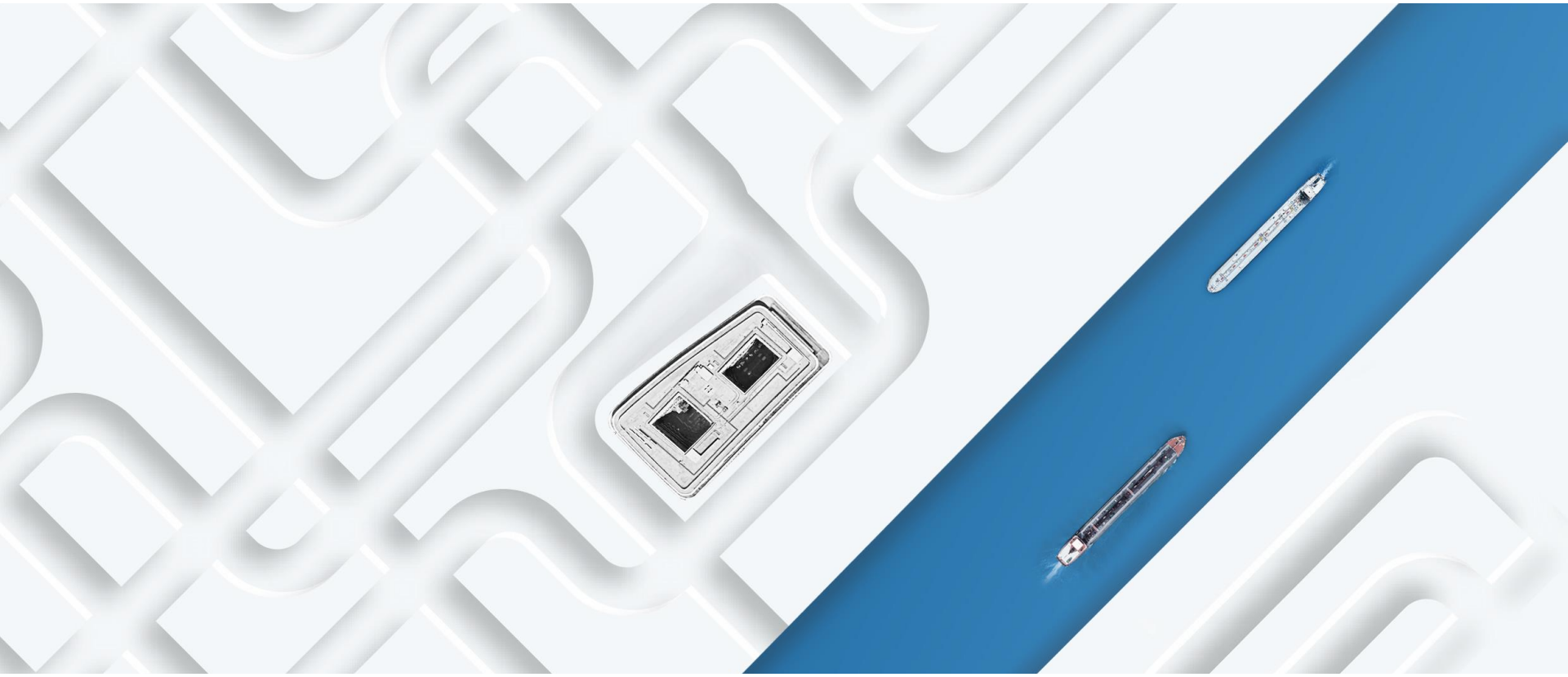
CO_2 regulation in Europe

A compendium – Version 4.3



INSTITUT DER DEUTSCHEN WIRTSCHAFT

2020/Thomas Puls

Chapter overview

The core theses: Brief overview

Climate protection

1. Europe's share of the worldwide CO_2 emissions is low and continuously decreasing. (100)

2. No solution without China: Europe's reduction of emissions is being eaten up by growth in emerging economies. (103)

3. Motor vehicles account for approximately one-seventh of the CO_2 emissions in the EU. Their share in transportation emissions is declining. (106)

CO_2 regulation for motor vehicles

4. New vehicles in Europe have become considerably more efficient in recent years. (108)

5. CO_2 legislation in Europe shows the most stringent target values in an international comparison. (110)

6. Europe has once again tightened the reins on the CO_2 limit values for motor vehicles and is requiring a further reduction of CO_2 within an even shorter span of time. (112)

7. Der Pkw-Sektor ist auch ohne eine weitere Verschärfung der CO_2-Grenzwerte nach 2020 auf Kurs, um die Ziele der EU-Klimapolitik bis 2030 zu erfüllen.(114)

8. Vehicle fleet limit values under 95 grams cannot be achieved with conventional engine types, and the market success of alternative engine types is still uncertain. (116)

9. EU environmental legislation is not coherent and, for a long time, had other priorities than CO_2 reduction. This had various consequences, including an increase of CO_2 emissions. (119)

10. Today's CO_2 laws regulate only new vehicles, completely disregarding the remaining vehicle fleet. (122)

11. An effective reduction of CO_2 emissions cannot address new vehicles alone but must take a much broader approach. (124)

Balance between climate protection and industrial policy

12. The EU is targeting a 20% industry share of GDP for the year 2020. This goal is presently a long way away, since industrial and climate protection policy are not yet aligned. (126)

13. The CO_2 abatement costs vary greatly between sectors and are most pronounced in the automotive sector. (129

14. Emissions trading as the most economically efficient form of CO_2 regulation can easily be applied to road traffic. (131)

Agenda

1 Megatrends

2 Political framework

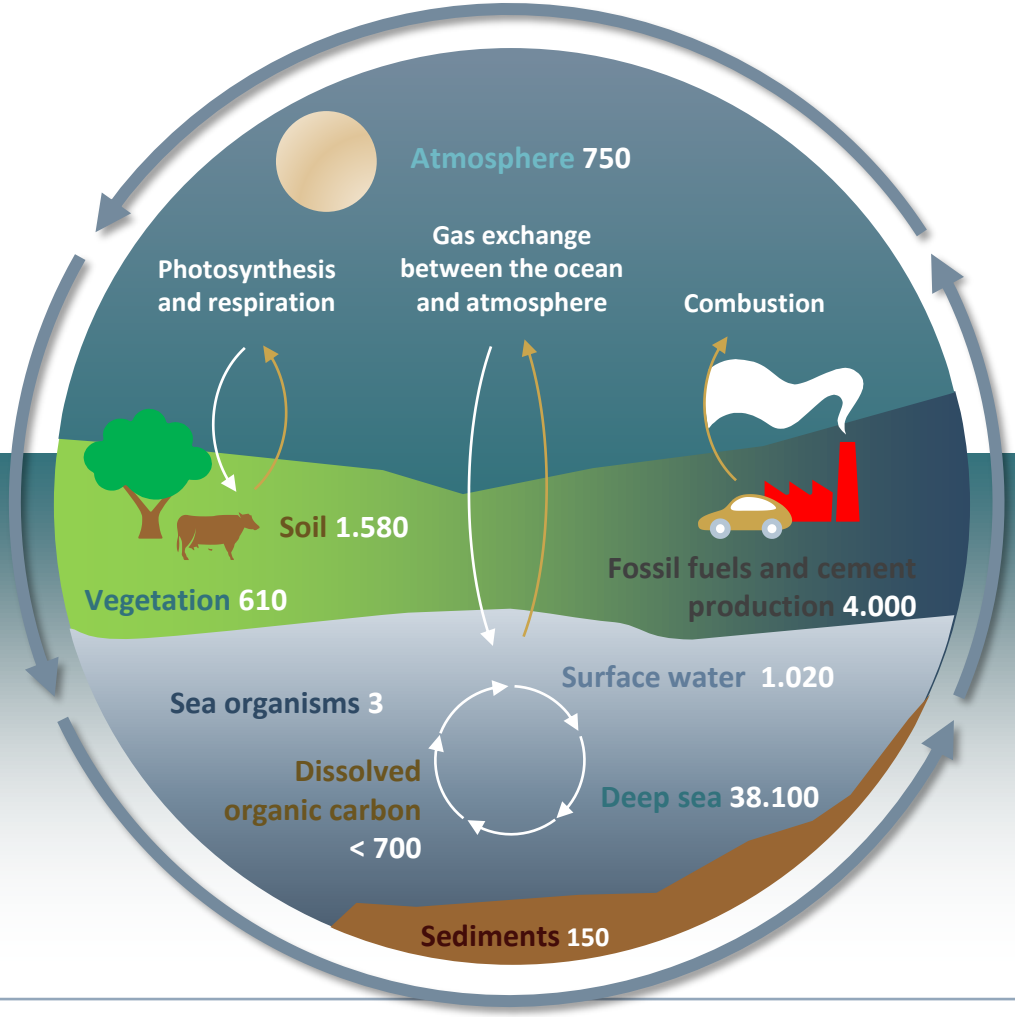
3 Transportation sector

4 Other sectors

5 Outlook

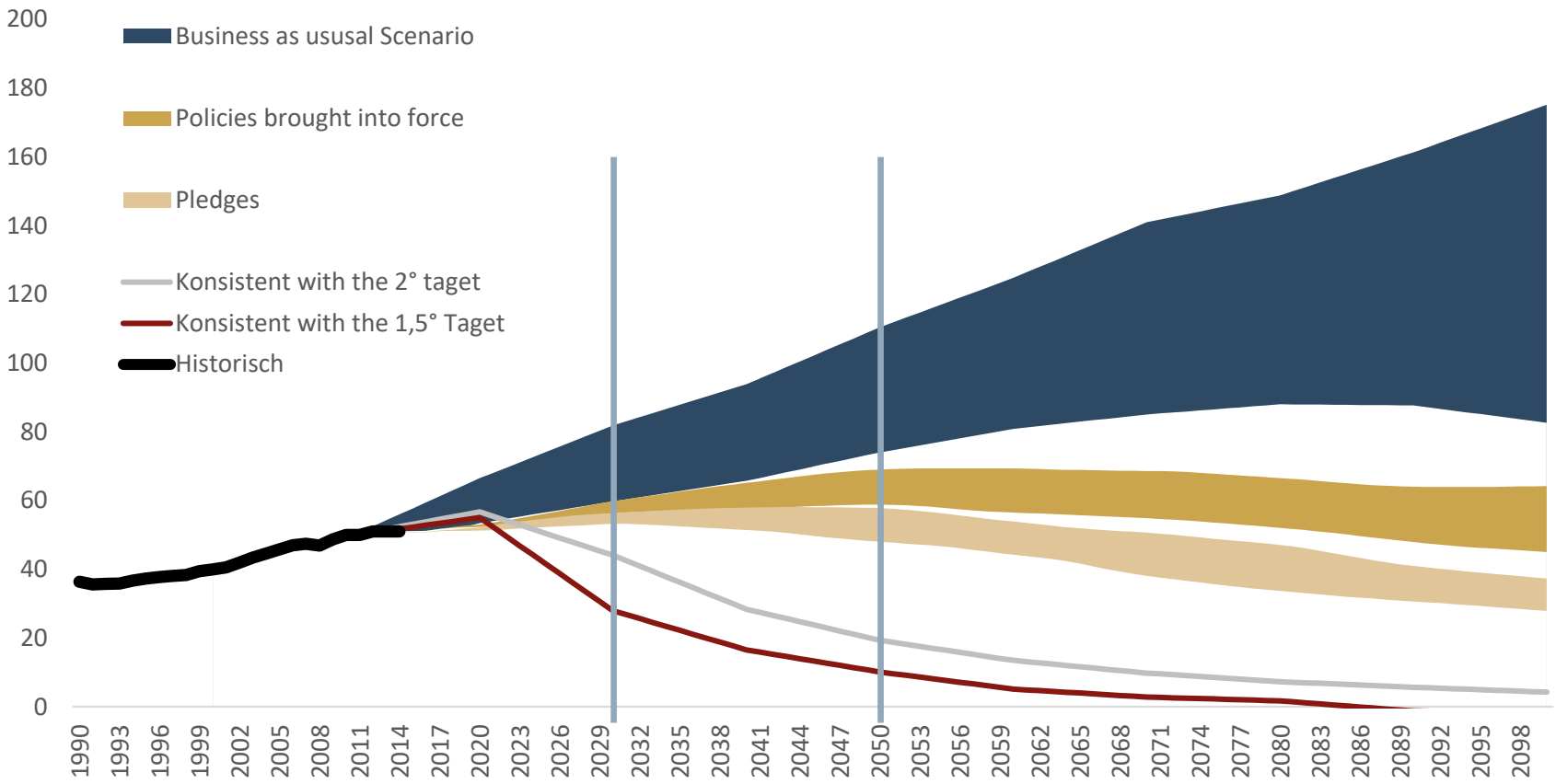
The carbon cycle

Carbon reservoirs in in billions of tonnes



Paris Climate accord: Urgent action required

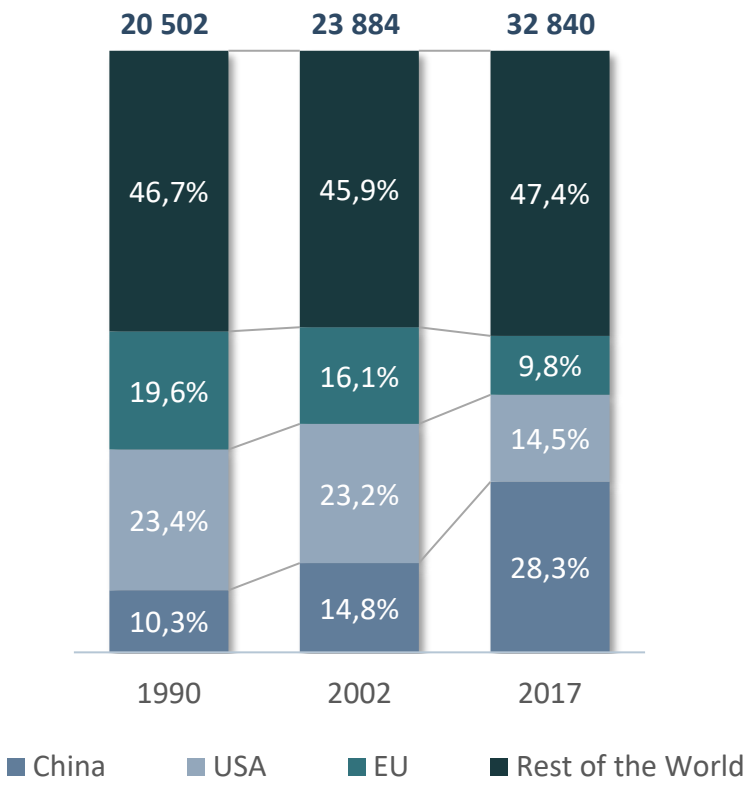
Global Emissions in Gigatons CO_{2eq}



Quelle: Climate Action Tracker Project, September 2019

CO_2 emissions: Europe's share sharply decreasing

Emissions from fuel use, in millions of tonnes



Source: IEA, CO_2 Emissions from Fuel Combustion – 2019

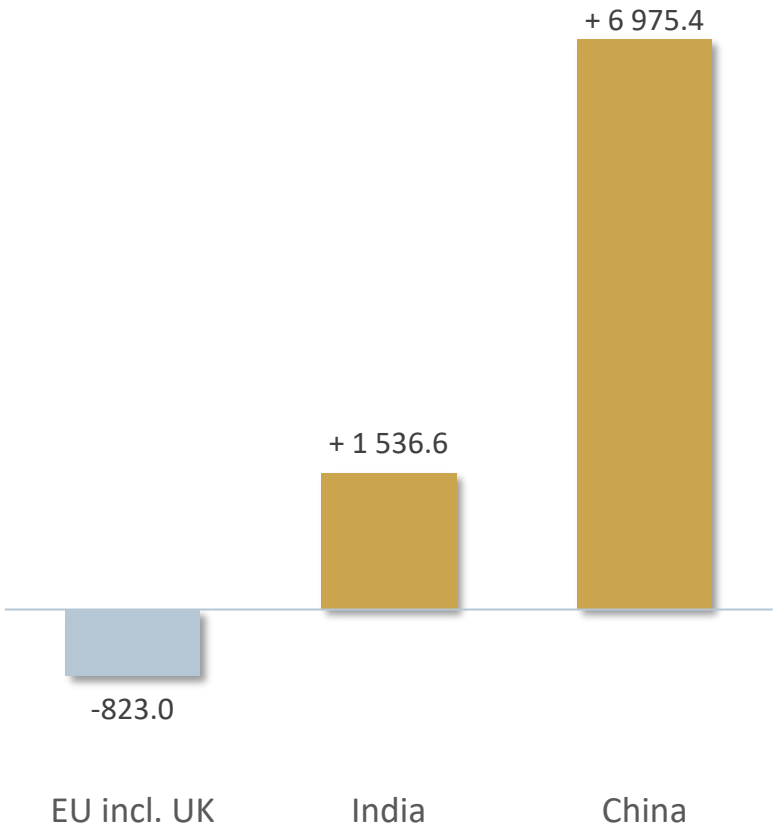
Compared to the year 1990, the absolute CO_2 emissions are decreasing in the EU only. Between 1990 and 2016 the EU decreased the emissions by approximately 815 Million tons.

At the current edge the US emissions are falling. In 2016 the emissions are converging to the emissions of 1990.

The impact of European regulations on global CO_2 emissions continues to decline.

Reduction in Europe, strong increase in Asia

Emissions from fuel use* – Changes between 1990 and 2017 in Millions of tonnes



Source: IEA, CO_2 Emissions from Fuel Combustion – 2020

While China shows an increase of 338 per cent during the years 1990–2017, the EU shows a decrease of 20.3 per cent.

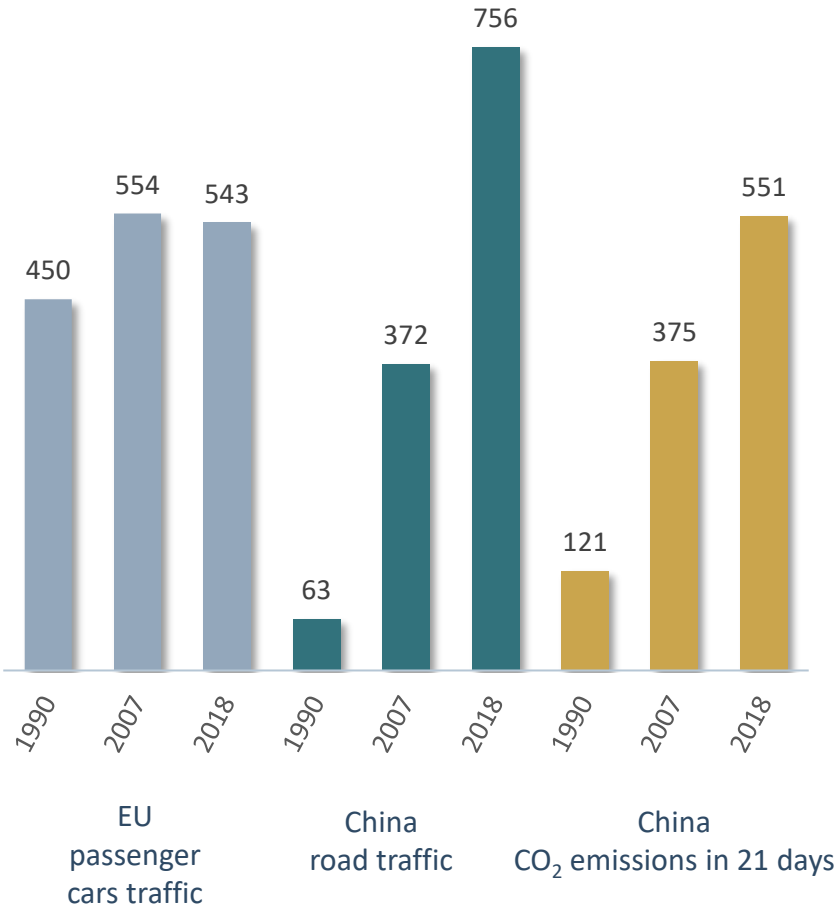
In 2017 alone, China's emissions increased by 200 million tonnes.

India increased it's emissions since 1990 by 310 Percent and this value is still increasing.

* Corresponding to category 1A according to the UNFCCC classification system

EU passenger cars – Relevant, yet not crucial

CO_2 emissions in millions of tons



Sources: EEA, 2020 (v23; IEA, CO_2 Emissions from Fuel Combustion – 2020

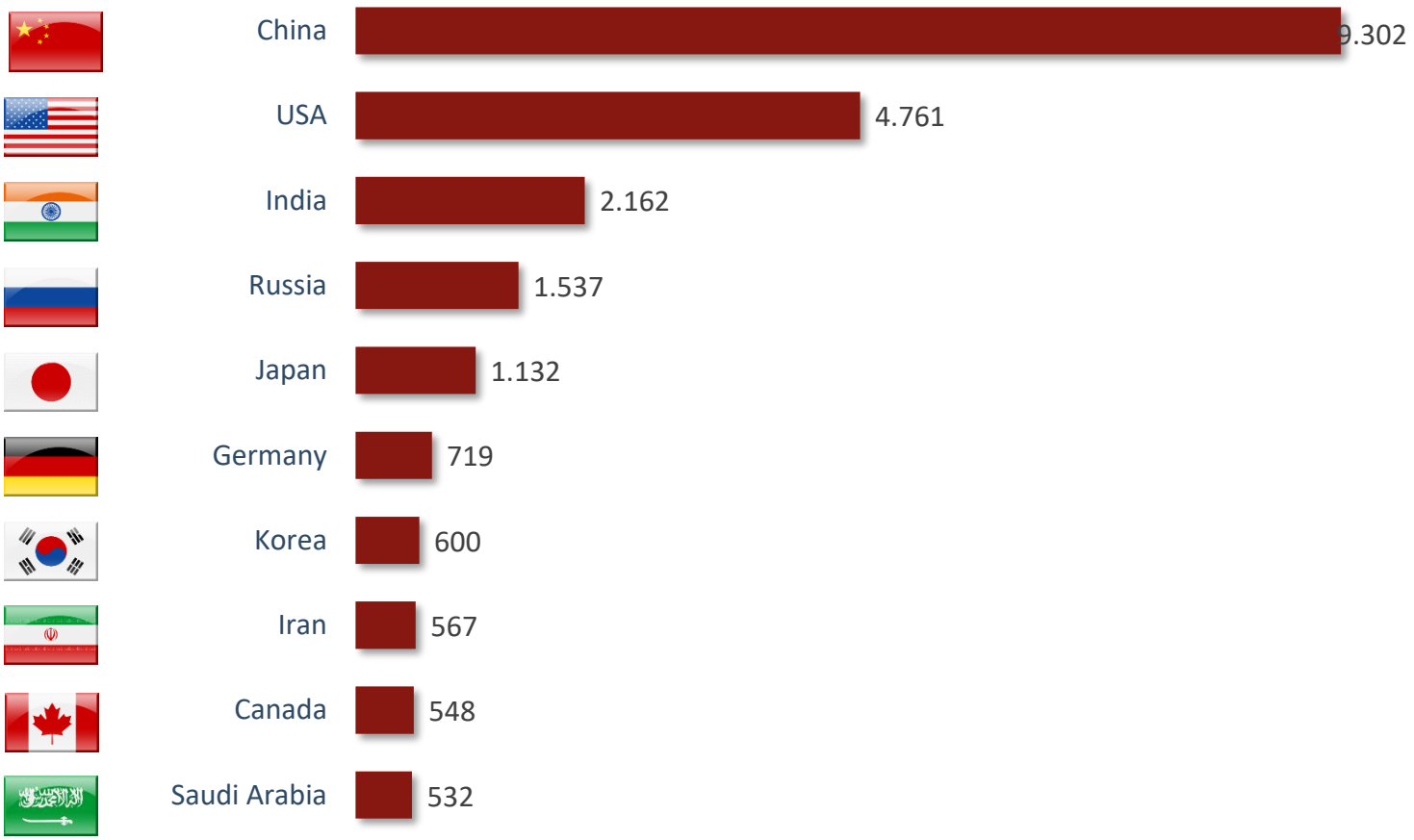
Relevant: Europe's total passenger car traffic 2017 emitted 543 million tonnes of CO_2, an upward trend compared to 2015.

Crucial? China, on the other hand, is showing a strong upwards trend in its use of fossil fuels – emitting nearly 526 million tonnes of CO_2 in just three weeks.

Dynamic: between 2014 and 2015 the plus in China was about 60 millions of tons. In the following year the emissions increased by 8 million tons.

10 countries, two-thirds of the CO_2 emissions

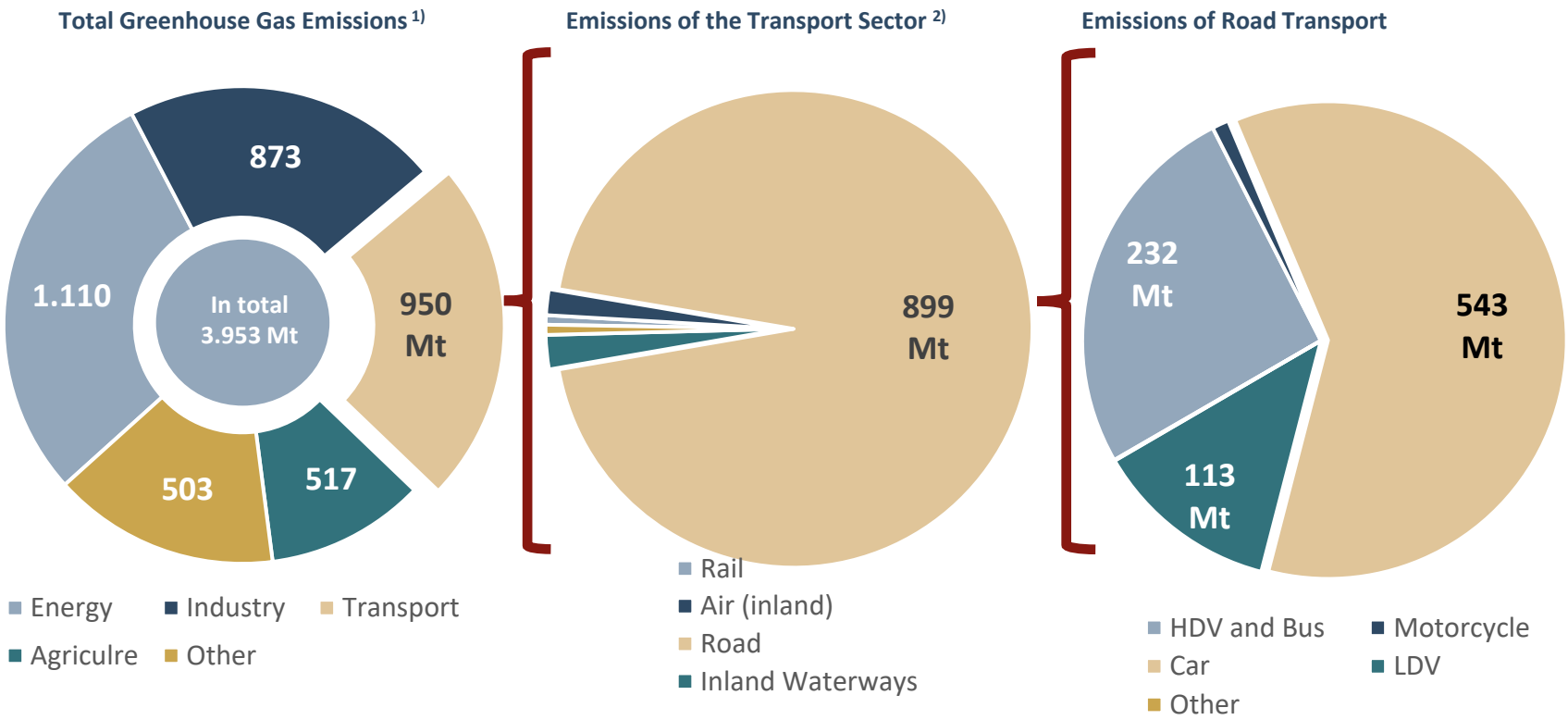
CO_2 emissions for the year 2016, in millions of tonnes



Source: IEA, CO_2 Emissions from Fuel Combustion – 2019

Road transport is a major source in Europe

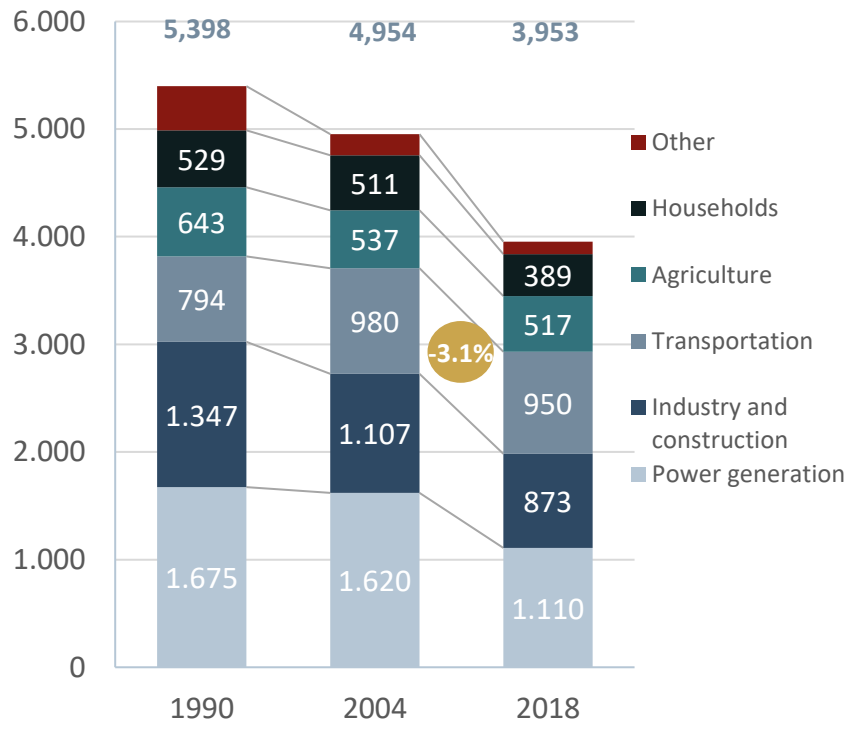
Emissions in the EU in the year 2018 in Megatons



[1] With sinks
[2)] Without internationalen Air and Sea traffic
Quelle: EEA, 2020 (V23)

Sector development

Greenhouse gas emissions in the EU 28 by sector, in millions of tonnes



Source: EEA, 2020 (v23)

- Split development after the fall of the Iron Curtain
- Traffic emissions increased quickly after 1990, since Eastern Europe was integrated into the European Economic Area. Emissions have been decreasing since 2007, even in the transportation sector, but began to rise again in 2014.
- In the early 1990s, considerable reductions were visible in the industry and energy generation sectors. Their emissions levels stagnated until around 2007, then dropped with the economic crisis.

Summary: CO_2 emissions

Global CO_2 emissions are continuously increasing, especially in Asia.

CO_2 emissions are declining only in Europe.

The reduction of emissions in Europe is hardly significant when viewed against the increase of emissions in Asia.

Today, European regulations have relatively little influence on global CO_2 emissions, and the influence is continuing to decline.

From the perspective of climate research, it is the overall volume of emissions at the global level which is relevant. The country or specific source of the emissions is essentially insignificant.

Fuels: Well-to-wheel emissions are what counts

Comparison of emissions and alternative fuels

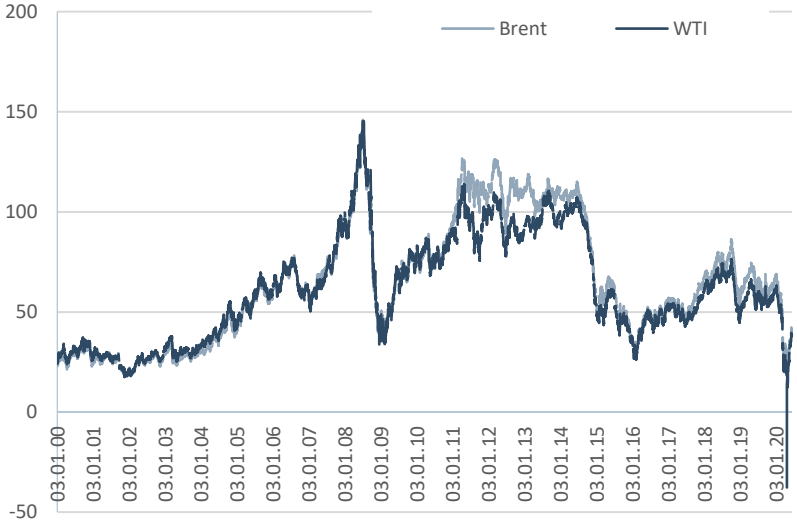
Fuel	Consumption per 100 km (Vehicle from compact-class in NEDC)		price in € per		TTW CO_2 Emissions In g CO_2 / Km	WTW GHG-Emissions In g CO_{2eq} / km	price* in Euro per 100 km	
Super E5 (conventional)	4,9	L	1,40	L	115,72	144,93	6,86 €	Nicht regenerativ
Diesel B7 (conventional)	3,9	L	1,14	L	102,86	128,74	4,45 €	Nicht regenerativ
PHEV (Benzin E5 + Conv. Strom)					49,59	99,39	4,77 €	Nicht regenerativ
LPG (Remote well)	6,4	L	1,57	L	104,37	127,93	3,66 €	Nicht regenerativ
Natural Gas (H-Gas, EU-Mix)	3,5	Kg	1,09	Kg	88,9	109,42	3,81 €	Nicht regenerativ
Electricity (D-Mix 2015)	12,7	kW/h	0,29	KW/h	0,0	74,55	3,71 €	Nicht regenerativ
Hydrogen (EU Mix)	0,97	Kg	9,50	Kg	0,0	134,2	9,22 €	Regenerativ
Bioethanol E85 (wood)	5,88	L	0,99	L	112,31	35,91	5,81 €	Regenerativ
Bioethanol E85 (grain)	5,88	L	0,99	L	112,31	119,69	5,81 €	Regenerativ
Biodiesel B100 (Rapeseed)	4,29	L	1,43	L	121,41	85,99	6,13 €	Regenerativ
Electricity (Regenerativ)	12,7	KW/h	0,29	KW/h	0,0	5,33	3,71 €	Regenerativ
Hydrogen (Aircraft)	0,97	Kg	9,50	Kg	0,0	15,14	9,22 €	Regenerativ
E-Gas (Regenerativ)	3,5	Kg	-	Kg	88,9	5,21	n.e.	E-Fuels
Synthetical diesel (Reg.)	3,9	L	-	L	102,86	2,18	n.e. (not yet commercially available)	E-Fuels

TTW: Tank-to-Wheel; WTW: Well-to-Wheel; CO_{2eq} – CO_2 Äquivalent

High oil prices: Incentive for more efficient motor vehicles

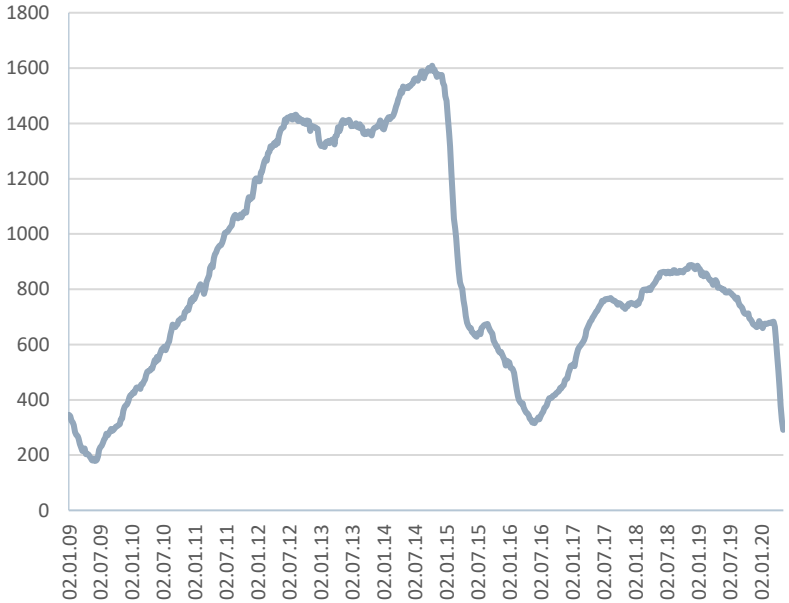
Oil prices rise again in 2018

In US Dollar



But the supply is already declining

Number of active drilling towers in the USA



- Oil prices have greatly increased from the year 2000 till 2014.
- As a result of fracking in the USA, oil prices started to diverge in 2010.
- The supply side in the US is strongly linked with oil prices. Rising prices lead to an increase in active oil rigs and vice versa.

Source: Bloomberg, Baker Hughes (Stand June 2020)

Summary: Fuels

Various fuel types reveal a very different carbon footprint in the well-to-wheel analysis. Today, electricity and natural gas are the alternatives with the most favourable ratio of emission reductions to fuel costs.

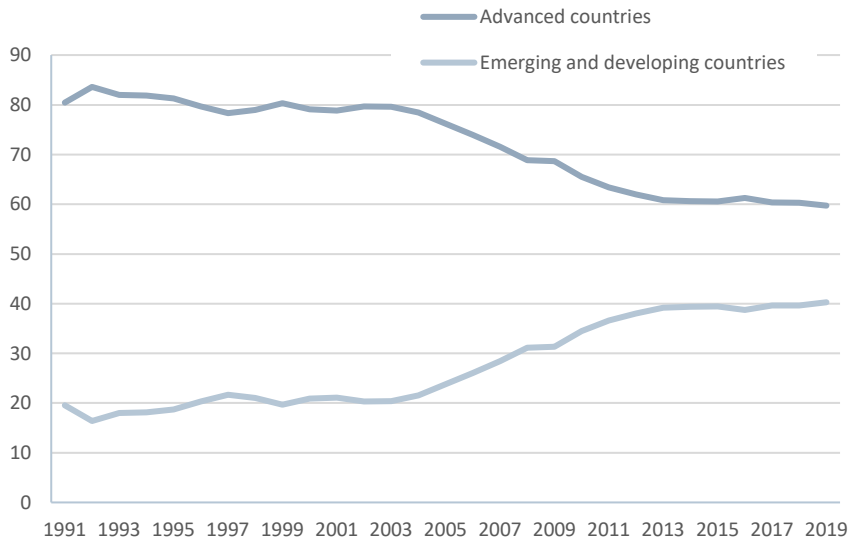
The EU has a very high rate of dependence on imported energy carriers. This leads to cases of political dependence. Avoiding such dependencies is a key driver for European policy in the field of primary energy supply.

The development of oil prices creates innovative pressure on motor vehicle manufacturers, since fuel consumption is a key selling point. Even without regulation measures, customers would increasingly demand efficient vehicles.

The weights are shifting in the world GDP

1991 – 2017

Share of the world GDP*
as percentage



Share of the world GDP*
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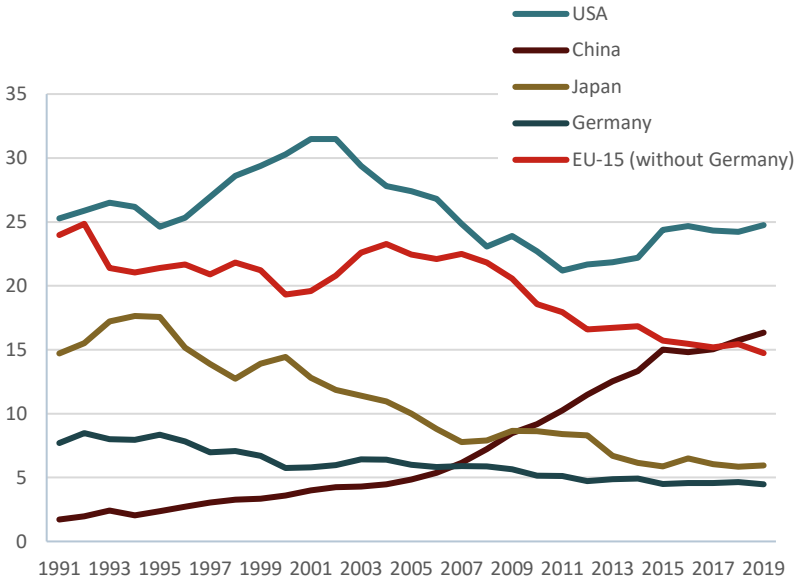
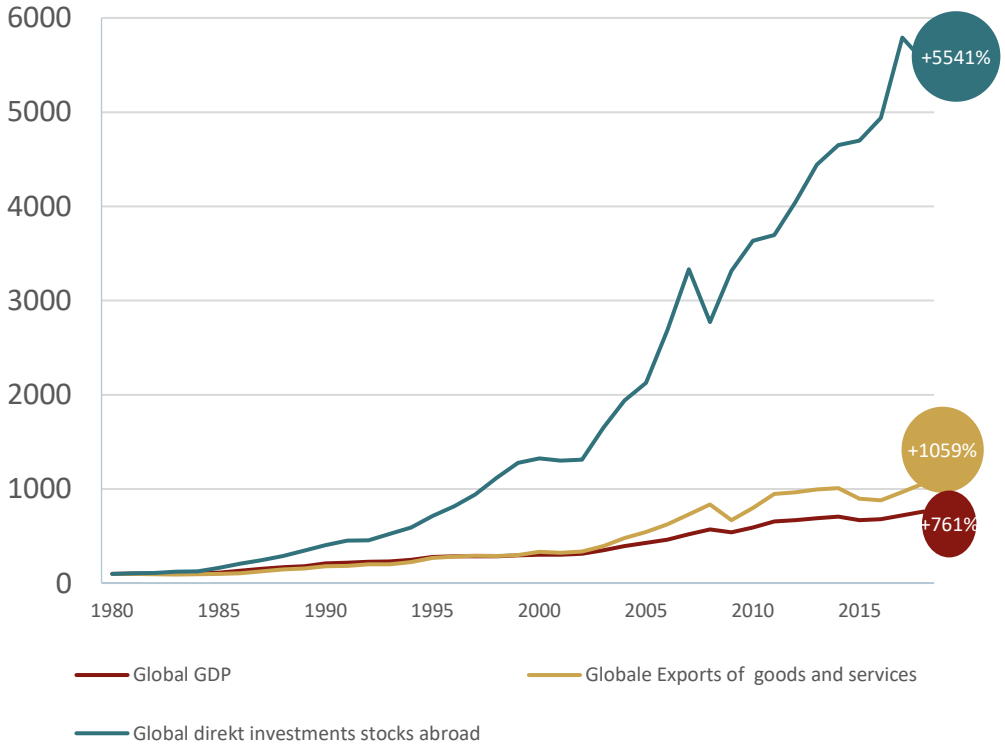


- The dominance of the industrialised countries is crumbling.
- China's significance is rapidly growing.

*Partly estimates or forecasts by the IWF
Source: IMF, 2019

Direct investments propel globalisation

Index for economic relations, 1980 = 100
1980 = 100, nominal figures



Source: UNCTAD, IWF, Weltbank, IW Köln

Globalisation means the establishment of global production structures through direct investments.

- Since 1980, the inventory of direct investments has grown at least five times as fast as international trade.
- Approximately one-third of international trade is already taking place in corporate networks.

Summary Globalisation

The emphasis of the world economy is shifting more and more towards Asia.

This trend is being fuelled by the establishment of production locations near the market.

Already today, the European locations are in strong competition with the countries in the growth regions, and many European locations are losing ground.

The significance of regulation in Europe is declining with the significance of the European economies.

If European industrial locations are to survive in terms of global competition, the EU must provide better local conditions.

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The EU plans to clearly increase its pace

Stipulated reduction compared to 2005, as percentage

	ETS*-Sektor	EU GHG target (Basis: 2005)	Non-ETS sector
2020	-21%	-12%	-10%
2030	-43%		-30%

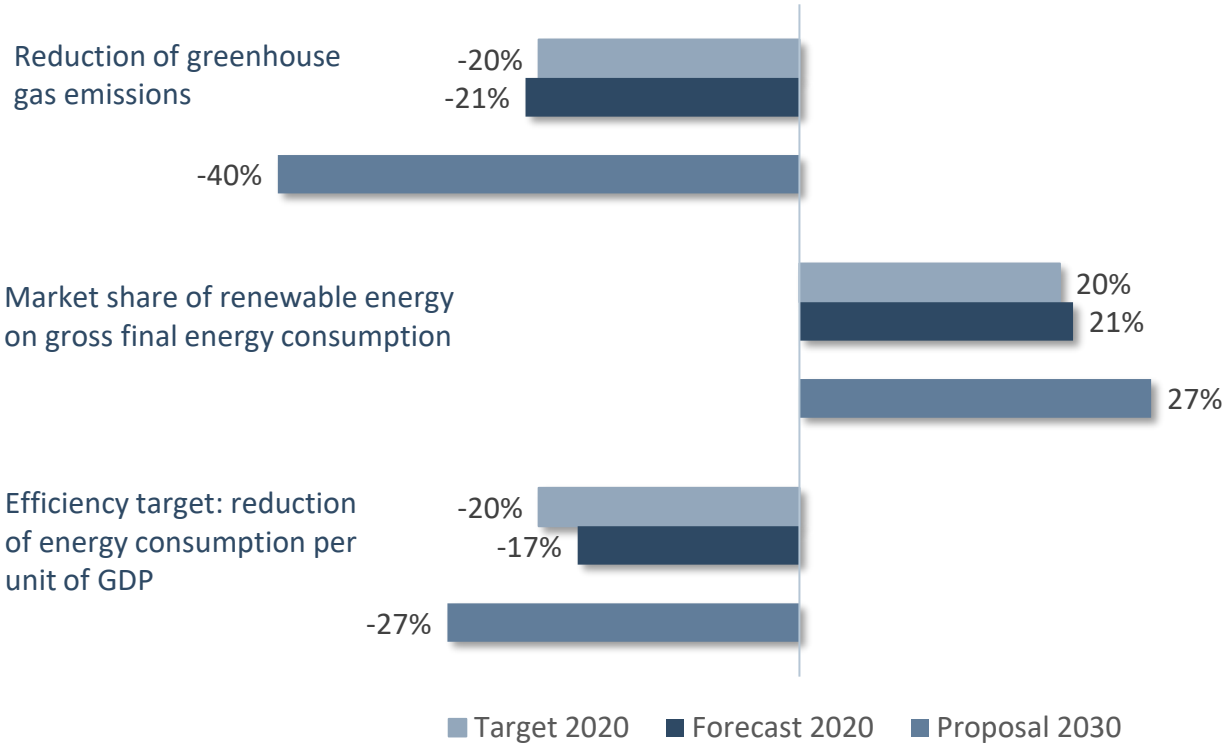
How?

- Emissions trading
- Establishment of a market stabilisation reserve
- Avoidance of relocation effects
- Incorporating binding national targets
- Supporting measures, e.g. emissions standards

- After 2020, the non-ETS sector is expected to reduce twice as much in 10 years as it did during the previous 15.
- The cost per reduced tonne of CO_2 will increase considerably.

The EU moves forward undeterred

The EU's long-term targets, as percentage; base year 1990

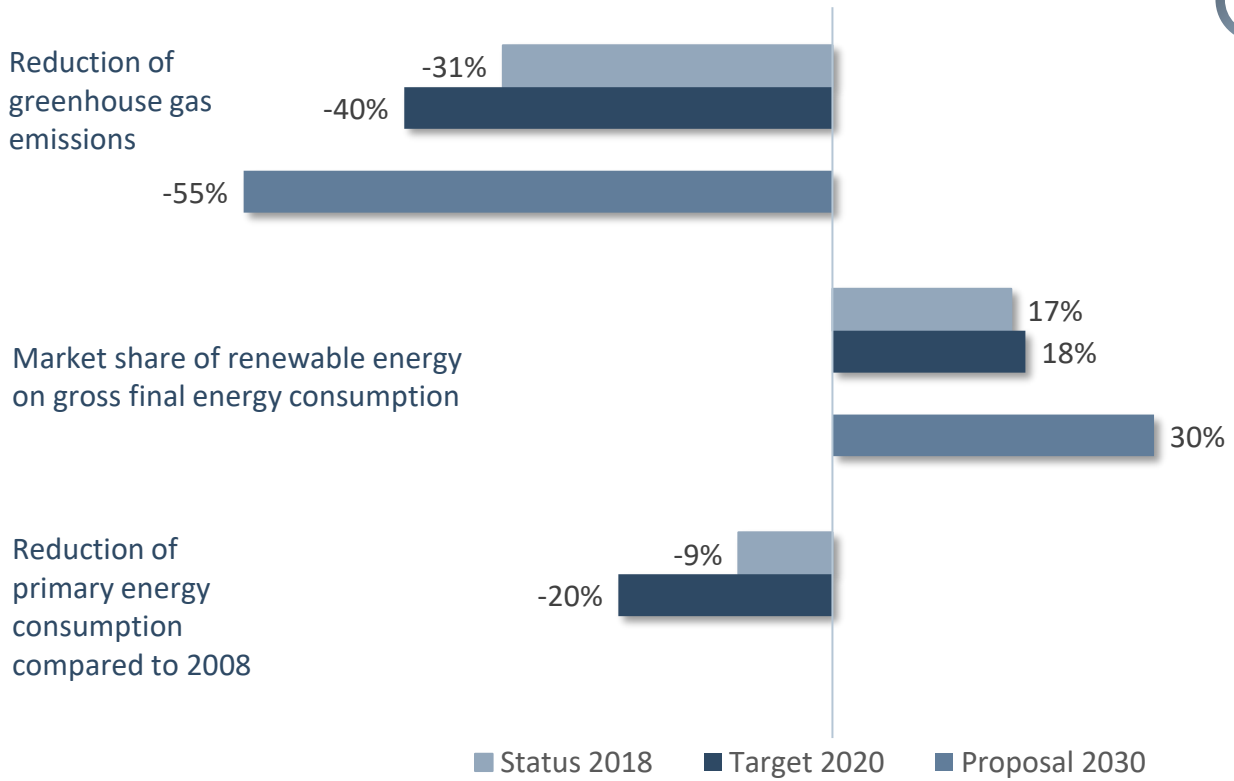


Sources: BMWi, UBA, AGEB

- The European Commission predicts that the climate targets for 2020 will largely be reached.
- Even if the rest of the world has not joined in so far, the EU plans to increase its tar-gets considerably after 2020.

Ten years faster: The German federal government exceeds EU targets

German federal government reduction targets, as percentage; base year 1990

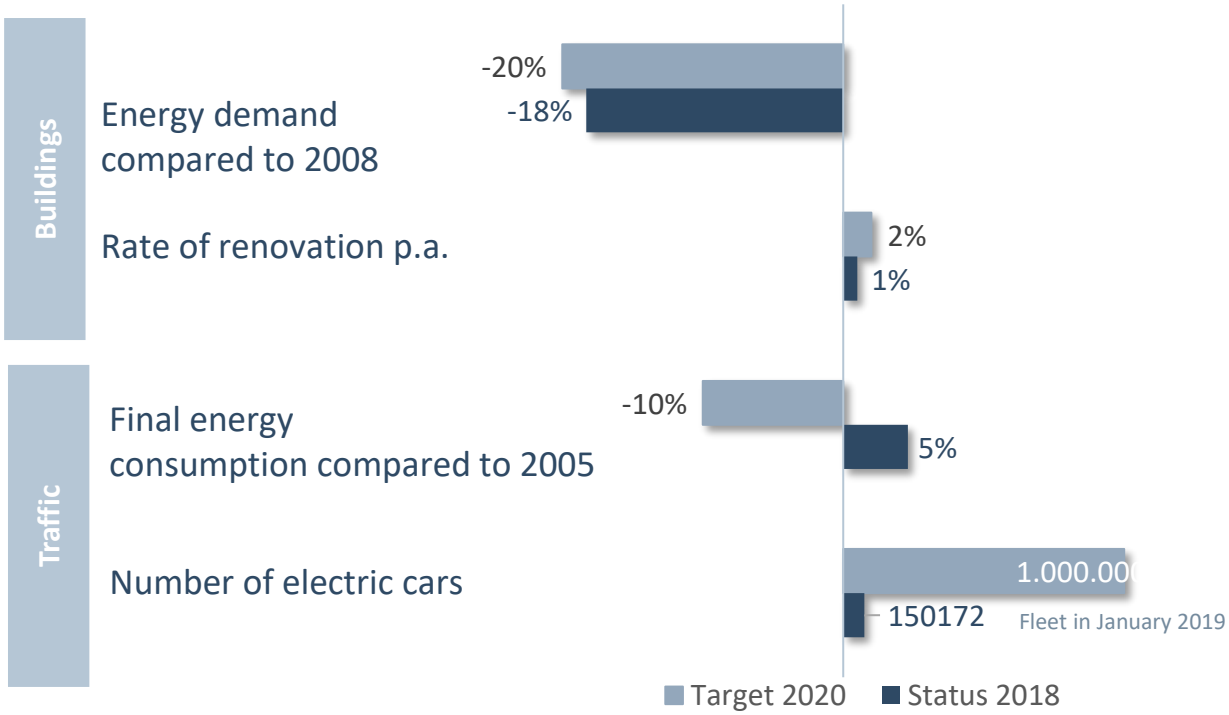


- The German federal government is currently demanding additional efforts to reach the target for 2020.
- For the period after 2020, the stipulated pace of change will be dramatically increased.

Sources: BMWi, UBA, AGEB

Buildings and traffic

German federal government reduction targets, as percentage



The target value for road traffic is 136–141 million tonnes of CO_2; value in 2016: 160.2 million tonnes of CO_2.

- The building sector will likely miss its target considerably.
- On January 1st 2018 53.861 battery electric cars and 44.419 Plug-In-Hybrids were licensed.

Sources: BMWi, IW Köln, KBA,UNFCCC, AGEB

Summary Climate policy

Global climate policy is currently experiencing a crisis.

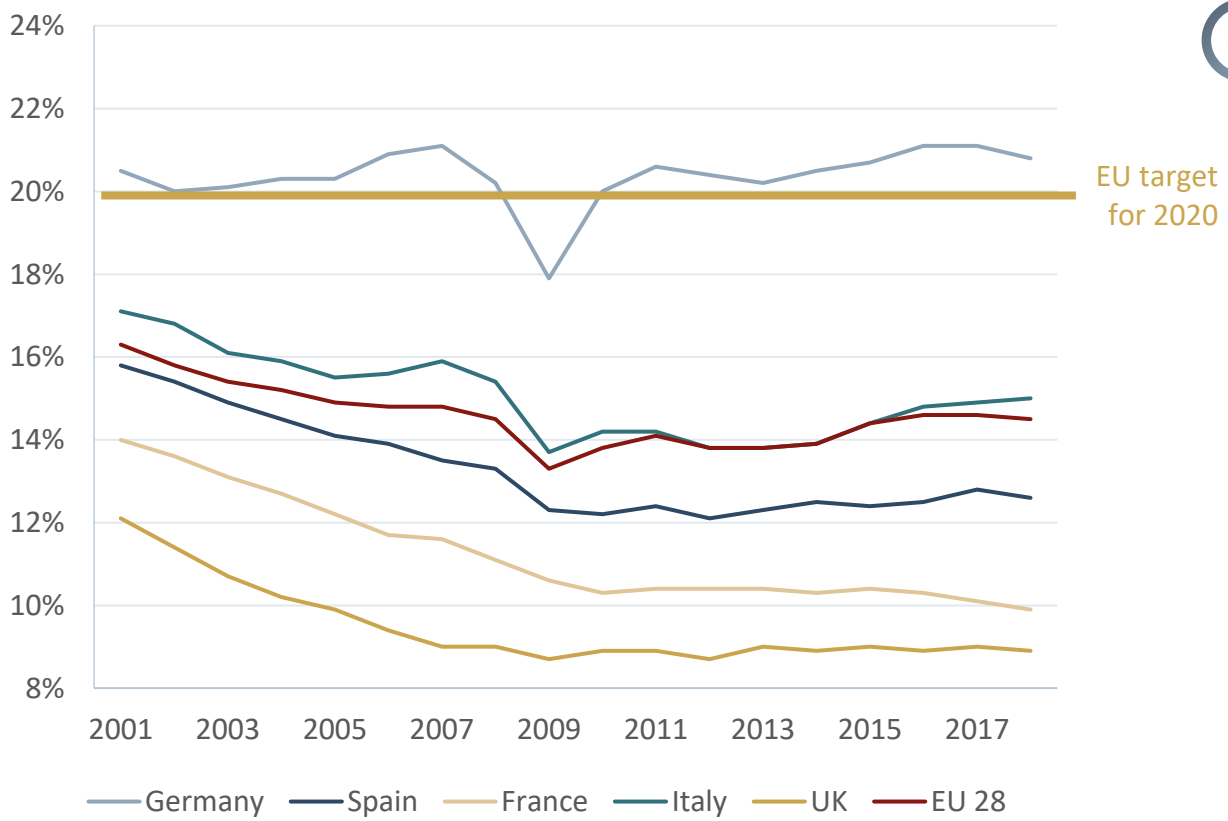
The EU enthusiastically advanced in the Kyoto process, but no one followed. Outside the EU, only the transition countries met their targets, which were very soft in the first place.

The EU will reach its climate targets – even after the economic distortions following 2008 – and plans to considerably increase its pace in climate protection in the period after 2020.

The federal government wants to go further than the EU. While traffic emissions are essentially on track, areas such as the building sector are far from being able to reach its targets.

The EU industrial sector: Collapse rather than rebirth

The manufacturing industry's share of the gross value, as percentage

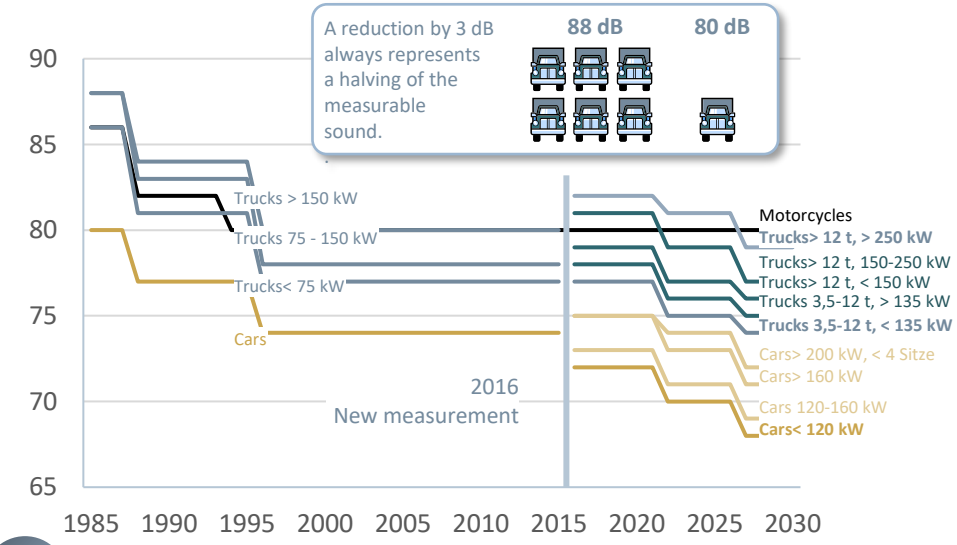


Source: Eurostat 2019

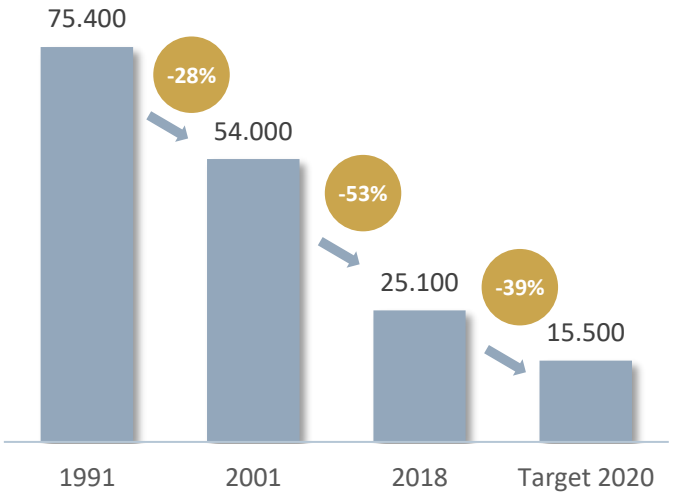
- EU target: The industrial sector is expected to have a 20 per cent share of the GDP in 2020
- Germany is reaching this target. The UK, Italy and France give cause for concern.
- Countries outside of Europe are improving quickly. Europe must respond in order to secure its position.

Progress in noise and safety targets

Noise targets: Noise emissions are expected to decline by up to 75 per cent.
EU vehicle noise limit values in dB (A)



Traffic safety: Ambitious targets
Road traffic fatalities in the EU 28 countries

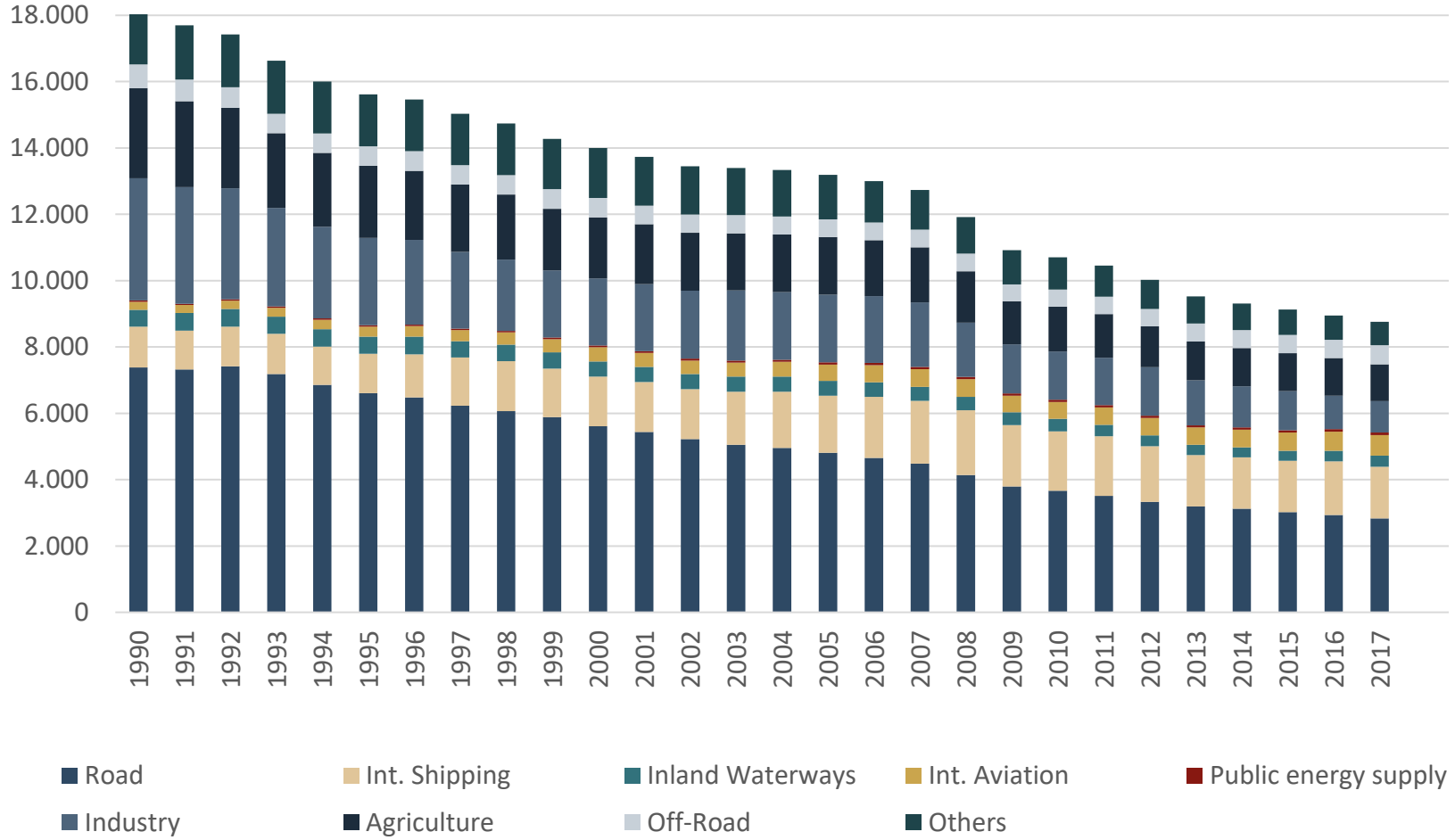


- Since 1990, the EU has shown considerable progress and has set ambitious regulations concerning noise emissions and safety.
- Additional sound reduction and safety devices bring extra weight and changes to the car body.
- The further targets result in a measurable overconsumption of new vehicles.

Sources: EU, Eurostat

Nitrogene oxide emissions dropped by 46 per cent

Data for EU 28* in kilo tonnes, No_x emissions converted in NO_2

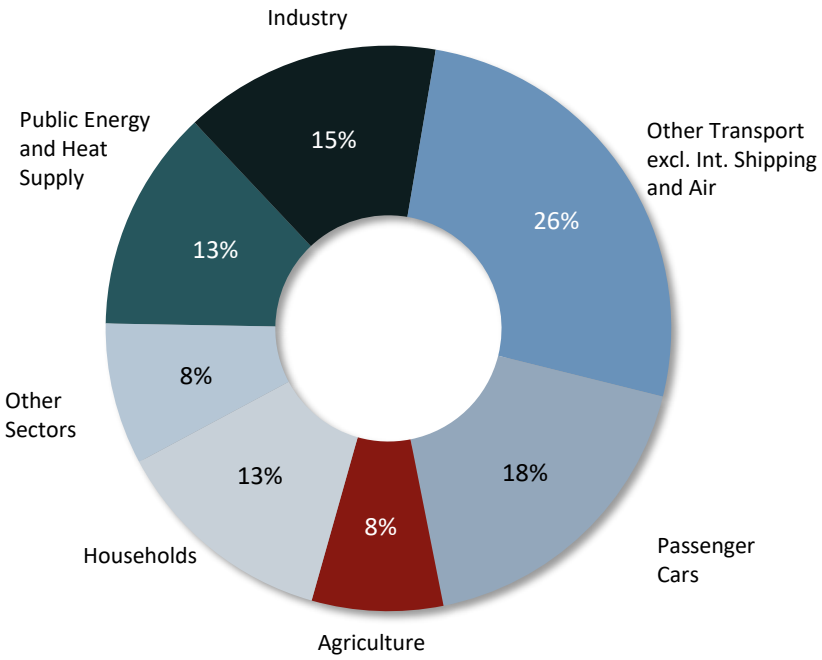


*Source: enep, 2019

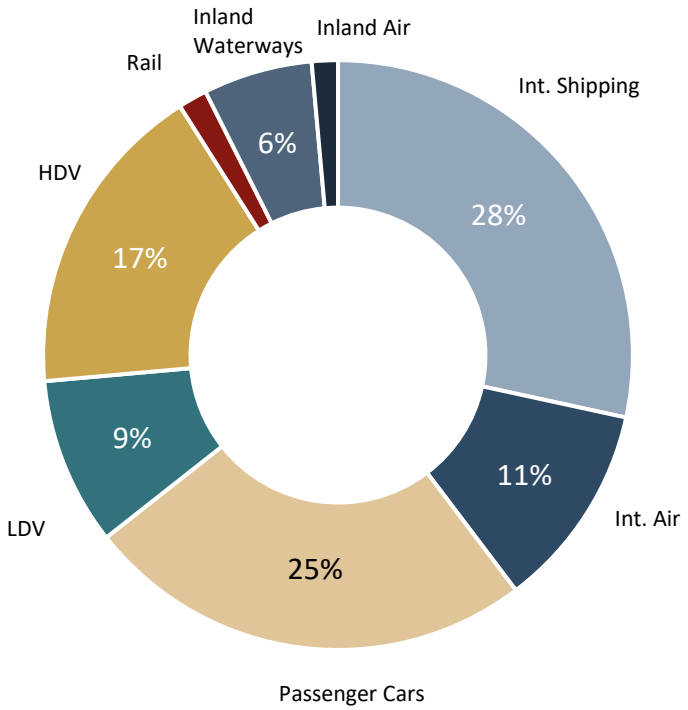
Nitrogene oxide emissions in the EU 28

Data of 2017, in per cent of the No_x emissions converted in NO_2

Emissions by Sector[1)]



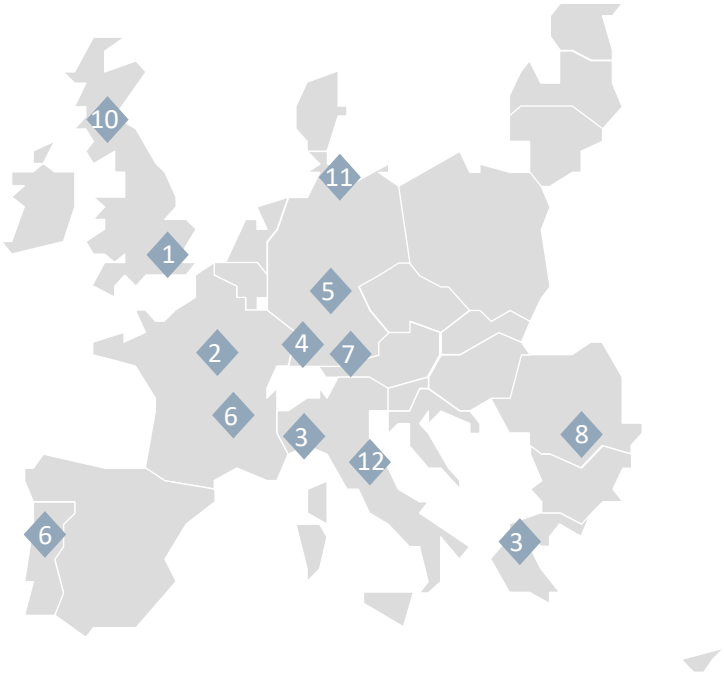
Transport by Modes



Quelle: emep, 2019

NO_2: A European Problem

The 12 cities of the EU with the highest level of NO_2-Immissions in 2018



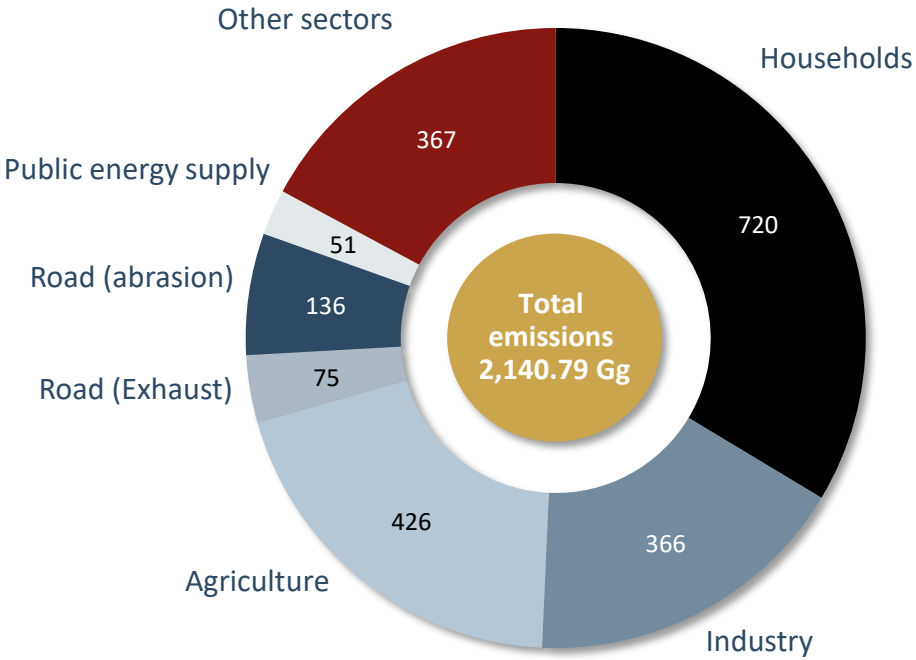
	Stadt	2018 in µg/m3	2010 in µg/m3	2006 in µg/m3
1	London	84,7	98,3	110,6
2	Paris	80,2	95,5	91,1
3	Athens	70,9	83,2	85,7
4	Stuttgart	70,8	99,9	121,3
5	Darmstadt	66,6	n.a.	n.a.
6	Lyon	66,3	89,8	n.a.
7	Munich	66,2	98,7	97,5
8	Bukarest	62,8	65,2	126,4
9	Porto	62,4	n.a.	n.a.
10	Glasgow	60,6	84,0	68,4
11	Kiel	60,3	n.a.	n.a.
12	Florenz	60,1	101,8	71,6

Quelle: EEA – Air Quality Statistics, 2019

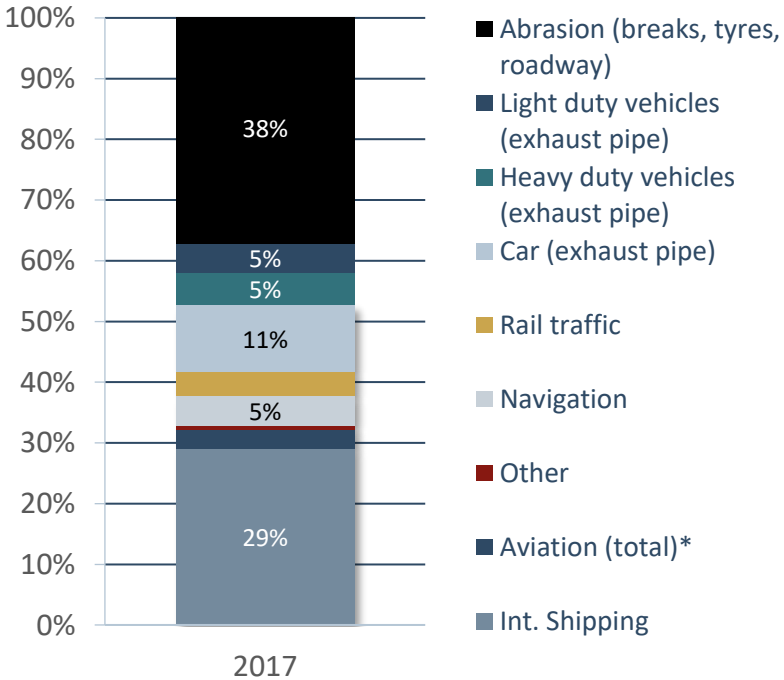
PM10 emissions in the EU 28

Data of 2017, in kilo tonnes fine dust (PM10)

Emissions by sectors



Transportation sector by transport modes

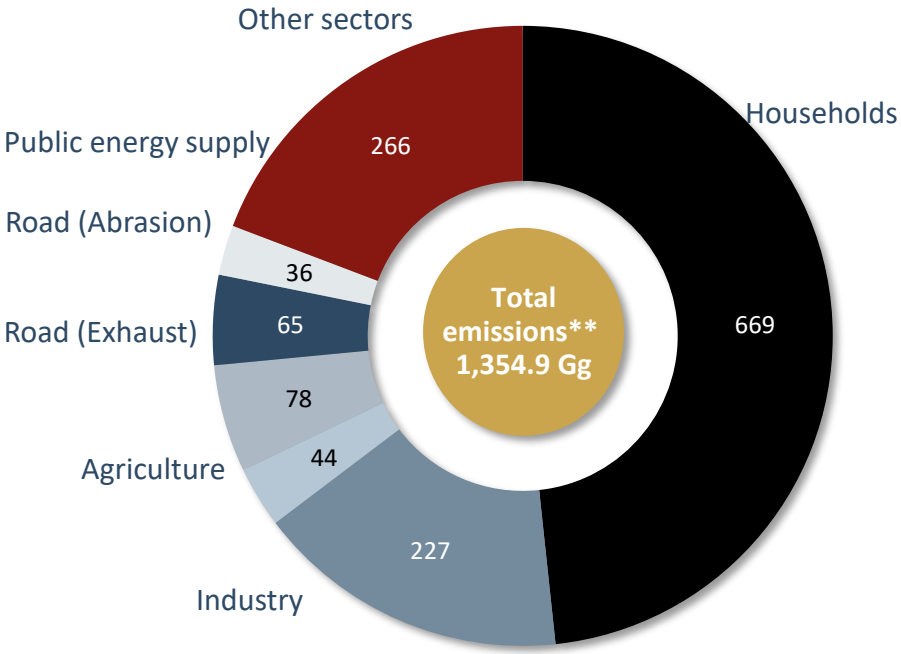


Source: enep, 2019

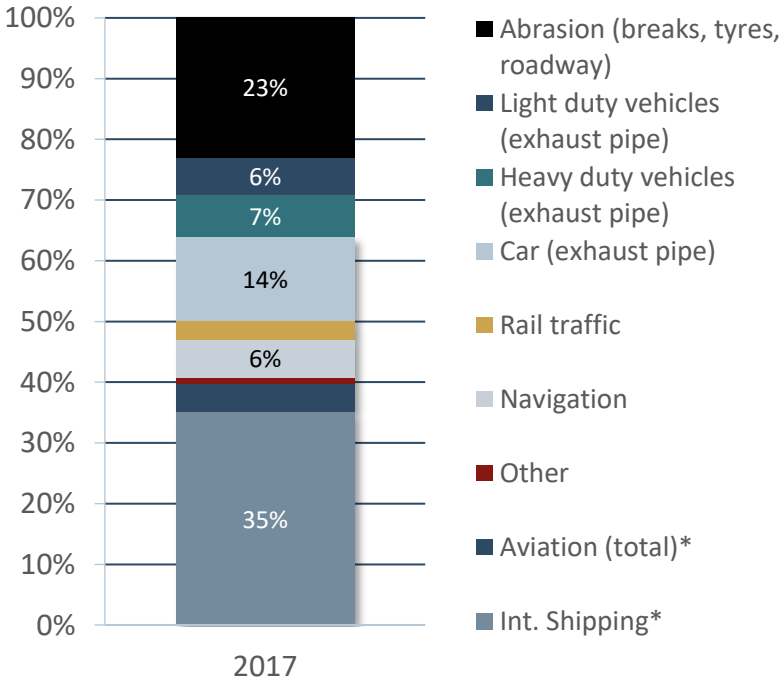
PM2,5 emissions in the EU 28

Data of 2017, in kilo tonnes of ultrafine dust (PM2,5)

Emissions by sectors



Transportation sector by transport modes



Source: enep, 2019

Summary: Regulation density and conflicting goals

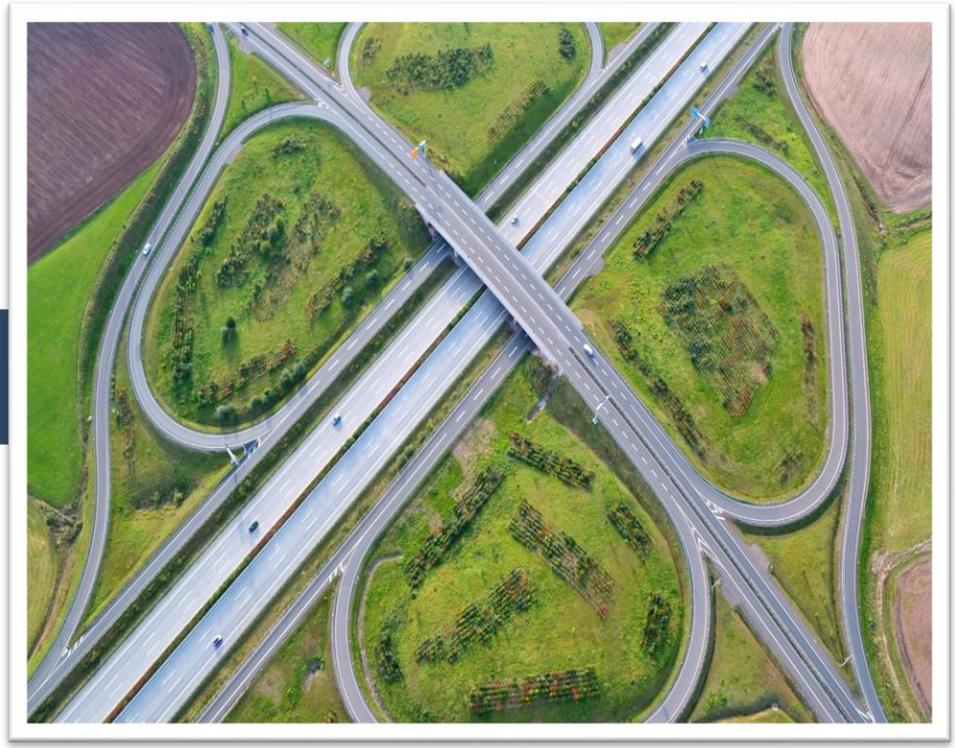
CO_2 reduction is only one of the traffic-related targets being pursued by the EU.

In the past, traffic-related regulation measures were focused on exhaust emissions and transportation safety.

Huge advancements have been made in regard to safety and harmful emissions of motor vehicles; but this has resulted in a higher consumption of energy.

The top priority for the future should be the reduction of CO_2 emissions from motor vehicles.

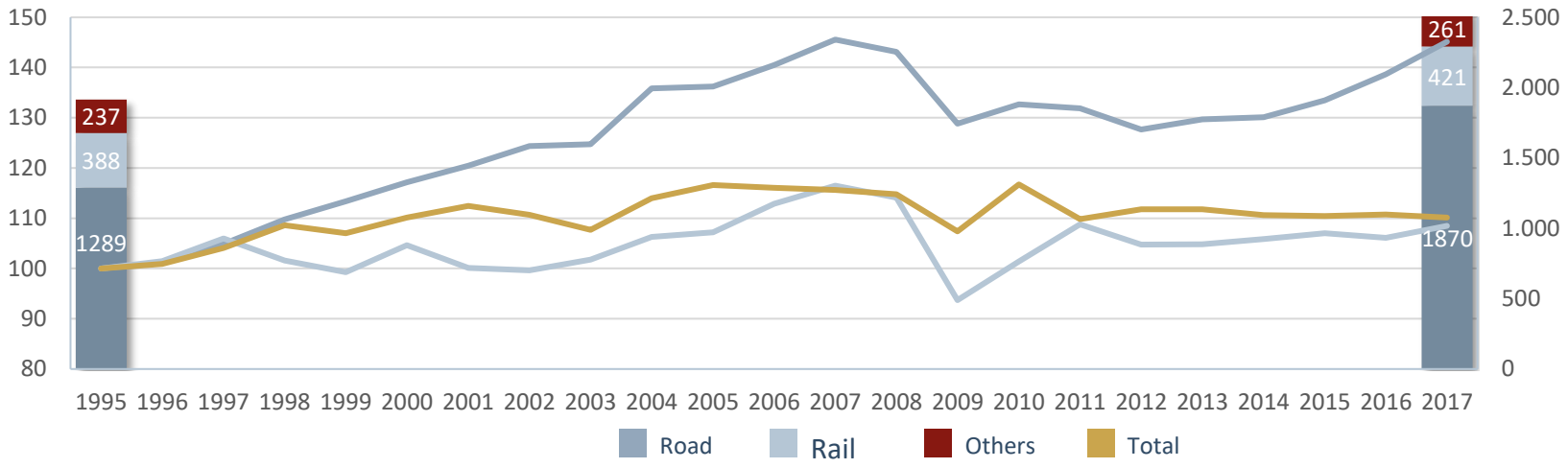
Agenda



Trucks are facilitating the Single European Market

Development of freight transport in the EU
1995 =100

Freight transport in the EU
1995 and 2017 in tkm



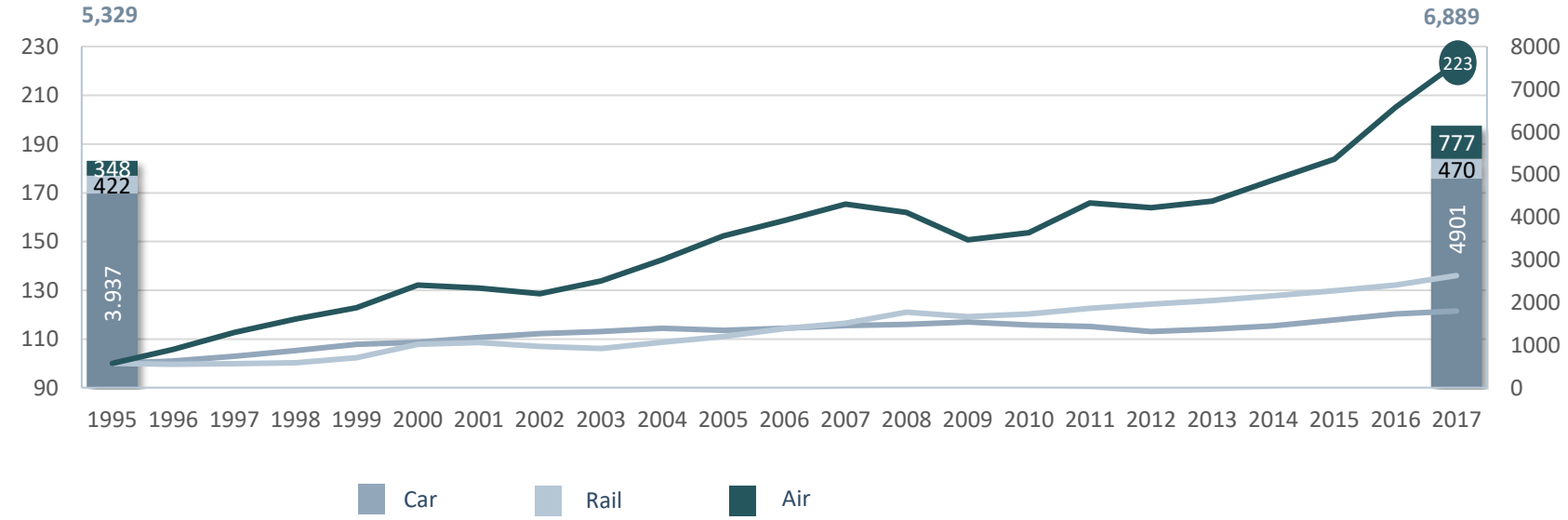
- The merging of the EU triggered tremendous growth in the area of freight transport.
- The creation of the Single European Market fuelled growth on both road and rail.
- Over 70 per cent of Europe's freight is transported by truck.
- Between 2007 and 2014, freight transport in Europe has decreased by 9 per cent but now it is rising again.

Source: Eurostat, Transport in Figures 2019

High level of dynamics in air transport, but cars are the backbone

Development of passenger traffic in the EU
1995 =100

Passenger transport in the EU
1995 und 2017 in pkm



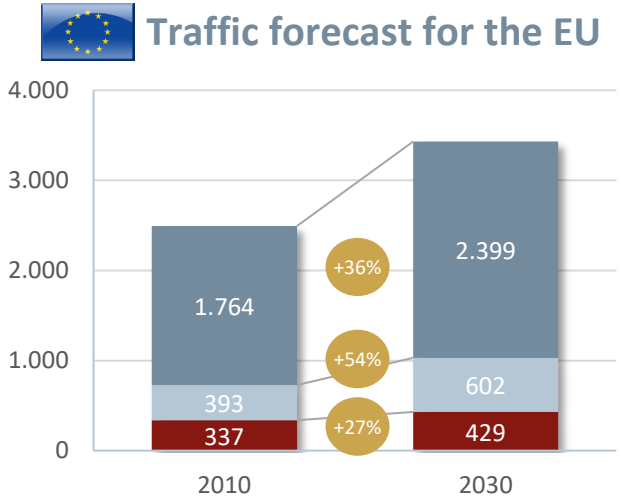
- Strong growth in air transport since the fall of the government monopoly.
- Considerable growth in rail transport since the EU started promoting national rail transport markets.
- Over 80 per cent of traffic is attributable to passenger transportation on roads. A stagnation has been evident since 2004

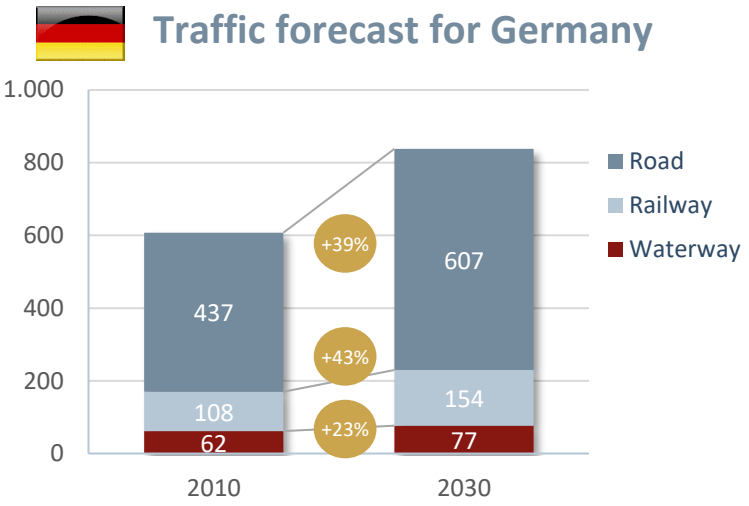
Source: Eurostat, Transport in Figures 2019

Official forecasts for freight transport in 2030

Trucks will continue to dominate the considerably growing transport market

in billions of tonne kilometres





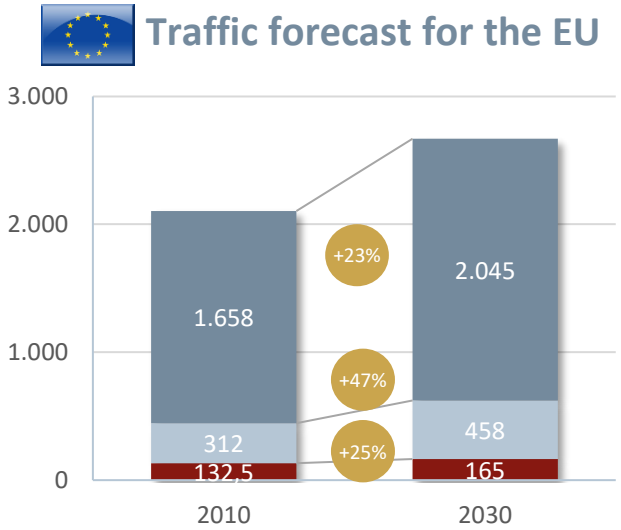
- There is some evidence that the PRIMES Prognosis from 2013 is outdated. It predicts an increase in goods traffic between 2010 and 2015, while it actually heavily decreased (Folie 42).

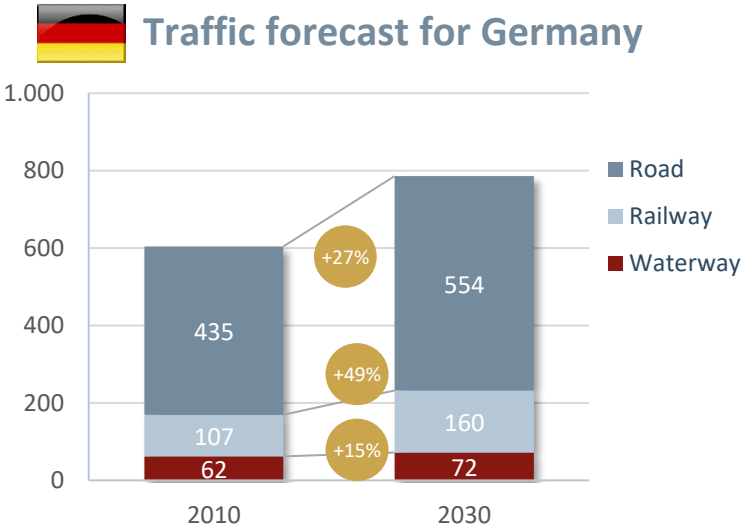
Sources: EU, Trends to 2050, 2013; BMVI, Verflechtungsprognose 2030, 2014

Current forecasts for freight transport in 2030

Limited increase in road transport in comparison to the official prognosis

in billions of tonnes kilometres





- The current prognosis covers 12 EU Countries with about 92 percent of total road transport. The coverage of rail and inland waterways is less sufficient.
- Growth rates after 2015 hardly differ from the official forecast.

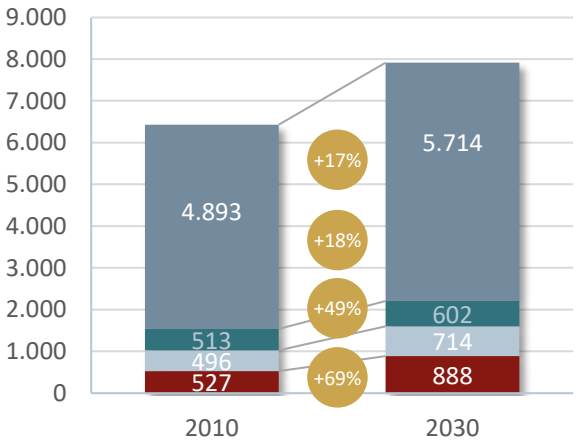
Quellen: Prognos, World Transport Report 2015//2016

Official passenger transport forecasts for 2030

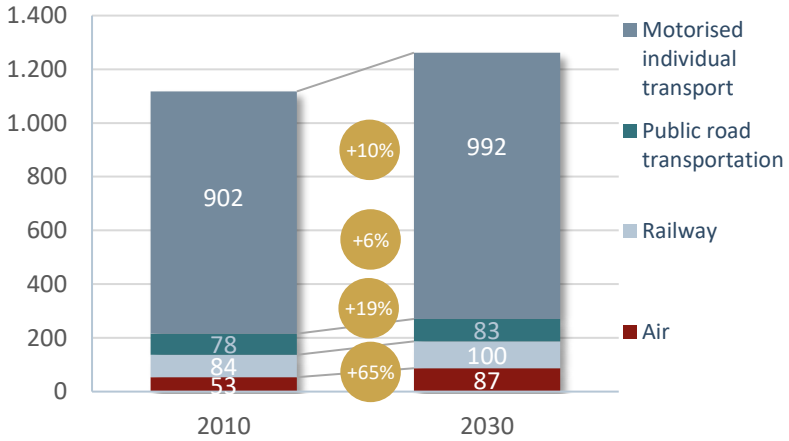
Cars will form the backbone of passenger transport for the long term

in billions of passenger kilometres

Traffic forecast for the EU



Traffic forecast for Germany



- Over the next 20 years, passenger transport will show a slower rate of growth than freight transport.
- Rail transport is expected to show substantial growth and to gain market shares.
- But: In passenger kilometres, between now and 2030, motor vehicle transport in the EU will increase by more than the total rail traffic being transported in 2030.

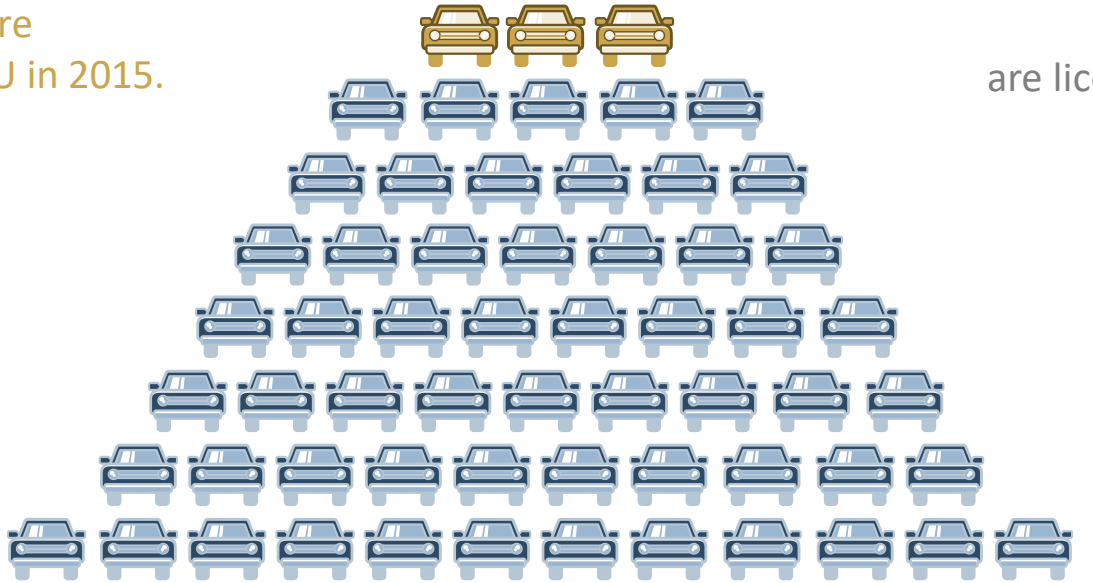
Sources: EU, Trends to 2050, 2014; BMVI, Verflechtungsprognose 2030, 2014

Limit values affect only new vehicles

Existing vehicles are not covered by the regulation

Approx. **15.1 million new vehicles** were licensed in the EU in 2015.

Altogether, **approx. 255 million cars** are licensed in the EU.

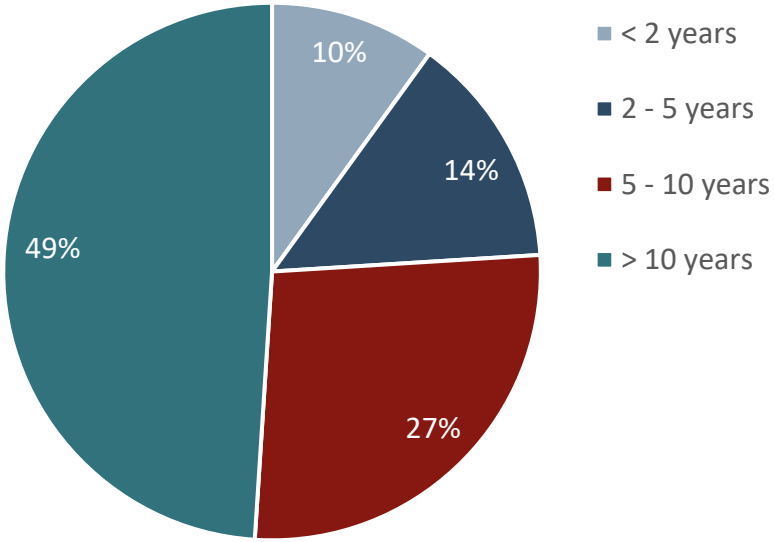


- Each year, only about 5 per cent of the vehicle fleet in the EU is replaced.
- Existing vehicles hold huge potential for CO_2 reduction.
- That is why measures for replacing the existing vehicle fleet are essential

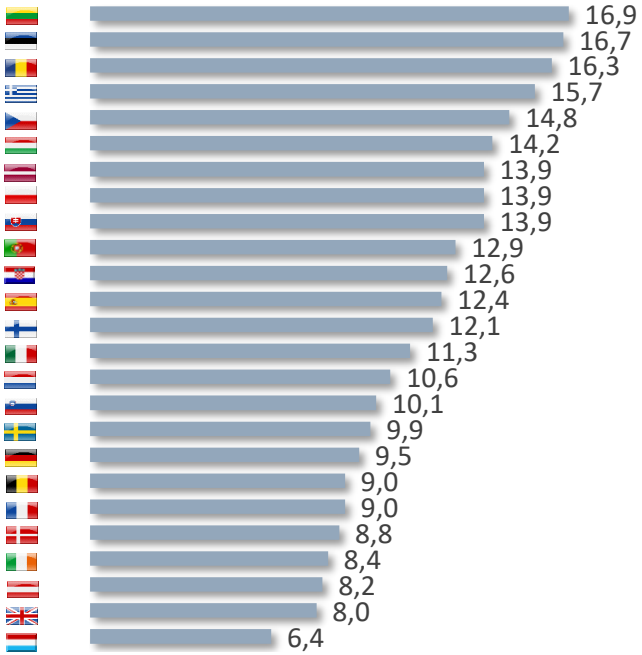
Source: ACEA, 2017; VDA ,2017

The existing vehicle fleet represents the technology from 10 years ago

Age of passenger cars in Europe
as percentage in 2015



Average age of licensed cars
in years

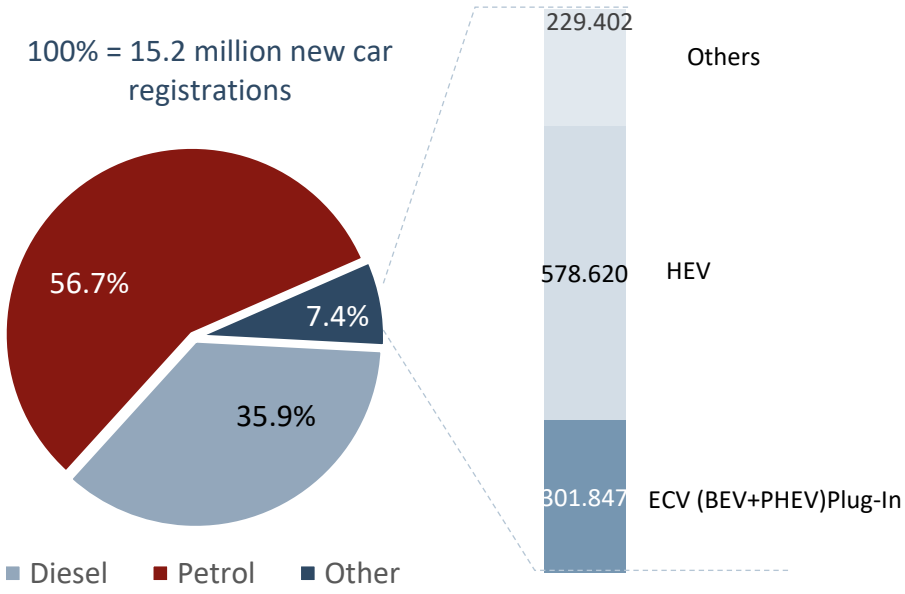


- Licensed cars in Europe are 9.6 years old, on average – and the trend is increasing.
- The average age of cars in several member states is more than 10 years.
- But: The best method for reducing CO_2 is to speed up the rate at which existing vehicles are replaced.

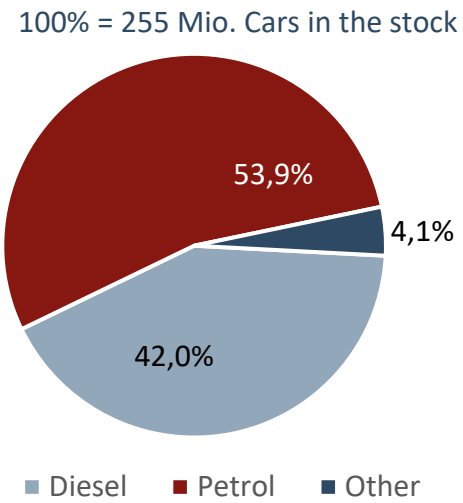
Sources: ACEA Report Vehicles in Use, 2019; ACEA Pocketbook 2017/2018

In its reduction of CO_2, Europe relies on diesel

New car registrations in the EU 28 in 2018



Existing vehicle fleet in the EU in 2016



- Since the mid-90s, Europe's fleet of new vehicles had a growing share of cars that run on diesel but now it is declining.
- Diesel plays a significant part in Europe's CO_2 reduction progress.
- Diesel motors are primarily used in vehicles that are expected to have high mileage.

Sources: EEA, Monitoring CO_2 Emissions from new passenger cars, 2019; ACEA, 2019; ACEA, 2016

Summary: Transportation today

Road traffic is the indispensable backbone of mobility for passengers and freight in Europe.

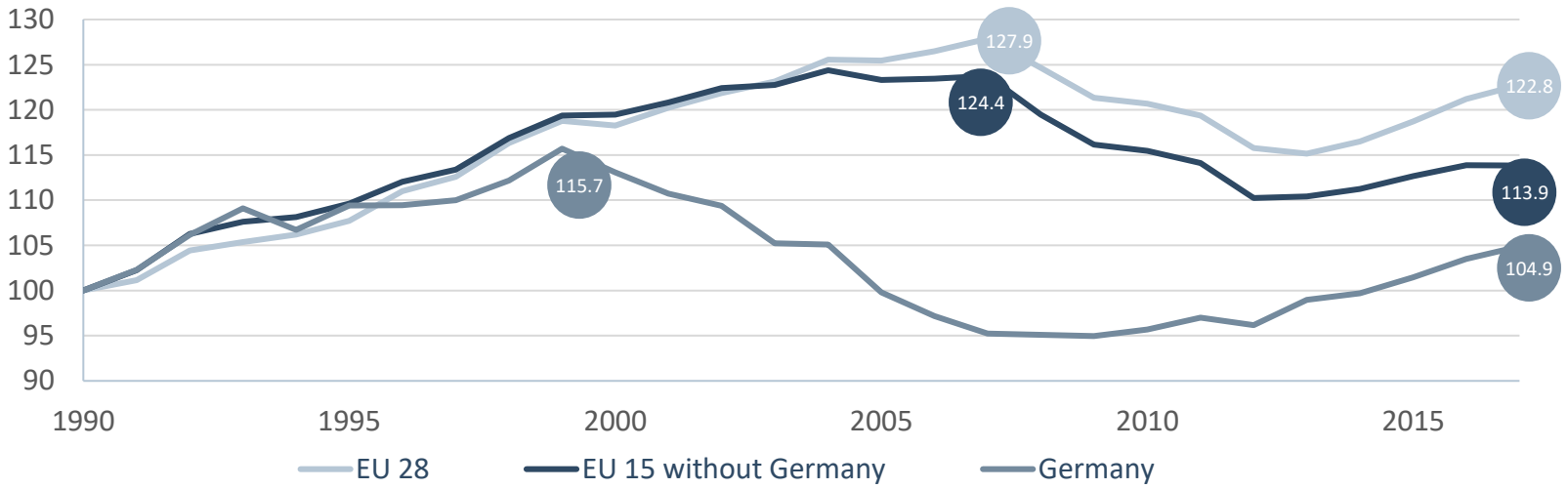
According to official forecasts, the dominance of roads in Europe will not change between now and 2030.

Since 2007, traffic volumes on the road have declined. Today, these volumes are often below the projected levels; and even the official growth expectations must be questioned.

The replacement of Europe's existing vehicles is an effective measure for reducing emissions; but it will be another ten years before the more efficient new vehicles dominate the fleet.

The turnaround came in Germany first

CO_{2EQ}-Emissions of road traffic, 1990 = 100

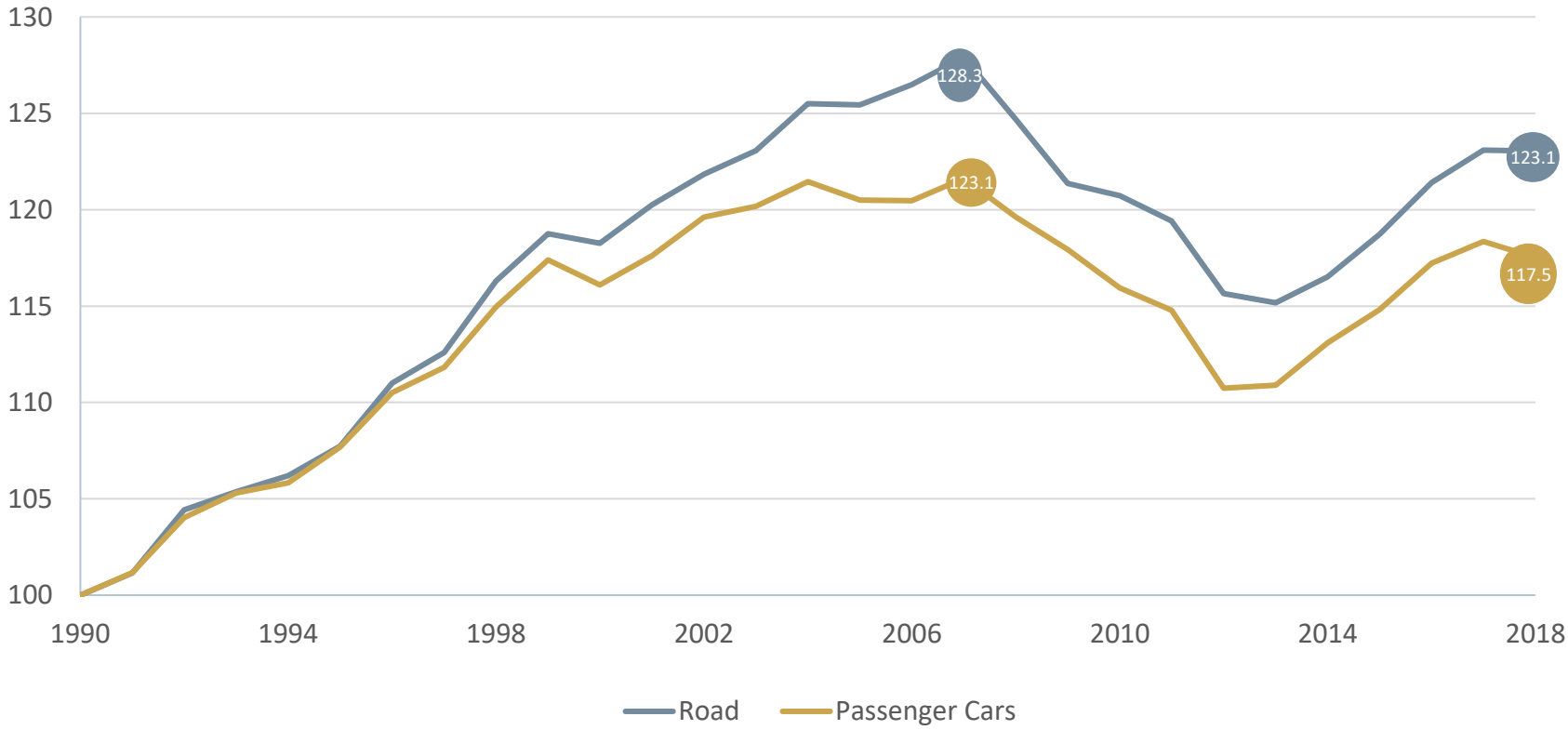


- Since 1999, emissions in Germany have declined by 24 million tonnes and then rose again.
- From 2000 on, an increase in emissions could primarily be seen in Eastern and Southern Europe.
- The turnaround in the EU 28 did not begin until the crisis of 2008.
- In the years 2014 till 2017 emissions increased significantly.

Quelle: EEA, 2017 (v20)

Passenger Cars in the EU: CO_2-Emissions are rising again

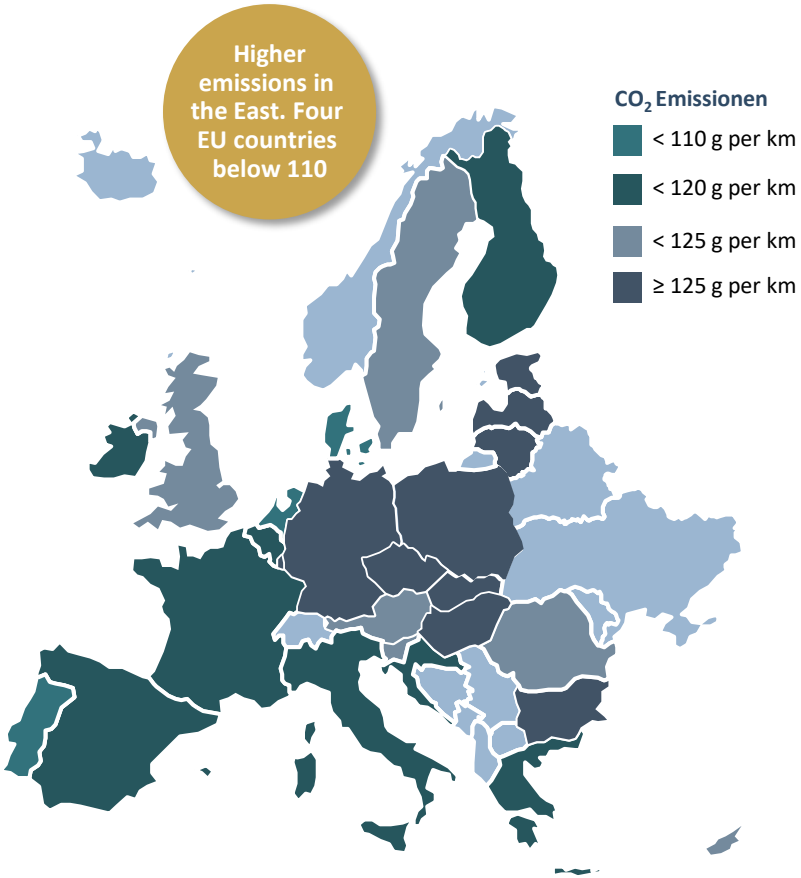
Absolute CO_{2EQ}-Emissionen, 1990 = 100



Quelle: EEA, 2020 (v23)

Emissions from new vehicles decreasing rapidly

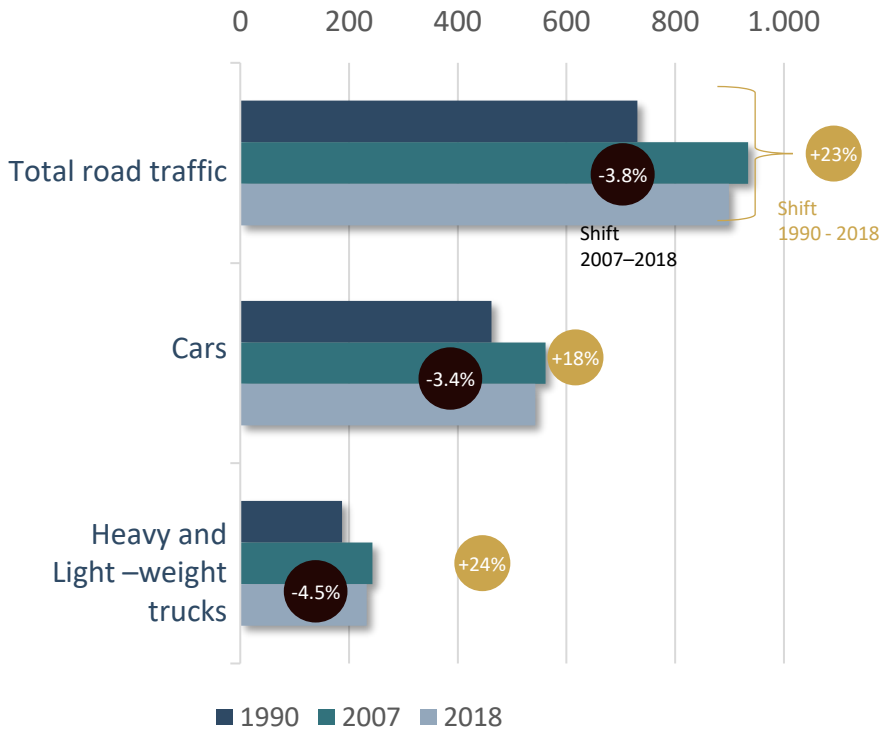
Country	Average CO_2 emissions of newly registered cars in 2018, in g per km	Change from 2007 to 2018, as percentage
Netherlands	105.5	-35.98
Portugal	106.1	-26.42
Malta	107.7	-27.13
Denmark	109.6	-31.41
Greece	111.4	-32.60
France	112.2	-24.89
Ireland	113.3	-29.89
Croatia	115.3	k.A.
Italy	115.9	-20.89
Finland	116.7	-34.18
Spain	118.1	-22.91
Belgium	119.4	-21.86
Slovenia	120.9	-22.65
Romania	121.5	-21.51
Sweden	122.2	-32.63
Austria	123.0	-24.49
Cyprus	123.4	-27.58
UK	124.6	-24.35
Czech Republik	126.0	-18.29
Bulgaria	126.7	-26.16
Slowakia	127.6	-16.44
Hungary	127.9	-17.48
Lithuania	128.6	-27.14
Latvia	128.8	-29.81
Germany	129.5	-27.14
Poland	129.8	-27.82
Luxembourg	131.4	-20.75
Estonia	132.4	-27.09



Source: EEA, 2020

The share of emissions from freight transport has significantly increased

In millions of tonnes of CO_{2EQ}



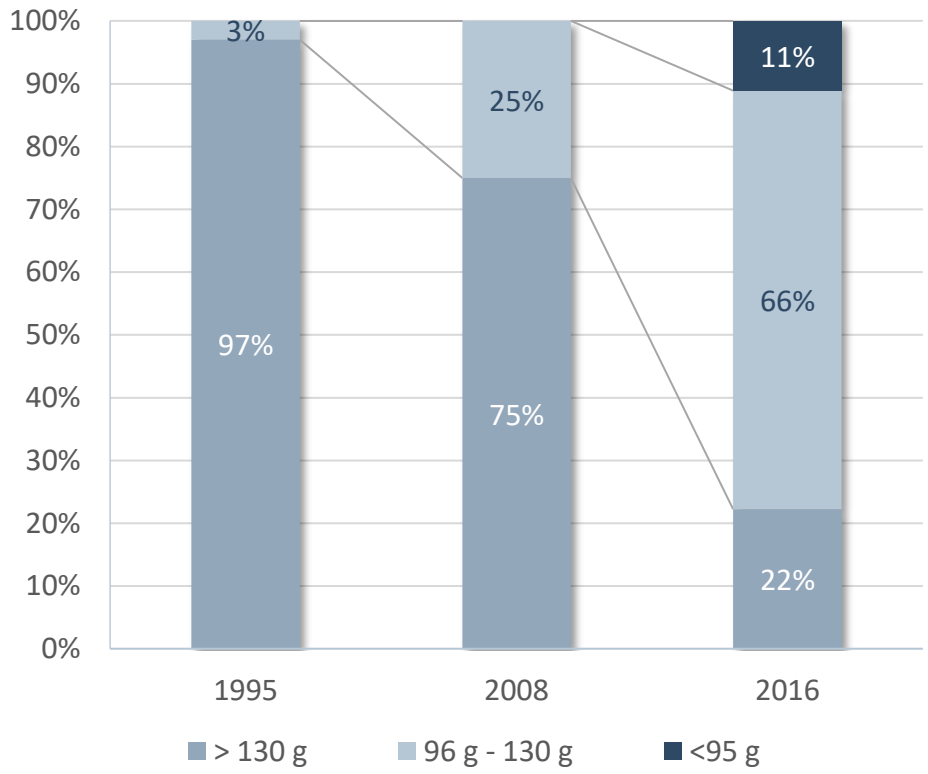
Since 2007, the CO2 emissions of road traffic in the EU have been declining. But since 2013 they are rising again.

- Between 1990 and 2007, emissions from truck traffic in particular saw a rapid increase.
- Since 2007, emissions from freight transport have been declining again.
- The increase of emissions from car traffic was relatively moderate. Emissions have stagnated since around 2004 and have been declining from 2007 till 2012. Since 2013 they are rising again.

Source: EEA, 2020 (v23)

High-emission cars are being phased out

CO_2 emissions of new vehicles in the EU, as percentage

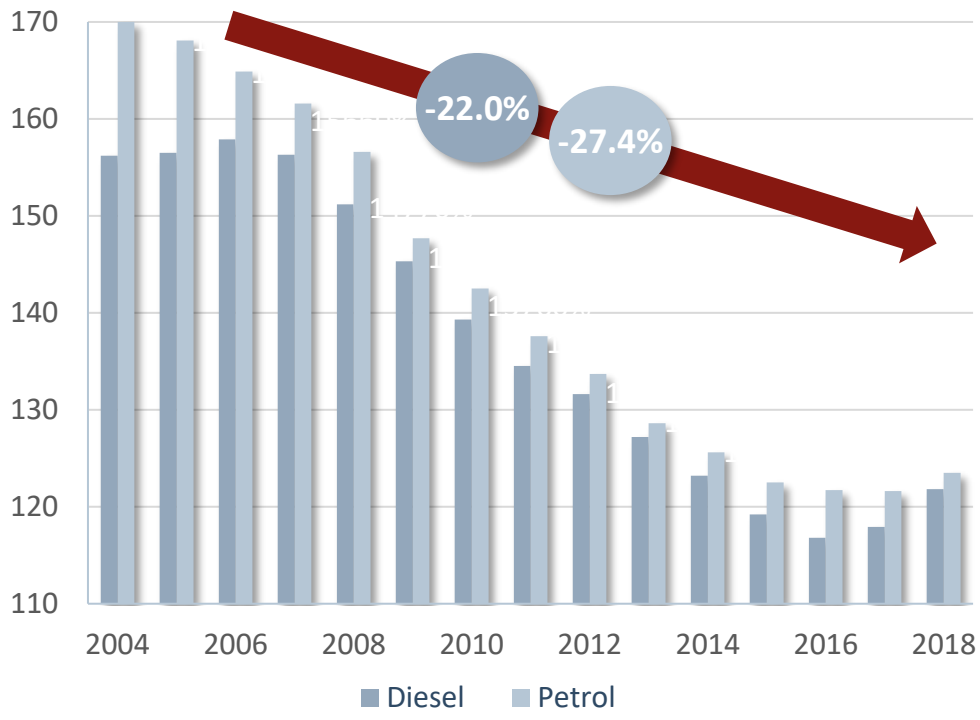


Source: ACEA, 2016

- The broad range of today's new vehicles already emits less than 130 g CO_2/km.
- Vehicles with high emissions are on the decline.
- In 1995 80 per cent of the new cars emitted more than 160 g CO_2/km.
- Vehicles with emissions under 95 g CO_2/km are now entering the market.
- More than 1/10th out of the new cars already meet the target for 2021.

Diesel- and petrol-powered vehicles are reducing their emissions

CO_2-emissions of new vehicles in the EU by engine type, in g of CO_2 per km



Soruce: EEA, Monitoring CO_2 Emissions from new passenger cars, 2019

Petrol-powered vehicles are showing great advancements and are catching up with diesel engines.

- But: Diesel engines dominate more among larger vehicles, while petrol engines dominate among smaller vehicles.
- The advancements among diesel engines appear stronger, since diesel vehicles spend more time on the road each year.
- In 2017 Diesel Emissions climbed for the first time.

Heavy trucks: clear progress in practical test

Scientifically evaluated road test of comparable heavy trucks of different years of construction for determining the real CO_2 emissions

1 Total difference in emissions of old and new

2 Reduktion of emissions per year

Daimler DEKRA	1996: **436 PS**	2016: **450 PS**	-22%	-1,10%
Scania AVL	1992: **500 PS**	2016: **500 PS**	-25%	-1,04%
Volvo AVL	1991: **405 PS**	2016: **460 PS**	-19%	-0,76%
MAN TÜV Süd	1994: **402 PS**	2016: **460 PS**	-31,5%	-1,45%
Iveco AVL	1994: **514 PS**	2016: **571 PS**	-21%	-0,95%

Source: ACEA, 2017, Reducing CO_2 from trucks: progress in practice – Third-party assessment

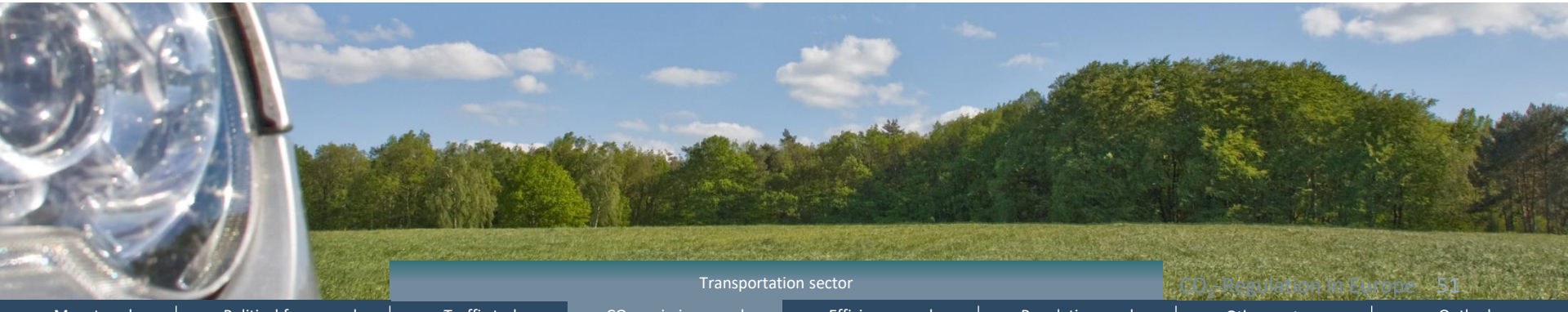
Summary: CO_2 emissions on the road

The CO_2 emissions of road traffic in the EU have been decreasing for years.

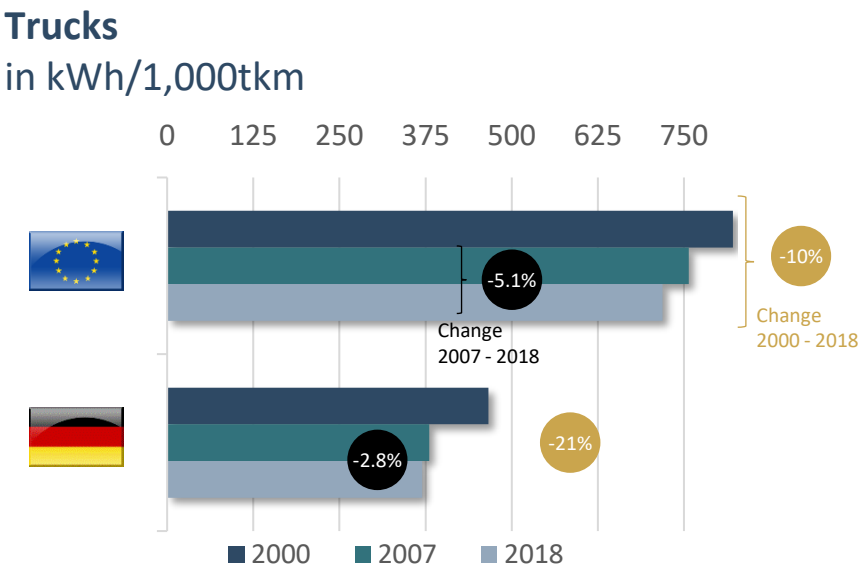
Compared to 1990, the emissions from truck traffic in particular increased dynamically but have been decreasing again since 2007. Emissions from car traffic have stagnated since 2004 and have shown a clear decline since 2007.

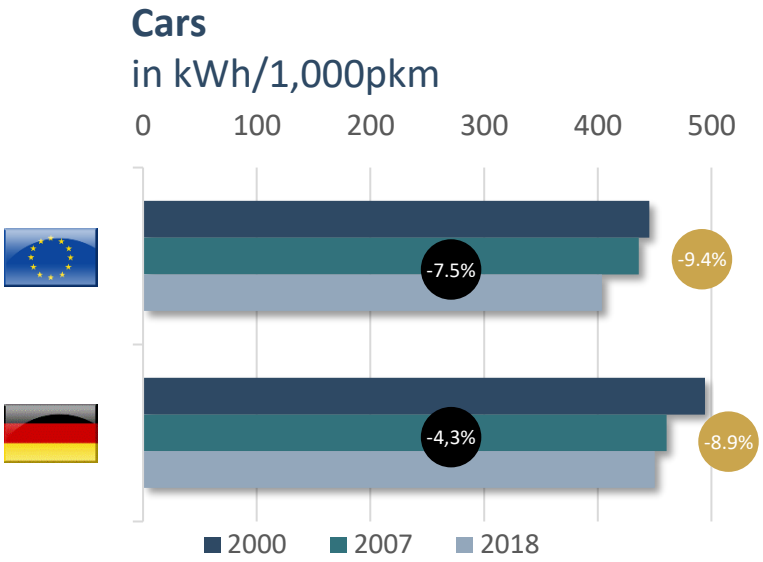
The increased distribution of more fuel-efficient new vehicles accounts for the decline in car emissions.

The increased use of diesel engines – especially in the case of larger vehicles – was a key driver in the reduction of emissions.



EU: Increased energy efficiency in road traffic





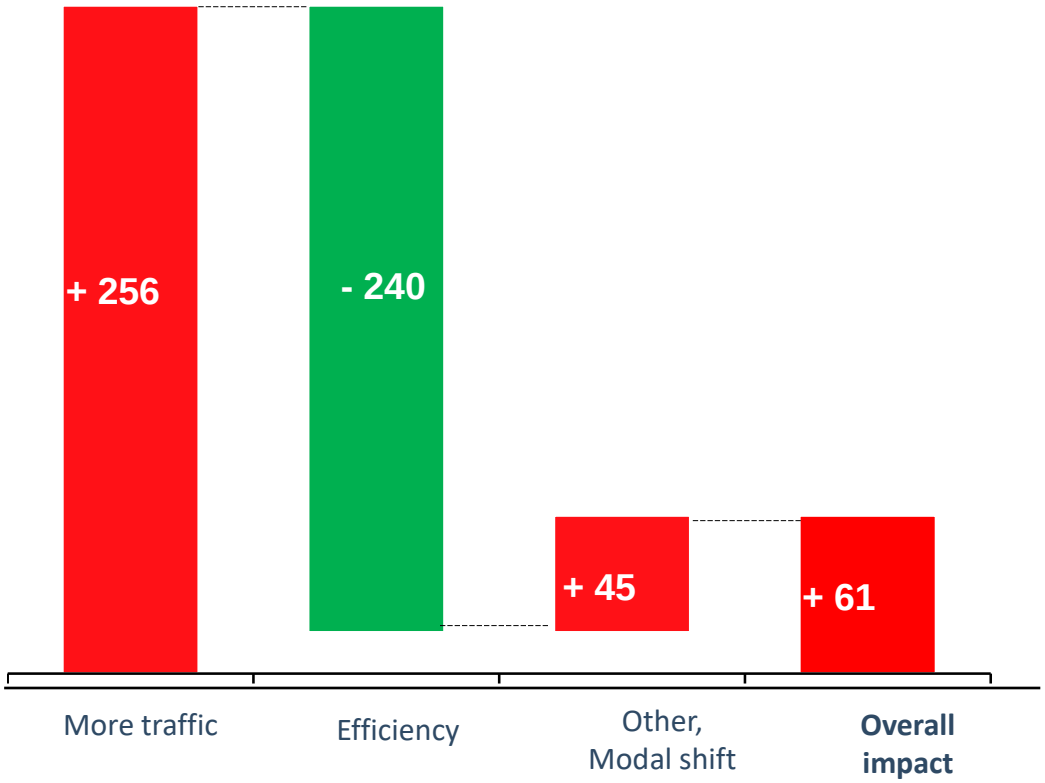
- The use of energy per unit of output has reduced considerably in European road traffic since 2000.
- But: Since 2007, truck traffic in the EU has relinquished a portion of its efficiency gains. Two new EU standards related to the reduction of pollutants were introduced in this time period, which likely led to the increased consumption of new vehicles.
- The increased efficiency of cars has accelerated considerably since 2007.

Source: Odyssee Database, 2020

EU freight transport between 2000 and 2017

Increases in efficiency are obscured by growth in the quantity of freight transported

Development of energy consumption by impact, in terawatt hours (TWh)



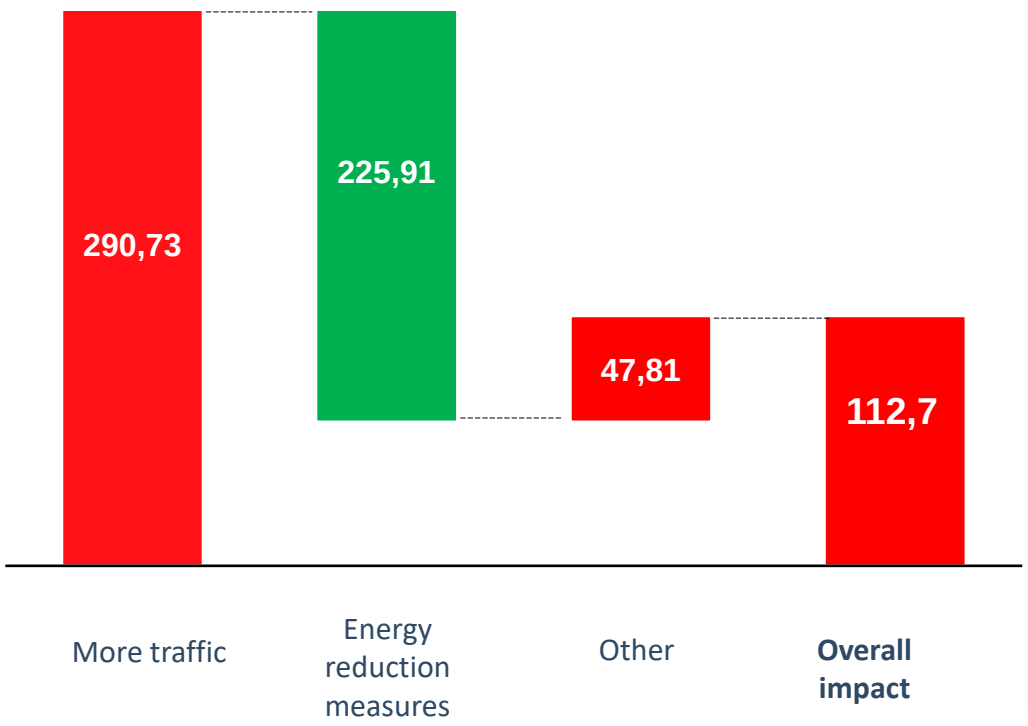
Source: Odyssee Database January 2020

- More efficient vehicles and routing help to offset approximately the increased consumption resulting from other factors.
- Modal shift effects play a subordinate role with an additional consumption of 29 TWH.

Car traffic between 2000 und 2017

More efficient vehicles have a growing impact on energy consumption levels

In terawatt hours (TWh)



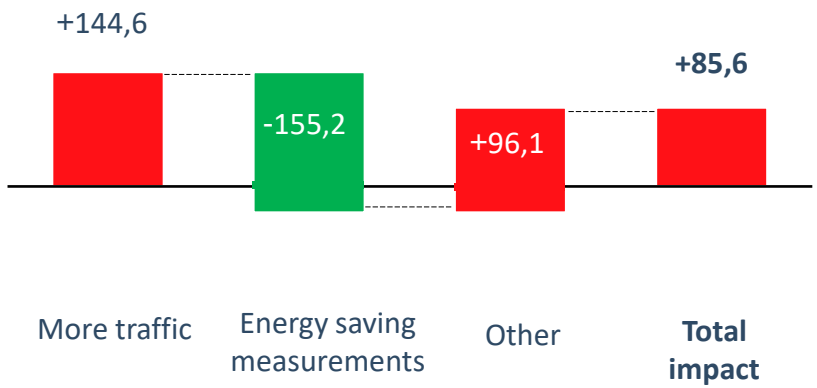
- As a result of increasing traffic volumes, energy consumption in car traffic has increased significantly since the year 2000.
- But: The dominant impact came about through more efficient vehicles.
- The total energy consumption in the year 2015 was on the same level as in the base year 2000.

Source: Odyssee Database January 2020

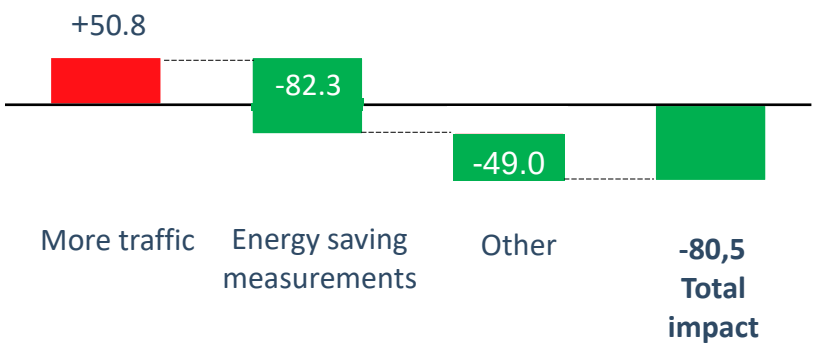
Car traffic between 2000 und 2017

More efficient vehicles have a growing impact on energy consumption levels

2000 – 2007 in terawat hours (TWh)



2007 – 2017 in terawat hours (TWh)



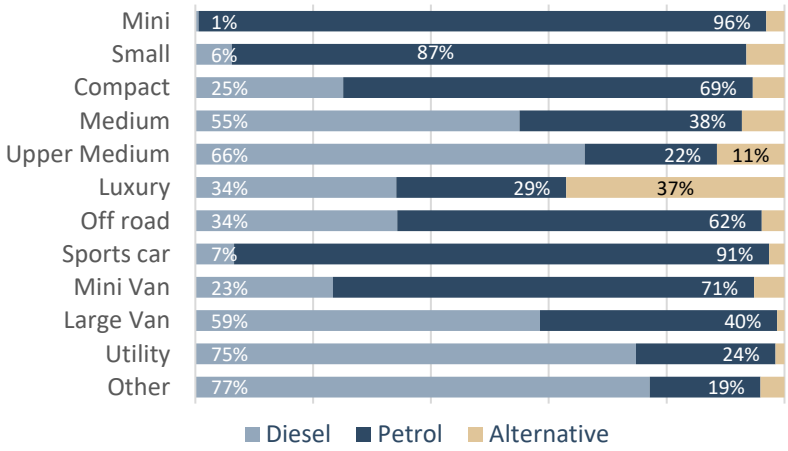
- Around the turn of the millennium, additional traffic led to an increase in energy consumption. This effect has changed course in the last seven years.
- During the second half of the reported period, the reduction effect became dominant against the effect of additional traffic, driven by the increased distribution of more efficient vehicles.

Source: Odyssee Database January 2020

Diesel ensures lower emissions from large cars

New car registrations in Germany

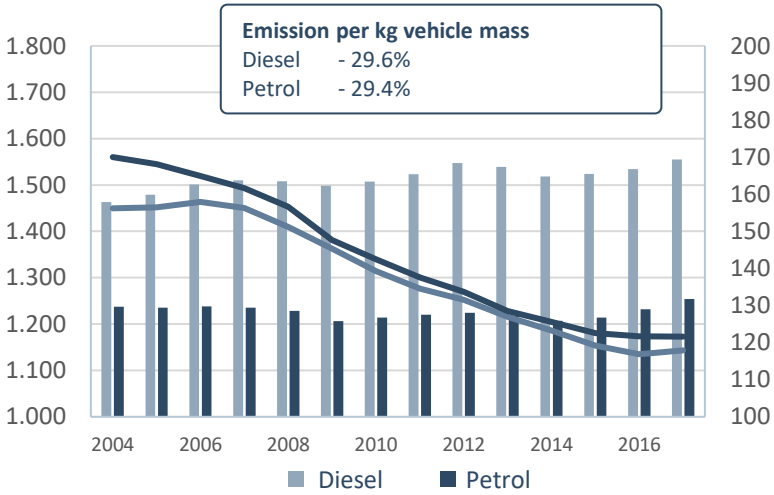
Market shares by segment and engine type, in %



Increased efficiency 2004 – 2017

Ø vehicle mass in kg

Ø CO_2-Emissions in g

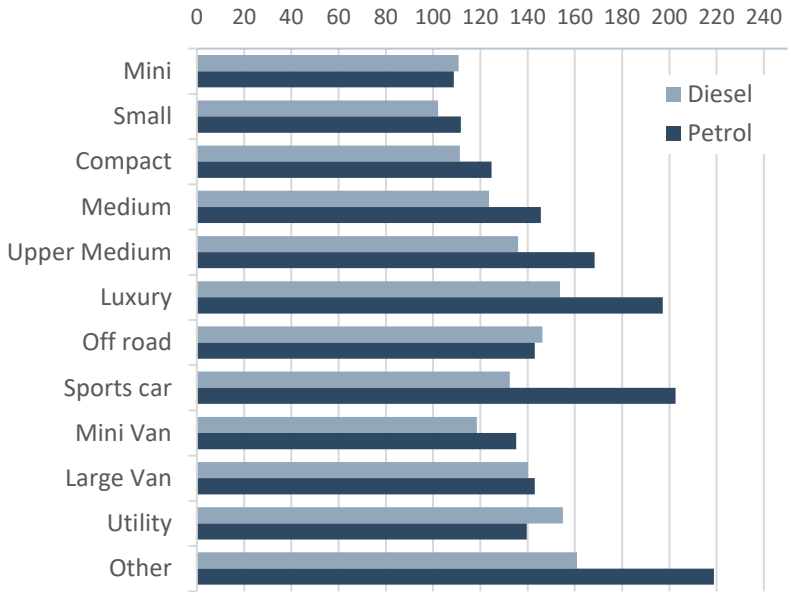


- Diesel is increasingly becoming the preferred engine for large vehicles that spend the most time on the road, while petrol engines still dominate the smaller car classes.
- As a result of this trend diesel engines have become heavier (more powerful), and petrol engines have been catching up in terms of standard fuel consumption. In 2016 a diesel car was 300 kg heavier than a petrol car.
- Fuel efficiency has in fact improved at essentially the same rate for both engine types.
- Luxury Class has by the highest share of alternative fuels.

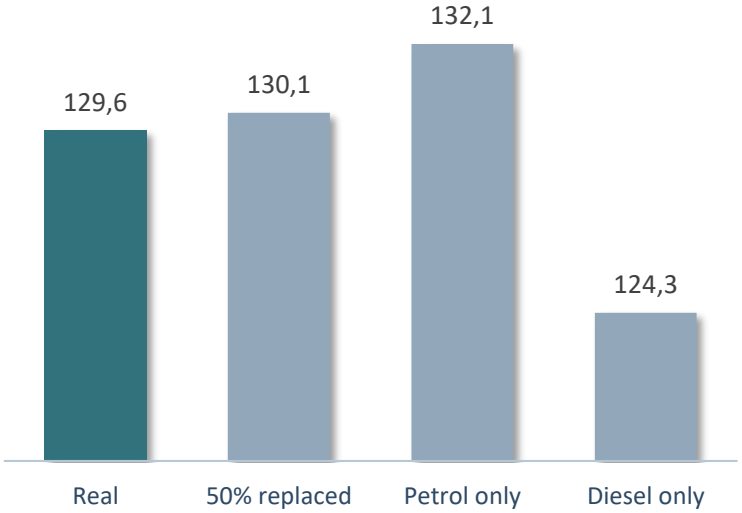
Sources: KBA 2016; EEA, Monitoring CO_2 Emissions from new passenger cars, 2019

Where would Germany be without diesel?

CO_2 emissions of newly registered cars in 2018
By segment and engine type, in g per km



How would emission levels compare if a portion of the diesel engines were replaced by petrol engines?
CO_2 emissions in g per km

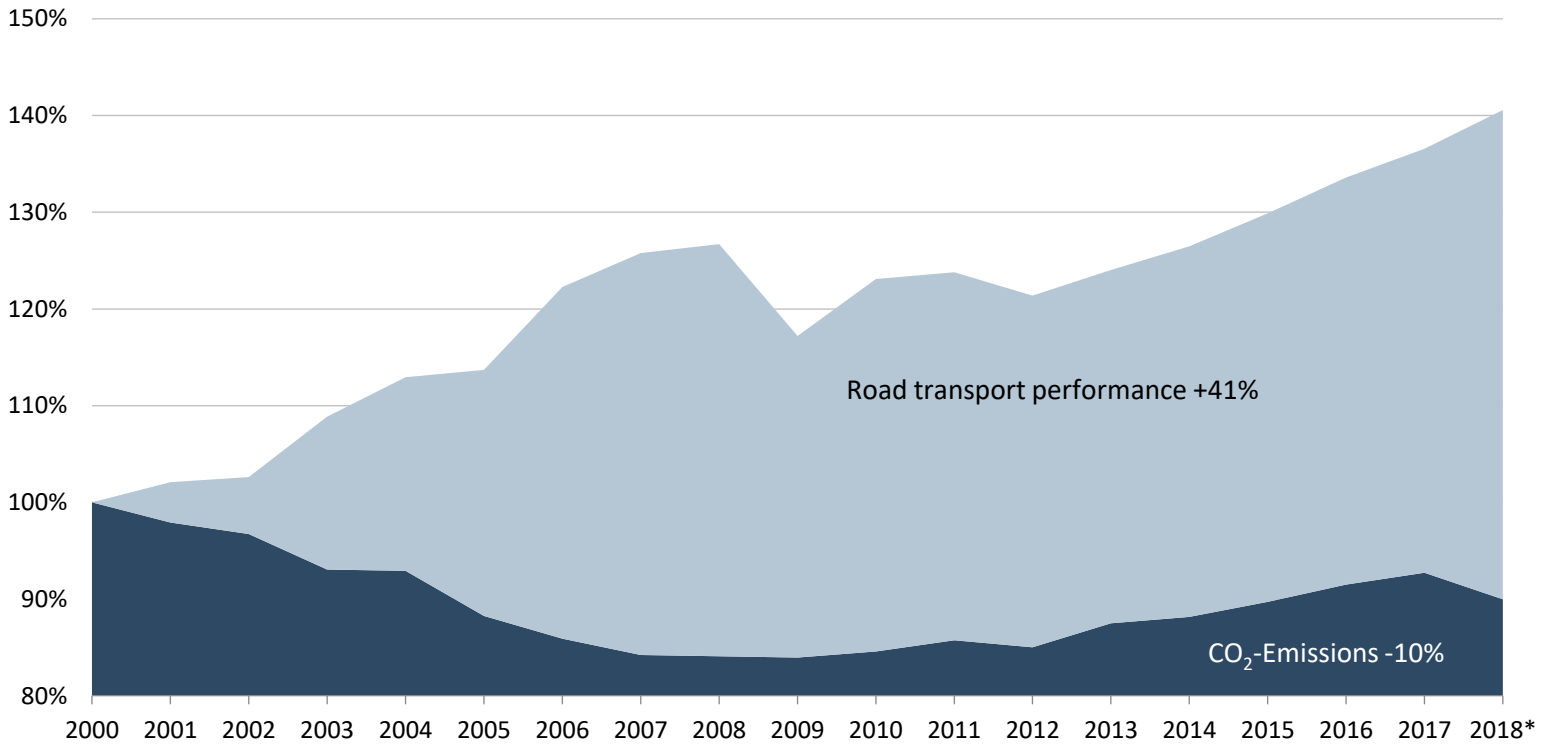


- Diesel emissions are lower than those of petrol in all vehicle segments.
- Diesel engines dominate the larger classes of vehicles.
- The emissions level of new vehicles would be significantly higher without the use of diesel engines.

Source: own calculations

Transport growth dominates the balance

Development of road transport performence and CO_2-Emissions of road transport in Germany since 2000

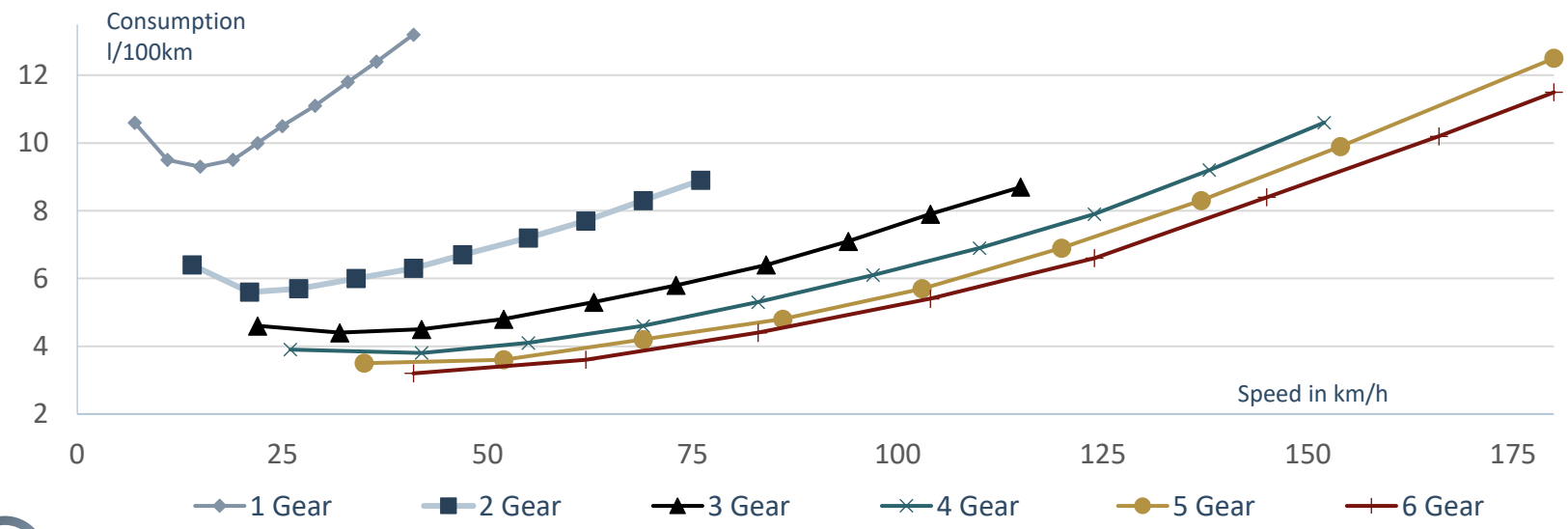


The calculation of the transport performance is carried out according to method of the Arbeitsgemeinschaft Energiebilanzen; Calculation factor 1tkm = 10 pkm

Source: Umweltbundesamt; Kraftfahrtbundesamt; Own Calculations

The driver determines the fuel consumption

Shifting gears early saves fuel: the fuel consumption curve of a Golf 1.4 TFSI (90 kW) in relation to its speed

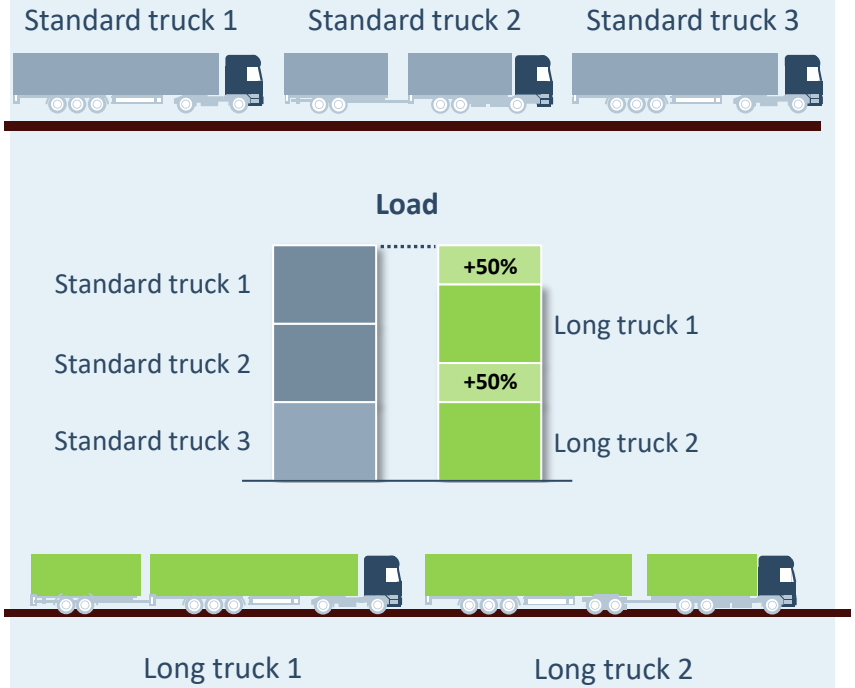


- Fuel saving training courses: Following the course, participants used approximately 20 per cent less fuel than before. In Germany alone, the reduction potential from fuel-efficient driving is estimated at 12 million tonnes of CO_2.
- Gear shifting support is particularly effective in urban traffic: when driving at a speed of 50 km per hour, the test vehicle consumes 1.2 litres less in fifth gear than in third.

Make 3 on 2 – Bigger Loading volume cuts fuel consumption

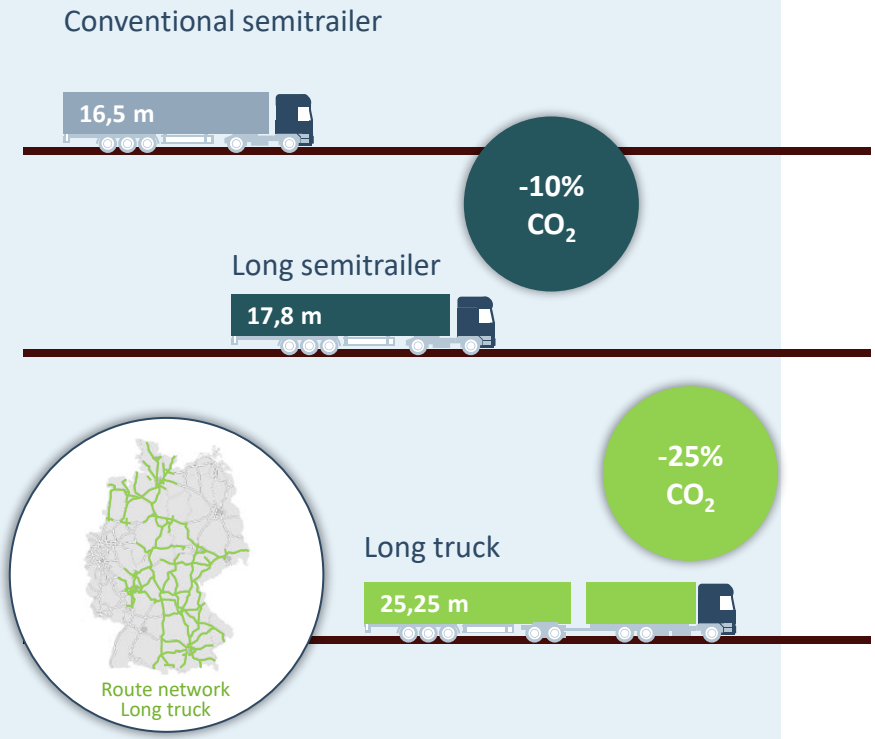
Make 3 on 2

Two long trucks are able to transport as much load as three standard trucks.



Low fuel consumption

The long truck rides more efficient than other trucks. Consequence: less fuel consumption per load.

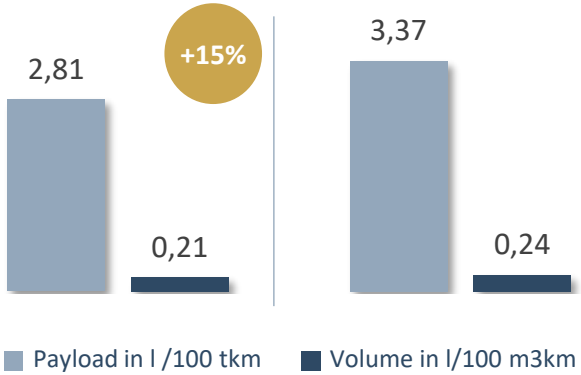


Long trucks: 15 per cent efficiency improvements confirmed in practical test*

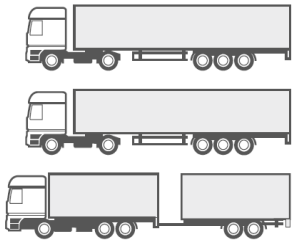
Long truck

gross vehicle weight:	40t
Load volume:	155 m^3
Valued track section:	8,900 km
Ø Fuel consumption:	33.9 l/100 km

Transport efficiency



Conventional semitrailer



gross vehicle weight :	36t
Load volume :	100 m^3
Valued track section :	10,700 km
Ø Fuel consumption :	24.1 l /100 km

- Long trucks are significantly more efficient in transporting high load volumes than conventional semitrailers.
- The advance in efficiency of a good 15 per cent lasts als long as the load volume will be fully used.
- Heavy loads can be transported much more efficiently than with normal trucks.
- A long truck consumes more fuel than a conventional semitrailer. This does only pay for the carrier, if he moves more load than the today's truck can carry.

* Results from a field experiment of the federal government; loads were transported with a density of 0,72 kg/dm^3 (paper: 0,8 kg/dm^3)
Source: BMVI

Summary: Efficiency on the road

More fuel efficient vehicles have led to a considerable increase in the overall efficiency of road traffic since the year 2000.

Increased traffic volumes have long prevented the more efficient vehicle technology from actually lowering the overall level of emissions.

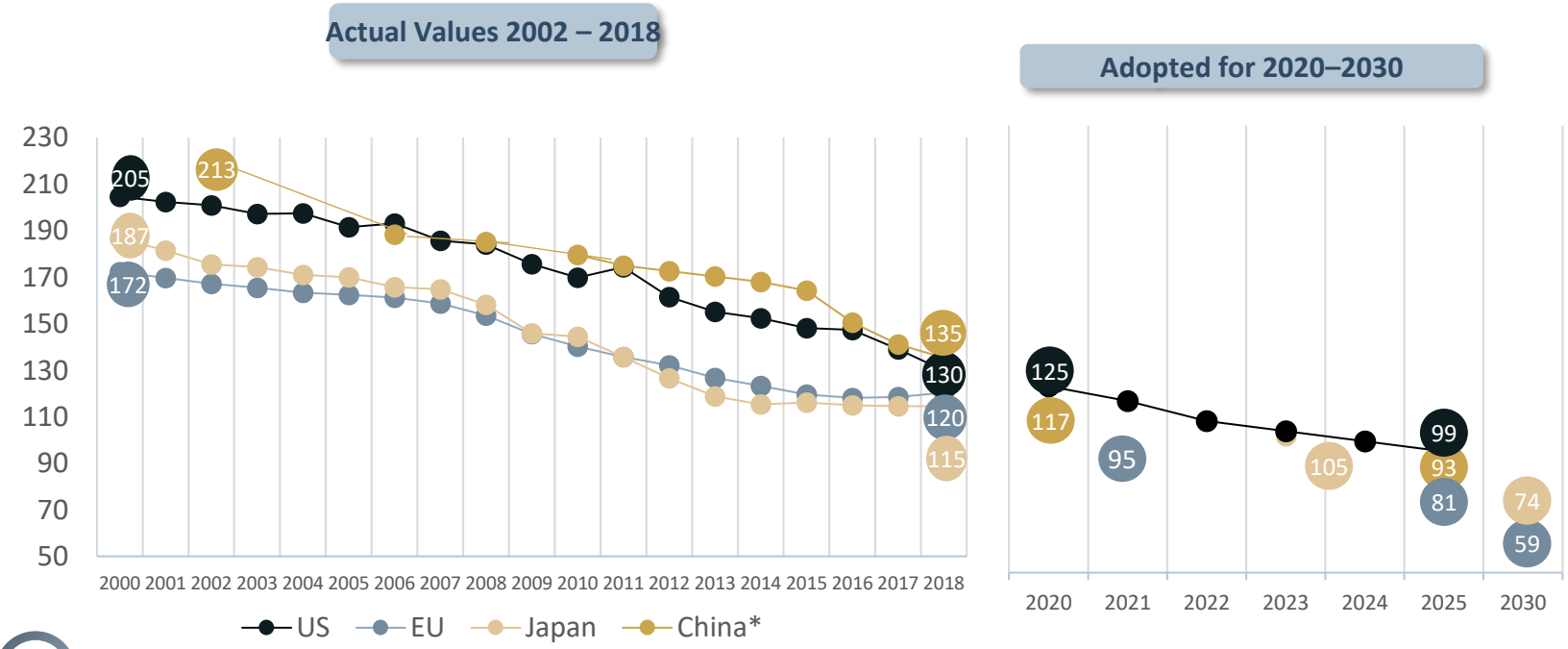
Diesel engines were a major driver of the increasing efficiency. They have led to considerably lower emissions, particularly in the case of larger vehicles.

Low-cost possibilities for increasing efficiency are being wasted. Fuel saving training courses can reduce consumption by 20 per cent.

The licensing of larger trucks could also save a lot of fuel.

The most stringent CO_2 target values for new vehicles

in g CO_2/km under the New European Driving Cycle (NEDC)

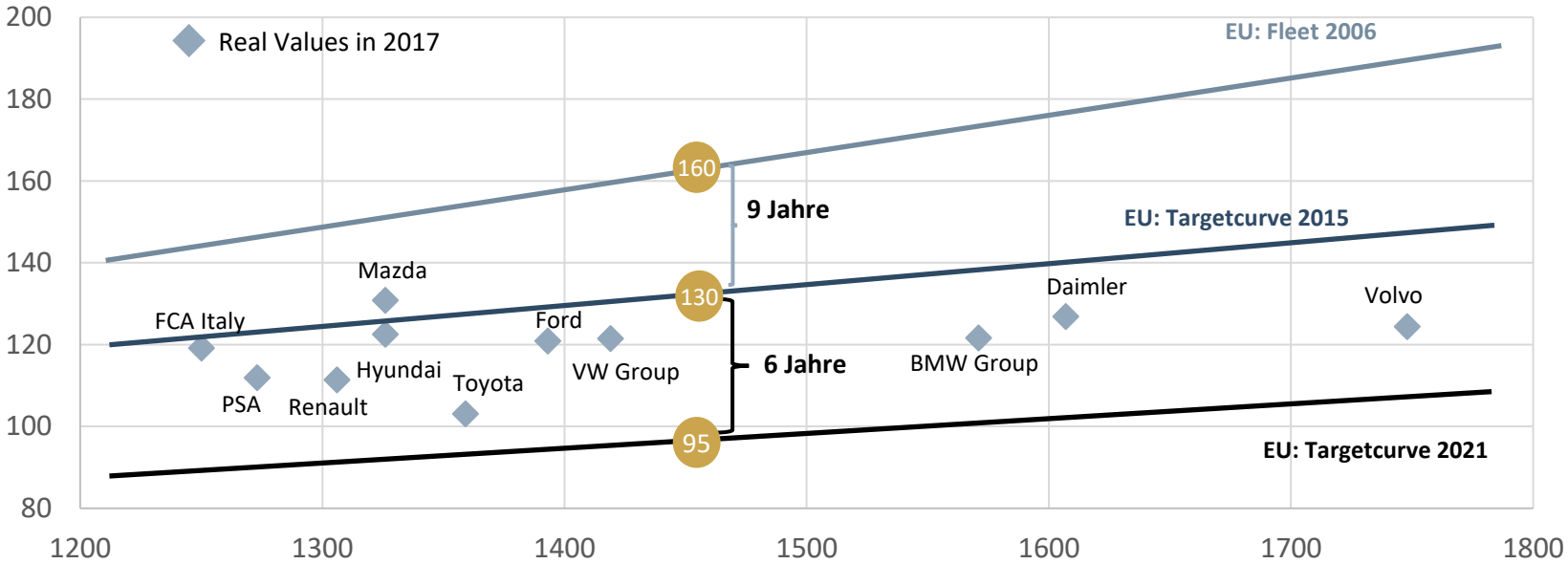


- The EU emission standard for 2030 is the most stringent standard in the world.
- In the US passenger cars only make up a third of the vehicle market. Light Trucks dominate and their limit Value is considerably higher (140 g/km in 2025)
- In November 2017 the EU Kommission proposed to lower the limit value within the period of 2021 until 2025 by 15 per cent and to codify a minus of 37.5 per cent until 2030.

* Gasoline only
Source: ICCT, 2020

CO_2 target values for 2021: High demands on the automotive industry

in g CO_2/km



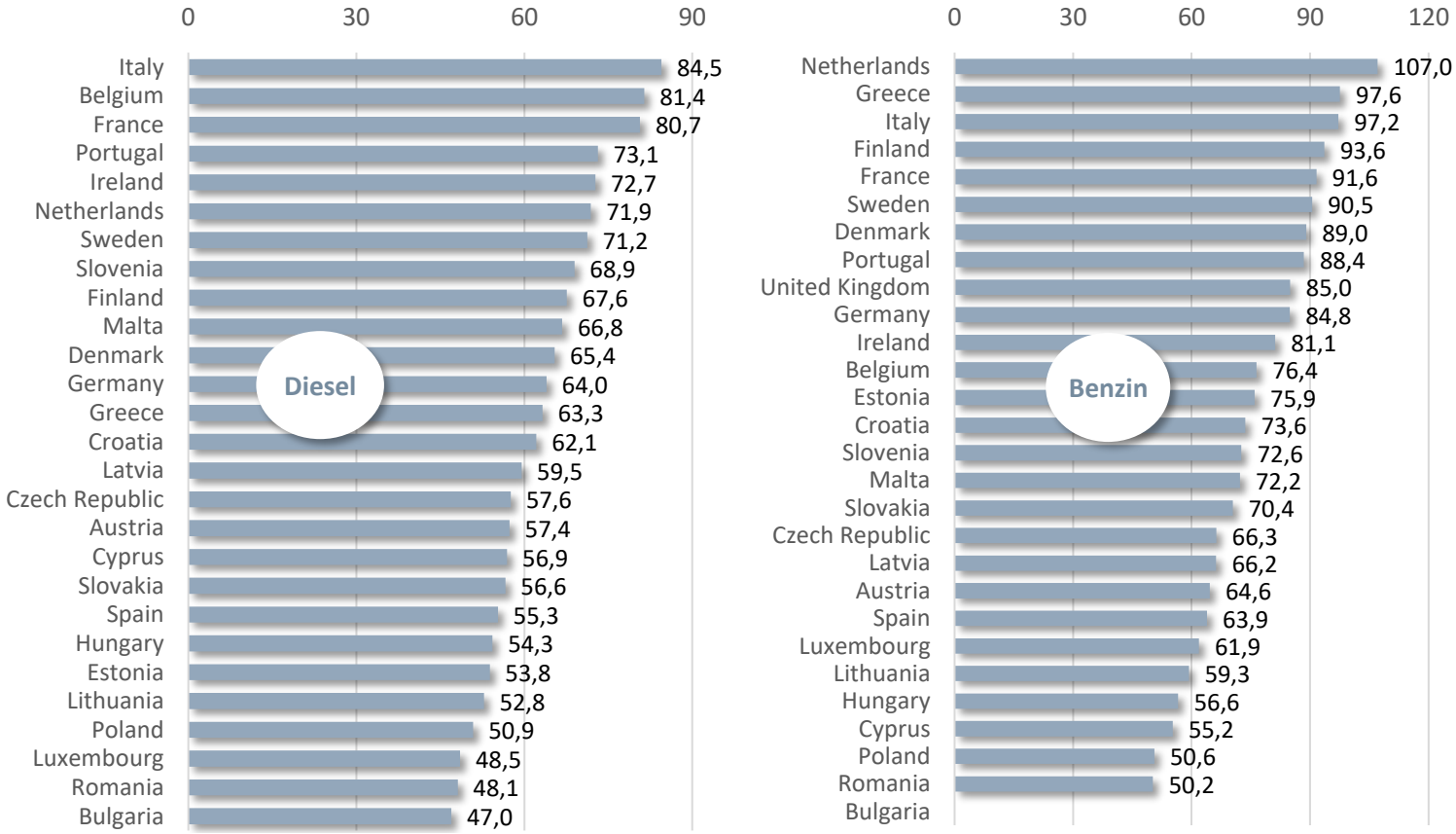
- Independent of vehicle weight, manufacturers of large cars have to show greater reductions than high-volume manufacturers.
- In the nine years from 2006 to 2015, a reduction of the average emissions by 30 g CO_2/km was required of new vehicles – from 160 g CO_2/km down to 130 g CO_2/km .
- Speeding up the pace: In the six years from 2015 to 2021, average emissions must be reduced by 35 g CO_2/km – from 130 g CO_2/km down to 95 g CO_2/km. For 2025 a suggestion has been raised by the commission of 81 g CO_2/km, that is a minus of 14 g CO_2/km in four years.

Sources: EU, EEA

High CO_2 emissions mean high payments:

Fuel related taxes per litre, in euro

– status as of: 01. June 2020

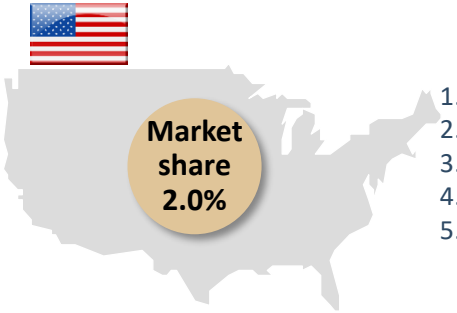


Source: EU Kommission DG Transport, Weekly Oil Bulletin

Electric cars: Quite different markets

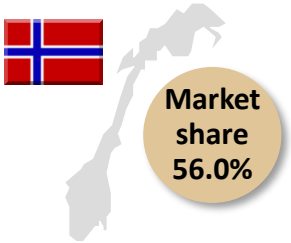
New vehicles and top-selling models of the year 2019

New vehicles BEV/PHEV: 325,000



1. Tesla Model 3
2. Toyota Prius PHV
3. Tesla Model X
4. Chevrolet Volt
5. Tesla Model S

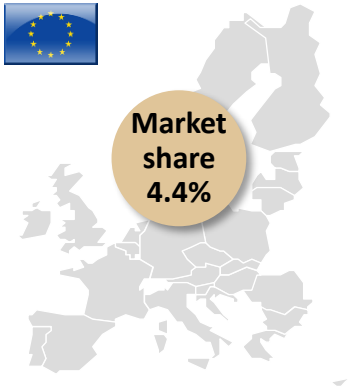
New vehicles BEV/PHEV: 79,640



1. Tesla Model 3
2. Volkswagen E Golf
3. Nissan Leaf
4. Audi e-tron
5. Mitsubishi Outlander

World 2019 2,209,831

New vehicles BEV/PHEV: 564,206



1. Tesla Model 3
2. Renault Zoe
3. Mitsubishi Outlander
4. Nissan Leaf
5. BMW i3

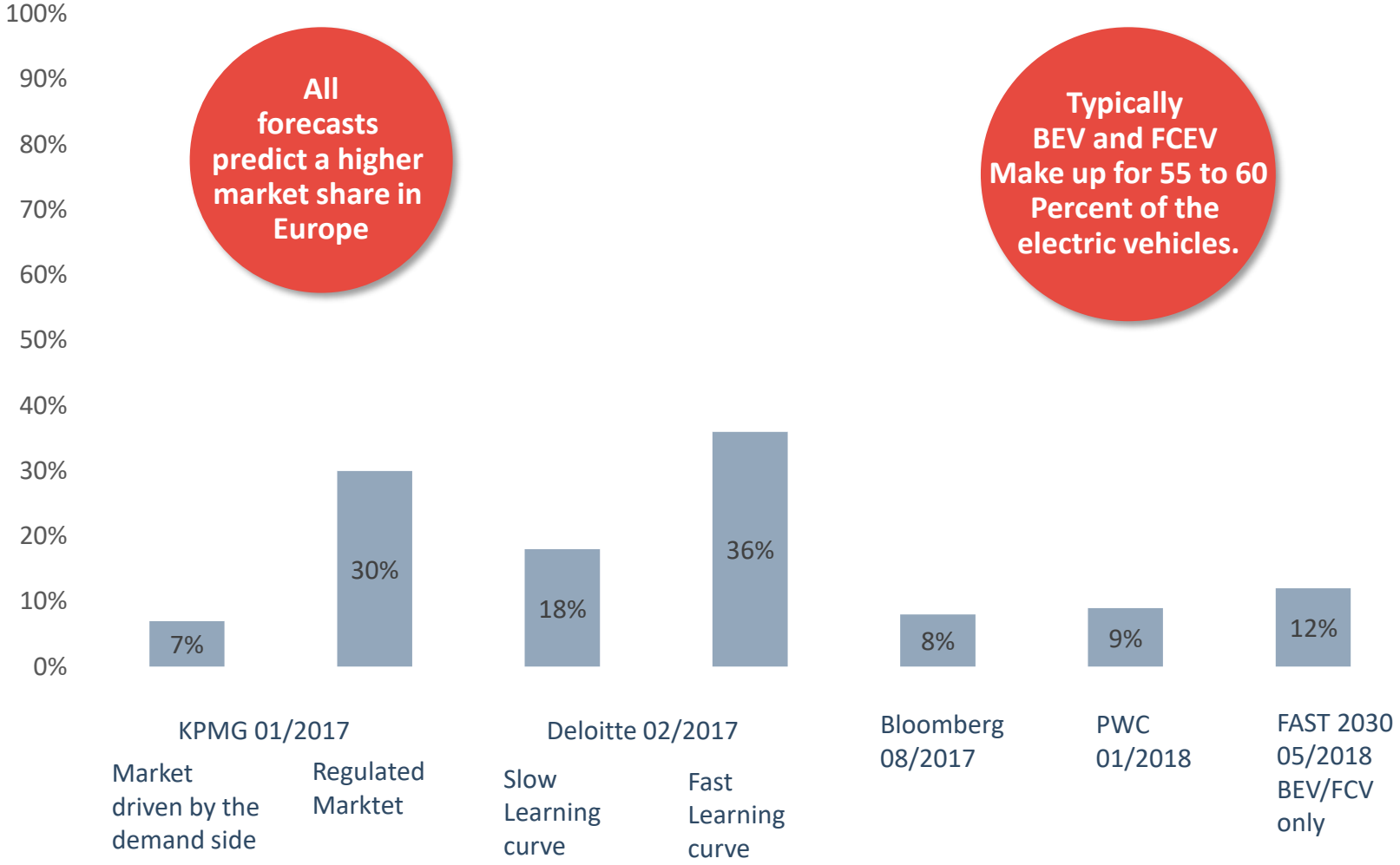
New vehecles BEV/PHEV: 1,177,421

1. BAIC EC Series
2. BYD Yuan
3. SAIC Baojun EV
4. Cherry EQ
5. BYD Tang

Source: ev-sales.blogspot, 2019

Market share forecasts for electric vehicles

Current forecasts for the global market share in the year 2025



These numbers include BEV, FCV and PHEV

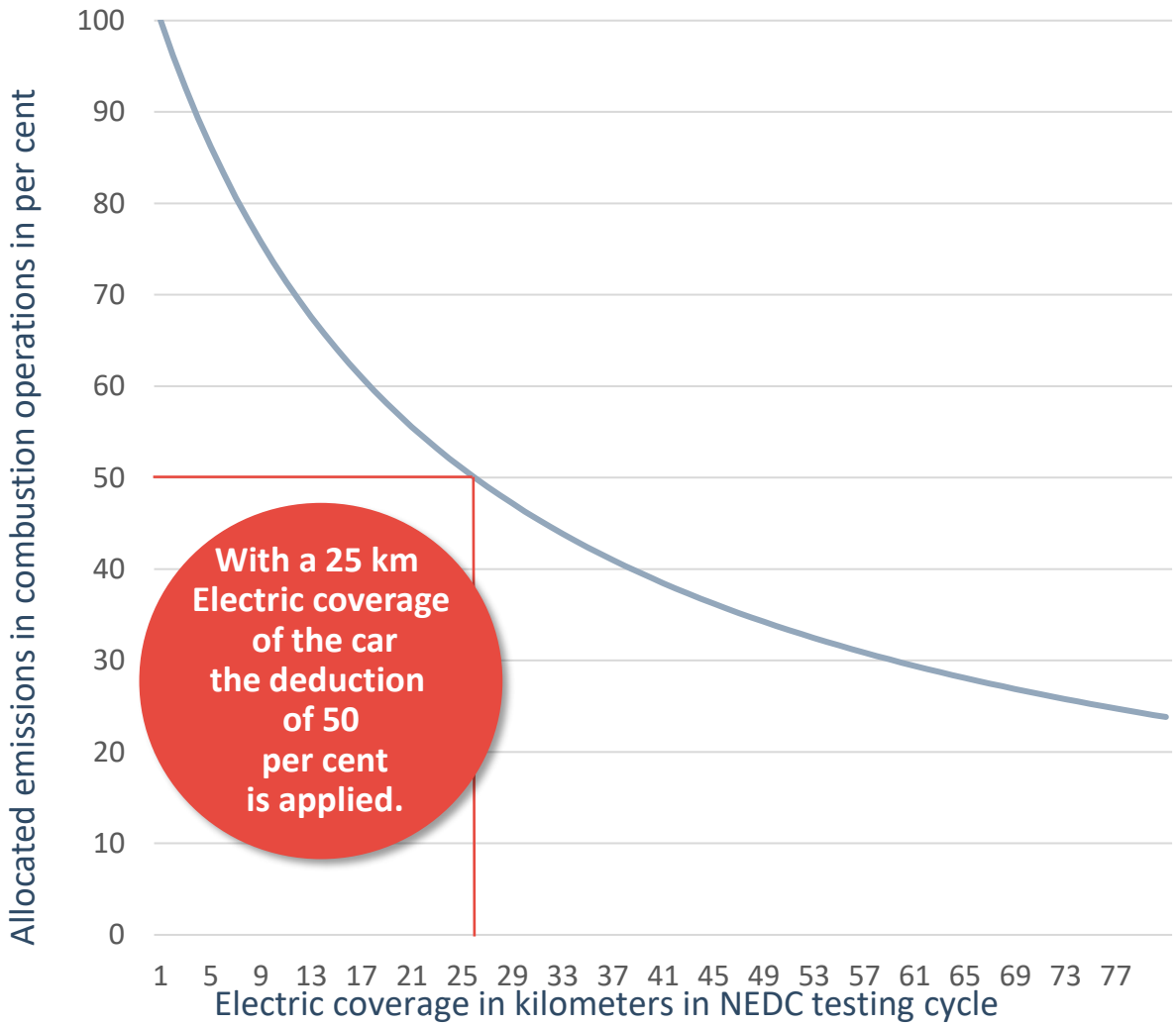
Emissions calculations for PHEV

Emissions from PHEV are calculated on the basis of the emissions in combustion operations and of the electric coverage of the car.

Firstly the PHEV participates in the European testing cycle (NEDC) in combustion operations.

Then it runs the cycle driven on electrical energy as long as the battery lasts.

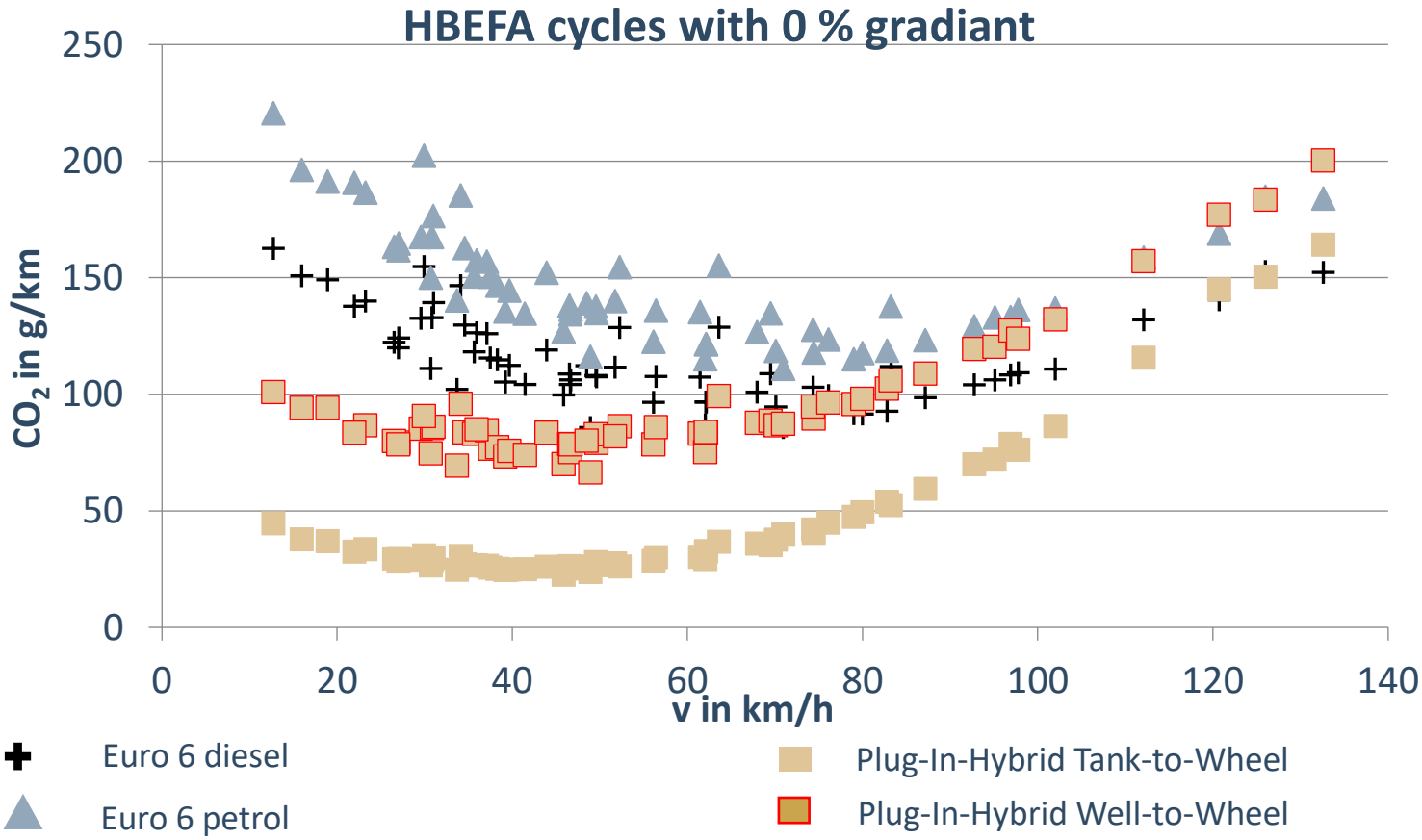
Depending on the such determined coverage of the car a pro rata deduction from the emissions in pure combustion operations is applied.



Source: EU Komission, Own calculations

Speed makes the difference

CO_2emissions of a middle class car with different drive versions and speed

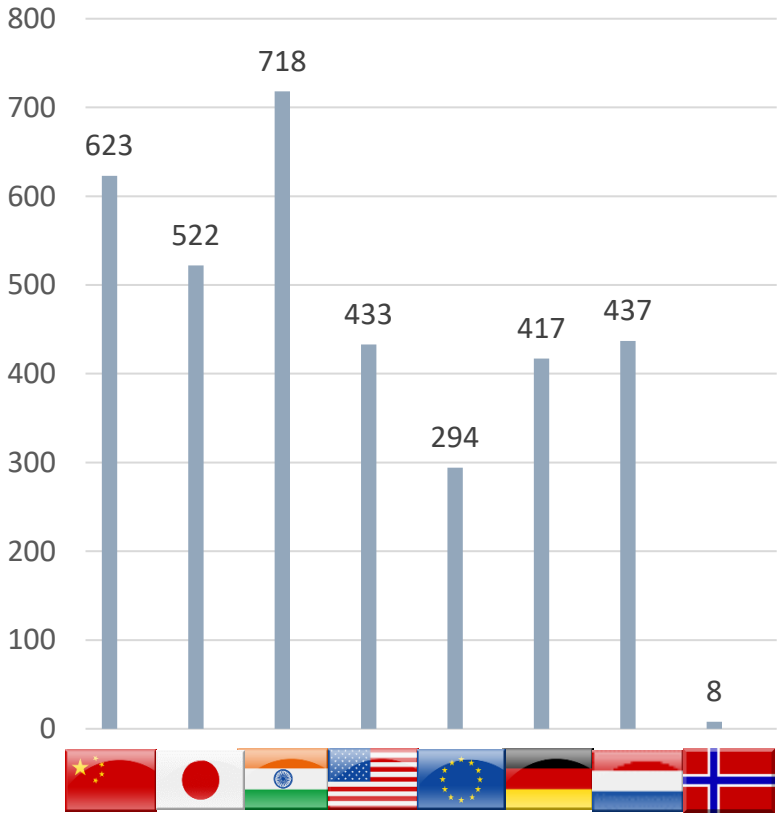


Source: TU Graz, 2018

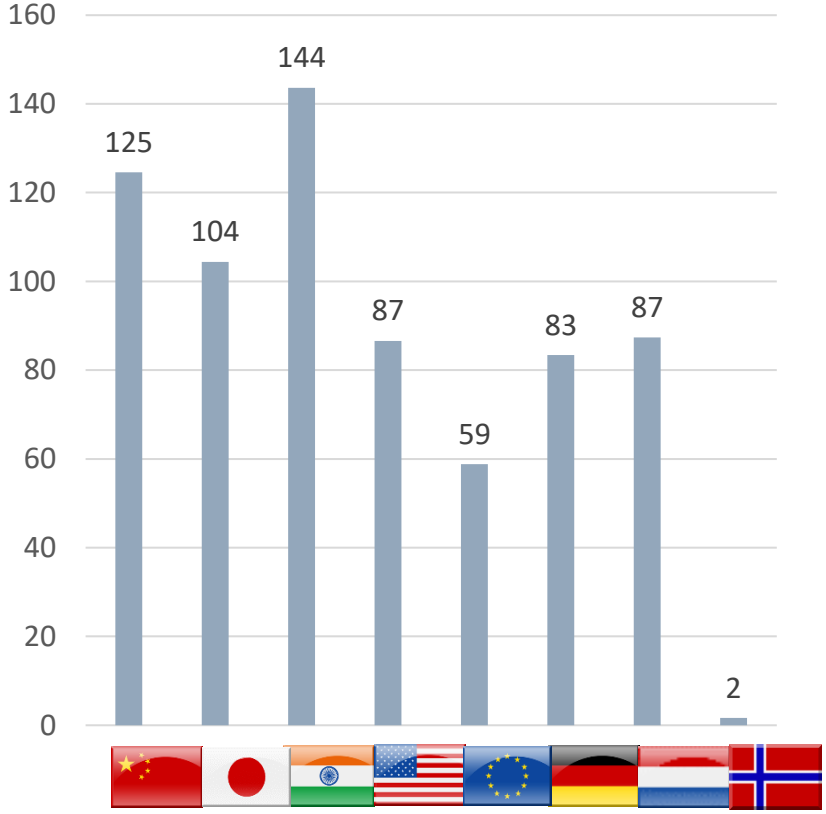
Electricity mix will decide on climate friendliness

CO_2 emissions of power production and electric cars

CO_2 emissions or power production in gCO_2/kWh



With a fuel consumption of 20 kWh/100km an electric car emits … gCO_2/km

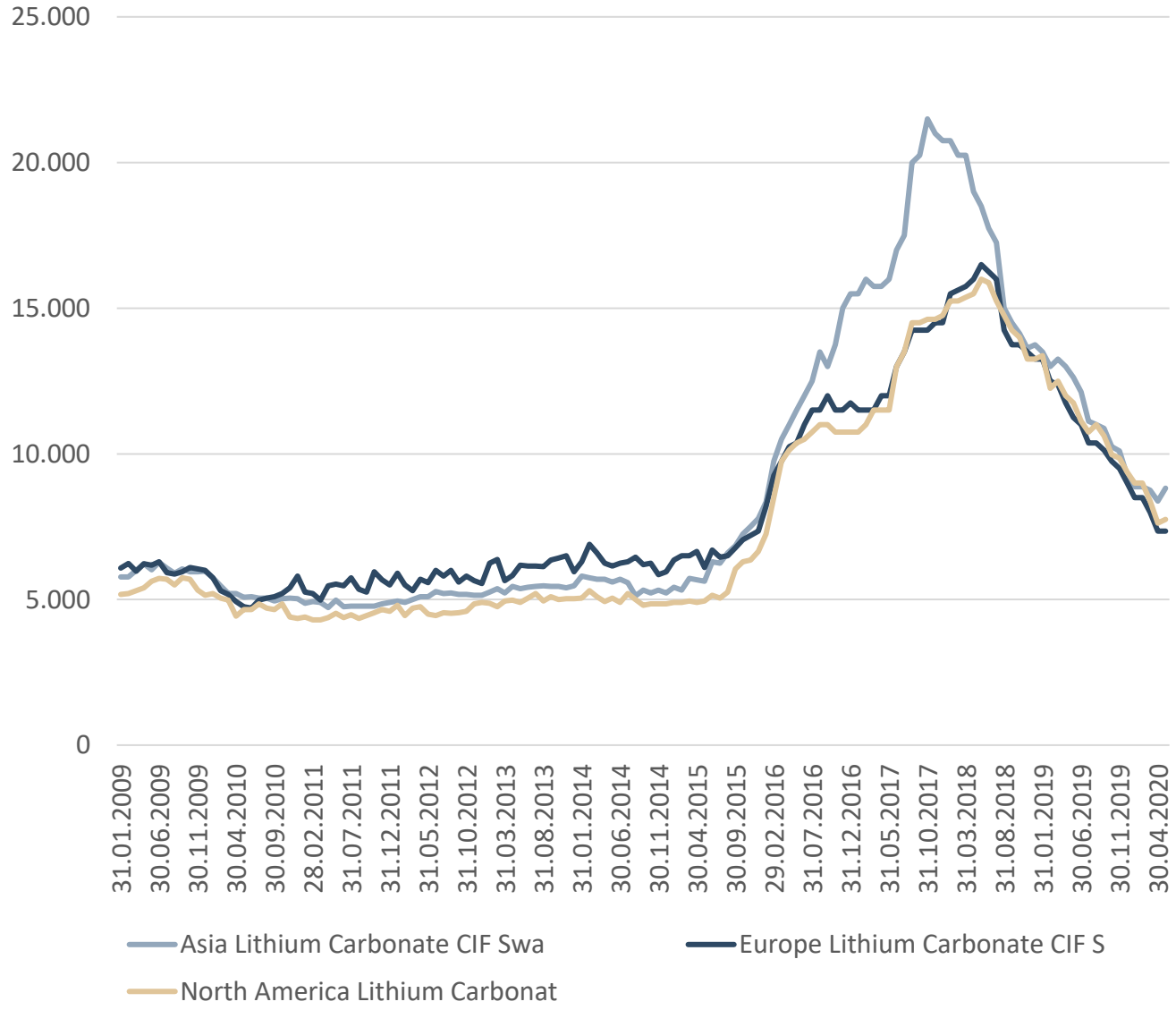


Source: IEA, Co2-Emissions from Fuel Combustion, 2019, own calculations

Price indices of lithium turned down

Lithium is highly reactive and is therefore traded in the form of lithium carbonate.

Only four plants account for 80 per cent of the worldwide production of lithium.



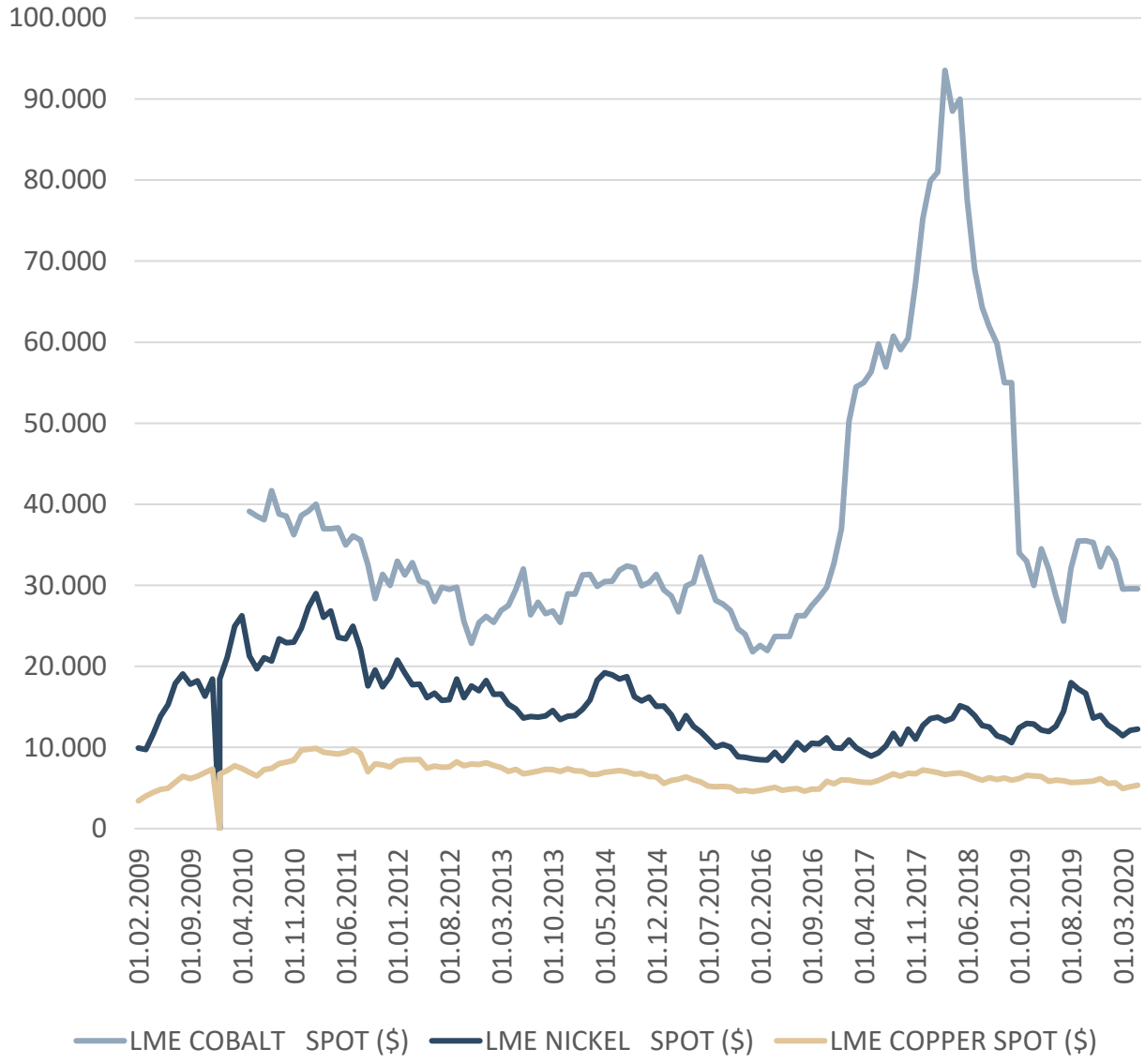
Source: Bloomberg 2020

Bargain prices for important raw materials

Bargain prices for cobalt have risen since March 2015 by a good 200 per cent and went down since May 2018.

Cobalt is mostly a by-product of the nickel and copper mining.

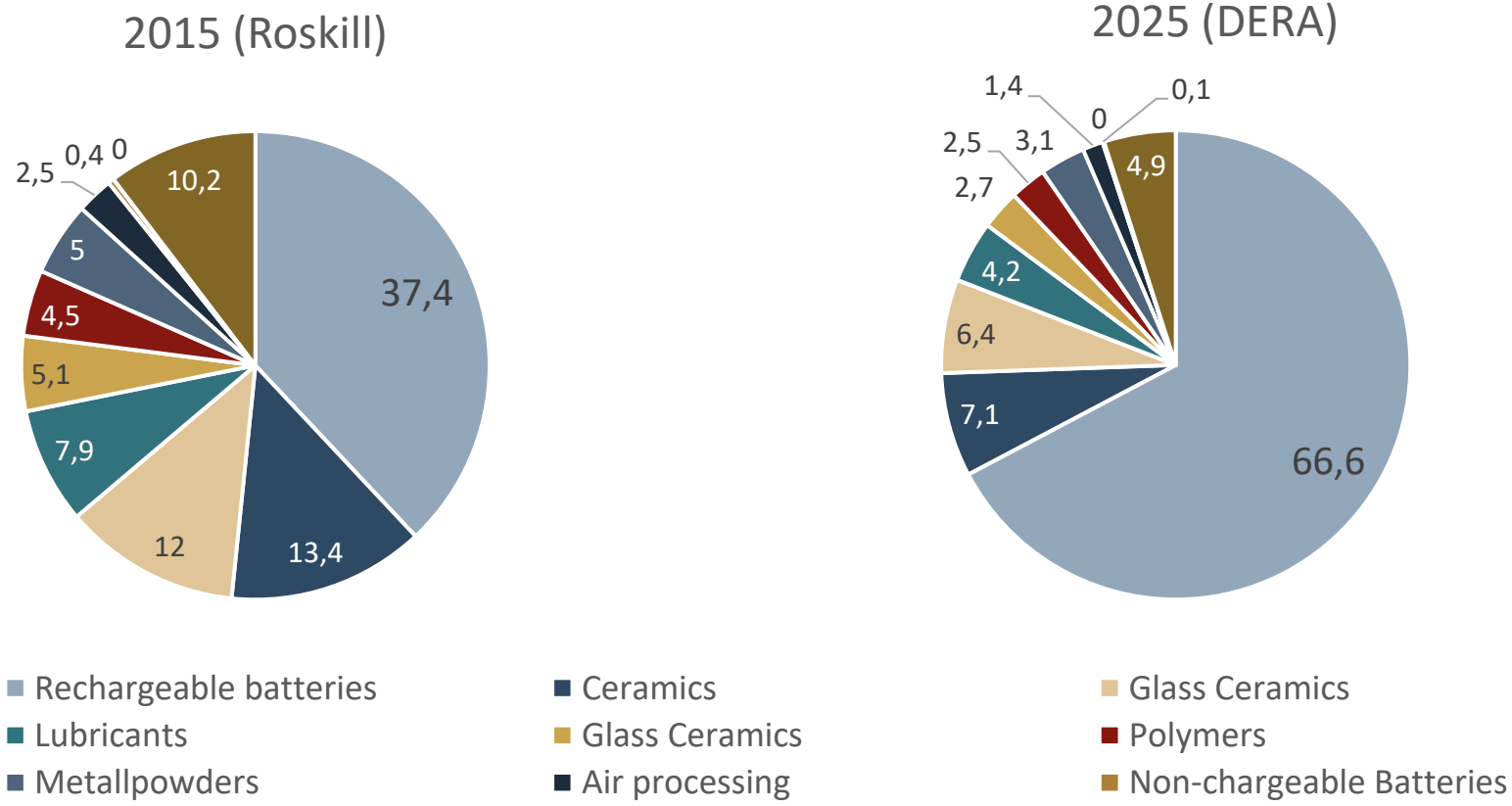
Falling prices of nickel and copper dampen cobalt production.



Source: Bloomberg 2020

Use of Lithium according to applications

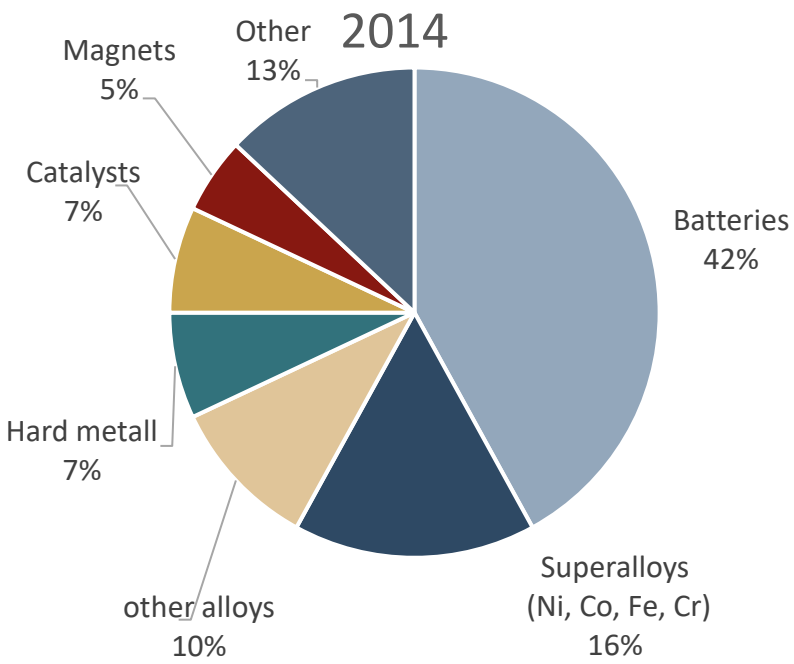
Status quo versus Forecast 2025

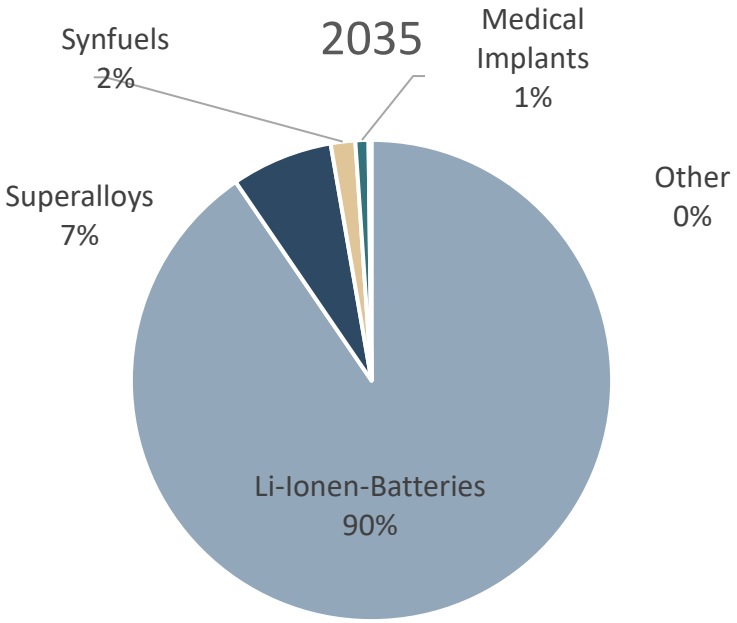


Quellen: Deutsche Rohstoffagentur (DERA), 2016, 2017 (Ursprungsdaten), eigene Darstellung

Use of Cobalt

Usage in 2014 (CDI) and prognosis to 2035 (DERA)



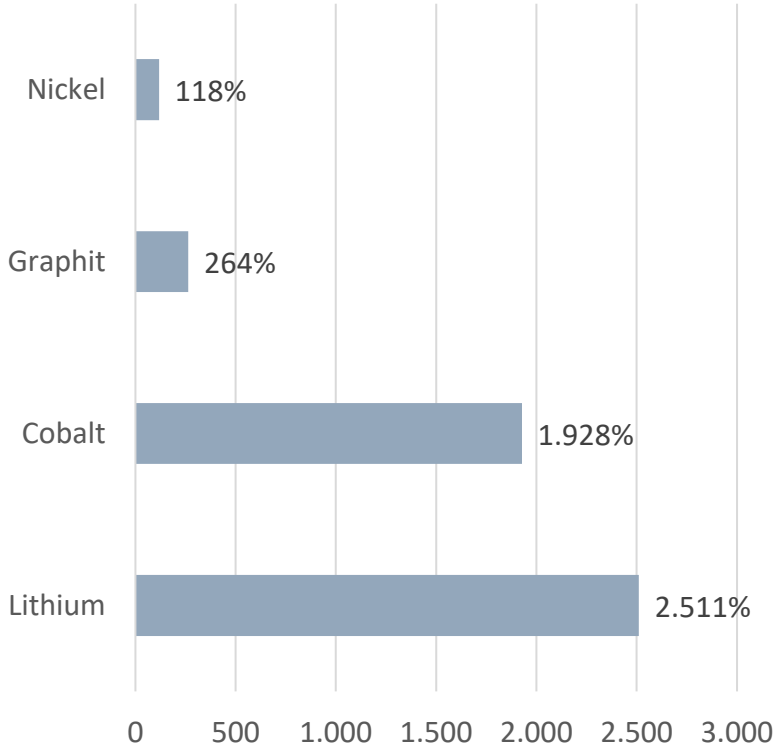


Quellen: Cobalt Development Institute (CDI), 2016; Deutsche Rohstoffagentur (DERA), 2016 (Ursprungsdaten), eigene Darstellung

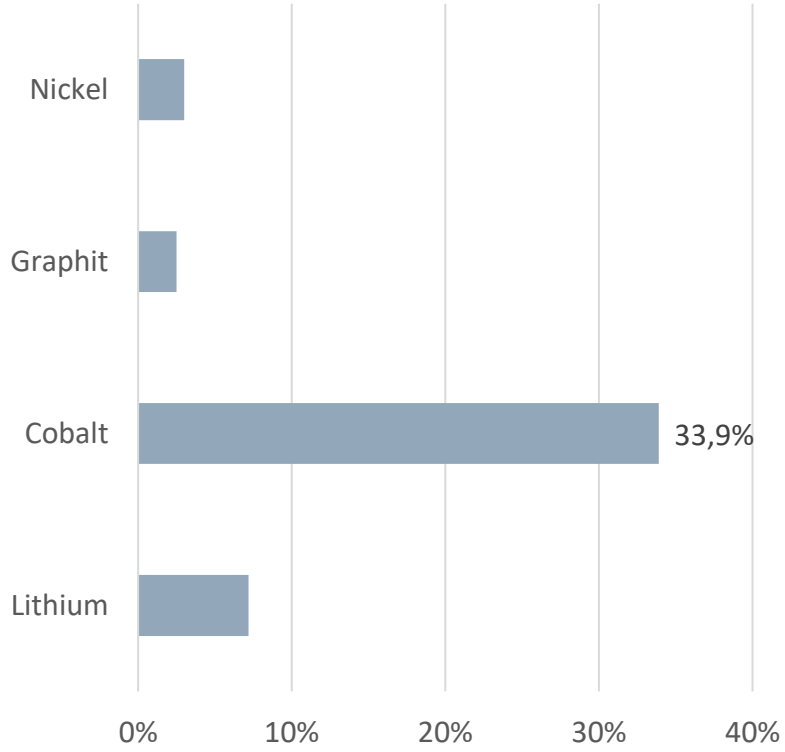
New battery types are required

In a world with 100 per cent of electric cars of present design …

the demand for raw materials would be … per cent higher.



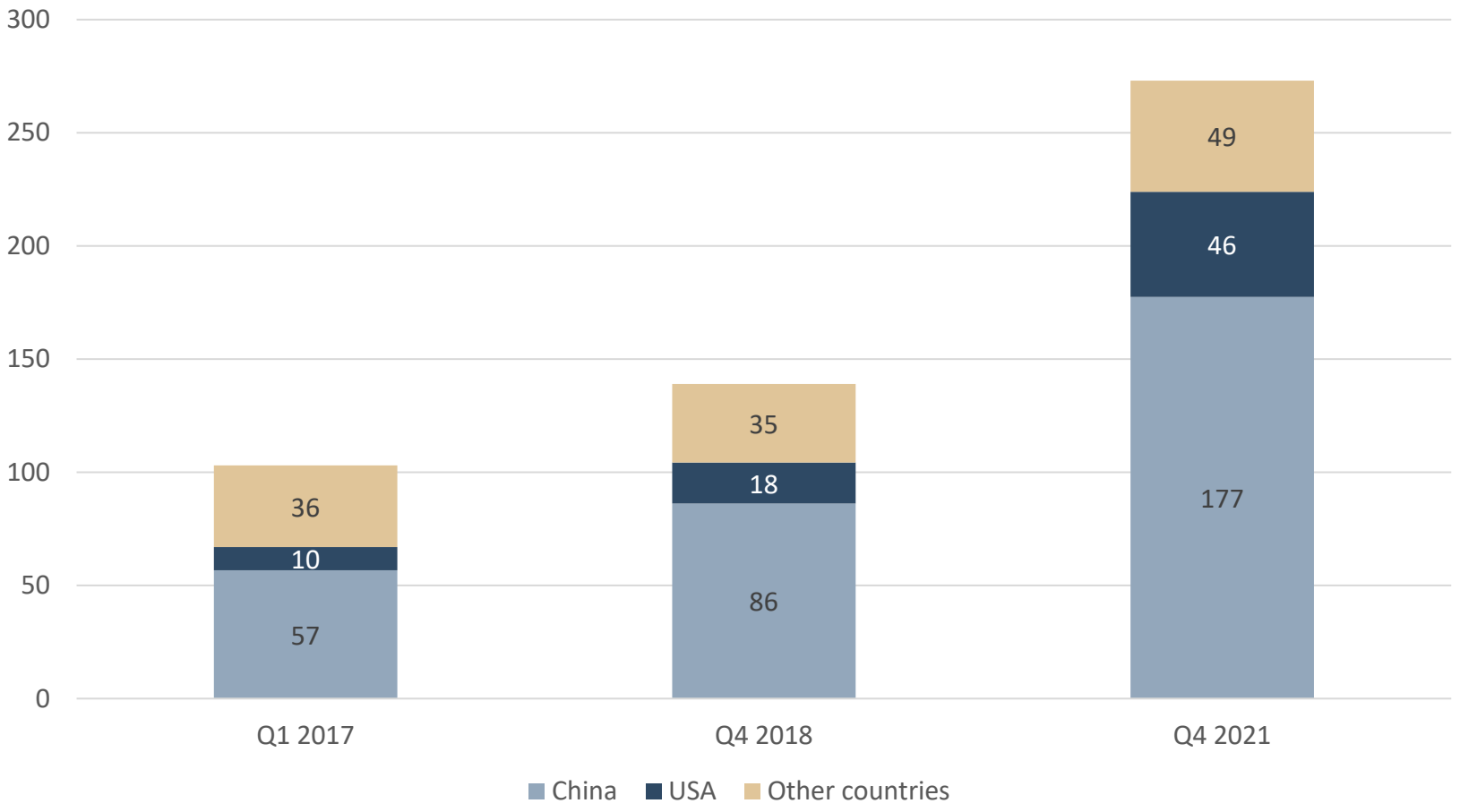
per year… per cent of the reserves would be eaten up.



Source: UBS Evidence Lab, Mai 2017

Battery cells: China propels capacity building

Cell production in GWh, consisting and developing



Source: Bloomberg Intelligence, 2017

Summary: regulation on the road

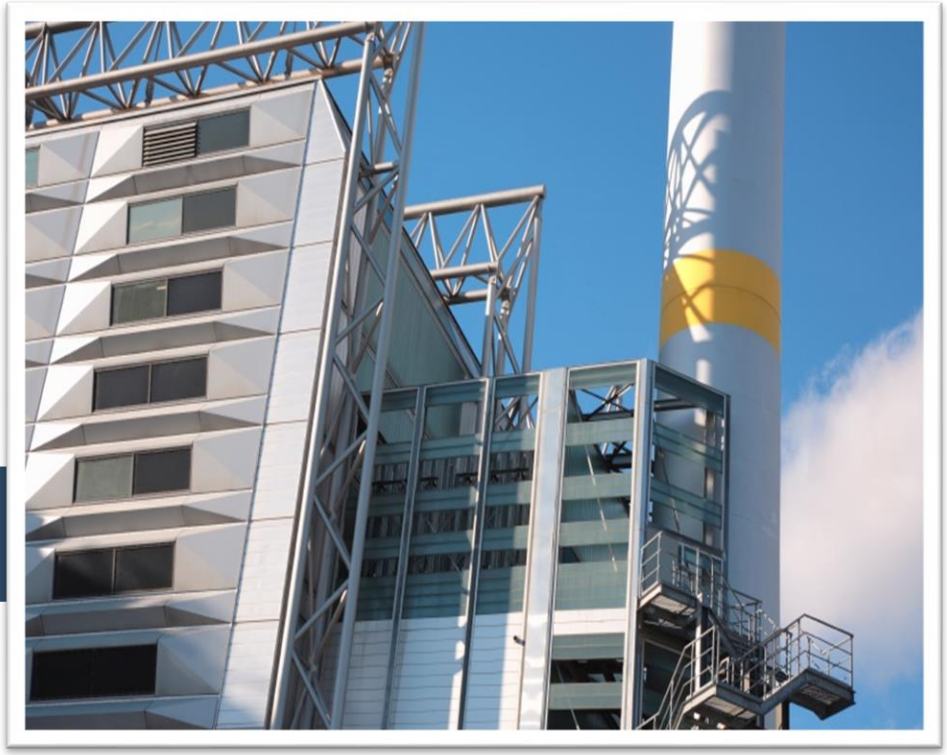
The EU has waived the world's most stringent CO_2 emission levels for cars. In 2021, the limit values will be one-third lower than those of the USA.

CO_2 emissions from road traffic are priced higher by the EU than emissions from other sources.

The "low-hanging fruits" have already been picked – and it will become more expensive in the future.

The manufacturers of large vehicles, in particular, have to gradually focus on the switch to electric powertrains. But: Today, the market run-up for electric cars and plug-in hybrids is slowing down. And no one knows how the market for these vehicles will develop in the future.

Agenda



CO_2 in other sectors: power generation

In the EU, the emissions from public heat and power generation are approximately 15 per cent less than the levels in 1990.

› More efficient power plants and a changing power mix help to cover the overconsumption.

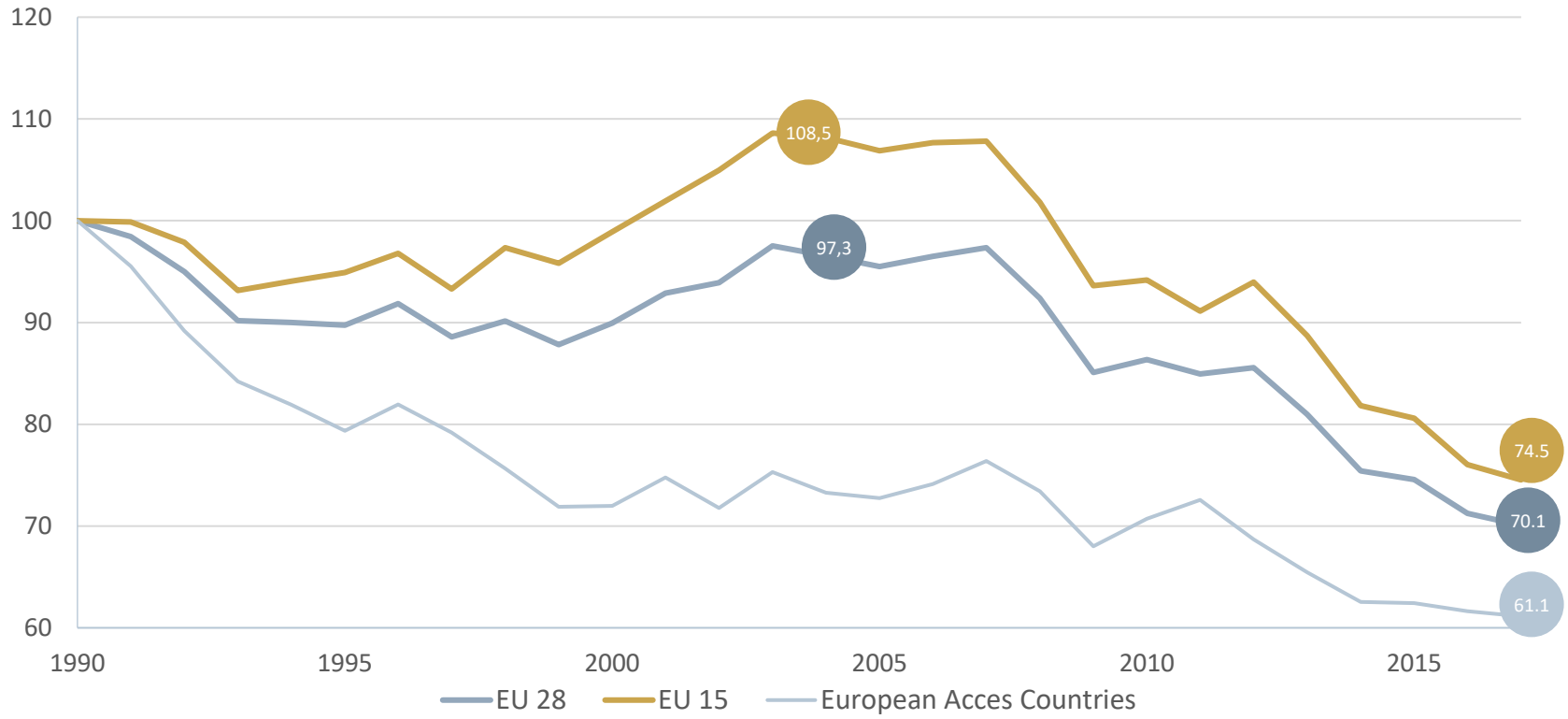
Power generation underlies European emissions trading. Emissions trading consists of two components:

› A prescribed cap on emission volumes that will continuously decrease up to the year 2020.

› A tool for distributing the burden (trade). The market for carbon credits ensures that the EU will meet the prescribed emission volumes at low costs.

The reduction can be credited to Eastern Europe in particular

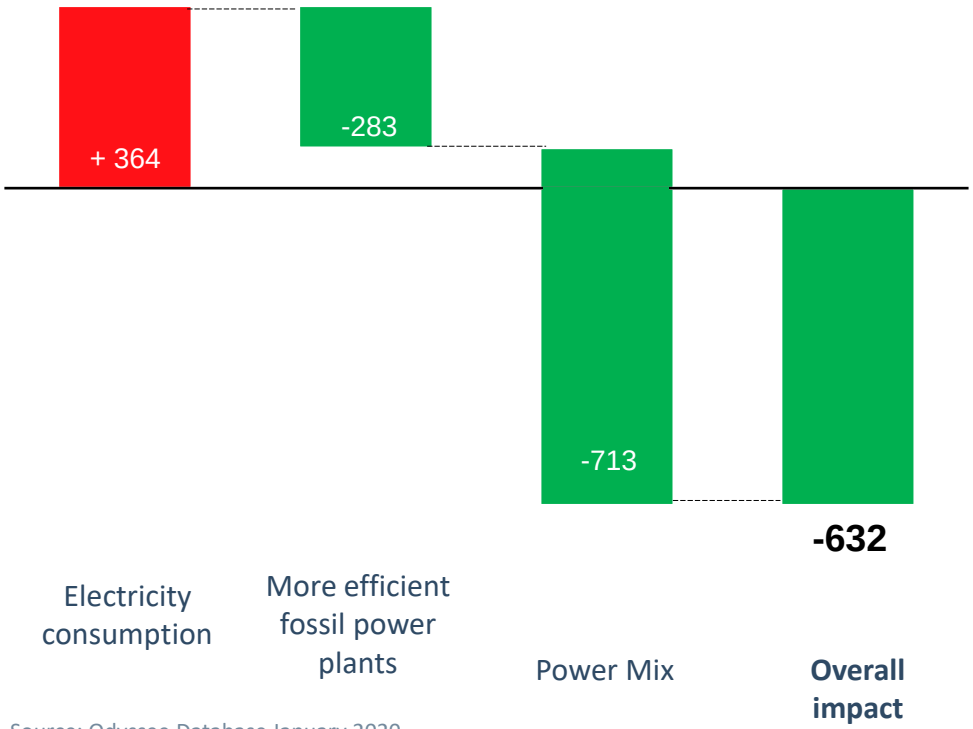
CO_{2EQ}- emissions of public heat and power generation, 1990 = 100



Source: EEA, 2017 (v20)

Power generation – consumption of fossil primary energy declining

in Terawatt hours (TWh) of primary energy use; changes from 2000 – 2017

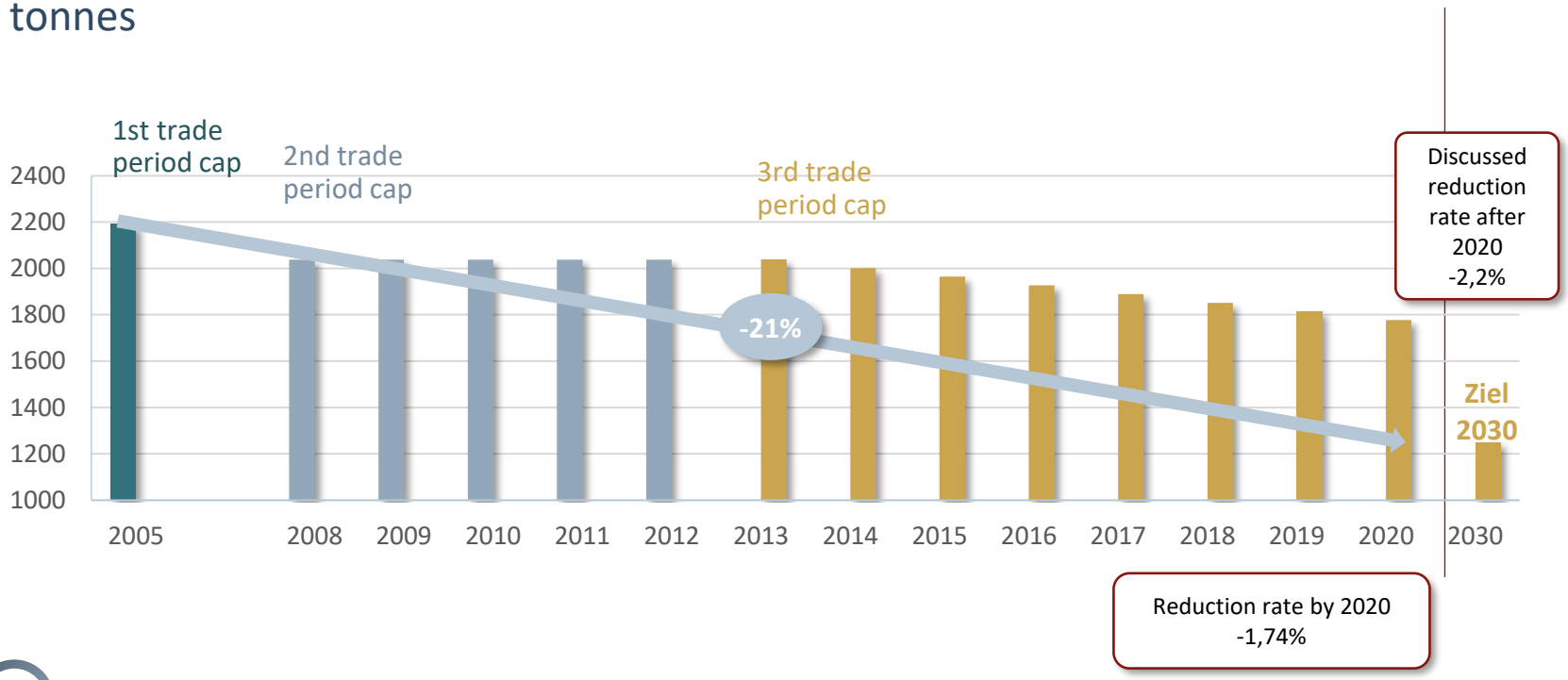


Source: Odyssee Database January 2020

- Electricity consumption in Europe is persistently increasing.
- Yet fewer fossil primary energy carriers are being consumed.
- Power generation is not an end in itself; it facilitates production and consumption in the industrial sector and in homes.

Cap: A government-prescribed reduction

Volume of carbon credits in the EU Emissions Trading System (ETS), in millions of tonnes



- Specific: The emissions target of -21 per cent is sure to be met on account of the decreasing cap.
- Apportioned: The initial auctioning of 20 per cent is expected to increase to 60 per cent by 2020.
- Flexible: It is not stipulated which trade participant will bring about the reduction.

Sources: EU, DIW

Trade: Emissions trading ensures an efficient distribution of the reduction burden

Case 1:
Emission restrictions

Exhaust up to now, in tonnes	Permiss-ible exhaust in the future, in tonnes	Reduc-tion costs per tonne	Total costs
5,000	4,500	20	10,000
5,000	4,500	50	**25,000**
10,000	9,000		**35,000**

Case 2:
Emissions trading: Carbon credit price at 30 euros per tonne

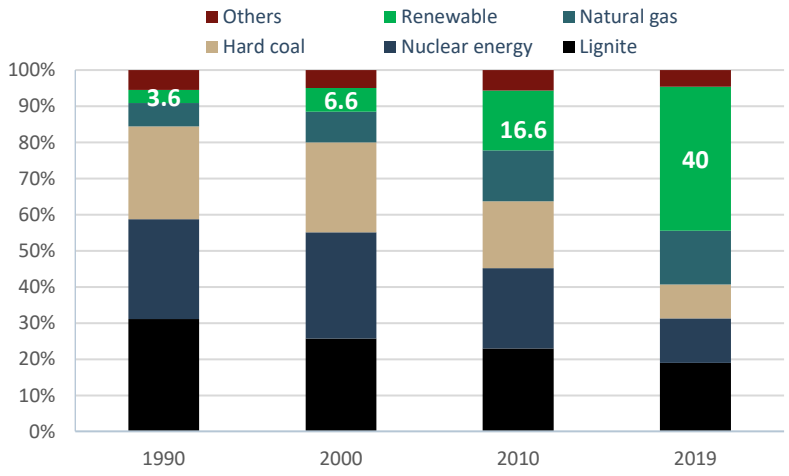
Exhaust up to now, in tonnes	Permiss-ible exhaust in the future, in tonnes	Carbon credits received, in tonnes	Reduc-tion costs per tonne	Achieved reduction, in tonnes	Cost for the reduction	Trade, in tonnes	Trade in euros	Total costs by trade
5,000	Insg. 9,000	4,500	20	1,000	20,000	500	15,000	**5,000**
5,000		4,500	50	0	0			**15,000**
10,000	9,000	9,000		1,000	20,000	500	15,000	**20,000**

- In the example above, Plant 1 renders the entire reduction but has three-fourths of the costs reimbursed through emissions trading. The example shows that both plants save thousands of euros compared to a restriction on emissions.
- The specific distribution of the reduction burden arises from the carbon credit price and the particular reduction costs.
- Participants with high abatement costs help to finance other participants' reduction efforts.

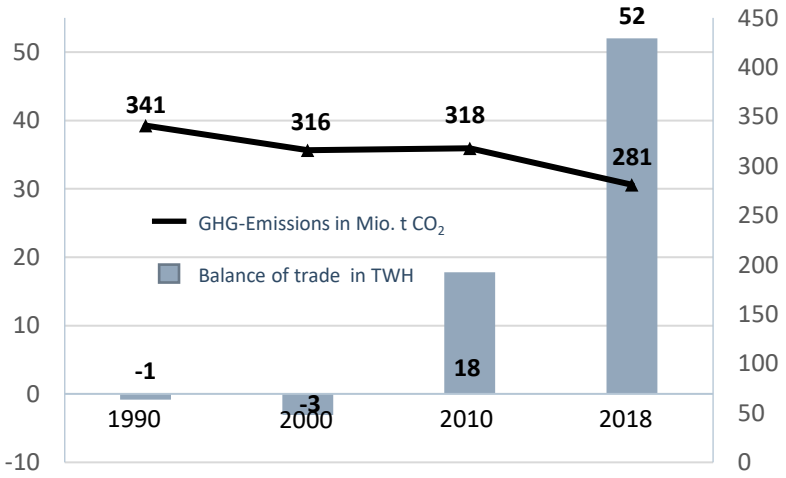
Germany's energy transition: Unexpected results

The subsidisation of renewable energies leads to an increasing export of electricity

Power mix



Power generation and trade in Germany



- Power generation: CO_2 emissions are still on the rise, in spite of the increasing share of renewable energies.
- The reason: Renewable energies are, in particular, replacing natural gas and coal-fired power plants; nuclear energy use is also declining. Lignite is filling the resulting base load gap.
- The subsidisation of renewable energies has resulted in an increased volatility of supply. This frequently results in surplus power that has to be exported outside the country at a cheap rate.

Source: Arbeitsgemeinschaft Energiebilanzen 2020, EEA 2020 (v23)

CO_2 in other sectors: industry

The CO_2 emissions of the industrial sector have declined by one-fourth in the last 20 years.

- Increased efficiency: Emissions in the industrial sector decreased by one-third per euro of added value.

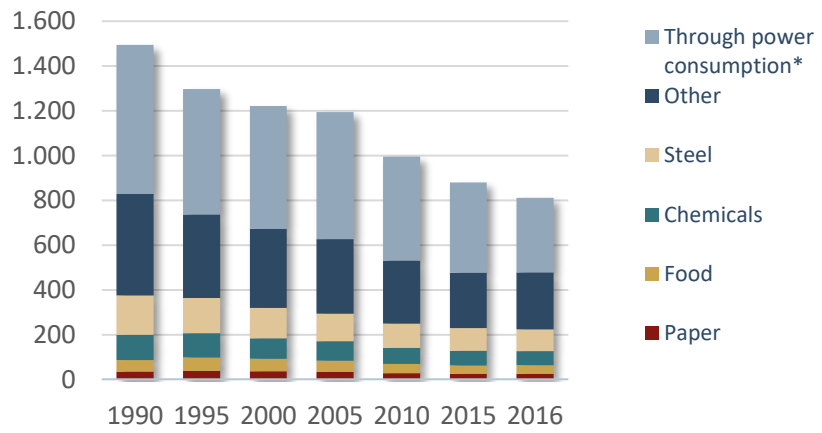
The industrial sector is governed by various regulations:

- Electricity consumption is subject to emissions trading and a high rate of taxation. In the USA, industrial energy costs only about half as much as the EU average.
- The EU Ecodesign Directive sets maximum tolerances for the energy consumption of consumer products such as lamps and household appliances. Products that do not meet the standard have to be removed from the market. The most noticeable target: light bulbs.

Industry in the EU 28: Decreased emissions, greatly improved efficiency

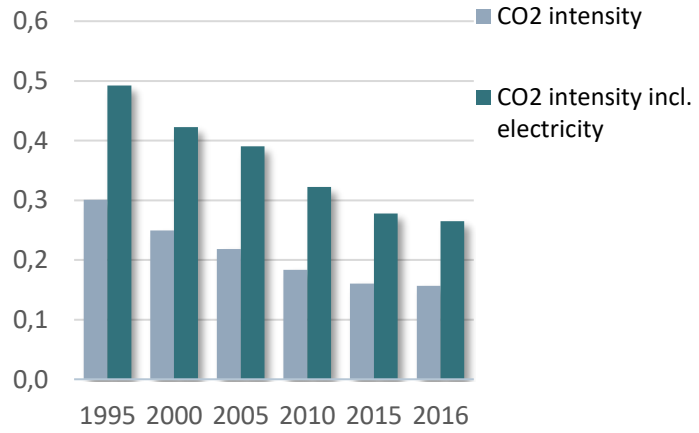
CO_2 emissions in the industrial sector are declining: -25% since 1995

in millions of tonnes of CO_2



Improved efficiency: One-third fewer emissions per euro of added value since 1995

in kg CO_2/$Euro_{2010}$

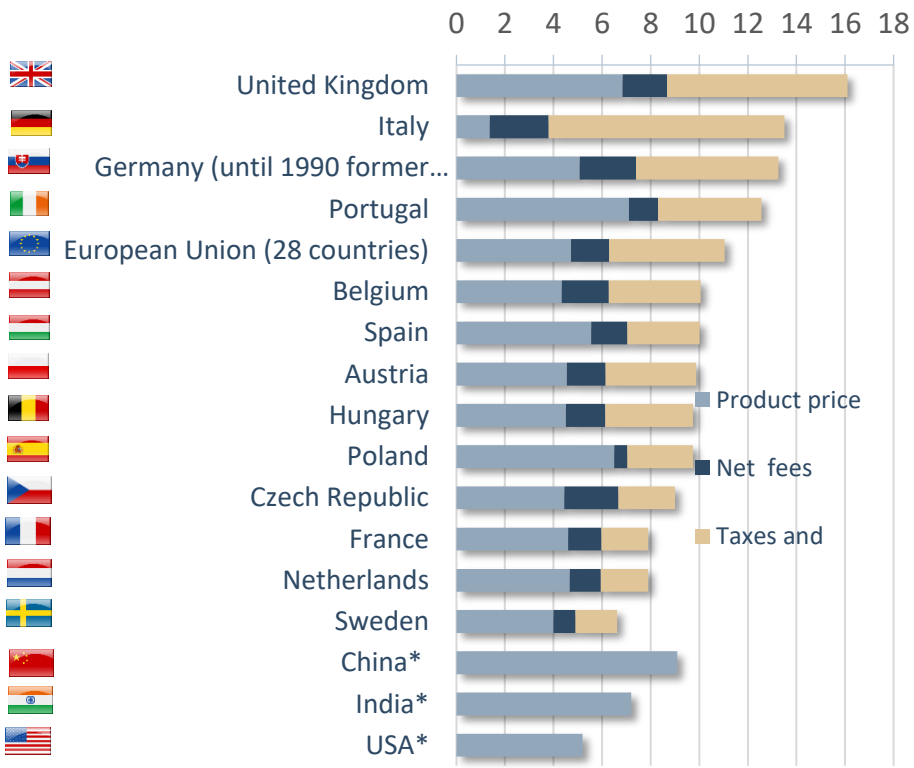


- Regulation: The largest share of CO_2 emissions caused by industrial activities is subject to emissions trading.
- Increased efficiency: The emissions per unit of gross value have decreased by a good third since 1995.
- Deindustrialisation: The movement of industrial activities out of many European countries has resulted in a decrease of CO_2 emissions in the EU.

Source: Odyssee Database January 2020

Industrial energy prices in the second half of 2019: Much less expensive in the USA

In cent pro kWh for companies with a consumption of 20 to 70 gigawatt hours



- Industrial energy prices in Europe are much higher than those of international competitors.
- The biggest difference is in comparison to the USA, where a kWh costs approximately 45 per cent less than in Europe.
- The highest prices apply in the UK and Italy. But for totally different reasons.
- Recoverable taxes – such as VAT – are viewed as transitory items for the company.

* For information only
Sources: Eurostat 2020, BDI

CO_2 in other sectors: Households

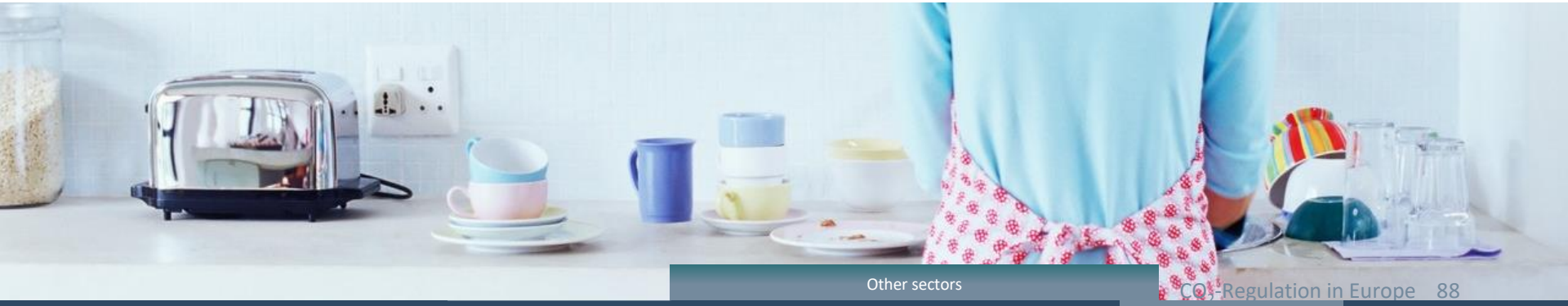
Household CO_2 emissions have decreased by 13 per cent since 1990.

- In the same reporting period, the number of households and the living space per person increased substantially.

The key to future emission reductions is in the area of heating.

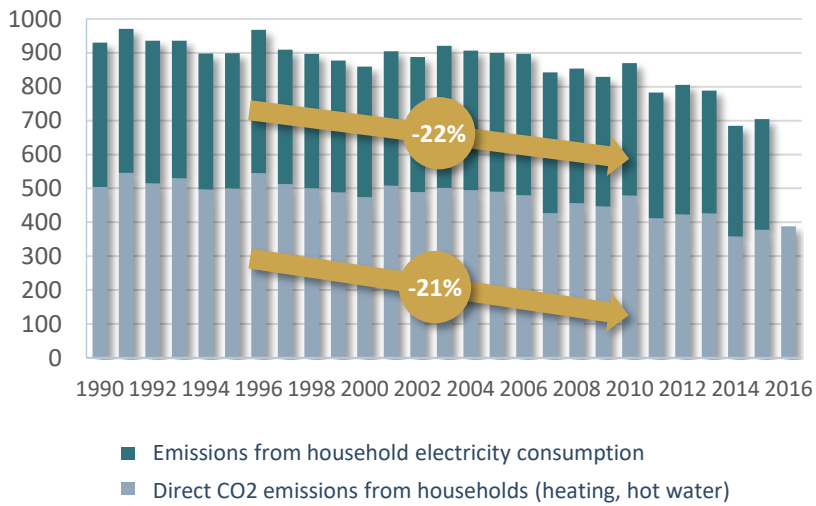
- Heating constitutes 70 per cent of a household's total energy consumption.
- In spite of the EU Ecodesign Directive, consumption has greatly increased through the use of electric appliances, since households contain an increasing number of them.

The installation of new heating units results in very low CO_2 abatement costs, but it rarely pays off for home owners without subsidisation.

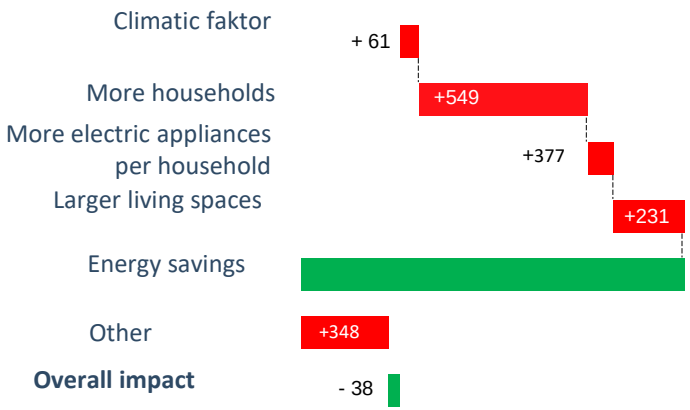


Households: Decreasing CO_2 emissions despite higher demands in living spaces

CO_2-Emissions
in millions of tonnes



Changes in household energy consumption between 2000 and 2016
in terawatt hours (TWh)

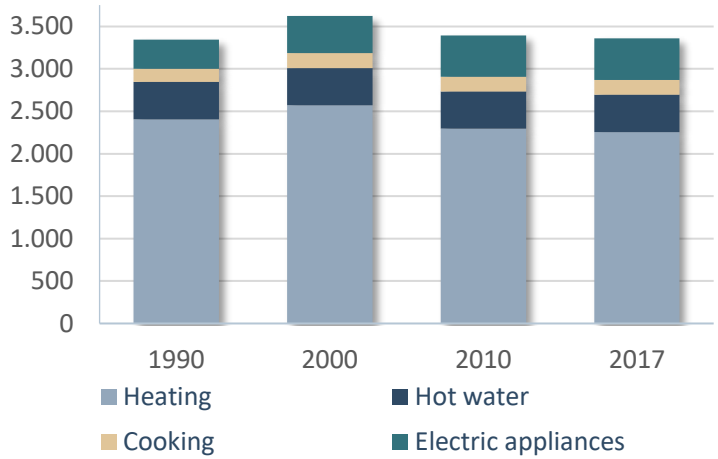


- Nearly half of household emissions fall under emissions trading.
- The trend is leaning towards more households and larger apartments, which increases emissions.
- Besides emissions trading, households are impacted by electricity taxes and energy consumption regulations for buildings.

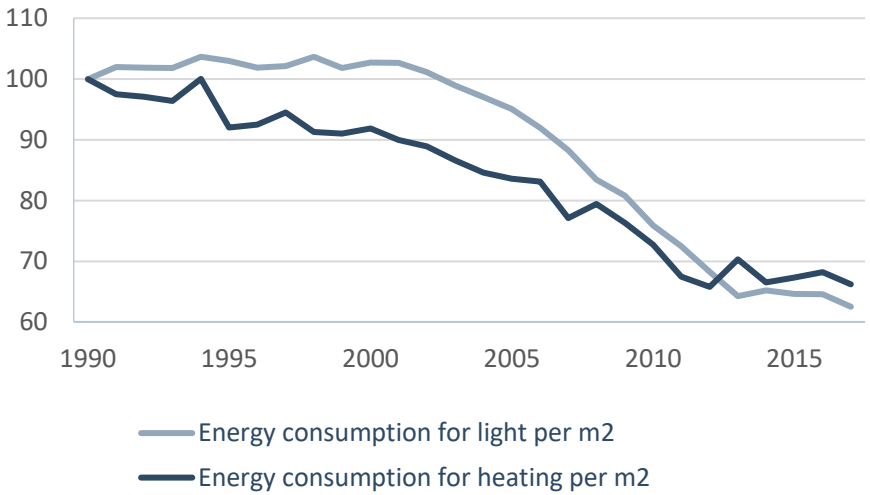
Source: Odyssee Database January 2020

Energy consumption: the potential lies in the heating market

The heating system is the key to lower emissions
in terawatt hours (TWh)



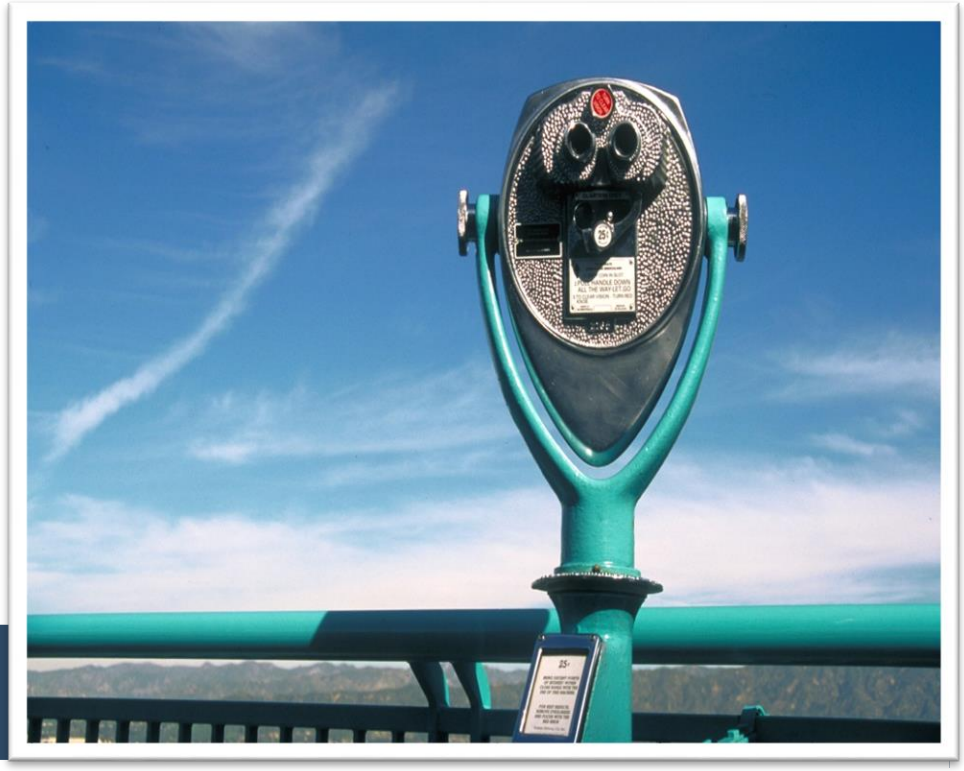
Significant progress per square metre of living space
1990 = 100



- Heating systems consume about 70 per cent of the final energy in households.
- Advancements in heating efficiency are almost entirely eaten up by increased living space.
- Electric appliances only play a minor role; however, due to the increasing number of appliances per household, overall energy consumption has risen by 45 per cent since 1990.

Source: Odyssee Database January 2020

Agenda



Limit values for cars: Only indirect influence on actual CO_2 emissions

Example

Assumptions

- Under the New European Driving Cycle (NEDC), a better transmission will save 4 g CO_2/km.
- The transmission costs an additional 200 euros.
- In Europe, an average car travels approximately 200,000 kilometres during its lifetime.

CO_2 savings, in tonnes:

4 g/km * 200,000 km = 800,000 g = 0.8 tonnes

Investment costs, in euros per tonne:

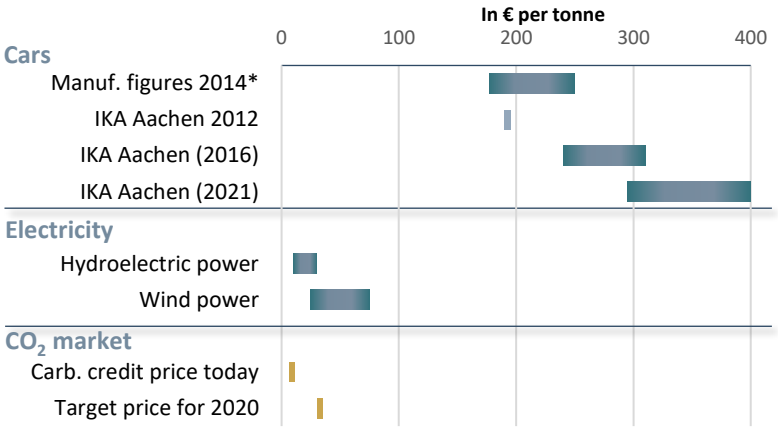
200 € / 0.8 tonnes = 250 € per tonne

+

- Today, Europe regulates a car's emissions potential in grams per kilometre.
- However, the actual target is the avoidance of CO_2 emissions in tonnes.
- There is no direct connection between emissions potential and actual emissions. The real impact is determined by the user.
- Result: Today's regulation is not precise and does not correspond to the regulation in other sectors.

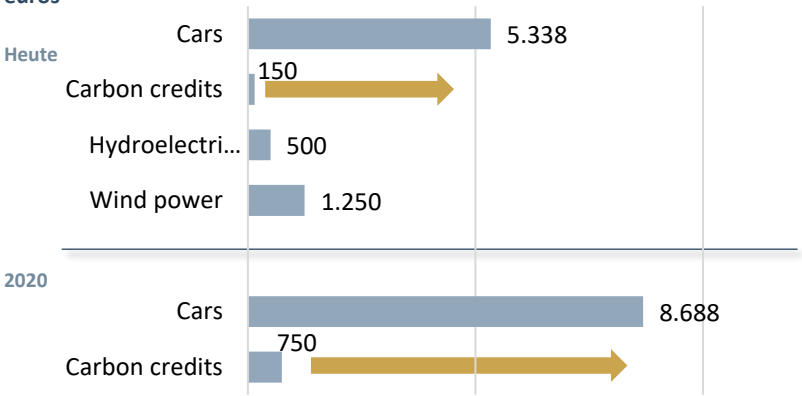
CO_2 avoidance in cars is expensive and would be cheaper to obtain in other sectors

Problem: CO_2 avoidance in cars is already comparatively expensive



Expensive CO_2 avoidance leads to excess burden

Assumption: CO_2 emissions in Europe are to be reduced by 25 million tonnes. Comparison of the resulting costs today and in 2020 in millions of euros**



- The reduction costs differ greatly from sector to sector.
- The avoidance of car emissions by means of improved technologies is relatively expensive, and these costs will continue to increase.
- Sector-based reduction targets lead to high additional costs in the economy.
- In the EU Emissions Trading System (ETS), permissible emissions are offset by carbon credits. One credit allows the emission of a tonne of CO_2.
- The trade with carbon credits ensures that the emission volume stipulated by the EU is generated where the reductions are least expensive

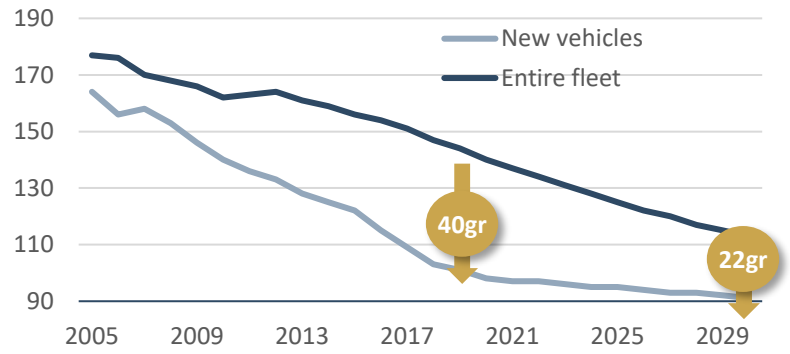
* Extrapolation from published reports ** Calculated based on the average value of the respective line.
Sources: AGFW, IKA Institut für Kraftfahrzeuge Aachen, EU

Efficient new vehicles impact the vehicle fleet

Based on model calculation. With today's regulation, an emissions reduction of 30 per cent is achievable between 2005 and 2030. This corresponds to the EU target for non-ETS sectors

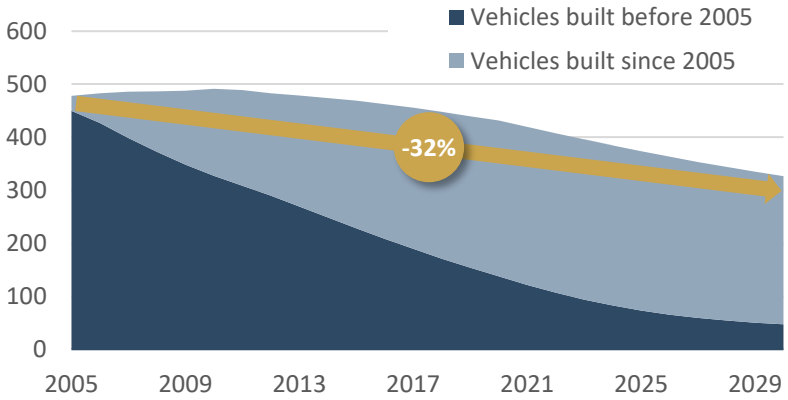
Relative car emissions

in g CO_2/km



Absolute car emissions

in millions of tonnes of CO_2



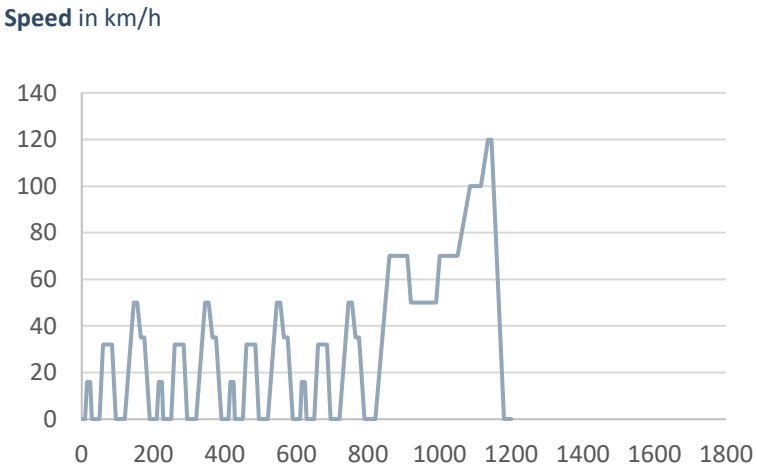
- The average consumption of the existing fleet is only gradually reacting to the more efficient new vehicles. That is why a difference can be seen between the emissions of new vehicles and the entire fleet.
- The gap will close once most of the older vehicles with higher emissions are taken off the roads.
- Based on a conservative estimate, the ongoing replacement of old vehicles will result in car traffic emissions in Europe decreasing by approximately 30 per cent by 2030, compared to the year 2005.
- Until 2014, the fleet was dominated by vehicles built before 2005. Several million of these vehicles will still be on the road in 2030.
- The advancements of recent years will long continue to have an impact on the vehicle fleet. Even if new vehicles were to hardly show improvements after 2021, the fleet emissions would continue to decrease.
- In regard to cars, the EU target can be achieved with the existing regulation

Source: Daimler

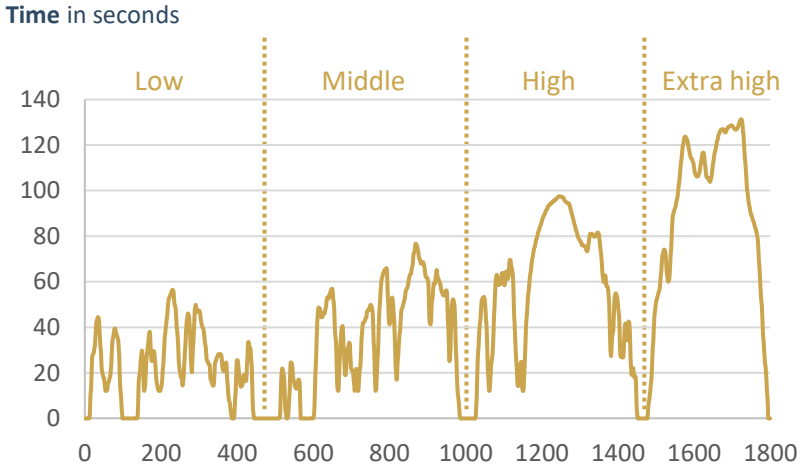
WLTP: A new test requires new limit values

The WLTP is intended to apply globally. Manufacturers' test costs are expected to be reduced through the implementation of the WLTP.

NEDC: Introduced in 1996 to calculate exhaust emissions



WLTP: Depiction of a car ride, based on worldwide averages



- A test cycle should facilitate legally compliant comparability.
- There are various cycles today. The EU and China use the NEDC, while the USA and Japan have their own tests.
- The figures on car emissions depend heavily on the test cycle; they are not simply convertible.
- Trials show that higher emissions levels are identified in the WLTP than in the NEDC. With the introduction of the WLTP, the regulation of limit values will have to start completely afresh.
- But: Even WLTP is "only" a test. It facilitates comparability under standardised conditions; hence, it represents an approximation of global driving behaviour, yet does not determine a value that is achievable in all contexts.

Sources: EU, UN

RDE Tests: wide dispersion even with maximum standardization

Limits of standardization in RDE consumption measuring

1 Measurement technology

Expected dispersion of the results: **8 gCO_2/km**

- Standardised PEMS-systems per vehicle (homogeneous within the measuring organisation)
- Calibration of the PEMS-system by aligning with test bed measurments
- **But: the achievable measurement inaccuracy using the up-to-date technique lies around ± 2,5 per cent.**

2 Environment & driver

Expected dispersion of the results: **10 gCO_2/km**

- Defined environmental conditions (moderate temperatures, favourable weather, gentle wind at maximum)
- Trained driver, who refer to the shift point display and create reproducable results
- **But: Slight variations, for example in wind and driving style lead to visible deviations.**

3 Route

Expected dispersion of the results: **12 gCO_2/km**

- Trips on a reference line in the same time and driving direction
- No fixed time slots but adaption to comparable traffic volume on the reference line
- **But: density of traffic, average speed and shares of start/stop are not reproducable.**

4 Vehicle

Expected dispersion of the results: **6 gCO_2/km**

- Comparable vehicle, as far as the status of running-in, technical upgrades, inflation pressure etc. is concerned
- Comparable use of vehicles: additional load, electrical consumers, window opening or driving mode
- **But: reactions to environmental conditions (e.g. temperature) affect the consumption.**

Summary: Limits of the system

The system of regulating limit values levels exhibits structural problems.

Inaccurate: The greatest disadvantage is the lack of precision, since the regulations affect potential emissions rather than actual emissions.

Expensive: Technology-driven savings in road traffic represent one of the most expensive possibilities for reducing CO_2 emissions.

Long-dated: It will still take years before the full impact of already-achieved improvements is reflected in statistics.

An acute continuation of the regulation of limit values does not currently appear very promising. Alternatives to the current system must be sought.

Improved regulation: Emissions standards for vehicles fall too short

To reduce emissions, drivers and the government need to be involved in the process

Integrated approach: Include all areas in the regulation process

Total emissions in tonnes =
Consumption in litres * Emissions factor in kg CO_2/litre * Mileage

Automotive industry

- Optimisation of combustion engine
- Alternative fuels
- Lightweight construction
- Switching to electric powertrains
- Use of digitalisation (avoidance of parking-related traffic)

Government

- Infrastructure conditions
- Construction site management
- Promotion of transmissions and fuels that produce fewer emissions
- Replacement of existing vehicles

Driver

- Route (how much?)
- Driving style (how?)
- Vehicle selection (with what?)

- Vehicle limit values only regulate potential emissions.
- The actual emissions are determined just as much by drivers as by the infrastructure.

Integrated approach: Future regulation must cover all areas

Estimate based on road freight traffic

CO_2-emissions

Vehicle-related measures

Vehicle
- Efficient engines
- Aero-dynamics
- Assisted driving systems

Trailer
- Permissible size (more transport volume)
- Aerodynamics
- Lightweight construction
- Assisted driving systems

Tyres
- Low-resistance tyres
- Air pressure controls
- Super Singles

Fuels

Alternative fuels
- Second-generation biofuels
- Synthetic fuels
- Natural gas (LNG)

Vehicle operation

Operation
- Driver training
- Route planning
- Volume utilisation

Infrastructure
- Improved infrastructure (road closures, detours)
- Telematics
- Congestion control

Fleet replacement
- Replacement of Euro 0–III vehicles (approx. 5% additional fleet replacement)

-6% + -2,5% + -13% = -21,5%

CO_2-Emissionen

- An integrated approach prevents rebound effects and can considerably increase savings.
- Various instruments are needed in order to enhance all potential savings.

Source: ACEA

Emissions trading in road traffic: Is that possible?

One stop towards an integrated approach would be the inclusion of road traffic in emissions trading. Fuel consumption can be precisely calculated in emissions. Heavy trucks cannot be integrated in the existing system of limit values; this is not a problem in emissions trading. The question remains as to who should make the carbon credits available

Upstream – Tankstellenbetreiber

The corresponding carbon credits must be purchased for every litre sold.

- 1L Benzin = 2,3 kg CO_2
- 1L Diesel = 2,6 kg CO_2

Pros

- ⊕ Easy to implement technically
- ⊕ Little demand from the well-financed
- ⊕ Actual emissions are limited

Cons

- ⊖ It only indirectly addresses those who are actually generating the emissions. The connection to the driver is the price signal, as in the case of a fuel tax.

Midstream – Autohersteller

When a new vehicle is sold, a volume of carbon credits must be purchased that corresponds to the car's expected emissions in its lifetime.

- In the case of 130 g CO_2/km und 200.000 km: carbon credits for 26 tonnes

- ⊕ Little demand from the well-financed
- ⊖ Inaccurate: The purchased amount represents a theoretical volume.
- ⊖ The manufacturer only determines the potential emissions, not the actual emissions.
- ⊖ The manufacturer only has an indirect influence over actual CO_2 emissions.

Emissions trading: A useful supplement

The inclusion of road traffic in emissions trading offers certain benefits

ETS Filling Station
Main Street 111, 12345 New Town
Station no. : 000000000xyz
Station tax no. : 13/456/xyzxyz
Company tax no. : 01 234 56789
Receipt no.1234/005/00001 03.03.2021 9:22
Card payment

*Super		65,13 EUR A #*
* Pump 03	43,45 l	1,499 EUR/l #*

EU-ETS carbon credits 3,04 EUR # C*
* 43,45l x 2,33 kg CO_2/l = 101,24 kg CO_2
* x 30,00 EUR/Credit for 1.000 kg CO_2

Total 68,17 EUR

Type	Net	VAT	Gross
A: 19,00%	54,73	10,40	65,13
C: 0,00%	3,04	0,00	3,04

Thank you for your visit. Have a safe trip!

+

- Simple: The necessary amount of carbon credits per tank filling is easy to calculate. The required purchase can be paid for with the fuel.
- Inexpensive for the driver: Based on the EU's targeted price of 30 euros per carbon credit in the year 2020, a litre of petrol would cost 7 euro cent more.
- Inexpensive for society: The abatement costs of road traffic are far above 30 euros per tonne. Emissions are avoided where it is cheaper to do so.
- But: Since the transportation sector would be purchasing so many carbon credits, other sectors would have to substantially step up their reduction efforts. Good judgment will be necessary in order to avoid an overload in the other sectors.
- Thus: Emissions trading is a useful supplement to today's limit values.

Summary: Alternatives

The inclusion of road traffic in emissions trading serves as a useful supplement to the prevailing system of limit values.

- Emissions trading would increase the precision of the regulation, since it factors in the influence of the driver on the emissions that are produced.
- Emissions trading would also apply to freight transport – an area that is difficult to incorporate in the current system of limit values.
- Emissions trading would lead to lower reduction costs for the overall economy, since road traffic would enter the carbon credit market as more of a buyer.

But: Oil prices continue to create pressure to innovate, but there are several factors that speak in favour of setting a new limit value for the long term.

The core theses: Brief overview

Climate protection

1. Europe's share of the worldwide CO_2 emissions is low and continuously decreasing. (100)

2. No solution without China: Europe's reduction of emissions is being eaten up by growth in emerging economies. (103)

3. Motor vehicles account for approximately one-seventh of the CO_2 emissions in the EU. Their share in transportation emissions is declining. (106)

CO_2 regulation for motor vehicles

4. New vehicles in Europe have become considerably more efficient in recent years. (108)

5. CO_2 legislation in Europe shows the most stringent target values in an international comparison. (110)

6. Europe has once again tightened the reins on the CO_2 limit values for motor vehicles and is requiring a further reduction of CO_2 within an even shorter span of time. (112)

7. Even without a further tightening of the CO_2 limit values after 2020, the motor vehicle industry is still on track to meet the EU's climate policy targets by 2030. (114)

8. Vehicle fleet limit values under 95 grams cannot be achieved with conventional engine types, and the market success of alternative engine types is still uncertain. (116)

9. EU environmental legislation is not coherent and, for a long time, had other priorities than CO_2 reduction. This had various consequences, including an increase of CO_2 emissions. (119)

10. Today's CO_2 laws regulate only new vehicles, completely disregarding the remaining vehicle fleet. (122)

11. An effective reduction of CO_2 emissions cannot address new vehicles alone but must take a much broader approach. (124)

Balance between climate protection and industrial policy

12. The EU is targeting a 20% industry share of GDP for the year 2020. This goal is presently a long way away, since industrial and climate protection policy are not yet aligned. (126)

13. The CO_2 abatement costs vary greatly between sectors and are most pronounced in the automotive sector. (129)

14. Emissions trading as the most economically efficient form of CO_2 regulation can easily be applied to road traffic. (131)

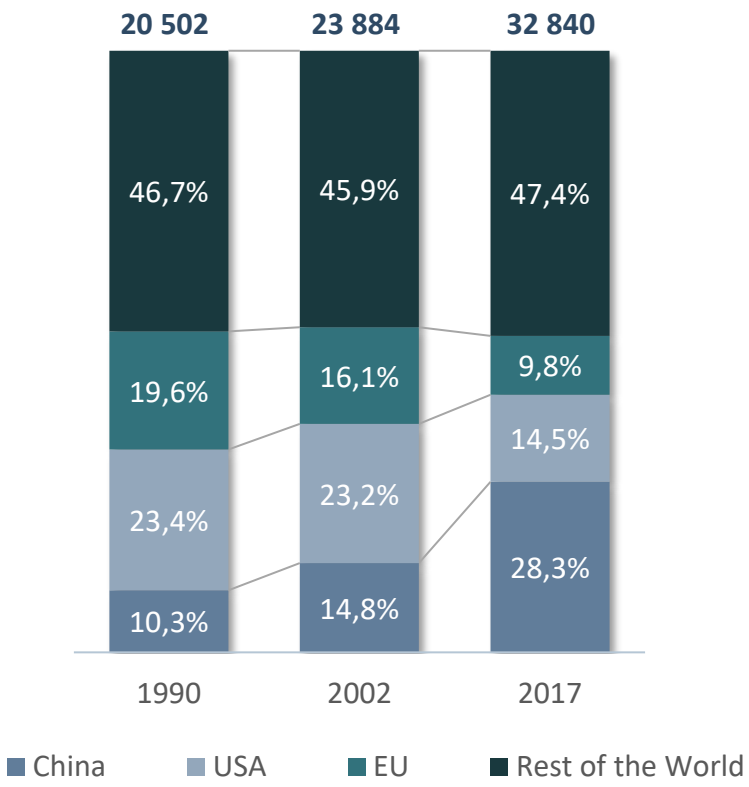
Core theses: Climate protection

1

Europe's share of the worldwide CO_2 emissions is low and continuously decreasing.

CO_2 emissions: Europe's share sharply decreasing

Emissions from fuel use, in millions of tonnes



Source: IEA, CO_2 Emissions from Fuel Combustion – 2019

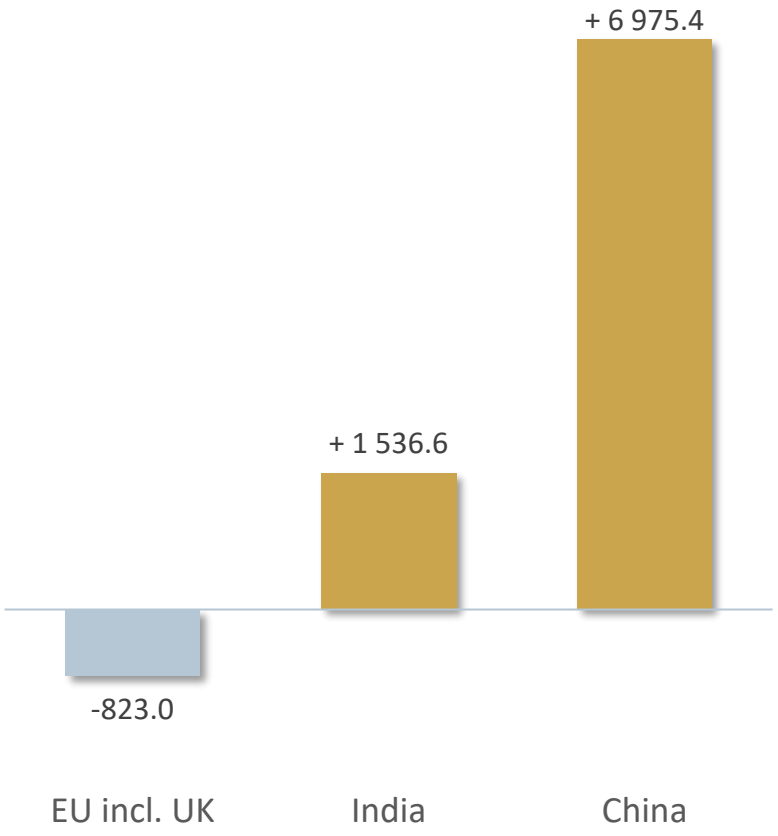
Compared to the year 1990, the absolute CO_2 emissions are decreasing in the EU only. Between 1990 and 2016 the EU decreased the emissions by approximately 815 Million tons.

At the current edge the US emissions are falling. In 2016 the emissions are converging to the emissions of 1990.

The impact of European regulations on global CO_2 emissions continues to decline.

Reduction in Europe, strong increase in Asia

Emissions from fuel use* – Changes between 1990 and 2017 in Millions of tonnes



Source: IEA, CO_2 Emissions from Fuel Combustion – 2020

While China shows an increase of 338 per cent during the years 1990–2017, the EU shows a decrease of 20.3 per cent.

In 2017 alone, China's emissions increased by 200 million tonnes.

India increased it's emissions since 1990 by 310 Percent and this value is still increasing.

* Corresponding to category 1A according to the UNFCCC classification system

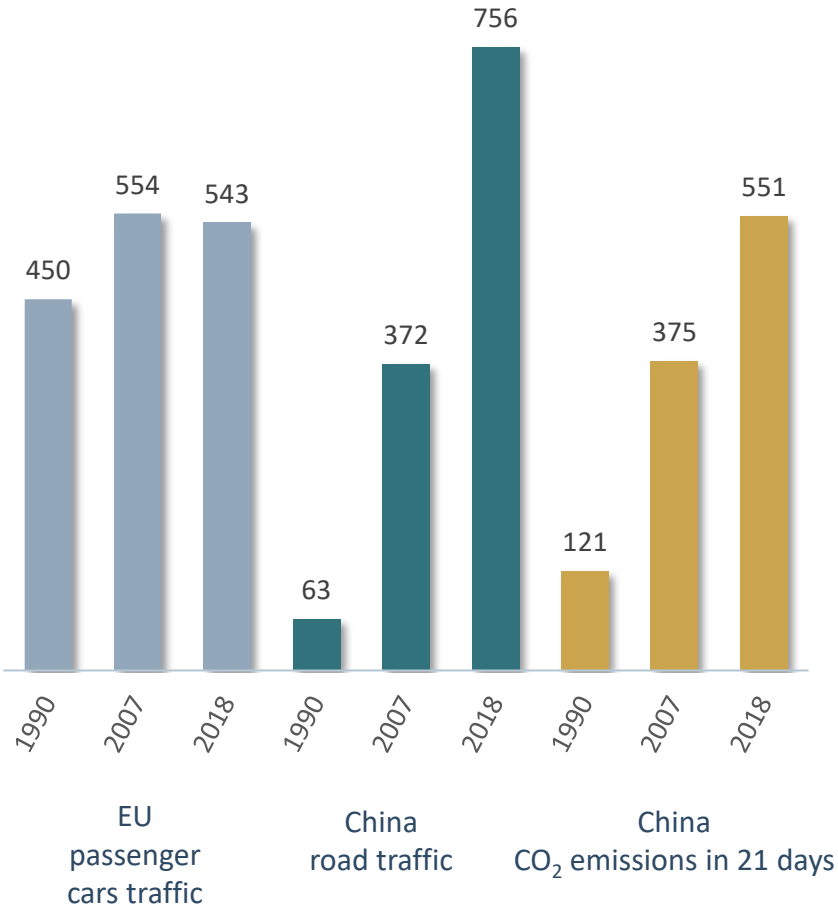
Core theses: Climate protection

2

No solution without China: Europe's reduction of emissions is being eaten up by growth in emerging economies.

EU passenger cars – Relevant, yet not crucial

CO_2 emissions in millions of tons



Sources: EEA, 2019 (v23; IEA, CO_2 Emissions from Fuel Combustion – 2020

Relevant: Europe's total passenger car traffic 2017 emitted 543 million tonnes of CO_2, an upward trend compared to 2015.

Crucial? China, on the other hand, is showing a strong upwards trend in its use of fossil fuels – emitting nearly 526 million tonnes of CO_2 in just three weeks.

Dynamic: between 2014 and 2015 the plus in China was about 60 millions of tons. In the following year the emissions increased by 8 million tons.

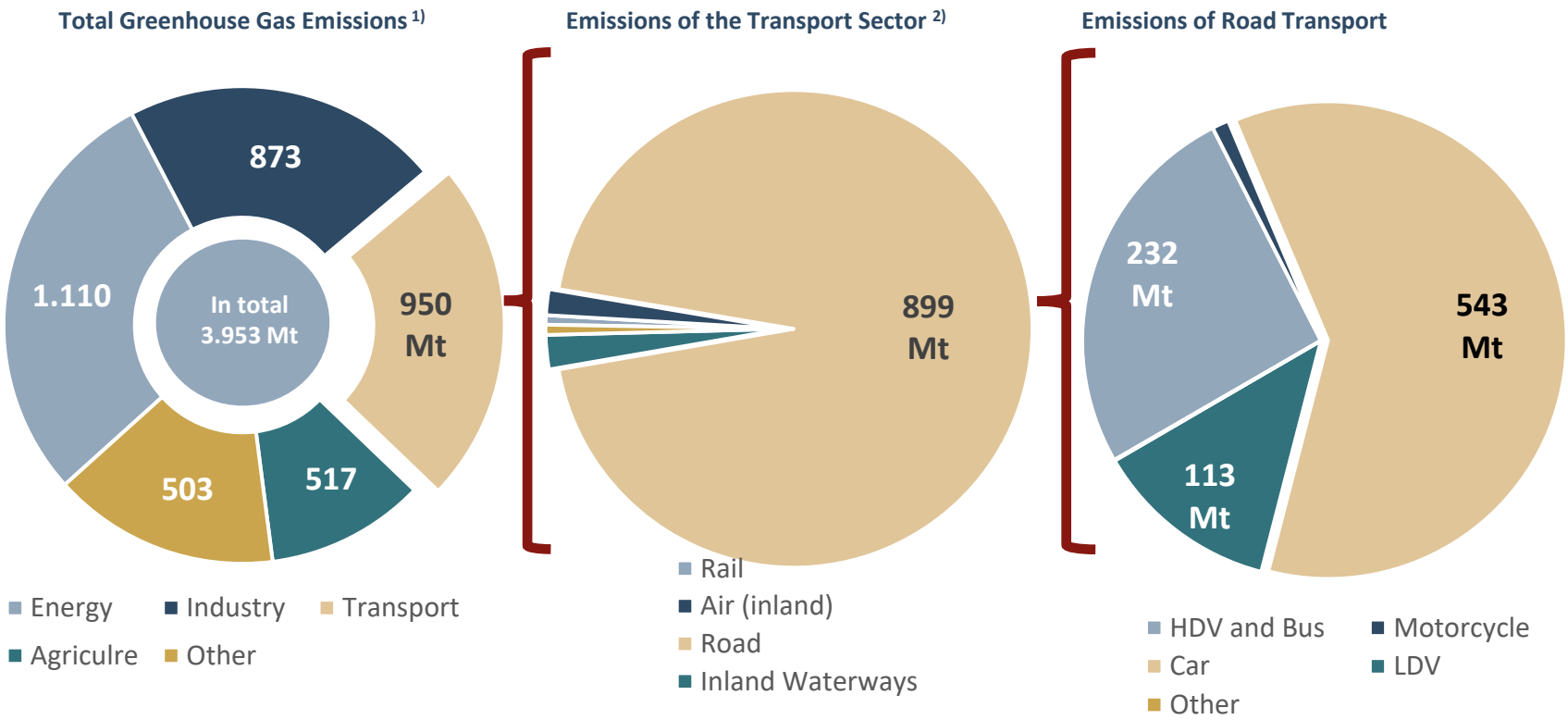
Core theses: Climate protection

3

Motor vehicles account for approximately one-seventh of the CO_2 emissions in the EU. Their share in transportation emissions is declining.

Road transport is a major source in Europe

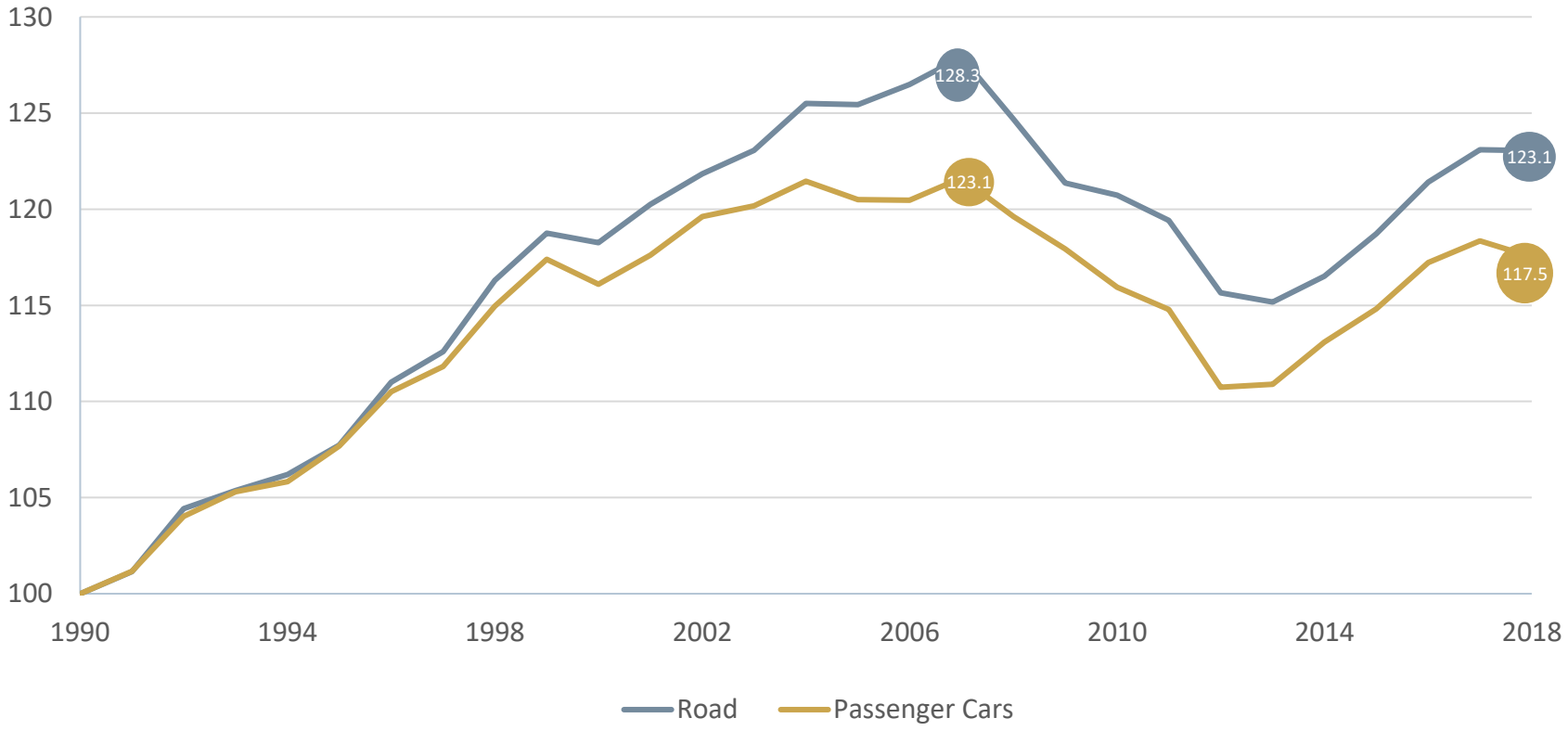
Emissions in the EU in the year 2018 in Megatons



[1] With sinks
[2] Without internationalen Air and Sea traffic
Quelle: EEA, 2020 (V23)

Passenger Cars in the EU: CO_2-Emissions are rising again

Absolute CO_{2EQ}-Emissionen, 1990 = 100



Quelle: EEA, 2020 (v23)

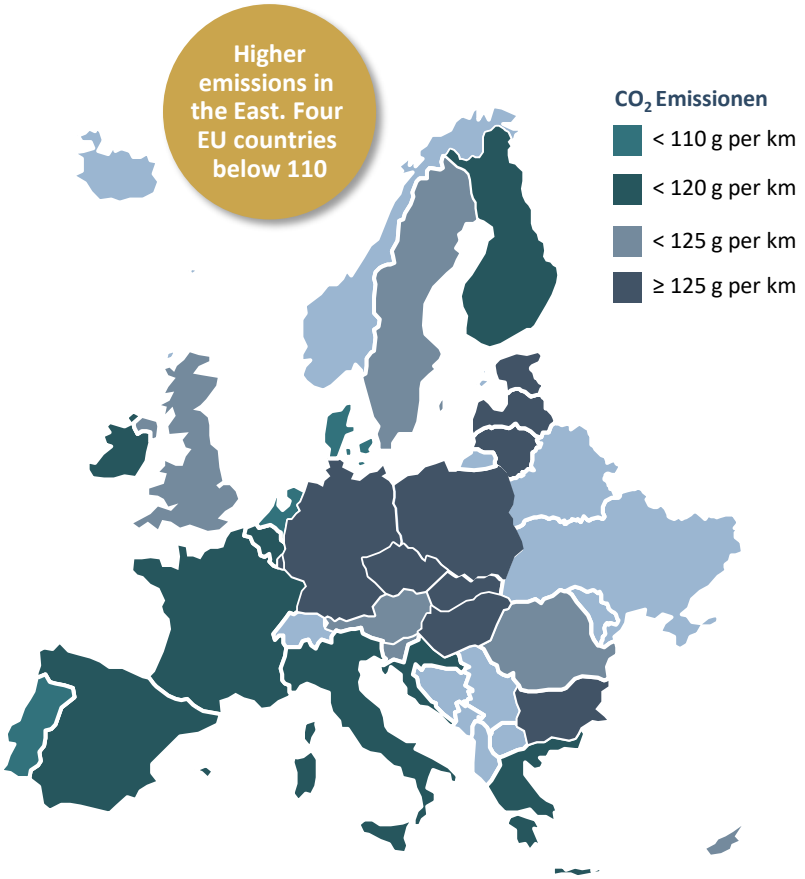
Core theses: CO_2 regulation for motor vehicles

4

New vehicles in Europe have become considerably more efficient in recent years.

Emissions from new vehicles decreasing rapidly

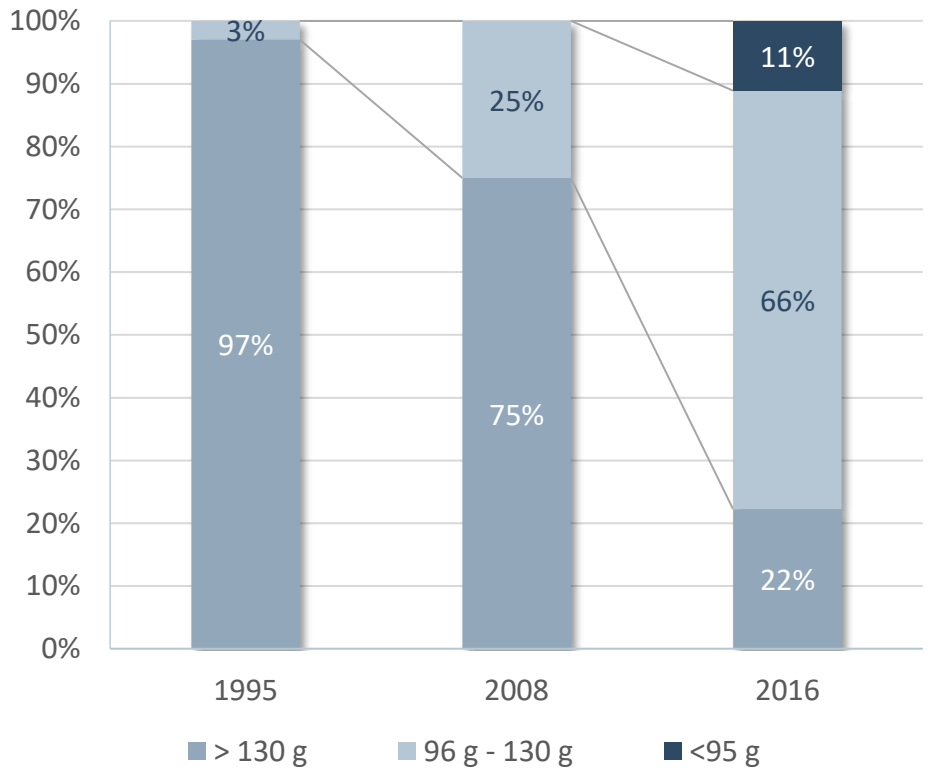
Country	Average CO_2 emissions of newly registered cars in 2018, in g per km	Change from 2007 to 2018, as percentage
Netherlands	105.5	-35.98
Portugal	106.1	-26.42
Malta	107.7	-27.13
Denmark	109.6	-31.41
Greece	111.4	-32.60
France	112.2	-24.89
Ireland	113.3	-29.89
Croatia	115.3	k.A.
Italy	115.9	-20.89
Finland	116.7	-34.18
Spain	118.1	-22.91
Belgium	119.4	-21.86
Slovenia	120.9	-22.65
Romania	121.5	-21.51
Sweden	122.2	-32.63
Austria	123.0	-24.49
Cyprus	123.4	-27.58
UK	124.6	-24.35
Czech Republik	126.0	-18.29
Bulgaria	126.7	-26.16
Slowakia	127.6	-16.44
Hungary	127.9	-17.48
Lithuania	128.6	-27.14
Latvia	128.8	-29.81
Germany	129.5	-27.14
Poland	129.8	-27.82
Luxembourg	131.4	-20.75
Estonia	132.4	-27.09



Source: EEA, 2020

High-emisson cars are on the decline

CO_2-emissions of new cars in the EU in per cent



Source: ACEA, 2016

- Already today the mass of new cars emits clearly less than 130 g CO_2/km.
- High-emission cars are on the decline. In 1995 80 per cent of the new cars emitted more than 160 g CO_2/km .
- More than 1/10 of the new cars already reach the target of the year 2021.

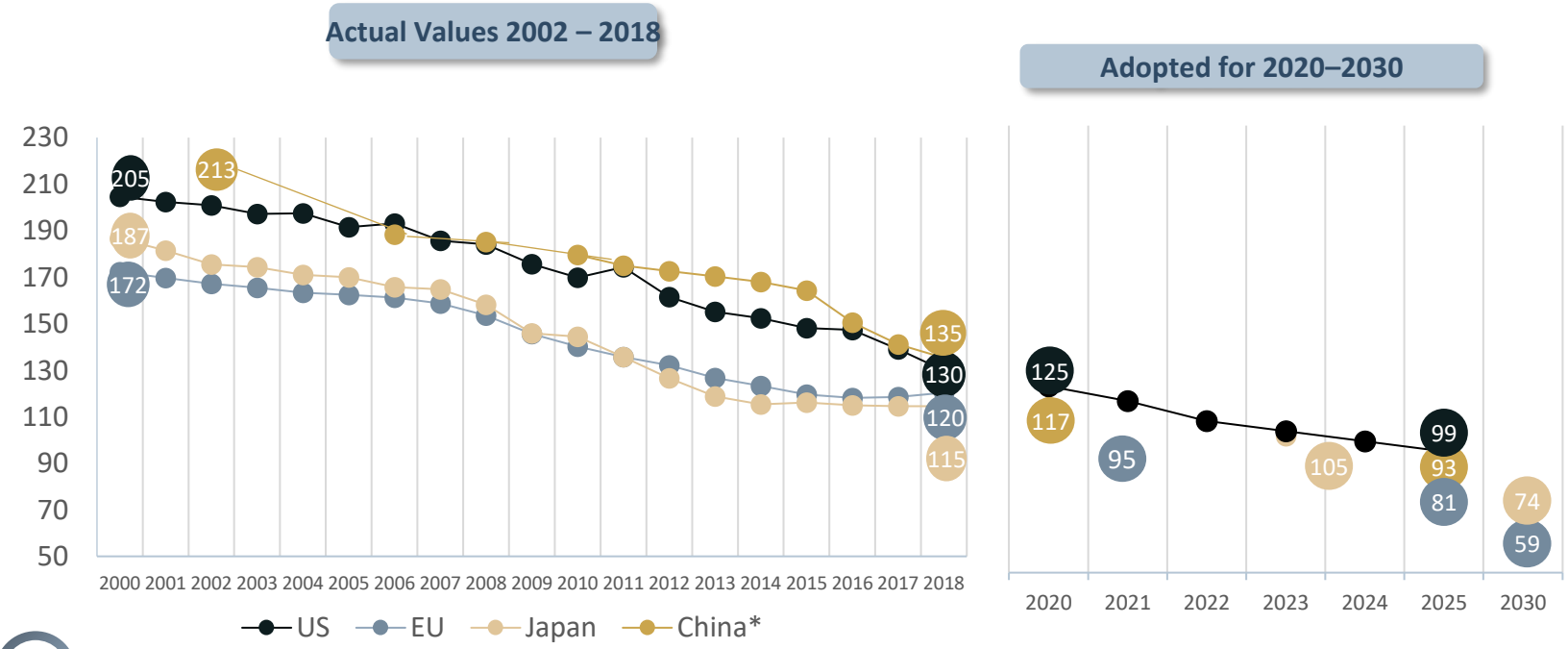
Core theses: CO_2 regulation for motor vehicles

5

CO_2 legislation in Europe shows the most stringent target values in an international comparison.

The most stringent CO_2 target values for new vehicles

in g CO_2/km under the New European Driving Cycle (NEDC)



- The EU emission standard for 2030 is the most stringent standard in the world.
- In the US passenger cars only make up a third of the vehicle market. Light Trucks dominate and their limit Value is considerably higher (140 g/km in 2025)
- In November 2017 the EU Kommission proposed to lower the limit value within the period of 2021 until 2025 by 15 per cent and to codify a minus of 37.5 per cent until 2030.

* Gasoline only
Source: ICCT, 2020

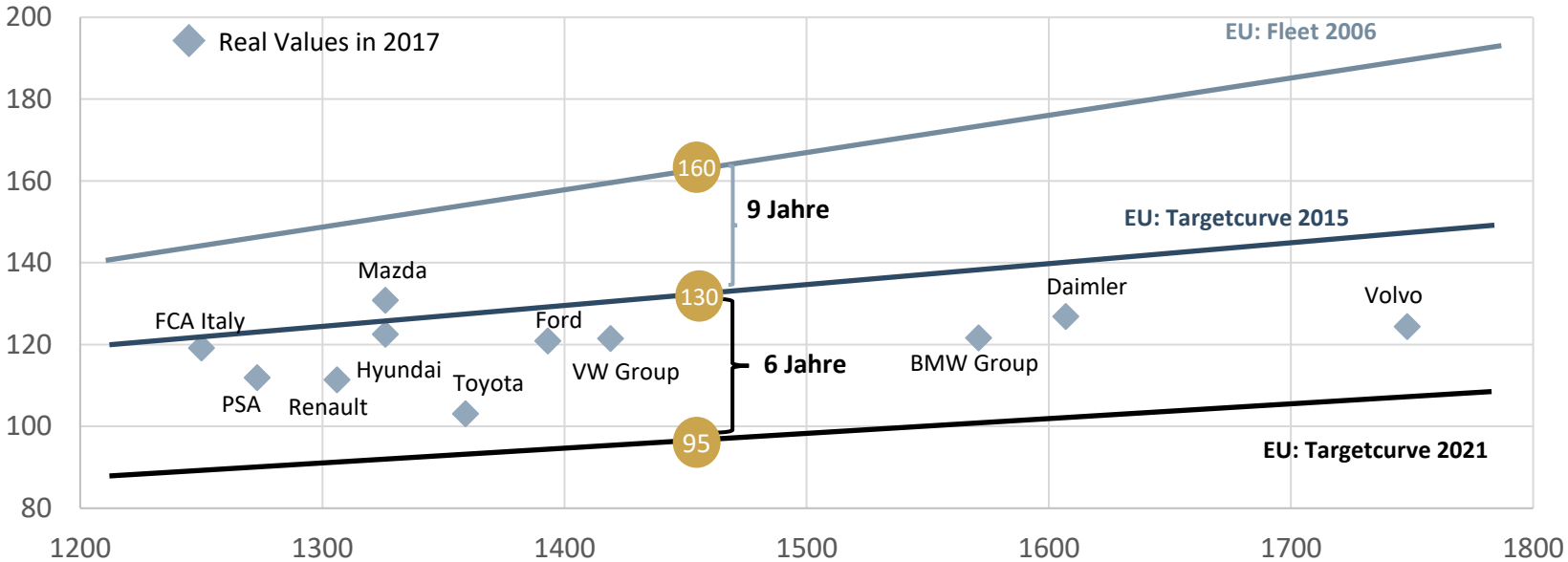
Core theses: CO_2 regulation for motor vehicles

6

Europe has once again tightened the reins on the CO_2 limit values for motor vehicles and is requiring a further reduction of CO_2 within an even shorter span of time.

CO_2 target values for 2021: High demands on the automotive industry

in g CO_2/km



- Independent of vehicle weight, manufacturers of large cars have to show greater reductions than high-volume manufacturers.
- In the nine years from 2006 to 2015, a reduction of the average emissions by 30 g CO_2/km was required of new vehicles – from 160 g CO_2/km down to 130 g CO_2/km .
- Speeding up the pace: In the six years from 2015 to 2021, average emissions must be reduced by 35 g CO_2/km – from 130 g CO_2/km down to 95 g CO_2/km. For 2025 a suggestion has been raised by the commission of 81 g CO_2/km, that is a minus of 14 g CO_2/km in four years.

Sources: EU, EEA

Core theses: CO_2 regulation for motor vehicles

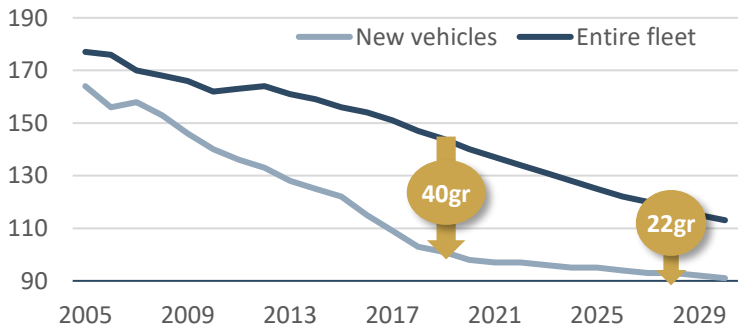
7

Even without a further tightening of the CO_2 limit value after 2020, the motor vehicle industry is still on track to meet the EU's climate policy targets by 2030.

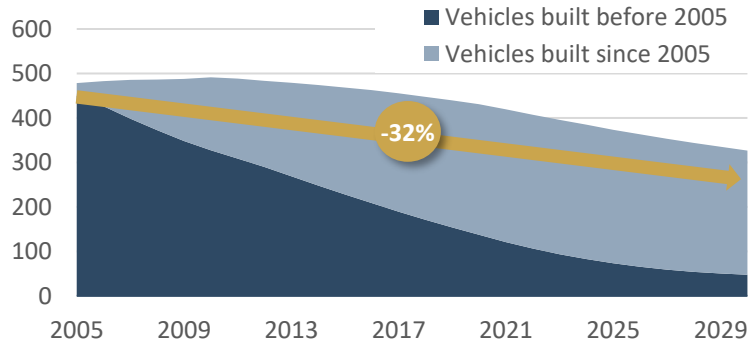
Efficient new vehicles impact the vehicle fleet

Based on model calculation. With today's regulation, an emissions reduction of 30 per cent is achievable between 2005 and 2030. This corresponds to the EU target for non-ETS sectors.

Relative car emissions
in g CO_2/km



Absolute car emissions
in millions of tonnes of CO_2



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- Based on a conservative estimate, the ongoing replacement of old vehicles will result in car traffic emissions in Europe decreasing by approximately 30 per cent by 2030, compared to the year 2005.
- Until 2014, the fleet was dominated by vehicles built before 2005. Several million of these vehicles will still be on the road in 2030.
- The advancements of recent years will long continue to have an impact on the vehicle fleet. Even if new vehicles were to hardly show improvements after 2021, the fleet emissions would continue to decrease.
- In regard to cars, the EU target can be achieved with the existing regulation.

Source: Daimler

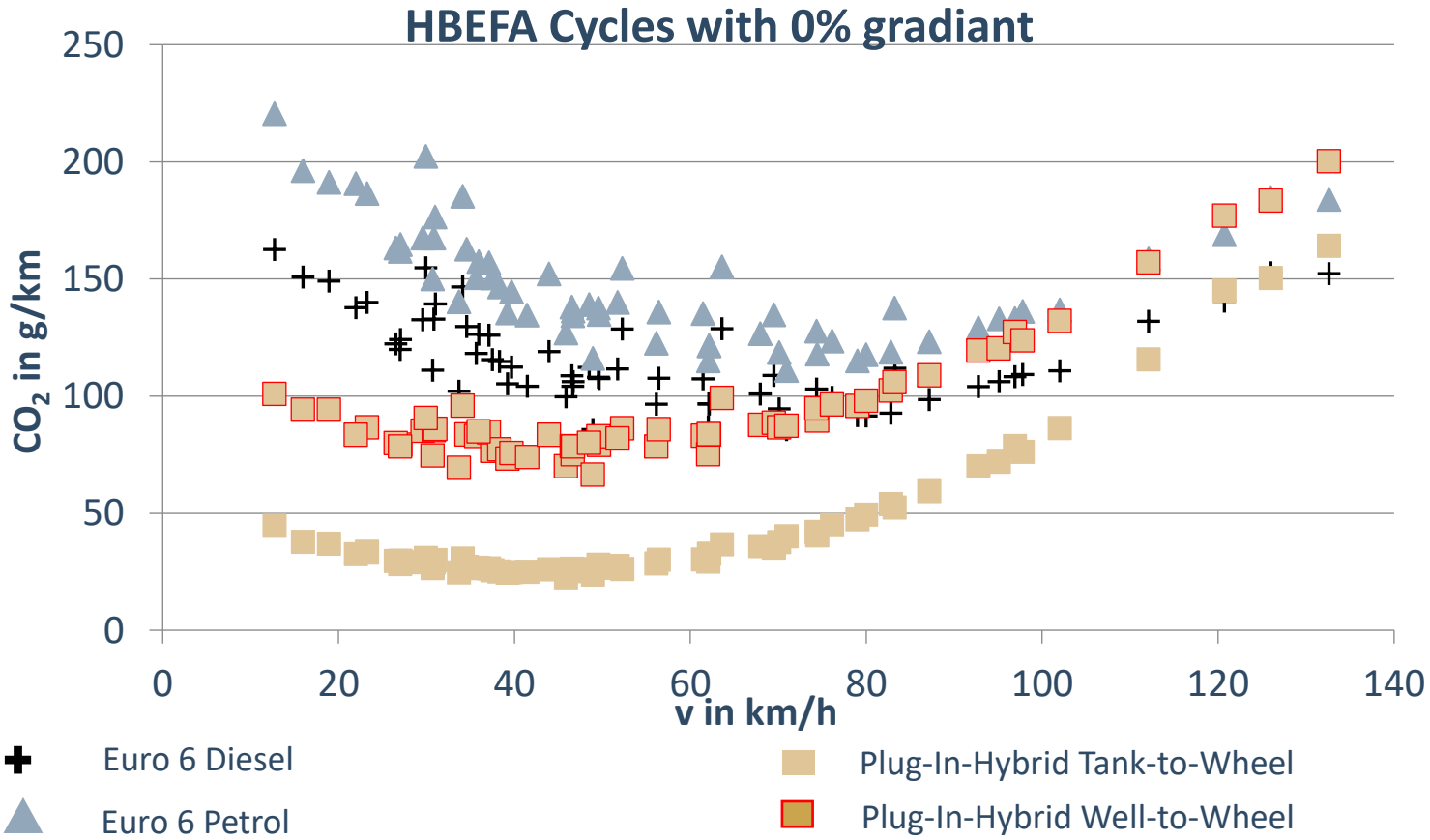
Core theses: CO_2 regulation for motor vehicles

8

Vehicle fleet limit values under 95 grams cannot be achieved with conventional engine types, and the market success of alternative engine types is still uncertain.

Speed makes the difference

CO_2 emissions of a middle class car depending on different drives types and speed



Source: TU Graz, 2018

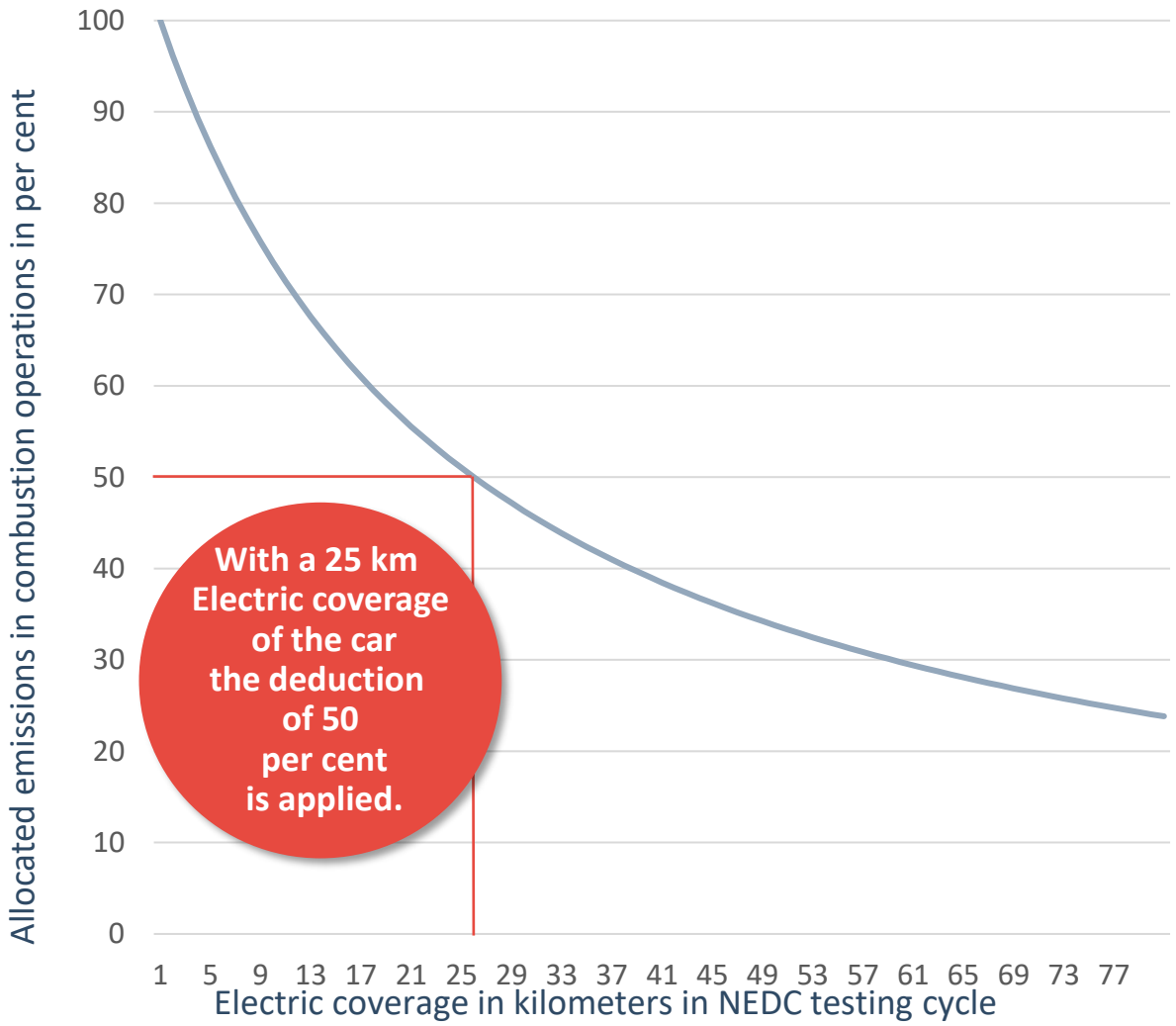
Emissions calculations for PHEV

Emissions from PHEV are calculated on the basis of the emissions in combustion operations and of the electric coverage of the car.

Firstly the PHEV participates in the European testing cycle (NEDC) in combustion operations.

Then it runs the cycle driven on electrical energy as long as the battery lasts.

Depending on the such determined coverage of the car a pro rata deduction from the emissions in pure combustion operations is applied.

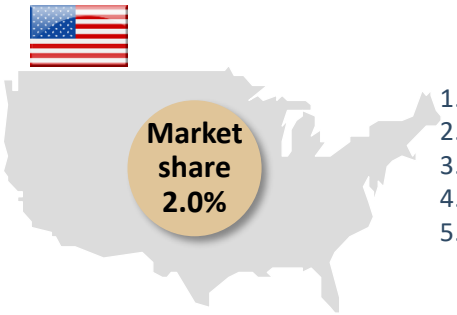


Source: EU Komission, Own calculations

Electric cars: Quite different markets

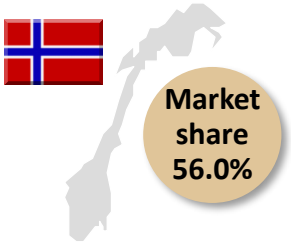
New vehicles and top-selling models of the year 2019

New vehicles BEV/PHEV: 325,000



1. Tesla Model 3
2. Toyota Prius PHV
3. Tesla Model X
4. Chevrolet Volt
5. Tesla Model S

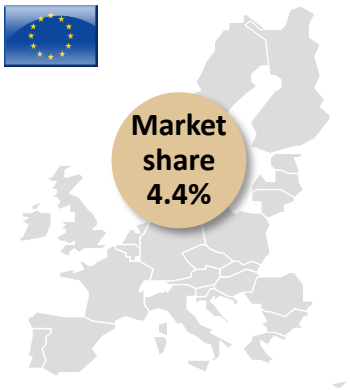
New vehicles BEV/PHEV: 79,640



1. Tesla Model 3
2. Volkswagen E Golf
3. Nissan Leaf
4. Audi e-tron
5. Mitsubishi Outlander

World 2019 2,209,831

New vehicles BEV/PHEV: 564,206



1. Tesla Model 3
2. Renault Zoe
3. Mitsubishi Outlander
4. Nissan Leaf
5. BMW i3

New vehecles BEV/PHEV: 1,177,421

1. BAIC EC Series
2. BYD Yuan
3. SAIC Baojun EV
4. Cherry EQ
5. BYD Tang

Source: ev-sales.blogspot, 2019

Core theses: CO_2 regulation for motor vehicles

9

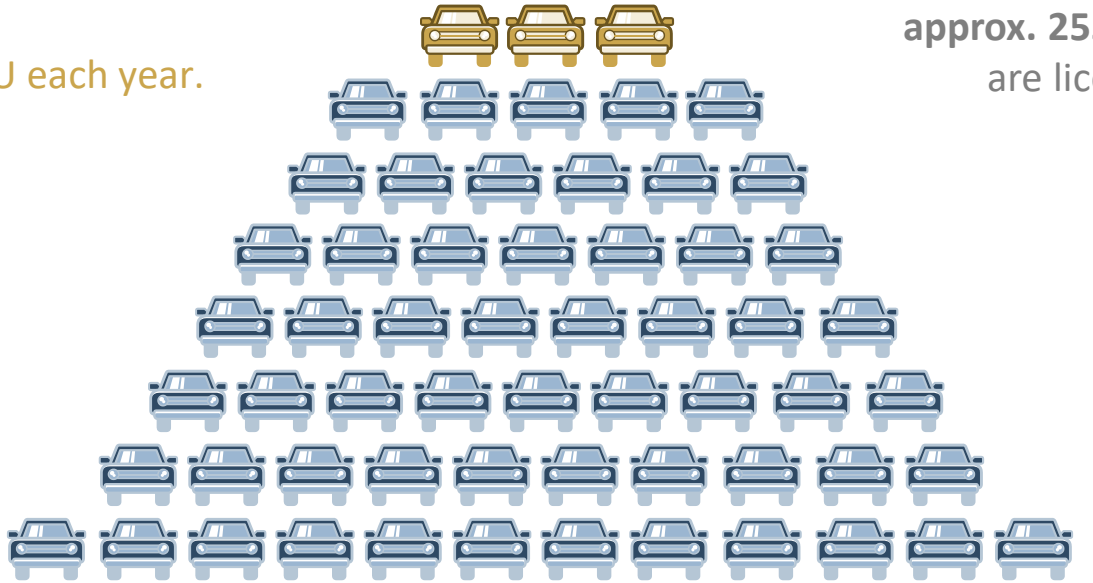
An effective reduction of CO_2 emissions cannot address new vehicles alone but must take a much broader approach.

Limit values affect only new vehicles

Existing vehicles are not covered by the regulation

Approx. **15.1 million new vehicles** are licensed in the EU each year.

Alltogether **approx. 255 Millionen cars** are licensed in the EU.



- Each year, only about 5 per cent of the vehicle fleet in the EU is replaced.
- Existing vehicles hold huge potential for CO2 reduction.
- That is why measures for replacing the existing vehicle fleet are essential

Quelle: ACEA, 2017; VDA ,2017

Improved regulation: Emissions standards for vehicles fall too short

To reduce emissions, drivers and the government need to be involved in the process

Integrated approach: Include all areas in the regulation process

Total emissions in tonnes =
Consumption in litres * Emissions factor in kg CO_2/litre * Mileage

Automotive industry

- Optimisation of combustion engine
- Alternative fuels
- Lightweight construction
- Switching to electric powertrains
- Use of digitalisation (avoidance of parking-related traffic)

Government

- Infrastructure conditions
- Construction site management
- Promotion of transmissions and fuels that produce fewer emissions
- Replacement of existing vehicles

Driver

- Route (how much?)
- Driving style (how?)
- Vehicle selection (with what?)

- Vehicle limit values only regulate potential emissions.
- The actual emissions are determined just as much by drivers as by the infrastructure

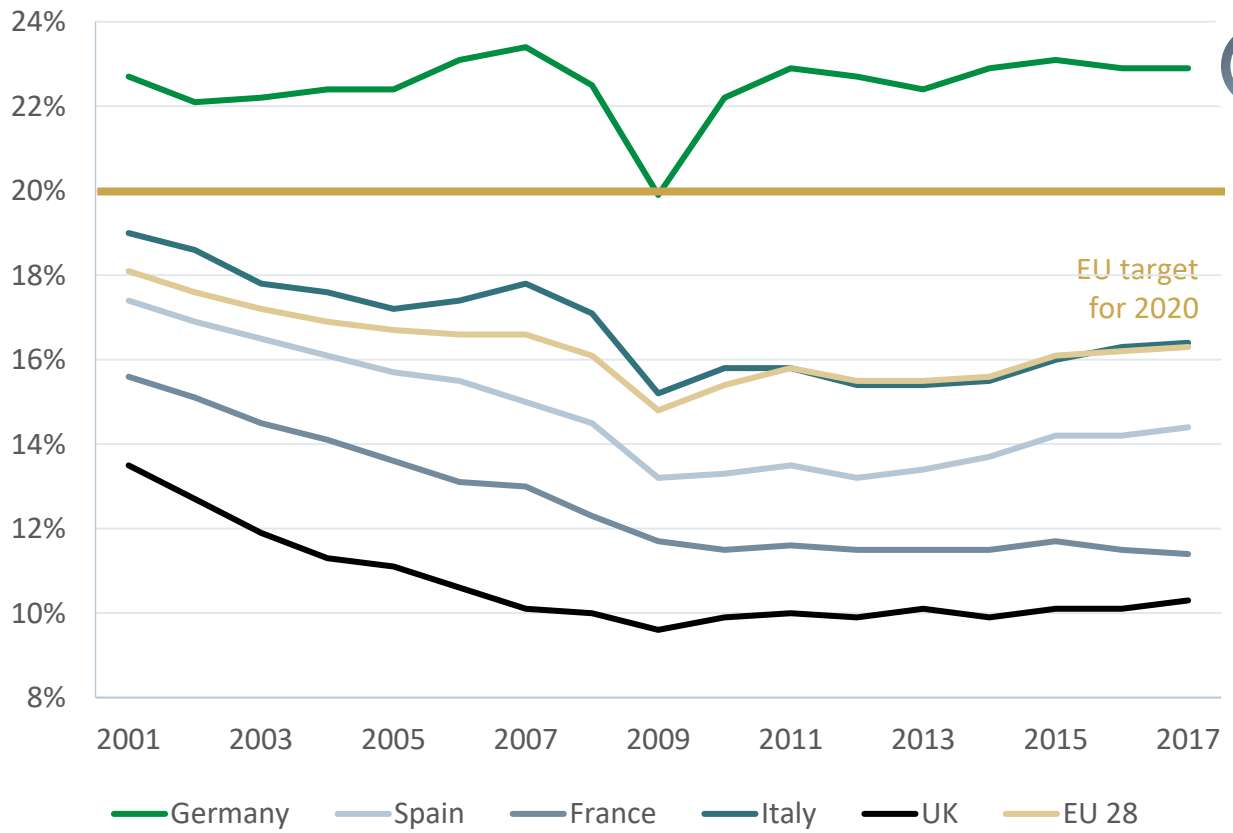
Core theses: Balance between climate protection and industrial policy

10

The EU is targeting a 20% industry share of GDP for the year 2020. This goal is presently a long way away, since industrial and climate protection policy are not yet aligned.

The EU industrial sector: Collapse rather than rebirth

The manufacturing industry's share of the gross value, as percentage



Source: Eurostat

EU target: The industrial sector is expected to have a 20 per cent share of the GDP in 2020.

- Germany is reaching this target. The UK, Italy and France give cause for concern.
- Countries outside of Europe are improving quickly. Europe must respond in order to secure its position.

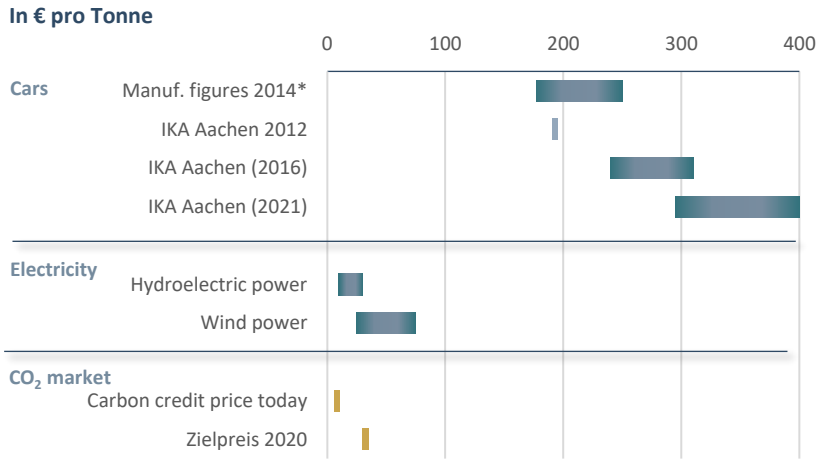
Core theses: Balance between climate protection and industrial policy

11

The CO_2 abatement costs vary greatly between sectors and are most pronounced in the automotive sector.

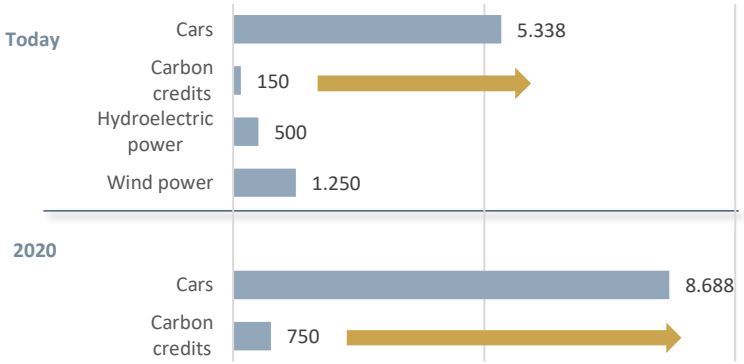
CO_2 avoidance in cars is expensive and would be cheaper to obtain in other sectors

Problem: CO_2 avoidance in cars is already comparatively expensive.



Expensive CO_2 avoidance leads to excess burden.

Assumption: CO_2 emissions in Europe are to be reduced by 25 million tonnes. Comparison of the resulting costs today and in 2020, in millions of euros**



- The reduction costs differ greatly from sector to sector.
- The avoidance of car emissions by means of improved technologies is relatively expensive, and these costs will continue to increase.
- Sector-based reduction targets lead to high additional costs in the economy.
- In the EU Emissions Trading System (ETS), permissible emissions are offset by carbon credits. One credit allows the emission of a tonne of CO_2.
- The trade with carbon credits ensures that the emission volume stipulated by the EU is generated where the reductions are least expensive.

* Extrapolation from published reports ** Calculated based on the average value of the respective line.
Sources: : AGFW, IKA Institut für Kraftfahrzeuge Aachen, EU

Core theses: CO_2 regulation motor vehicles

12

Emissions trading as the most economically efficient form of CO_2 regulation can easily be applied to road traffic.

Emissions trading in road traffic: It that possible?

One stop towards an integrated approach would be the inclusion of road traffic in emissions trading. Fuel consumption can be precisely calculated in emissions. Heavy trucks cannot be integrated in the existing system of limit values; this is not a problem in emissions trading. The question remains as to who should make the carbon credits available:

Upstream: Filling station operators

The corresponding carbon credits must be purchased for every litre sold.

- 1L petrol = 2,3 kg CO_2
- 1L diesel = 2,6 kg CO_2.

Pro

- Easy to implement technically
- Little demand from the well-financed
- Actual emissions are limited.

Contra

- It only indirectly addresses those who are actually generating the emissions. The connection to the driver is the price signal, as in the case of a fuel tax.

Midstream: Car manufacturers

When a new vehicle is sold, a volume of carbon credits must be purchased that corresponds to the car's expected emissions in its lifetime.

- In the case of 130 g CO_2/km and 200.000 km: carbon credits for 26 Tonnes

- Little demand from the well-financed

- Inaccurate: The purchased amount represents a theoretical volume.
- The manufacturer only determines the potential emissions, not the actual emissions.
- The manufacturer only has an indirect influence over actual CO_2 emissions.

Emissions trading: A useful supplement

The inclusion of road traffic in emissions trading offers certain benefits

ETS Filling Station
Main Street 111, 12345 New Town
Station no.: 000000000xyz
Station tax no.: 13/456/xyzxyz
Company tax no.: 01 234 56789
Receipt no. 1234/005/00001 03.03.2021 9:22
Card payment

*Super		65.13 EUR A #*
*Pump 03	43.45 l	1.499 EUR/l #*

*EU ETS carbon credits	3.04 EUR C* #*

* 43.45 l x 2.33 kg CO_2/l = 101.24 kg CO_2
* x 30.00 EUR/credit for 1,000 kg CO_2

Total 68.17 EUR

Type	Net	VAT	Gross
A: 19.00%	54.73	10.40	65.13
C: 0.00%	3.04	0.00	3.04

Thank you for your visit. Have a safe trip!

- Simple: The necessary amount of carbon credits per tank filling is easy to calculate. The required purchase can be paid for with the fuel.
- Inexpensive for the driver: Based on the EU's targeted price of 30 euros per carbon credit in the year 2020, a litre of petrol would cost 7 euro cent more.
- Inexpensive for society: The abatement costs of road traffic are far above 30 euros per tonne. Emissions are avoided where it is cheaper to do so.
- But: Since the transportation sector would be purchasing so many carbon credits, other sectors would have to substantially step up their reduction efforts. Good judgment will be necessary in order to avoid an overload in the other sectors.
- Thus: Emissions trading is a useful supplement to today's limit values.

Puls, Thomas

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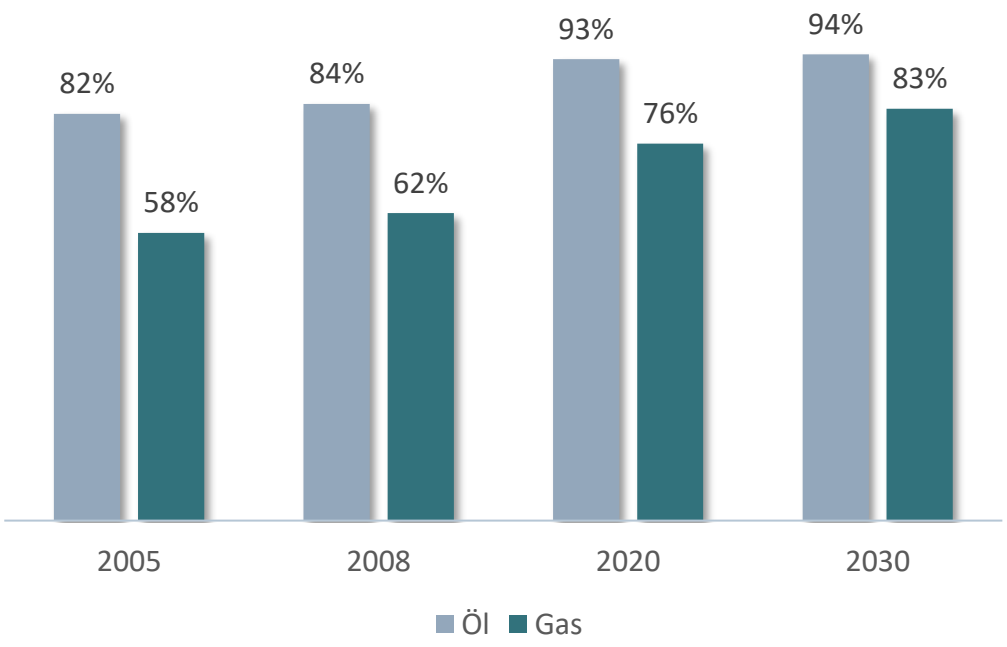
Annex

Gestrichene Folien, die nicht mehr aktualisiert werden

Rohstoffe: Hohe Importabhängigkeit der EU

Der Verbrauch an Öl und Gas kann nicht aus heimischen Quellen gedeckt werden

Anteil importierter Primärenergieträger am Verbrauch in Prozent

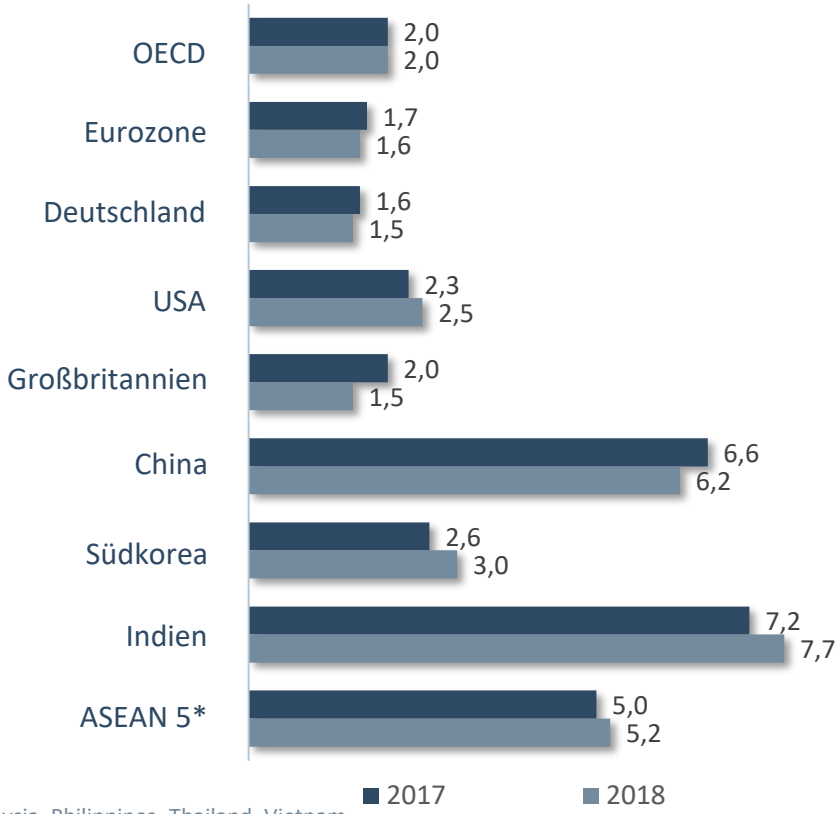


Quelle: Europäische Kommission

- Kaum Reserven: Die EU verfügt nur über 1-3 Prozent der Reserven an fossilen Primärenergieträgern.
- Erschöpft: Die europäische Förderung von Öl und Gas sinkt.
- Problem: Auch wenn der Verbrauch sinkt, bestehen politische Abhängigkeiten von den Förderländern.

Aufholprozess in Asien setzt sich fort

Wachstumsprognosen in Prozent

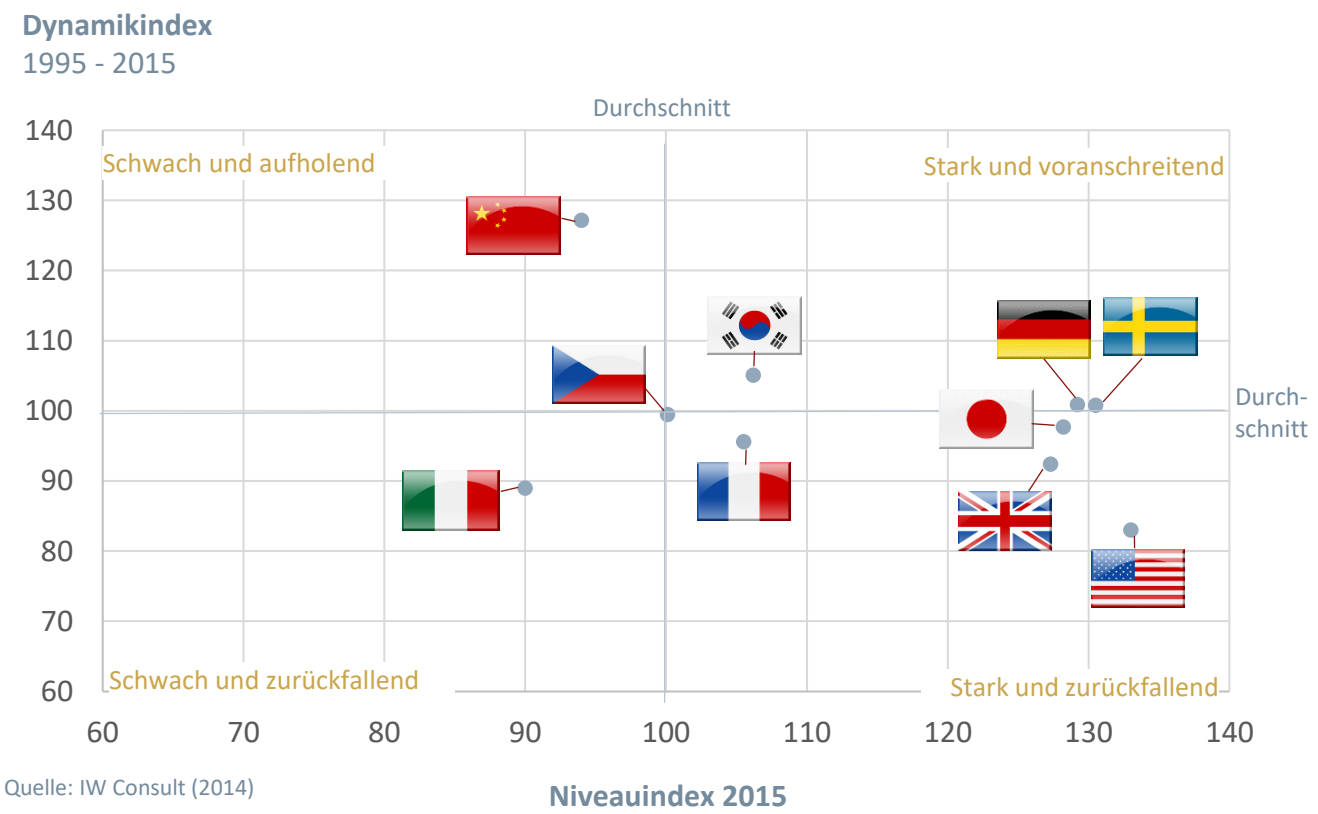


*Indonesia, Malaysia, Philippines, Thailand, Vietnam
Quelle: Internationaler Währungsfonds, World Economic Outlook April 2017

- Das globale Wachstum bleibt auf Asien fokussiert.
- Die OECD-Länder verlieren weiter an Gewicht.

Niveau und Dynamik der Standortqualität

Der Standortvorteil vieler OECD-Staaten schrumpft

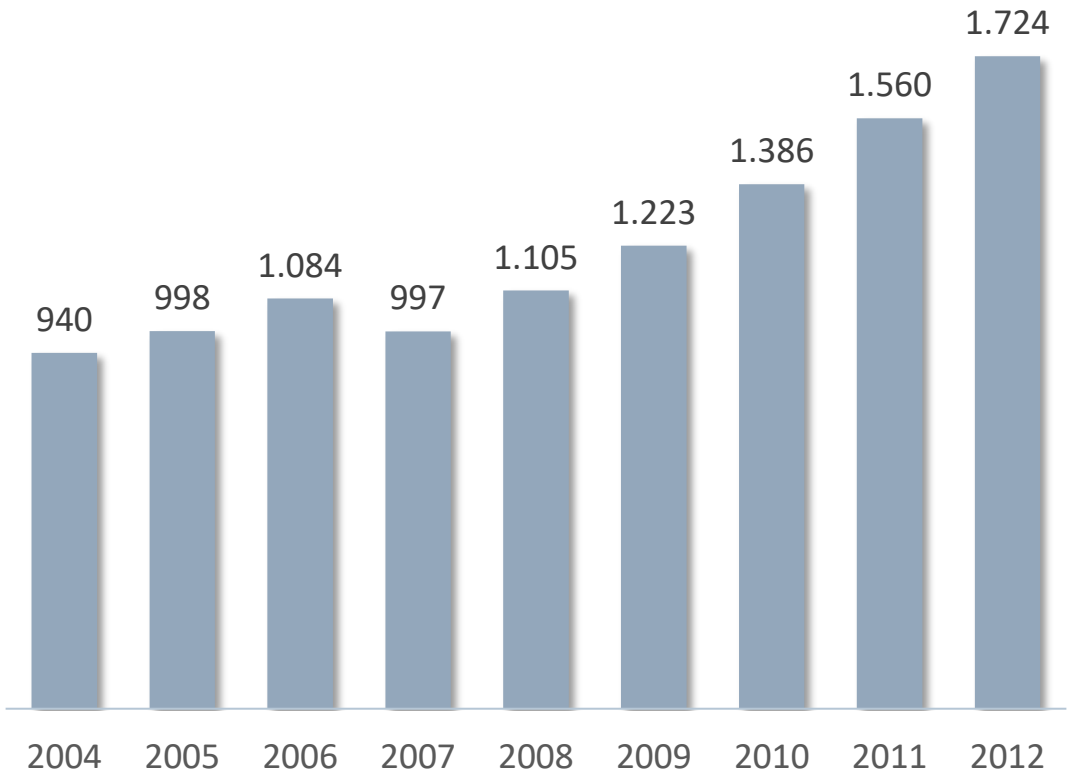


Quelle: IW Consult (2014)

- China holt qualitativ zu den etablierten Industrieländern auf.
- Gemessen am globalen Durchschnitt haben sich viele OECD-Standorte seit 1995 auf ihrer starken Stellung ausgeruht.

Die Regelungsdichte in Europa ist sehr hoch und wird immer dichter

Anzahl der EU-Vorschriften für Gesundheit, Sicherheit und Umwelt



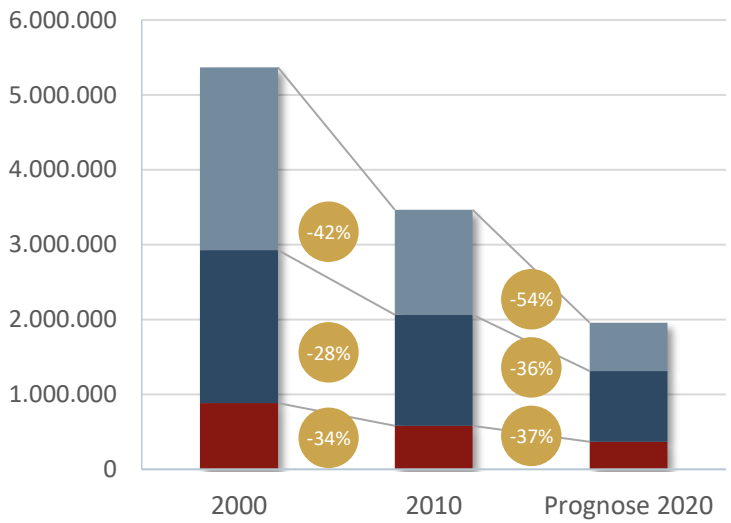
Quelle: EU

- Die ohnehin schon hohe Regelungsdichte in der EU nimmt immer weiter zu.
- Die verschiedenen Ziele und Regulierungen der EU neigen dazu, sich zu widersprechen.
- Um alle Ziele zu verfolgen, braucht es vor allem eine bessere Regulierung.

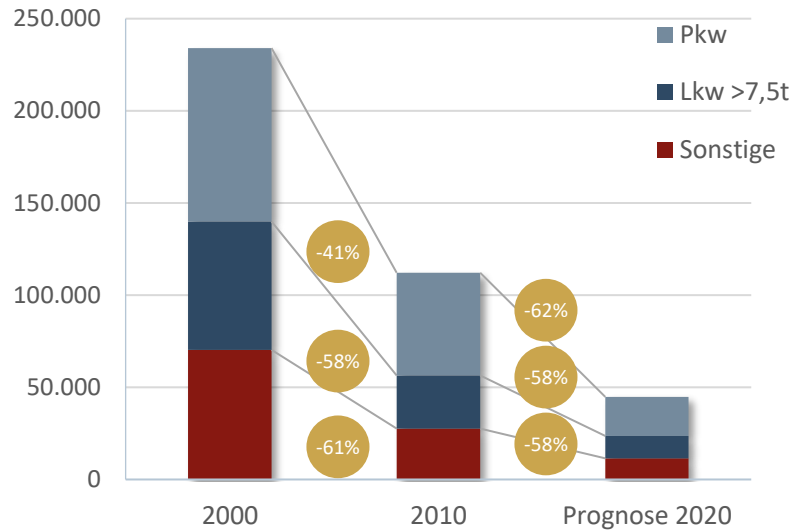
Der Straßenverkehr ist sauberer geworden – trotz gestiegener Verkehrsmengen

Schadstoffemissionen in der EU-27 in Tonnen

Stickoxide (NO_x)



Partikelmasse (PM)

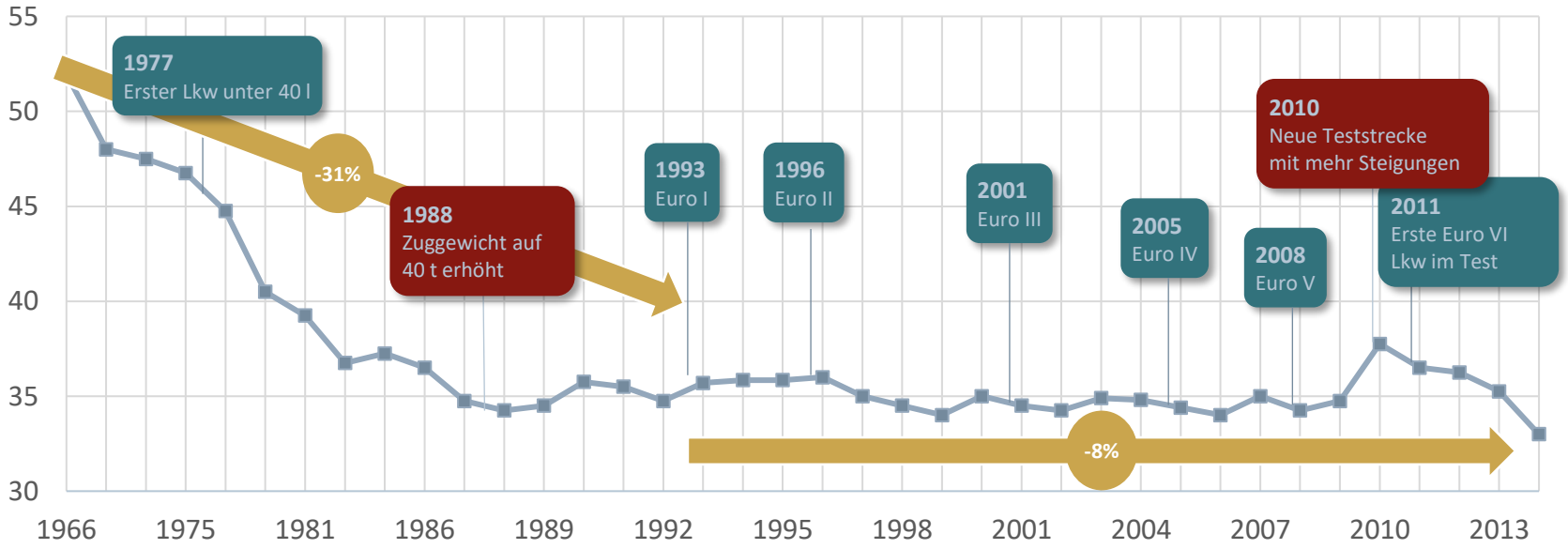


- Seit Ende der 80er Jahre lag der Fokus der Politik auf der Schadstoffreduktion. Schadstoffe sind bei Kontakt gesundheitsgefährdend. Das Treibhausgas CO_2 ist somit kein Schadstoff.
- Obwohl die Fahrleistungen stark gewachsen sind, gehen die Schadstoffemissionen der Kfz deutlich zurück.

Quelle: EU (TREMOVE)

Der Kraftstoffverbrauch der Fahrzeuge sinkt langsamer

Verbrauchsentwicklung schwerer Lkw im Praxistest* in Liter Diesel auf 100 km



Mit Ankündigung der Euro-I-Norm im Jahr 1988 kam die Verbrauchsreduktion der von der Redaktion getesteten Fahrzeuge fast zum Stillstand.

Die gefahrene Ø Geschwindigkeit stieg aber weiter an und die Schadstoffemissionen nahmen drastisch ab.

Aber: Kein wissenschaftlicher Vergleichstest, denn die von Markt nachgefragten und getesteten Fahrzeuge (Leistung, Fahrzeughöhe) und Verkehrslage auf den Teststraßen (Geschwindigkeit, Staugefahr) haben sich im Zeitablauf stark verändert.

* 800 km Rundkurs auf deutschen Straßen
Quelle: transaktuell 10/2014

Gut 22 Prozent weniger Verbrauch vergleichbarer Lkw

Technische Daten des Tests

Verbrauchsrelevante Faktoren

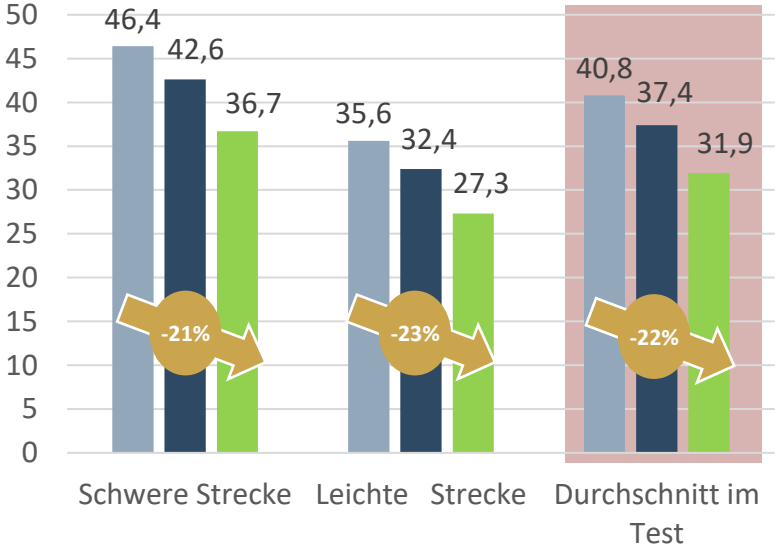
Lkw von 1996: Euro 2
Testgewicht: 39.240 kg
Nennleistung: 435 PS
Ø Geschwindigkeit: 83,7 km/h

Lkw von 2003: Euro 3
Testgewicht: 39.420 kg
Nennleistung: 456 PS
Ø Geschwindigkeit: 84,7 km/h

Lkw von 2015: Euro 6
Testgewicht: 39.820 kg
Nennleistung: 449 PS
Ø Geschwindigkeit: 84,0 km/h

Kraftstoffverbräuche

Nach Streckenart in Litern pro 100 km

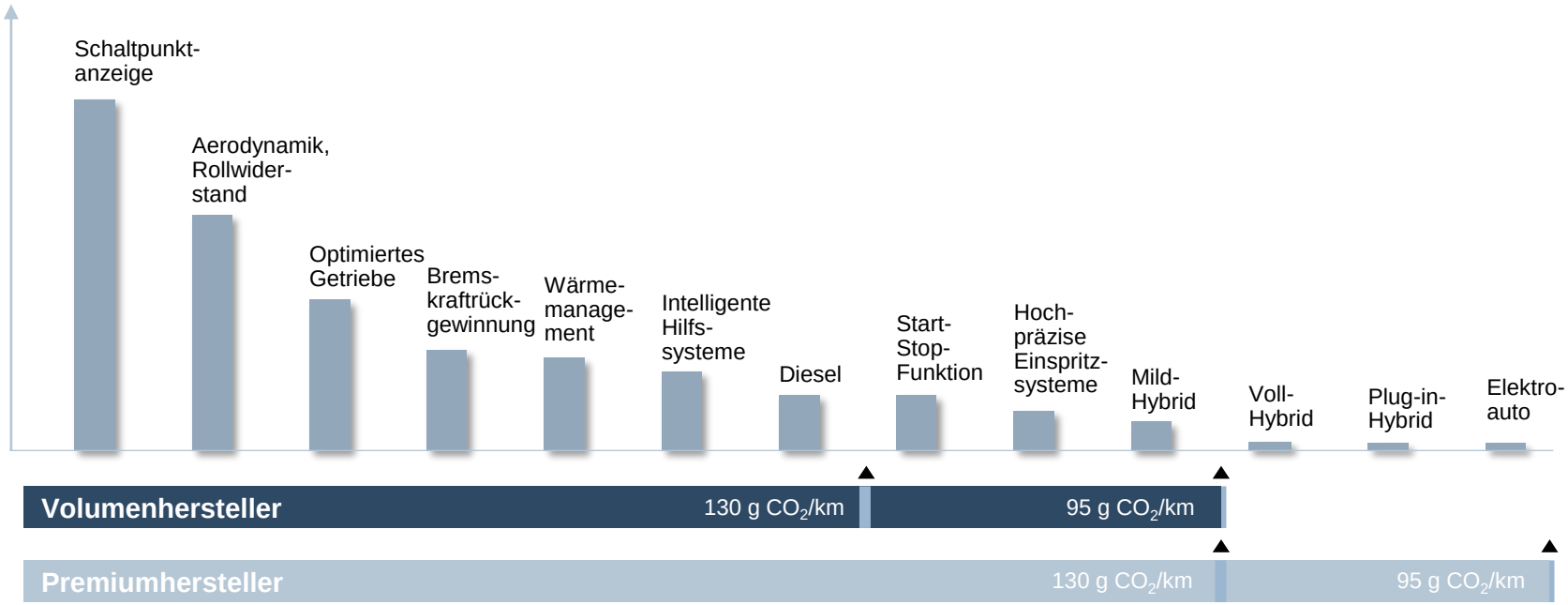


- Von der DEKRA begleiteter Straßentest (Dauer: 4 Tage; Fahrleistung: ca. 2.000 km je Testfahrzeug).
- Die Test-Lkw repräsentieren drei unterschiedliche Fahrzeuggenerationen des selben Herstellers.
- Die getesteten Fahrzeuge entsprechen in Bezug auf die Leistung den heute üblichen Anforderungen.
- Moderne Technik und Assistenzsysteme unterstützen den Fahrer beim verbrauchsarmen Fahren.

Quelle: lastauto omnibus, Heft 10/2016

CO_2-Reduktion: Künftig wird es teurer

CO_2-Einsparung pro Euro Herstellungskosten



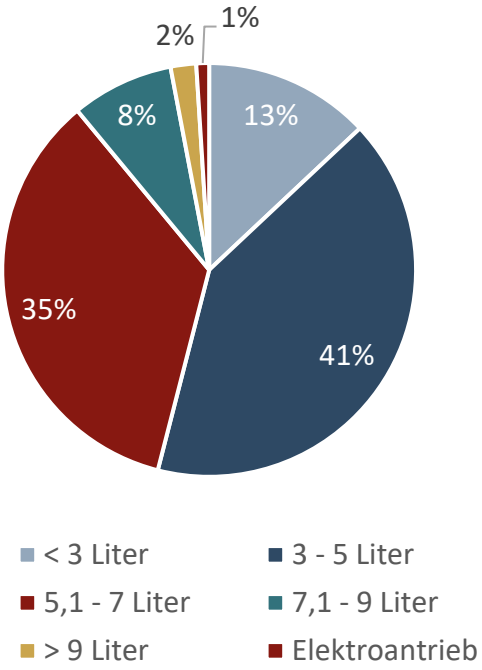
- Die einfachen und billigen Optionen werden zuerst ergriffen, daher ist die permanente Beschleunigung des Reduktionstempos ein Problem.
- Der Verbrauch lässt sich nicht beliebig reduzieren. Ohne Elektrifizierung werden neue Grenzwerte nicht zu schaffen sein, Hersteller großer Pkw müssen bereits jetzt elektrifizieren.

Quelle: BMW

Aber: Der Markthochlauf stockt

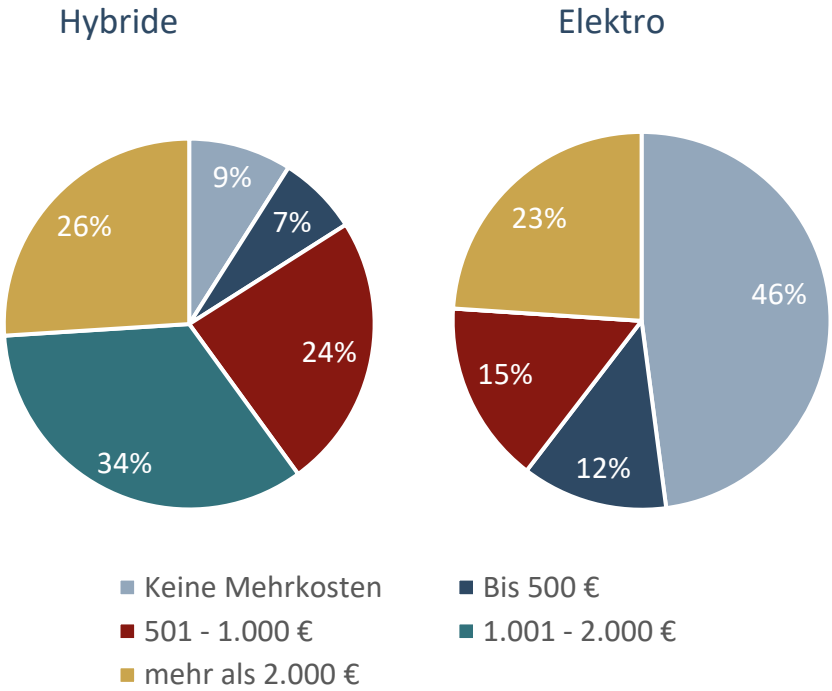
Sparsam ist gefragt.*

Frage: *What is the fuel economy you will expect in your new car as an average range of liter per 100 km?*



E-Autos: Nur ohne Mehrkosten*

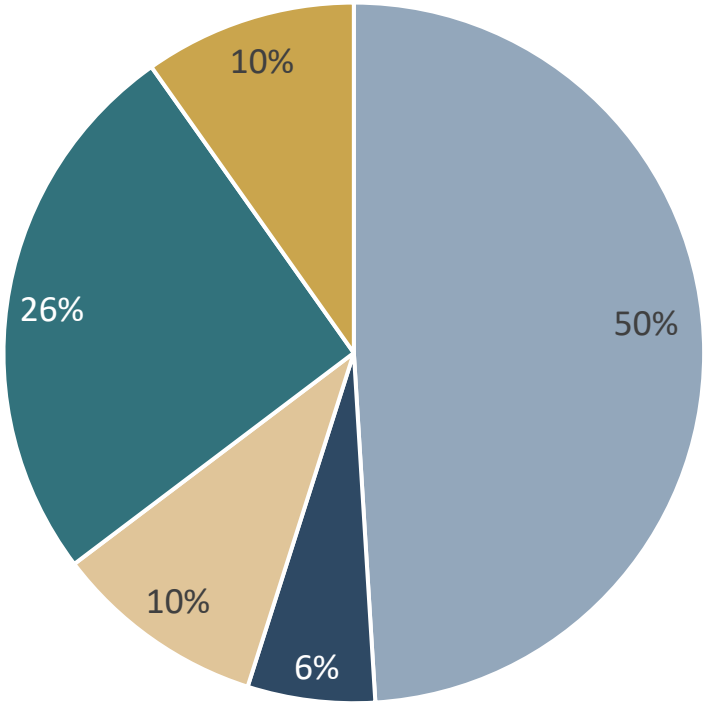
Frage: *How much would you be prepared to pay for a hybrid drive / electric drive?*



* Befragung von 1.500 Neuwageninteressenten in den drei größten Märkten Europas
Quelle: PwC

Lithium: Batteries dominate demand

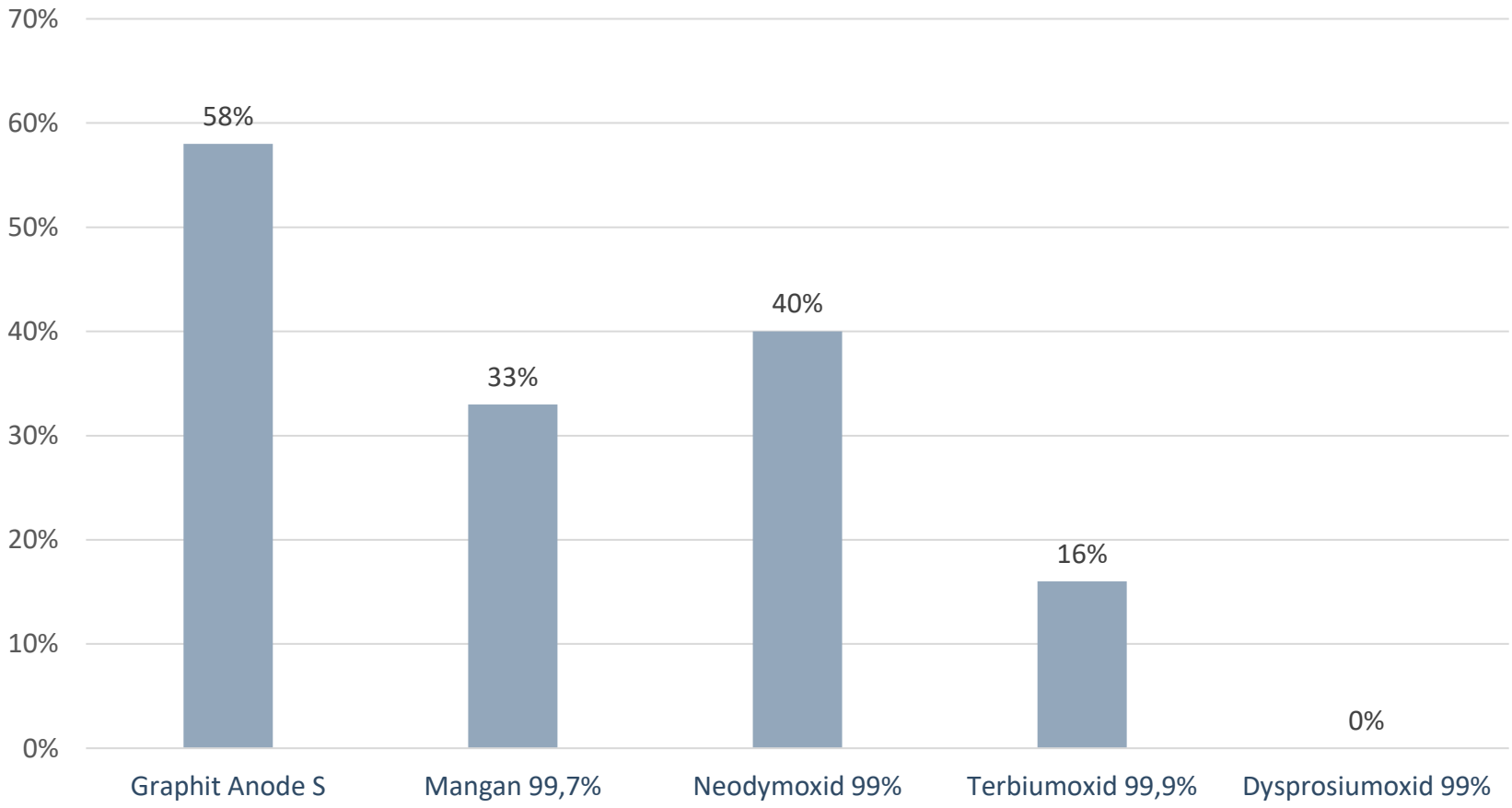
Demand for lithium in the year 2016 according to specific application



Source: Bloomberg Intelligence, 2017

Relevant raw materials increase in price

Change in prices from January 2017 to March 2018 in per cent

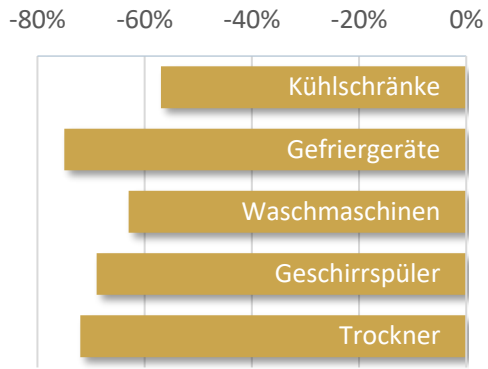


Source: MBI E-Mobility Materials, Nr. 13 2017

Ökodesignrichtlinie: Verbot von starken Stromverbrauchern

Der Energieverbrauch von Haushaltsgeräten ist zwischen 1999 und 2014 stark gefallen.

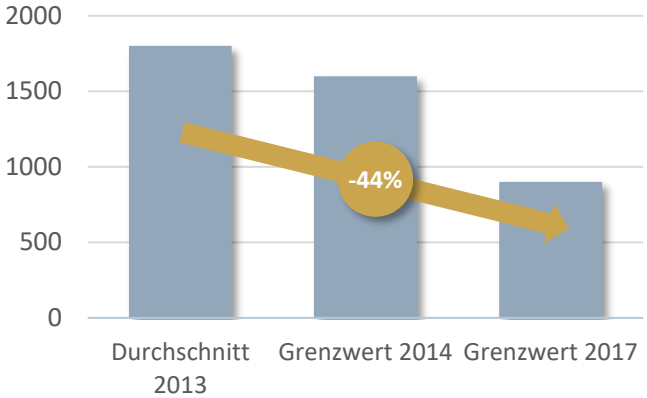
Energieverbrauchssenkung
bis zu … Prozent



Verbreitung in Europa
auf 100 Haushalte kommen … Geräte

Die Ökodesignrichtlinie führt zum Verbot von Stromfressern.

Stromaufnahmeleistung von Staubsaugern
in Watt



- Die Ökodesignrichtlinie legt Anforderungen für energieverbrauchsrelevante Produkte fest.
- Ein Produkt, welches zu viel Strom verbraucht, darf nicht mehr ausgeliefert werden.
- Die Effizienz des Ansatzes ist umstritten. Strom unterliegt bereits dem Emissionshandel und der Beitrag durch effizientere Haushaltsgeräte ist gering.
- Der Verkauf von Lagerbeständen bleibt zulässig. Dieses Schlupfloch führte zum Hamstern von Glühbirnen.

Quellen: Bosch, Odyssee Database 2014

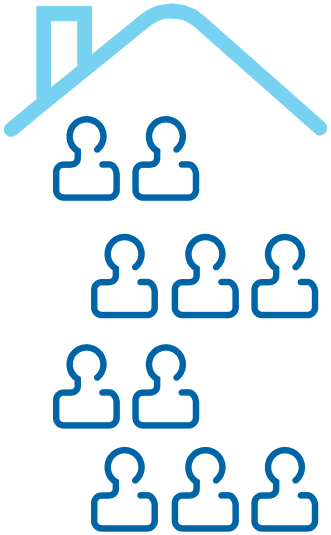
Viel Potenzial für relativ geringe Kosten

Beispielfall

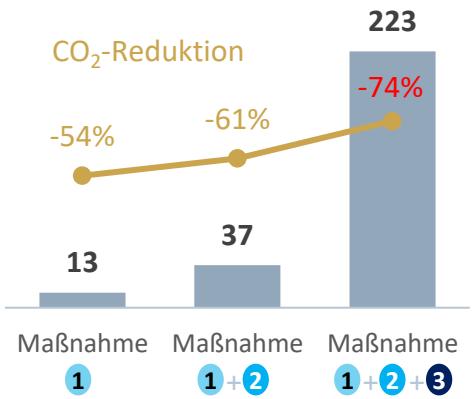
Mehrfamilienhaus
Baujahr 1972

Fläche:
62.030 m²

Finanzierung:
Zinssatz 4%
über 15 Jahre



Vermeidungskosten pro Tonne CO_2
in Euro



1 Umrüstung von Nachtspeicher auf Zentralheizung

2 Zentrale Trinkwasserwärmung

3 Komplette Bausanierung

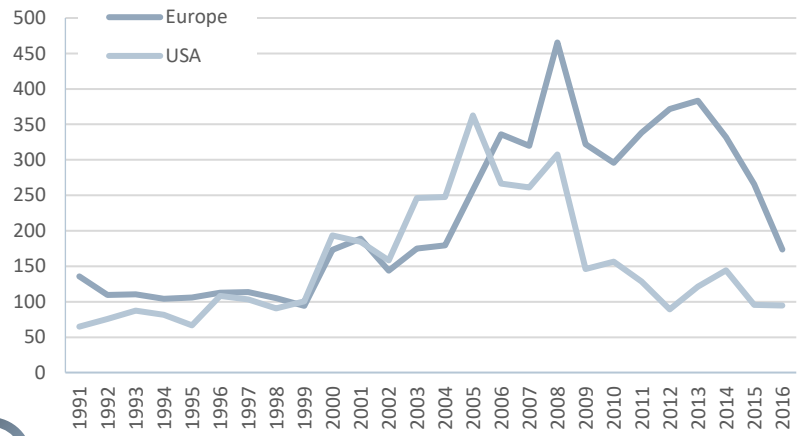
- Vermeidungskosten sind immer Ergebnis einer Einzelfallbetrachtung.
- Es gilt das Prinzip der fallenden Grenzerträge: Je mehr man einspart, desto teurer wird der nächste Schritt.
- Problem: Vollsanierungen lohnen sich ohne Förderung nur selten. Auch energetische Sanierungen scheitern oft an den Kosten.
- Folge: Das Tempo der energetischen Sanierungen ist zu gering. Es müsste etwa verdoppelt werden, um die Ziele der Politik bis 2020 zu erreichen.

Quelle: Hochtief, 2012

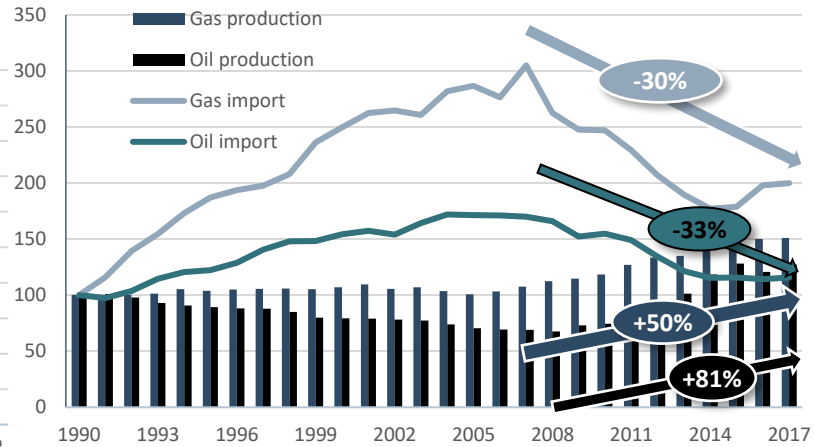
Fossil energy in the USA

Fracking has changed the rules of the game

Gasprice
in US-$ per 1,000m³



US production and import of oil and natural gas
Index, 1990 = 100

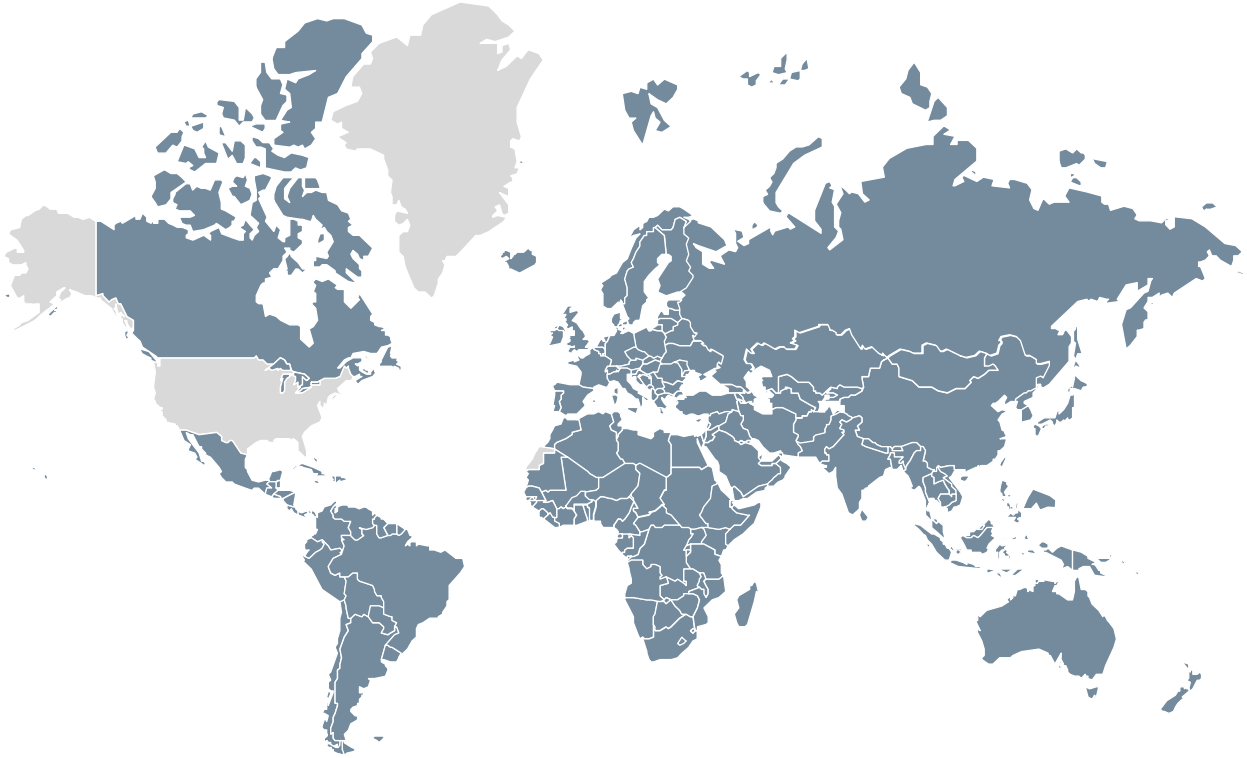


- Fracking has strongly impacted the world market for fossil fuels.
- Favourable: The Gas price sank since 2005 clearly under the European level.
- The USA has greatly increased its domestic production of oil and natural gas.
- Independency: This greatly reduced the USA's need to import fuel.

Sources: Weltbank, Economic Monitor (GEM) Commodities, 2017; IEA, World Energy Statistics, 2018

Kyoto-Protocol

Only Europe really joined in

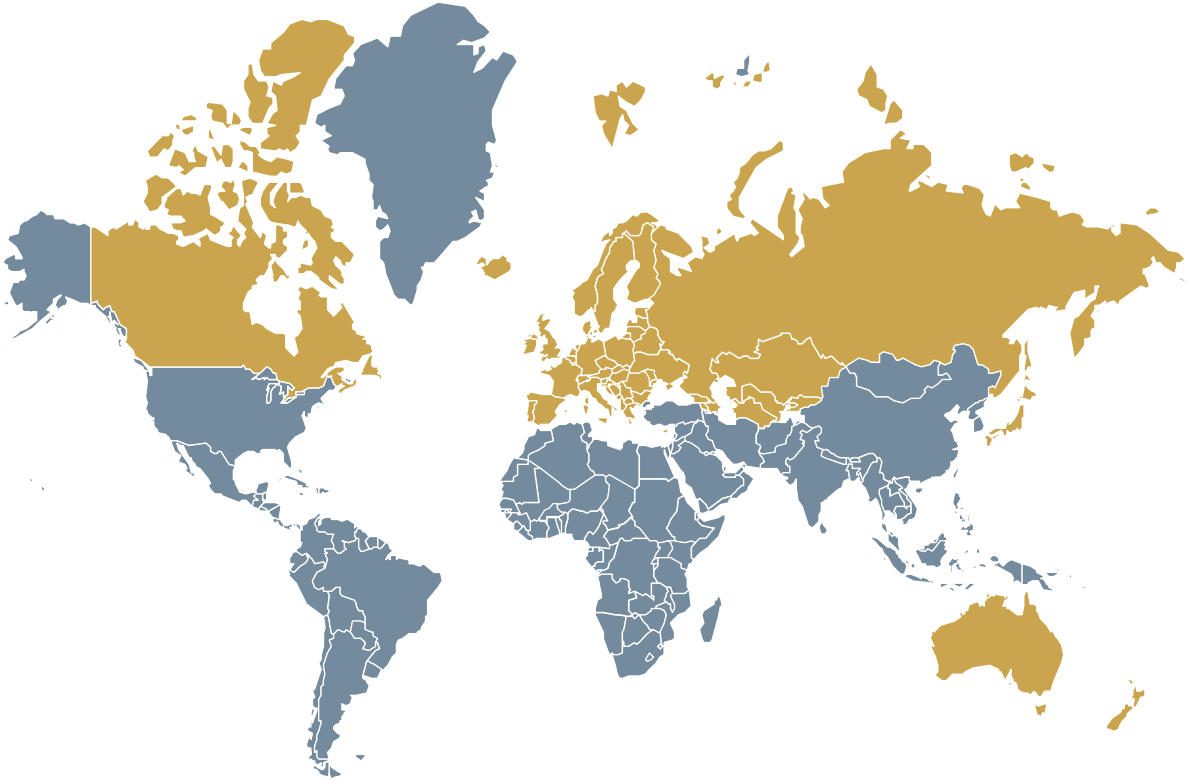


Kyoto signatories

Almost all of the world's nations entered into the Kyoto agreement.

Kyoto-Protocol

Only Europe really joined in



Kyoto signatories
with emission target

- Almost all of the world's nations entered into the Kyoto agreement.
- Only a few countries accepted emission targets.

Kyoto-Protocol

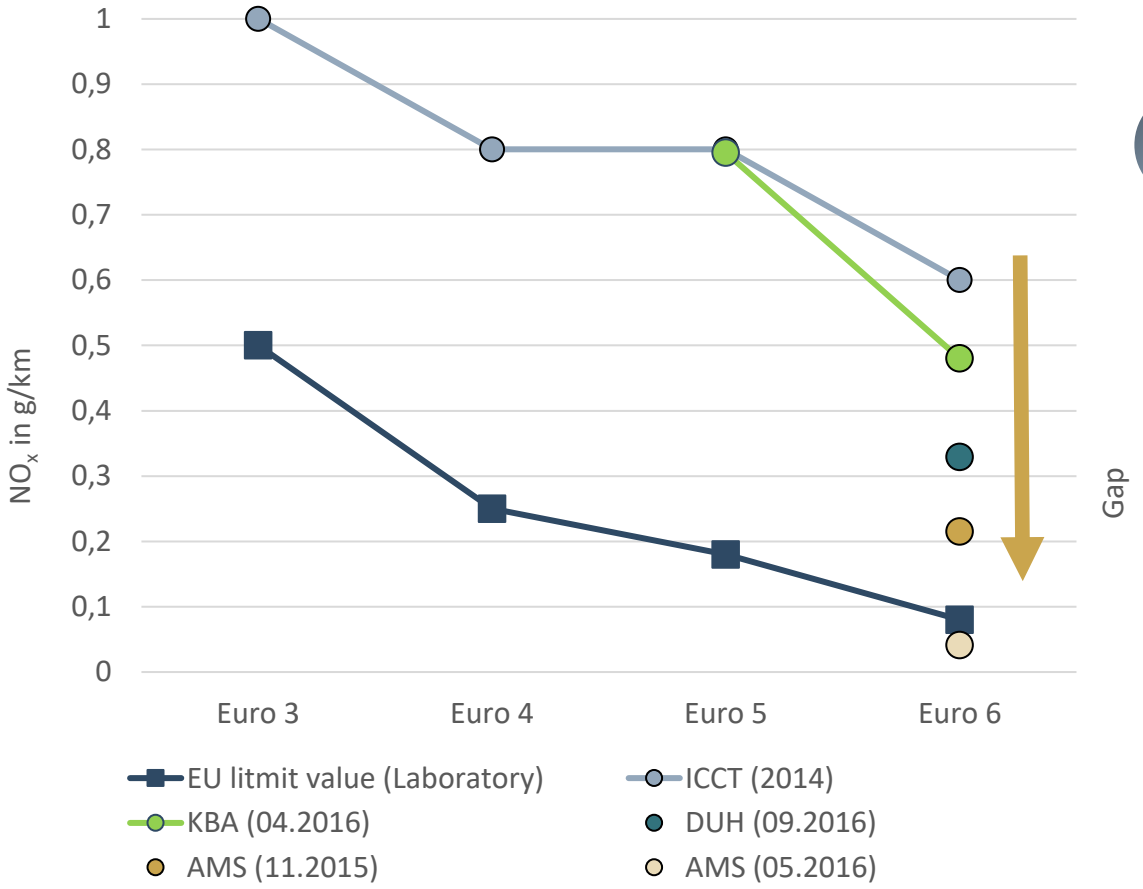
Only Europe really joined in

Kyoto signatories
who kept their emission target

- Almost all of the world's nations entered into the Kyoto agreement.
- Only a few countries accepted emission targets.
- Soft targets, in some cases: countries of the former Eastern bloc merely aimed to not exceed their figures from 1990.

Real-Driving-Emissions NO_x – Fast progress

The gap between RDE and laborotory is closing



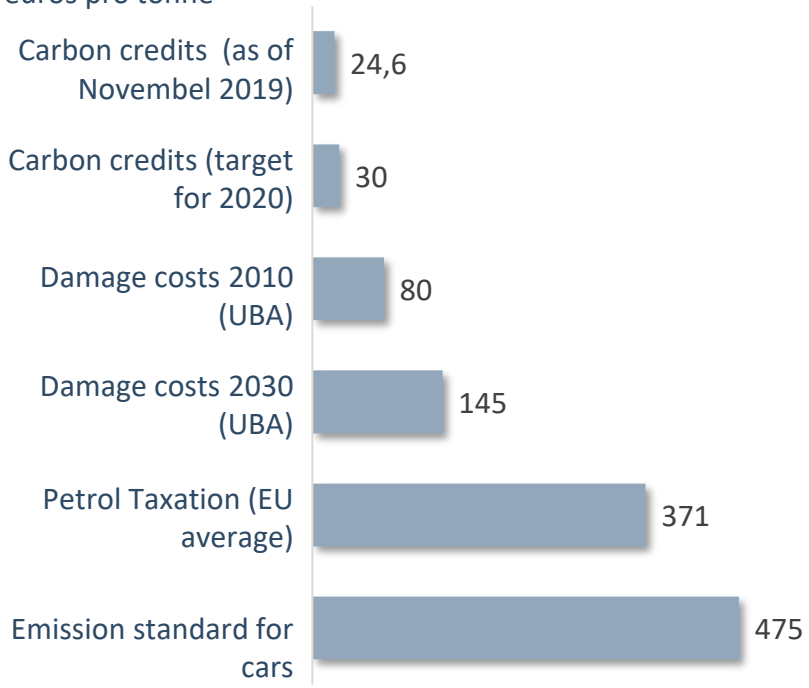
The first RDE tests of passenger cars were conducted in 2014.
The performance of the up to date cars in RDE tests is much better.
The Values taken from AMS show the same model with two engine generations
The technology to meet the limit values is on the market.

Sources: ICCT, 2014; Kraftfahrtbundesamt (KBA), 2016, Deutsche Umwelthilfe (DUH), 2016, Auto Motor Sport (AMS), 2015; Auto Motor Sport (AMS), 2016; Bosch

CO_2 from cars comes at a high cost in the EU

A penalty of 95 euros will apply for each gram that exceeds the target, for each vehicle sold. This corresponds to approximately 475 euros per tonne of CO_2

CO_2-Prices
in euros pro tonne



Sources: EU, UBA, Weekly Oil Bulletib, own calculations

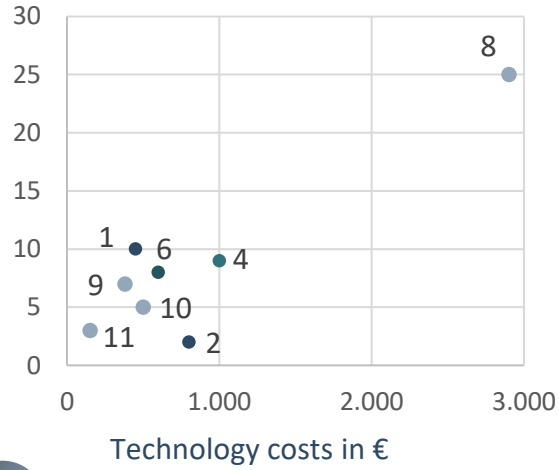
- From 2021, full penalty fees will apply to car manufacturers who do not reach their specific target.
- If a car drives 200,000 km, a reduction by 1g/km corresponds to an emissions reduction of 200 kg over the life of the vehicle.
- Based on this assumption, the manufacturer will pay a penalty of 475 euros per tonne of CO2.
- This cost is considerably higher than what others have to pay.

The potential for further reduction exists but is becoming harder to achieve

Research | Pre-development | Series development | Series

Petrol engines (compact class)

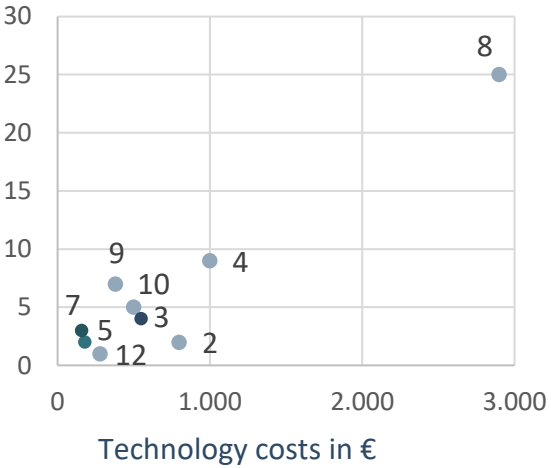
CO_2 reduction potential in %



1	HCCI
2	Thermoelectric generator
3	Variable compression
4	Lightweight construction (comprehensive)
5	Improved EGR
6	Direct injection w/ stratified charge
7	Cylinder deactivation
8	Full hybrid
9	Micro-hybrid
10	Dual clutch transmissions
11	Homogeneous direct injection
12	Fully variable valve control system

Diesel (compact class)

CO_2 reduction potential in %



- Due to the technologies needed for boosting efficiency, new vehicles will cost approximately 2,700 euros more in 2020.
- This expense will be offset, however, by savings resulting from lower fuel consumption. These savings are spread across the entire life of the vehicle (17 years on average); so, the first customer will only enjoy part of this benefit but will carry the full cost of the new technologies when purchasing the vehicle.

Source: IKA Aachen