Current Global Fuel Economy Levels and Projections

Pierpaolo Cazzola

Africa Clean Mobility Week

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GFEI is a major pillar of global action on transport efficiency

- **Partnership between 6 organisations that promote research, discussion and action to improve fuel economy worldwide**

- **Action so far focused so far primarily on LDVs**

  The initiative has a **target of improving average fuel economy of new LDVs by 50% between 2005 and 2030**, worldwide

- **Scope of work now including EVs and broadening to trucks**

Transport Analysis at the IEA building on

- The IEA **Mobility Model (MoMo)** & the partnership of stakeholders supporting it

- The leading role assumed by the Agency in the **Electric Vehicle Initiative (EVI)** of the Clean Energy Ministerial (CEM)

Electric Vehicles Initiative

- The long-standing engagement in the **Global Fuel Economy Initiative (GFEI)**

GFEI

- This enabled significant outputs, including:
  - The Future of Trucks
  - Global EV Outlook 2017
  - Nordic EV Outlook 2018
  - GFEI benchmarking analyses

IEA engagement in GFEI

- The GFEI message fully aligned with IEA message on energy efficiency (first fuel, need to scale up)
- The GFEI target was largely based on IEA scenario analysis

Focus on the GFEI fuel economy benchmarking analysis

- Aiming at monitoring developments against GFEI target over time
- Comprehensive compilation of global data
- Covers more than 80% of the global car market
- Information available for 2005, 2008, 2010-15
- 5th edition published in 2017
- Work on 6th edition starting

Progress against GFEI target for LDVs

Source: GFEI Working paper 15

			2005	2008	2010	2012	2014	2015	2030
OECD & EU average	average fuel economy (Lge/100km)		8.8	8.2	7.8	7.6	7.4	7.3	
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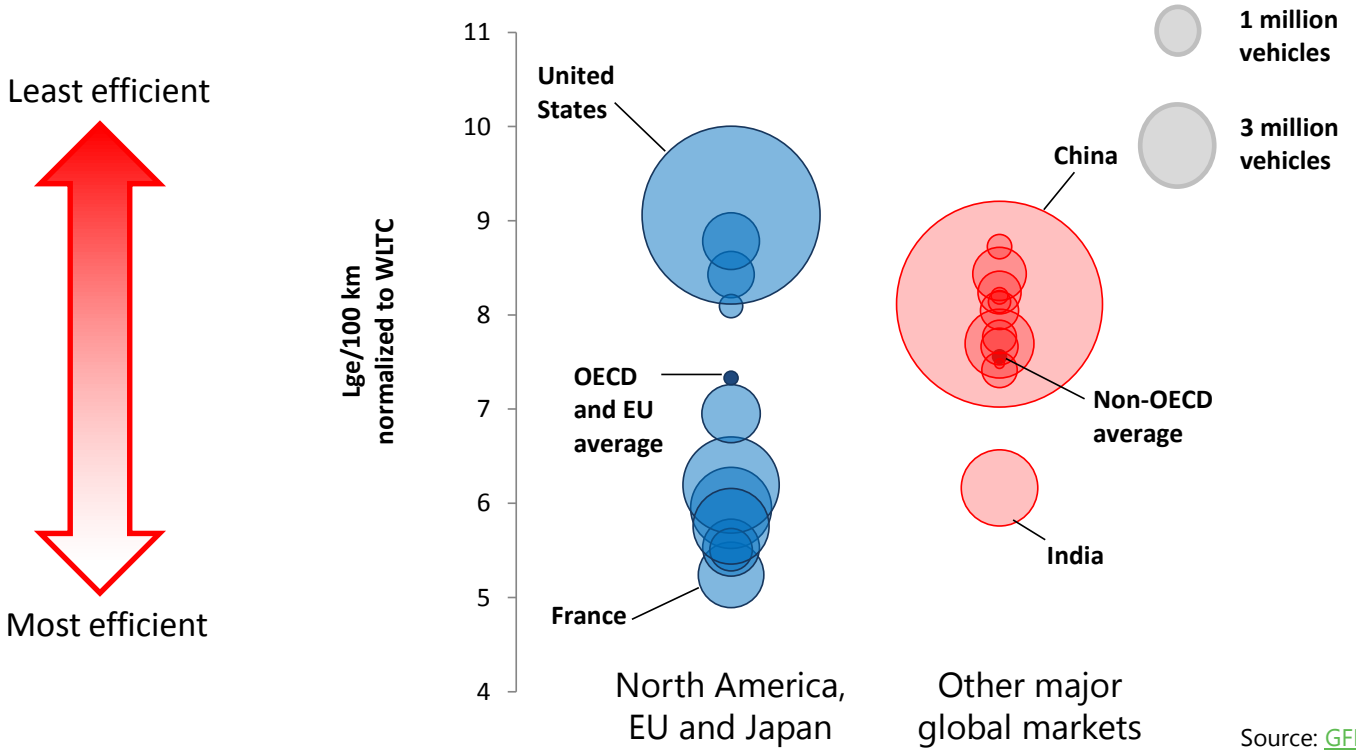
		2015 base year						**-3.7%**	

The **latest GFEI data update** shows that **improvements slowed down in OECD in recent years**
Despite an acceleration in fuel economy improvement in some non-OECD markets,
we are still far from meeting GFEI improvement targets

Fuel economies are heterogeneous across markets



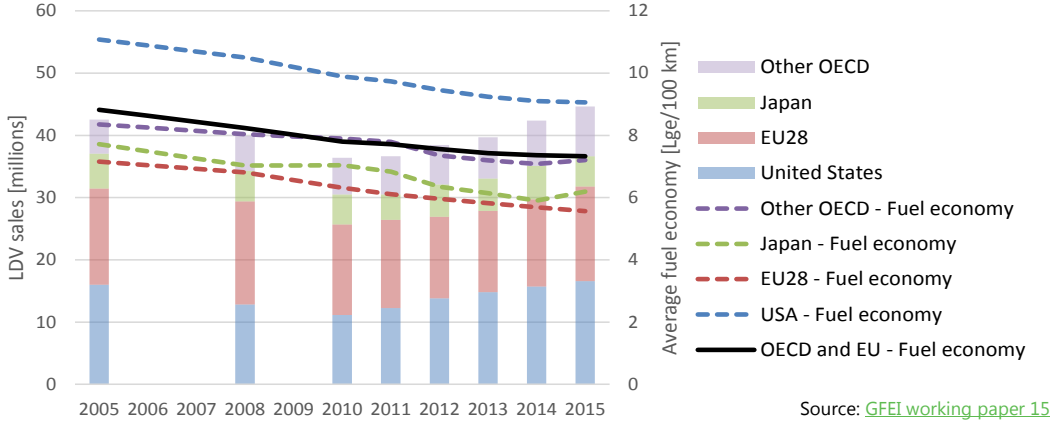
Source: GFEI working paper 15

Values influenced by income, fuel taxes, vehicle taxes, consumer preferences, policy context
North America & EU/Japan: both most efficient (lower cluster) and least efficient (upper cluster)

Recent trends show important changes

North America, EU and Japan

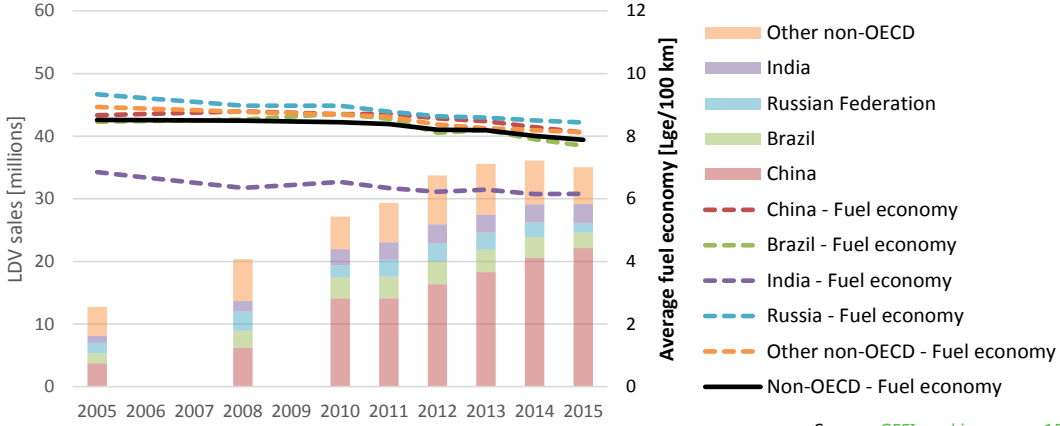
- Trend reversal in Japan in 2014-15
- Market share of North American vehicles growing



Source: GFEI working paper 15

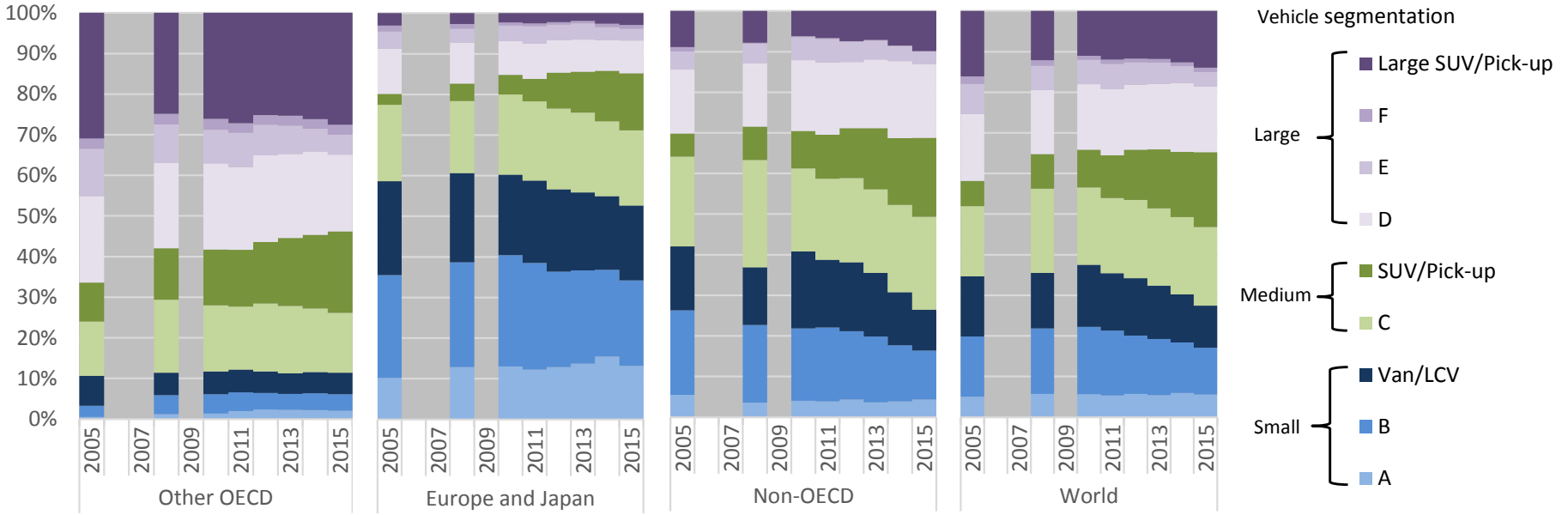
Other markets

- Market share of non-OECD markets with fuel economy policies (China and Brazil) growing
- Limited spillover effects



Source: GFEI working paper 15

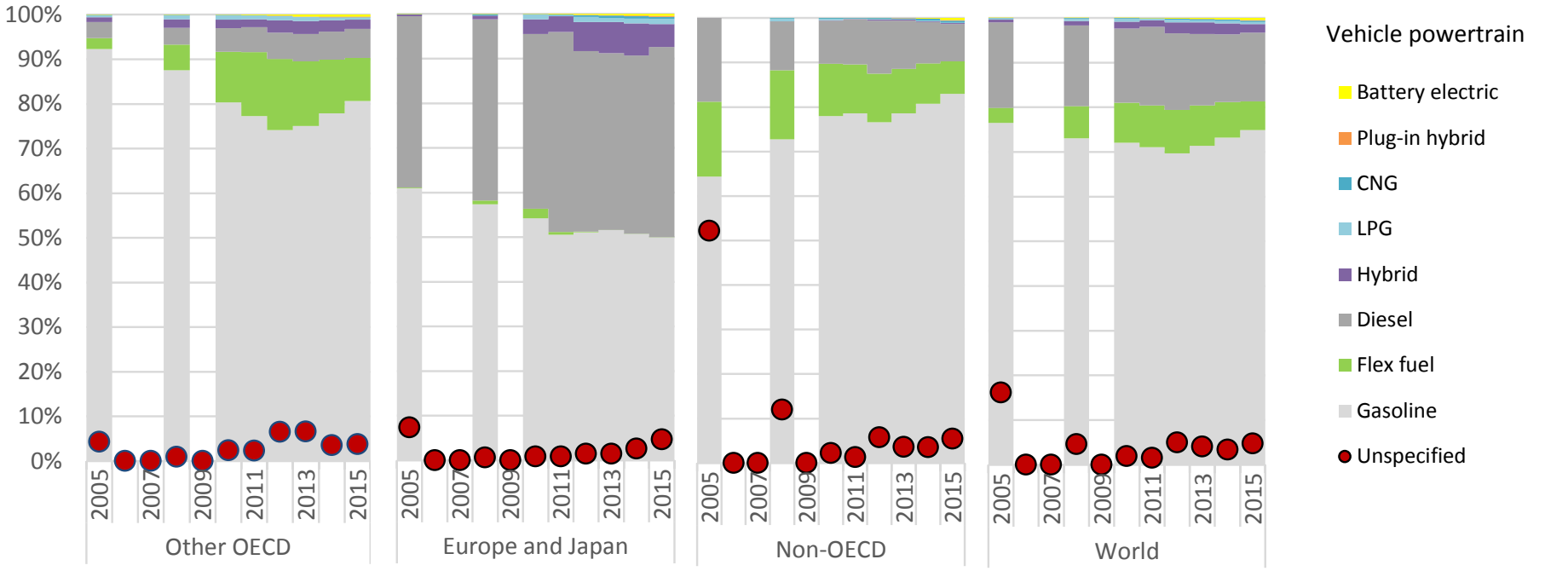
Cars are getting bigger



Source: GFEI working paper 15

Crossovers (medium-sized SUVs and pick-ups) have experienced significant growth across all countries: their market share has tripled over the past decade

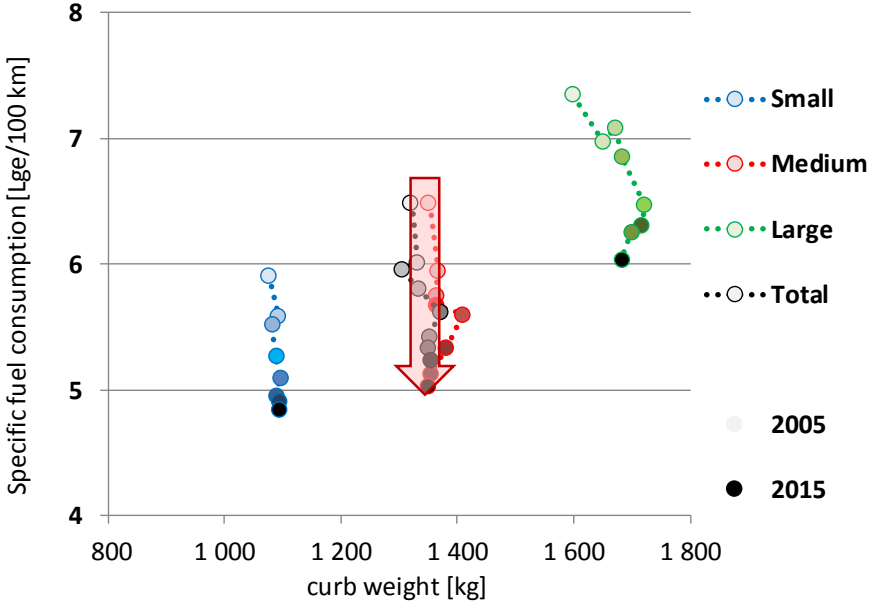
Local factors influence powertrain choices

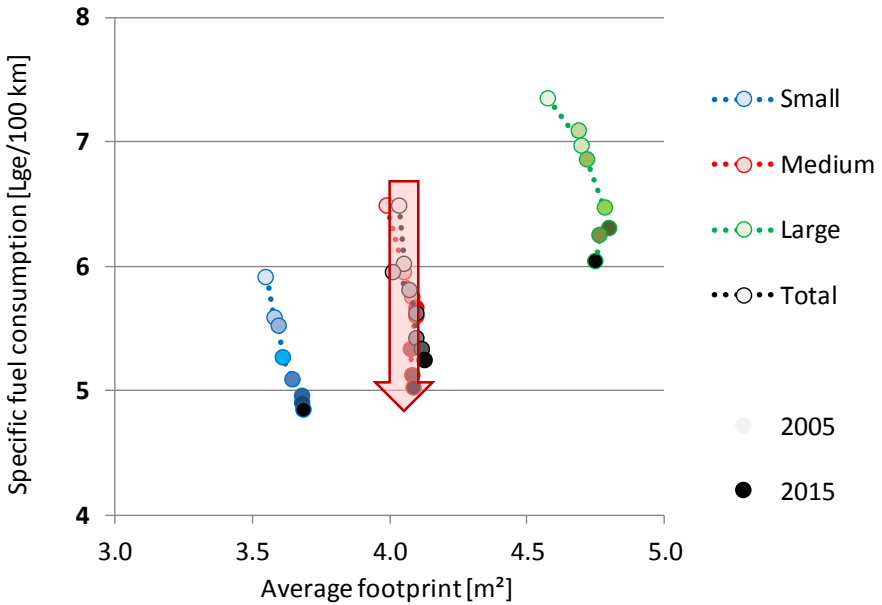


Source: GFEI working paper 15

Challenges to meet air quality policy targets started impacting significantly diesel shares after 2015
Several OEMs announced the phase out of diesels (very recent development)

Policies matter - Case 1: France

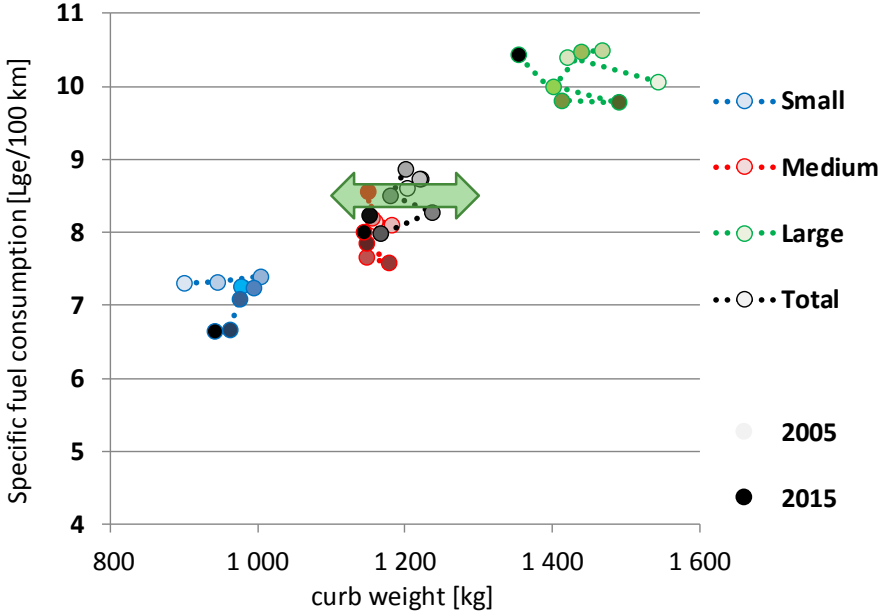


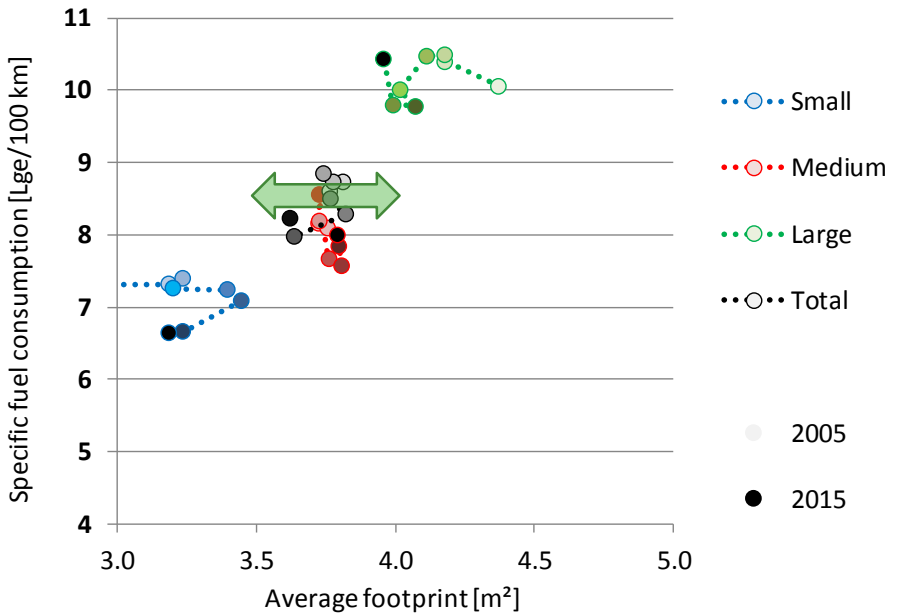


Source: GFEI working paper 15

Stringent fuel economy regulations in place, as well as monetary incentives (feebate, differentiated vehicle taxation based on CO_2/km), resulted clearly in an improving trend over the past decade

Policies matter - Case 2: Indonesia

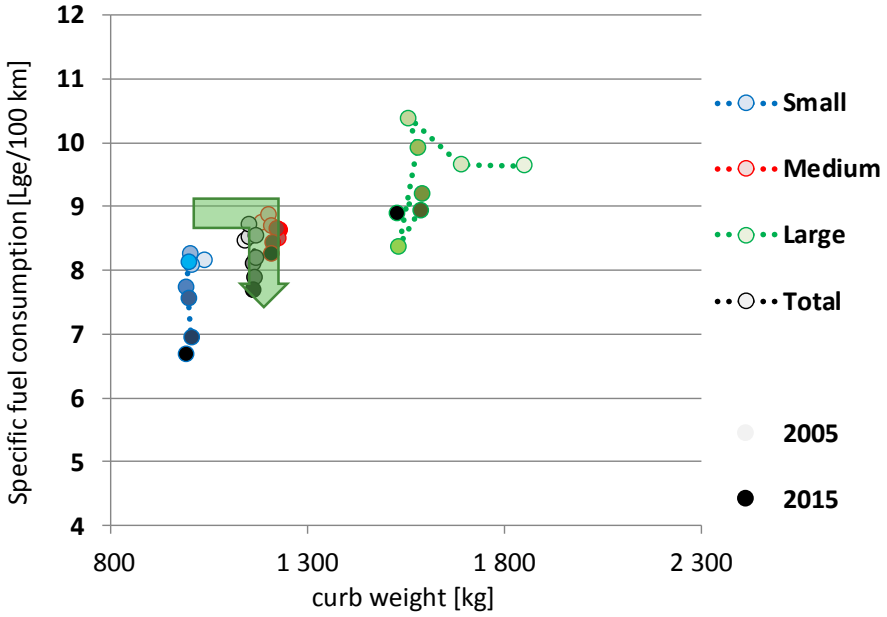


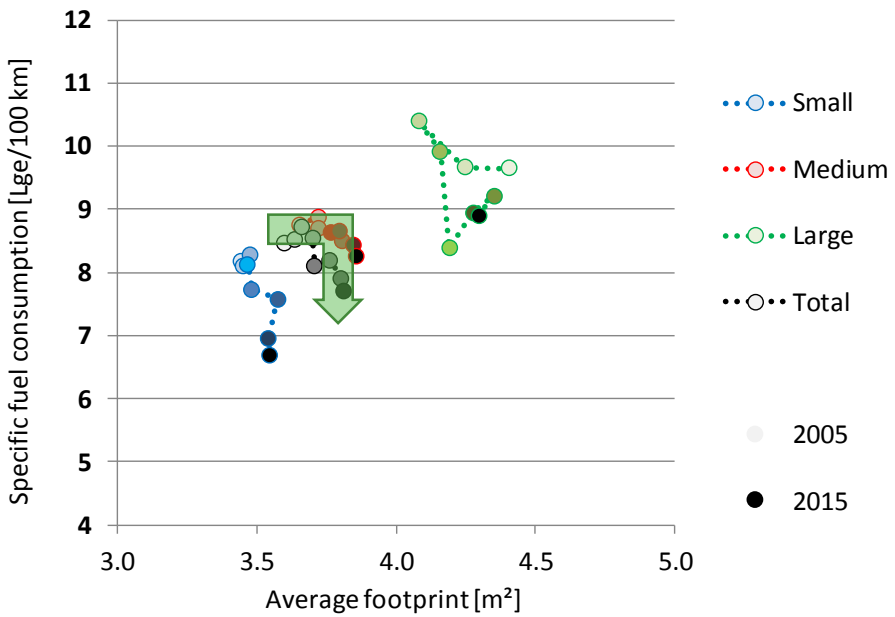


Source: GFEI working paper 15

No fuel economy regulations, no monetary incentives up to 2015 resulted clearly in stagnating fuel economies

Policies matter - Case 3: South Africa





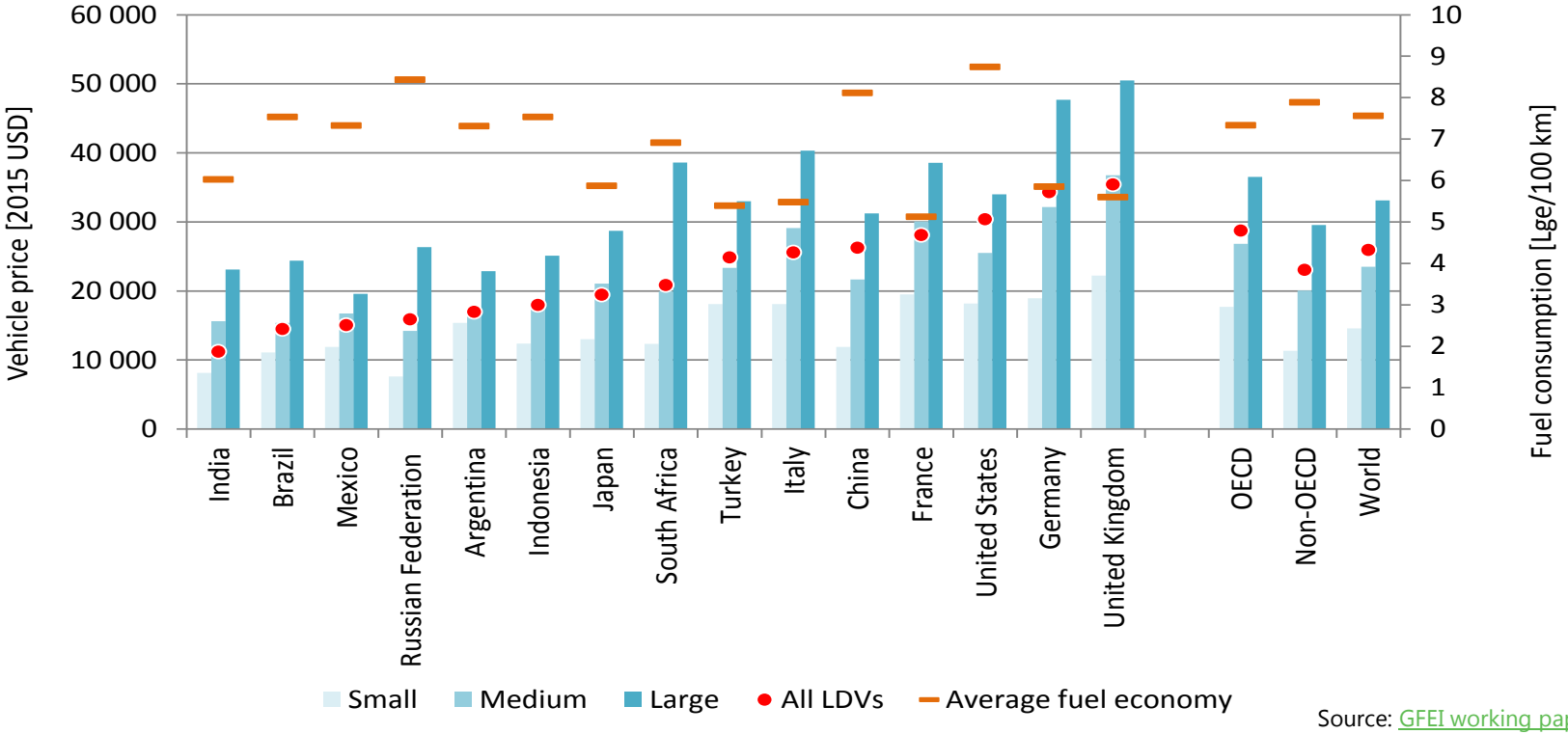
Source: GFEI working paper 15

No fuel economy regulations, monetary incentives since 2010 resulted in a significant change in trend

Key messages on the role of policy

- Ambitious policy frameworks can effectively improve fuel economy and limit carbon emissions of cars
- Fuel economy policies had little effect on the weight or size of vehicles
- Differentiated vehicle taxation demonstrated a good capacity to improve fuel economies, even in the absence of regulatory measures
- In the absence of policies, the tendency for most vehicle attributes (including fuel use/km is to stagnate)

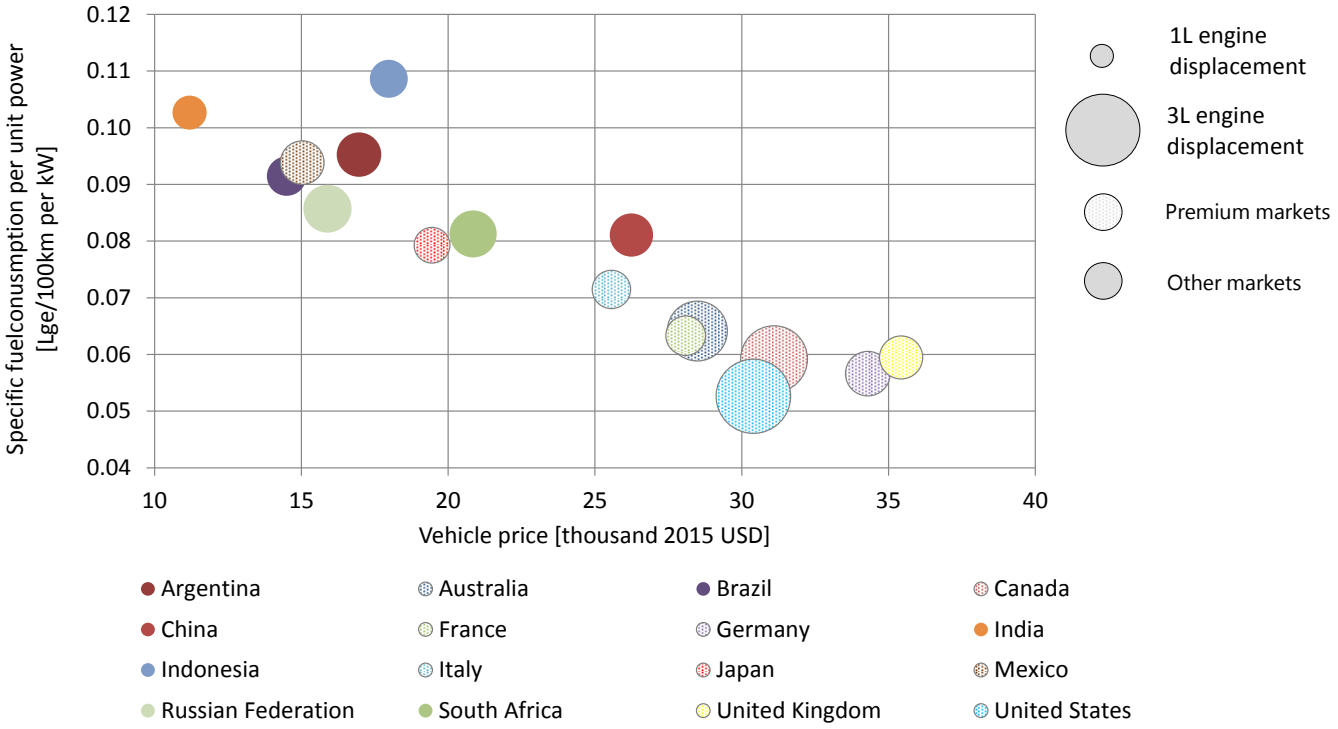
How about vehicle prices?



Source: GFEI working paper 15

There is a wide variation between top (USA, Europe) and bottom (India, Brazil, Mexico)

How about vehicle prices?



Source: GFEI working paper 15

LDVs sold in premium markets (often more expensive - light shading bubbles) use less fuel/km (at same power) than those marketed in other markets (full shading bubbles)

So… are fuel economy regulations increasing car prices?

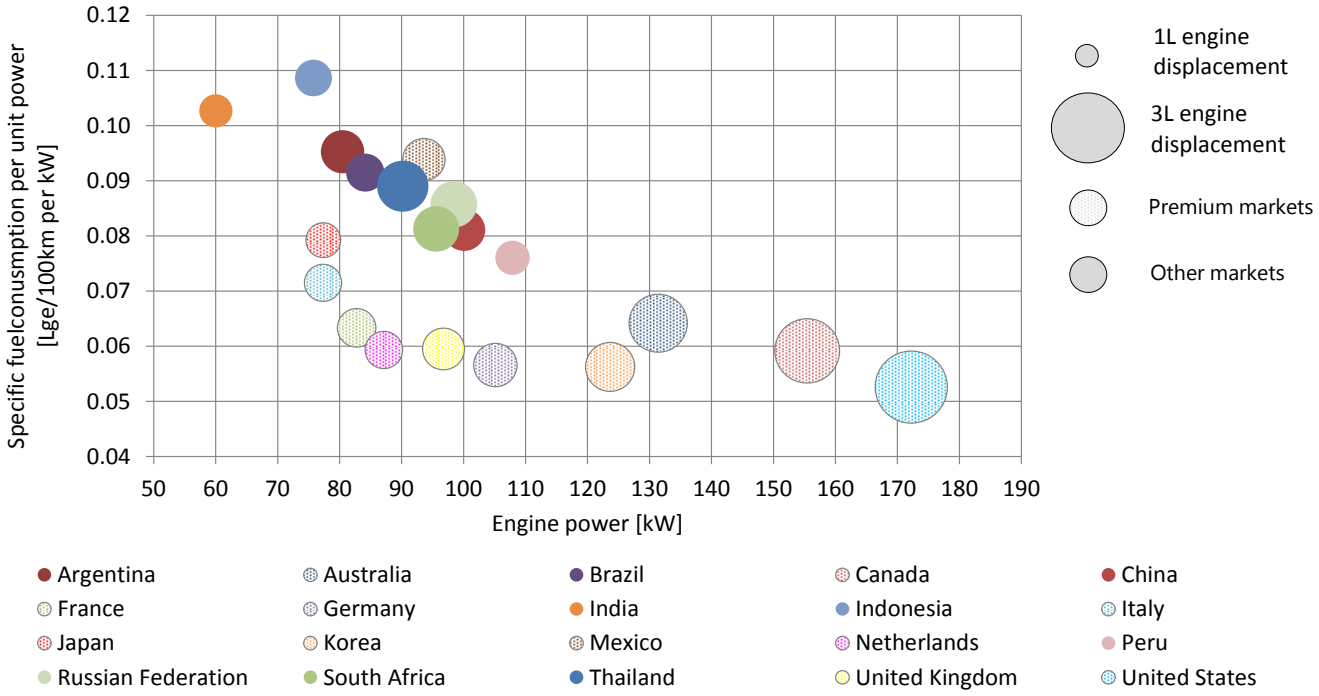
- LDVs sold in premium markets use less fuel/km (at same power) than those marketed in other markets

- **However, average vehicle prices are not strongly driven by fuel economy parameters, but rather by a much wider range of attributes**

- LDVs in the OECD are on average
  - 33% more expensive
  - 65% more powerful
  - 38% heavier and
  - with a 22% larger footprint

  … than those sold in non-OECD countries, but
  - they are only consuming 7% less fuel per 100 km

Power rating vs. fuel consumption per unit power



Source: GFEI working paper 15

LDVs sold in premium markets (light shading bubbles) are often more powerful, in absolute terms, than those marketed in other markets (full shading bubbles)

Key insights on fuel economy and prices

- Price is important for technology deployment
- Powertrain technologies are a strong determinant of average fuel economy
- Price and technologies are not enough to explain price and fuel economy differences across regions: other vehicle attributes matter
- Vehicles in larger vehicle segments and power classes are typically prices well above others

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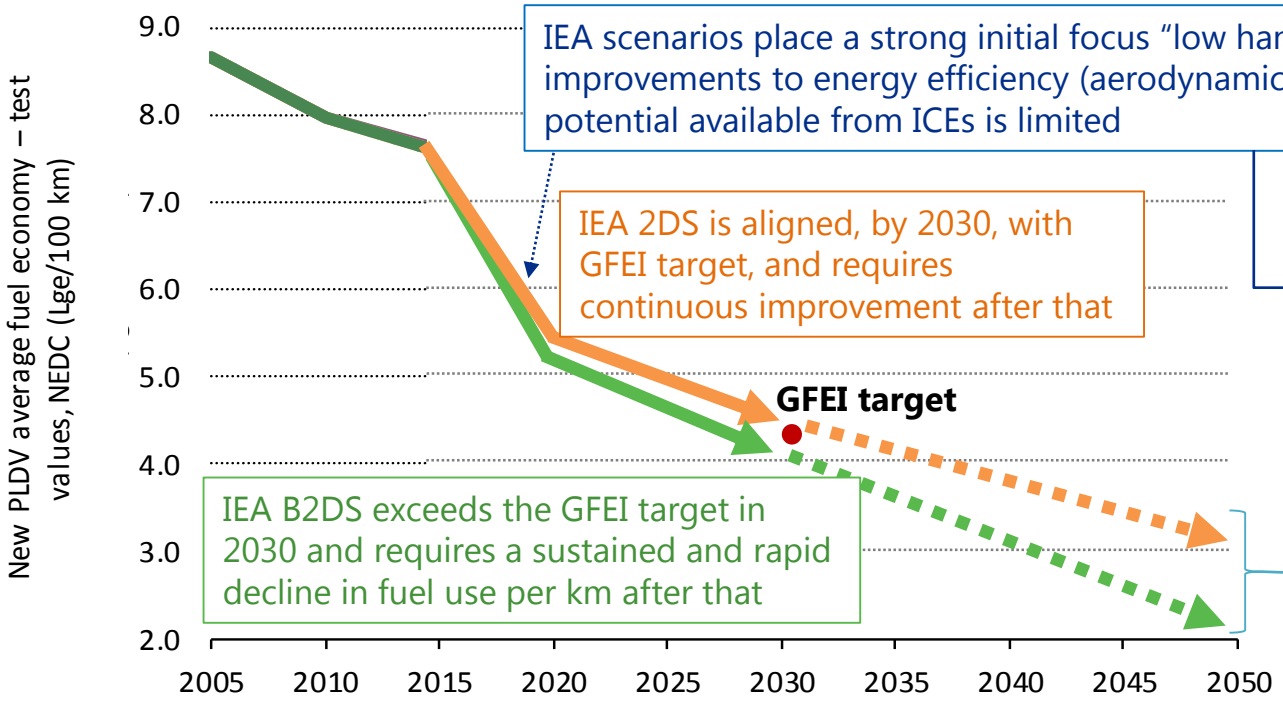
- Higher fuel use per km and price in premium markets (Australia, North America) are coupled with high vehicle power, weight and footprint
- Comparing Europe/Japan to other markets (similar vehicle size) shows that fuel economy differences are largely imputable to technological gap, and may be coupled with a price gap

LDV fuel economy projections in IEA scenarios



IEA scenarios place a strong initial focus "low hanging fruits". i.e. incremental improvements to energy efficiency (aerodynamics, ICE improvements…), but the potential available from ICEs is limited

IEA 2DS is aligned, by 2030, with GFEI target, and requires continuous improvement after that

IEA B2DS exceeds the GFEI target in 2030 and requires a sustained and rapid decline in fuel use per km after that

Is this feasible?
Need for clear policy driver already, otherwise the product line-up from automakers in unlikely to be ready

Is this feasible?
Need to deploy significant shares of ZEV, already in 2030, to enable this type of development after that

Source: IEA analysis based on scenarios developed for the *Energy Technology Perspectives 2017* report

Achieving the GFEI target needs to build on incremental improvements (lower cost), but the potential available from ICEs is limited: achieving the clean energy transition requires the deployment of ZEV

Conclusions

- Fuel economy improvement rates were well below the rate of improvement required to meet the 2030 GFEI target*
- Country-level results show that fuel economy policies can deliver effective fuel economy improvements
- Achieving fuel economy reductions may be easier if efforts are focused on larger vehicle segments and power classes (due to higher price, greater capacity to recover costs, greater consumption per km and likely greater mileage): policies including provisions requiring greater relative fuel economy improvements in these classes make sense
- Achieving the GFEI target needs to build on incremental improvements (lower cost), but the potential available from ICEs is limited: achieving the clean energy transition requires the deployment of ZEV
- The struggle of diesels to meet air quality targets and their progressive phase out is also increasing pressure to deploy ZEV earlier
- Continuing to monitor the evolution of international fuel economy is important to understand local and global impacts of policy action (or inaction)

* This analysis focuses on test results, but policies shall also aim to close the gap in fuel economy between test and real-world driving conditions

Thank you

transportinfo@iea.org

Advancing Improvements in Fuel Economy

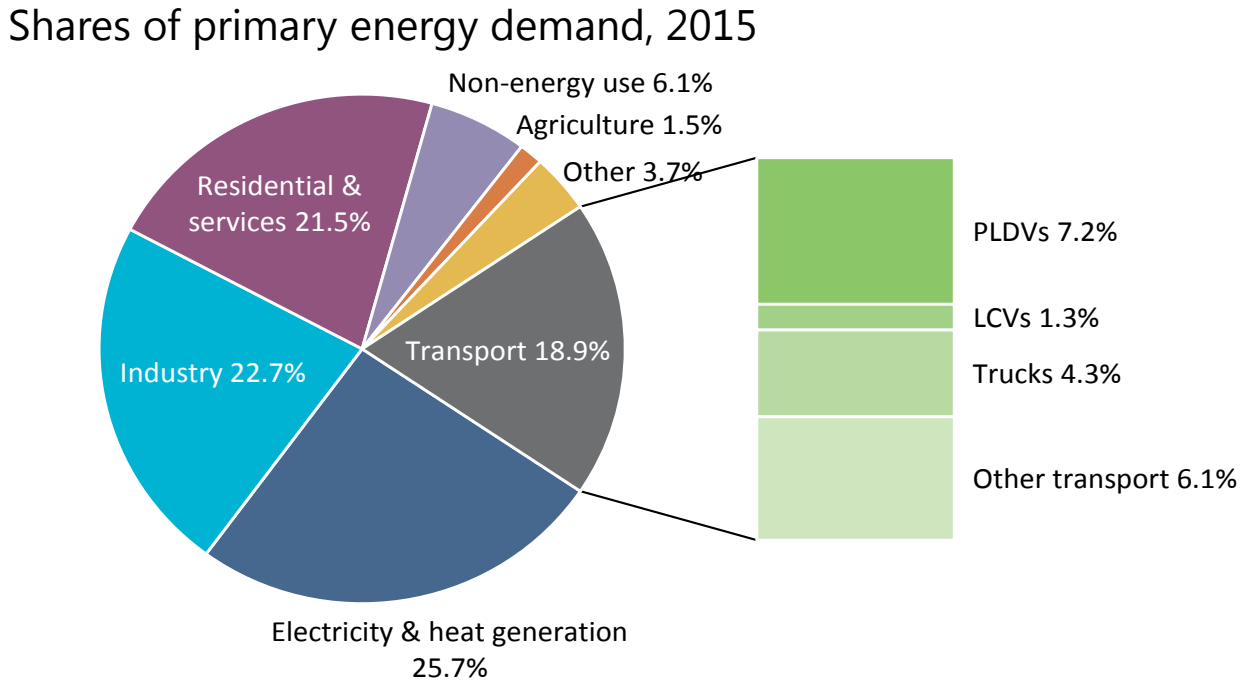
The role of EVs and trucks

Pierpaolo Cazzola

Africa Clean Mobility Week

Nairobi, 12 March 2018

Relevance of cars and trucks for energy use and CO_2

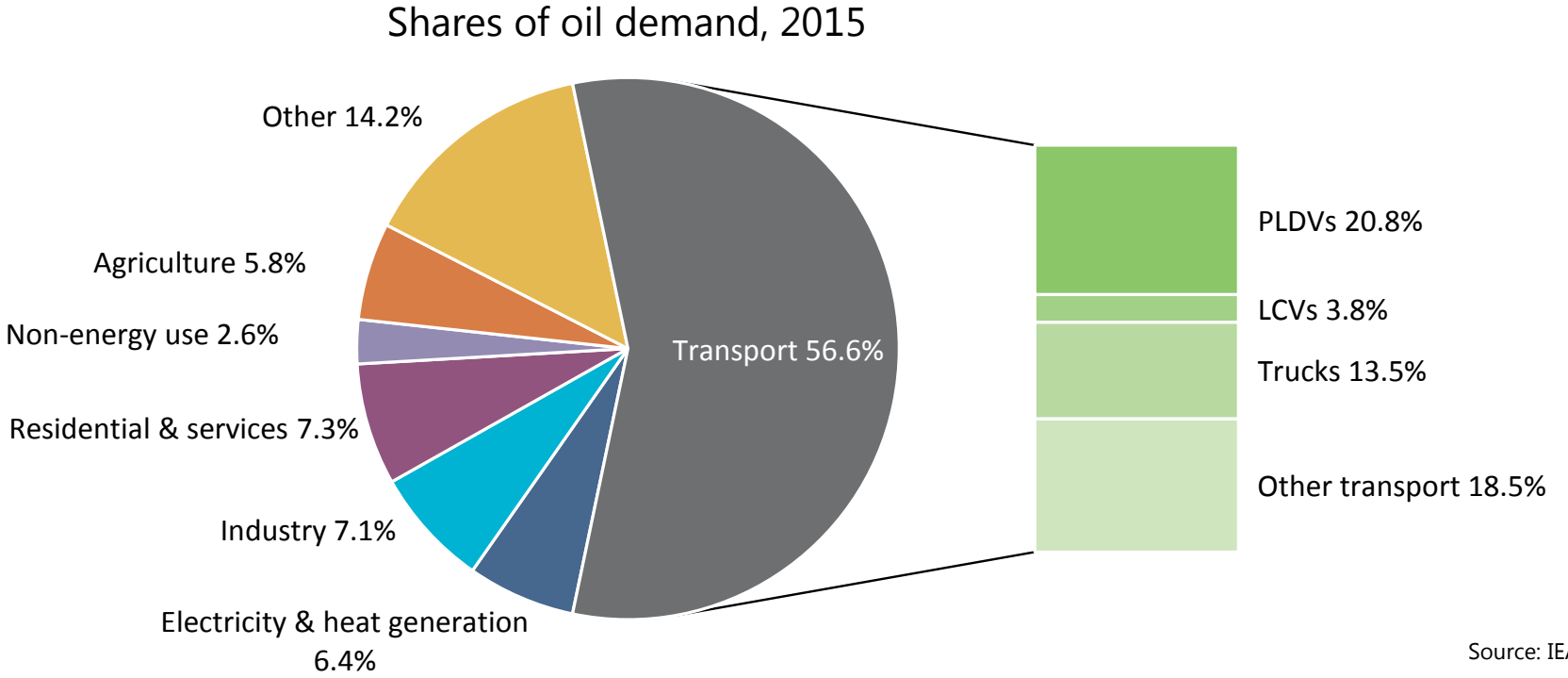


Source: IEA statistics

Transport (excluding fuel production) accounts for nearly 1/5 of primary energy demand and 23% of CO_2 emissions from fuel combustion

LDVs represent 44% of the transport energy use, trucks 23%, and similar shares of CO_2 emissions

Numbers get worse when looking at oil demand



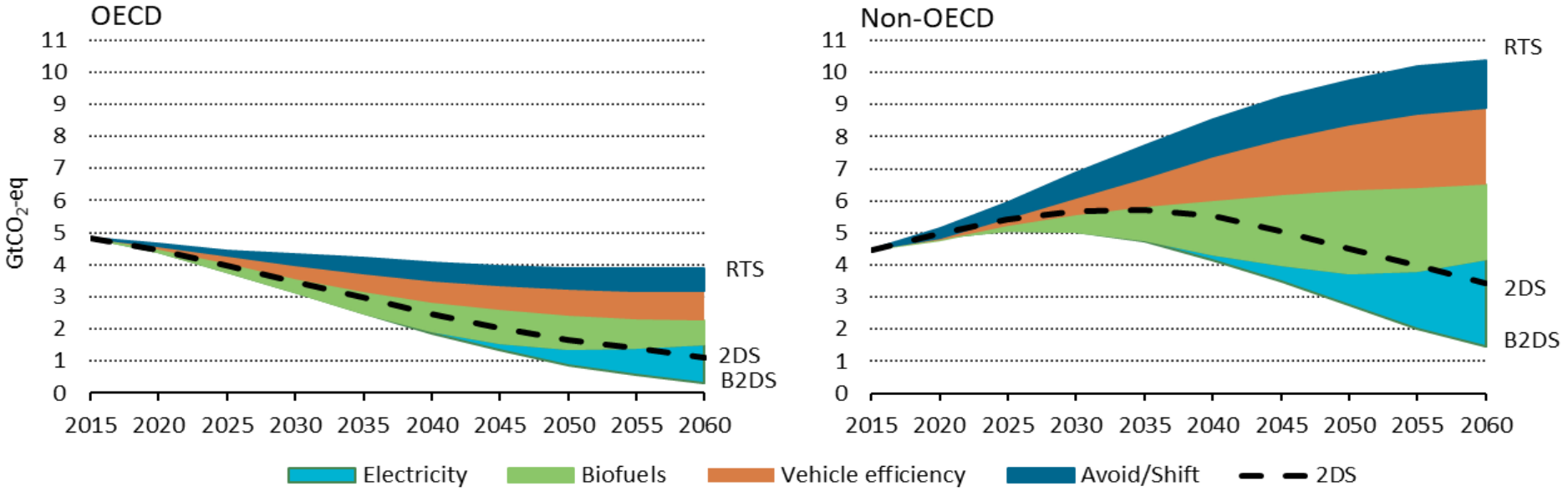
Source: IEA statistics

Transport accounts for 56% of the total oil demand (excluding additional oil use in refining)

LDVs account for nearly a quarter of the global total, and trucks for 13.5%

Future prospects

Well-to-wheel GHG emission in transport, OECD and non-OECD countries, by scenario, 2015-2060



Source: IEA report *Energy Technology Perspectives 2017*

Taking action to improve efficiency is an essential pillar of the IEA scenario allowing to meet the Paris Agreement (B2DS)

WTW GHG emissions are reduced by 90% in the OECD, and 66% in the non-OECD (2015 to 2060)

GFEI is a major pillar of global action on transport efficiency

- **Partnership between 6 organisations that promote research, discussion and action to improve fuel economy worldwide**

- **Action so far focused so far primarily on LDVs**

  The initiative has a **target of improving average fuel economy of new LDVs by 50% between 2005 and 2030**, worldwide

- **Scope of work now including EVs and broadening to trucks**

Progress against GFEI target for LDVs

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Despite an acceleration in fuel economy improvement in some non-OECD markets,
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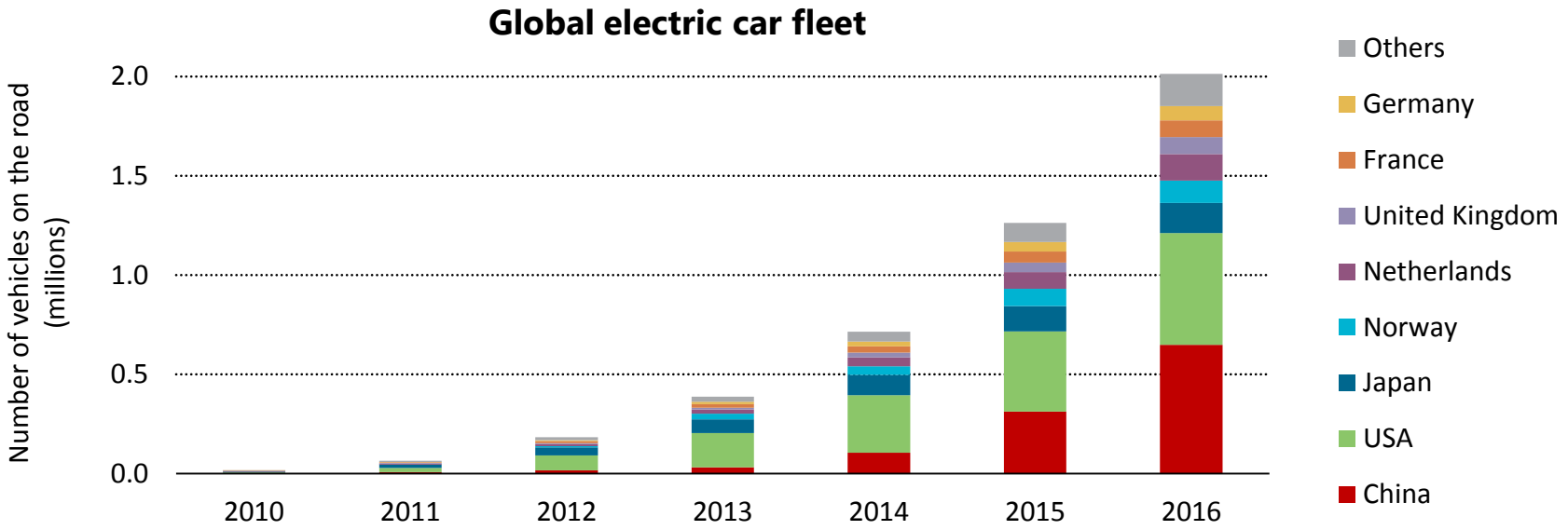
Actions undertaken by GFEI to foster progress

- **Capacity building** for countries interested to develop fuel economy policies
  - Support for **in-country workshops**, **baseline studies** and policy options for governments
  - **Training events**
  - **Networking events** amongst policy makers involved in fuel economy policy developments
  - **Expert guidance**
- **Tracking progress** on average fuel economy globally
  - Monitoring report published every 2 years
- **Outreach and awareness raising** to stakeholders

Embracing EVs in GFEI activities



Source: *Global EV Outlook 2017*

Electric mobility is breaking records…

The global electric car fleet reached 2 million in 2016, and one more million EVs were added in 2017

…but it still represents far less than 1% of the global LDV market

Most electric car sales took place in a few countries having high ambitions and supporting EVs deployment

Policy support remains critical

Embracing EVs in GFEI activities

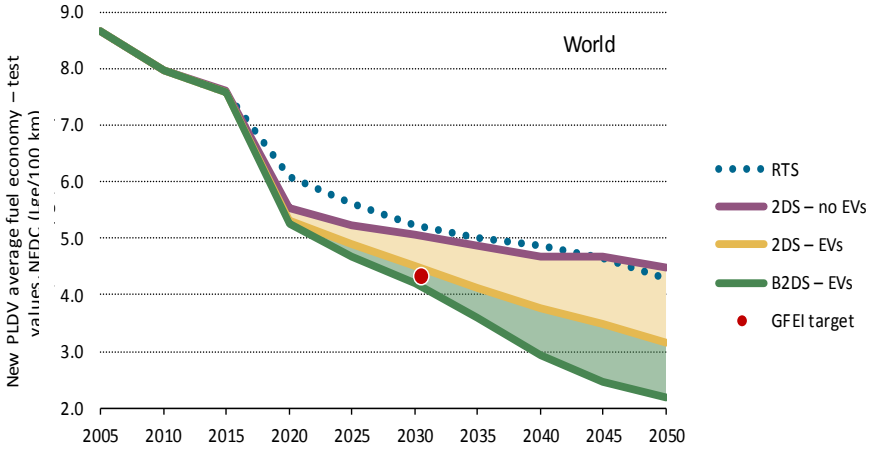
- **The policy context is changing rapidly**
  - **Changes in global test procedures** used to measure fuel economy and pollutant emissions of LDVs make it more challenging to meet regulatory requirements from ICEs
  - Some of the **major global vehicle markets** (China, EU and India) are **adopting policies that clearly support the uptake of EVs**
  - Announcements from governments include **commitments for an EV market share increase in by 2030** (EV30@30 CEM Campaign) and **the ICE phase out in the 2030s/2040s (**France, India, the Netherlands, Norway, the UK)
- **Battery technologies are evolving**
  - Prospects for future developments confirm the encouraging signs in cost and performance improvements observed over the past decade
- **The automotive industry is mobilising investments**
  - Several **OEMs announced plans to deploy EVs**, and a number of them indicated **deployment targets for the 2020 to 2025** time frame

Embracing EVs in GFEI activities

EVs need to play a central role in scenarios meeting the ambition of the Paris Agreement, given

- the **need for a major deployment of zero-emission technologies for LDVs** in 2050
- the **strong decarbonization of the power sector** (already on its way, with 60% of the new power generation capacity added in 2016 coming from renewables and major announcements to abandon coal)
- the **pivotal role of EVs for the facilitation of the clean energy transition**, and namely the integration of variable renewables in the energy mix

Contribution of EVs for fuel economy improvements in IEA scenarios



Source: IEA analysis based on scenarios developed for the *Energy Technology Perspectives 2017* report

Embracing EVs in GFEI activities

GFEI partners are aware of the significant benefits offered by EVs

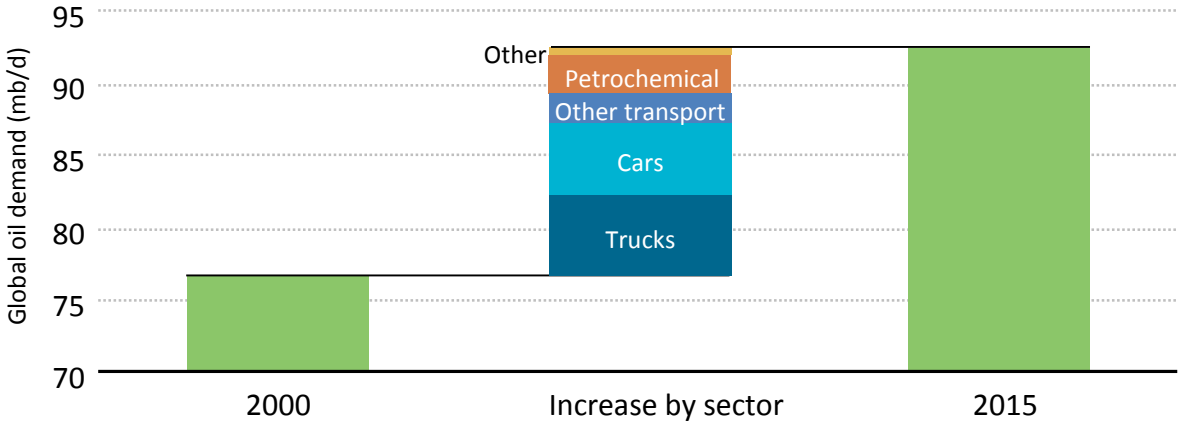
- EVs clearly offer the best efficiency advantage over the conventional ICE powertrains
- EVs promote a shift from petroleum fuels to electricity, helping to diversify the transport energy mix
- EVs are a pivotal technology for the facilitation of the clean energy transition
- EVs are the most effective solution for the reduction of local pollution
- PEVs allow for net savings over the vehicle life and, if battery costs approach USD 100/kWh, allow to achieve cost parity with ICEs even for first owner economics, even with current mileage, in many global regions

GFEI partners welcome the developments taking place on the electrification of transport and embrace a strong roll out of EVs in helping to reach the GFEI target

GFEI will work proactively to integrate policies stimulating the adoption of EVs in their technical assistance and capacity building work for the development of fuel economy policies

Trucks and GFEI: rationale for action

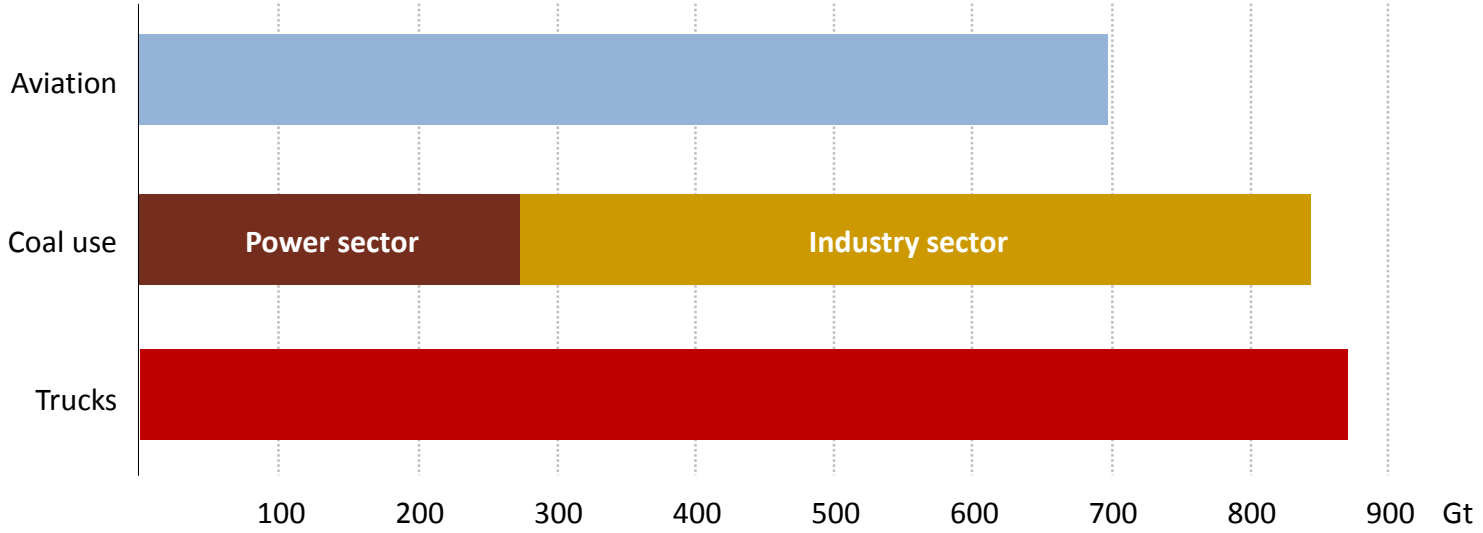
- At around 17 mb/d, **trucks are the second largest source of global oil demand**
  - Trucks also make up for around **half of global diesel demand**
- Trucks are also an **important source of emissions**
  - Around 35% of transport-related **CO_2** emissions are from trucks
  - Trucks are also responsible for 20% of energy-related **NO_X** emissions
- **40% of the growth in global oil demand since 2000 came from trucks**
  - This makes trucks the fastest growing source of oil demand



Source: IEA analysis based on the datasets developed for the IEA report *The Future of trucks*

Trucks and GFEI: rationale for action

CO_2 emissions growth in the Reference Scenario, 2015-2050



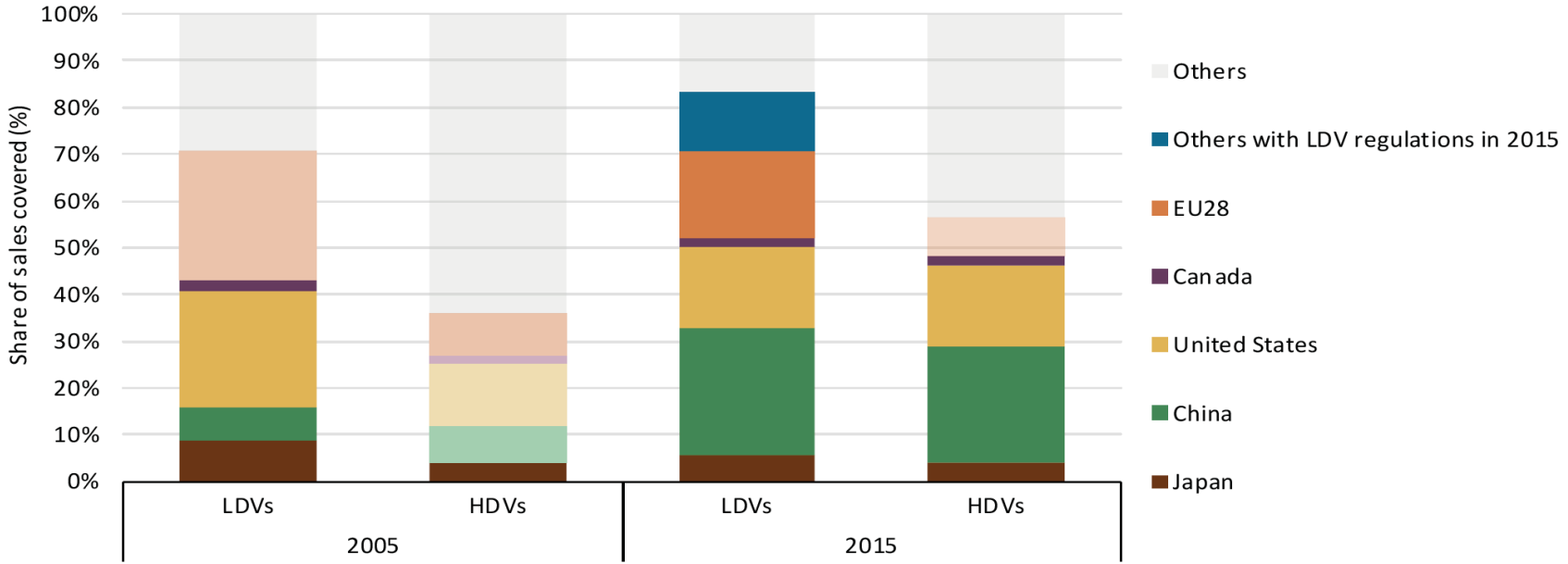
Source: IEA analysis based on the datasets developed for the IEA report *The Future of trucks*

Future prospects strengthen arguments on the relevance of trucks for transport efficiency

Without further policy efforts (IEA Reference Technology Scenario), trucks will account for 40% of the oil demand growth to 2050, and for 15% of the increase in global CO_2 emissions

Trucks and GFEI: rationale for action

Vehicle efficiency standards for light-duty vehicles (LDVs) and heavy-duty vehicles (HDVs)



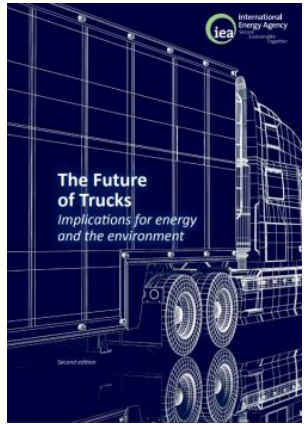
Source: IEA report *The Future of trucks*

Policy efforts for trucks are not widespread

While fuel economy standards cover more than 80% of the LDV market,
only 4 countries (Canada, China, Japan and US) had truck fuel economy standards in place in mid 2017
[India enacted a basic standards, based on constant speed testing, in the second half of 2017]

Trucks and GFEI: rationale for action

- There are **good opportunities to save fuel and reduce emissions**
  - **Ranges of potential for technical and operational efficiency investments over the 2015-2030 timeframe fall close to 30%** - Many solutions (including retrofits) pay for themselves within less than 3 years
  - **Greater potential for savings for HDVs**
  - **Improvements of 50% proven as technically feasible using best-in-class technologies** (SuperTruck challenge)
  - **Growing interest for electrification technologies** also emerging for trucks (examples include Scania, Tesla, Daimler, Ford-DHL & UPS-UES vans)
- **Adopting policies targeting truck efficiency was identified as a key priority in recent IEA report on the future of trucks**
- The IEA report includes a recommendation to **progressively reduce the fuel use per km of new vehicles by 35%, relative to a 2015 baseline, by 2035,** for MFTs and HFTs taken together
- **This aligns well with work developed by GFEI partners**



Where to get help: EVs

- Government-to-government forum comprising 13 countries

- Currently co-chaired by Canada, China and the United States*, and coordinated by the IEA
- Released several analytical publications

- Instrumental to mobilize action and commitments (Paris Declaration on Electro-Mobility and Climate Change at COP21, Government Fleet Declaration at COP22)
- **Launched the EV30@30 Campaign in June 2017,** aiming to achieve a 30% market share for EVs by 2030
- Building of the **Pilot City Programme** network of cities (launch at CEM9)
- **Open to interested countries (at a small fee)**
- New project in preparation with the **Global Environment Facility** and **UNEP** for support to EV policy-making, in cooperation with

Where to get help: HDVs

- G20 Transport Task Group, promoted by

- Aiming to…

provide direct technical and policy support to participating governments → codify lessons learned and make recommendations for adaptation of existing tools → communicate findings to G20 and expand support for continued work on HDV efficiency programs

- Activities include
  - Conference calls (vehicle simulation, component certification, market segmentation and duty cycles, baseline and standard parameters, HDV CO_2 standards development)
  - Reports
  - Workshops (foreseen back to back with G20 meetings)
- ICCT developed significant expertise on the topic (including knowledge of existing simulation tools, GEM in US and VECTO in the EU)

GREENHOUSE GAS EMISSIONS MODEL GEM P2v3.0

VECTO Vehicle Energy Consumption Calculation Tool

Conclusions

Transport efficiency and GFEI

- Energy efficiency is an essential component of increased sustainability of transport
- **GFEI is a major pillar of global action on transport efficiency**, as demonstrated by its effectiveness in boosting the adoption of fuel economy policies

EVs

- EVs are the best option available to fully meet long term policy goals for sustainable transport
- Recent dynamics encouraging, but policy support is still needed
- **GFEI partners embrace a strong roll out of EVs in helping to reach its 2030 target and will integrate policies stimulating the adoption of EVs in their technical assistance and capacity building work**

Trucks

- Without additional policy action, trucks will account for 40% of the oil demand growth to 2050, and for 15% of the increase in global CO_2 emissions
- Good opportunities exist also to improve the fuel economy of trucks, and a 35% improvement goal for 2015 (vs. 2015) is well suited to do so cost effectively
- **Adopting policies targeting vehicle efficiency is seen as a key priority by GFEI partners**
- **GFEI partners already started working to integrate fuel economy polices for heavy duty vehicles in their technical assistance and capacity building work**

Thank you

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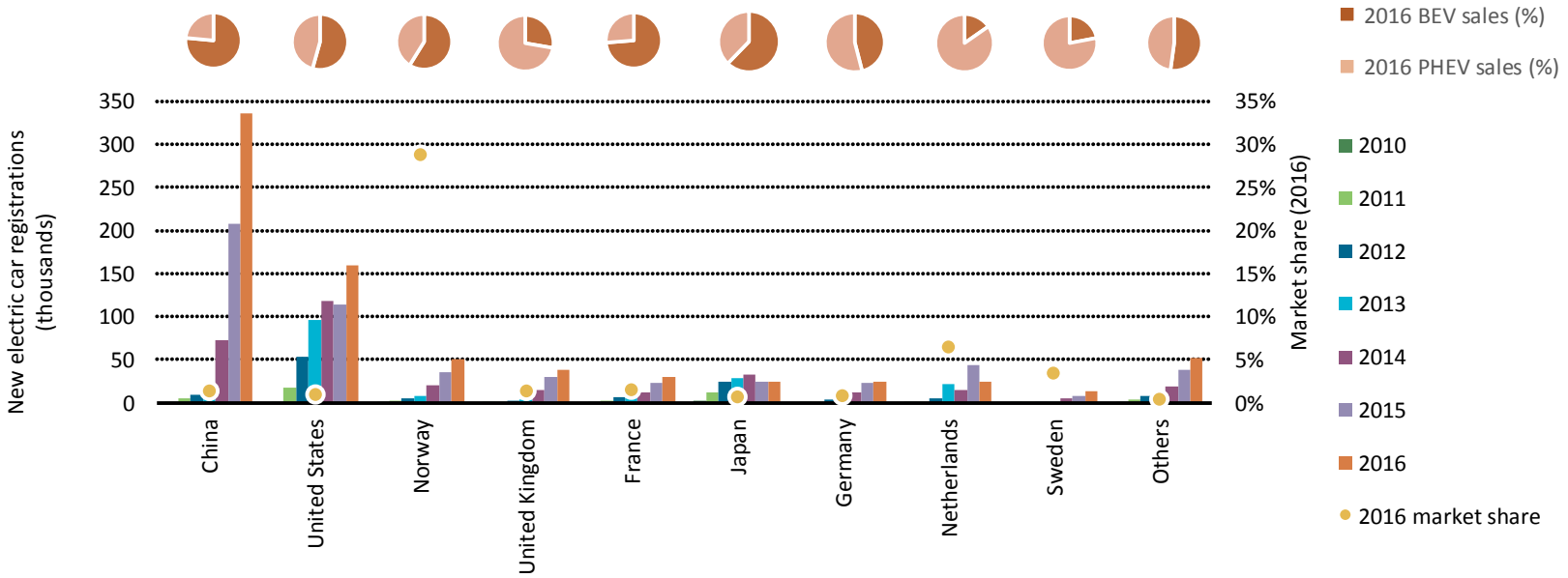
Backup slides

Backup slides

EVs

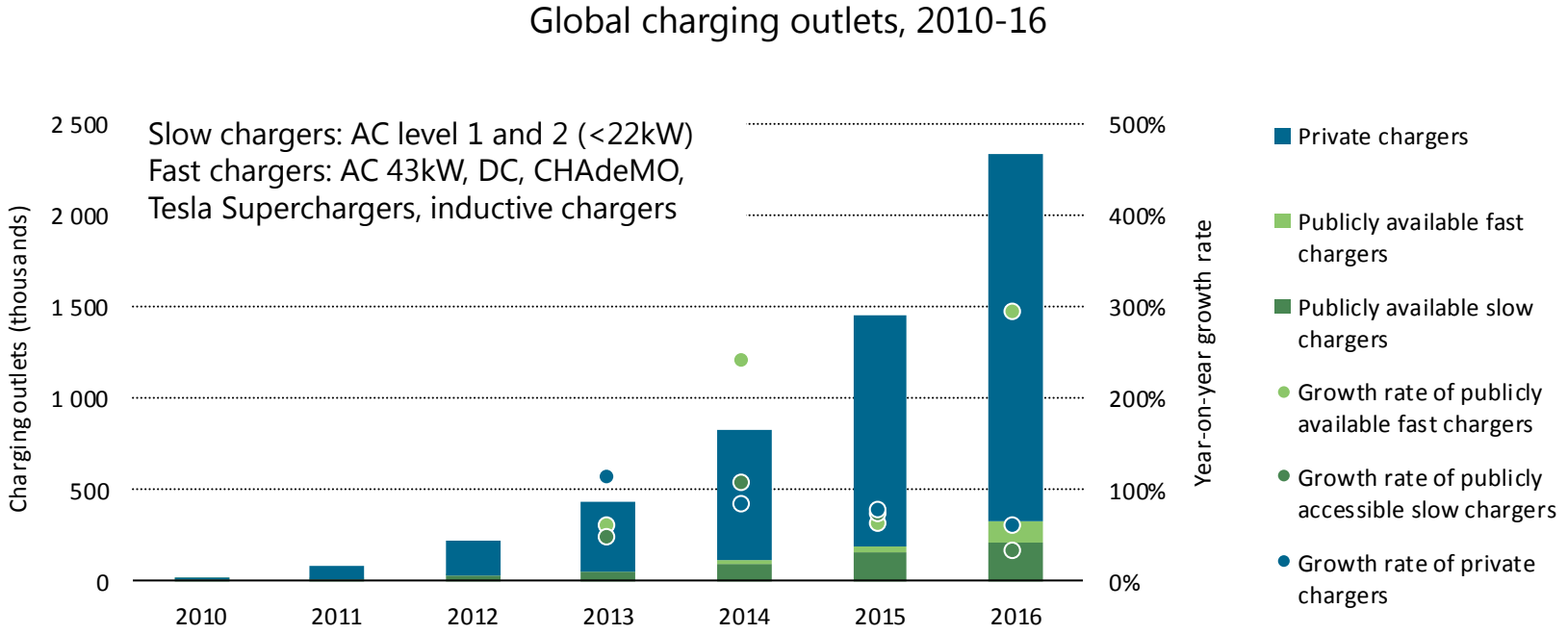
New electric car registrations reach 750 000 units in 2016

Electric car sales, market share, and BEV and PHEV sales shares in selected countries, 2010-16



95% of global electric car sales in 2016 took place in 10 countries, and 6 countries had a market share above 1%: Norway, Netherlands, Sweden, France, United Kingdom, China

EVSE deployment rates were higher than e-car adoption rates in 2016



Publicly accessible infrastructure is growing to support the emerging EV market, especially publicly accessible fast chargers. This shows encouraging signs in addressing the *chicken-and-egg* issue.

E-mobility is gaining ground in non-car modes; China leads the way

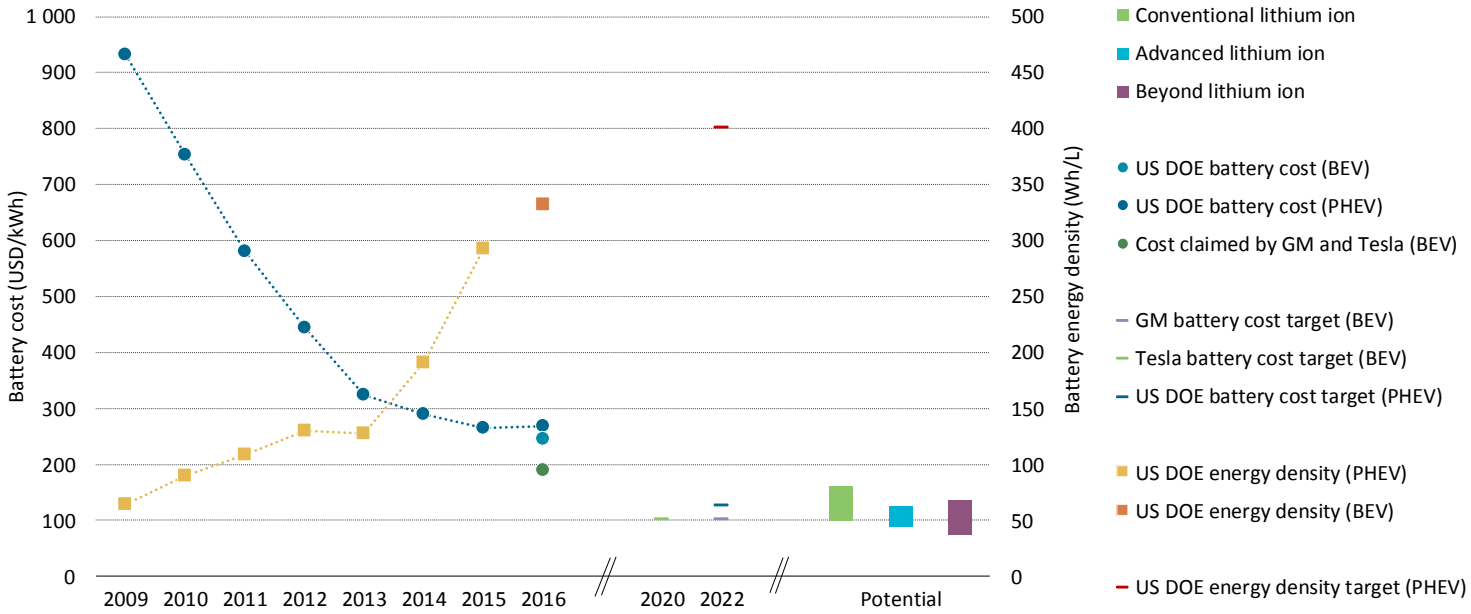
Electric 2-wheelers: > 200 million, mainly in China
In other countries: ~200 000 in India, ~30 000 in the Netherlands, ~1 000 in the UK

Low-Speed Electric Vehicles: ~4 million in China

Electric buses: 350 000 in China
In Europe: deployment stage and ambitious procurement plans

Battery costs and range as key factors for the success of e-mobility

Evolution of battery energy density and cost, 2009-16, and future prospects

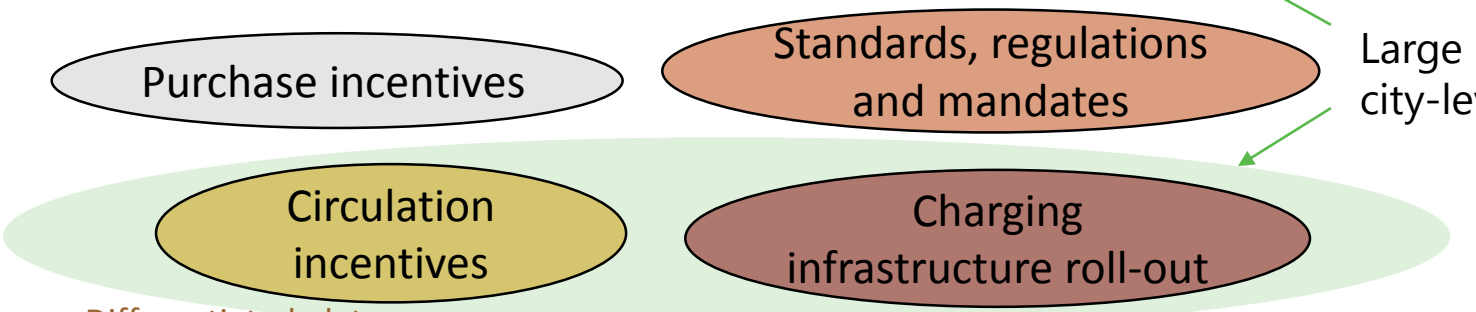


Battery costs and energy density progresses are expected to keep delivering positive outcomes. This will further help lowering adoption barriers.

EV support policies

- CO_2-based, technology-based differentiated taxation and rebates
- Feebates
- VAT exemptions
- …

- Fuel economy standards
- Zero emission vehicle (ZEV) mandates
- Fuel taxes
- Public fleets, taxi fleets initiatives
- …



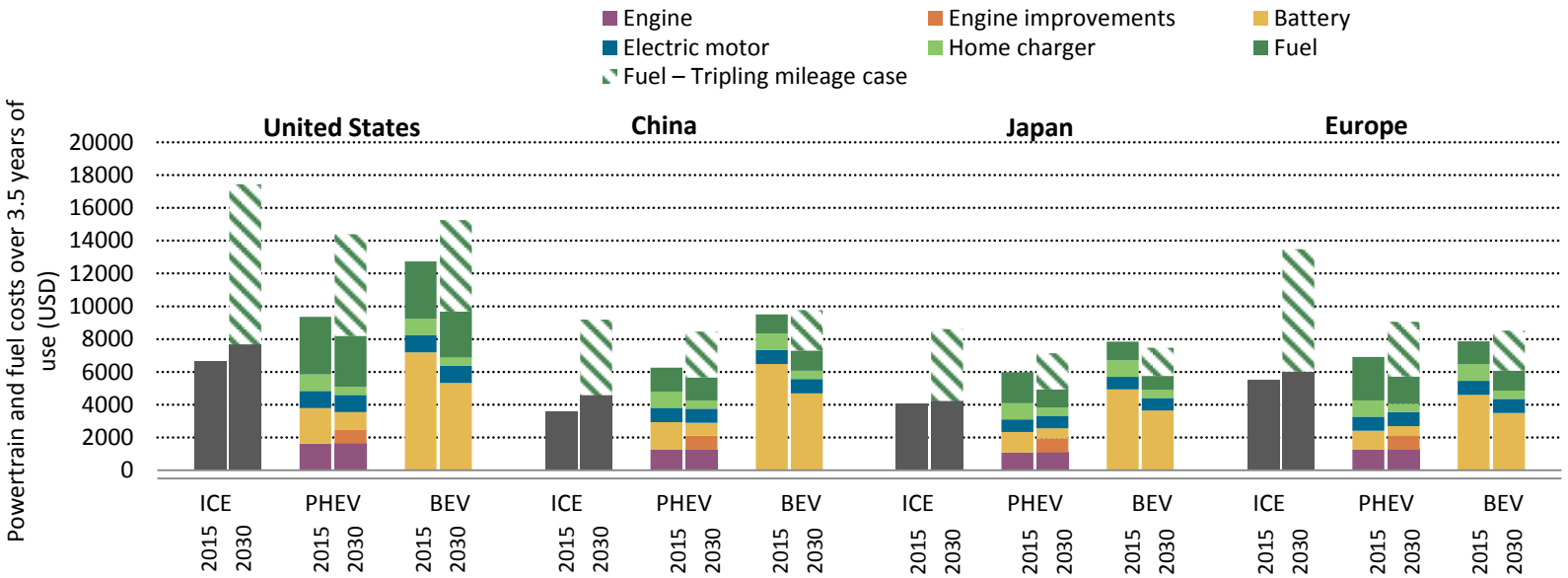
- Differentiated plates
- Access to bus lanes
- Free/dedicated parking
- Circulation/congestion charge exemption
- …

- Direct public investment
- Public-private partnerships
- Charger standards harmonization
- Fast and slow charging network planning
- …

Close monitoring of the effect of EV support policies are paramount to avoid adverse effects

Cost-competitiveness prospects and policy needs

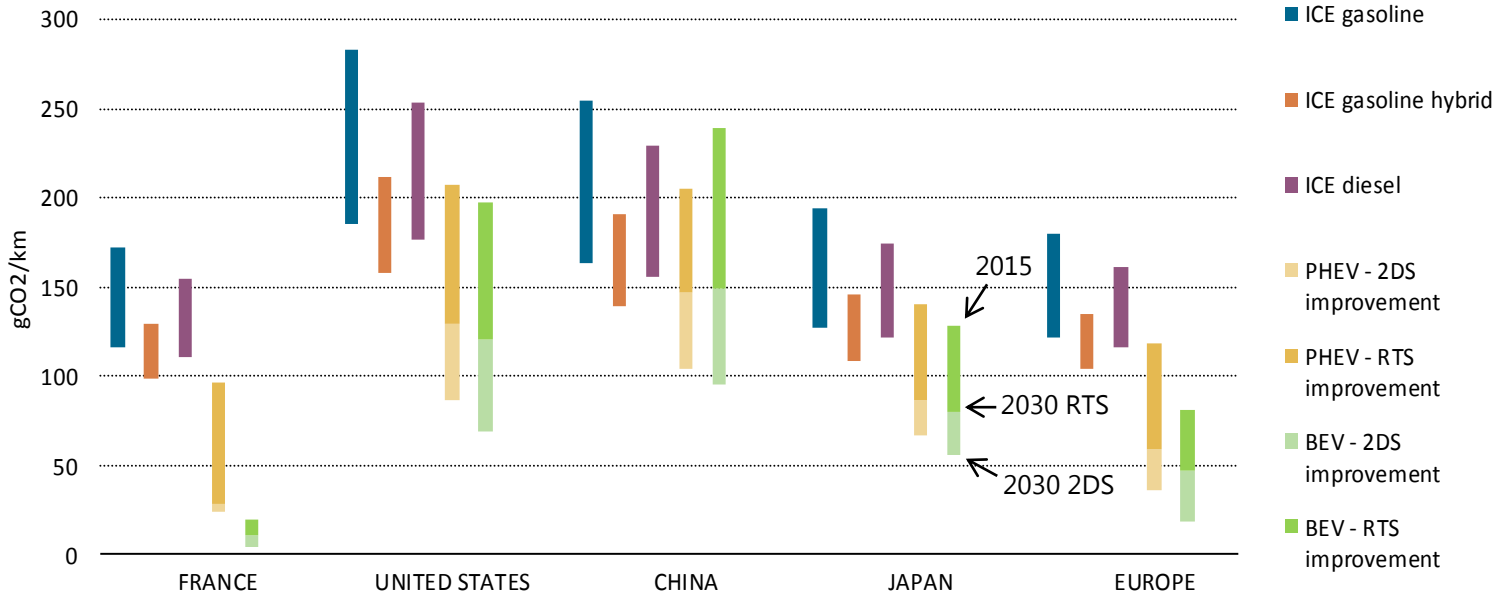
Comparative cost of passenger car technologies by country/region in the 2DS, 2015 and 2030



Achieving cost-competitiveness over the next decade will require policy instruments to allow market scale-up, reflect the cost of externalities of ICEs, and encourage synergies with new mobility models.

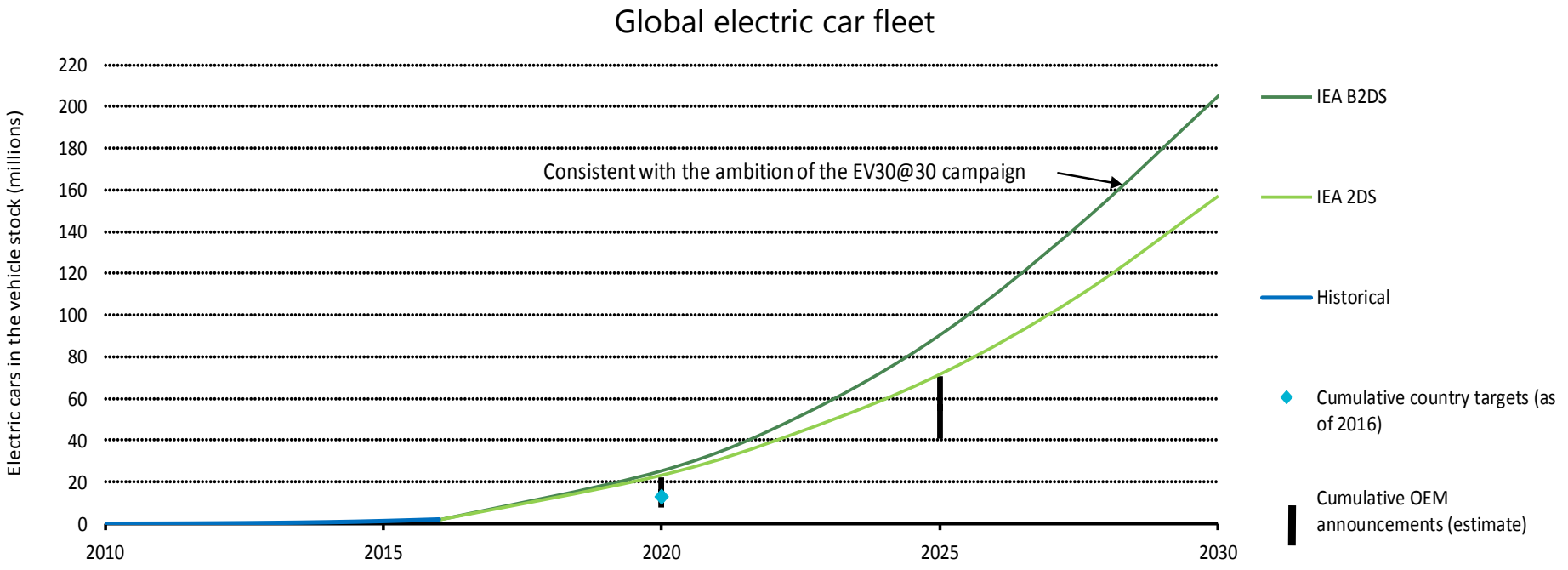
EVs benefit the environment and are essential to reduce CO_2 emissions

On-road WTW CO_2 emissions for various technologies by country/region, RTS and 2DS, 2015 to 2030



If coupled to low-carbon power, the high energy efficiency of EVs offers prospects for substantial CO_2 emissions reductions. This complements their air quality, energy security and noise reduction benefits.

Prospect for EV uptake in different scenarios



EVs will be needed to meet sustainability goals, as suggested by the EV30@30 campaign target

The level of ambition resulting from the OEM announcements shows a fairly good alignment with country targets to 2020. To 2025, the range estimated suggests that OEM ambitions are failry close to the 2DS projections from the IEA

Backup slides

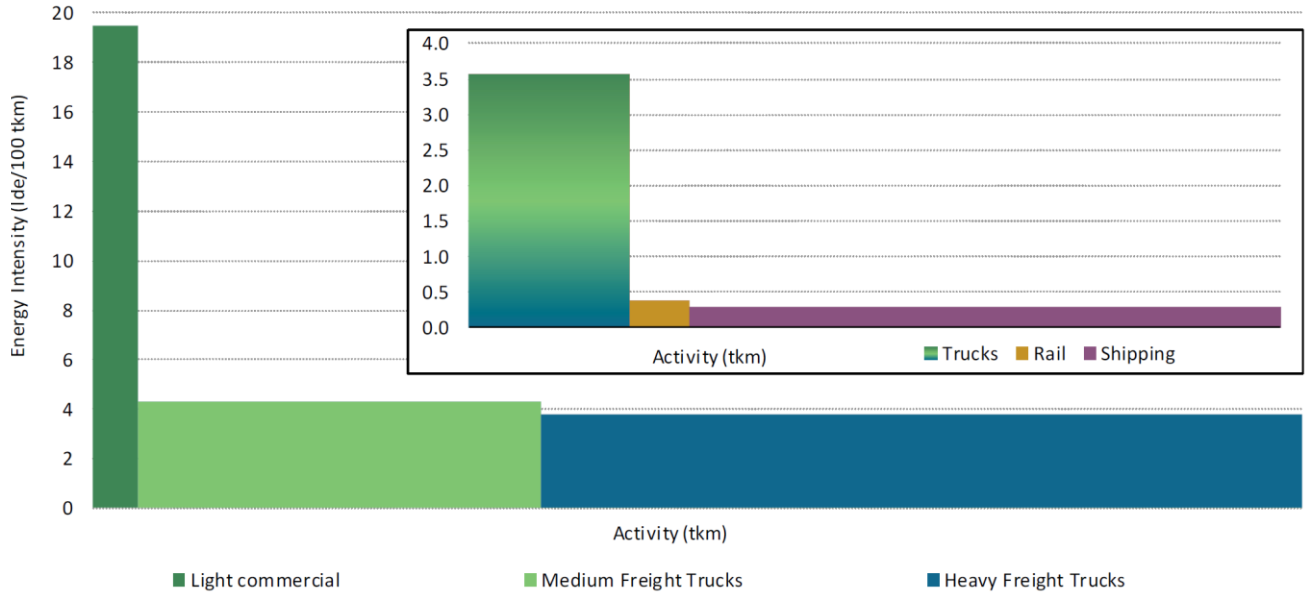
Trucks

Truck fuel economies

Country	LCVs			MFTs			HFTs		
	lde/ 100 km	payload (tonnes)	lde/ 100 tkm	lde/ 100 km	payload (tonnes)	lde/ 100 tkm	lde/ 100 km	payload (tonnes) tkm	lde/ 100
United States	7.9	0.55	14.4	28.2	6.4	4.4	41.2	15.4	2.7
European Union	6.8	0.62	11.0	23.3	7.0	3.3	34.6	14.5	2.4
China	9.9	0.82	12.1	23.3	8.7	2.7	39.1	13.3	2.9
India	6.4	0.96	6.7	25.0	9.7	2.6	44.9	12.9	3.5

- Differences in vehicle attributes, such as engine size and power, the availability of auxiliaries, and the mission profiles and vehicle size distributions in each category, complicate the comparison of average fuel economy and load across regions
- Trucks are most efficient in Europe
- Higher payloads on LCVs and MFTs lead to lower fuel use per tkm in China and India

Trucks: energy use



- Even if it accounts only for 20% of all tkm globally, road freight consumes more tan 70% of the energy needed to move goods
- At around 17 mb/d, road freight transport is the second largest users of oil (after passenger cars) today
- It was also responsible for nearly 40% of the oil demand growth since 2000
- Most of this energy goes to medium and heavy duty trucks
- LCVs are – by far – the least efficiency road freight transport mode

Trucks: vehicle efficiency

Vehicle and powertrain technologies allowing to reduce consumption

	Range of energy savings
Improved aerodynamics	Up to 3-5% of energy use*, retrofit possible
Lower rolling resistance tyres	10% to 30% reduction of rolling resistance and about 3-5% of total energy use*, retrofit possible
Light weighting/material substitution	1-3% in near term, up to 7% in the long term
Transmission and drivetrain improvements	1 to 5% from automatic transmission (mission profile matters)
Engine efficiency	4 to 18% (long haul)
Reducing idling	Up to 2.5%
Hybridization	6% to 35%, range depends on mission profile

* excluding engine power adjustments

Trucks: systemic measures in logistics

Measures requiring little or no co-operation across stakeholders

	Range of energy savings
Route optimization	5-10% intra-city, 1% long haul
High Capacity Vehicles (HCVs)	Up to 20%, primarily in long haul, risk of rebound
Driver training and feedback	3 to 10%
Platooning	5 to 15%
Last mile delivery optimization	5 to 10%, depends on degree of implementation

Examples
- Delivery booking and re-timing to optimize use of available facilities
- Changing delivery frequency
- Consolidating orders and suppliers
- Manage waste, reduce volumes and collection frequencies
- Promote the use of efficient and zero emission vehicles

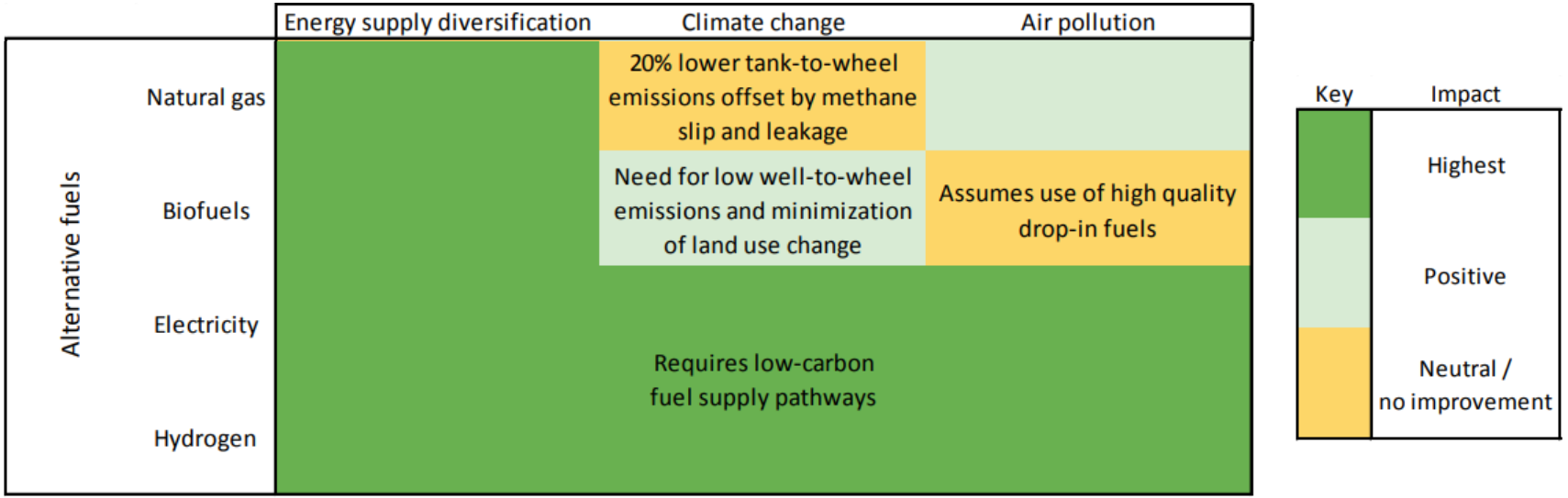
Trucks: systemic measures in logistics

Measures requiring closer collaboration, including sharing of assets and services between and among companies and more radical re-envisioning of how logistics systems operate

	Range of energy savings
Supply chain collaboration/co-loading	Up to 15%
Matching cargo and vehicles via IT • Includes freight exchanges, digital freight matching • Links with crowdshipping and co-modality	5 to 10% in urban areas
Urban consolidation centres	20-50% in urban centres (all measures combined, including vehicle techs)
Physical internet	Up to 20%

Efficiency and collaboration can drive major changes leading to reduced GHG emissions – this conflicts with “just-in-time” and same- or next-day deliveries

Trucks: alternative fuels and powertrains



- Literature points to high abatement costs of alternative fuels
- Considerable debate on the extent to which these fuels can lead to real-world reductions in greenhouse gas emissions – an issue exemplified by the controversy surrounding indirect land use change but that is also relevant for natural gas and to a lesser extent the cases of electricity and hydrogen
- In all these cases, delivering reliable GHG emissions reductions will require that production and supply pathways are themselves decarbonised.

Trucks: policy priorities

- **Adopting policies targeting vehicle efficiency, including fuel economy standards and differentiated taxes on vehicle purchase**

  The two policies complement each other: the former regulatory policy ensures that all new truck sales achieve minimum efficiency performance, and the latter fiscal measure favours the best performing models, pushing further improvements.

  For MFTs and HFTs taken together, the fuel use per kilometre of new vehicle registrations needs to be progressively reduced by 35%, relative to a 2015 baseline, by 2035.

- **Supporting widespread data collection and information sharing in logistics**

  Data gathering and information sharing are key prerequisites to realising some of the potential that underlies systemic improvements of freight logistics, including the sharing of assets and services.

  Policy makers should take a proactive role in supporting data collection and sharing platforms by promoting closer collaboration among all stakeholders.

- **Promoting the deployment of alternative fuels and the vehicles that use them**

  This typically requires support across four areas: RD&D, market uptake of alternative fuel vehicles, adequate access to charging or refuelling infrastructure and the availability of alternative fuels.