Energy Transitions Commission

Energy productivity in the road transport sector
Key insights

ETC Representatives Meeting

19th September 2024

ETC 2024 work programme

Extending our influence in the global climate debate

- Disseminating ETC insights & recommendations
- Leveraging existing knowledge
- Informing the influencers

Delivering action through future COPs

- Ambition and format of NDCs
- COP 29, 30, 31

Building the clean energy system faster

	Main reports	Shorts
Power system transformation – barriers to clean electrification	Grids	Offshore wind
	Energy storage & flexibility	Power demand growth
Energy productivity	Buildings decarbonisation	Road transport
		HTA sectors (MPP)
	Energy Productivity across the economy	

Building the ETC regional network

Supporting the MPP

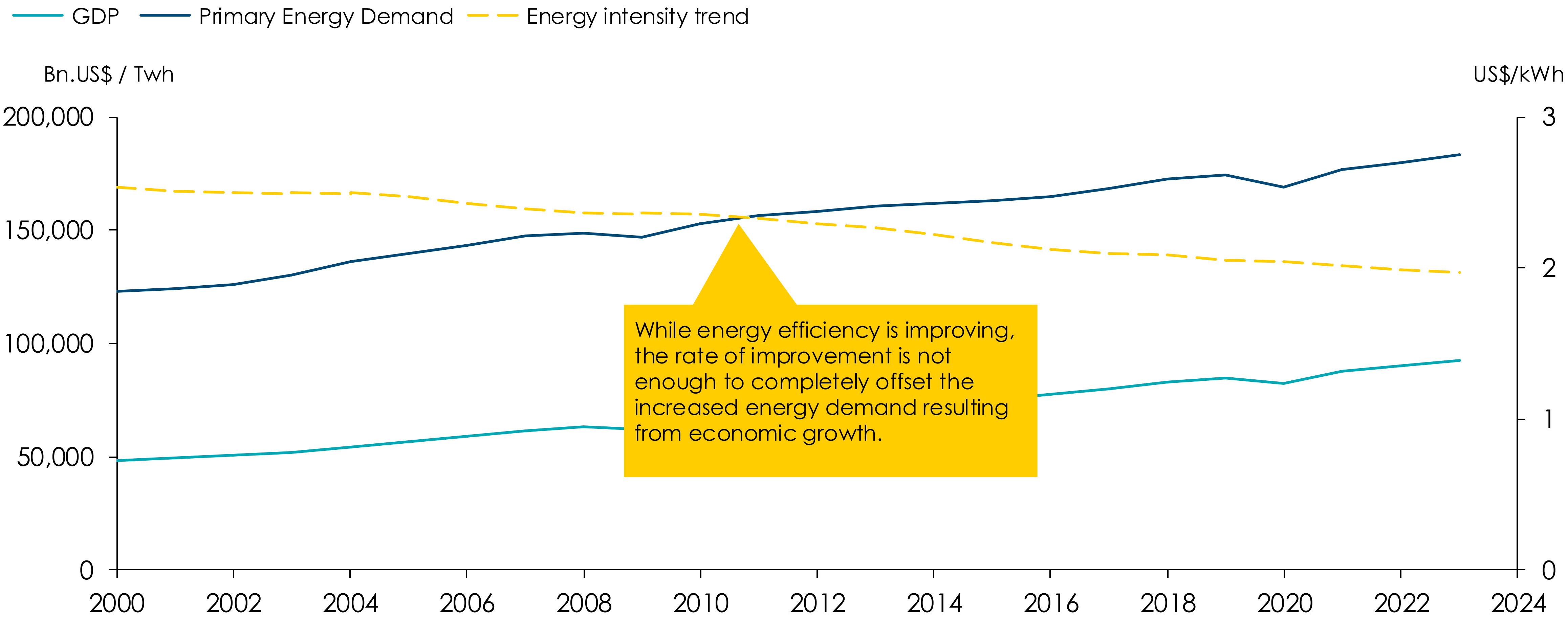
MISSION POSSIBLE PARTNERSHIP

Supporting the ETC members

Overall context: Despite energy intensity declining, primary energy demand growth indicates energy intensity improvements lagging behind GDP growth

Total GDP vs. Primary Energy Demand, 1965- 2023

GDP in constant 2015 Bn.US$, Primary Energy Demand in TWh; Energy intensity trend in constant 2015 US$/kWh

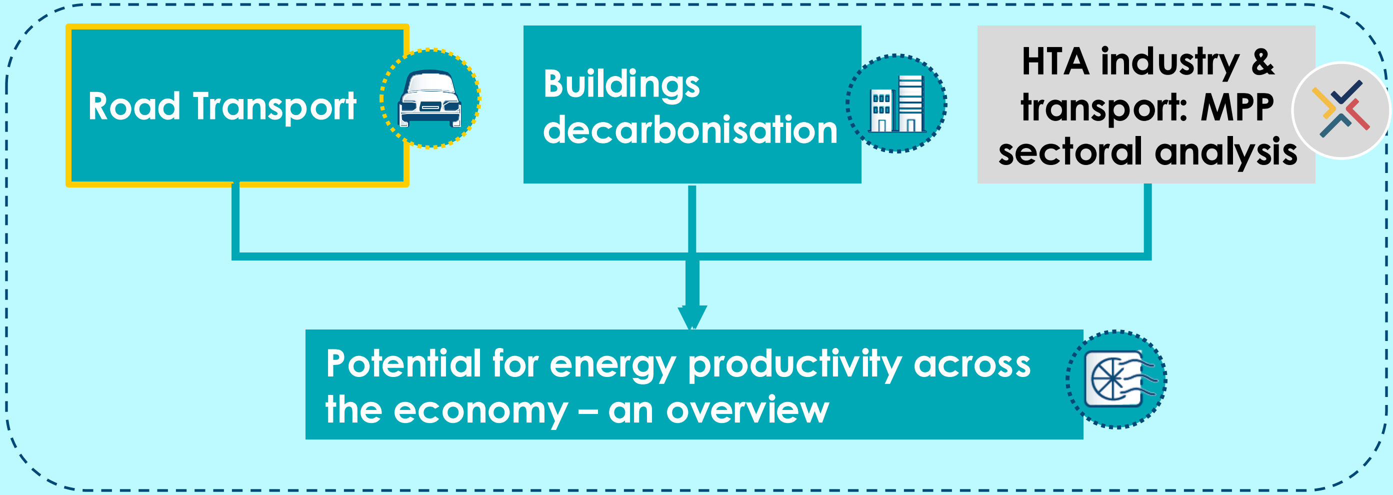


Notes: NZE: Net Zero Emissions by 2050 Scenario from the IEA

Sources: Systemiq analysis for the ETC; World Bank Group; Our World in Data; IEA (2023), *Energy Efficiency 2023*

The road transport productivity deepdive will feed into the synthesis of overall energy productivity potential

2024 ENERGY PRODUCTIVITY SERIES

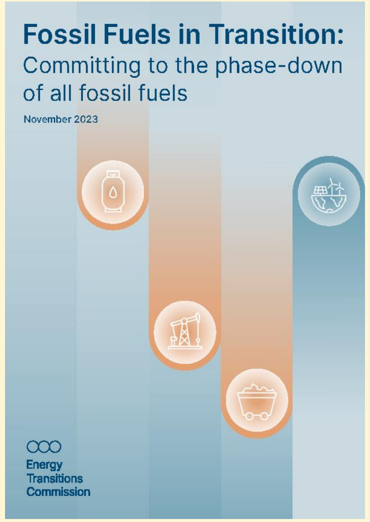


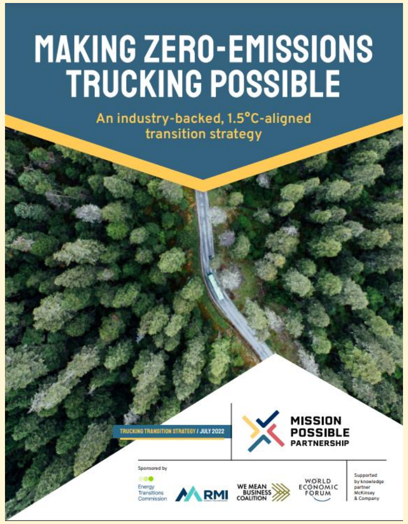
The overview of energy productivity potential will draw on three inputs:

- **Buildings**, encompassing both in-use structures and those under construction.
- **Industry and long-distance transport**, consolidating insights from the Mission Possible Partnership (MPP) analysis.
- **Road transport**, covering both passenger and freight aspects.

ROAD TRANSPORT DEEPDIVE

This report will build on…





To assess energy productivity potential in the road sector, we use the ETC energy productivity framework

Target figure	Key lever		Guiding question	Reduced quantity	Example
Energy Productivity (living standard per energy input) =	Energy process efficiency ×		How can we decrease the energy input per (production) process?	Process energy	Shift to less energy-intense production technology, incremental energy efficiency increase
	Service efficiency ×	Demand efficiency ×	How can we decrease the demand without sacrificing living standard?	Demand (for specific service)	Behavior changes, e.g. switch to train journey instead of airplane
		Product efficiency	How can we increase the utilization of the product?	Product	Reuse, sharing of products, increased product lifetime
	Material efficiency		How can we decrease the material input per product?	Material	Recycling and use of recycled content, reduce primary material use while maintaining specs of product

Not a key focus of this work as covered in 2023 ETC Materials Report

Report structure

The report aims to assess whether, alongside supply-side decarbonisation via electrification, it is possible to further reduce cumulative emissions through energy productivity improvements, whether relating to the declining fleet of Internal Combustion Engines (ICE) vehicles, the increasing fleet of electric vehicles, or both.

This report is structured in 5 Chapters:

1) **The primary role of electrification**, which is both the key to supply-side decarbonisation and the most important driver of energy productivity improvement – both at the final energy level and at the primary energy level, provided power generation is itself decarbonised.

2) **Potential improvements in energy process efficiency**, achieved through improved energy efficiency of both ICE and EV vehicles, reductions in vehicle size, or changes in driving style.

3) **Potential improvements in service efficiency**, achieved via better urban design and modal shift, where the potential is significant but inherently difficult to assess.

4) **The impact of autonomous vehicles** on both energy process efficiency and service efficiency, which could be either positive or negative.

5) **Conclusions on aggregate potential and a summary of key policies to seize this potential**.

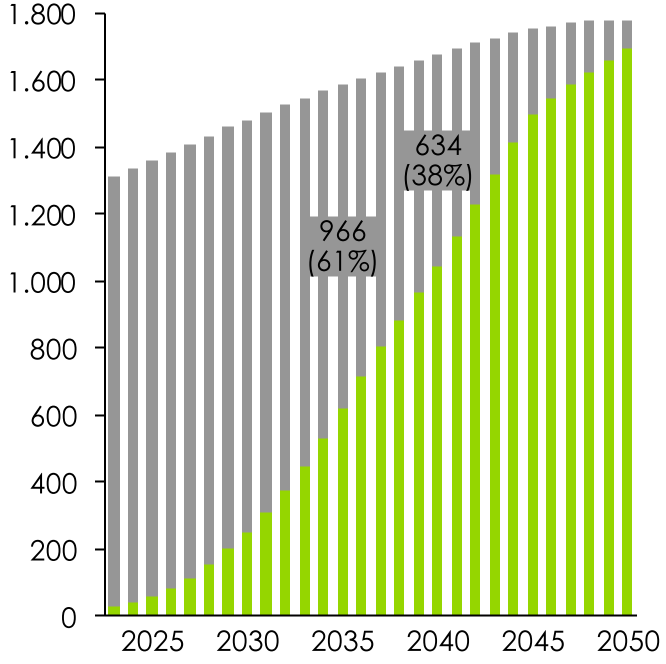
Electrification is the key productivity lever

Fleet continues to grow to 2050, with increased electrification

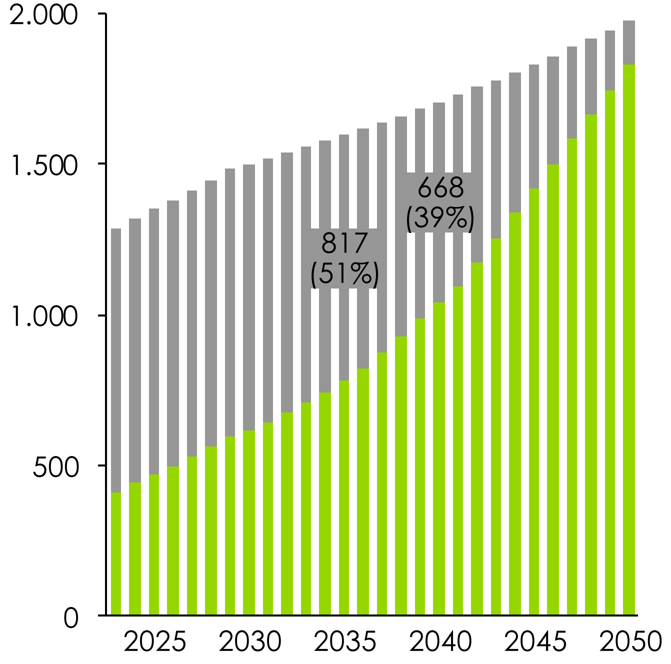
Fossil fuels in Transition report:
Accelerated but Clearly Feasible (ACF) scenario

Stock of vehicles in the ACF[1] scenario
Millions of vehicles

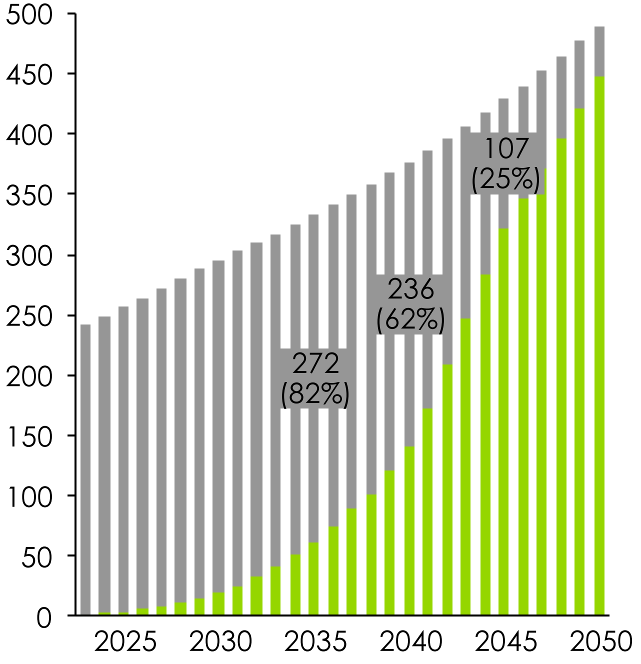
ICE ZEV[2]



Passenger vehicles



Two-Three-wheelers



Commercial vehicles[3,4]

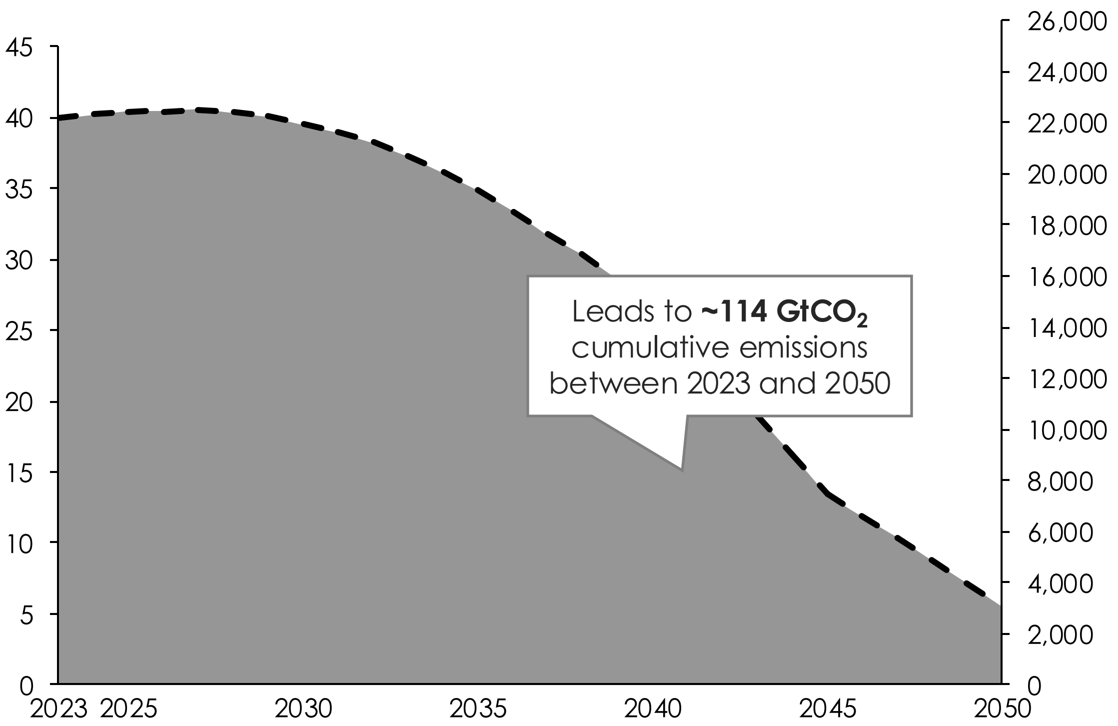
Note: 1. Accelerated but Clearly Feasible; 2. Zero-emission vehicles; 3. Commercial vehicles include light, medium and heavy commercial vehicles; 4. Commercial vehicles include both Electric Vehicles and Fuel-cell Electric Vehicles

Sources: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

In the ACF scenario, cumulative CO_2 emissions are projected to reach approximately 128 $GtCO_2$, primarily due to the use of combustion engines

Oil demand for road transport

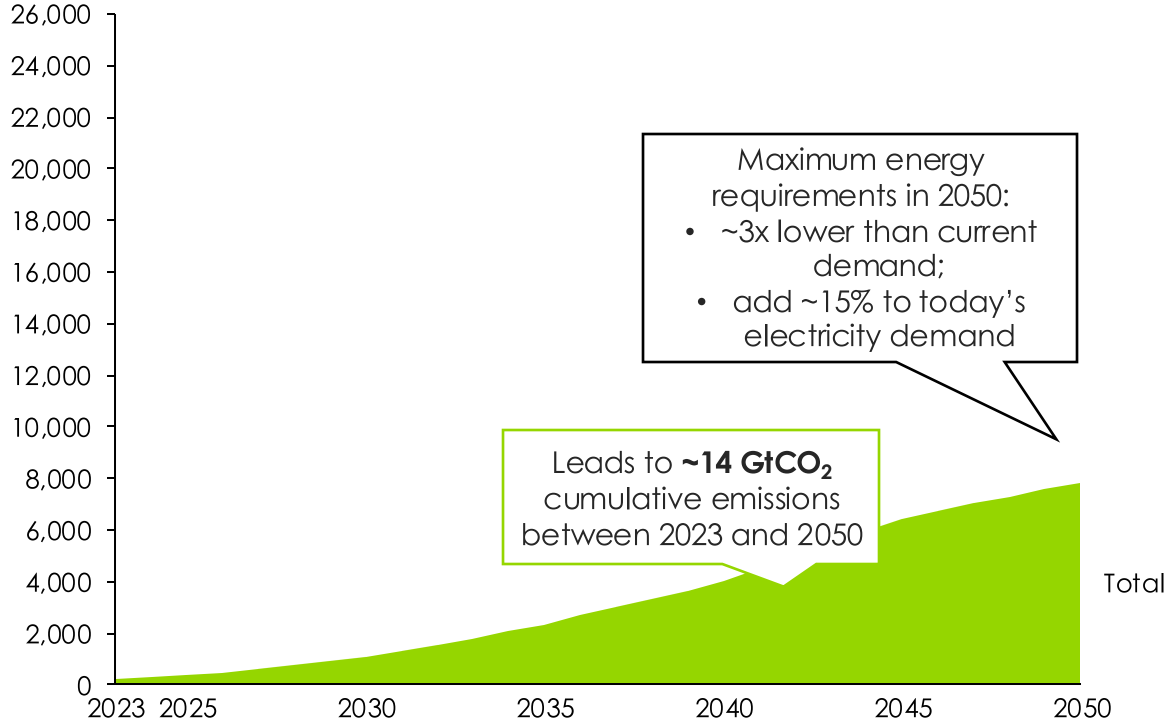
mb/d (LHS); TWh (RHS)



Oil demand

Electricity demand for road transport

TWh



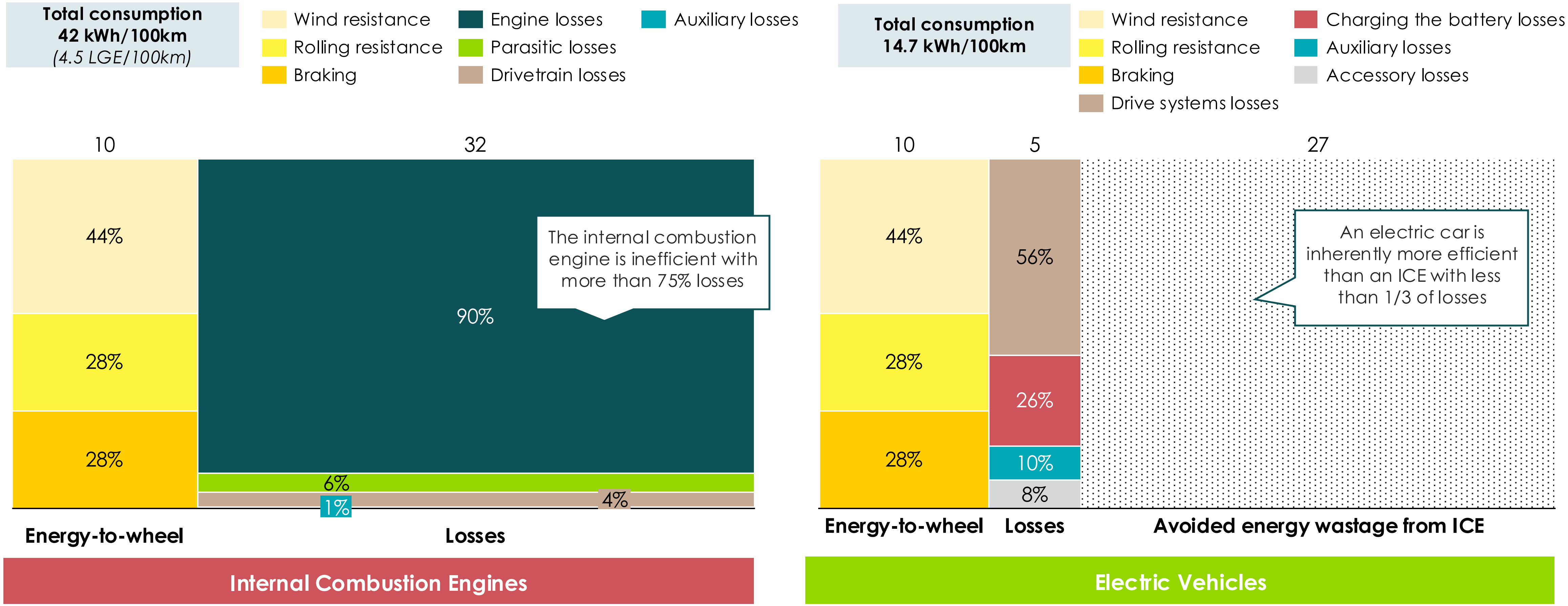
Electricity demand

Note: **ACF** = Accelerated but Clearly Feasible, Energy productivity assumptions are already baked in: efficiency improvements of new ICE vehicles of 0.7% p.a. and of new Evs of 1.6% p.a.. Other vehicles, such as those used in construction or mining are not included. 2-3-wheelers and buses are not included. We consider that the combustion of a barrel of oil equivalent results ~405 kg CO_2Source: Systemiq analysis for the ETC; BNEF (2023), *Electric Vehicle Outlook*, MPP (2022), *Making Zero-Emissions Trucking Possible*; IEA (2023), *Emissions from Oil and Gas Operations in Net Zero Transitions*, ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Today, when comparing equivalent models, Electric Vehicles are 3x as efficient as Internal Combustion Engines

Comparison of Hyundai Kona and electric Hyundai Kona 2024 energy efficiency

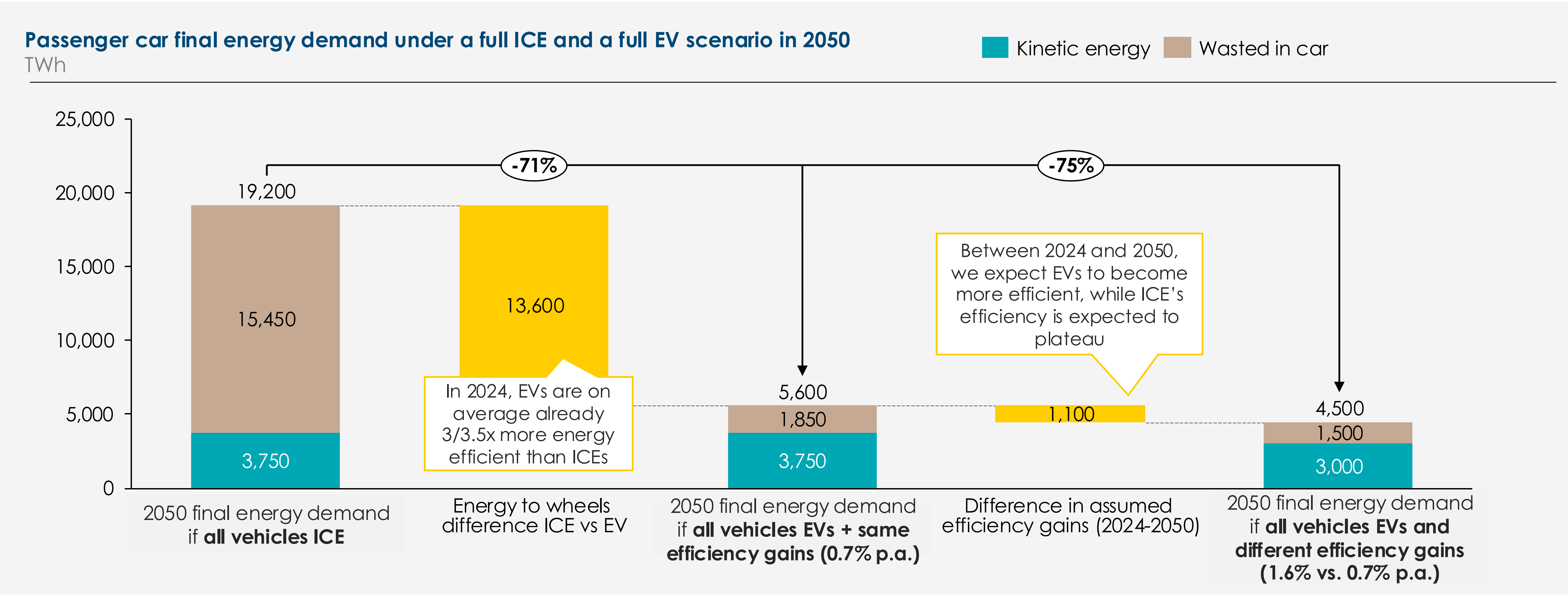
kWh/100km and %



Note: We do not consider regenerative braking and potential energy reduction for EVs. We take a consumption of 14.7 kWh/100km for the Hyundai Kona Electric 2024 and 4.5 Lge/100km for the Hyundai Kona 2024. There are 9.3 kWh per Lge (Liter of gasoline equivalent). Energy use and losses vary from vehicle to vehicle. These estimates are provided to illustrate the general differences in energy flow in different vehicle types during different drive cycles.

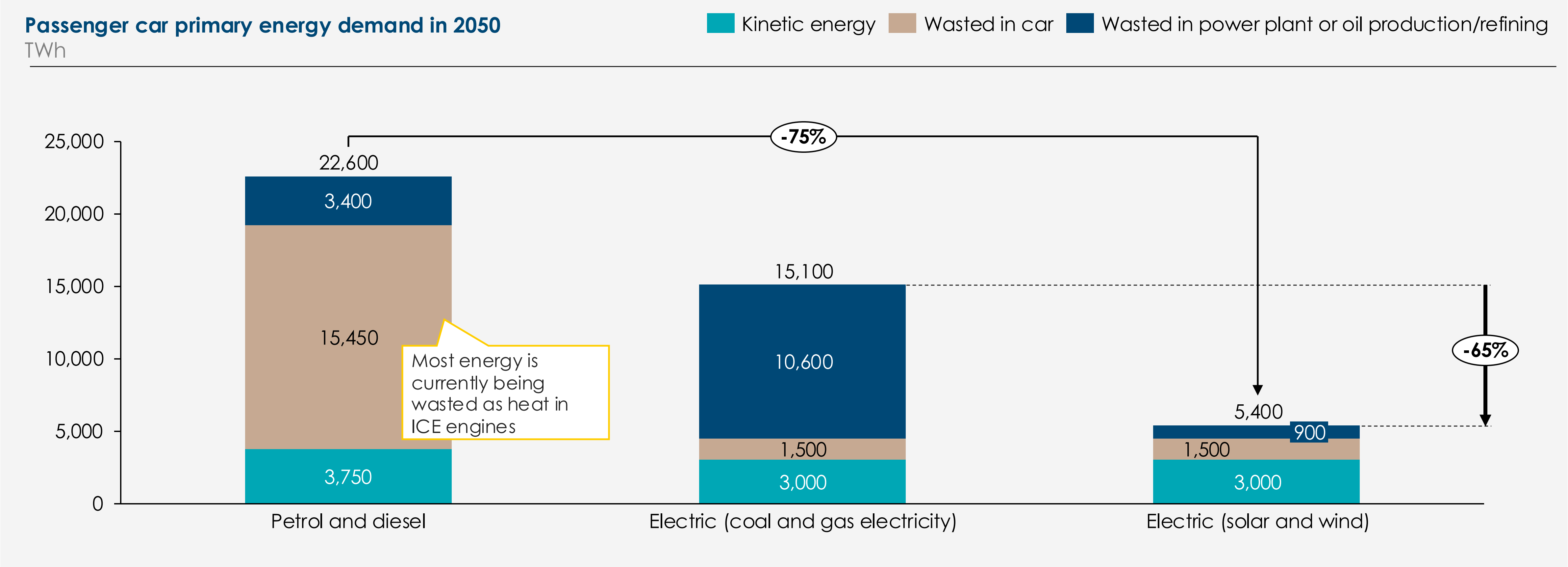
Sources: Systemiq analysis for the ETC; US Department of Energy; GFEI (2023), *Trends in the global vehicle fleet 2023*

Passenger cars: electrification could reduce final energy demand by 75%



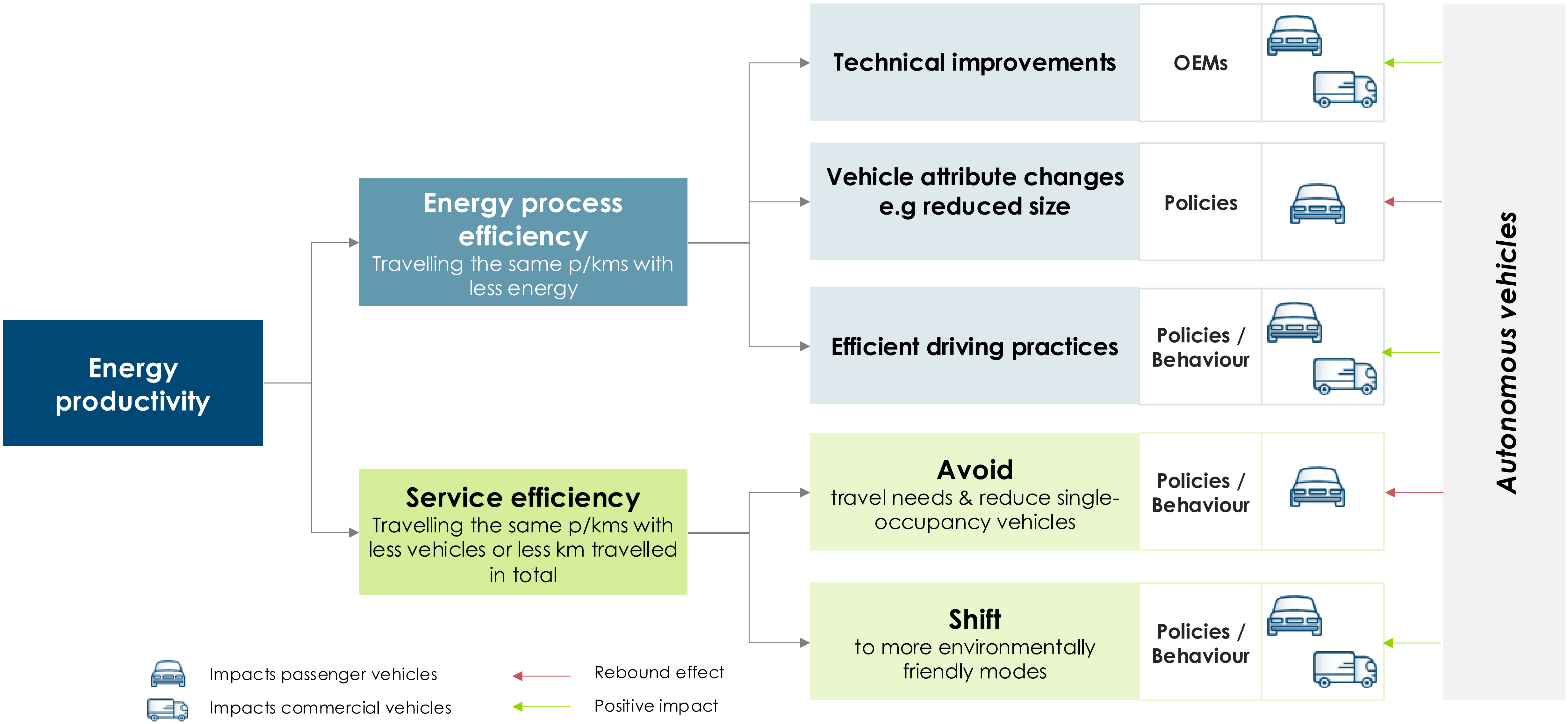
Notes: For Final Energy Demand, demand for transport of ~30,500bn km in 2050, with a fleet of 1.8Bn vehicles; In 2024, new EVs consume on average 20 kWh/100km, and new ICEs 7.4 Lge/100km. We consider efficiency improvements of 1.6% p.a. for EVs and 0.7% p.a. for ICEs, respectively reaching 12.9 kWh/100km and 6.1 LGE/100km in 2050. There are 9.3 kWh per Lge (Liter of gasoline equivalent). 5% electricity efficiency losses are assumed as well.
Sources: Systemiq analysis for the ETC.

Passenger cars: electrification combined with low-carbon energy will reduce our overall primary energy demand by ~75%



Notes: For Primary Energy demand, energy efficiency of 85% from fossil fuel extraction to tanker, energy efficiency of 30% for fossil fuel power and 83% for renewables power (e.g., electricity conversion and transmission losses). Focus only on passenger vehicles. We assume the average energy-to-wheel energy requirement in 2050 is 9 kWh/100km for a medium size car, excluding auxiliaries. We assume demand for transport of ~30,500bn km in 2050. 5% electricity efficiency losses are assumed as well.
Sources: Systemiq analysis for the ETC.

Key productivity levers beyond electrification



Note: OEM stands for Original equipment manufacturer
Source: Systemiq analysis for the ETC.

Energy process efficiency could play a role for both ICEs and EVs

Energy process efficiency – key things that matter

<table>
<tr><th></th><th>Drive unit improvements</th><th>Tire rolling resistance</th><th>Weight</th><th>Speed</th></tr>
<tr><td>ICEs</td><td>Main efficiency gain is hybridisation (= electrification)</td><td rowspan="2">Benefits both vehicles proportionately.</td><td>ICE SUVs generally weight more than BEV SUVs.</td><td rowspan="2">Reducing high speeds improves efficiency, particularly for EVs which are more inefficient at higher speeds.</td></tr>
<tr><td>EVs</td><td>Scope for 20% improvement in efficiency</td><td>Bigger range = bigger weight, but inherent EV efficiency and regenerative breaking limits impact.</td></tr>
</table>

By 2050, ICE vehicles can boost efficiency by up to 50%

Category	Levers	Description	Realistic potential (%)	Ambitious potential (%)
Tire rolling resistance	Tire rolling resistance	Reducing tire rolling resistance through use of specially designed tires (e.g., Bridgestone) can also be applied to ICE	-5%	-18%
Lightweight technologies	Lightweight materials	Selective use of lightweight materials to replace heavy steel	Marginal impact	-10%
	Glider weight	Reduce glider weight by more than 20%.		-5%
Other improvements	Aerodynamic drag	Reduce aerodynamic drag coefficient from 0.28 to 0.17 through closer attention to styling, wheel wells, and vehicle rear geometry		-4%
Hybrid vehicles	Strong hybridization	Hybrid powertrains recover a portion of braking losses and improve overall driveline efficiency.	-15%	-25%
Total improvement	Combined effect of improvements	The maximum potential improvement for ICV is around 50%	-20%	-50%

However, looking ahead, fuel efficiency innovation will likely slow as most improvements are achieved and OEMs shift R&D from ICE models to EVs

Note: WLTP: Worldwide harmonized Light vehicles Test Procedures

Sources: Systemiq analysis for the ETC from EPRI (2024), *Valuing Improvements in Electric Vehicle Efficiency;* ICCT (2023), *Vision 2050 Strategies to align global road transport well below 2°C;* The ICCT (2023), *Real-world usage of plug-in hybrid vehicles in Europe. of battery electric passenger cars in China;* Global Fuel Economy Initiative (2023), *Trends in the global vehicle fleet 2023;* The ICCT (2024), *On the way to 'real-world' CO2 values? The European passenger car market after 5 years of WLTP*

By 2030, ICE long-haul commercial vehicles can boost efficiency by 20-50%

Category	Levers	Description	Realistic potential (%)	Ambitious potential (%)
Engine technologies	**Engine improvements**	E.g. engine friction reduction, combustion optimization, turbo improvements, engine downsizing, and waste heat recovery. Incremental engine technology levels can further improve efficiency.	-5%	-10%
Tire rolling resistance	**Tire rolling resistance**	Reducing tire rolling resistance through the use of specially designed tires (e.g., Bridgestone). The coefficient of rolling resistance (CRR) relates the force opposing the rotating motion of the tires to the normal force between the tire and the surface.	-4%	-9%
Road load reduction	**Aerodynamics**	Improving tractor and trailer aerodynamics, such as using aerodynamic features and advanced designs.	-7% (trailer excluded)	-15%
	Lightweighting	Utilizing lightweight materials and design to reduce vehicle curb weight. This allows for increased payload without changing fuel consumption or reduces fuel consumption for volume-constrained vehicles.	Marginal impact	-1.5%
Driveline	**Axle efficiency**	Improving the efficiency of the axles to reduce energy loss in the driveline.		-1%
	Transmission	Improved transmission systems, including automated manual transmissions (AMTs), which have higher efficiency and optimize gear shifting.		-1%
	Hybrid powertrain	Hybrid powertrains recover a portion of braking losses and improve overall driveline efficiency.	-7% but not cost-effective	-10%
Vehicle	**Other improvements**	Includes vehicle accessories improvement, vehicle speed limiter, predictive cruise control, and L2/L3 automation.	-3%	-5%
Total improvement	**Combined effect of improvements**	Combined effect of the aforementioned improvements leads to significant overall efficiency gains.	-20% (excluding trailer)	-50%

Notes: A tractor is the vehicle with the engine and driver's cab used to pull a trailer, which is the unpowered unit designed to carry cargo.
Sources: Systemiq analysis for the ETC; The ICCT (2017), *Fuel efficiency technology in European heavy-duty vehicles: Baseline and potential for the 2020–2030 timeframe*

Combining various strategies could double EV efficiency by 2050

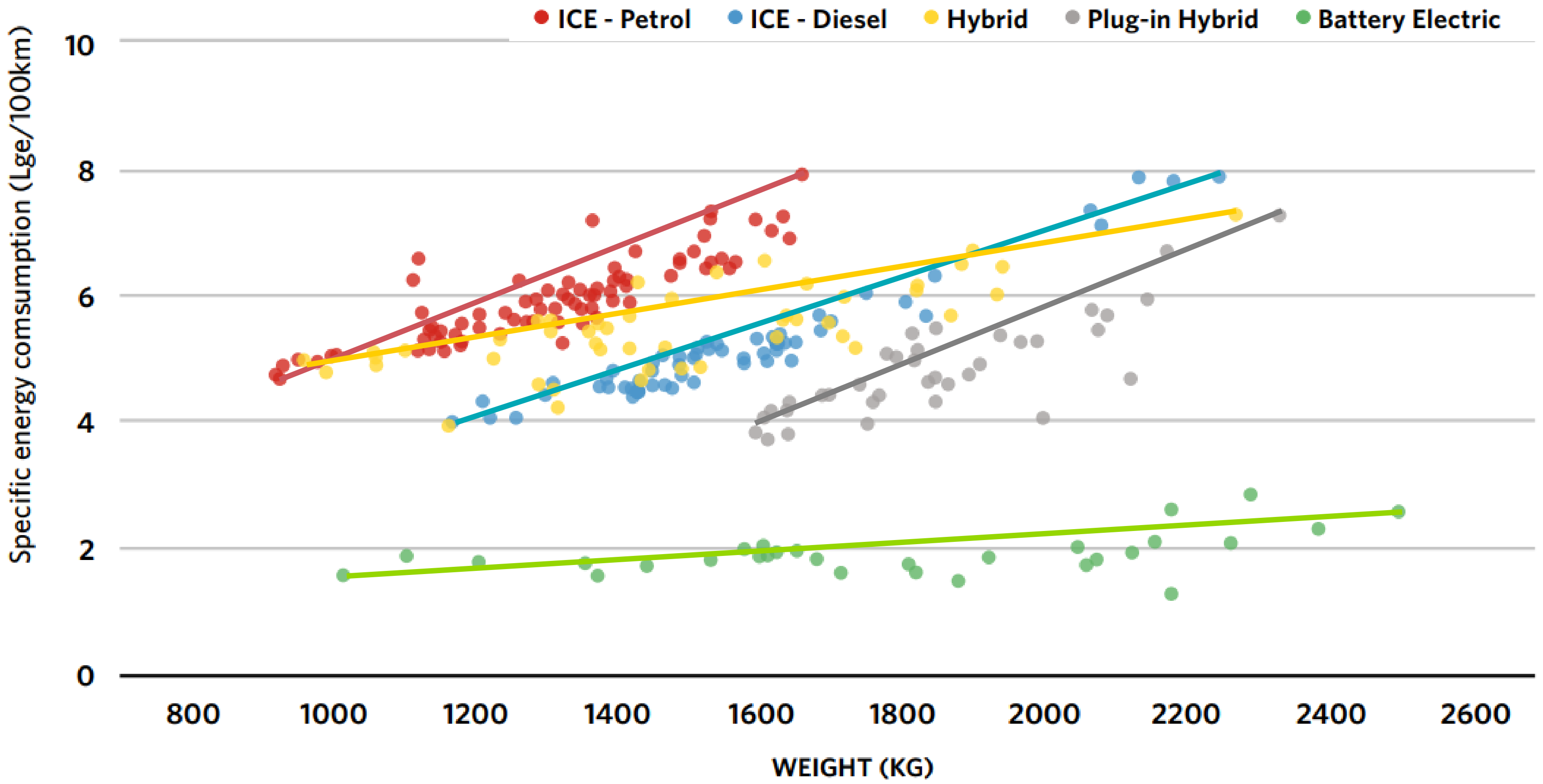
Category	Levers	Description	Estimated efficiency potential (%)
Drive unit improvements	In-wheel motors	In-wheel motors integrate the electric motor into the wheel hub, enhancing overall efficiency by up to 20% and requiring less space by eliminating the need for a conventional drivetrain	-20%
	Other improvements	Reducing iron losses, better wires, etc.	
Tire rolling resistance	Tire rolling resistance	Reducing tire rolling resistance through use of specially designed tires (e.g., Bridgestone)	-18%
Reduce vehicle weight	Higher density batteries	Energy density of Lithium-Ion Batteries will increase by a further 60–80% by around 2035. Solid-State battery is also expected to be the technology of the 2030s.	-20%
	Lightweight materials	Selective use of lightweight materials to replace heavy steel	
Other improvements	Aerodynamic drag	Reduce aerodynamic drag coefficient from 0.28 to 0.17 through closer attention to styling, wheel wells, and vehicle rear geometry	-8%
	Reducing front area	Smarter packaging, reducing width by setting front as well as rear wheels completely flush with the sides	-6%
	Charging improvements	Better charging cables, thicker cables, better thermal management systems in car	-5%
Auxiliaries (excluded in WLTP[1])	Auxiliary improvements	More efficient accessories: A/C, seat heating, optimal in-car energy consumption. Auxiliaries can currently increase electric consumption by up to 50%	-(15-25)%
Total potential improvement	Combined effect of improvements	The combined effect of these modeled improvements for a 2050 high-efficiency car is a doubling of efficiency, from around 20 kWh/100km to 10 kWh/100km	-50%

Note: WLTP: Worldwide harmonized Light vehicles Test Procedures. There is a growing divergence between real-world and WLTP CO_2 emissions data for internal combustion engine cars and hybrid cars. On-board fuel and energy consumption monitoring (OBFCM) devices should be used, especially for EVs.
Sources: Systemiq analysis for the ETC from EPRI (2024), *Valuing Improvements in Electric Vehicle Efficiency;* Fraunhofer (2023), Alternative Battery Technologies Roadmap 2030+; Deepdrive (2023); The ICCT (2023), *Real-world performance of battery electric passenger cars in China;* Global Fuel Economy Initiative (2023), *Trends in the global vehicle fleet 2023;* The ICCT (2023), *Real-world performance of battery electric passenger cars in China*.

The heavier the car, the more it consumes, especially for ICEs that are inherently less efficient and lack the energy recovery capabilities of EVs

Specific energy consumption plotted against vehicle mass, by powertrain for top selling light-duty vehicles in Europe

Lge/100km



In the U.S., a standard **ICE-SUV** weighs 800 kg more and **uses 45% more fuel than a medium car**, while for **EVs, the increase is 33% for the same weight difference**. Reasons are:

1. **EVs are inherently more efficient**, bigger vehicles therefore lose less energy
2. **Regenerative braking benefits larger EVs**, offsetting some energy losses in heavier EVs compared to heavier ICEs.

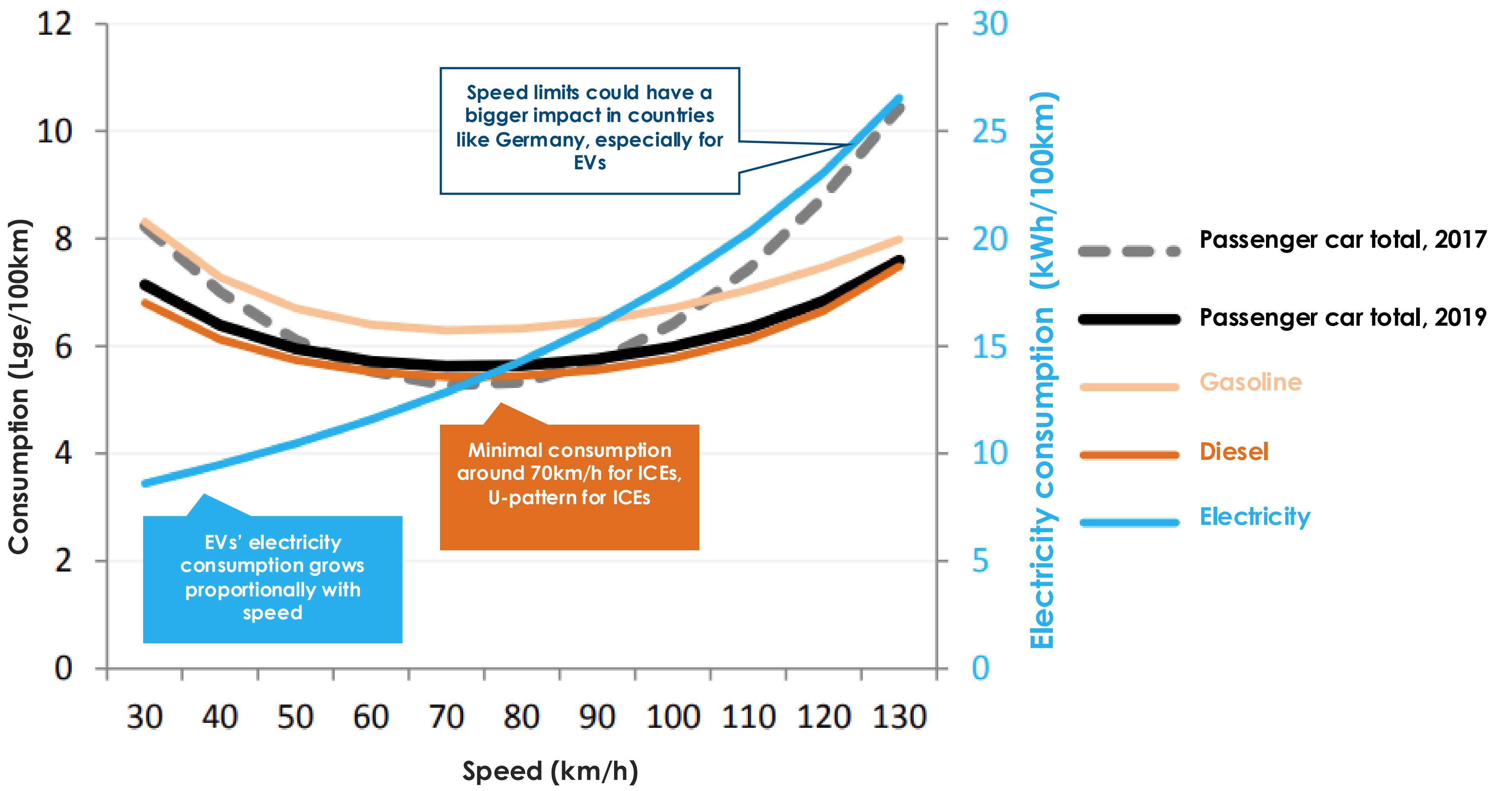
Notes: ICE-SUV means internal combustion SUV. Specific energy consumption for PHEV was calculated using a utility factor derived from the all-electric range reported in the EEA database using a function reflective of real-world usage (Fraunhofer ISI, 2021), specific energy consumption of elecitricty for driving phased in all-electric mode and specific fuel consumption for other driving phases.

Source: Systemiq analysis for the ETC; Global Fuel Economy Initiative (2023), *Trends in the global vehicle fleet 2023*; IEA (2023), *Energy Efficiency 2023*

Speed greatly impacts efficiency: High speeds degrade ICE performance, while EV energy use increases proportionally with speed

Relationship between speed and energy consumption for passenger vehicles

Km/h, Lge/100km, kWh/100km



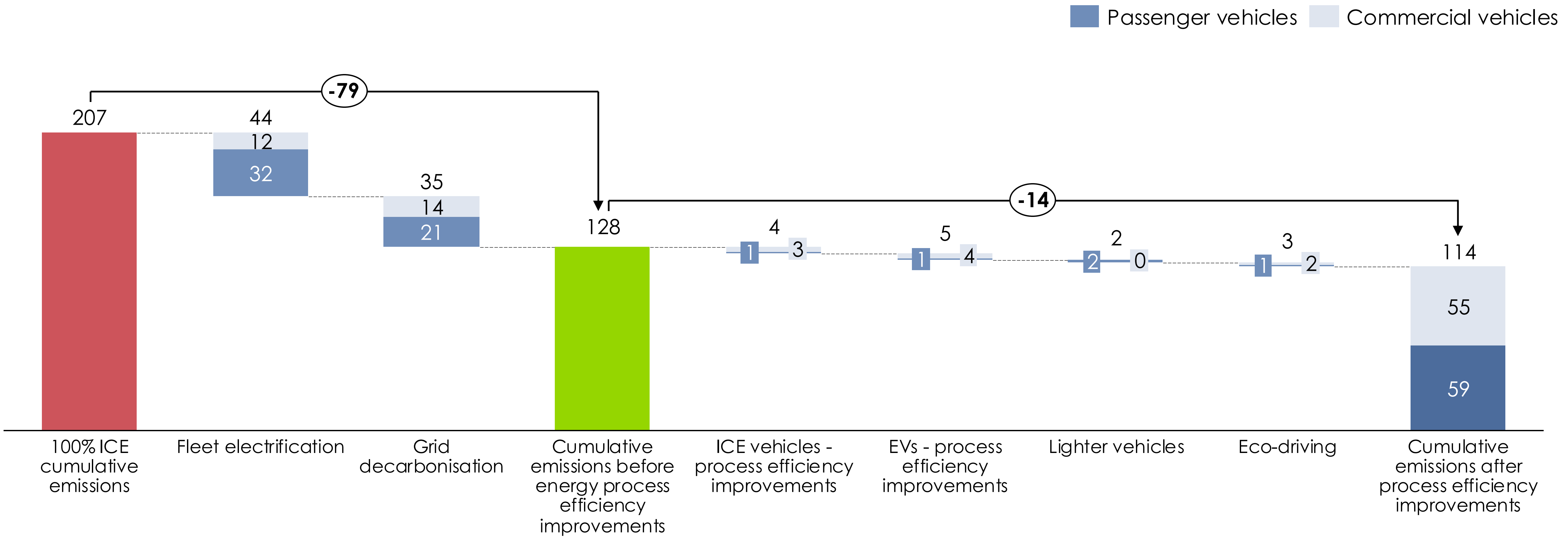
Notes: Lge: liter of gasoline equivalent

Source: Systemiq analysis for the ETC; Aurelien Bigo (2020), *Vitesse des déplacements : accélération au 20ème siècle, ralentissement au 21ème ?*; BonPote (2022), *10 reasons to lower speed limits on highways*

Combining electrification and energy process efficiency levers could reduce road sector emissions from 207 $GtCO_2$ to 114 $GtCO_2$

Projected cumulative CO_2 emissions between 2023 and 2050 in a full ICE scenario vs with energy productivity levers

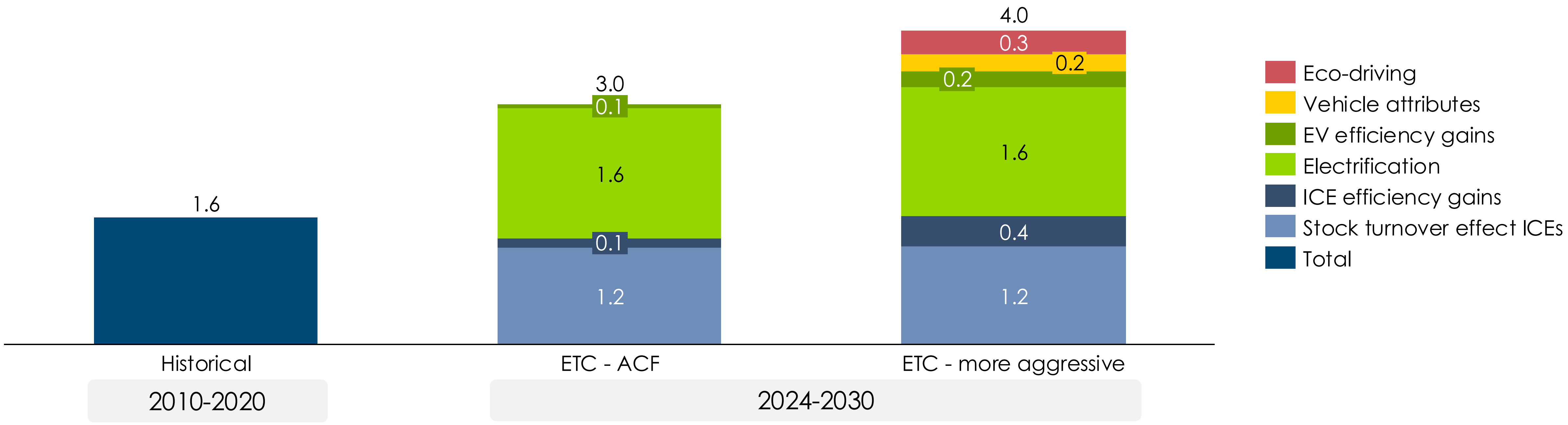
$GtCO_2$



Note: All ICE means Internal Combustion Engine Vehicles, EV means Electric Vehicles. We consider that the combustion of a barrel of oil equivalent results ~405 kg CO_2.
Source: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Passenger car energy productivity could improve by 3-4% annually

Passenger cars: annual % improvement in energy productivity as % of GDP
%



- New ICE efficiency improvements: 0.7% p.a.
- New EV efficiency improvements : 1.6% p.a.

- New ICE efficiency improvements: 2.5% p.a.
- New EV efficiency improvements : 6% p.a. until 2035
- Ban on vehicles above 1,8 tons
- 20km/h speed limit on highways

Notes: 1. Past improvements were driven by an increase in the share of electric vehicles in fleets, continued improvements in engine technology and the introduction of hybrid powertrains.
Sources: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Service efficiency potential could be large, but uncertain

Big European cities are enforcing measures to reduce demand for polluting ICEs and incentivise modal shift towards cleaner transport modes

Oslo: Planning to establish a **ZEZ in the city center** area, overlapping with the car-free zone

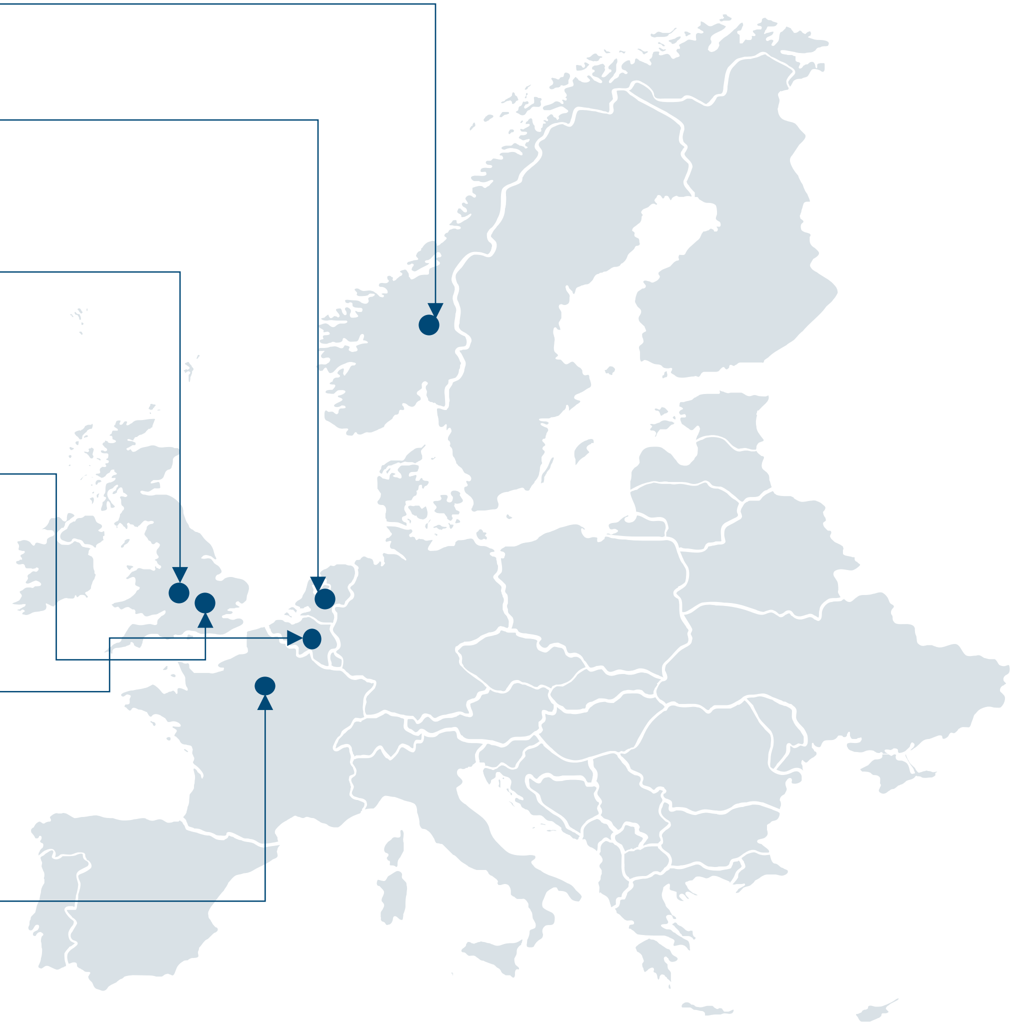
Amsterdam:
- Remove **>10,000 parking spaces** by 2025
- **Bicycle Plan of €54 million** between 2017 and 2022

Oxford:
- Reduce **car trips by a quarter by 2030** and achieve **net-zero transport by 2040**
- City plans to install **more ZEZ enforcement cameras**

London:
- In 2017, the mayor introduced a **£42 million taxi delicensing scheme to scrap older diesel taxis** for zero-emission capable vehicles.
- With the planned expansion of the ULEZ, the city introduced a **new £110 million vehicle-scrappage scheme**

Brussels:
- Good Move plan aims to **reduce private car use by 24% in Brussel**
- Bruxell'Air scheme offers a **bonus for scrapping a car** in exchange **for active modes**, **public transport or car sharing**

Paris:
- Recently allocated **€250 million for 180 km of new cycling roads** and over **130,000 new bicycle parking spaces**
- Government offers up **to €4,000 to low-income households in the LEZ for swapping their old ICE for e-bikes**

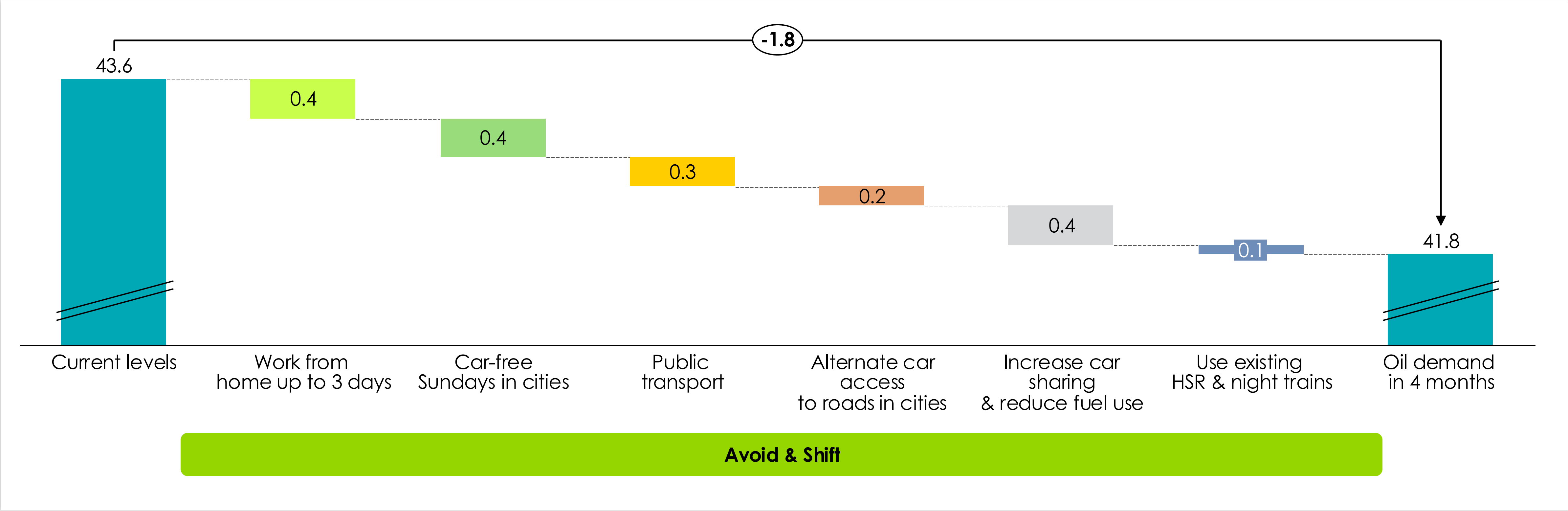


Notes: LEZ = Low Emission Zones, ZEZ: Zero Emission Zones
Sources: Systemiq analysis for the ETC; The ICCT (2023), *Planning and implementation of low- and zero-emission zones in cities*

Avoid & shift levers could displace ~1.8 mb/d overnight according to the IEA

Oil demand reductions in advanced economies within four months in the IEA's 10-Point Plan*, 2022

Mb/d

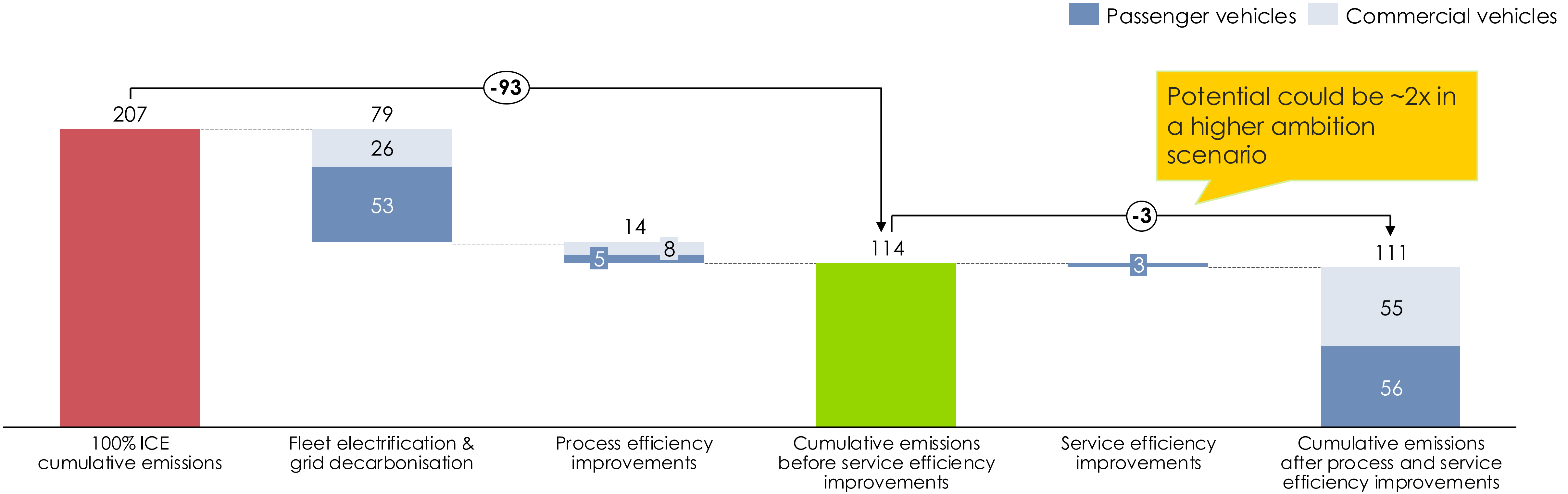


Notes: HSR = high-speed rails. *In the face of the emerging global energy crisis triggered by Russia's invasion of Ukraine, the IEA's 10-Point Plan to Cut Oil Use proposes 10 actions that can be taken to reduce oil demand with immediate impact – and provides recommendations for how those actions can help pave the way to putting oil demand onto a more sustainable path in the longer term. Only 6 points related to avoid & shift in passenger road transport are highlighted.

Sources: Systemiq analysis for the ETC; IEA (2022), *A 10-Point Plan to Cut Oil Use*

Combining electrification, energy process and service efficiency levers could reduce road sector emissions from 207 $GtCO_2$ to 111 $GtCO_2$

Projected cumulative CO_2 emissions between 2023 and 2050 in a full ICE scenario vs with energy productivity levers
$GtCO_2$

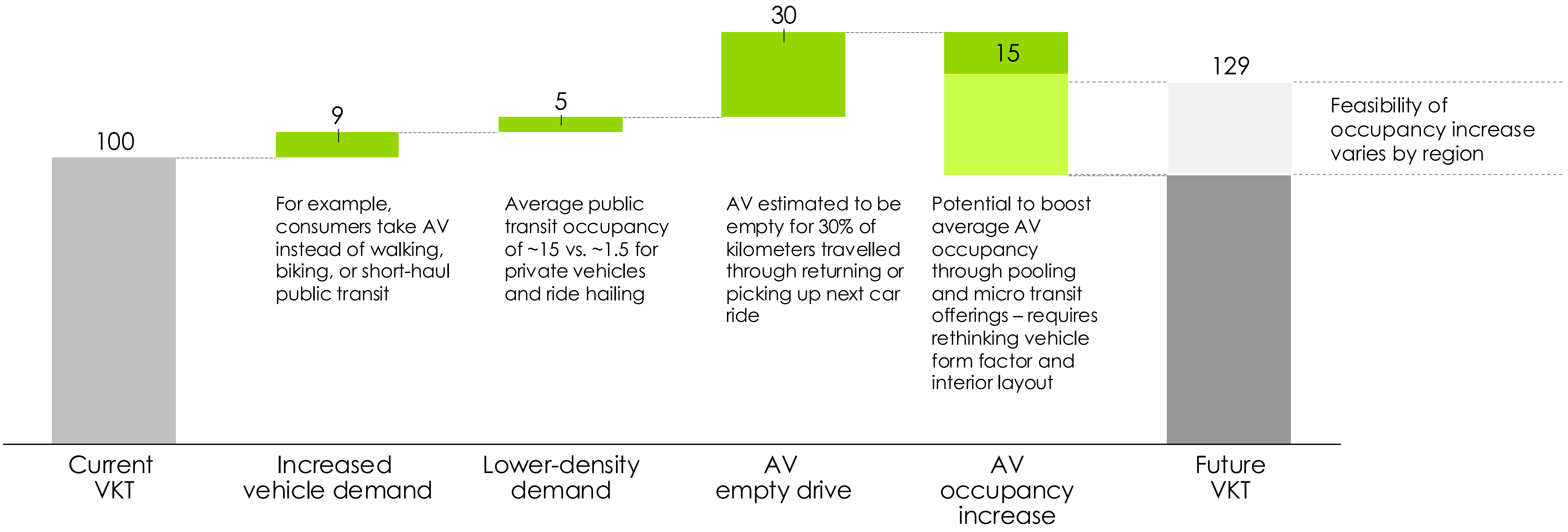


Note: All ICE means Internal Combustion Engine Vehicles, EV means Electric Vehicles. We consider that the combustion of a barrel of oil equivalent results ~405 kg CO_2.
Source: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Autonomous vehicles- an ambivalent effect

Ambivalent impact of autonomous vehicles on total passenger car demand

Illustrative effects of autonomous vehicles on vehicle kilometers travelled (VKT)



Notes: AV refers to autonomous vehicles; pooling refers to rides shared with other passengers; vkt refers to vehicle kilometers traveled.
Sources: Systemiq analysis for the ETC; BCG analysis (2022)

For commercial road transport, rise of autonomous vehicles could lead to increased efficiency

Energy process efficiency

- **Vehicle attributes**: Removing human-centric features and optimising vehicle design for autonomous operation can reduce weight and improve aerodynamics (e.g. truck cabin redesigned).
- **Limiting highway speeds**: More consistent driving at optimal speeds reduces fuel consumption by maintaining lower speeds without the pressure of limited driving hours .
- **Eco-driving:** Autonomous trucks can consistently apply optimal driving techniques, such as efficient acceleration, braking, and coasting, to save fuel.

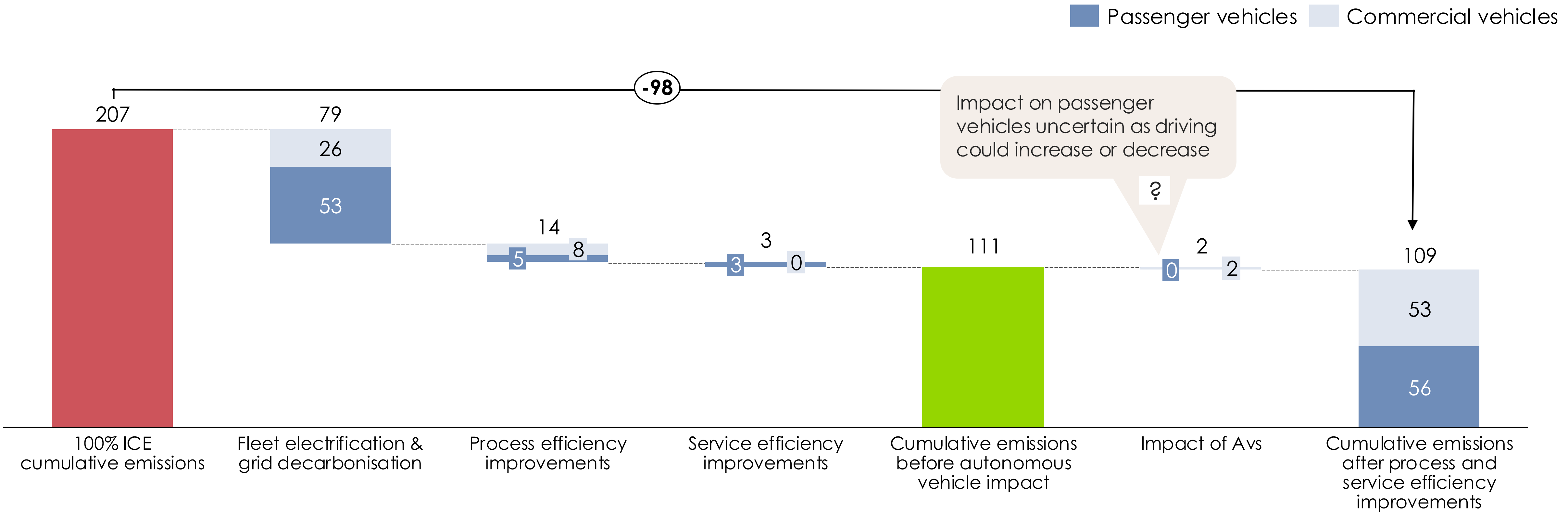
Service efficiency

- **Reducing idling:** Eliminating driver rest breaks cuts down on idle time and fuel wastage.
- **Deadhead reduction:** By optimising logistics, autonomous trucks can minimise empty "deadhead" miles (currently ~15% of truck mileage in the U.S), reducing overall fuel use.
- **Off-peak driving:** Autonomous trucks can operate nearly 24/7, significantly increasing vehicle utilisation and reducing operational costs by shifting to low congestion times.

Source: Transport and environment report (2022), *Digitalisation in the mobility system: challenges and opportunities, Annex 3 Autonomous freight transport,* Aurora (2024), *The Sustainability Opportunity of Autonomous Trucking.*

Combining electrification, process energy and service efficiency levers, and autonomous vehicles could reduce road sector emissions from 207 $GtCO_2$ to 109 $GtCO_2$

Projected cumulative CO_2 emissions between 2023 and 2050 in a full ICE scenario vs with energy productivity levers
$GtCO_2$



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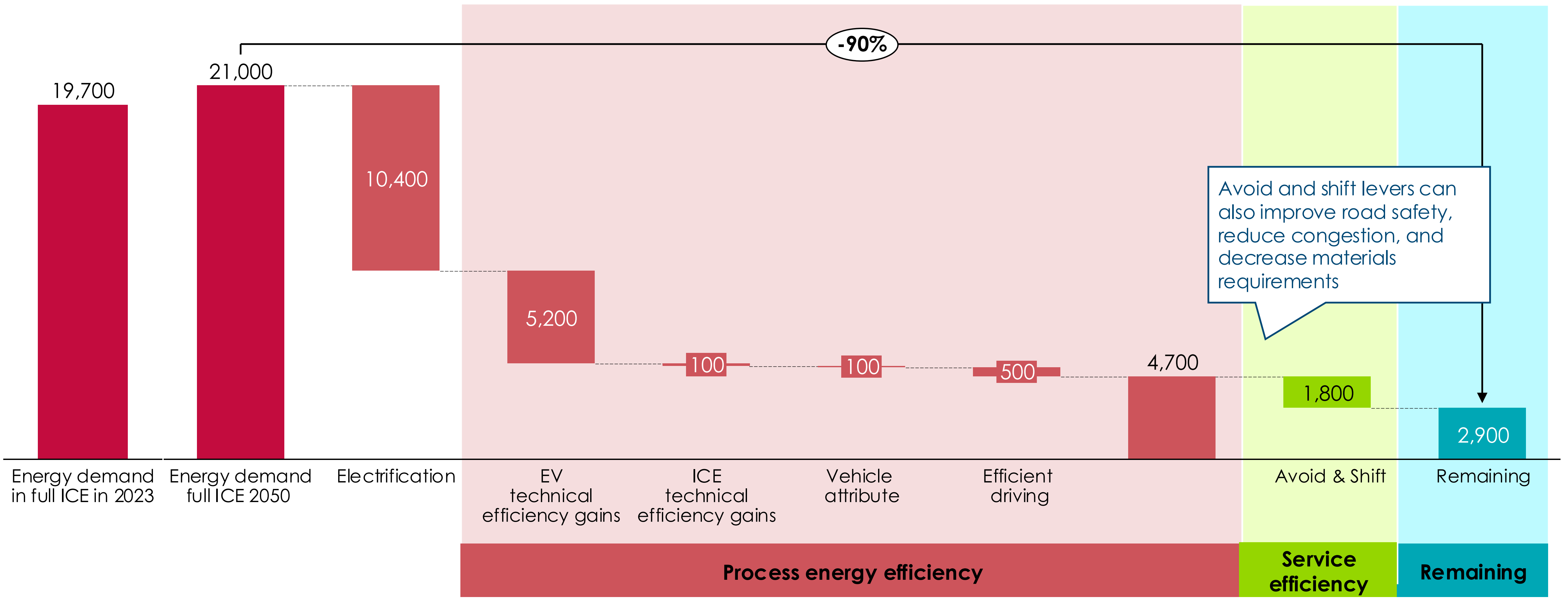
Source: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Summary conclusions

Passenger car final energy demand reduction: suite of levers is critical

Passenger car final energy demand in 2050 and impact of energy productivity levers
TWh

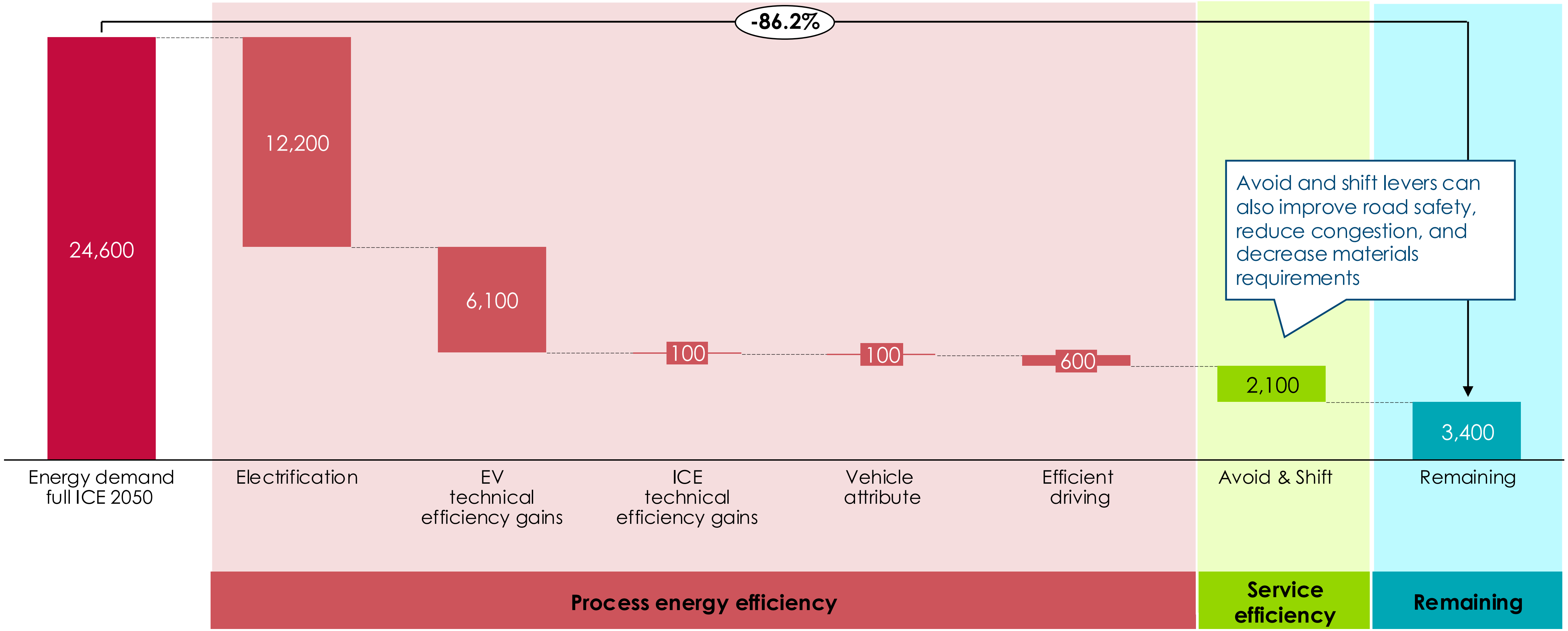


Note: ICE means Internal Combustion Engine Vehicles, EV means Electric Vehicles. Productivity levers: 20% efficiency gains for ICEs by 2050, 50% efficiency gains for EVs by 2035, 20km/h speed limit reduction on highways and 30km/h speed limit in urban areas, 36% demand reduction by 2050 through Avoid & Shift levers. Final Energy Demand attributed by lever with LMDI (Logarithmic Mean Divisia Index) methodology. For Primary Energy demand, energy efficiency of 85% from fossil fuel extraction to tanker, and for renewables power (e.g., electricity conversion and transmission losses) is taken,
Source: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Passenger car primary energy demand reduction: suite of levers is critical

Passenger car primary energy demand in 2050 and impact of efficiency levers

TWh

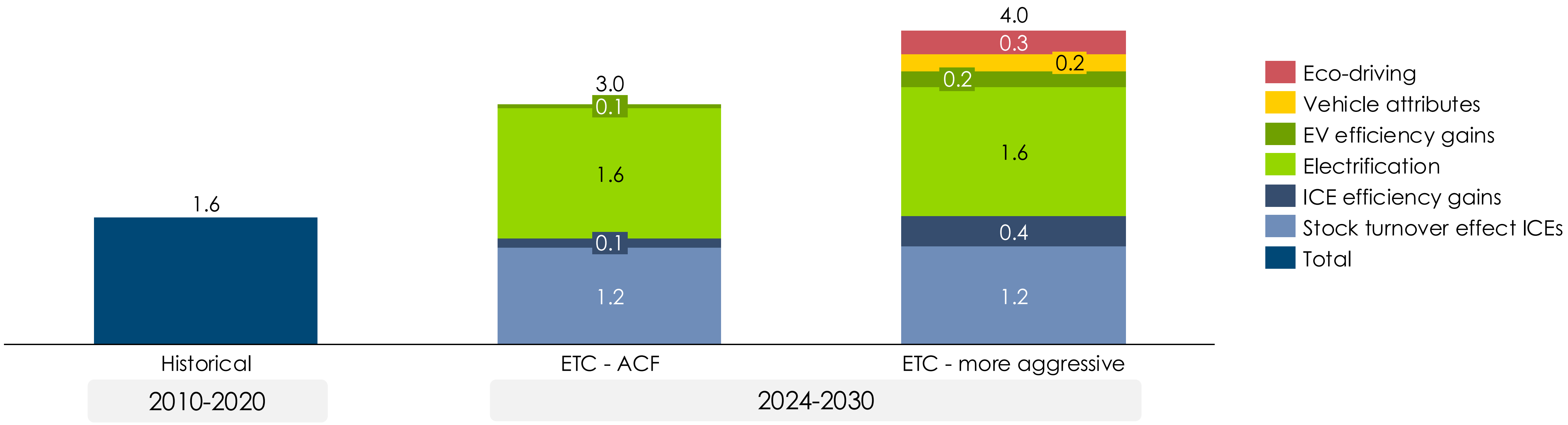


Note: ICE means Internal Combustion Engine Vehicles, EV means Electric Vehicles. Productivity levers: 20% efficiency gains for ICEs by 2050, 50% efficiency gains for EVs by 2035, 20km/h speed limit reduction on highways and 30km/h speed limit in urban areas, 36% demand reduction by 2050 through Avoid & Shift levers. Final Energy Demand attributed by lever with LMDI (Logarithmic Mean Divisia Index) methodology.

Source: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Passenger car energy productivity could improve by 3-4% annually

Passenger cars: annual % improvement in energy productivity as % of GDP
%



- New ICE efficiency improvements: 0.7% p.a.
- New EV efficiency improvements : 1.6% p.a.

- New ICE efficiency improvements: 2.5% p.a.
- New EV efficiency improvements : 6% p.a. until 2035
- Ban on vehicles above 1,8 tons
- 20km/h speed limit on highways

Notes: 1. Past improvements were driven by an increase in the share of electric vehicles in fleets, continued improvements in engine technology and the introduction of hybrid powertrains.
Sources: Systemiq analysis for the ETC; ETC (2023), *Fossil Fuels in Transition: Committing to the phase-down of all fossil fuels*

Key actions for policymakers & industry

- **Fleet electrification and grid decarbonisation** should remain critical priorities for all stakeholders, especially policymakers.

- **Ensure proper vehicle Scrappage:** With the accelerated pace of fleet electrification, ensuring proper old ICE scrappage should also be a key priority for policymakers to prevent these polluting vehicles from ending up in second-hand markets.

- **Process Energy Efficiency:** Energy efficiency improvements can be achieved with ambitious policies.

- **Service Efficiency Policies:** Service efficiency relies on systemic transformation and behavioural changes, requiring all stakeholders to work hand in hand.

- **Autonomous vehicles:** Given the rebound effect associated with autonomous vehicles, it is crucial for regulators and OEMs to prioritise their appropriate applications to ensure climate-positive impacts.