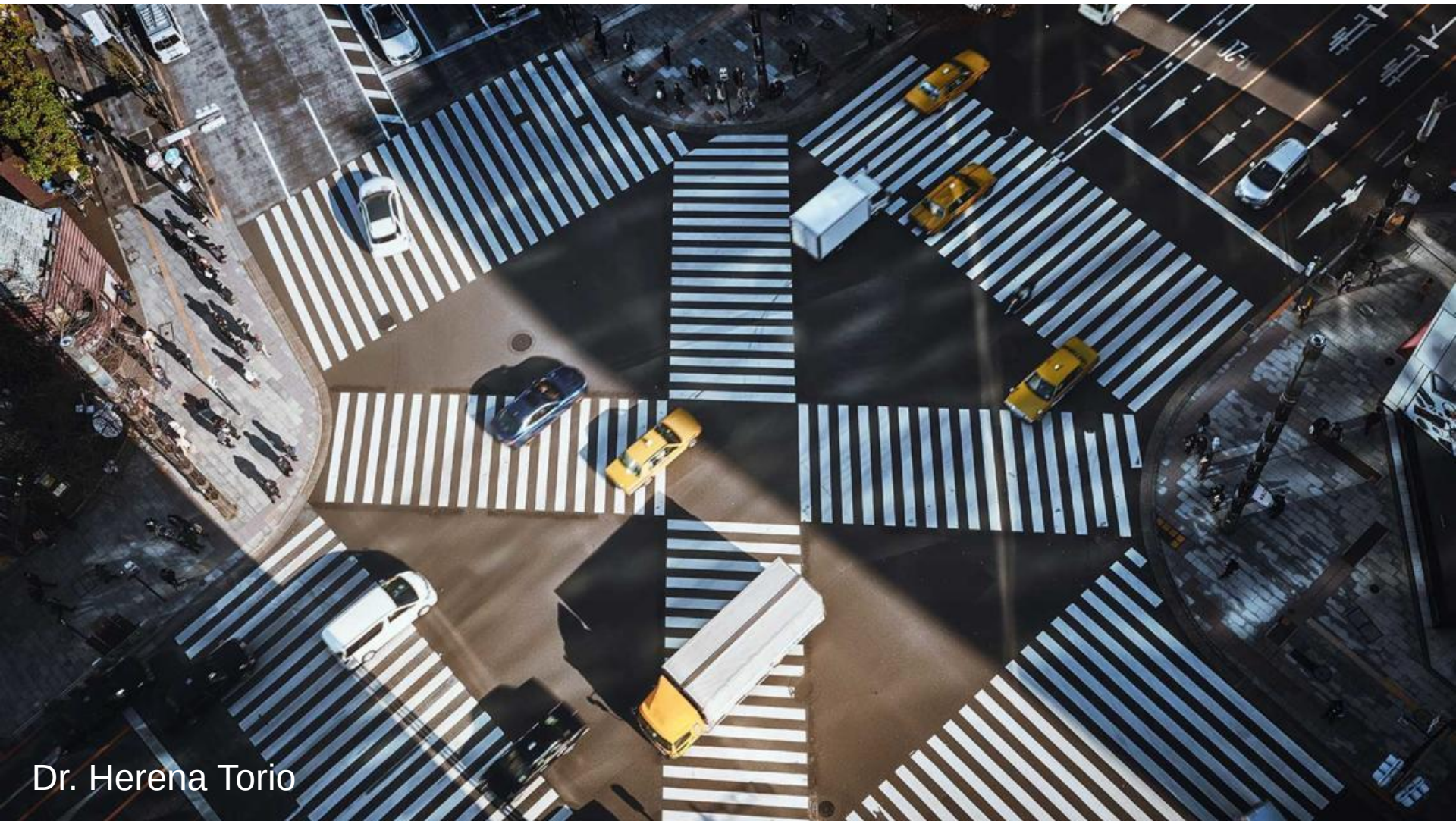


Introduction to Mobility



Dr. Herena Torio

Content

Part I: Mobility Status

- Indicators
- Global Facts and Trends
- Summary

Part II: Ways out?

- RE Supply
- E-mobility
- Side effects

References

Selected Passenger Mobility Parameters



Vehicle-km

Vehicle x km



Person-km

Travelled km x “moved” people
(Goods: Travelled km x Tons)



Fatality Rate

Fatalities / 100.000 inhabitants

Selected Passenger Mobility Parameters



Motorisation Rate
cars / Mio inhabitants



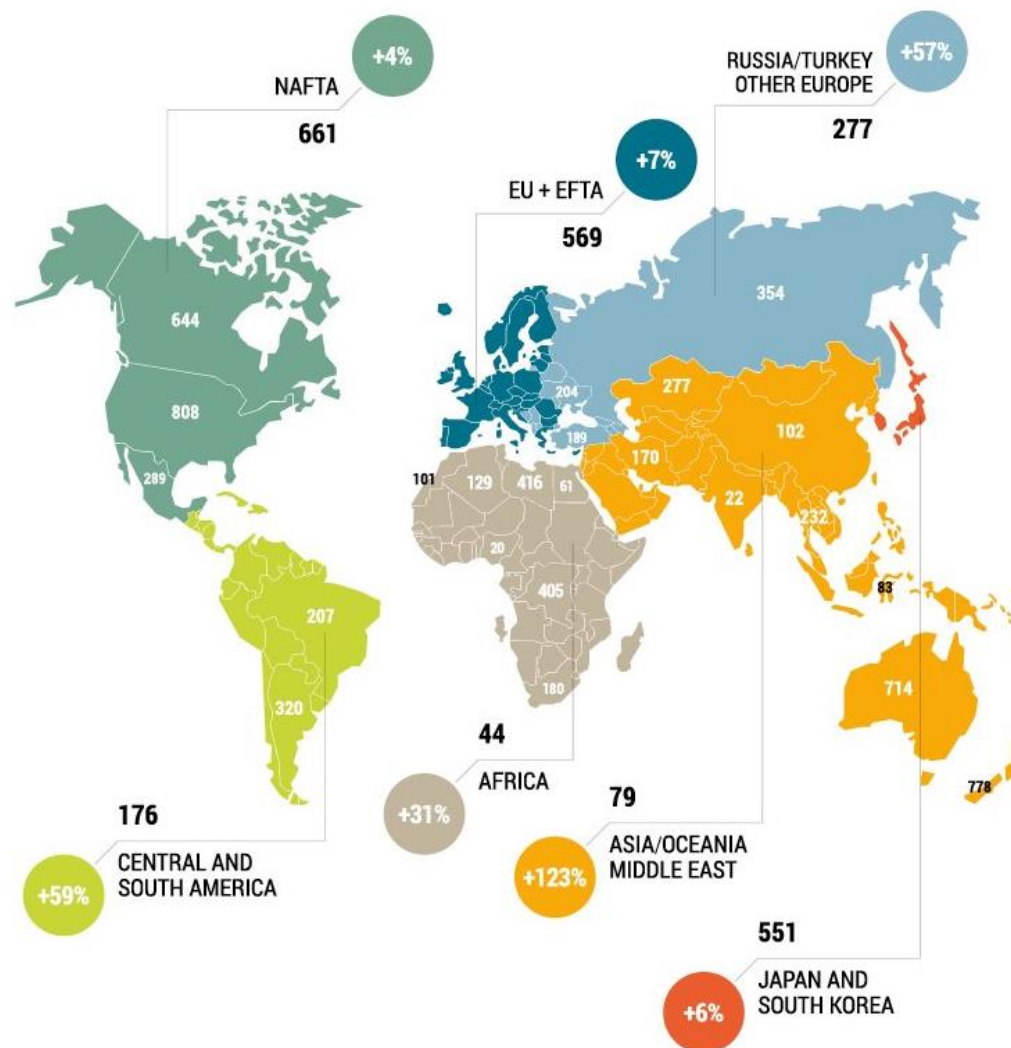
Modal Share / Split

percentage of travelers using a particular
type of transportation or number of trips
using said type



Motorisation rate per 1,000 inhabitants

IN UNITS, % CHANGE
2014 – 2005



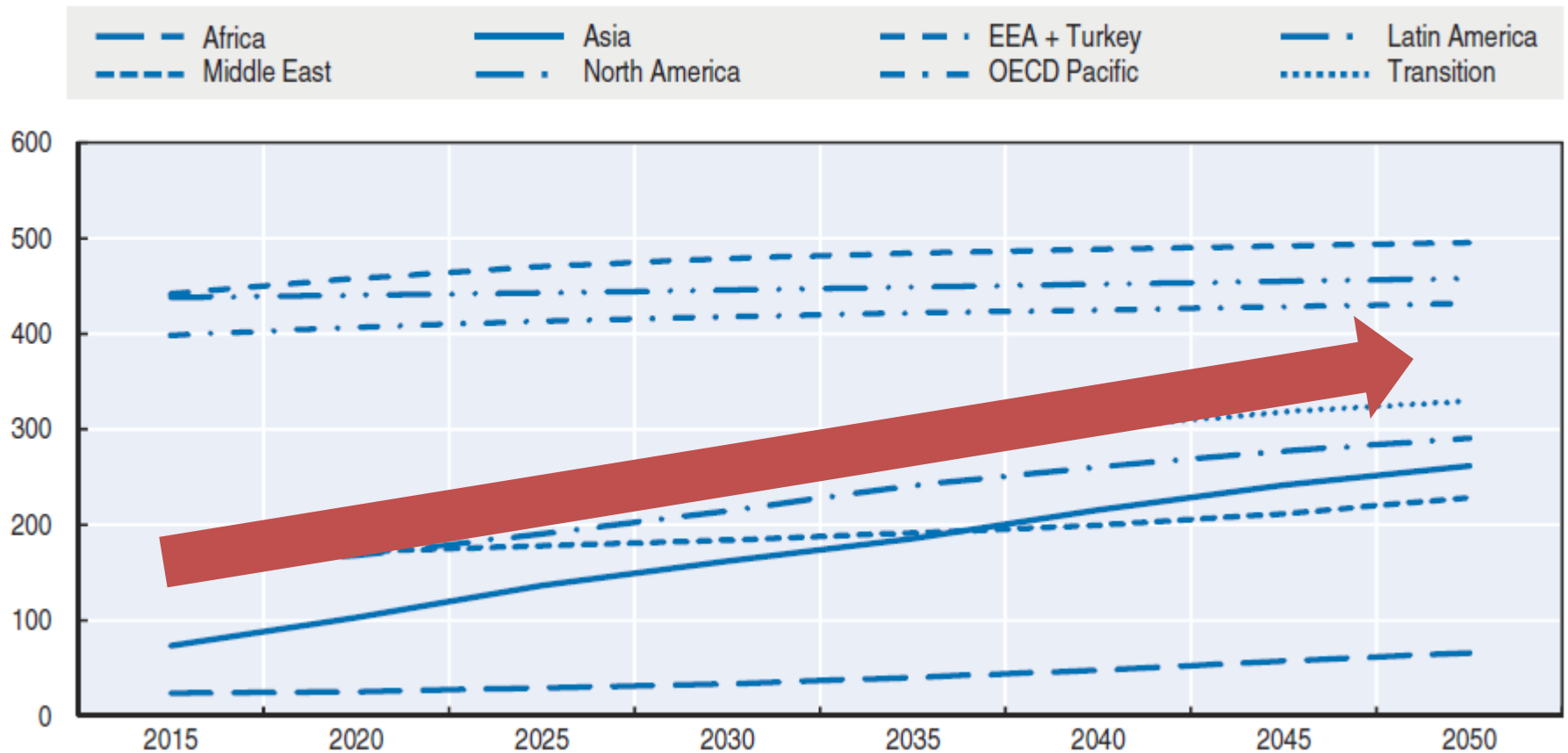
WORLD 180 vehicles per 1,000 inhabitants (+25%)

SOURCE: OICA

Motorisation rate

Figure 2.3. **Passenger car ownership by region**

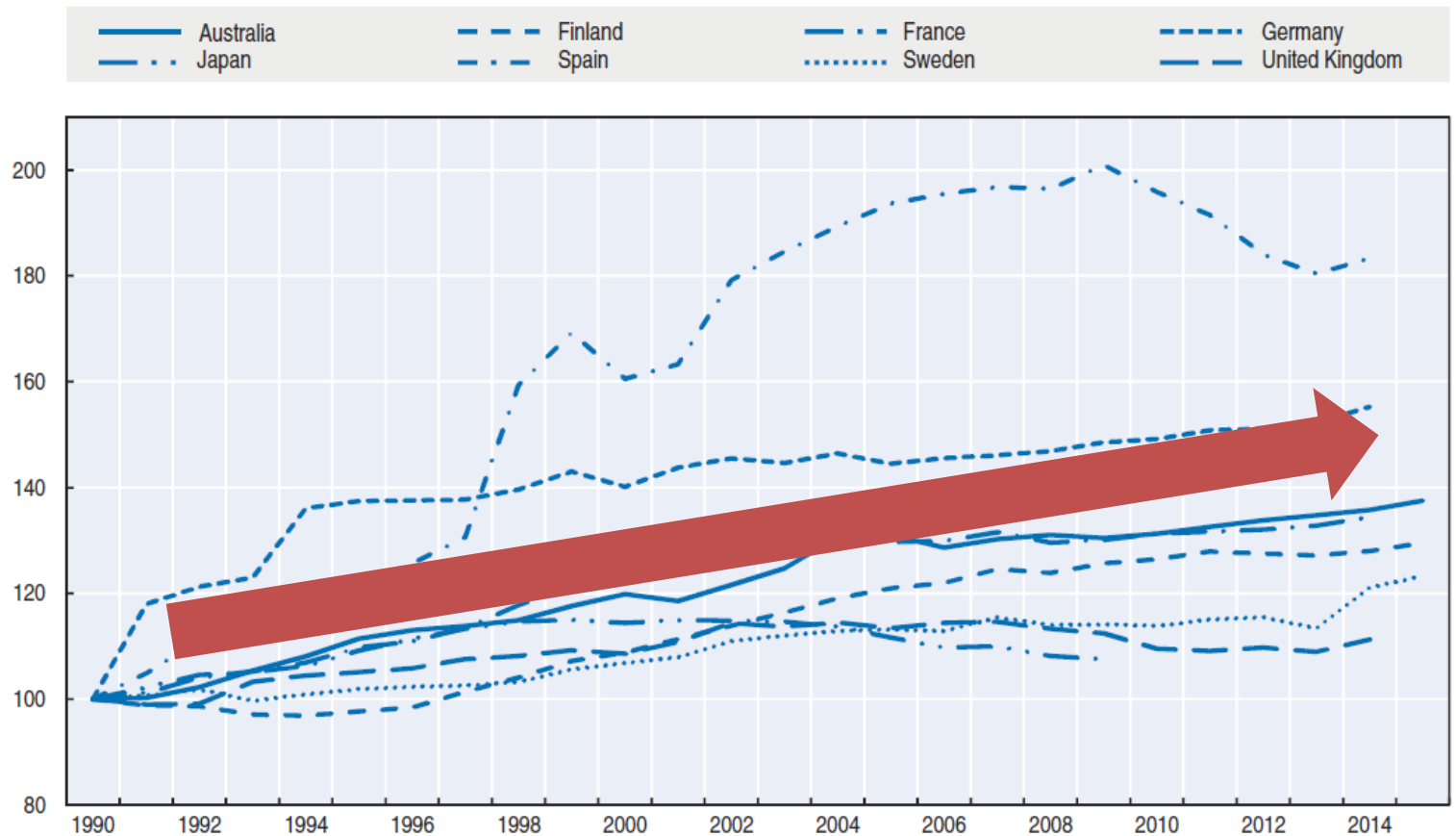
Passenger car per thousand inhabitants, baseline scenario



Passenger kilometers

Figure 1.9. **Passenger-kilometres by private car**

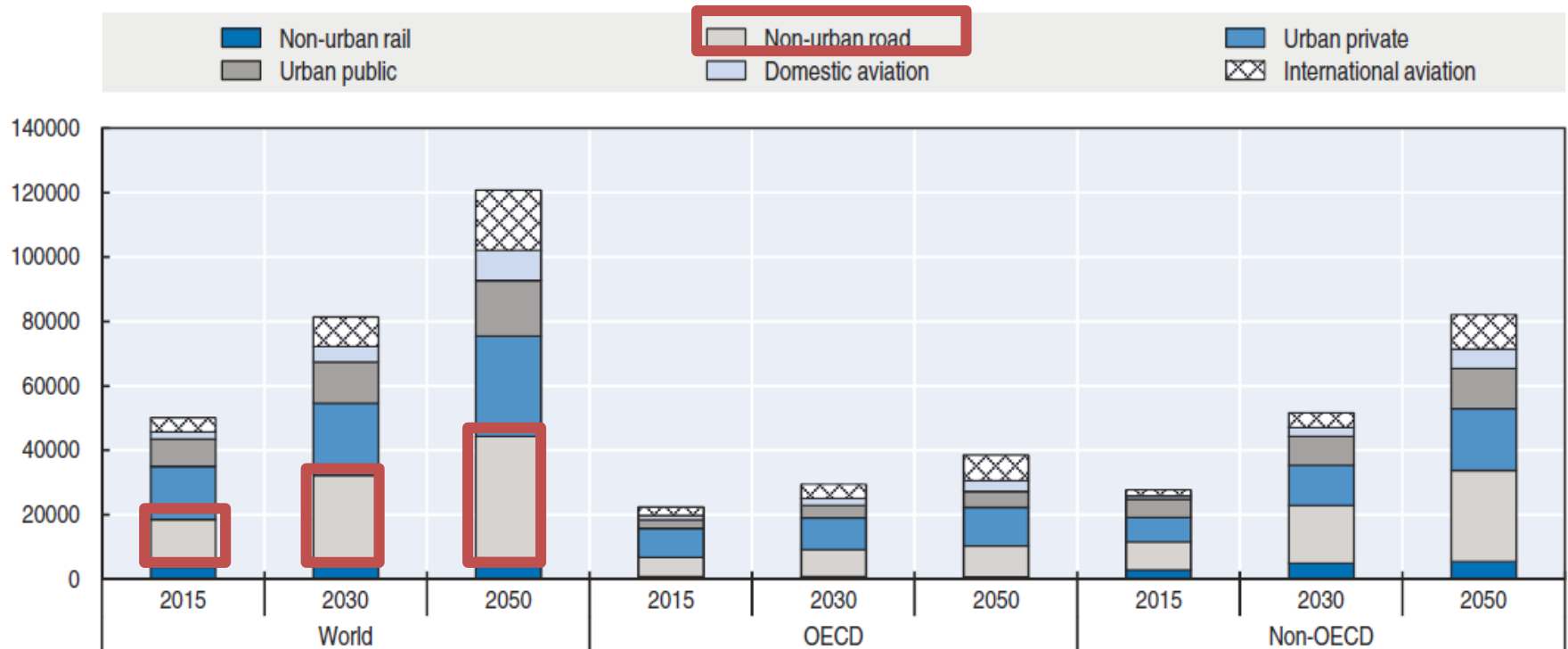
1990 = 100



Passenger kilometers

Figure 2.1. **Demand for passenger transport by mode**

Billion passenger-kilometres, baseline scenario

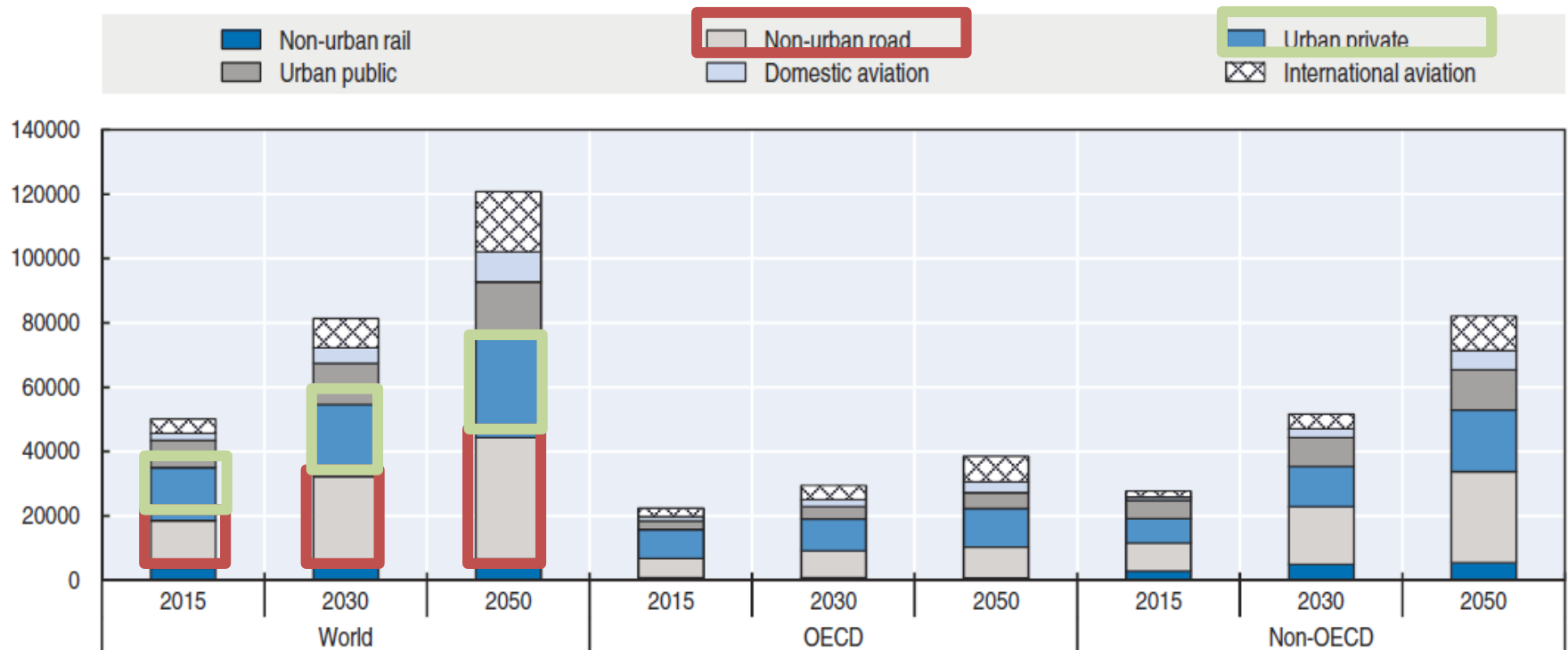


Note: International passenger numbers are divided equally between the country of origin and the country of destination.

Passenger kilometers

Figure 2.1. **Demand for passenger transport by mode**

Billion passenger-kilometres, baseline scenario

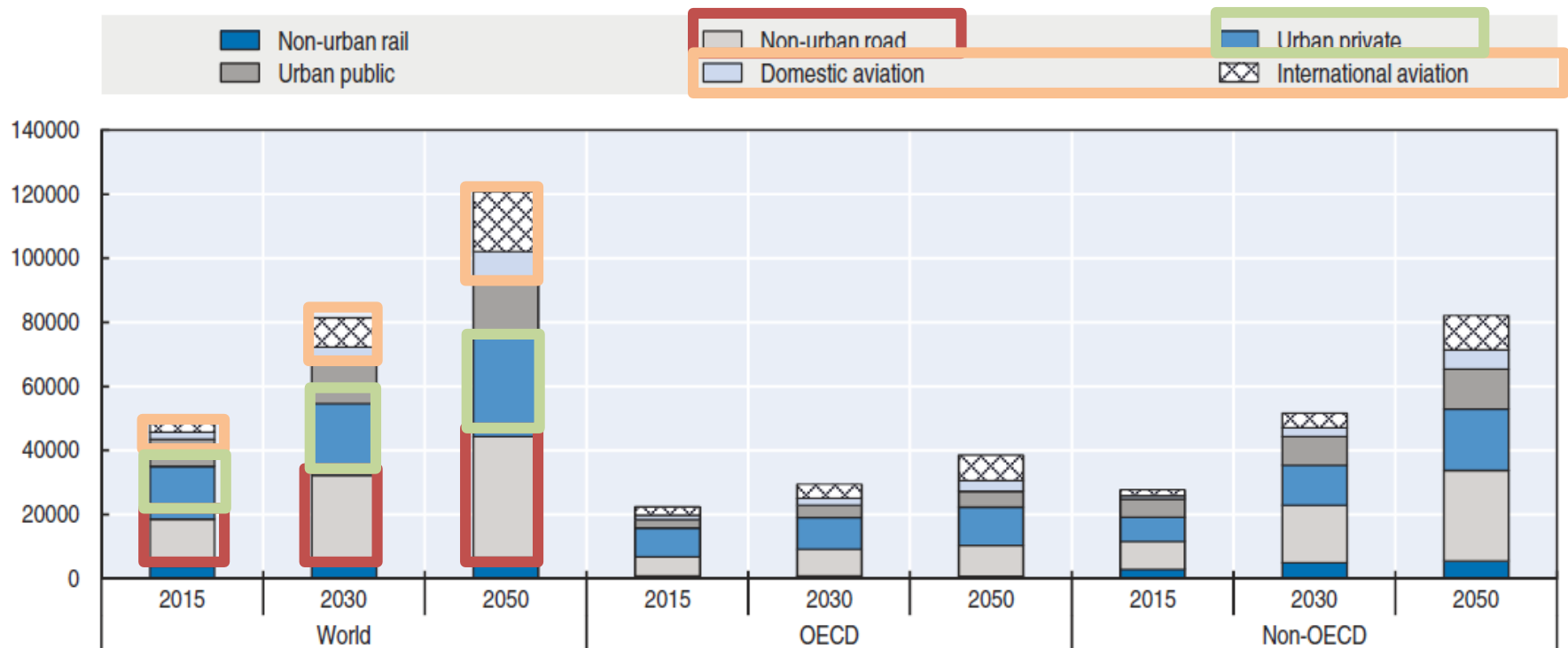


Note: International passenger numbers are divided equally between the country of origin and the country of destination.

Passenger kilometers

Figure 2.1. **Demand for passenger transport by mode**

Billion passenger-kilometres, baseline scenario

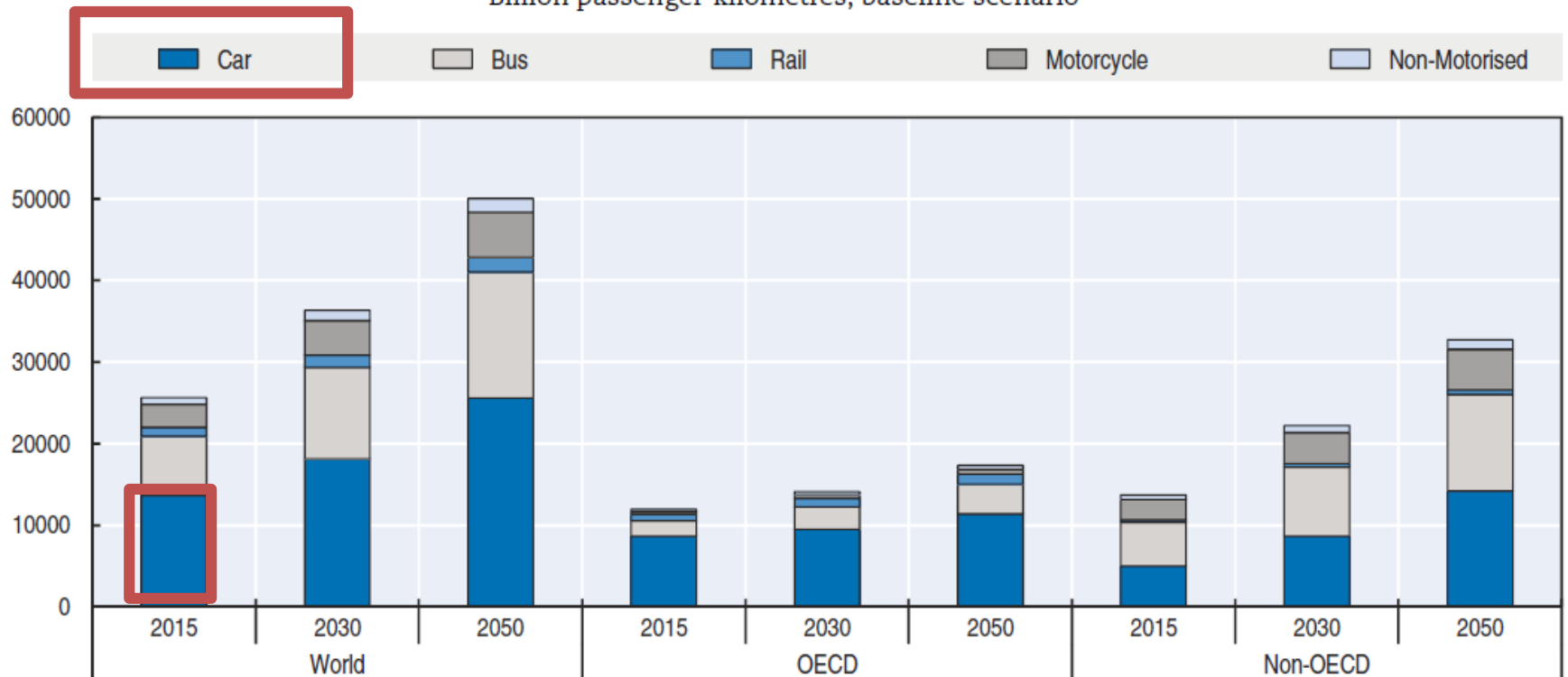


Note: International passenger numbers are divided equally between the country of origin and the country of destination.

Passenger kilometres: Modal split

Figure 2.5. **Urban transport demand by mode**

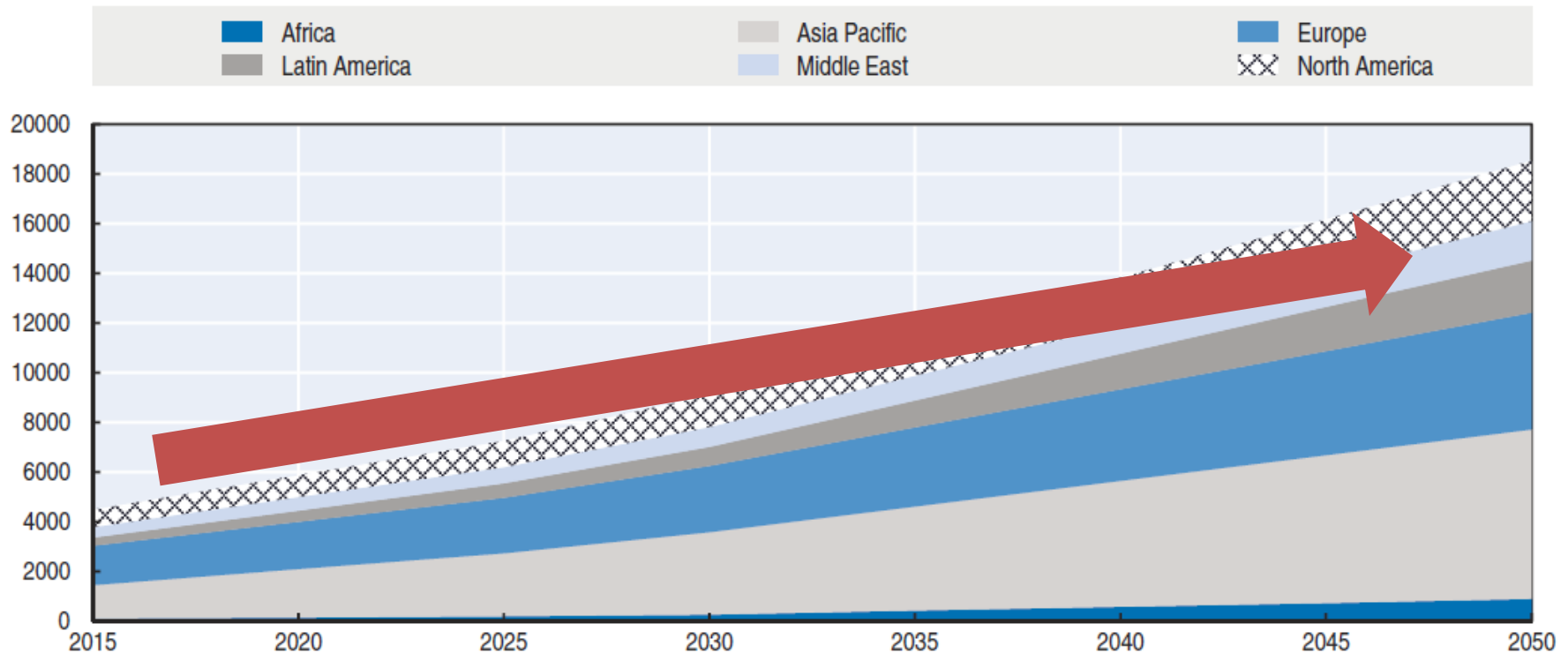
Billion passenger-kilometres, baseline scenario



Passenger kilometres: Air travels

Figure 2.6. **International air transport demand by region**

Billion passenger-kilometres, by region of origin, baseline scenario



Emissions from aviation

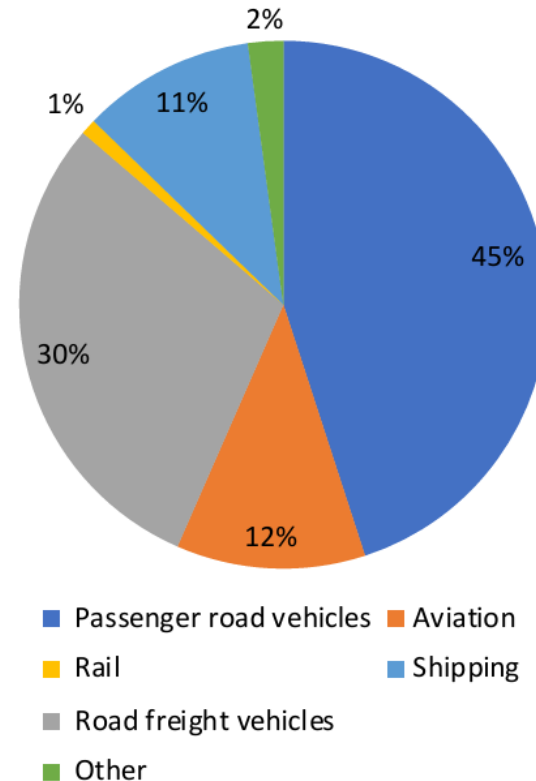
Meaningful alternatives pls?

Short haul flights (<1000 km)

- 13% of all flights
- 19% of CO₂ emissions from aviation

(Source: Global Mobility Report, 2022)

Figure 2.4: Global Transport sector carbon dioxide emissions by mode in 2020



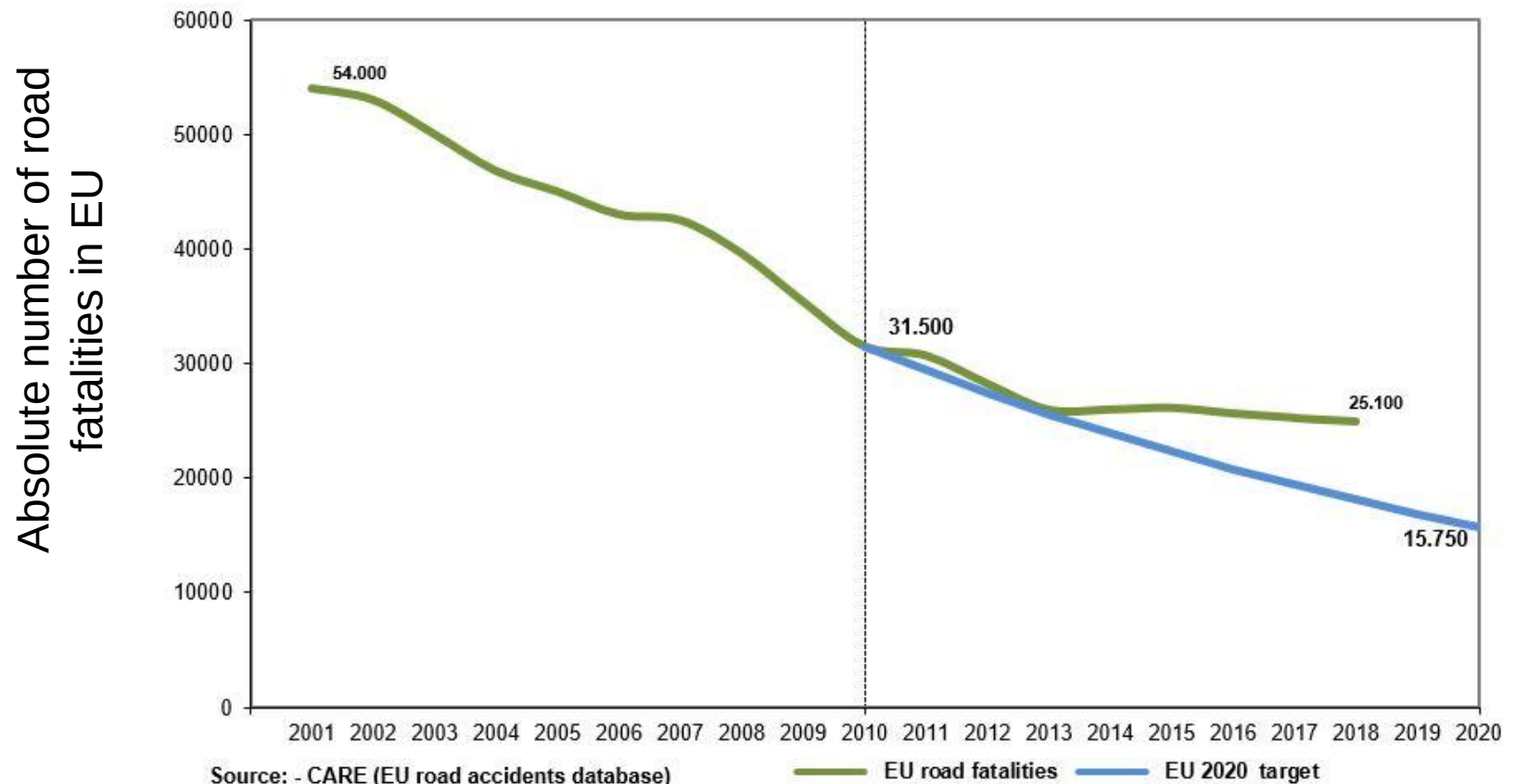
Source: International Energy Agency raw data with authors' analysis.
Note: "Other" includes pipeline and non-specified transport. In terms of the absolute level of emissions, road passenger transport contributed 3.64 GtCO₂e, while road freight transport contributed 2.41 GtCO₂e, aviation contributed 0.94 GtCO₂e, shipping contributed 0.86 GtCO₂e, rail transport contributed 0.08 GtCO₂e and others including pipeline and non-specified transport contributed 0.17 GtCO₂e.

Fatalities

Developed countries: ca. 7 per 100000 inhabitants

Development countries: ca. 21 per 100000 inhabitants

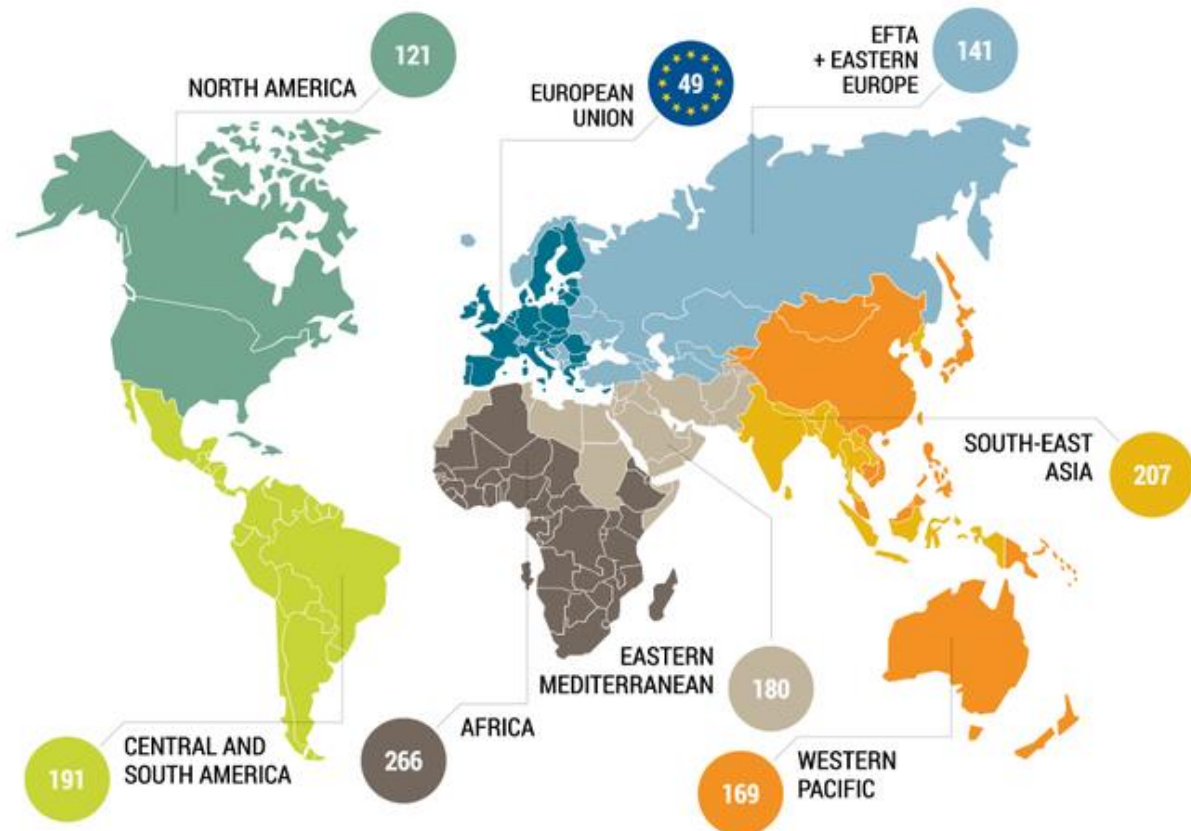
(Source: Global Mobility Report, 2022)



https://ec.europa.eu/commission/presscorner/detail/en/MEMO_19_1990

Road fatalities per million inhabitants (world)

BY REGION
2016



ACEA

WORLD

182 road fatalities per million inhabitants

SOURCE: CARE (EU ROAD ACCIDENTS DATABASE), WHO (WORLD HEALTH ORGANIZATION)

Source, ACEA, 2018

acea.be



linkedin.com/company/ACEA

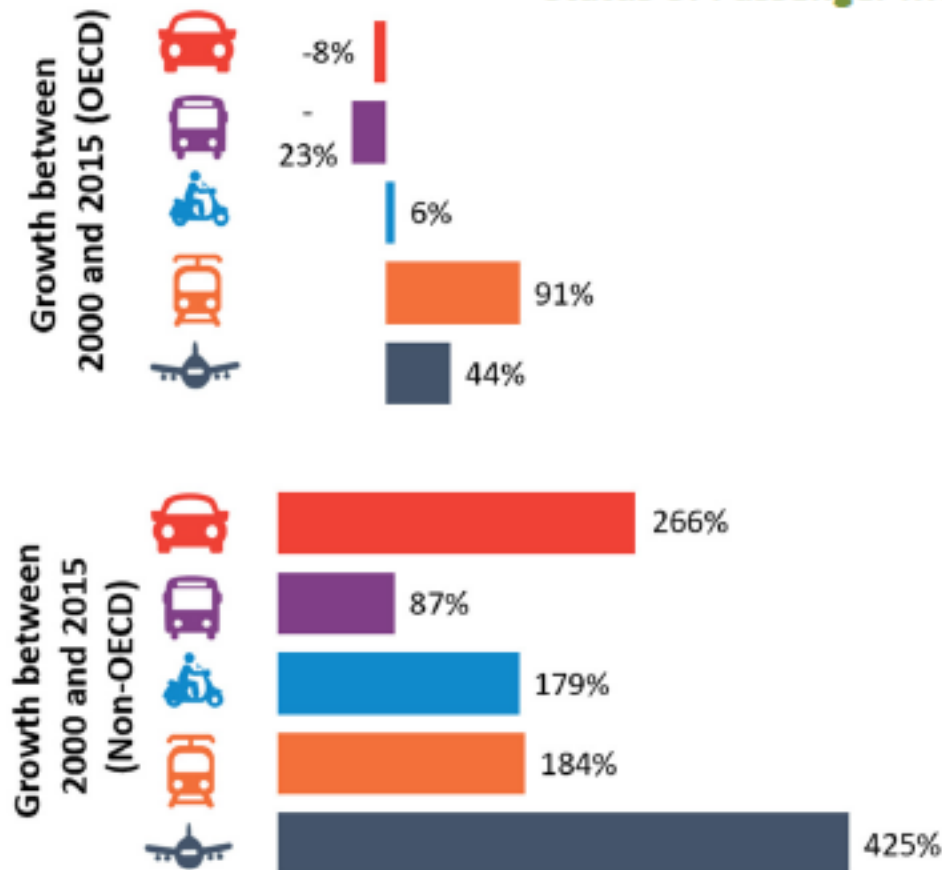


twitter.com/ACEA_eu



Travel demand growing worldwide, spurring increase in private motorization

Status of Passenger Mobility



- Modal share shifts rapidly towards **private autos and air travel**
- **Public transport services** being less used in OECD and have slow growth in non-OECD

The role of income

24 African countries → less than 1% of total transport emissions!

(Source: Global Mobility Report, 2022)

Figure 2.3: Performance on GHG emissions per capita by regions for developing countries

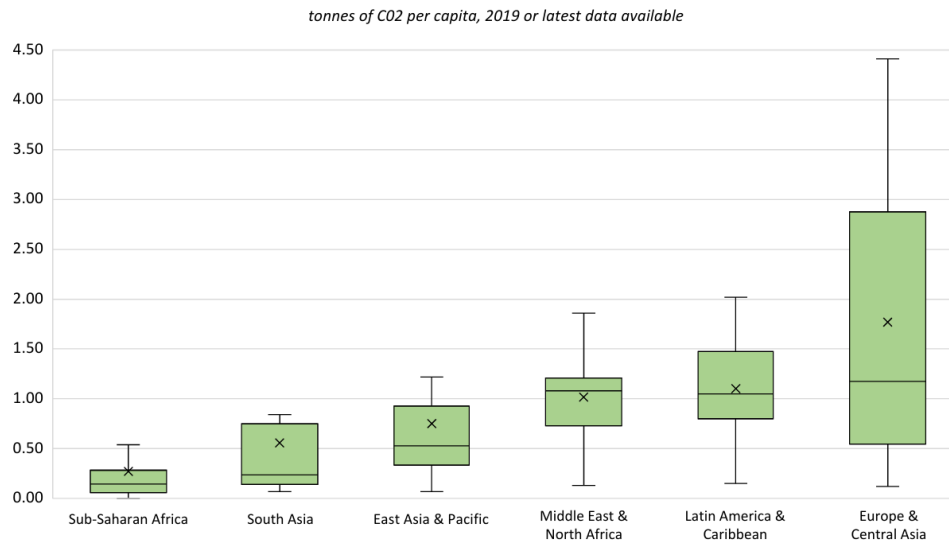
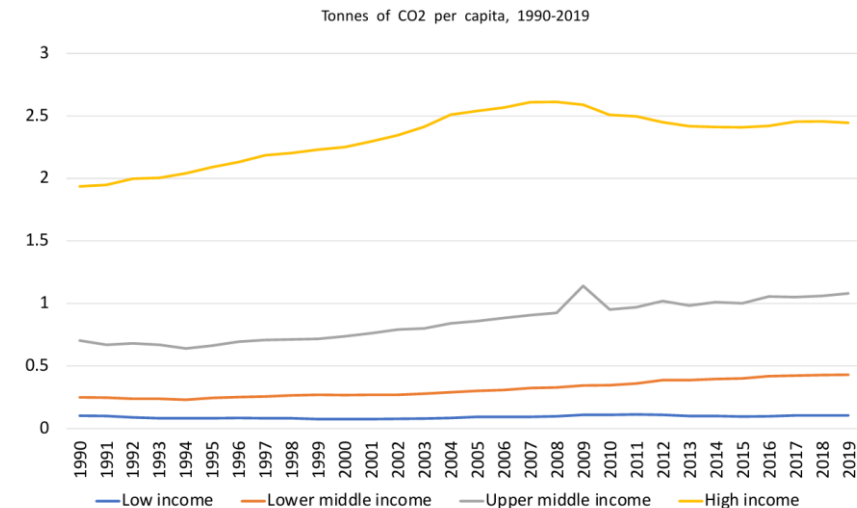


Figure 2.1: Average transport-related GHG emissions per capita by income level

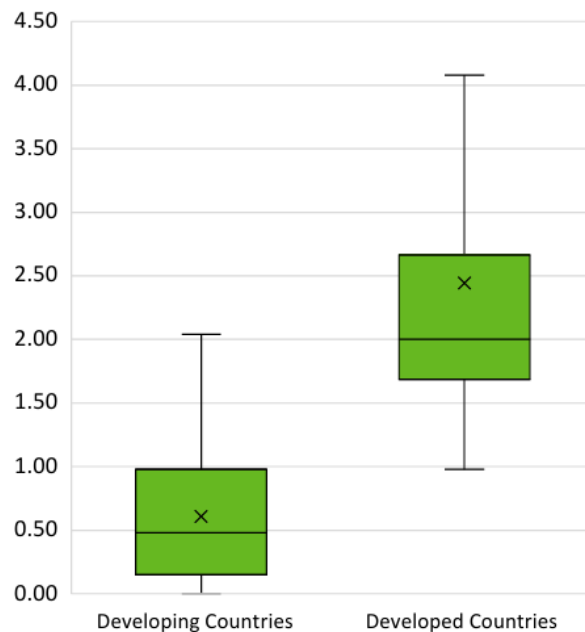


Source: Global Mobility Report, 2022

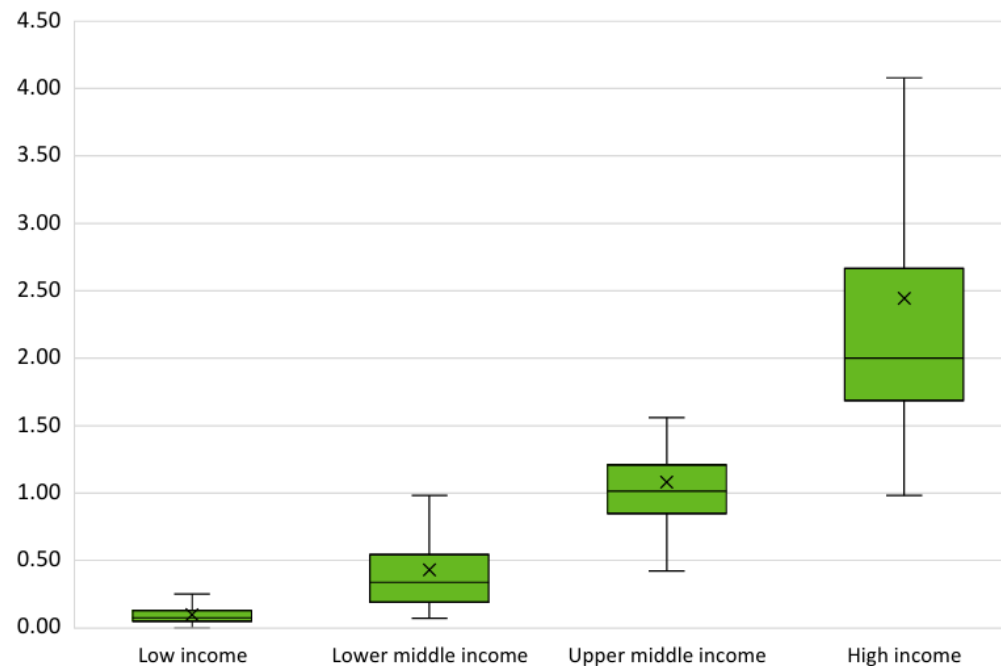
The role of income

Figure 2.2: Performance on GHG emissions per capita by the level of development and by income group classifications

Transport Related GHG Emission per capita by Level of Development
tonnes of CO₂ per capita, 2019 or latest data available



Transport Related GHG Emission per capita by Income Level tonnes of CO₂ per capita,
2019 or latest data available



The role of income

Figure 2.1: Average transport-related GHG emissions per capita by income level

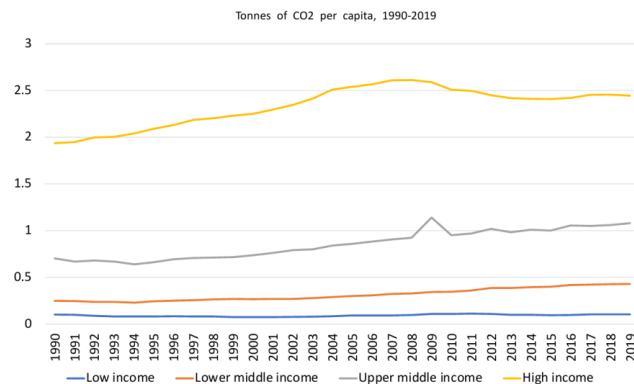
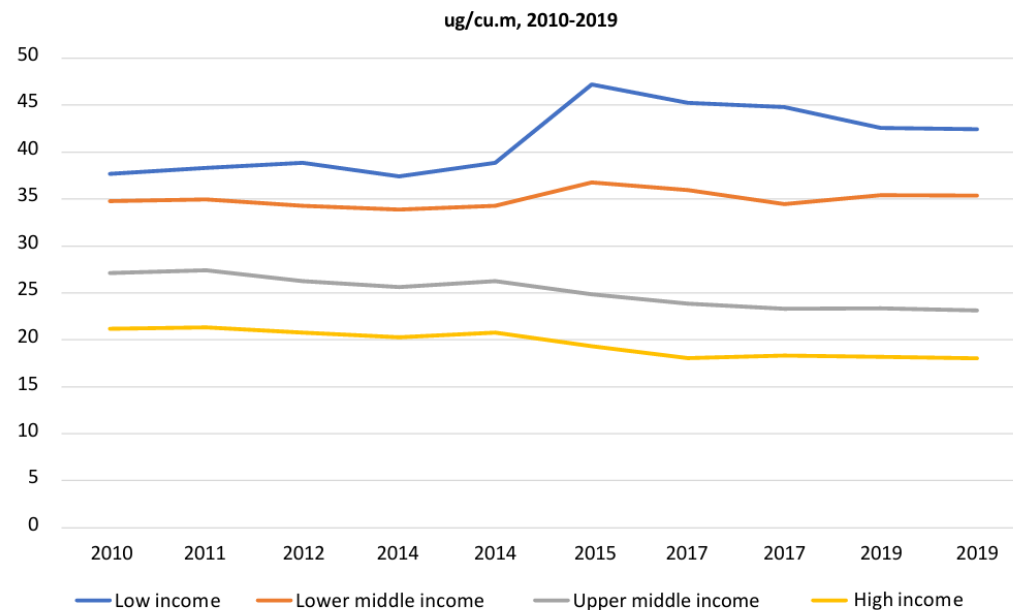


Figure 2.5: PM_{2.5} Air pollution average annual exposure by the income level

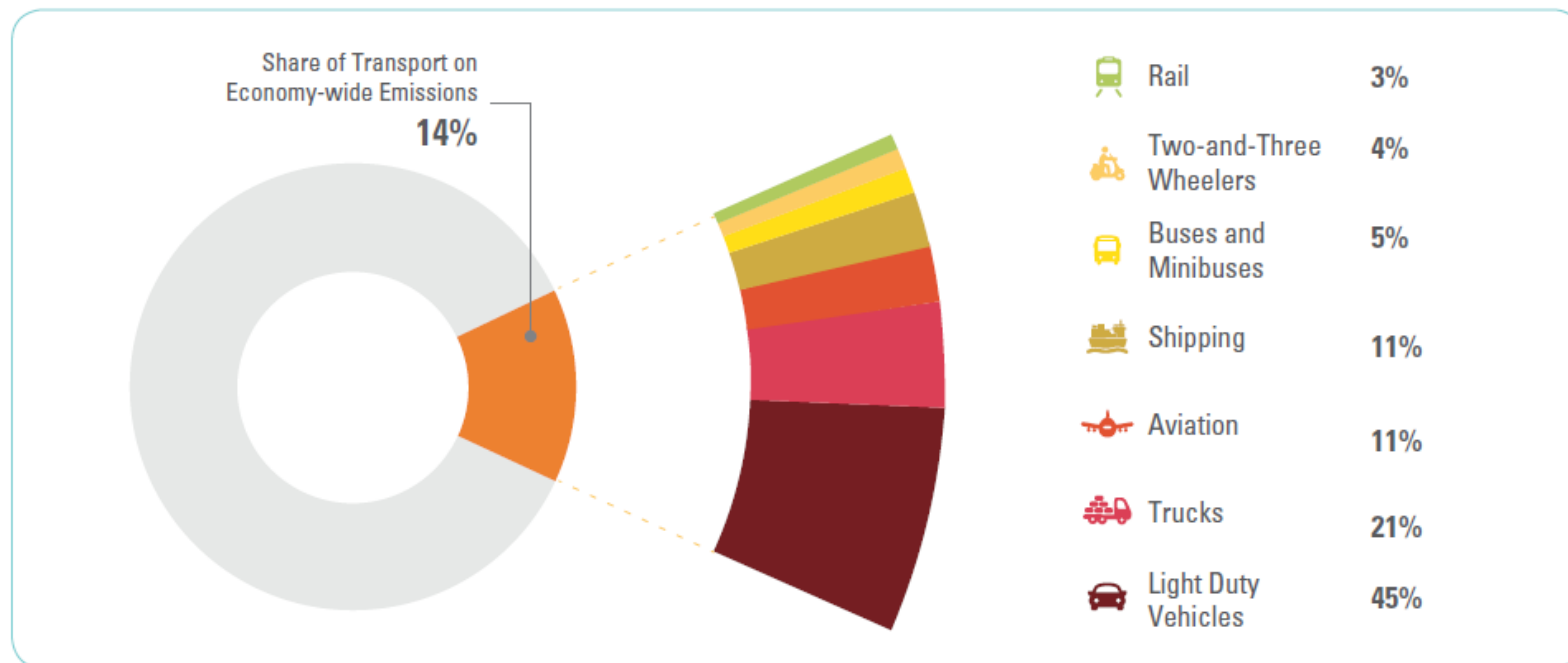


Source: UNHABITAT and Global Burden of Disease Study raw data with authors' analysis.

Source: Global Mobility Report, 2022

Carbon emisisions from transport

Figure 1: Share of Transport Sector GHG Emissions by Mode (2015)¹¹

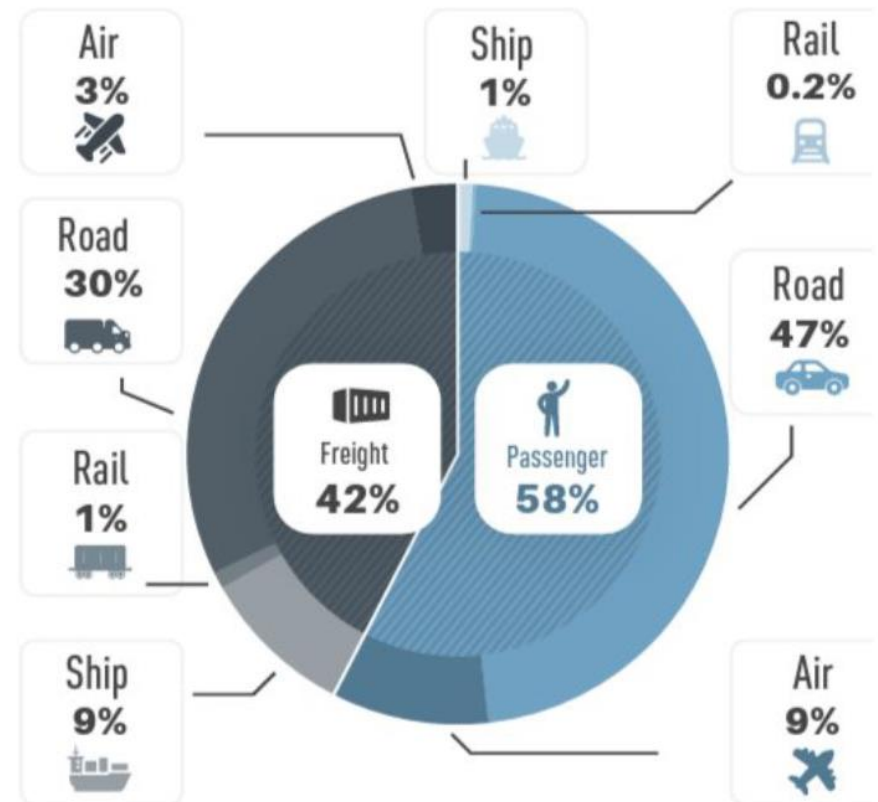


Source: SLoCaT 2018

Carbon emisisions from transport

The share of passenger and freight transport

Transport CO₂ emissions by activity and mode, 2019

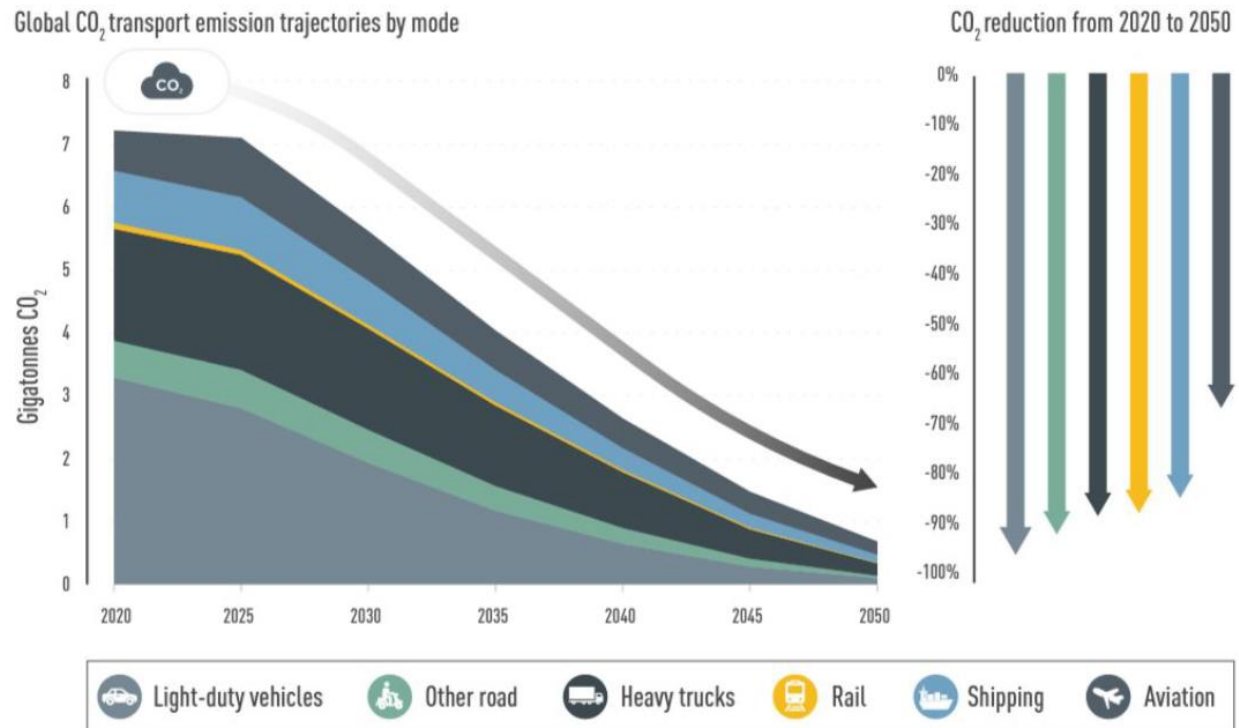


Source: Shell (2020), The Energy Transformation Scenarios, <https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/the-energy-transformation-scenarios.html> (accessed 20 August 2022)

Carbon emisisions from transport

Required reductions for net zero scenarios **by transport mode**

Global transport CO₂ emission trajectories by mode required to achieve IEA net zero emissions scenario, 2020 to 2050



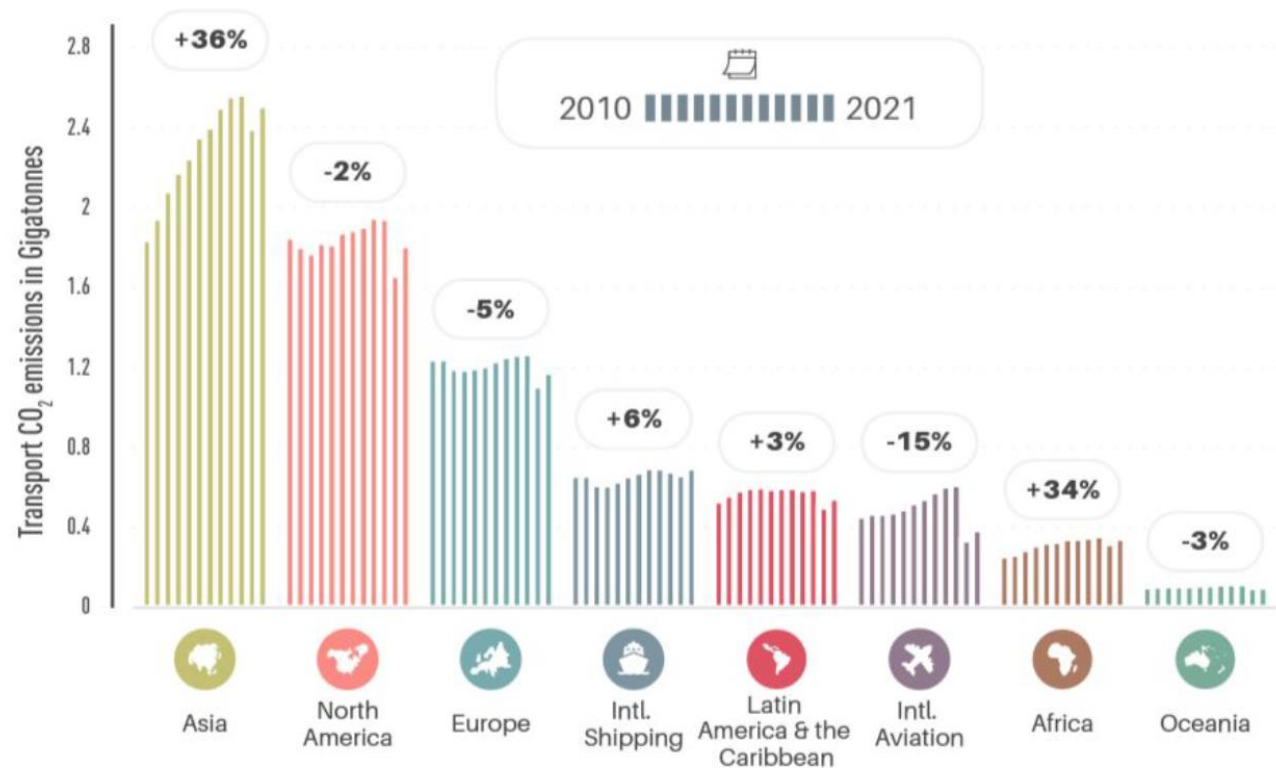
Source: IEA (2021), Net Zero by 2050, IEA, Paris, <https://www.iea.org/reports/net-zero-by-2050> (accessed 20 January 2023)

Source: SLoCaT 2022, https://tcc-gsr.com/wp-content/uploads/2023/09/GSR-3rd-edition-Key-Insights_Module-1-1.pdf

Carbon emisisions from transport

Transport CO₂ emissions, by region and for international shipping and aviation, 2010-2021

Trend of carcon emissions by region



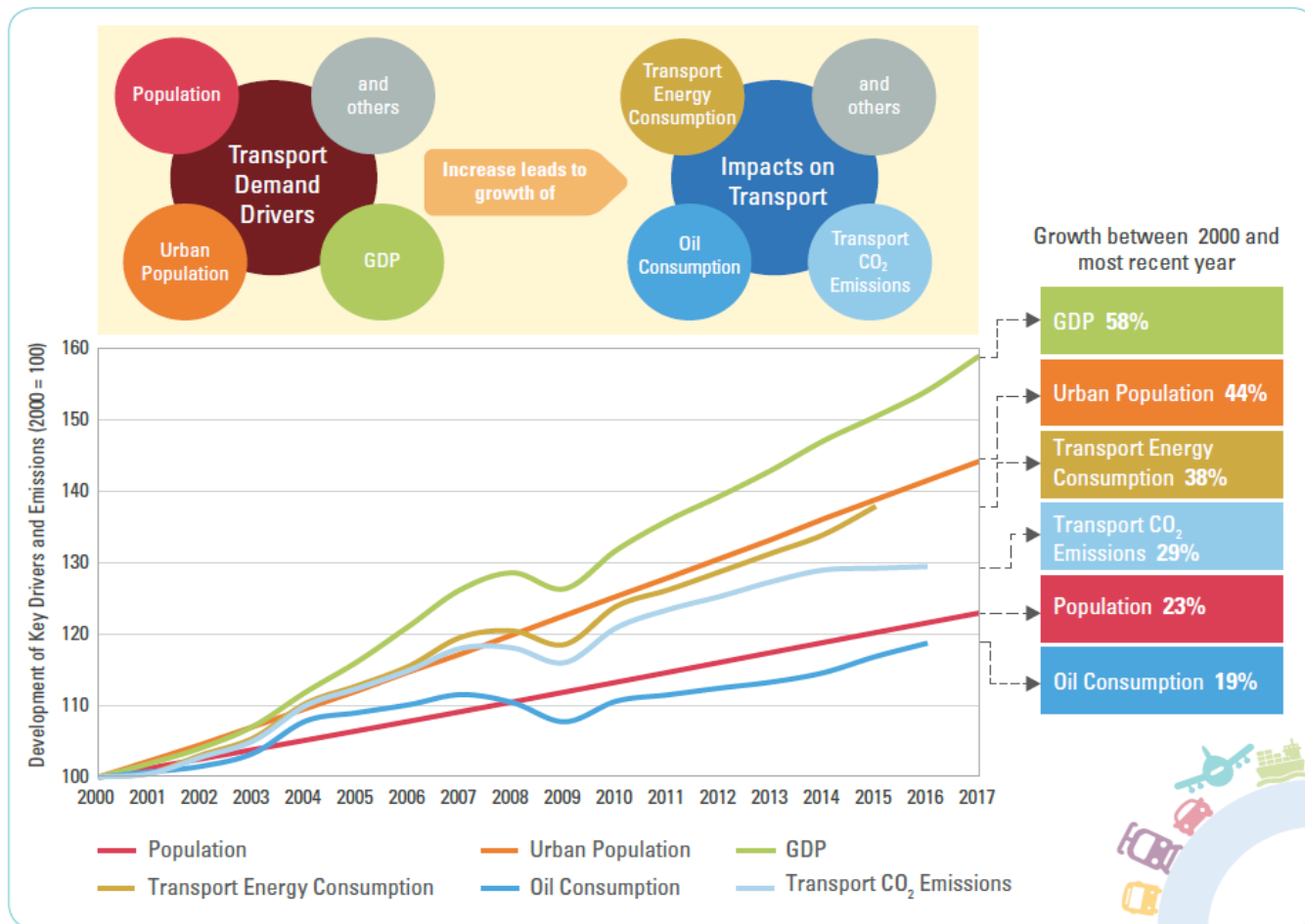
Source: SLOCAT analysis based on Crippa, M. et al (2022), CO2 emissions of all world countries - 2022 Report, doi:10.2760/730164, https://edgar.jrc.ec.europa.eu/report_2022 (accessed 20 September 2022)

Source: SLoCaT 2022, https://tcc-gsr.com/wp-content/uploads/2023/09/GSR-3rd-edition-Key-Insights_Module-1-1.pdf

Carbon emisisions from transport

Drivers and impacts

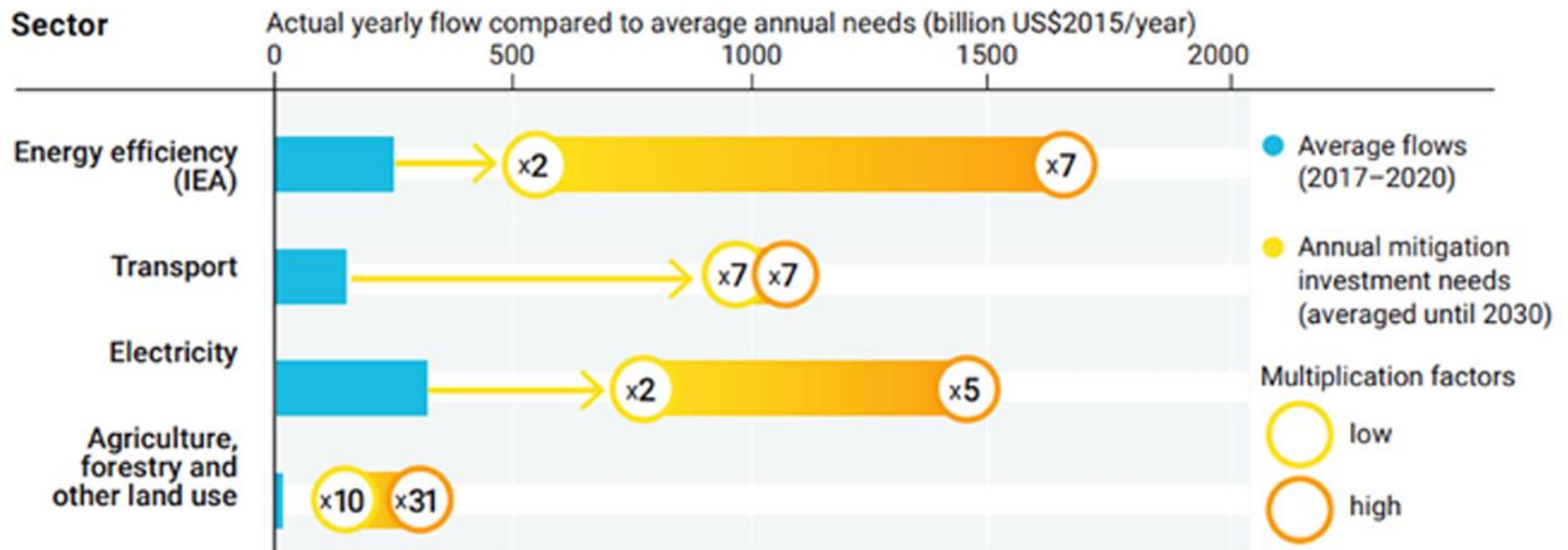
Figure 6: Transport Demand Drivers and Impacts (2000 to 2017)²³⁴



Carbon emisisions from transport

Investment needs for mitigation

Figure 2.8: Finance flows and mitigation investment needs by sector



Source: United Nations Environment Programme. 2022. Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies. Nairobi. <https://www.unep.org/emissions-gap-report-2022>. Figure 7.1 Finance flows and mitigation investment needs by sector, type of economy, and region, Page 66.

Summary

- Global passenger transport demand → still growing, (mainly in Asia: coupled to economic development)
- Motorisation rate -> saturation ca. 600 private cars / 1000 inhabitants
- Major driving forces for a transition: the role of income (and GDP) → environmental concerns
- Trends for a change (public and private) → still marginal
- Passenger mobility → still leading the emissions
→ individualism and freedom?

Content

Part I: Mobility Status

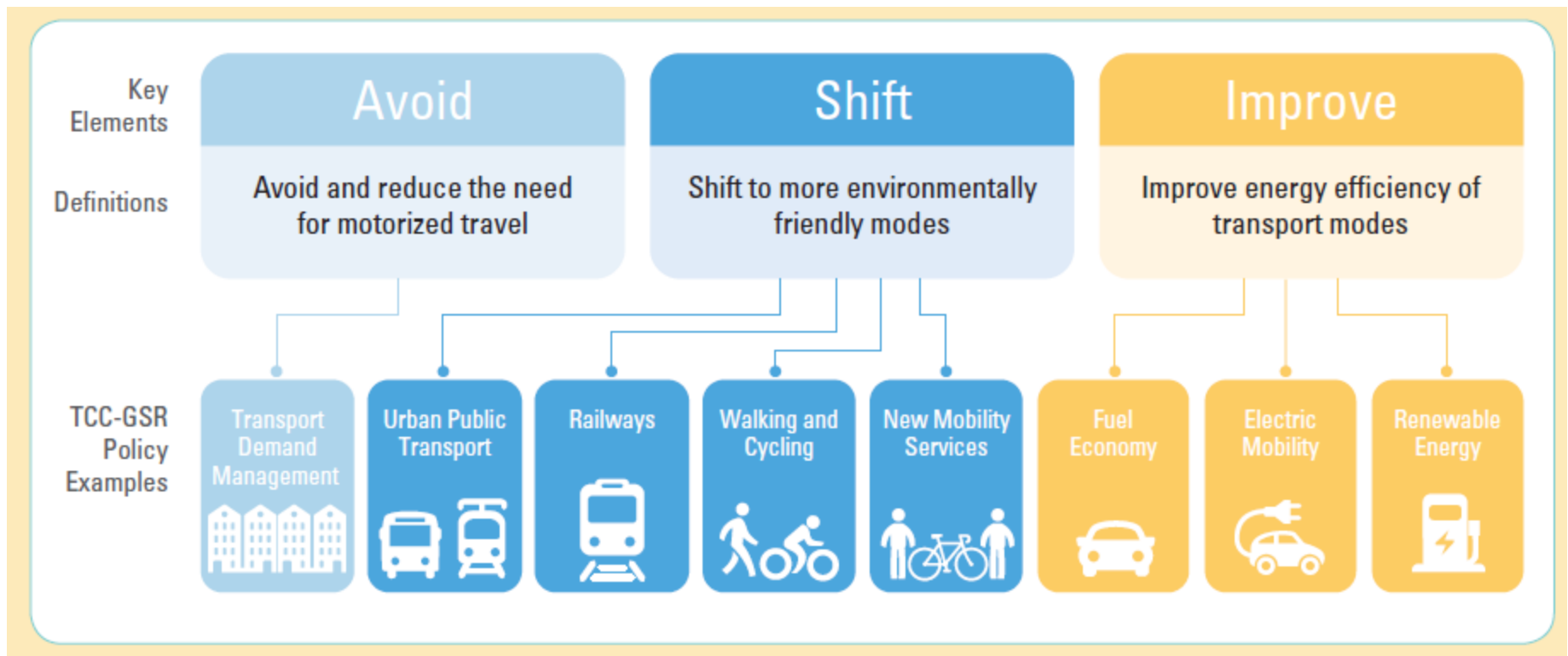
- Indicators
- Global Facts and Trends
- Summary

Part II: Ways out?

- RE Supply
- E-mobility
- Side effects

References

Mitigation Strategies

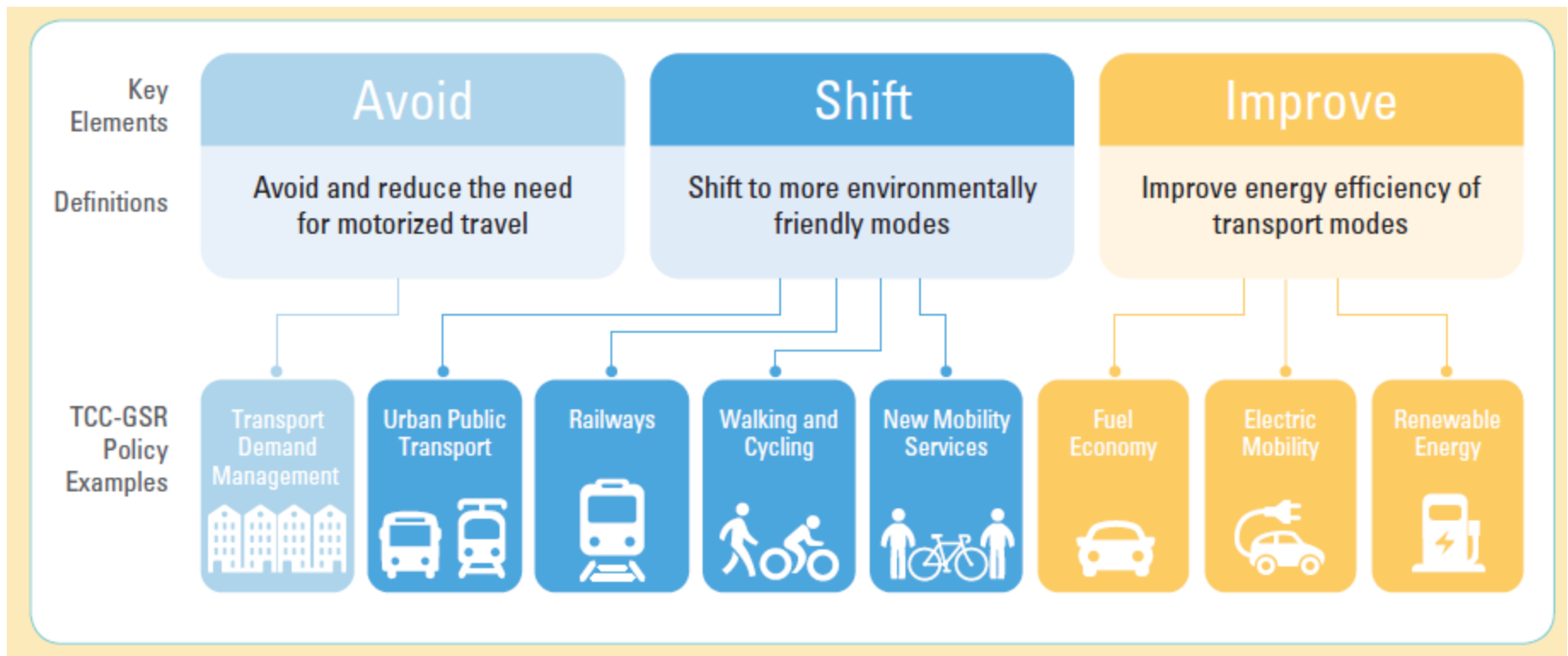


Mitigation Strategies

Sufficiency

Consistency

Efficiency

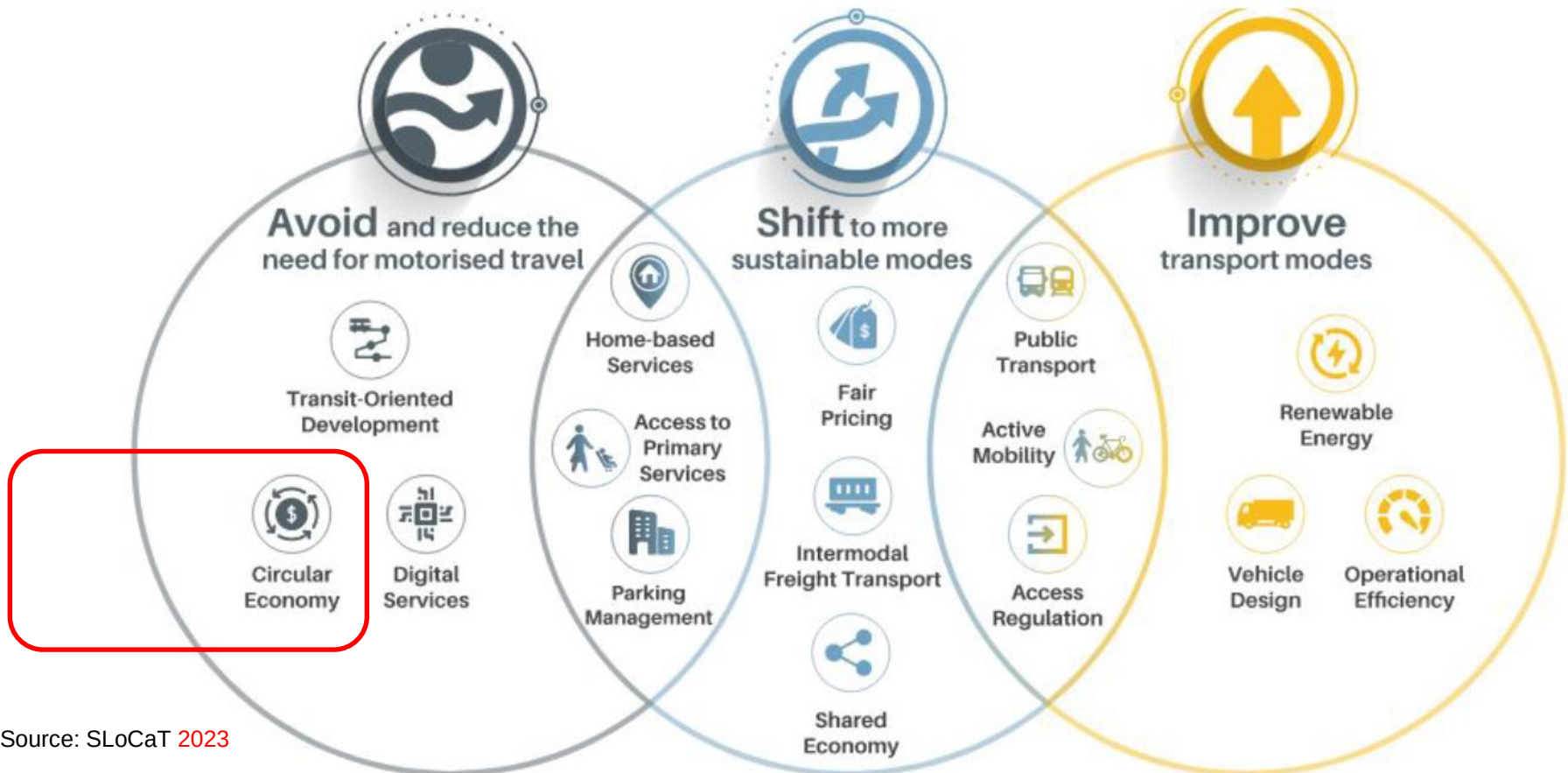


Mitigation Strategies

Sufficiency

Consistency

Efficiency



Source: SLoCaT 2023

*The A-S-I diagramme presents a non-exhaustive list of measures for illustrative purposes only.

Mitigation Strategies

Sufficiency

Consistency

Efficiency

Source: SLoCaT 2023. https://tcc-gsr.com/wp-content/uploads/2023/09/GSR-3rd-edition-Key-Insights_Module-1-1.pdf

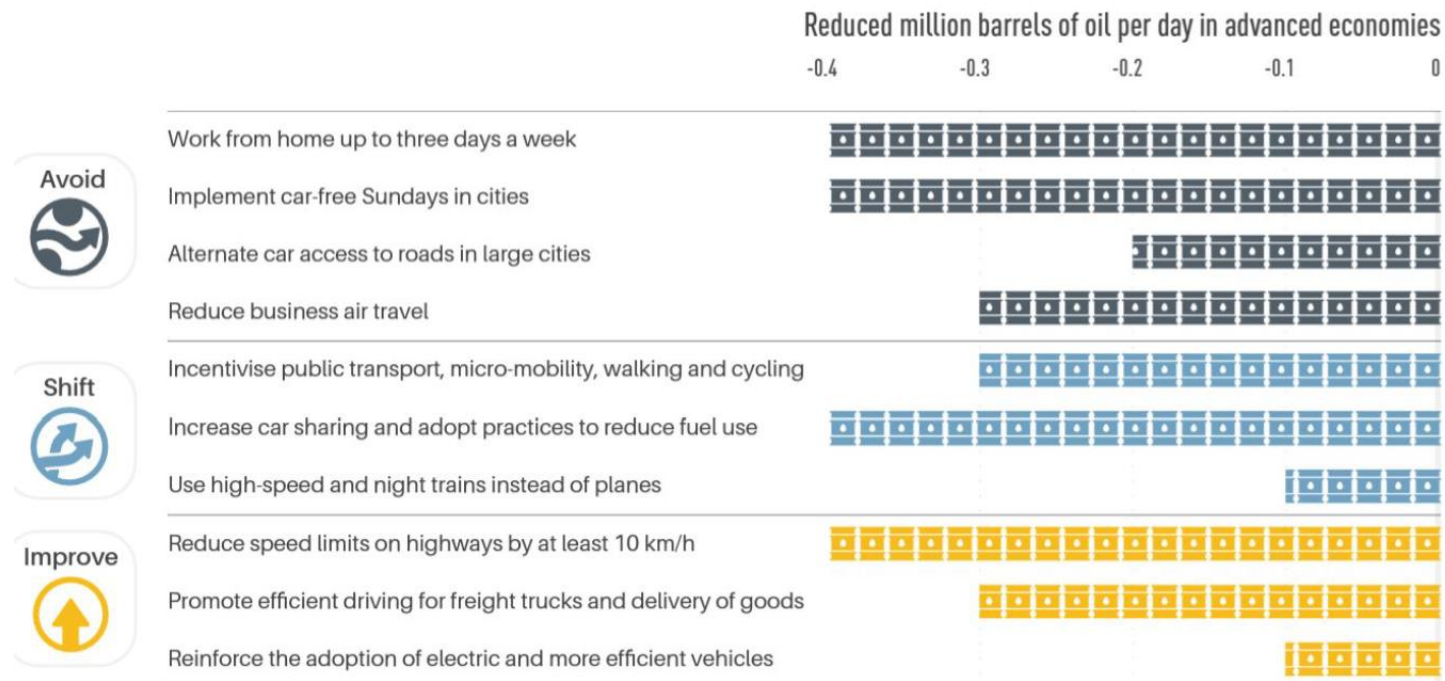
Key
Elements

Avoid

Shift

Improve

Actions to reduce oil dependency in transport, through Avoid-Shift-Improve measures

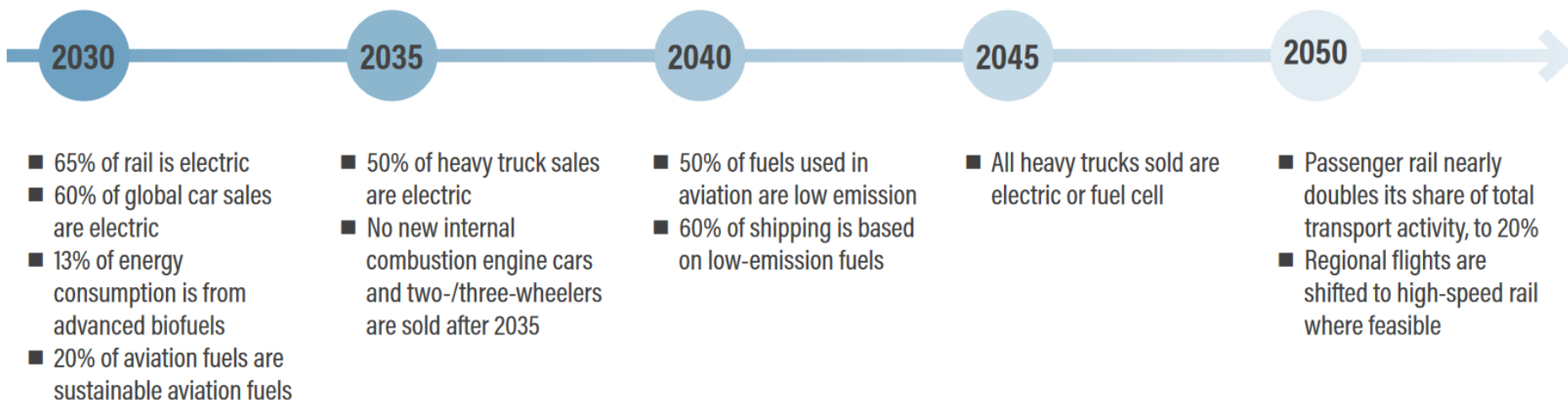


Mitigation Strategies

Source: SLoCaT 2023. https://tcc-gsr.com/wp-content/uploads/2023/09/GSR-3rd-edition-Key-Insights_Module-1-1.pdf

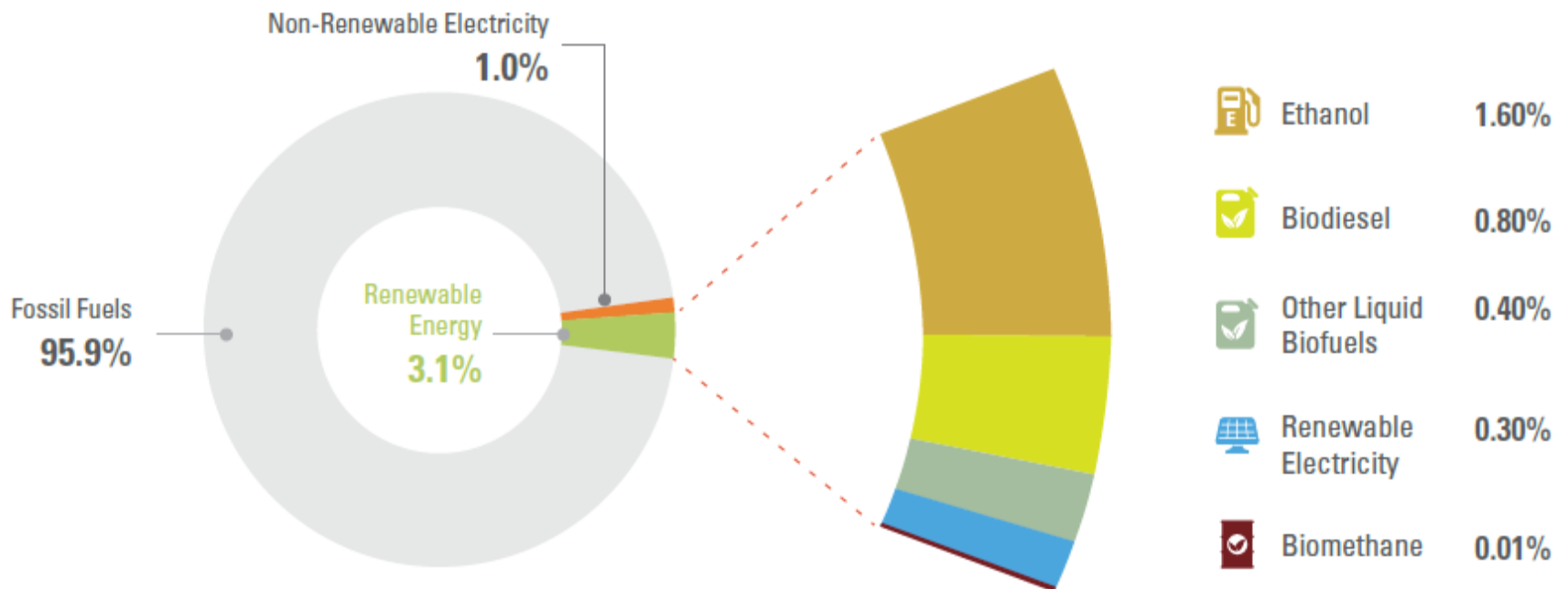
TABLE 1. Milestones towards net zero transport emissions, according to the IEA Net Zero Scenario

Source: See endnote 89 for this section.



I. Consistency: RE for E-mobility?

Figure 51: Share of Renewable Energy in Transport in 2015⁸¹⁵



I. Consistency: E-fuels (or “E-fools” (from: TE, 2021))?

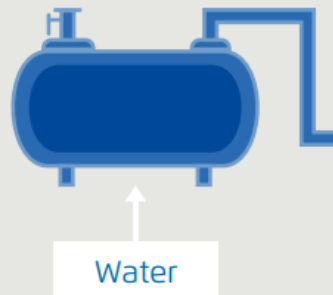
Production process for hydrogen, P2G methane and P2G fuels from sun and wind

Figure 7.2

Electricity from renewable energy



Electrolysis



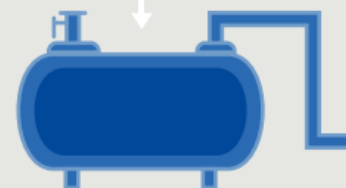
Hydrogen
 H_2

Methanation



Synthetic methane
(based on
renewable energy)

CO_2



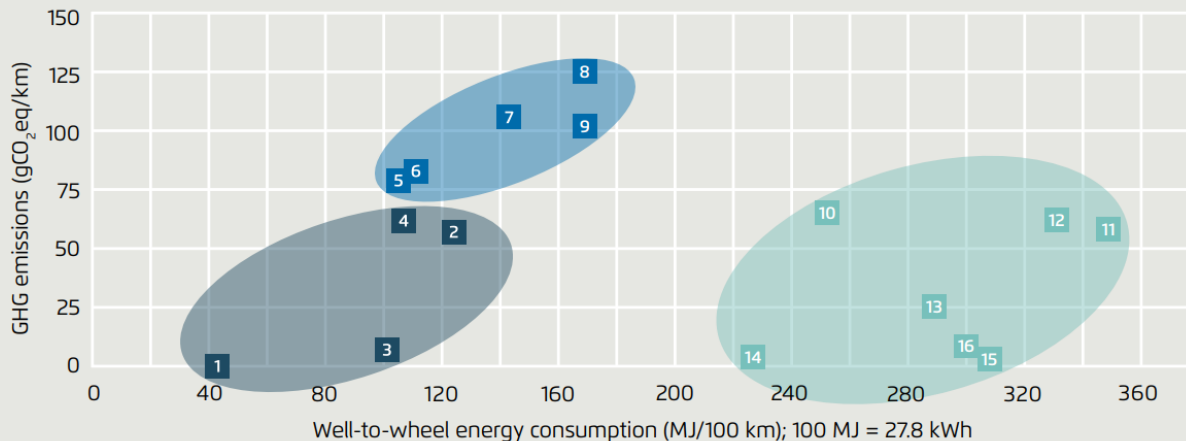
Synthetic gasoline
Synthetic diesel
Synthetic kerosene
(all based on
renewable energy)

Fischer-Tropsch process

I. Consistency: E-fuels (or “E-fools” (from: TE, 2021))?

GHG emissions relative to energy consumption in 2020 (well-to-wheel)

Figure 7.1



Electric vehicles

- 1 Electricity in BEV (wind)
- 2 Electricity in BEV (EU mix)
- 3 Hydrogen in FCEV (wind)
- 4 Hydrogen in FCEV (reforming of natural gas)

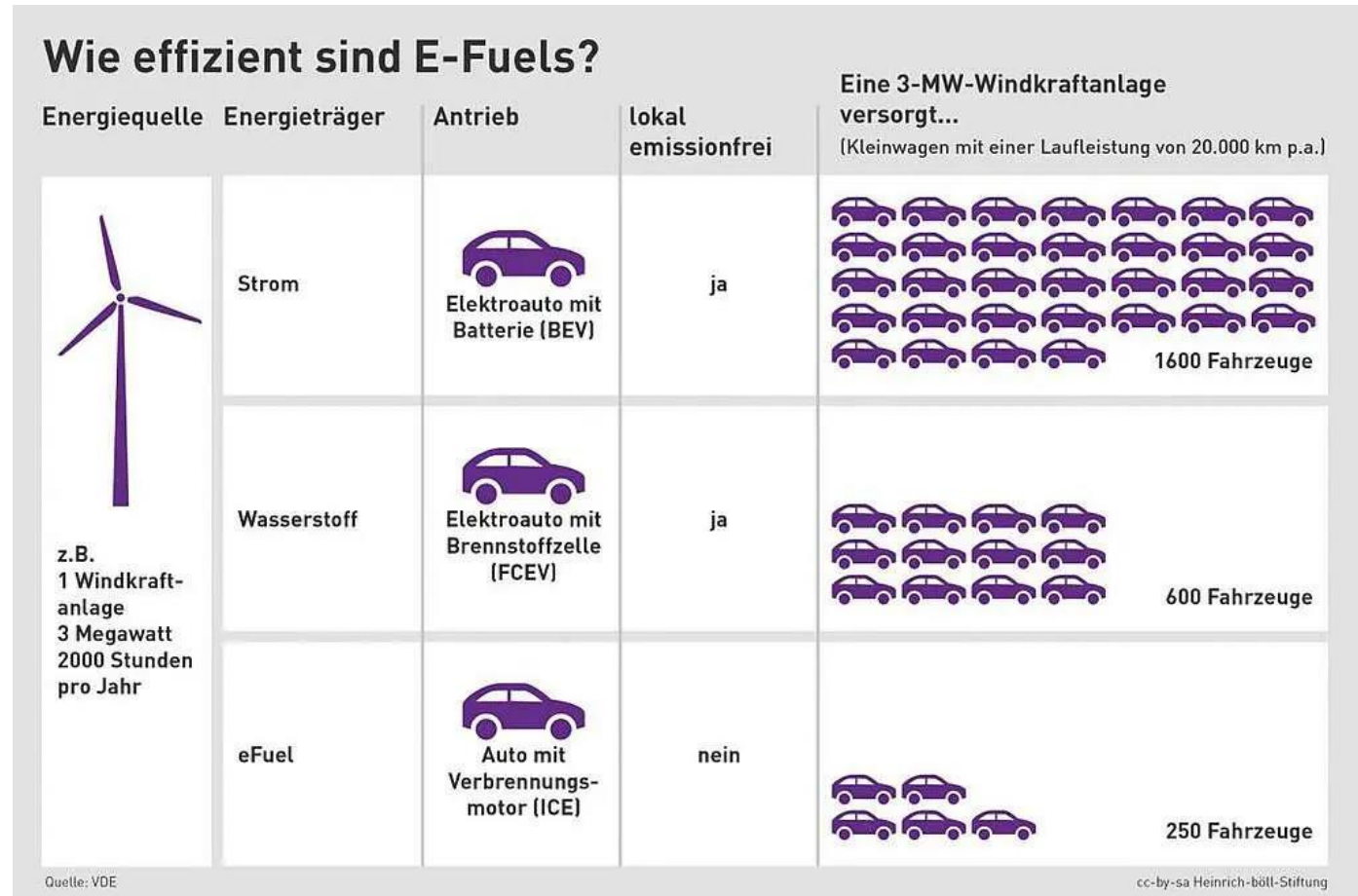
Fossil fuels

- 5 Hybrid diesel (petroleum)
- 6 Hybrid gasoline (petroleum)
- 7 Diesel (petroleum)
- 8 Gasoline (petroleum)
- 9 Natural gas (CNG)

Biofuels and synthetic fuels

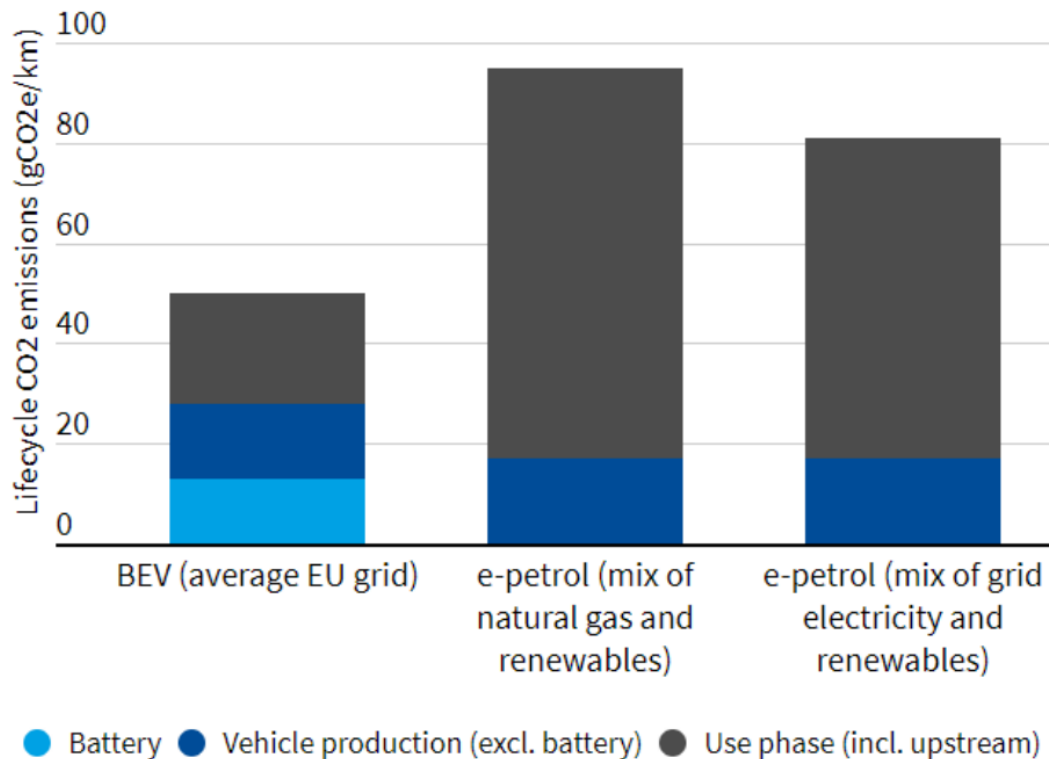
- 10 Biodiesel (rapeseed)
- 11 Ethanol (sugar beet, used in E10 blends)
- 12 Biomethane (maize)
- 13 Biomethane (municipal waste)
- 14 Syndiesel (B2L, waste wood)
- 15 Syndiesel (P2L, renewable electricity)
- 16 Synmethane (P2G, renewable electricity)

I. Consistency: E-fuels (or “E-fools” (from: TE, 2021))?



Source: [E-Fuels im Vergleich: Energieaufwand, Kosten und Nachhaltigkeit - emobicon® | Die eMobil Experten!](#)

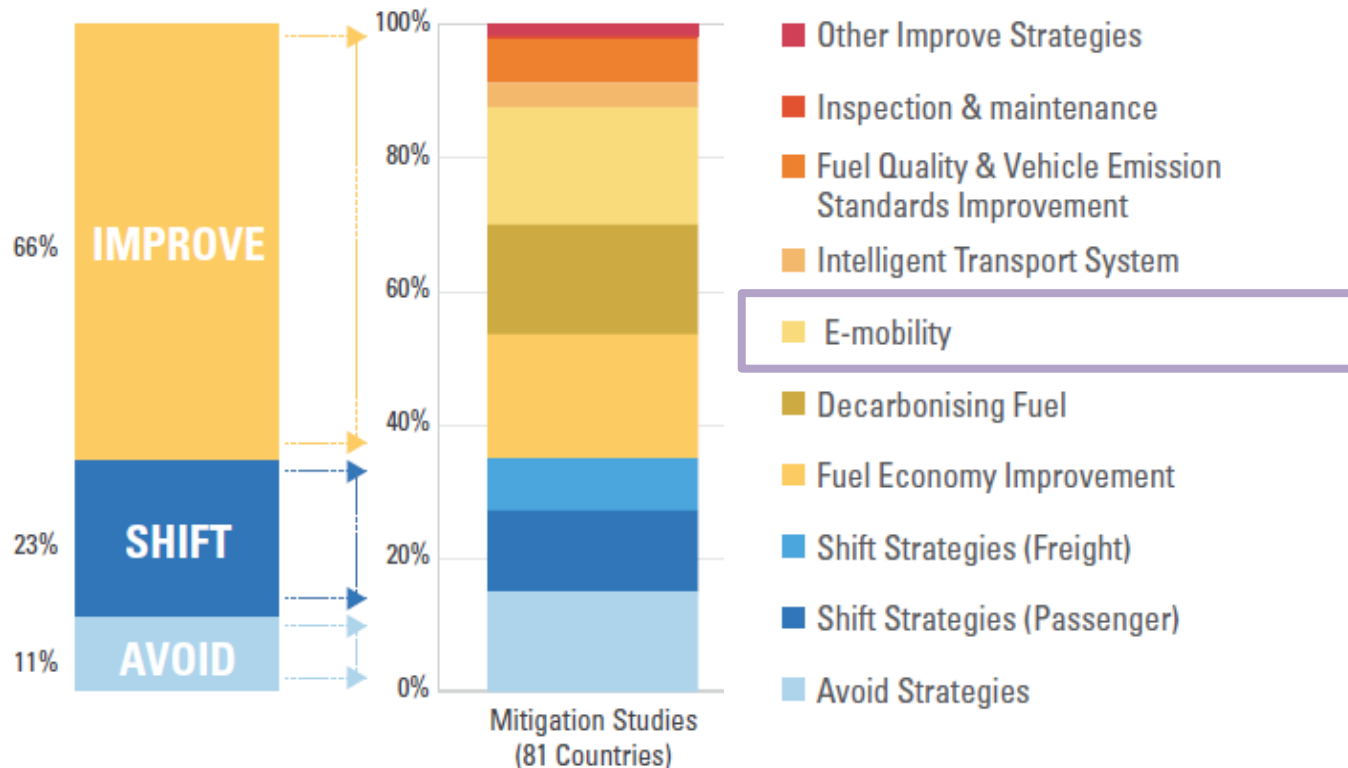
I. Consistency: E-fuels (or “E-fools” (from: TE, 2021))?



Summary:

- Not climate neutral: CH4 and NOx
- More costly: ca. 2.80Eur/liter
- Not sufficient: 2% of european car fleet!
- Put pressure on green hydrogen economy

II. Consistency and efficiency: E-mobility

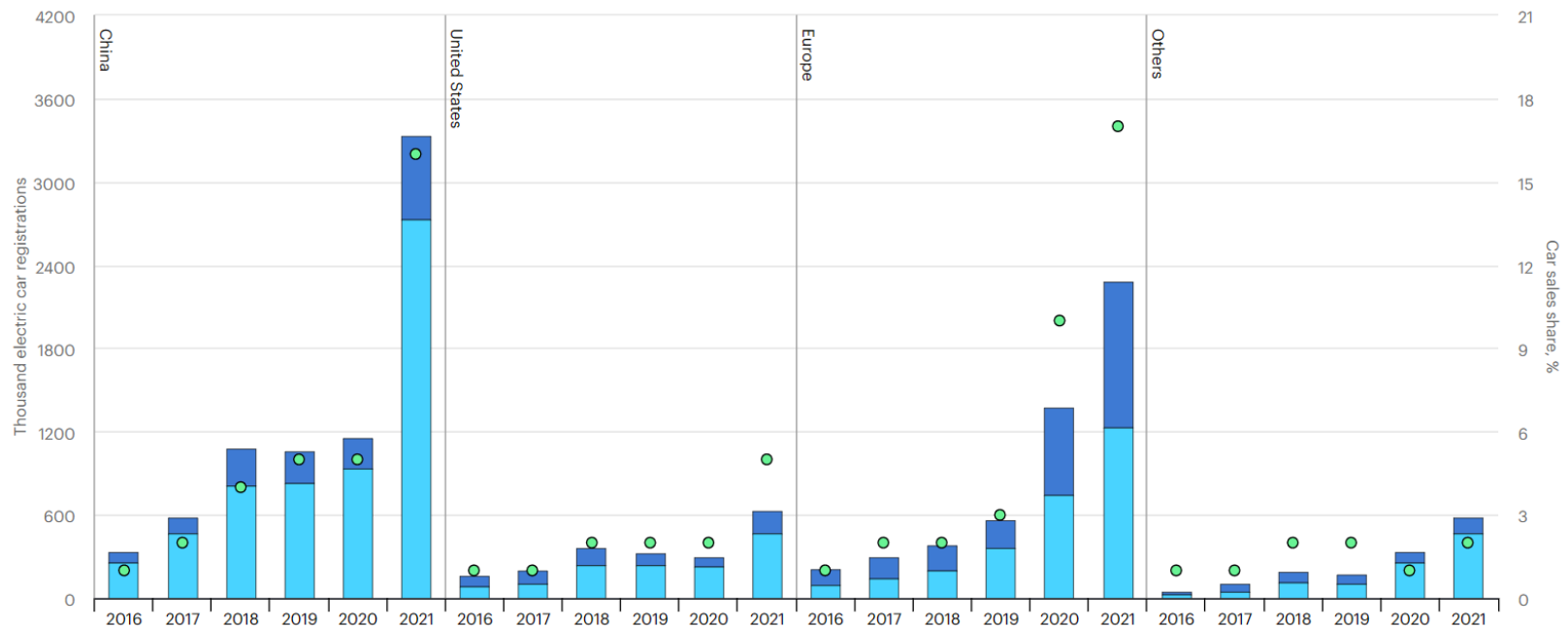


Source: Transport and Climate Change Report 2018, modified

II. Consistency and efficiency: E-mobility

Electric car registrations and sales share in China, United States, Europe and other regions, 2016-2021

Open ↗

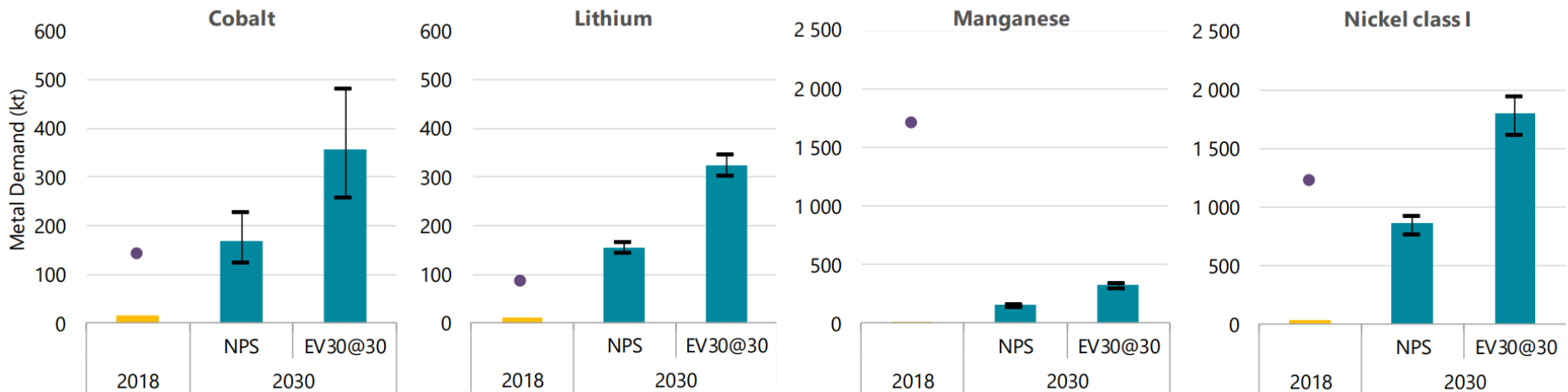


IEA. Licence: CC BY 4.0

● BEV (light shade) ● PHEV (dark shade) ● Electric car sales share

II. Consistency and efficiency: E-mobility

Increased annual demand for materials for batteries from deployment of electric vehicles by scenario, 2018-30



Note: The battery chemistry mix considered for 2030 in this analysis is composed of 10% of NCA, 40% of NMC 622 and 50% of NMC 811

Current demand: 71 kt/a
Total reserves: 8.3 million tons

www.statista.com/statistics/875808/cobalt-demand-worldwide/

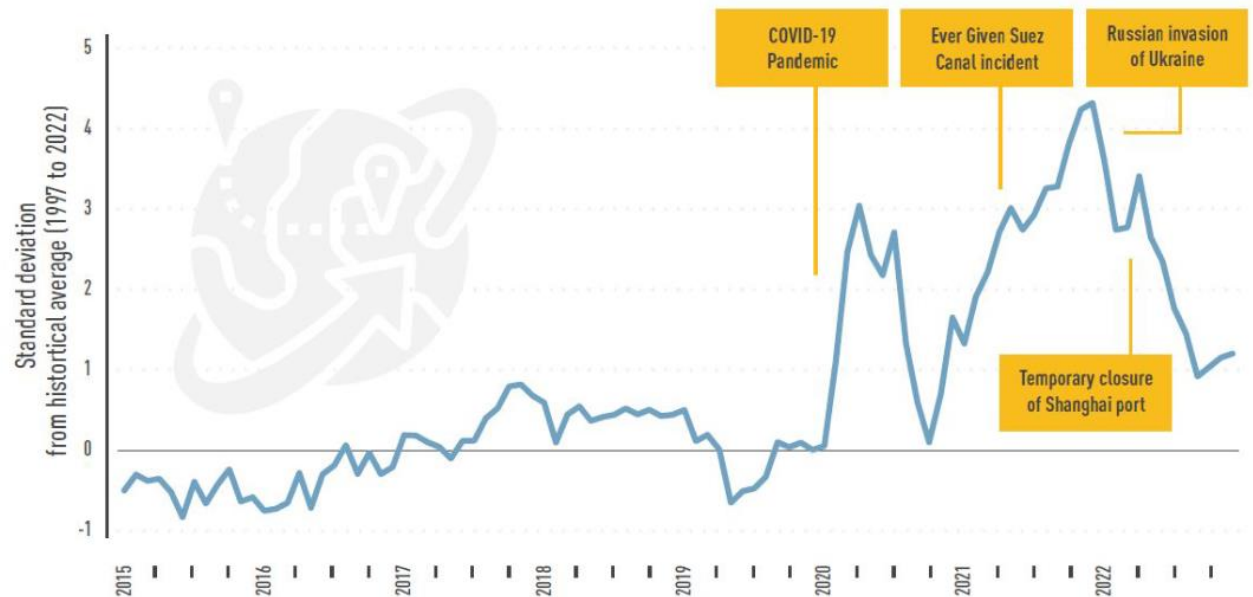
Current demand: 292 kt/a
Total reserves: 22 million tons
[Global lithium demand volume by application 2020-2030](https://www.statista.com/statistics/875808/cobalt-demand-worldwide/)

Current demand: 3000 t/a
Total reserves: 89 million tons
<https://www.statista.com/statistics/273634/>

Source: <https://www.itf-oecd.org/sites/default/files/docs/iea-global-ev-outlook-life-cycle-analysis.pdf>

II. Consistency and efficiency: E-mobility

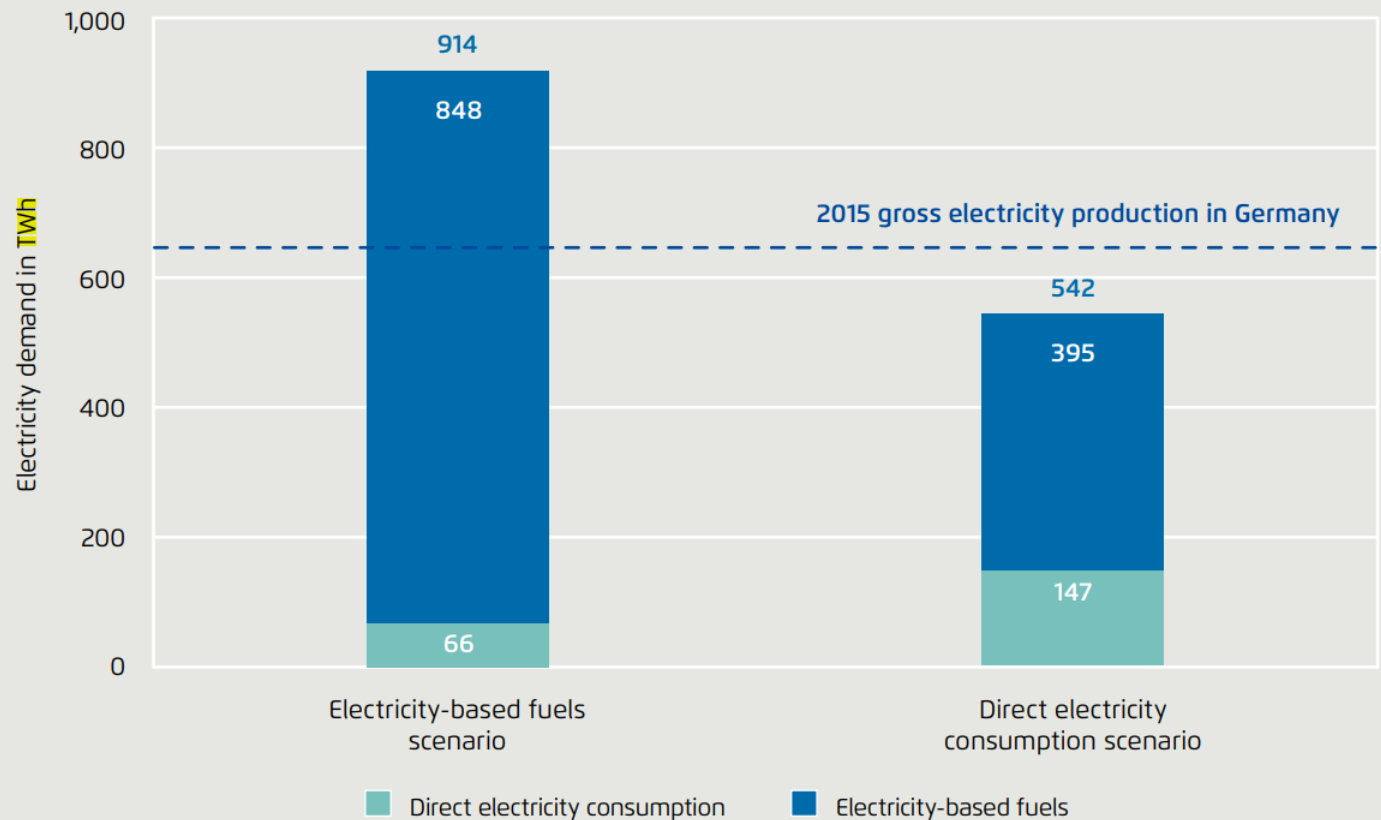
Global supply chain pressure index (higher value means higher pressure),
2015 to 2022



II. Consistency and efficiency: E-mobility

Electricity demand of transport sector (including international air travel from Germany and sea travel with German ports) in relation to decarbonisation strategy

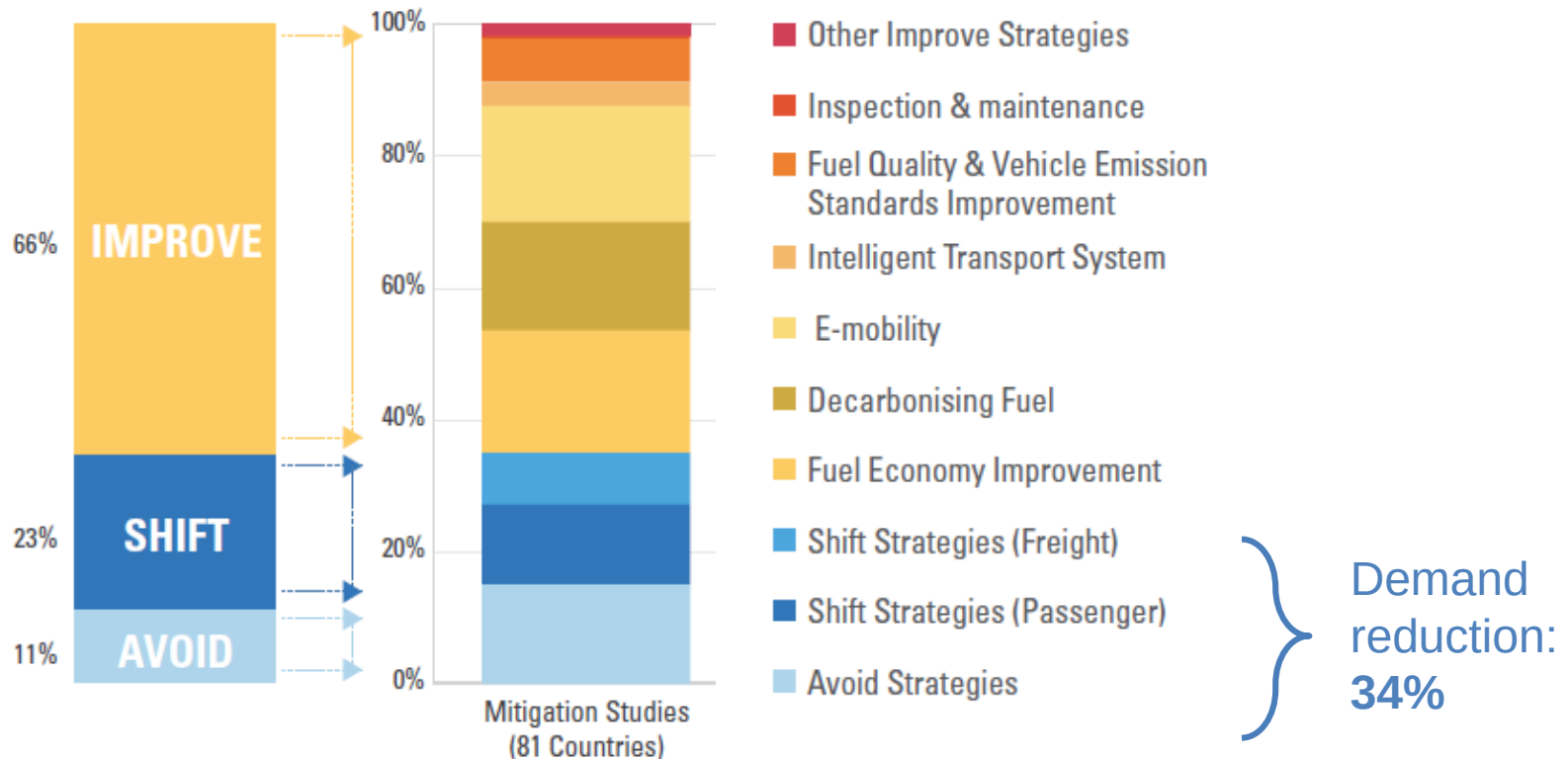
Figure 7.3



**E- Fuels:
ships & planes**

Source: AGORA 2017

III. Sufficiency: Reduction



Source: Transport and Climate Change Report 2018, modified

III. Sufficiency: Reduction

Pictures from Corona-Crisis

FIGURE 8. CO₂ emissions from international aviation and shipping, 2015-2021

Source: See endnote 59 for this section.



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TE 2021. E-fools: why e-fuels in cars make no economic or environmental sense. Position paper, 2021.

Thank you for your attention