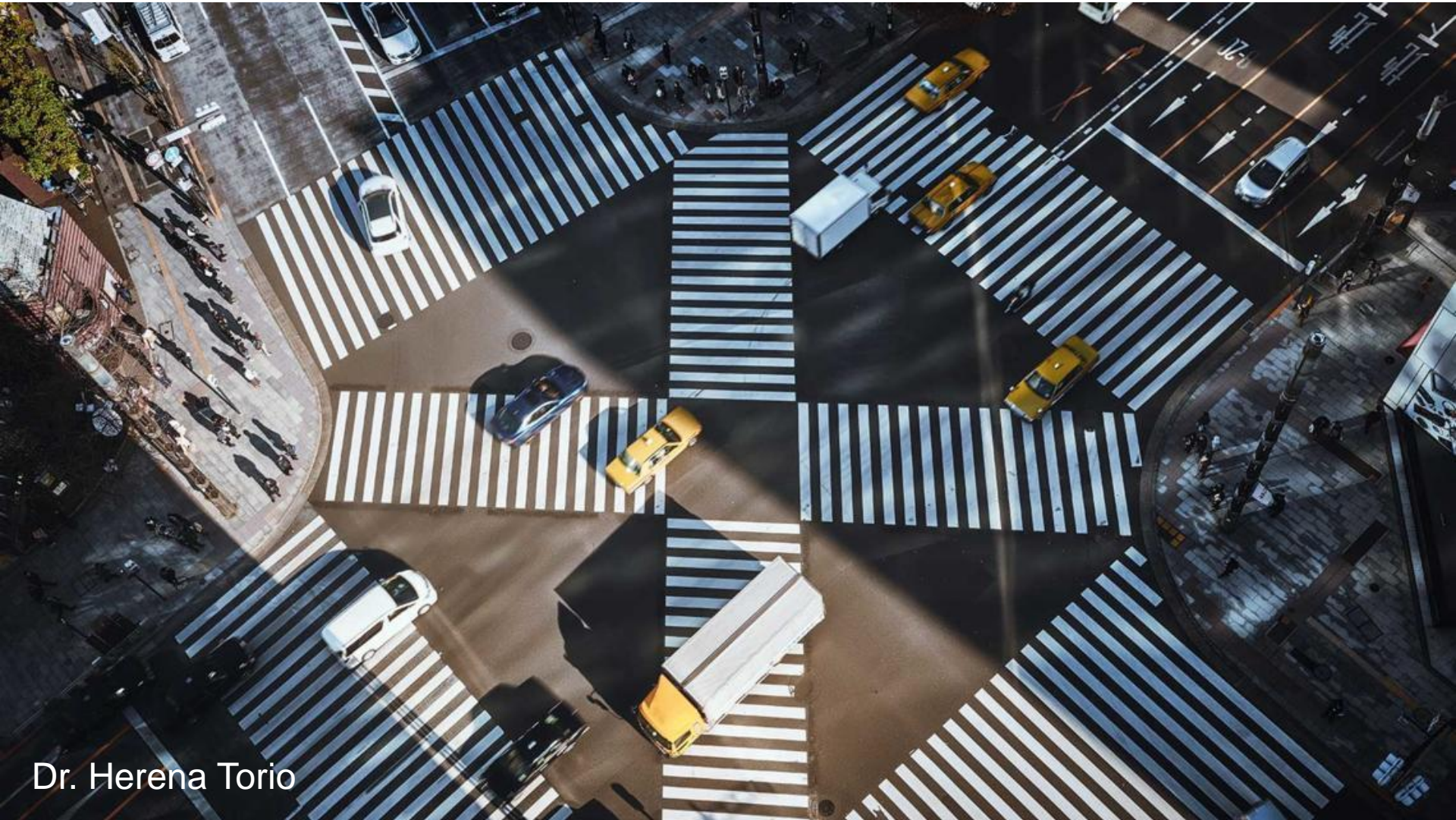


Introduction to Mobility



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



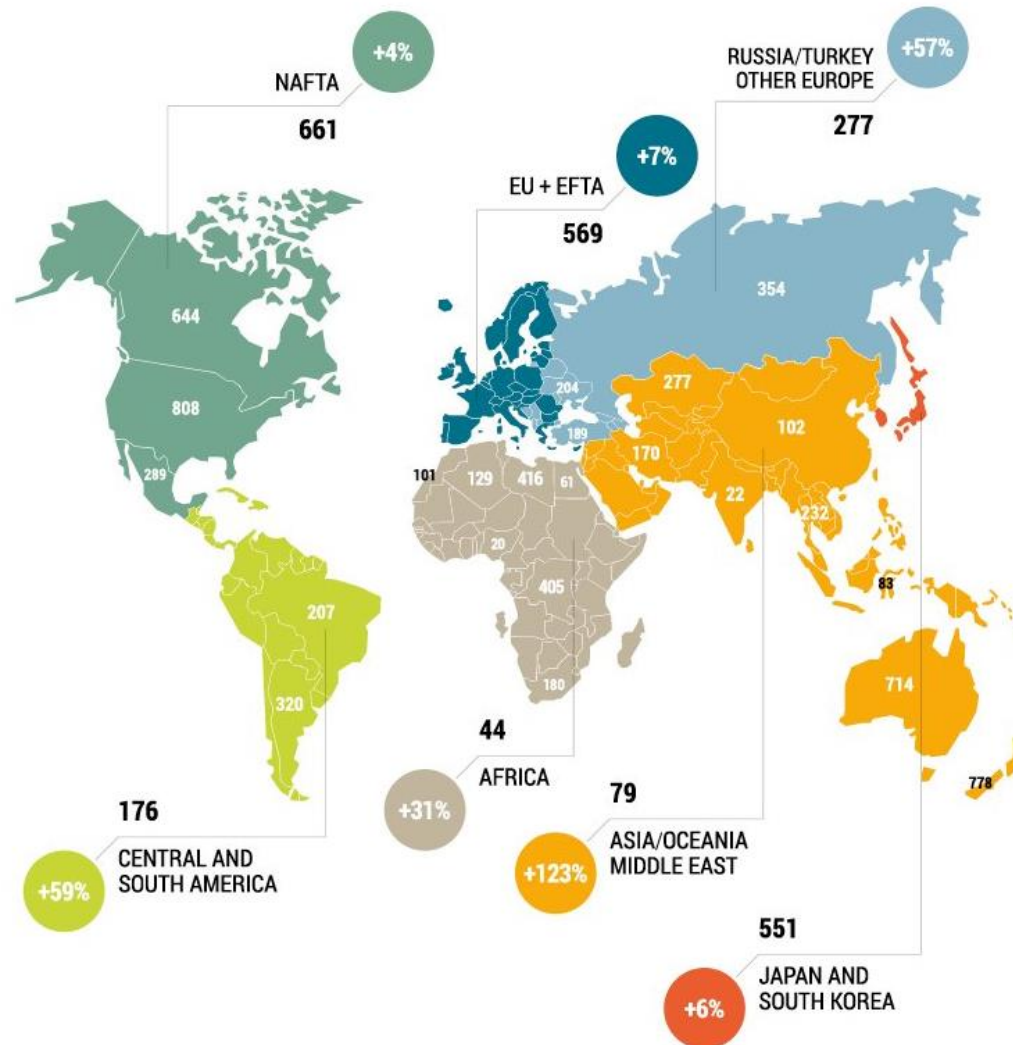
Modal Share / Split

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



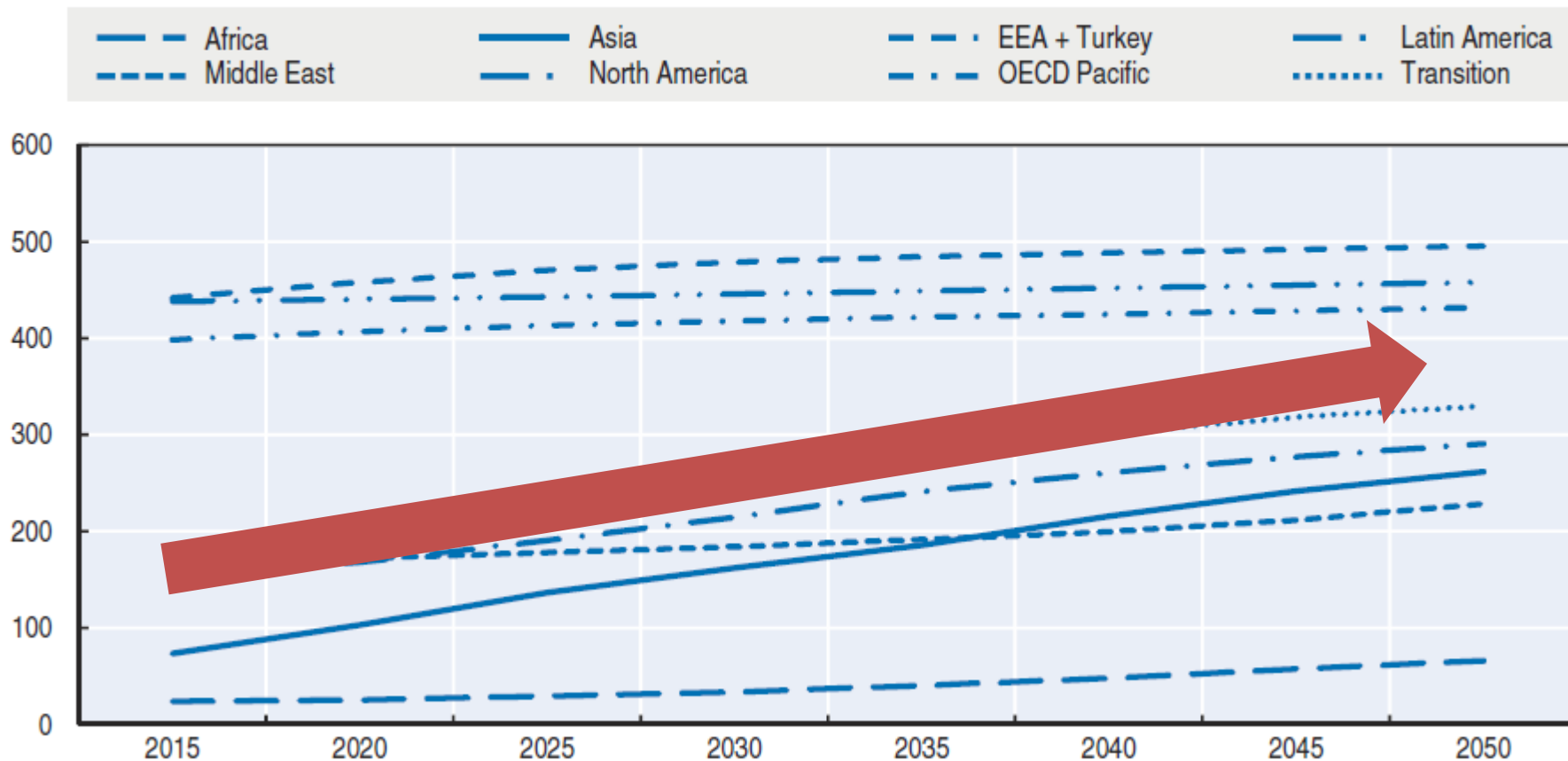
WORLD 180 vehicles per 1,000 inhabitants (+25%)

SOURCE: OICA

Motorisation rate

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

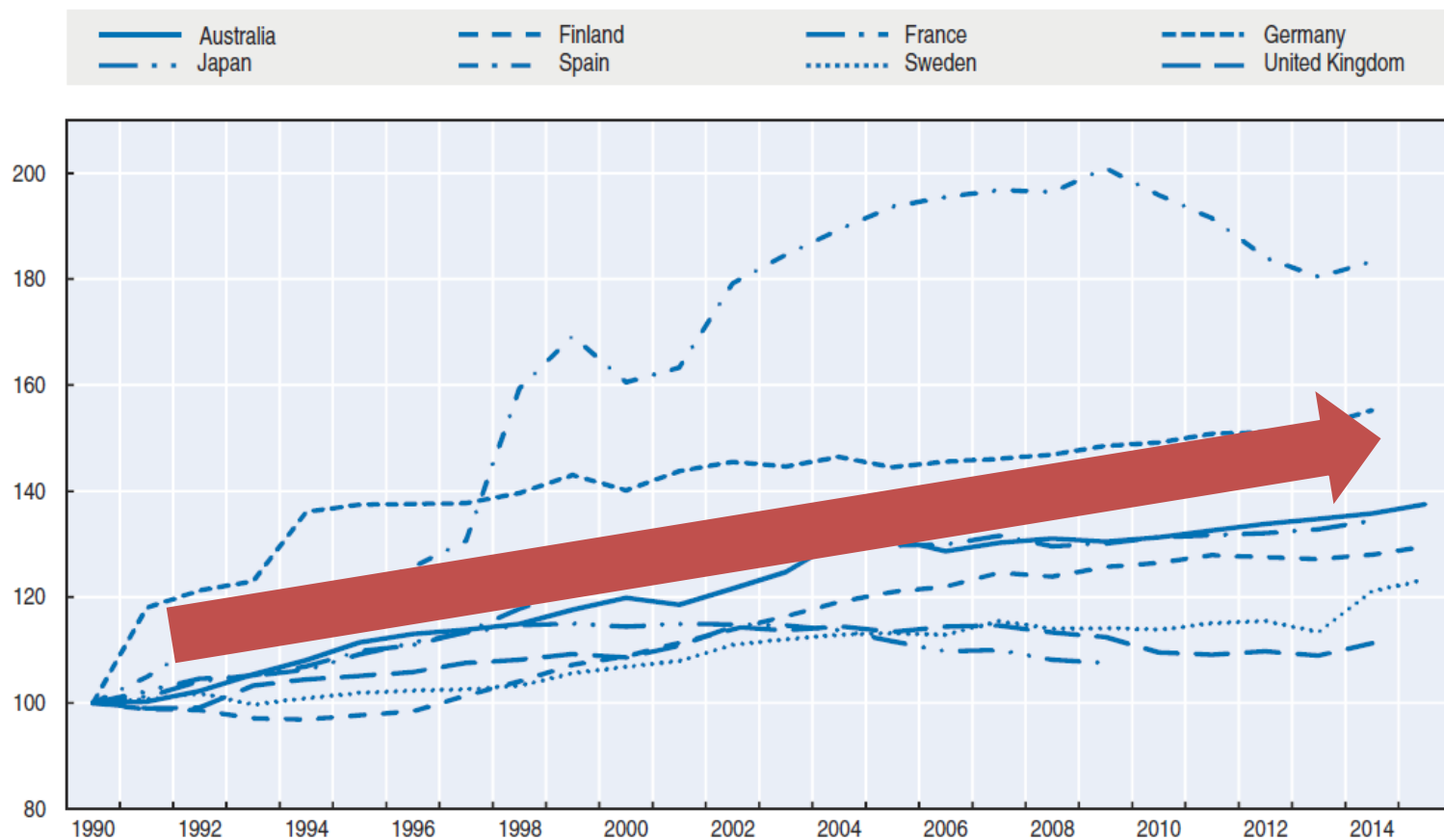
Passenger car per thousand inhabitants, baseline scenario



Passenger kilometers

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

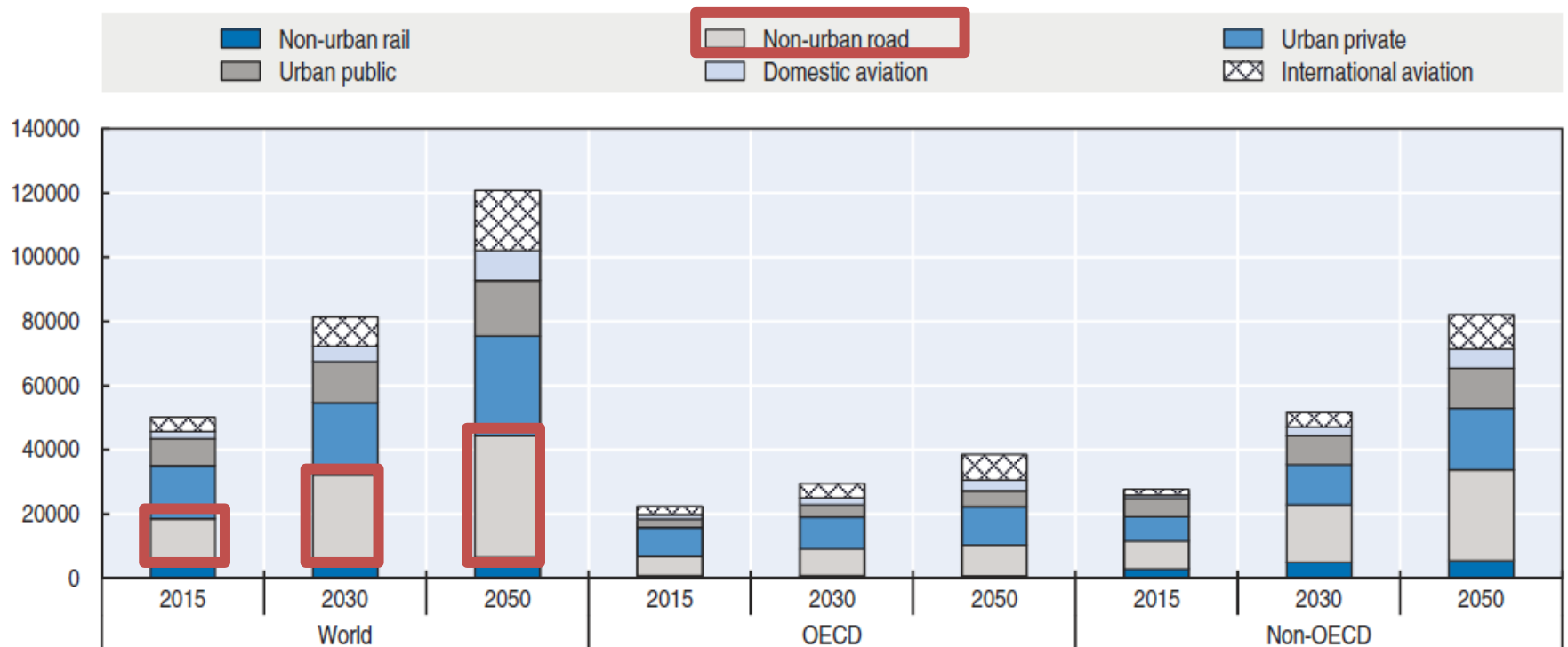
1990 = 100



Passenger kilometers

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

Billion passenger-kilometres, baseline scenario

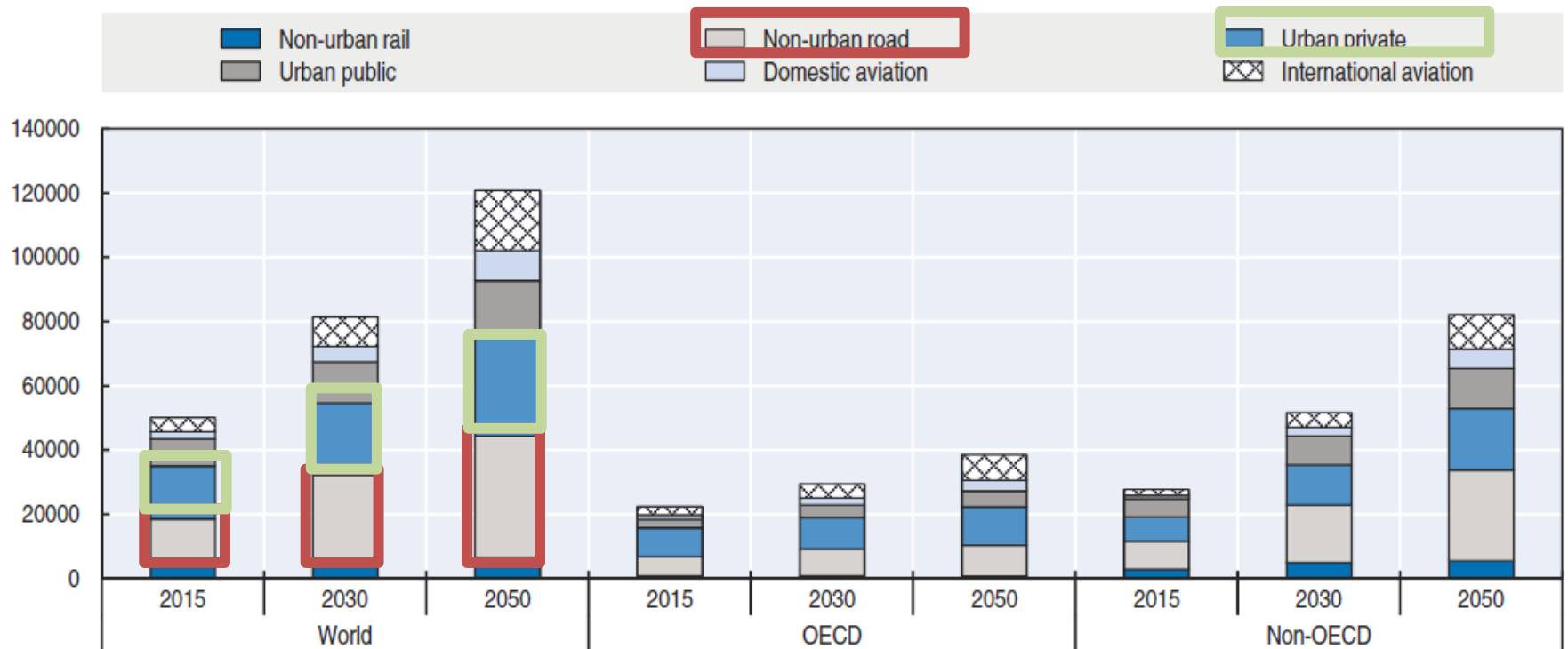


Note: International passenger numbers are divided equally between the country of origin and the country of destination.

Passenger kilometers

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

Billion passenger-kilometres, baseline scenario

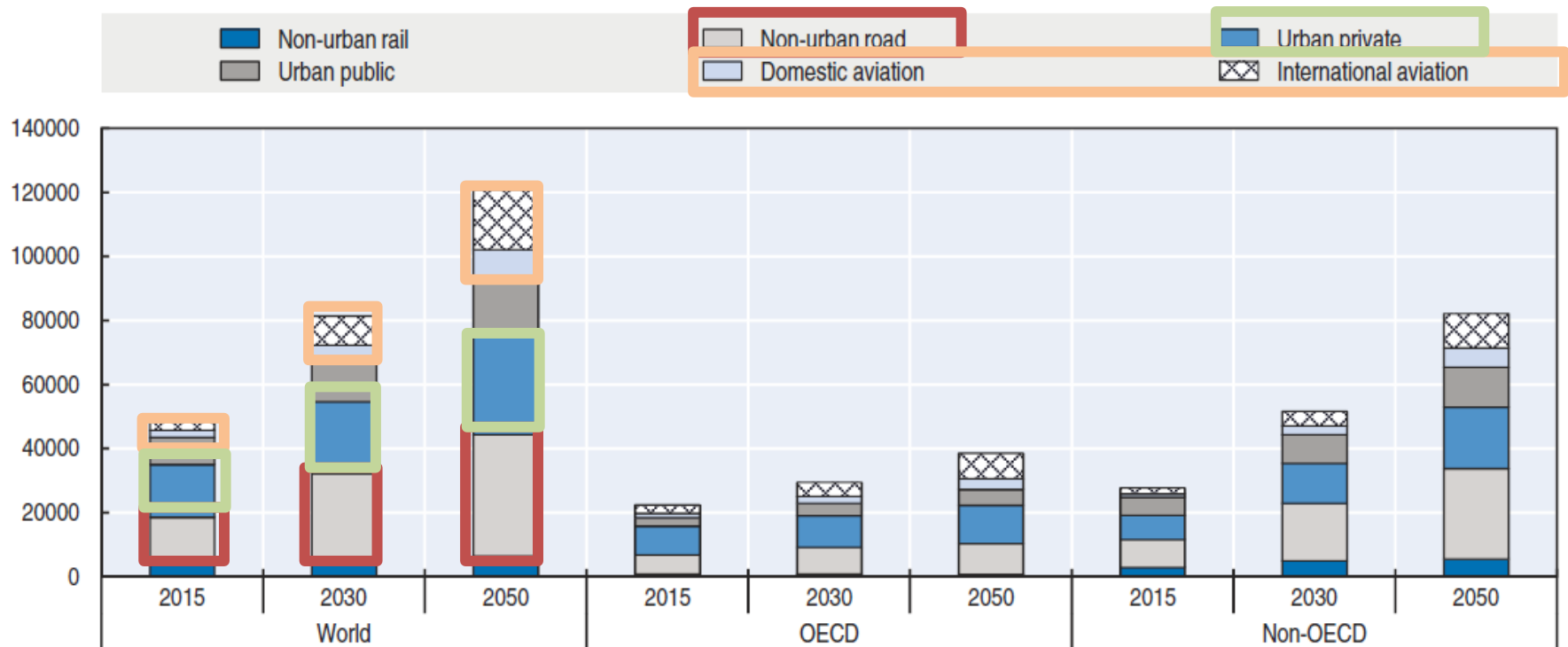


Note: International passenger numbers are divided equally between the country of origin and the country of destination.

Passenger kilometers

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

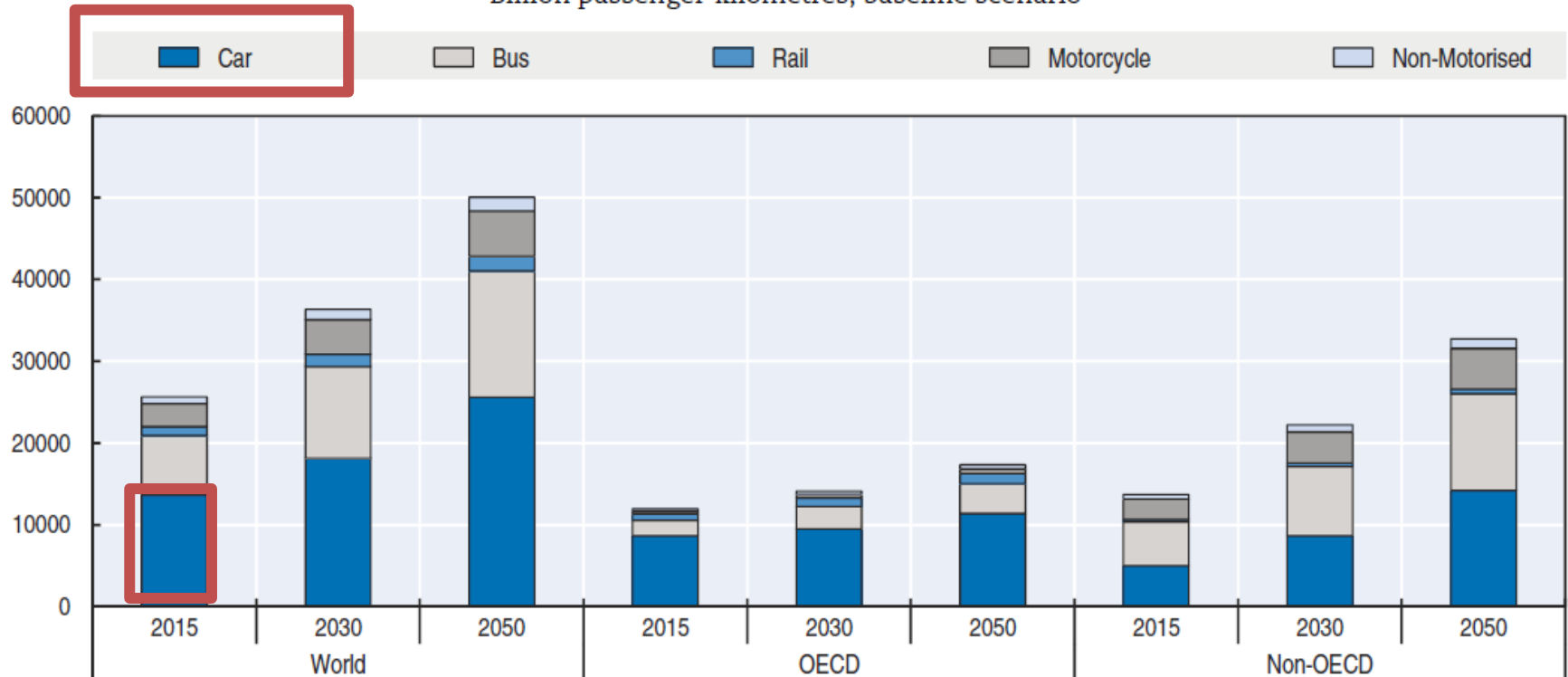
Billion passenger-kilometres, baseline scenario



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

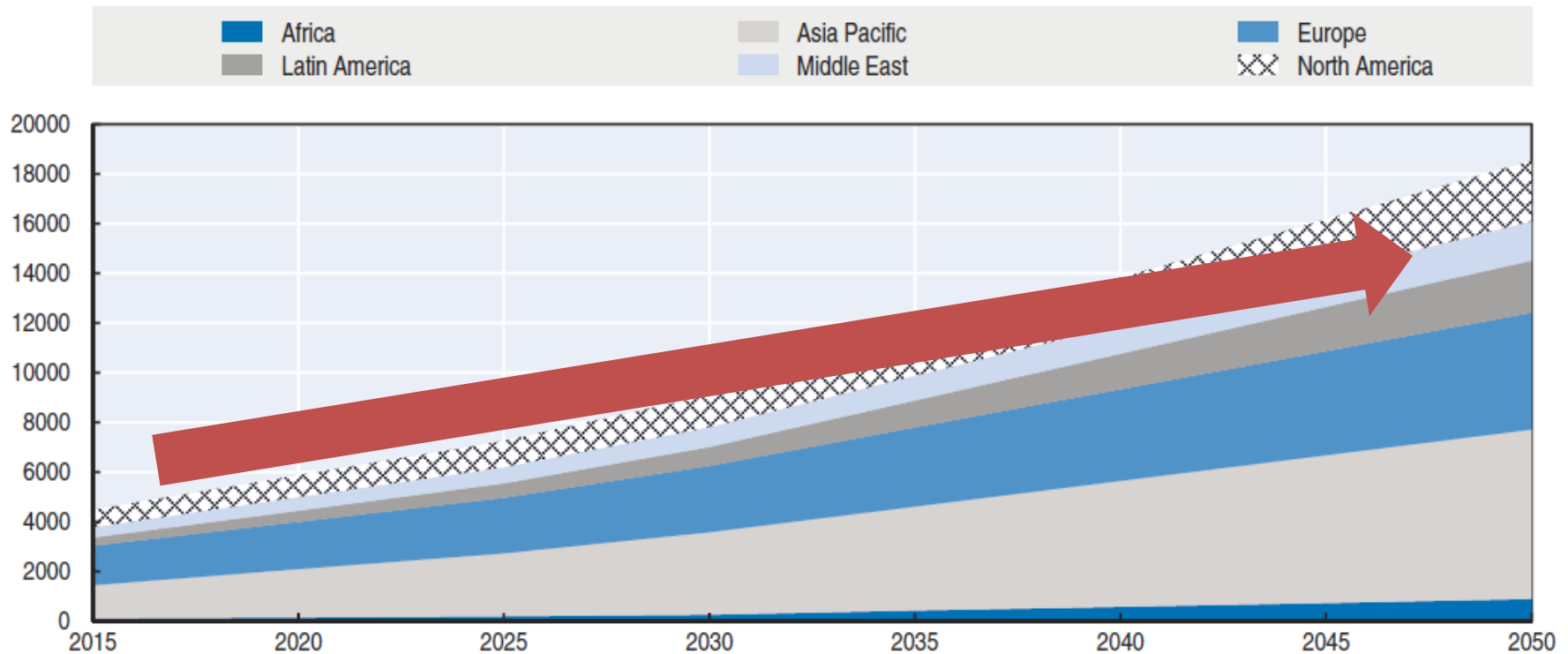
Passenger kilometres: Modal split

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

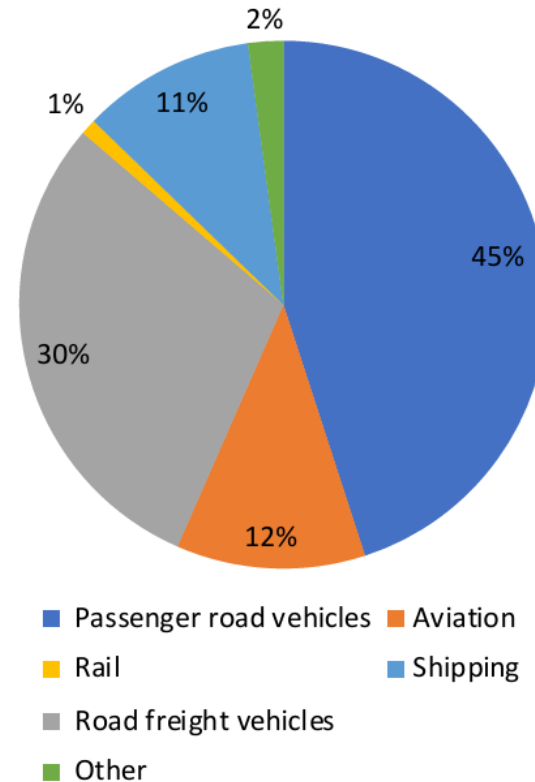
Meaningful alternatives pls?

Short haul flights (<1000 km)

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

(Source: Global Mobility Report, 2022)

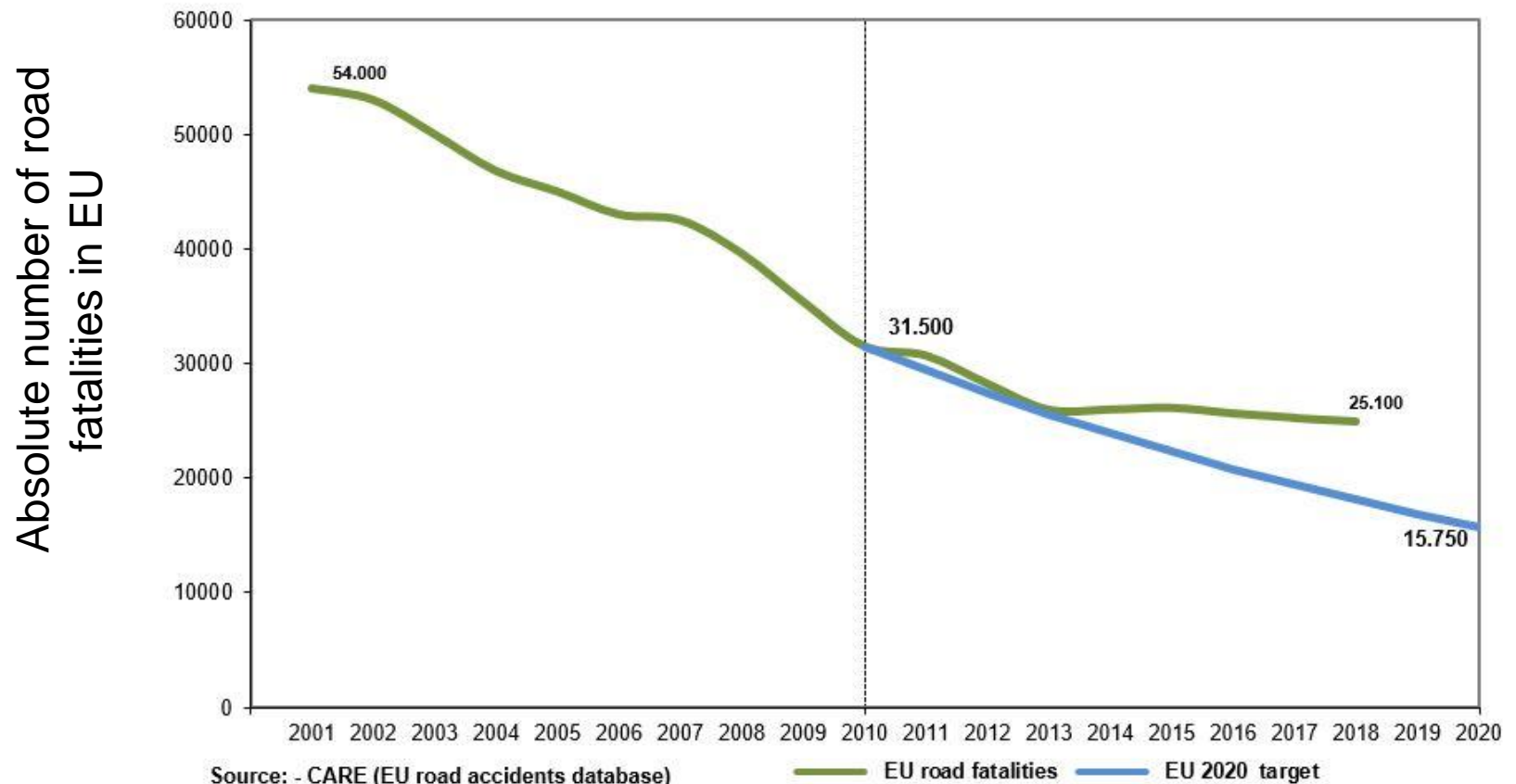
Figure 2.4: Global Transport sector carbon dioxide emissions by mode in 2020



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)



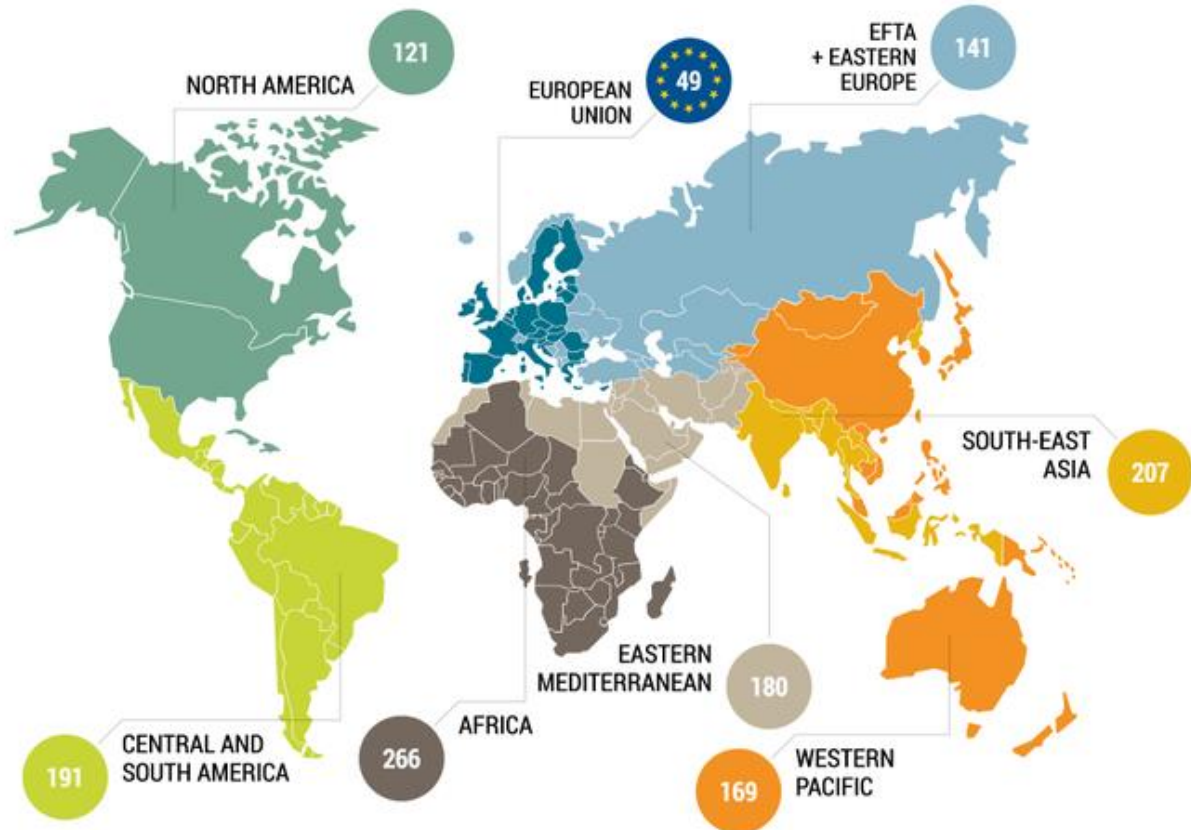
Source: - CARE (EU road accidents database)

— EU road fatalities — EU 2020 target

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

Road fatalities per million inhabitants (world)

BY REGION
2016



WORLD 182 road fatalities per million inhabitants

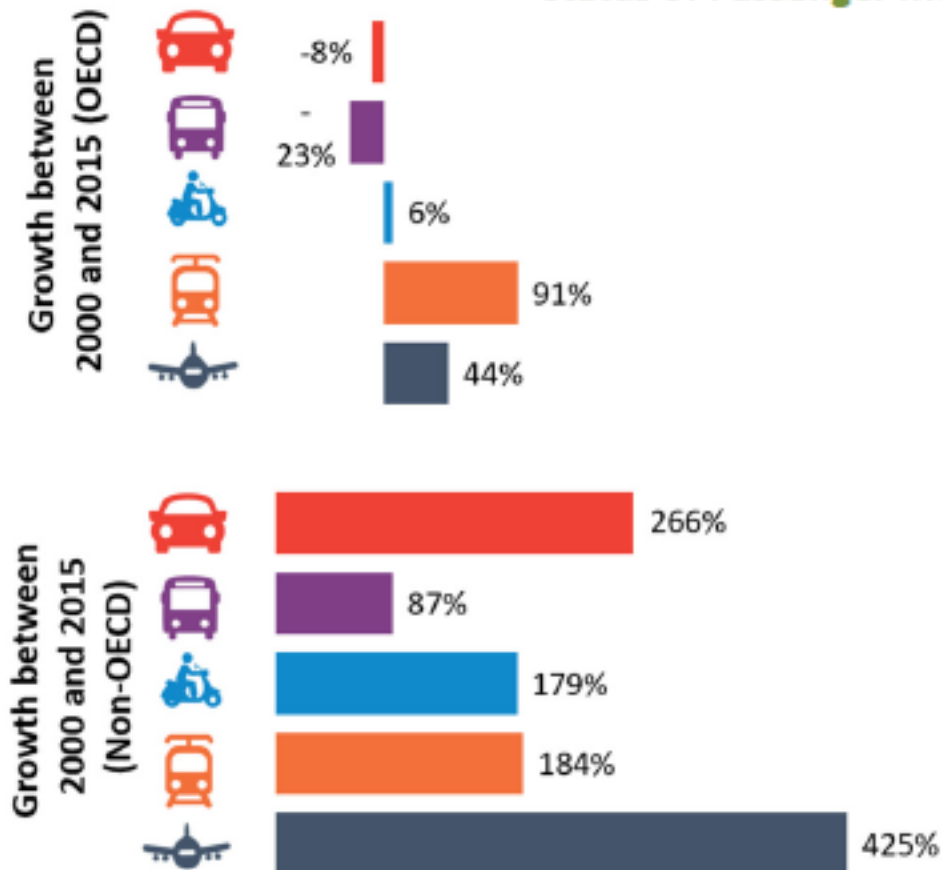
SOURCE: CARE (EU ROAD ACCIDENTS DATABASE), WHO (WORLD HEALTH ORGANIZATION)

[linkedin.com/company/ACEA](https://www.linkedin.com/company/ACEA)
twitter.com/ACEA_eu
[acea.be](http://www.acea.be)



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

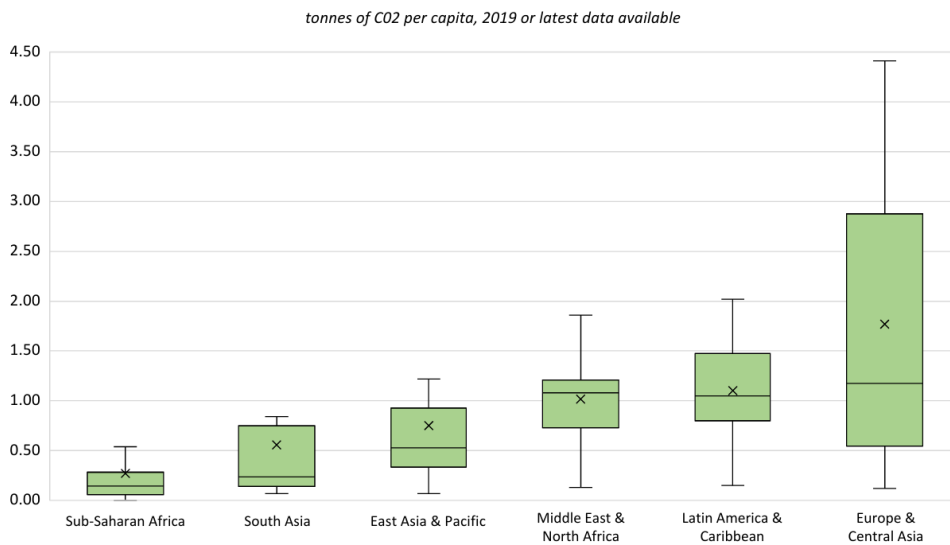
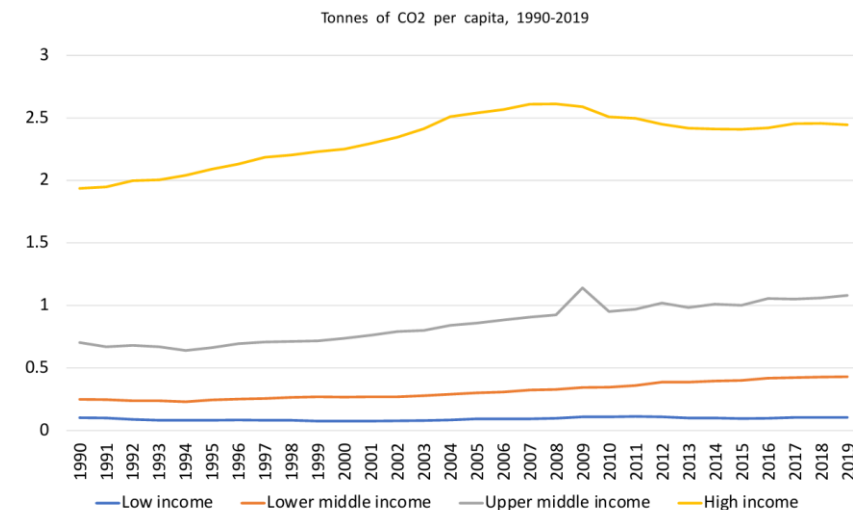


Figure 2.1: Average transport-related GHG emissions per capita by income level

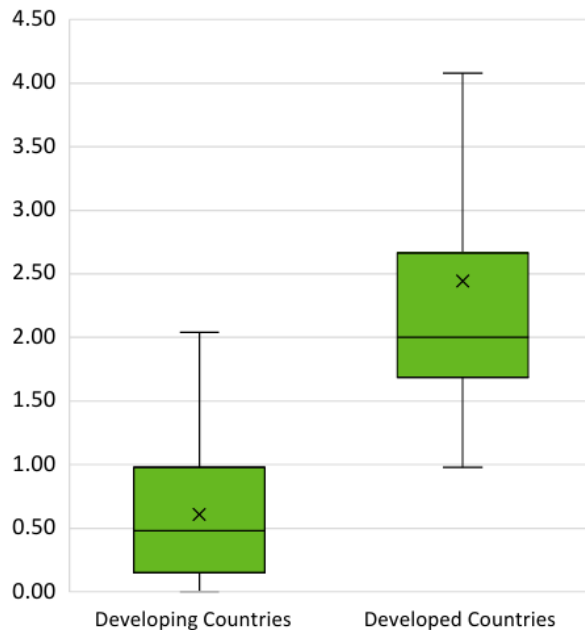


Transport-related GHG emissions by regions

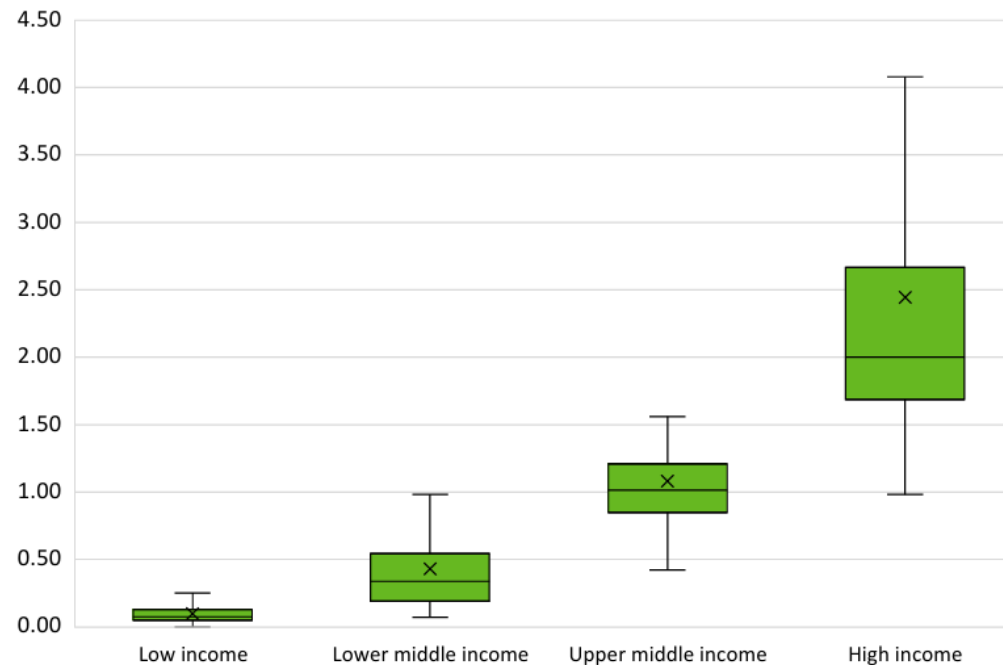
The role of income

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*



Source: Global Mobility Report, 2022

The role of income

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

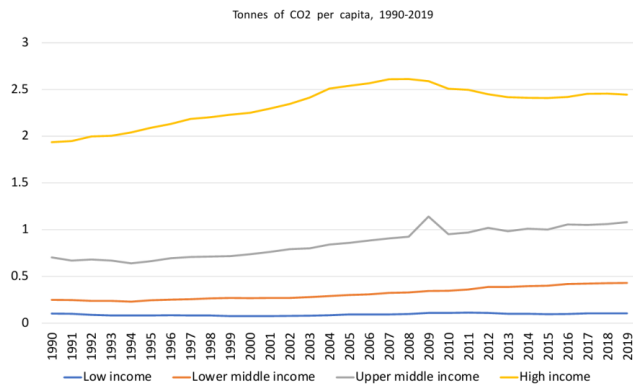
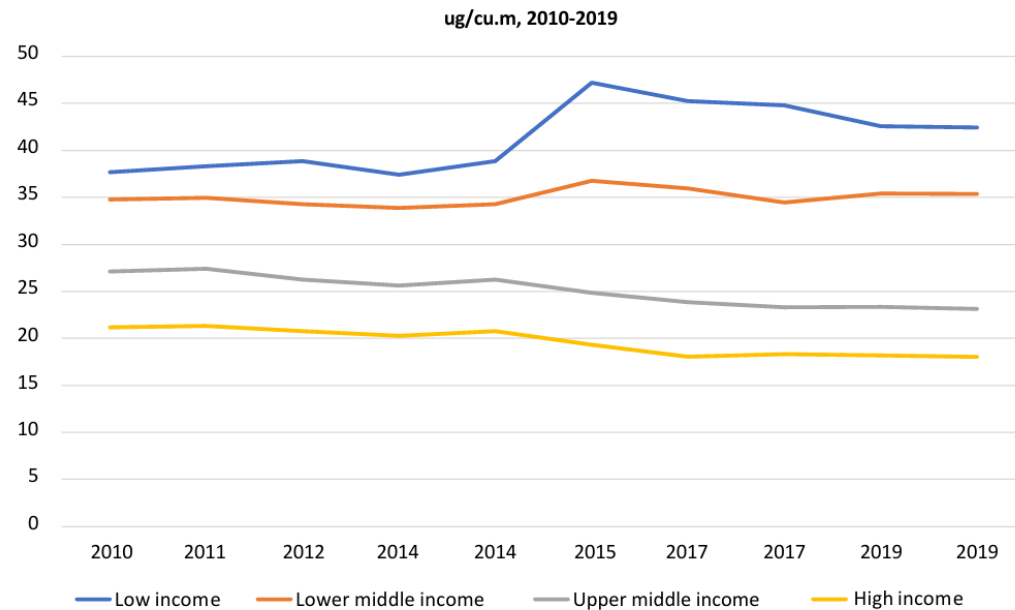


Figure 2.5: PM_{2.5} Air pollution average annual exposure by the income level

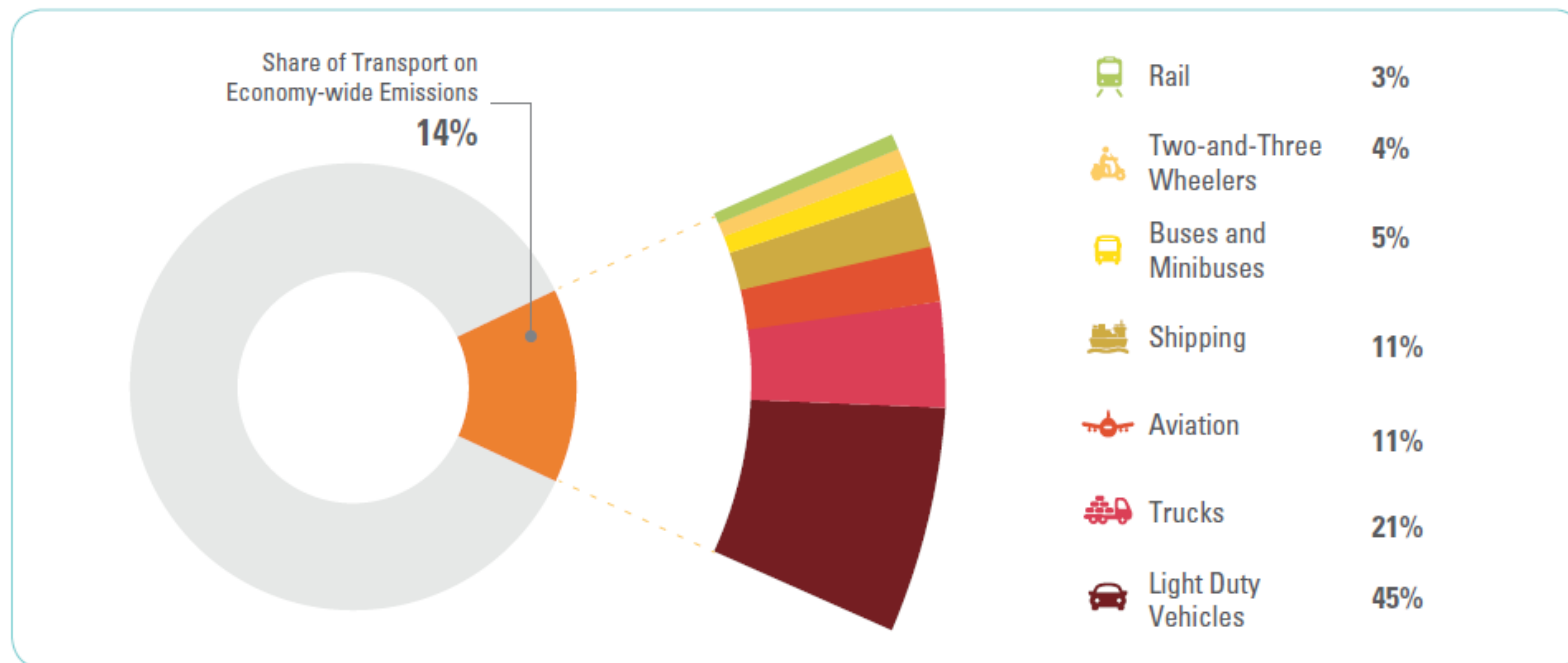


Source: UNHABITAT and Global Burden of Disease Study raw data with authors' analysis.

Source: Global Mobility Report, 2022

Carbon emisisions from transport

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

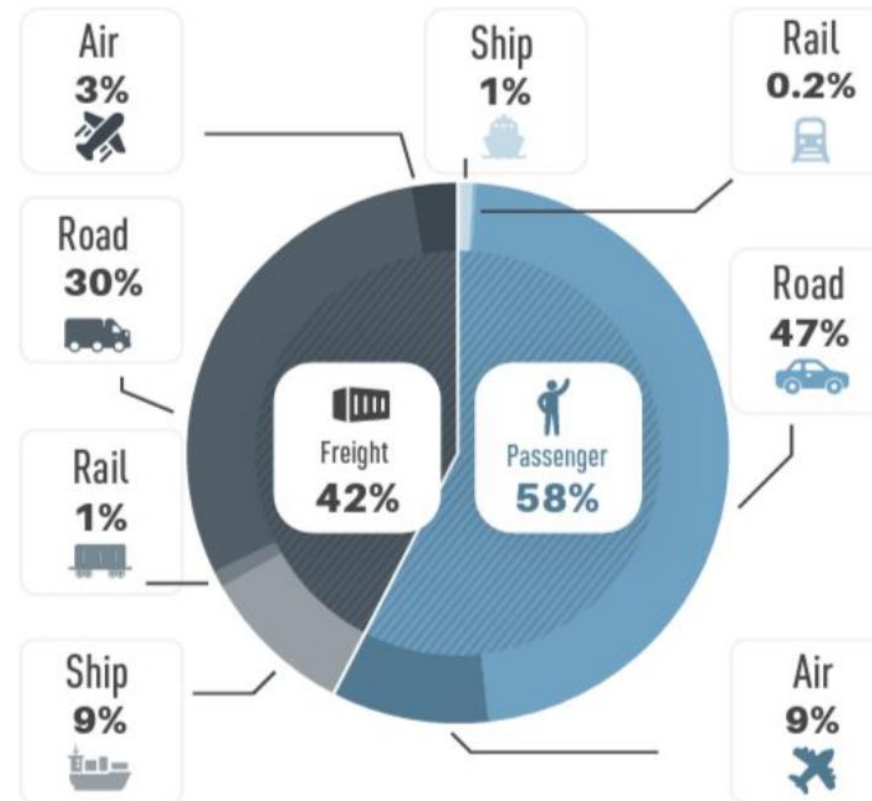


Source: SLoCaT 2018

Carbon emissions from transport

The share of passenger and freight transport

Transport CO₂ emissions by activity and mode, 2019



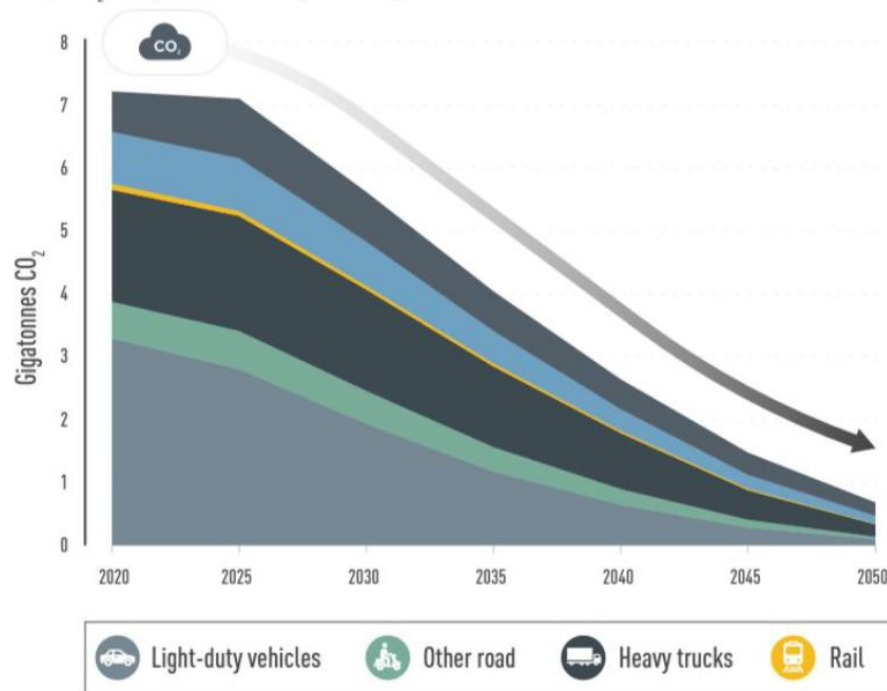
Source: Shell (2020), The Energy Transformation Scenarios, <https://www.shell.com/energy-and-innovation/the-energy-future/scenarios/the-energy-transformation-scenarios.html> (accessed 20 August 2022)

Carbon emisisions from transport

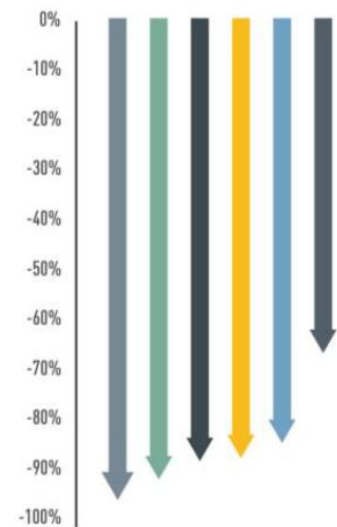
Required reductions for net zero scenarios by transport mode

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

Global CO₂ transport emission trajectories by mode



CO₂ reduction from 2020 to 2050



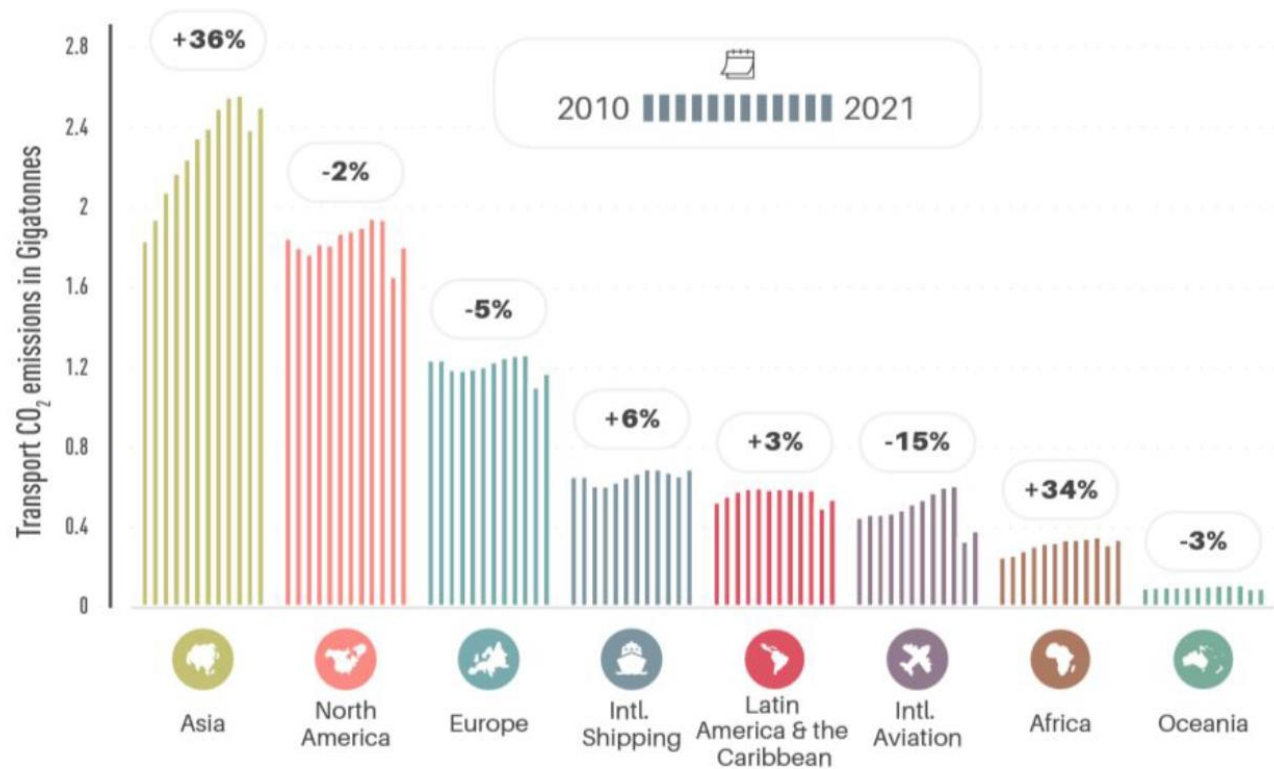
Source: IEA (2021), Net Zero by 2050, IEA, Paris, <https://www.iea.org/reports/net-zero-by-2050> (accessed 20 January 2023)

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

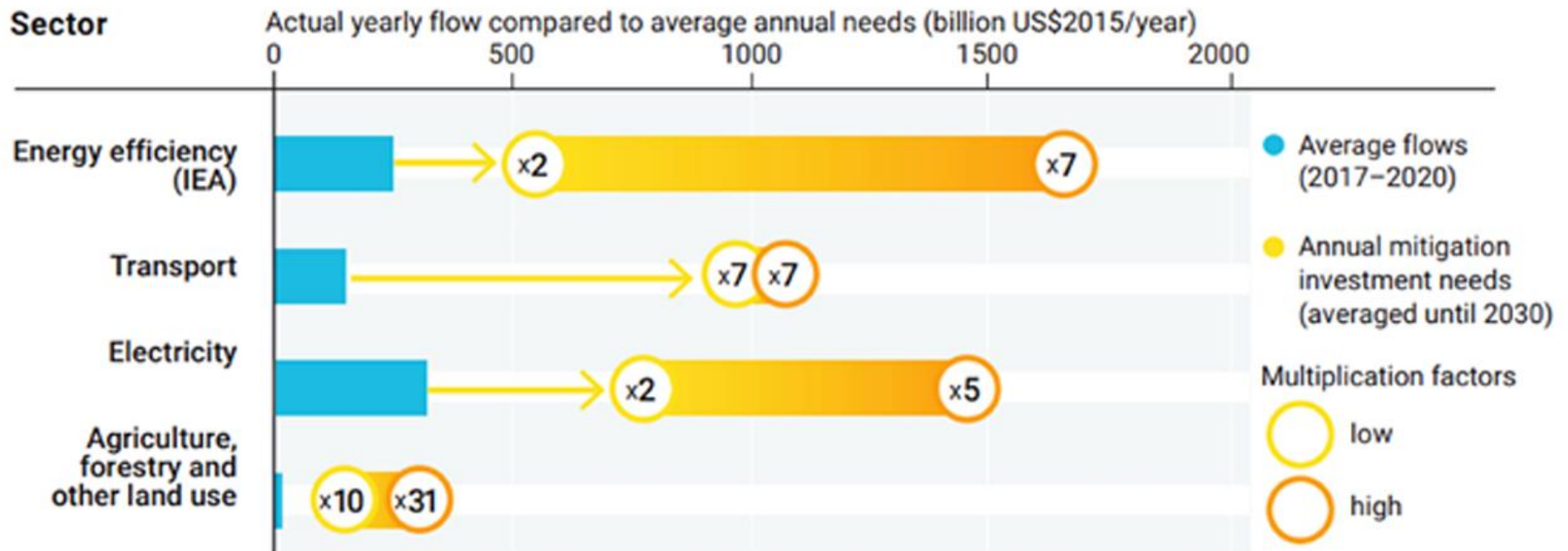


Source: SLOCAT analysis based on Crippa, M. et al (2022), CO2 emissions of all world countries - 2022 Report, doi:10.2760/730164, https://edgar.jrc.ec.europa.eu/report_2022 (accessed 20 September 2022)

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

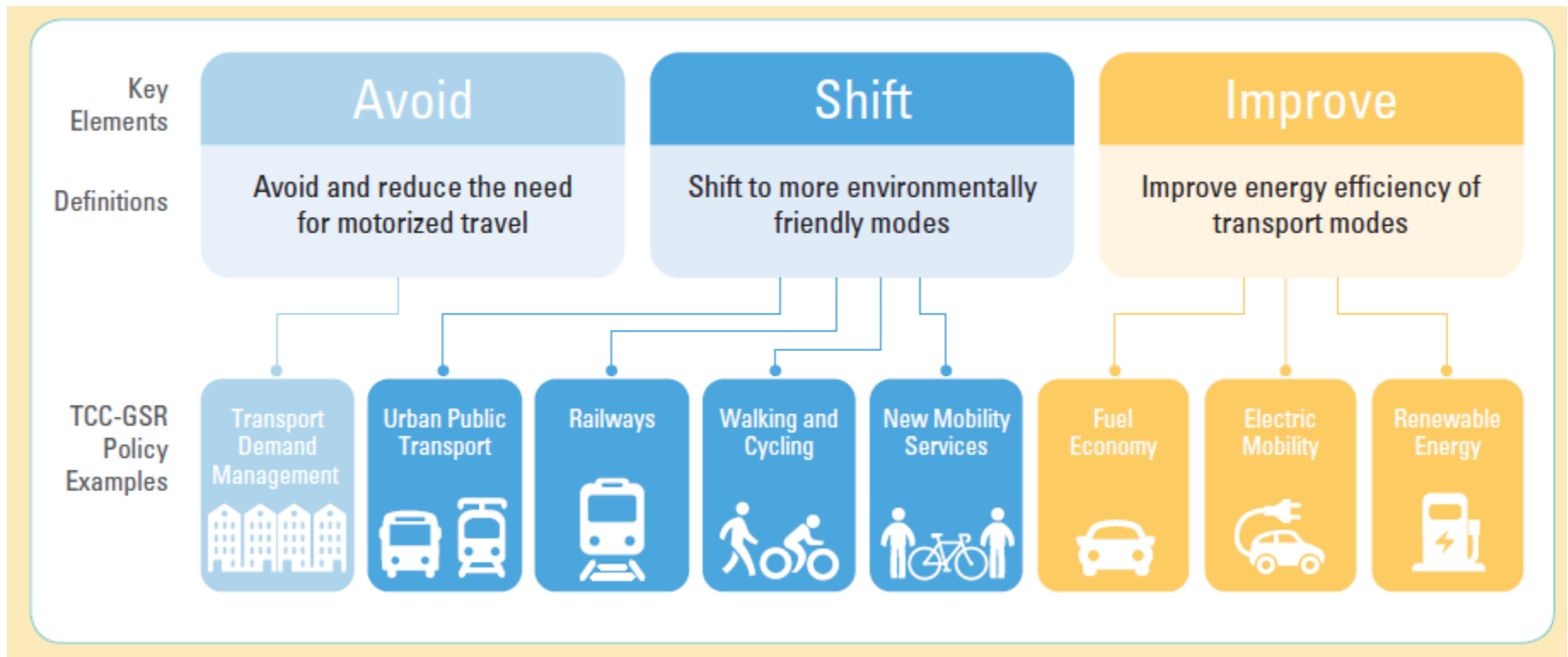
- Indicators
- Global Facts and Trends
- Summary

Part II: Ways out?

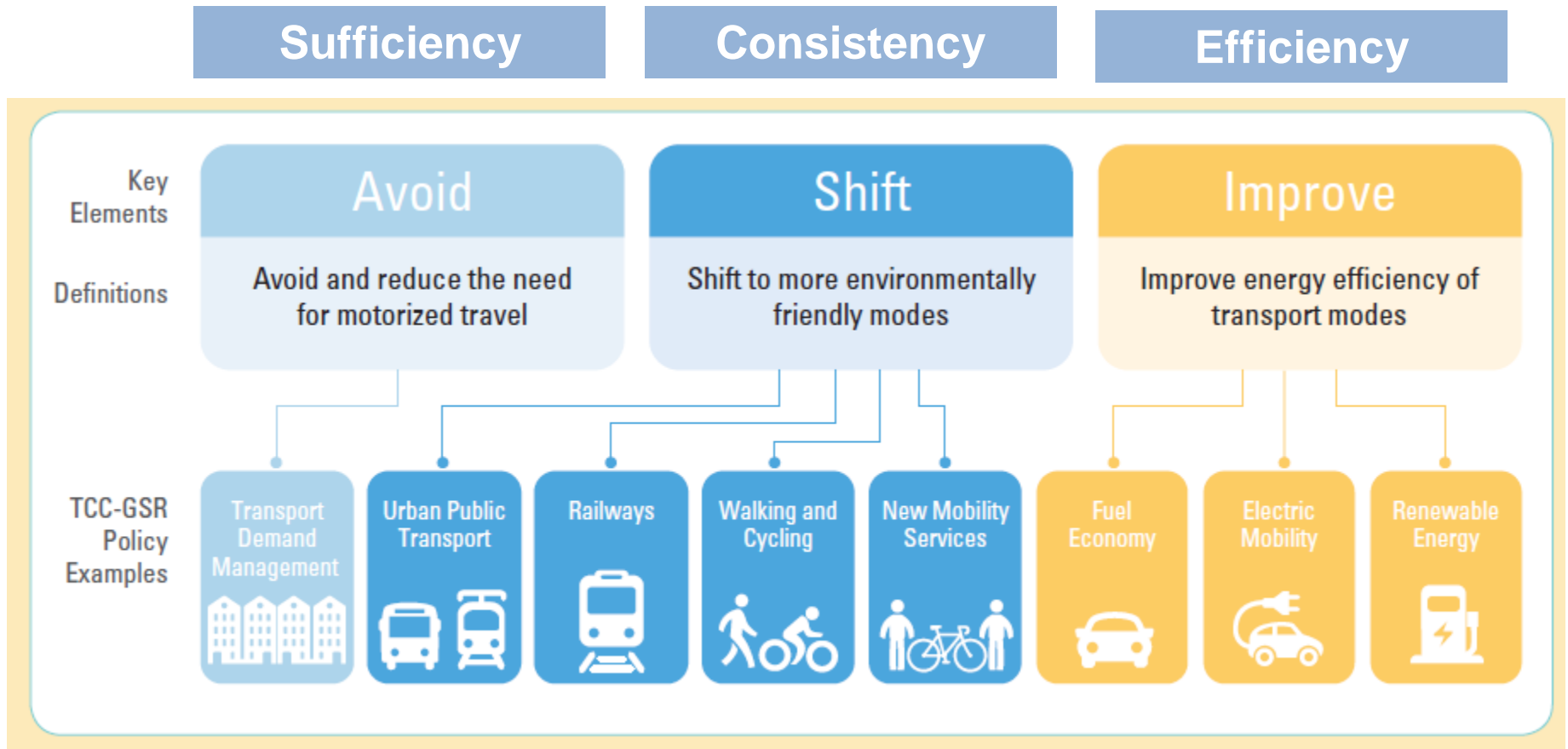
- RE Supply
- E-mobility
- Side effects

References

Mitigation Strategies



Mitigation Strategies

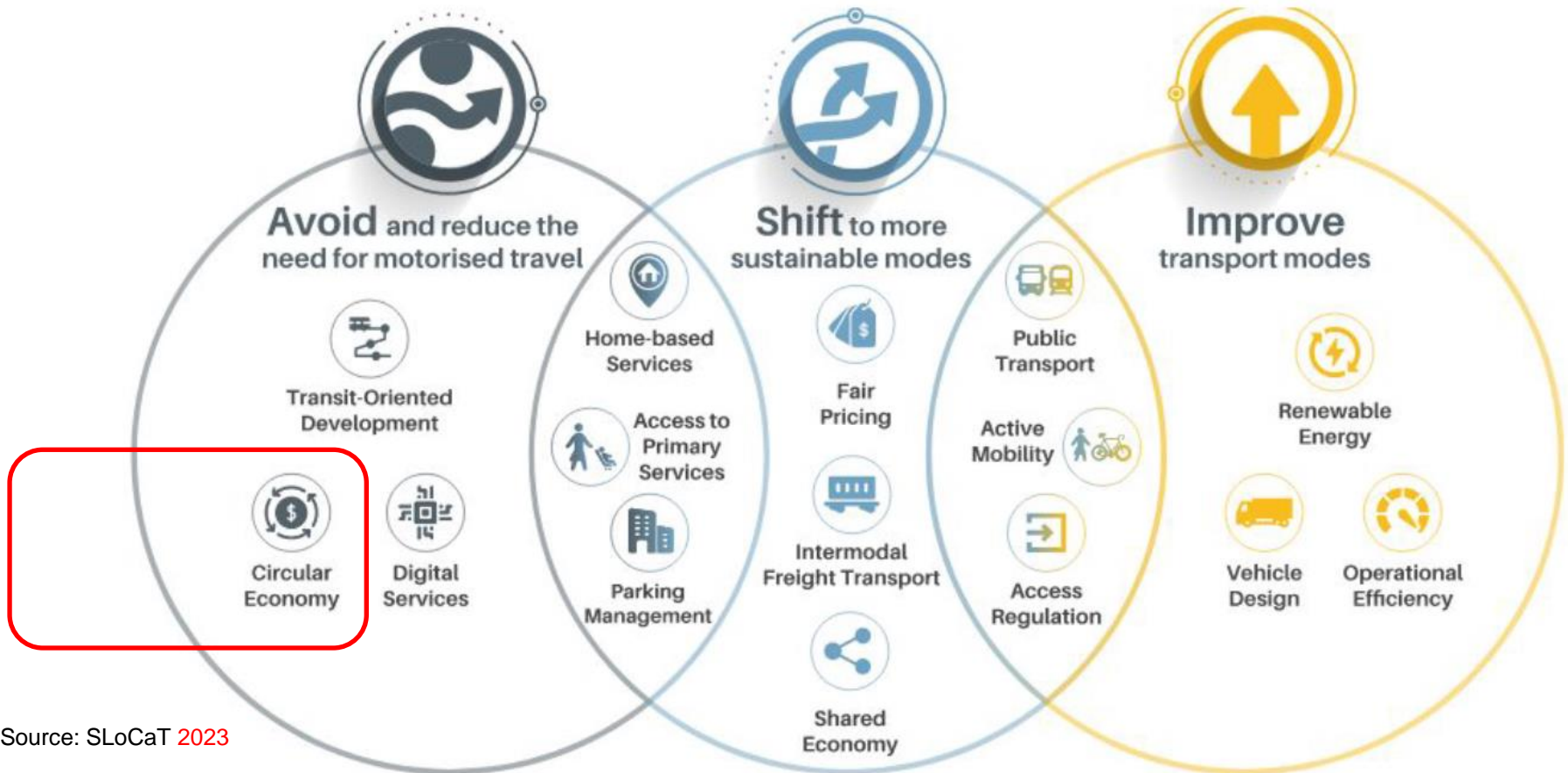


Mitigation Strategies

Sufficiency

Consistency

Efficiency



Source: SLoCaT 2023

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

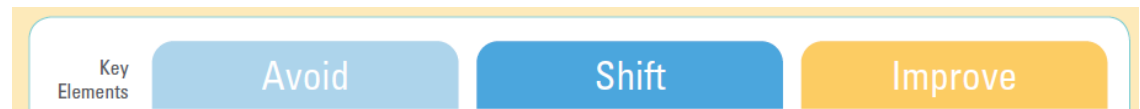
Mitigation Strategies

Sufficiency

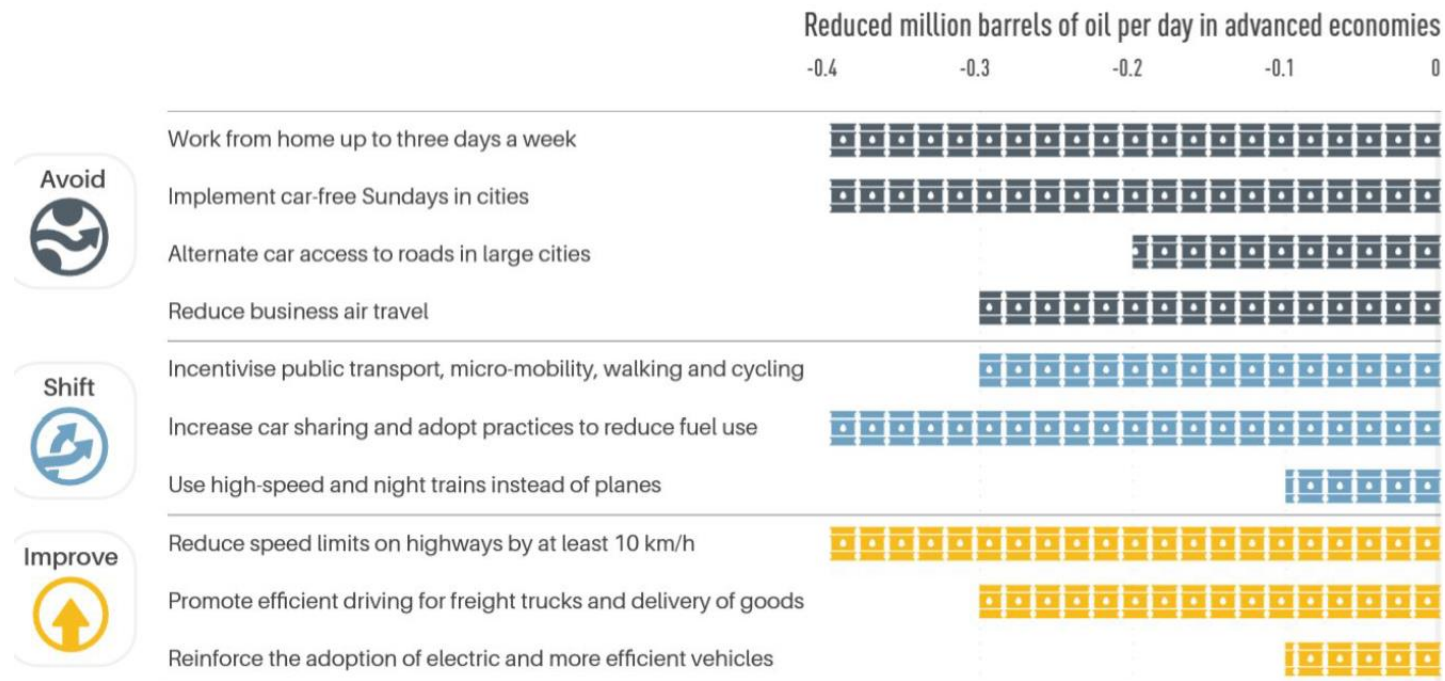
Consistency

Efficiency

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



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

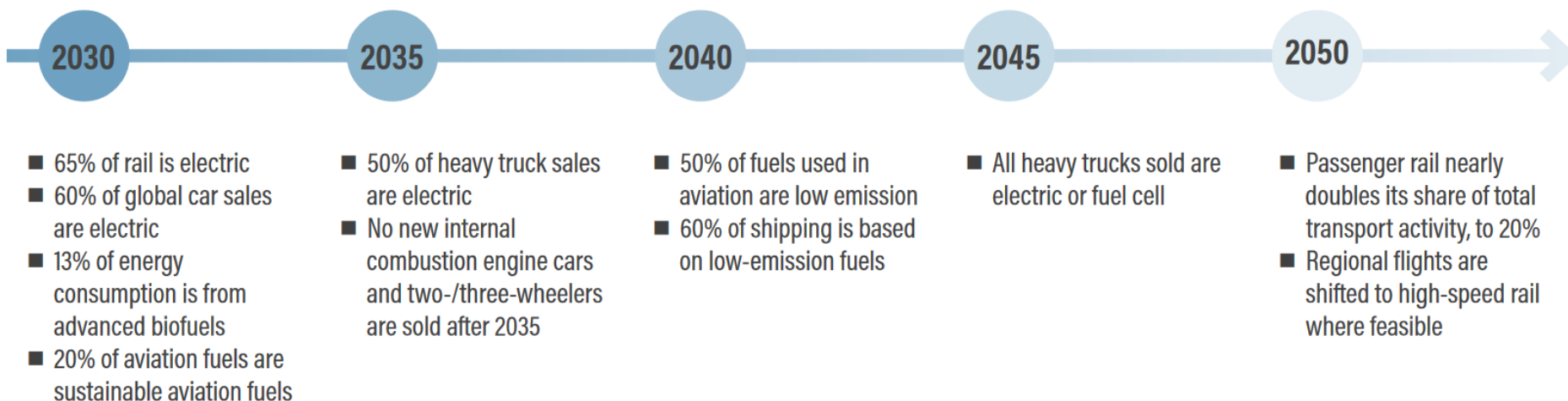


Mitigation Strategies

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

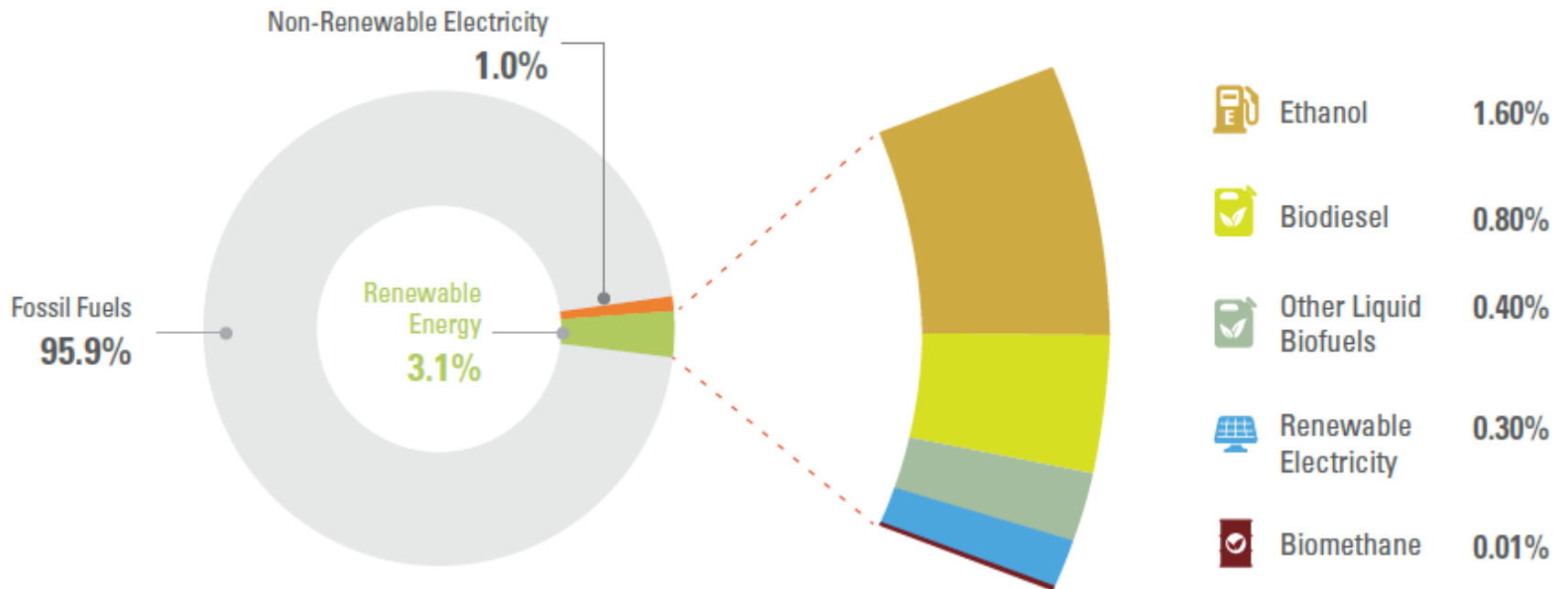
TABLE 1. Milestones towards net zero transport emissions, according to the IEA Net Zero Scenario

Source: See endnote 89 for this section.



I. Consistency: RE for E-mobility?

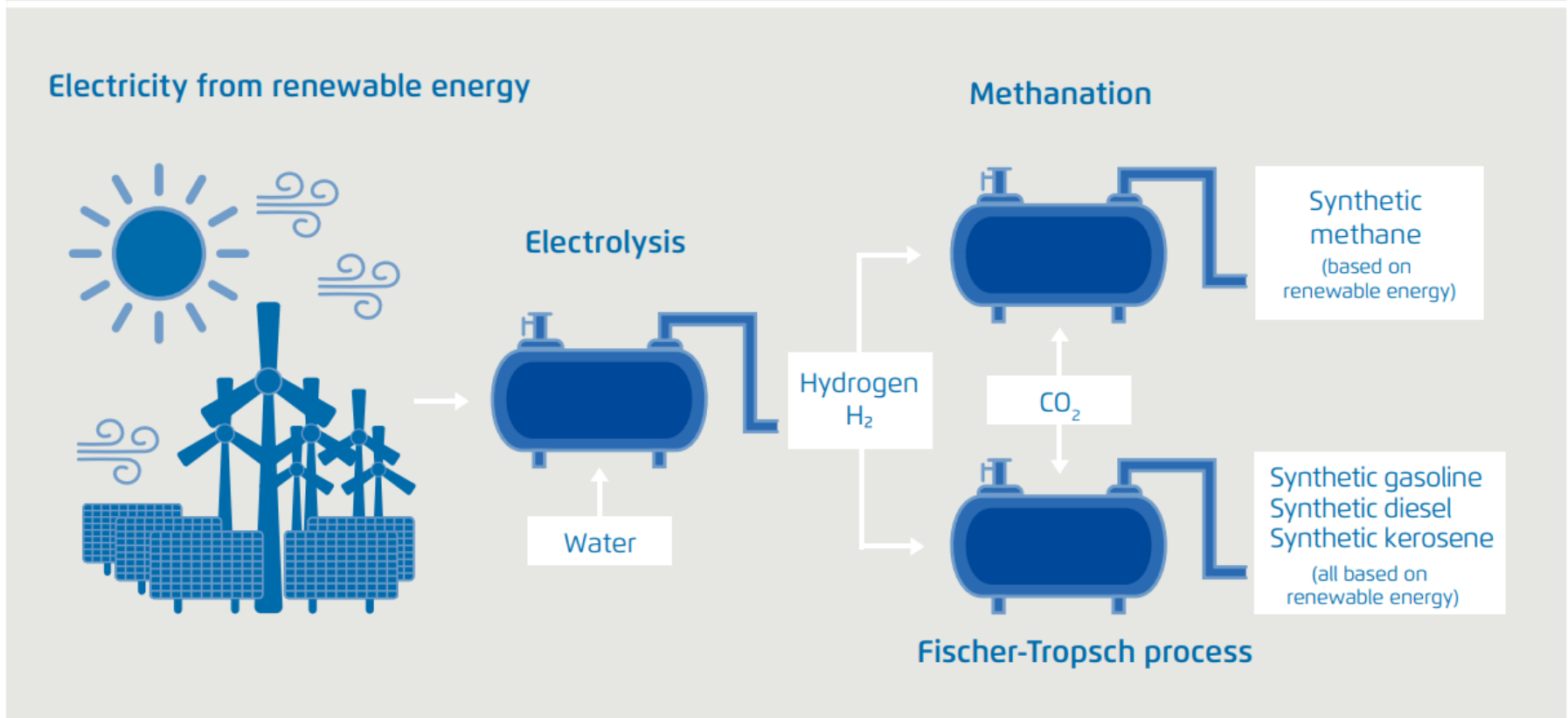
Figure 51: Share of Renewable Energy in Transport in 2015⁸¹⁵



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

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

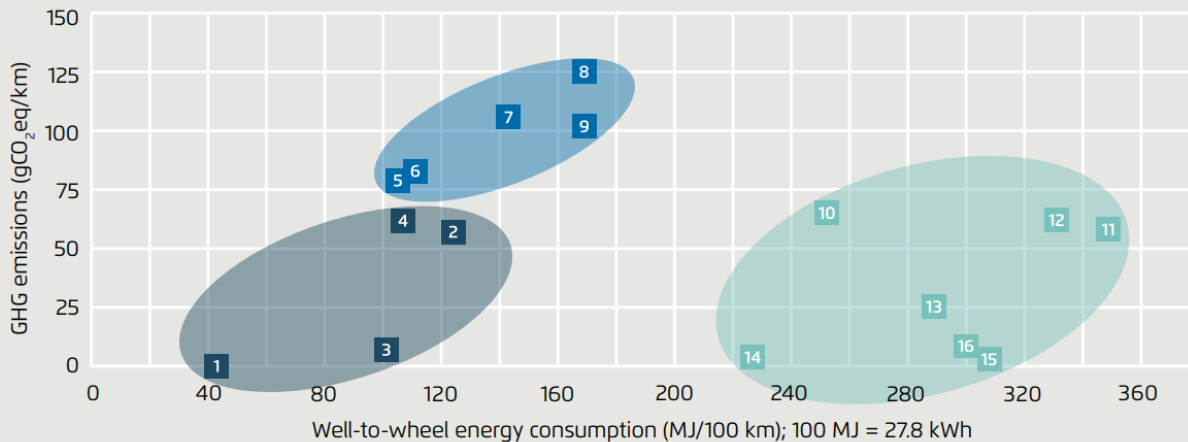
Figure 7.2



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)

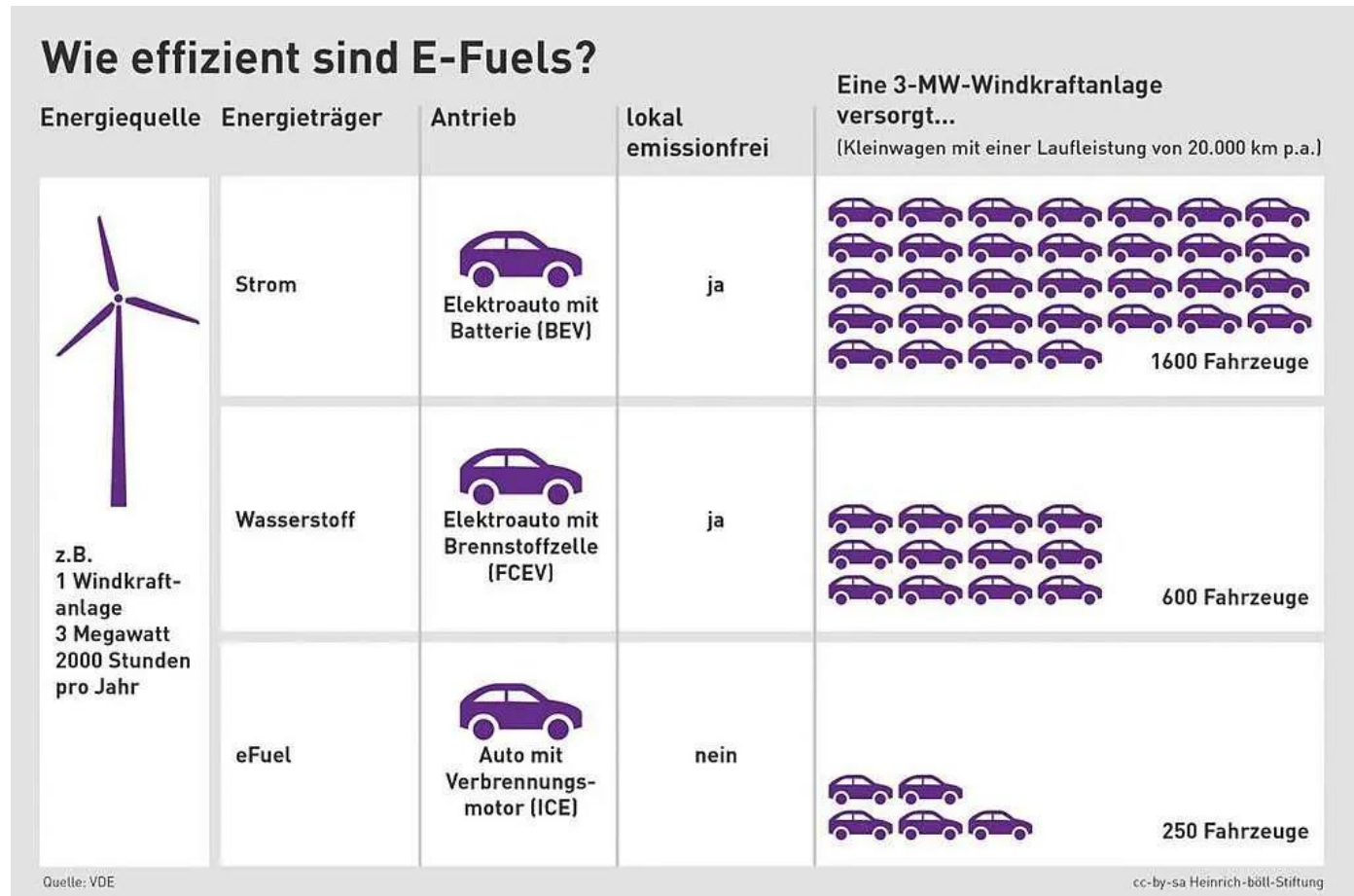
Fossil fuels

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

Biofuels and synthetic fuels

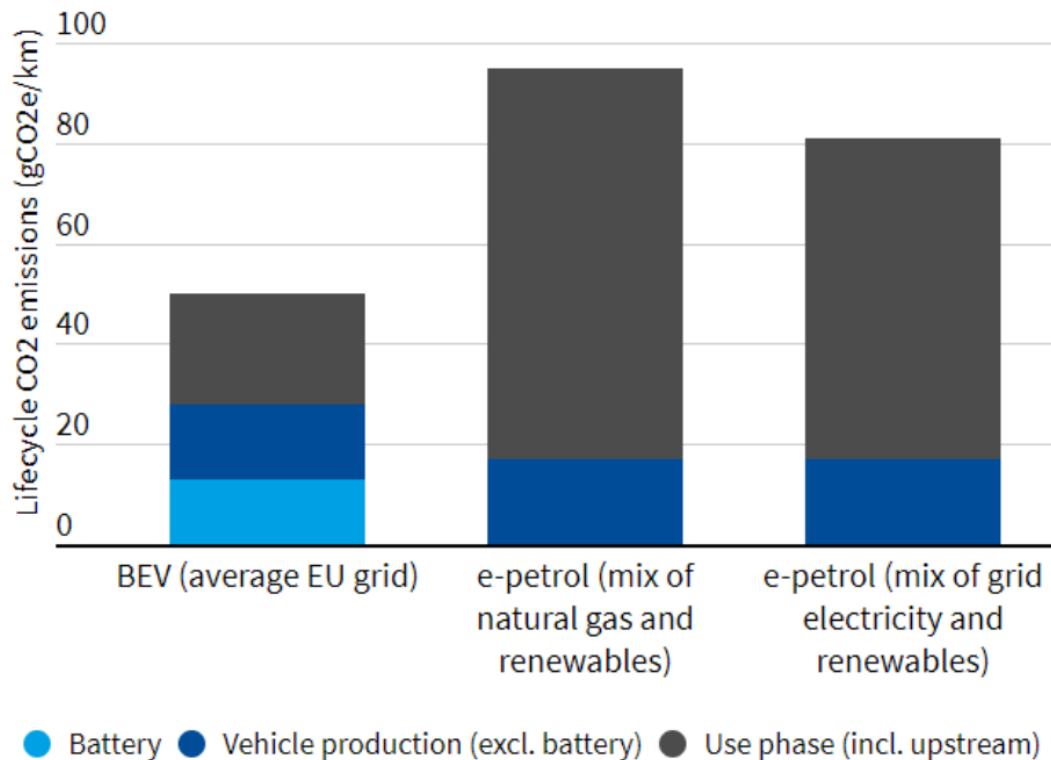
- 10 Biodiesel (rapeseed)
- 11 Ethanol (sugar beet, used in E10 blends)
- 12 Biomethane (maize)
- 13 Biomethane (municipal waste)
- 14 Syndiesel (B2L, waste wood)
- 15 Syndiesel (P2L, renewable electricity)
- 16 Synmethane (P2G, renewable electricity)

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



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

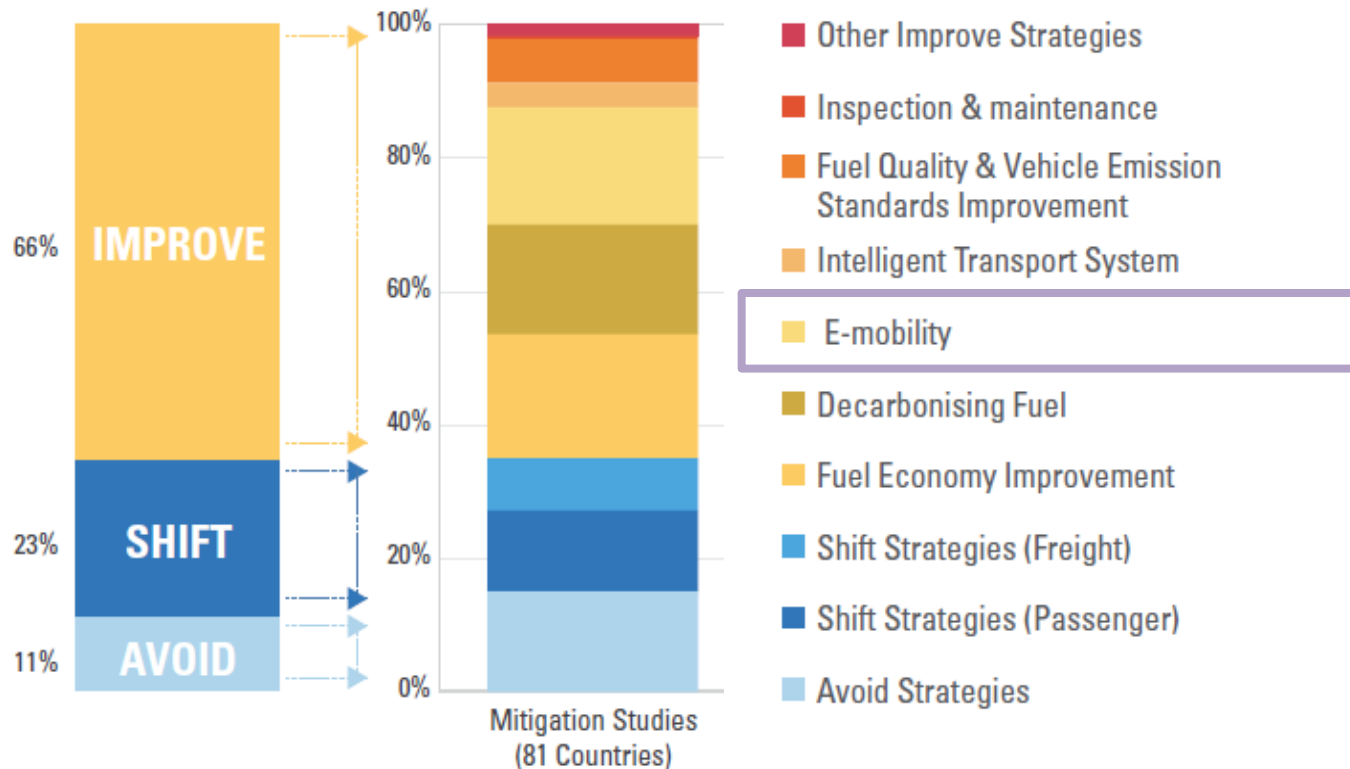
I. Consistency: E-fuels (or “E-fools” (from: TE, 2021))?



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

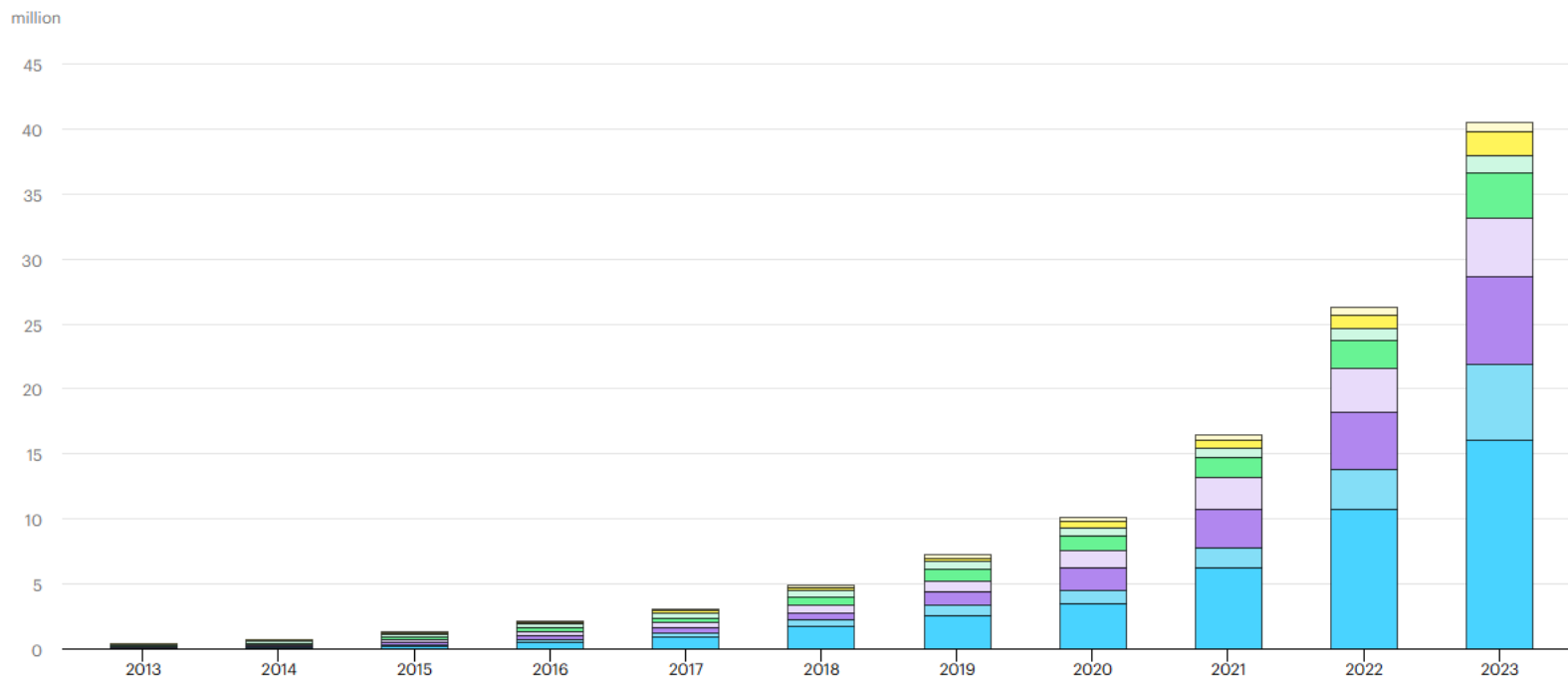


Source: Transport and Climate Change Report 2018, modified

II. Consistency and efficiency: E-mobility

Global electric car stock, 2013-2023

Open 



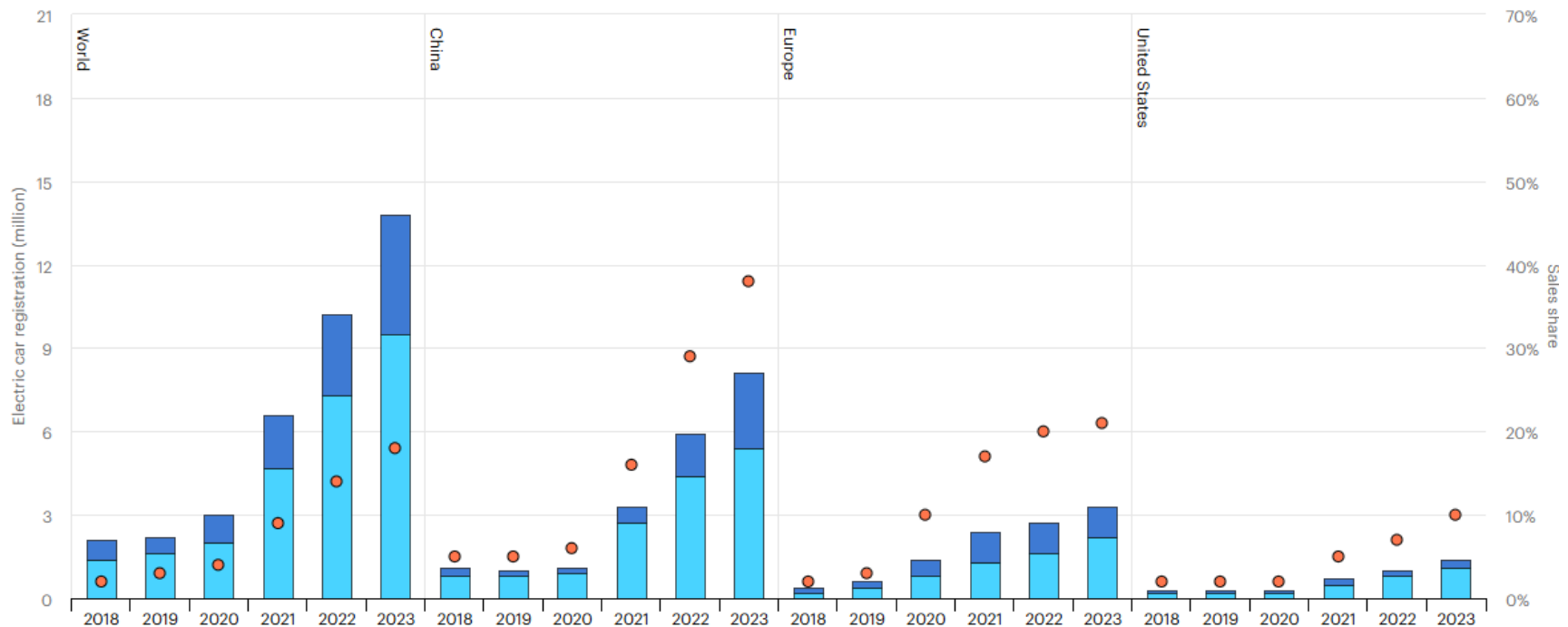
IEA. Licence: CC BY 4.0

● China BEV
 ● China PHEV
 ● Europe BEV
 ● Europe PHEV
 ● United States BEV
 ● United States PHEV
 ● Rest of the world BEV
 ● Rest of the world PHEV

Source: [Trends in electric cars – Global EV Outlook 2024 – Analysis - IEA](#)

II. Consistency and efficiency: E-mobility

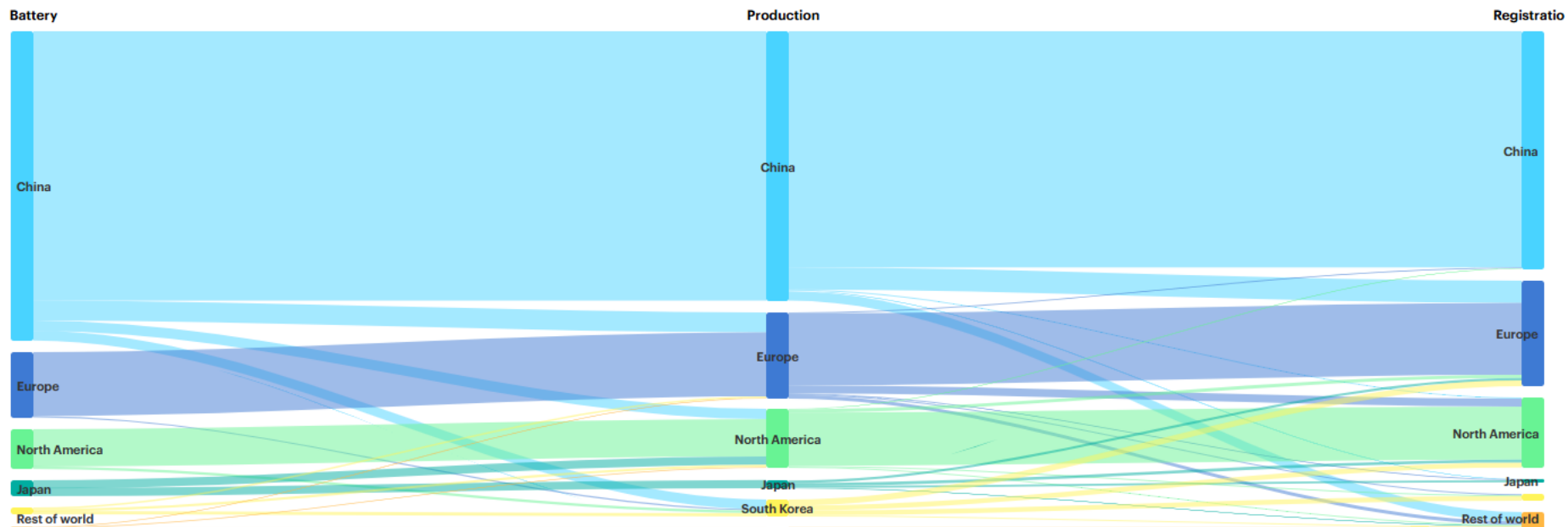
Electric car registrations and sales share in China, United States and Europe, 2018-2023



Source: [Trends in electric cars – Global EV Outlook 2024 – Analysis - IEA](#)

II. Consistency and efficiency: E-mobility

Global trade flows for lithium-ion batteries and electric cars, 2023

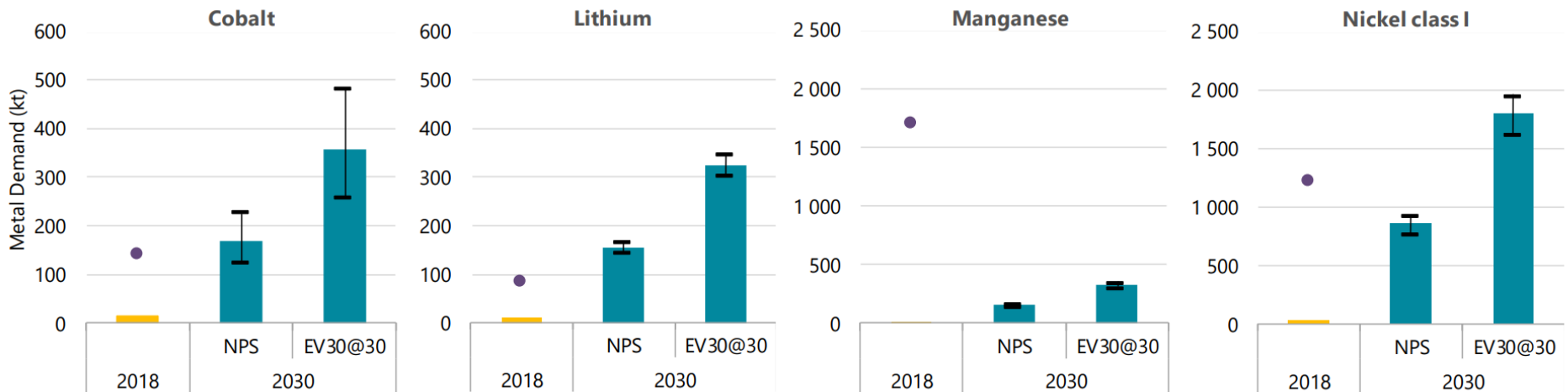


Source
 IEA analysis based on data from [Benchmark Mineral Intelligence](#) and [EV Volumes](#).

Source: [Trends in electric cars – Global EV Outlook 2024 – Analysis - IEA](#)

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

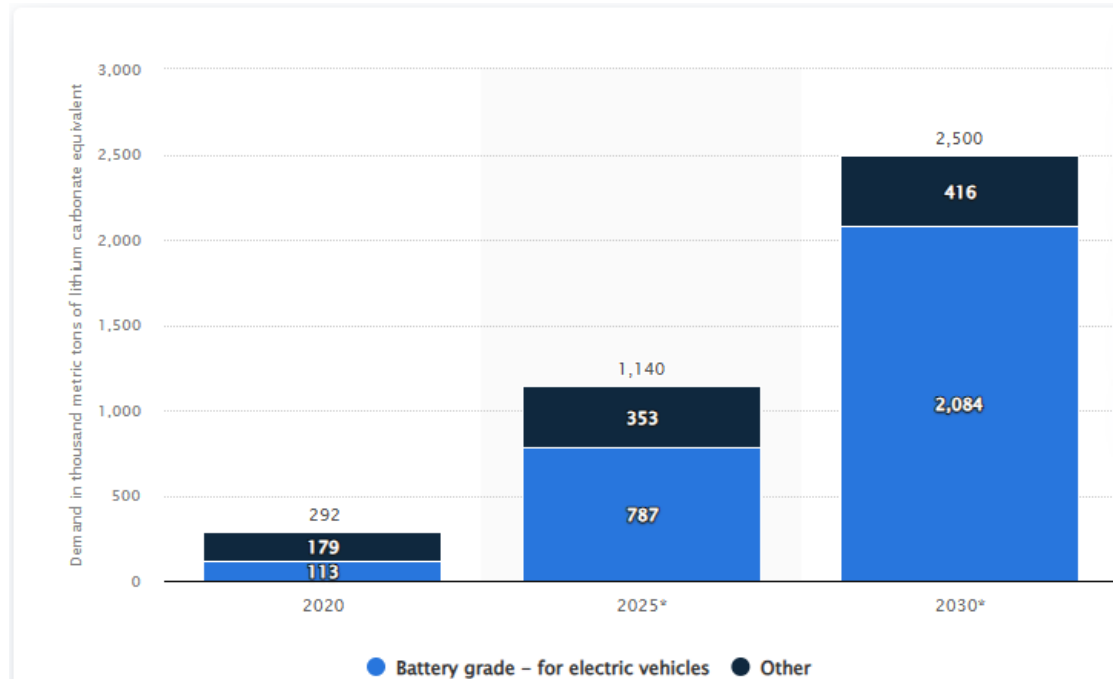
Cobalt (ca. 100y)
 Current demand: 71 kt/a
 Total reserves: 8.3 million tons
www.statista.com/statistics/875808/cobalt-demand-worldwide/

Lithium (ca. 75y)
 Current demand: 292 kt/a
 Total reserves: 22 million tons
[Global lithium demand volume by application 2020-2030](https://www.statista.com/statistics/273634/global-lithium-demand-volume-by-application-2020-2030/)

Nickel
 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 lithium demand volume by application 2020-2030](#)

Lithium (ca. 75y)

Current demand: 292 kt/a

Total reserves: 22 million tons

[Global lithium demand volume by application 2020-2030](#)

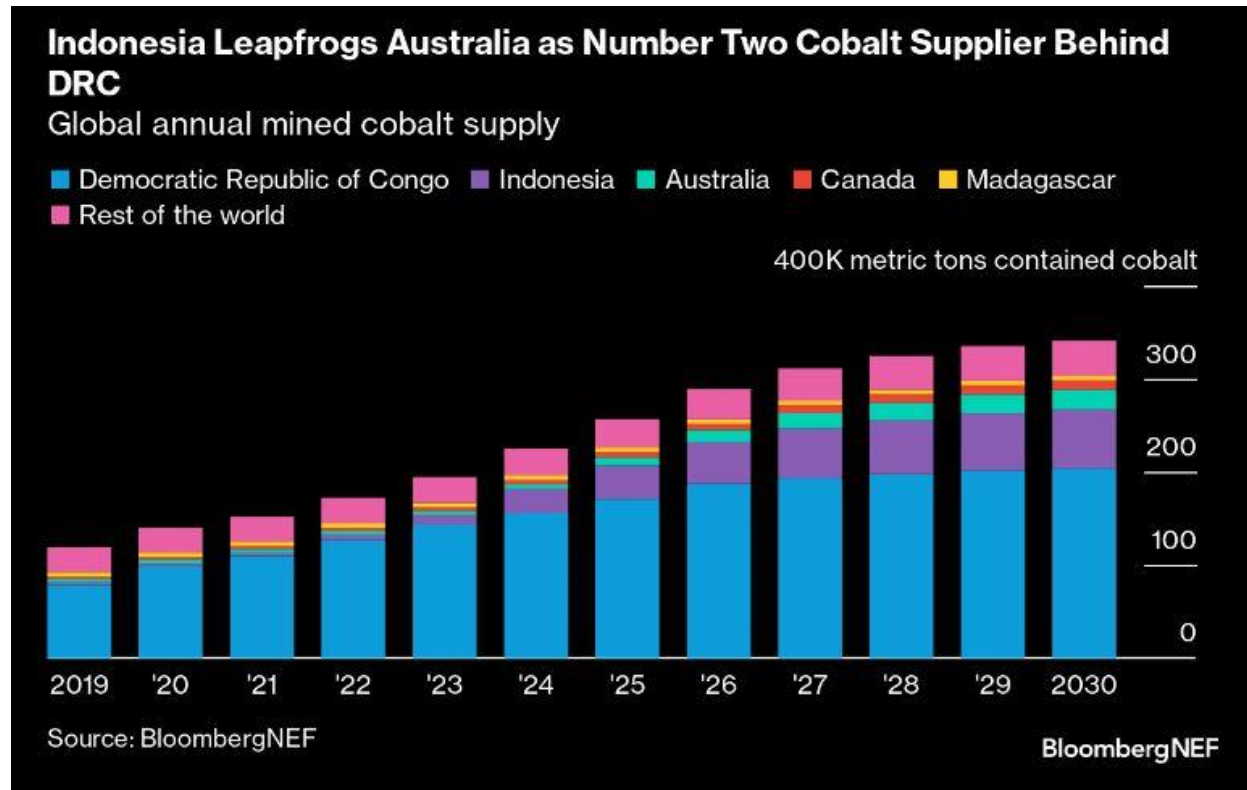
II. Consistency and efficiency: E-mobility

Cobalt (ca. 100y)

Current demand: 71 kt/a

Total reserves: 8.3 million tons

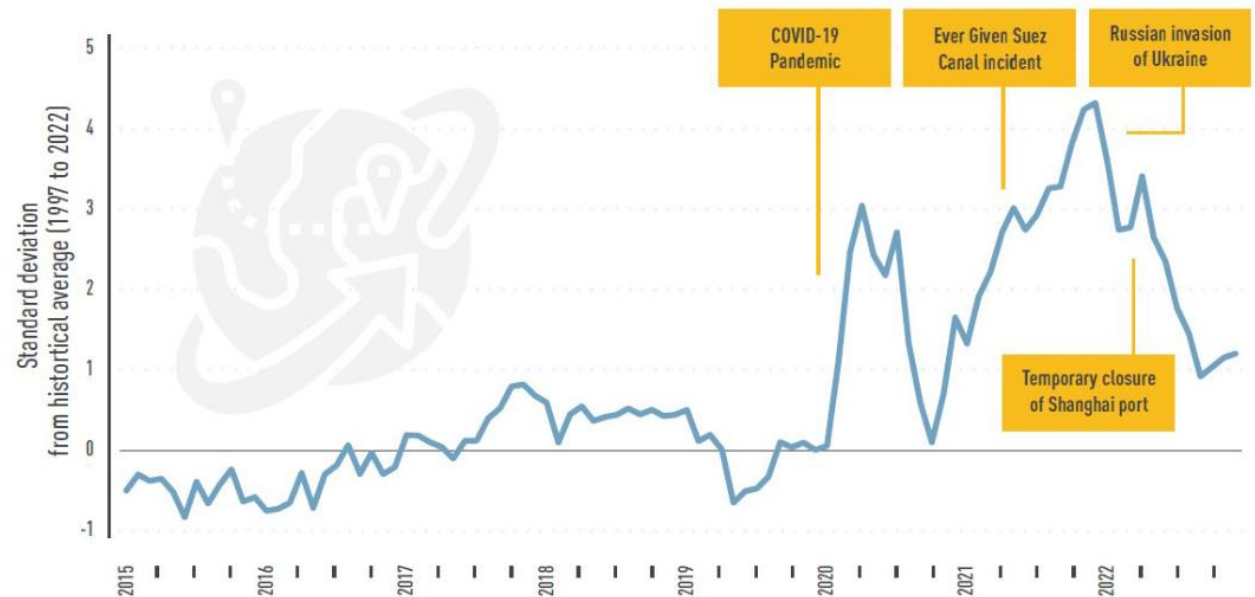
www.statista.com/statistics/875808/cobalt-demand-worldwide/



Source: [Cobalt Suppliers Up Their Game to Cash In on EV Rush | BloombergNEF](#)

II. Consistency and efficiency: E-mobility

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



References

ACEA. 2018. The automobile industry pocket guide, 2017- 2018. European Automobile Manufacturers Association. Link: https://www.acea.be/uploads/publications/ACEA_Pocket_Guide_2017-2018.pdf, Last accessed: 10.04.2020.

ACEA. 2020. The automobile industry pocket guide, 2019- 2020. European Automobile Manufacturers Association. Link: https://www.acea.be/uploads/publications/ACEA_Pocket_Guide_2019-2020.pdf , Last accessed: 10.04.2020.

AGORA 2017: Transforming Transport to Ensure Tomorrow's Mobility 12 Insights into the Verkehrswende. Link: https://www.agora-verkehrswende.de/fileadmin/Projekte/2017/12_Thesen/Agora-Verkehrswende-12-Insights_EN_WEB.pdf Last accessed: 02.05.2023

IEA 2016. Energy Technology Perspectives – Flagship report. IEA 2016.

Öko-Institut 2017. Strategien für die nachhaltige Rohstoffversorgung der Elektromobilität. Synthesepapier zum Rohstoffbedarf für Batterien und Brennstoffzellen. Studie im Auftrag von Agora Verkehrswende.

Agora 2019. Verteilnetztausbau für die Energiewende- Elektromobilität im Fokus. Schlussfolgerungen zu einer Studie im Auftrag von Agora Verkehrswende, Agora Energiewende und The Regulatory Assistance Project (RAP). August 2019.

SLoCaT 2018. Transport and Climate Change Global Status Report 2018. Available at: <http://slocat.net/tcc-gsr> Last accessed: 10.04.2025.

GMR 2022. Global Mobility Report 2022. Available at: https://www.sum4all.org/data/files/global_mobility_report_2022_04052023_final.pdf Last accessed: 08.04.2025.

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