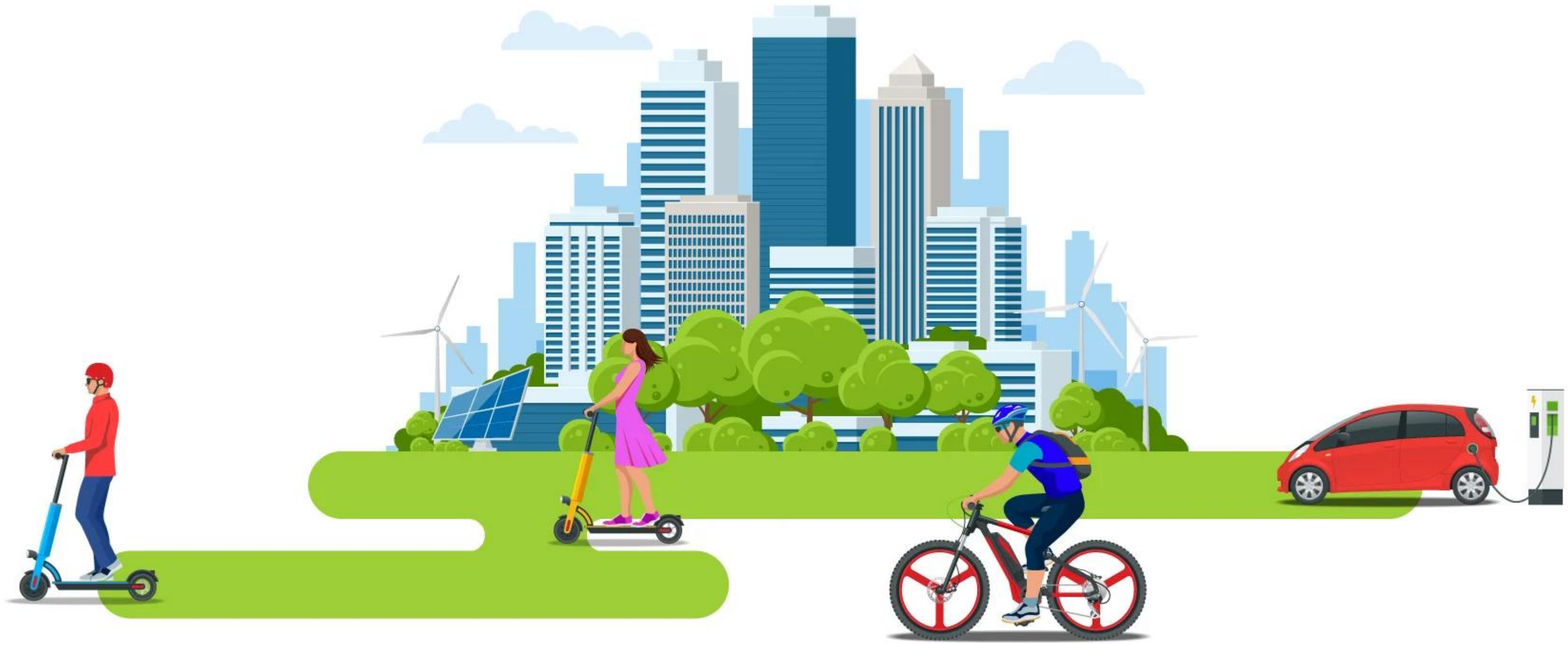
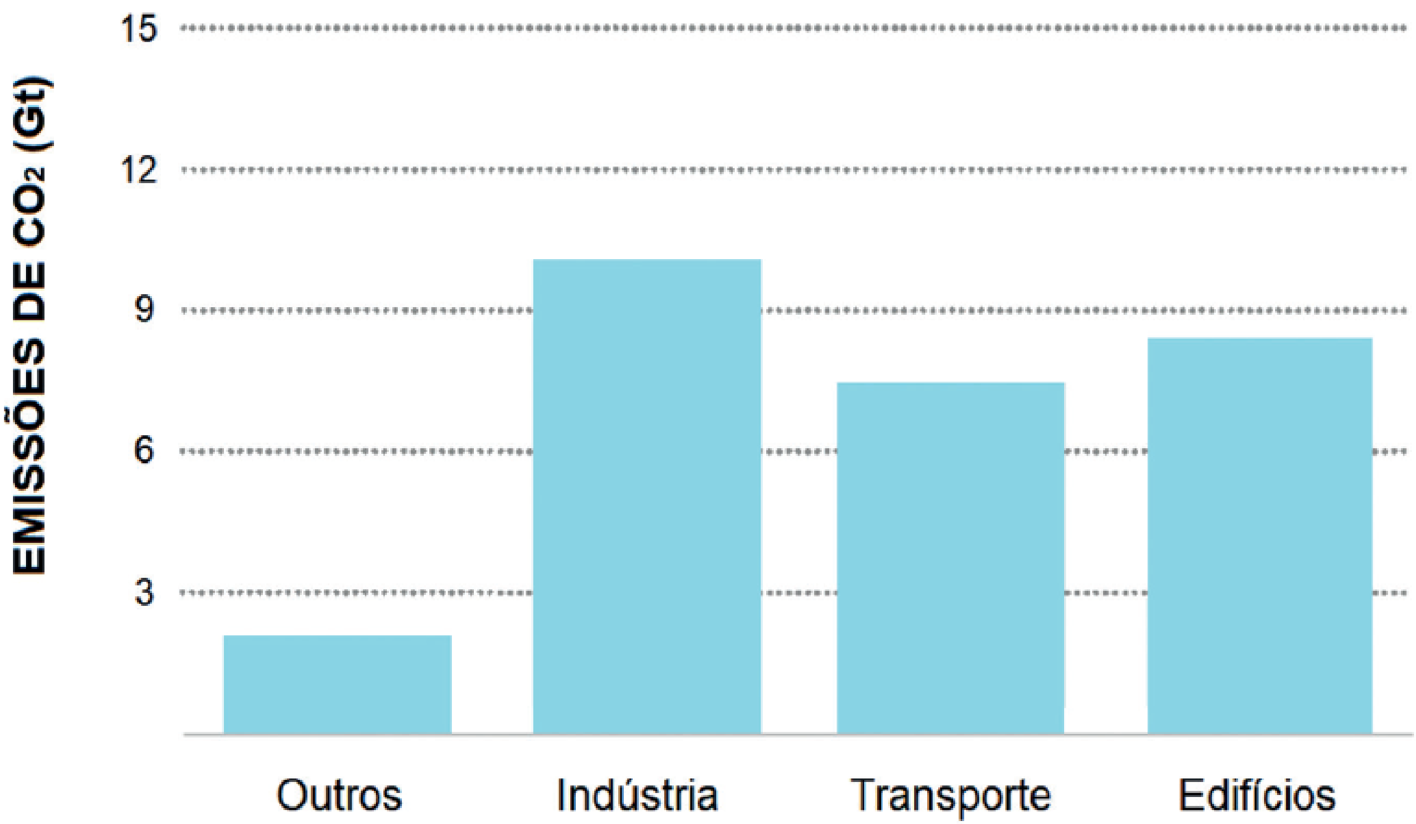
Energia e sustentabilidade

Transports – sustainable mobility



Energia e sustentabilidade

Fontes de CO_2 por setor



Source: “Materiais e Sustentabilidade”, João Labrincha, Rui Novais, Dachamir Hotza, Engebook 2024. ISBN: 978-989-9177-48-2

Energia e sustentabilidade

Transportes – consumo de energia

Figure 20.1. This chapter's starting point: an urban luxury tractor. The average UK car has a fuel consumption of 33 miles per gallon, which corresponds to an energy consumption of 80 kWh per 100 km. Can we do better?

Cenário ótimo:
Capacidade máxima de utilização.

3–9 kWh per 100 seat-km, if full

Two high-speed trains. The electric one uses 3 kWh per 100 seat-km; the diesel, 9 kWh.

7 kWh per 100 p-km, if full

21 kWh per 100 p-km, if full

Energia e sustentabilidade

Transportes – consumo de energia

Cenário realista:

Consumos de energia médios

Figure 20.1. This chapter's starting point: an urban luxury tractor. The average UK car has a fuel consumption of 33 miles per gallon, which corresponds to an energy consumption of 80 kWh per 100 km. Can we do better?

32 kWh per 100 p-km

9 kWh per 100 p-km

Energy consumption (kWh per 100 p-km)	
Car	68
Bus	19
Rail	6
Air	51
Sea	57

Table 20.8. Overall transport efficiencies of transport modes in Japan (1999).

Energia e sustentabilidade

Transportes – consumo de energia e emissão de CO_2

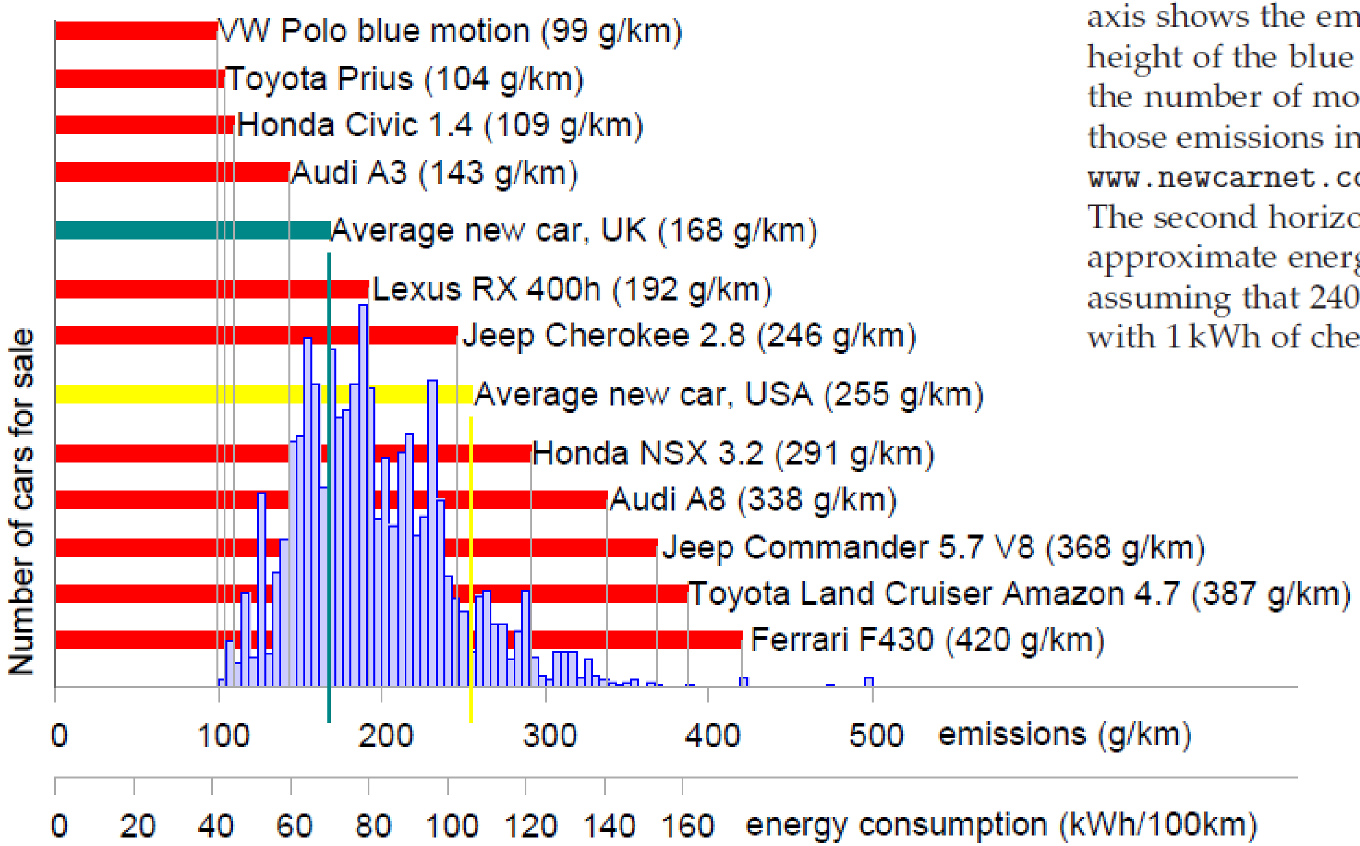
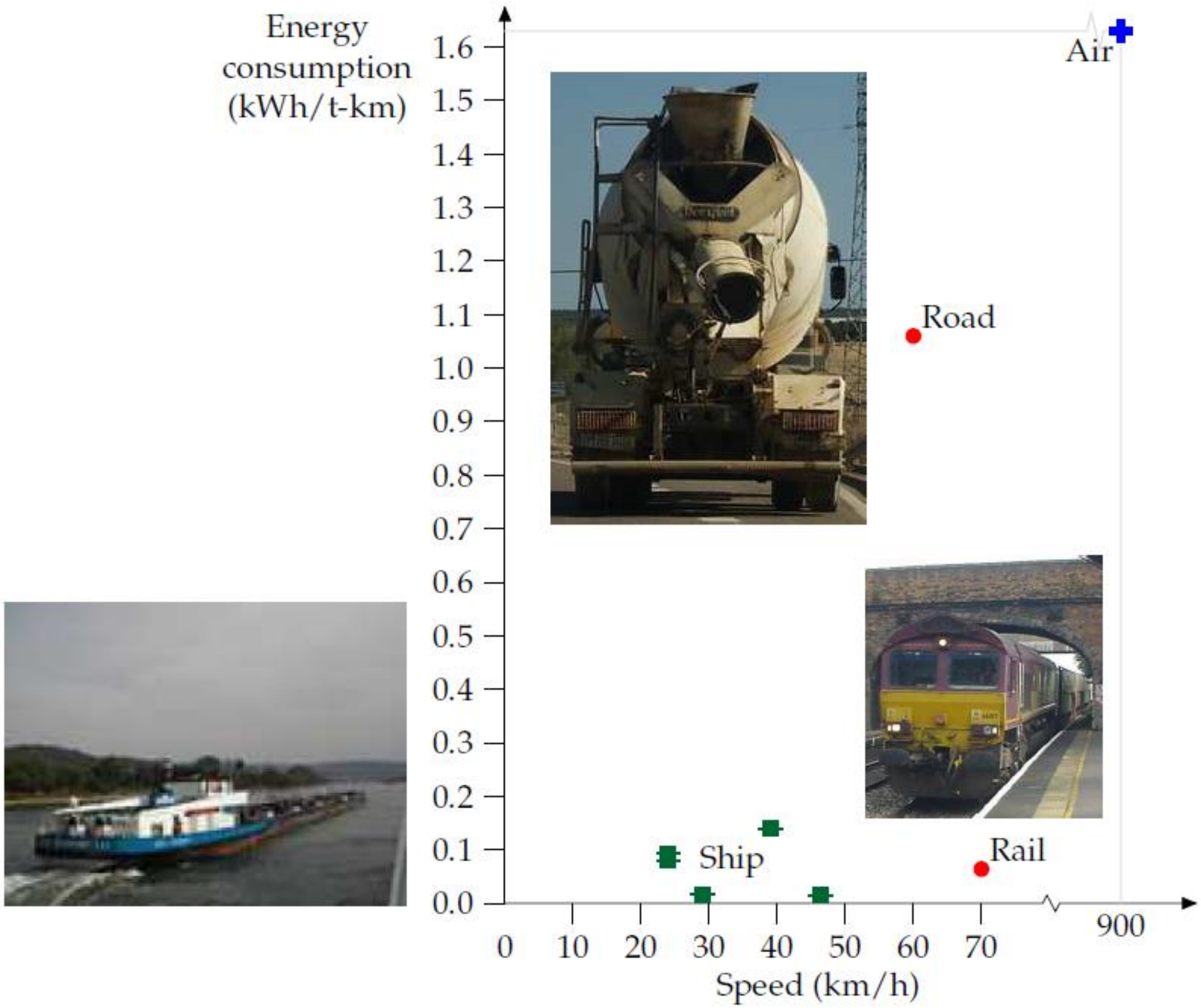


Figure 20.9. Carbon pollution, in grams CO_2 per km, of a selection of cars for sale in the UK. The horizontal axis shows the emission rate, and the height of the blue histogram indicates the number of models on sale with those emissions in 2006. Source: `www.newcarnet.co.uk`.
The second horizontal scale indicates approximate energy consumptions, assuming that 240 g CO_2 is associated with 1 kWh of chemical energy.

Energia e sustentabilidade

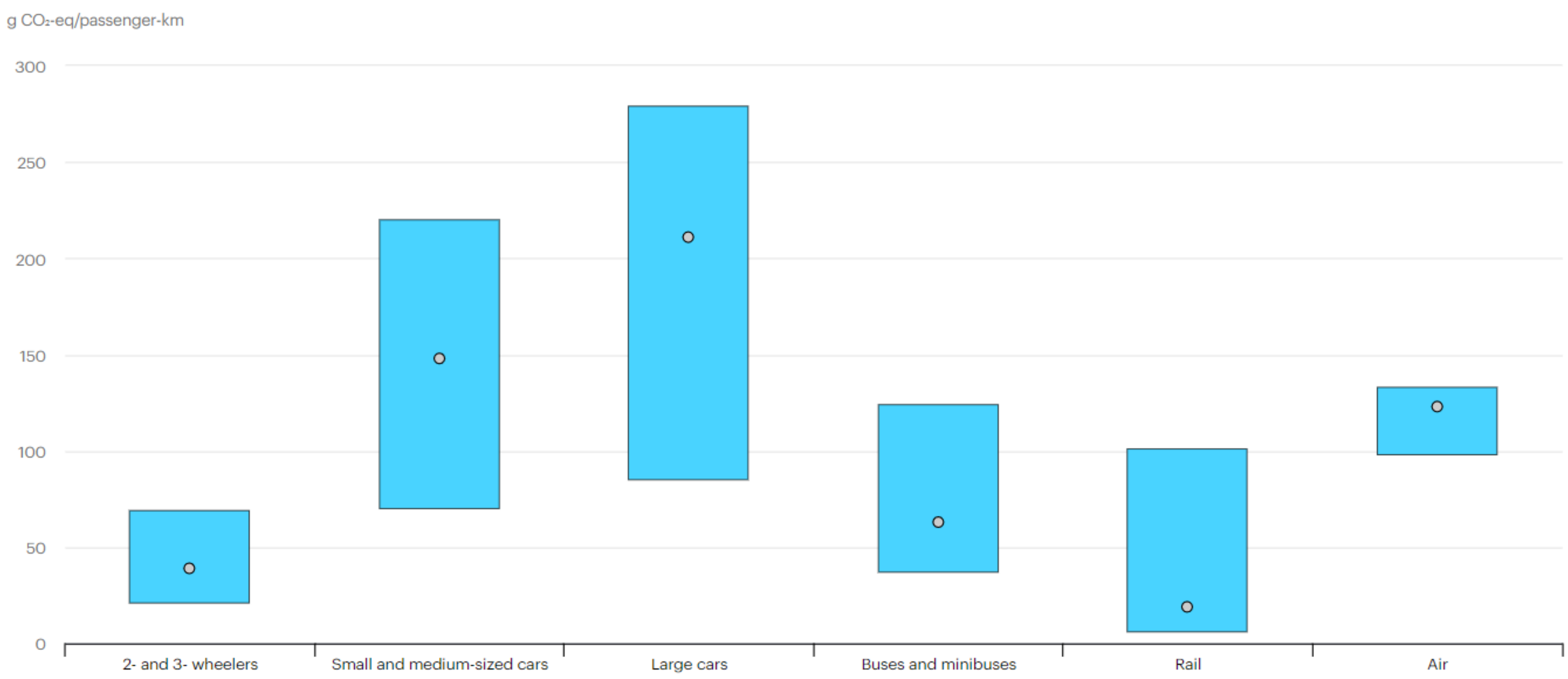
Transportes – consumo de energia vs velocidade



Energia e sustentabilidade

Transports

Well-to-wheel (wake/wing) GHG intensity of motorised passenger transport modes



Source: IEA (https://www.iea.org/reports/rail)

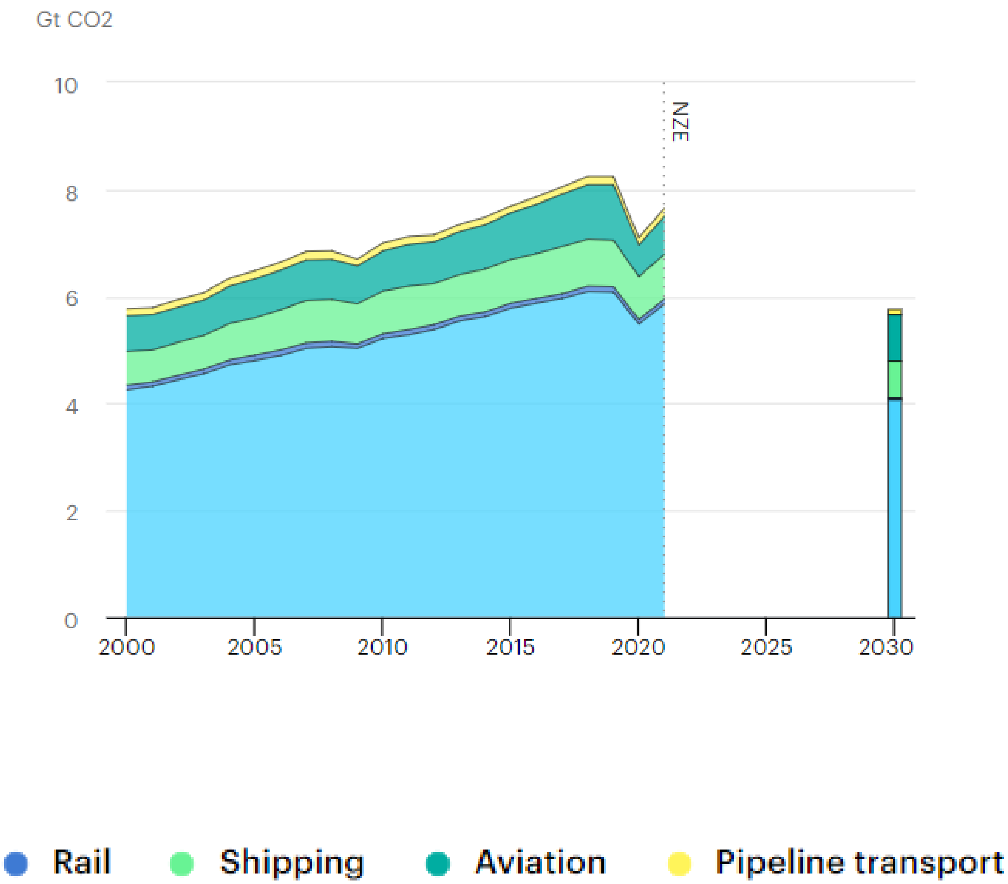
Energia e sustentabilidade

Transports

Transport has the highest reliance on fossil fuels of any sector and accounted for 37% of CO_2 emissions from end-use sectors in 2021.

Net zero Scenario – transport sector emissions should fall by about 20% to less than 6 Gt by 2030.

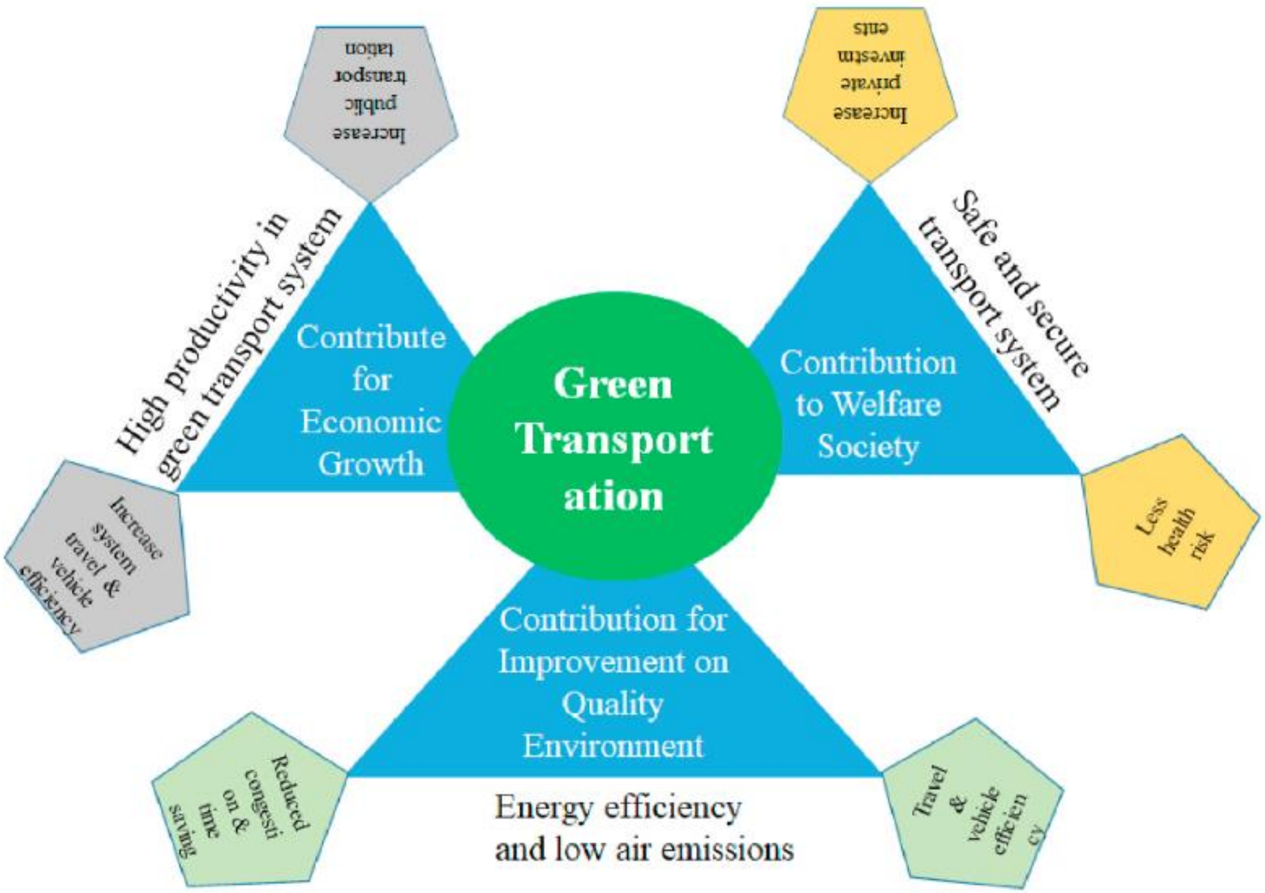
Global CO2 emissions from transport by sub-sector in the Net Zero Scenario, 2000-2030



Source: IEA (https://www.iea.org/topics/transport)

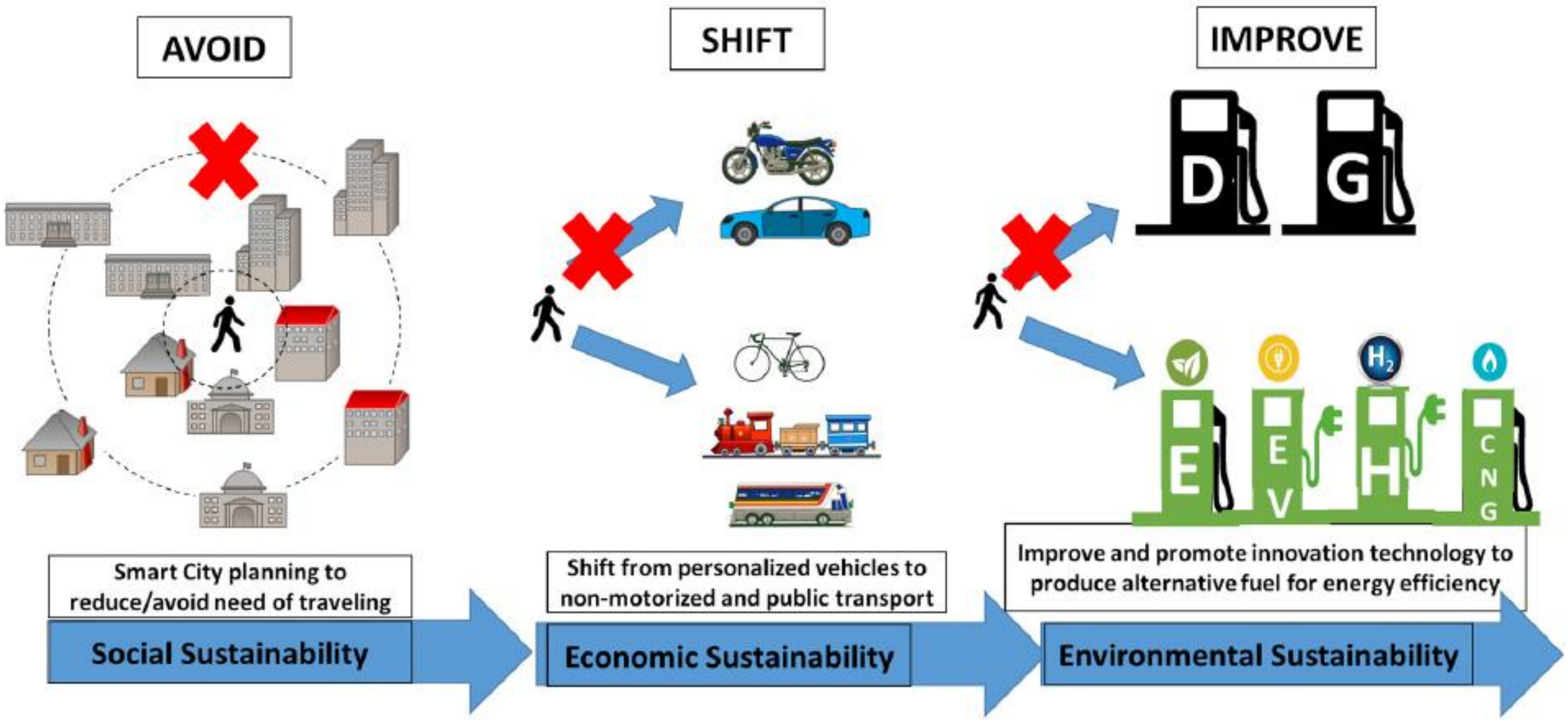
Energia e sustentabilidade

Parâmetros chave para atingir a sustentabilidade na mobilidade



Fonte: Shah *et al.*, **“**Green transportation for sustainability: Review of current barriers, strategies, and innovative technologies”. Journal of Cleaner Production 326 (2021).

Estratégia “Avoid-Shift-Improve”



Fonte: Shah *et al.*, **“**Green transportation for sustainability: Review of current barriers, strategies, and innovative technologies”. Journal of Cleaner Production 326 (2021).

Transports

Net zero Scenario –

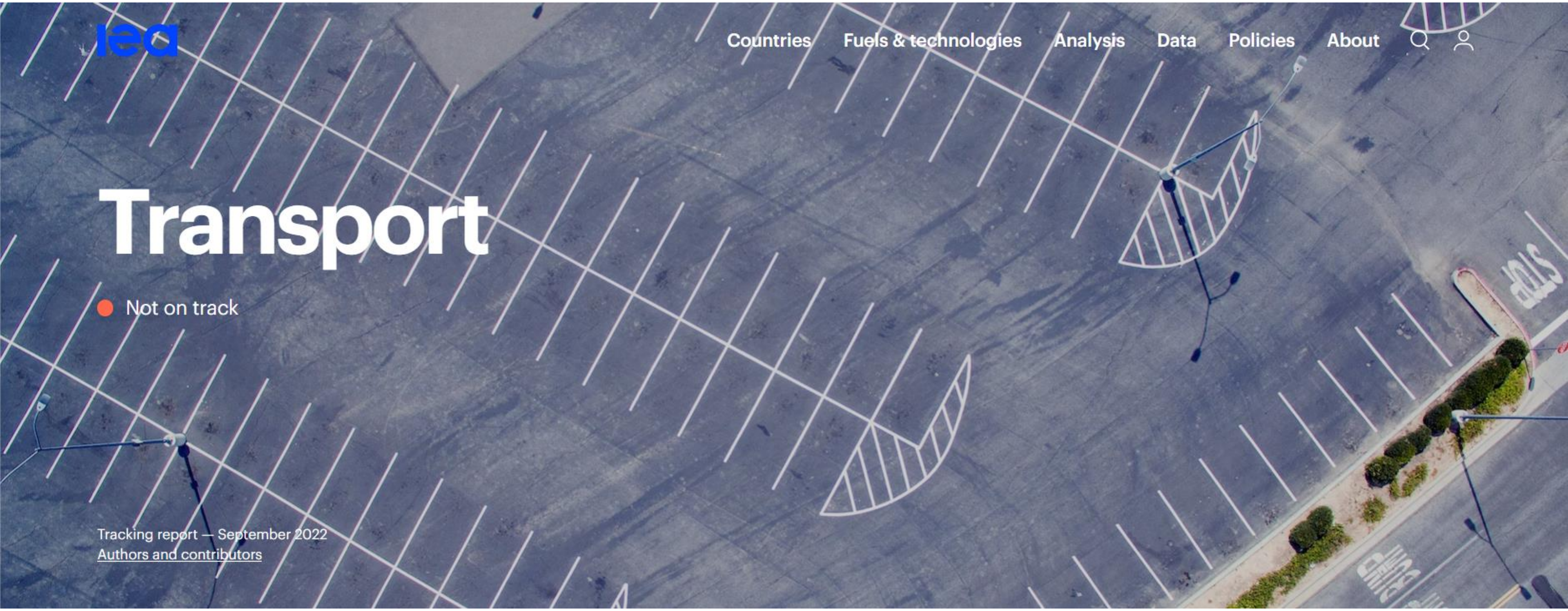
transport sector emissions should fall by about 20% to less than 6 Gt by 2030.

How to reach this?

- Rapid electrification of road vehicles, operational and technical efficiency measures
- Commercialization of low-carbon fuels (e.g., particularly in maritime and aviation sub-sectors)
- Policies to encourage modal shift to lower carbon-intensive travel option

Energia e sustentabilidade

Transports



https://www.iea.org/reports/transport

Transports

Cars and vans

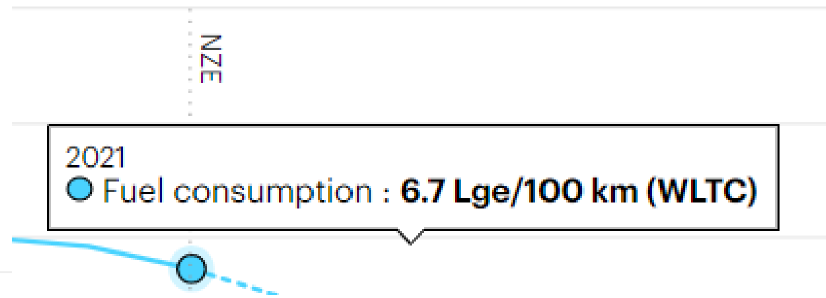
Cars and vans accounted for about 8% of global direct CO_2 emissions in 2021. Thanks to continuous improvements in engine, powertrain and vehicle technology, the specific fuel consumption of new vehicles has declined. However, a long-term trend of increasing vehicle size and power has slowed progress.

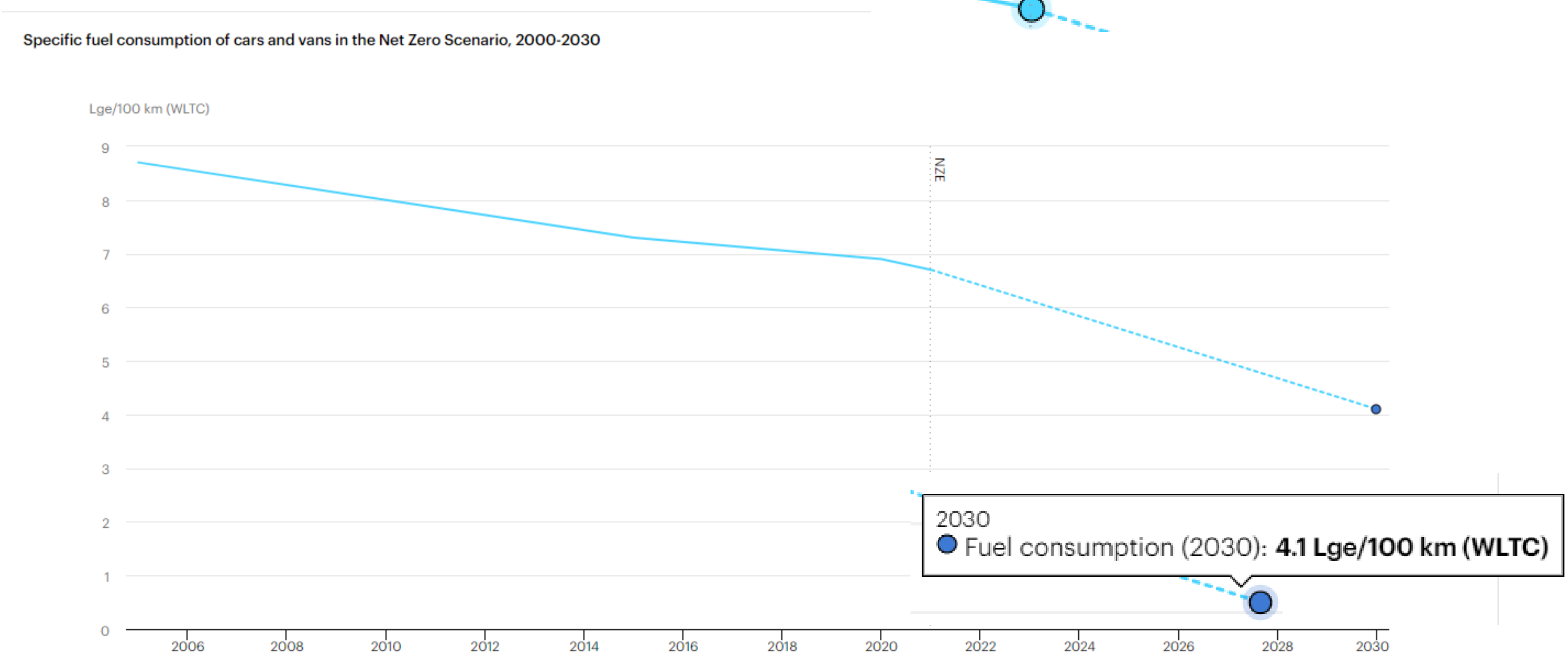
Electrification has more recently emerged as the dominant technology driving down the average fuel consumption of new vehicles. To be on track with the pathway in the Net Zero Emissions by 2050 Scenario, much more rapid improvements in the fuel economy of new conventional (internal combustion engine) vehicles is needed, even as the share of electric vehicle sales will need to continue to grow.

Source: IEA (https://www.iea.org/topics/transport)

Transports

Cars and vans



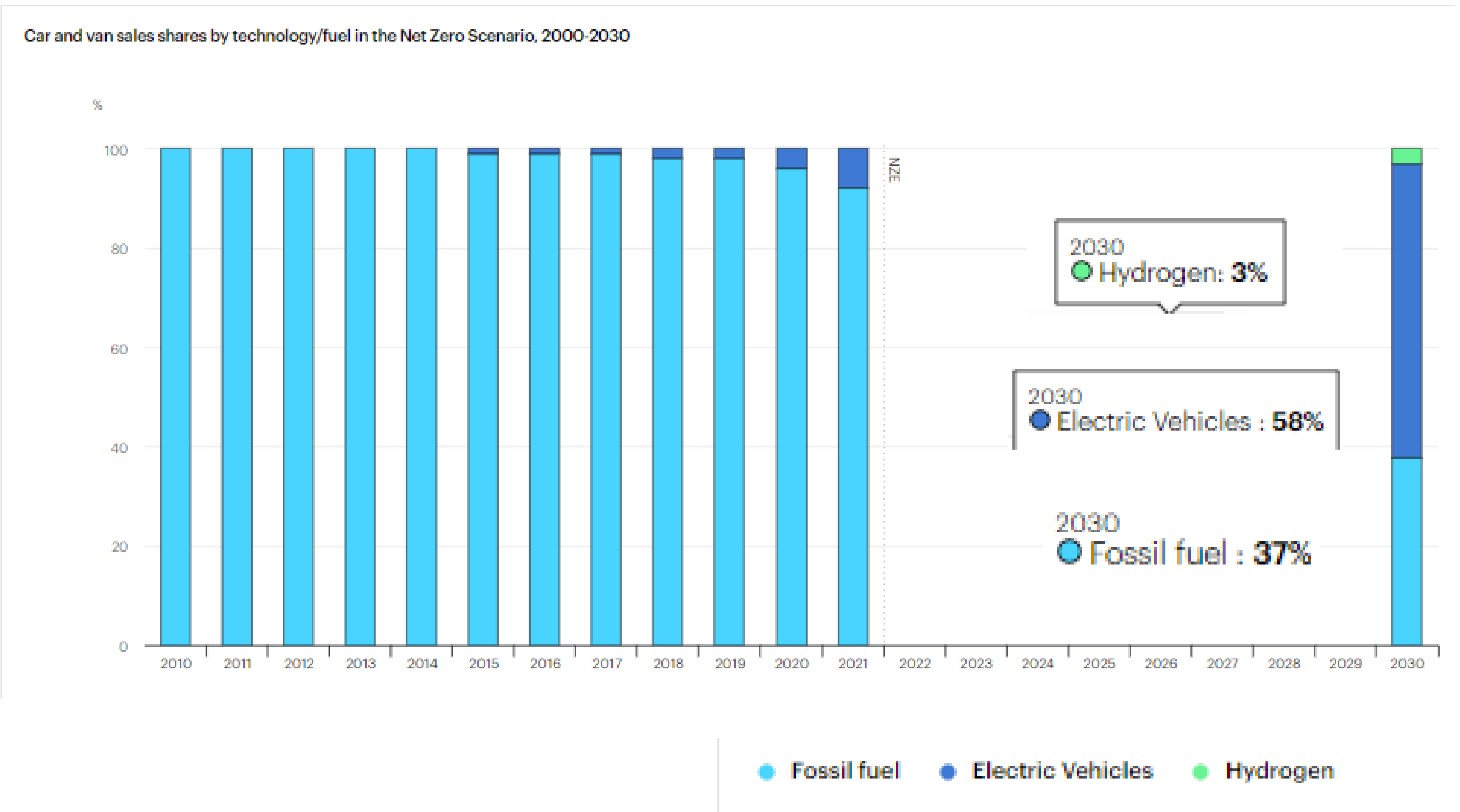


Source: IEA (https://www.iea.org/topics/transport)

Energia e sustentabilidade

Transports

Cars and vans



Source: IEA (https://www.iea.org/topics/transport)

Fuel economy standards and zero-emission vehicle mandates rachet up in major markets

Cars and vans

In the **European Union,** the Fit-for-55 package includes a regulation, recently passed by the European Commission, that requires fleet emission reductions (from a 2021 starting point) of 55% for cars and 50% for vans by 2030, and 100% for both by 2035. This effectively mandates that all new cars and vans sold from 2035 onward would need to emit zero tailpipe emissions. While this does not yet mean that only fully zero-emission powertrains (i.e. battery and fuel-cell electric) can be sold, and leaves the door open in theory for conventional cars running on internal combustion engines, so long as they use electrofuels, in practice it is a strong signal of regulatory support for electric vehicles.

Fit for 55 package is a **set of proposals to revise and update EU legislation** and to put in place new initiatives with the aim of ensuring that EU policies are in line with the climate goals agreed by the Council and the European Parliament

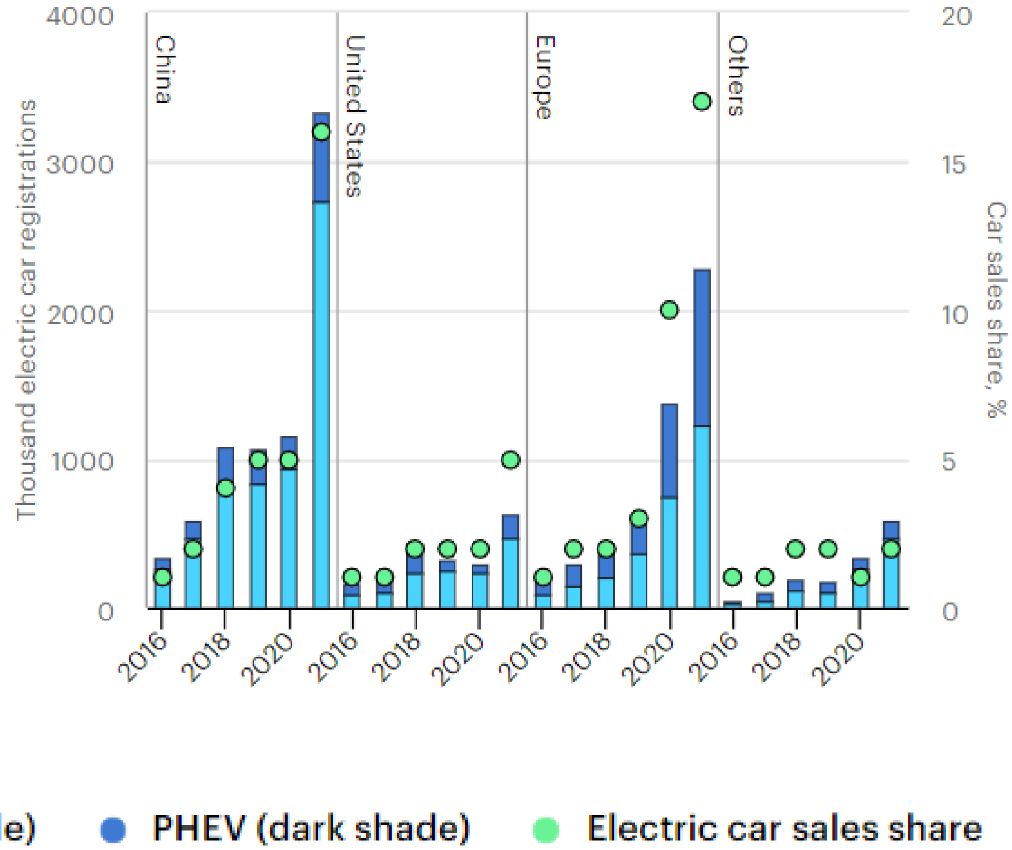
Source: IEA (https://www.iea.org/topics/transport)

Energia e sustentabilidade

Transports

Electric cars

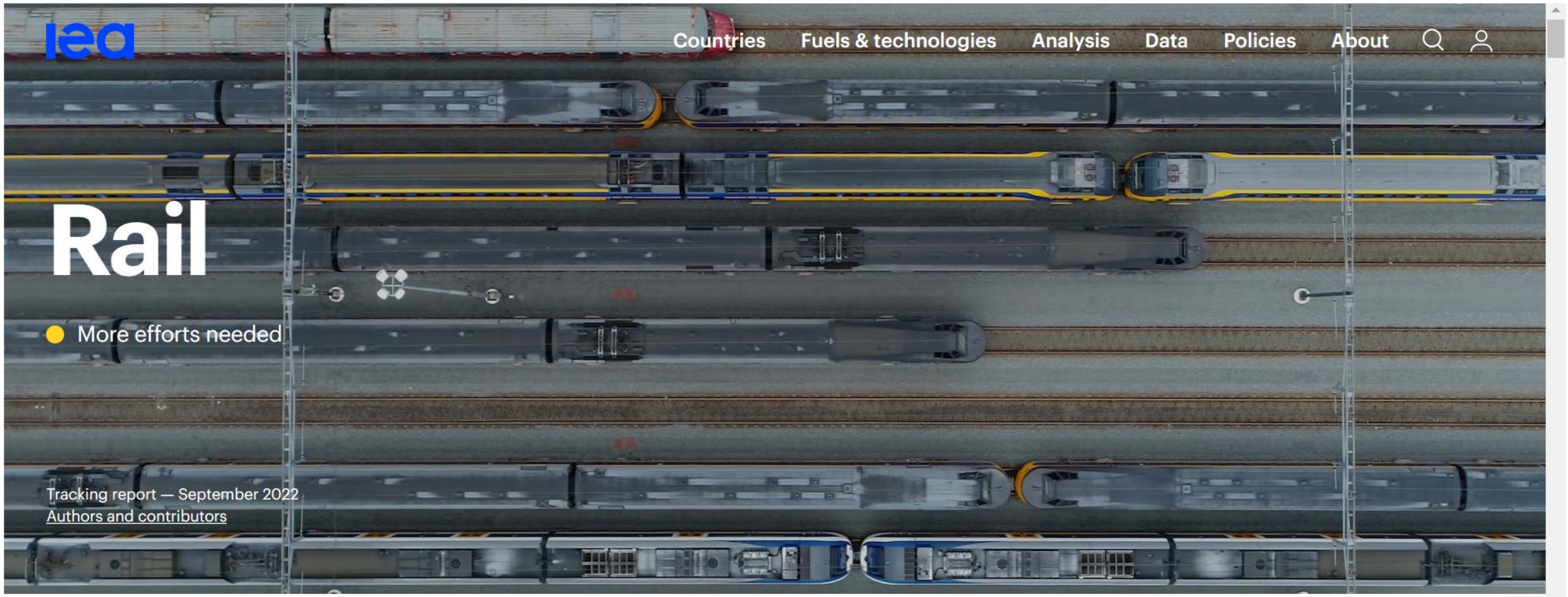
Electric car registrations and sales share in China, United States, Europe and other regions, 2016-2021



Source: IEA (https://www.iea.org/topics/transport)

Energia e sustentabilidade

Transports



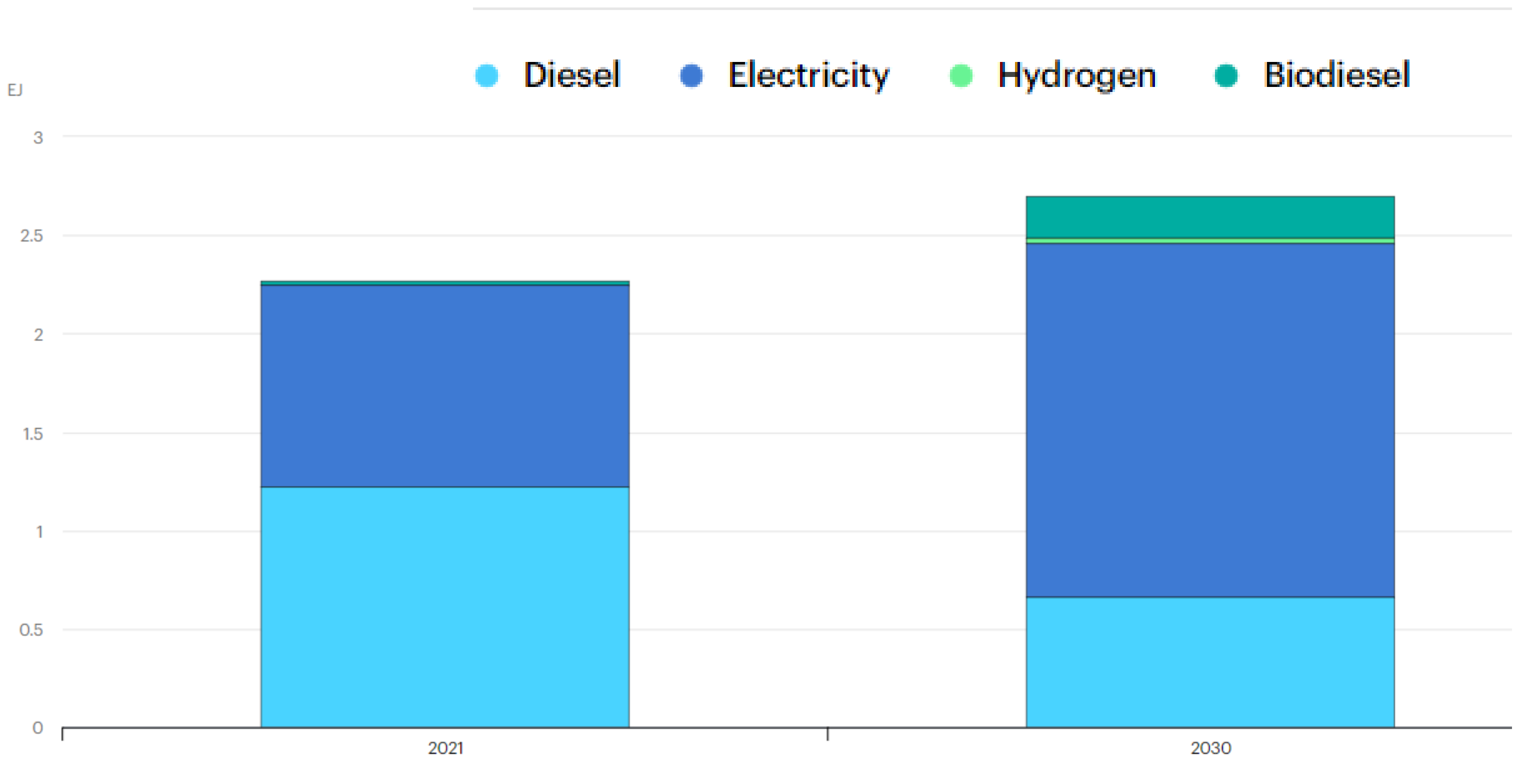
From their peak in 2019, direct CO_2 emissions from rail are not projected to increase beyond just over 100 Mt CO_2. Over the past two decades, direct CO_2 emissions from diesel rail operations increased through 2019 by less than 1% on average annually (electric rail, which accounts for about 80% of passenger rail activity and half of freight movements, does not release any direct CO_2 emissions). To get on track with the Net Zero Emissions by 2050 Scenario, emissions will need to decline by about 6% annually, a goal which requires the electrification of diesel operations wherever viable, as well as blending biodiesel and implementing a wide range of other efficiency measures.

Source: IEA (https://www.iea.org/reports/rail)

Energia e sustentabilidade

Transports

Energy consumption for rail by fuel in the Net Zero Scenario, 2021-2030



Source: **IEA** (https://www.iea.org/reports/rail)

Energia e sustentabilidade

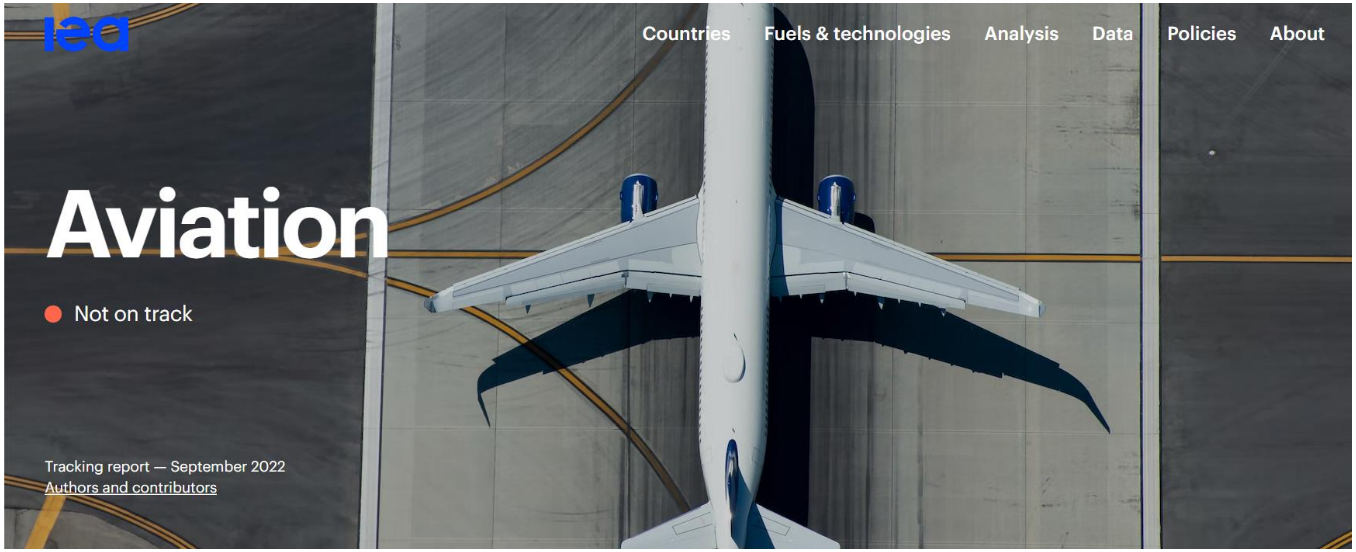
Transports

In 2021 international shipping accounted for ~2% of global energy-related CO_2 emissions. While measures approved by the International Maritime Organization are likely to curb the rise of emissions over the 2020s, greater policy ambition is needed to steer the maritime shipping sector onto the pathway in the Net Zero Emissions by 2050 Scenario, which entails an almost 15% reduction in emissions from 2021 to 2030. Technological innovation, supportive policies and collaboration across the value chain are needed to drive the adoption of low- and zero-carbon fuels and technologies for oceangoing vessels.

Source: IEA (https://www.iea.org/reports/international-shipping)

Energia e sustentabilidade

Transports

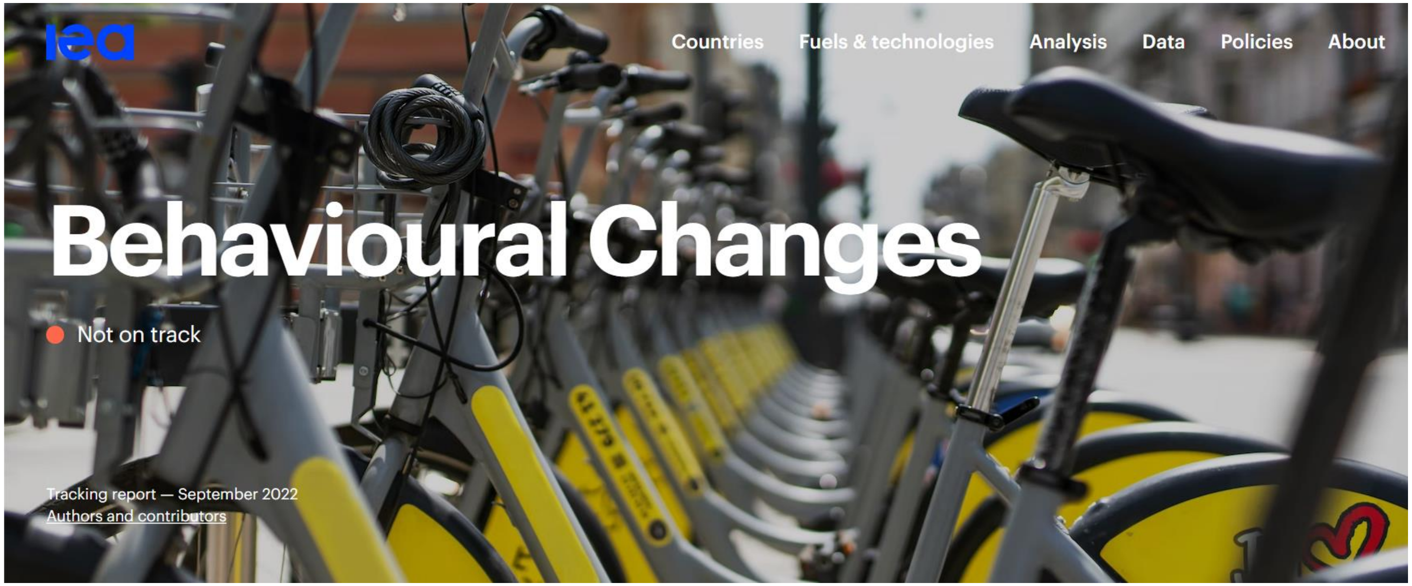


In 2021 aviation accounted for over 2% of global energy-related CO_2 emissions, having grown faster in recent decades than road, rail or shipping. As countries emerged from Covid-19 lockdowns, aviation emissions in 2021 reached around 720 Mt, regaining nearly one-third of the drop from 2019 levels seen in 2020. Many technical measures related to low-carbon fuels, improvements in aircraft and engines, operational optimisation and demand restraint solutions are needed to get on track with the Net Zero Emissions by 2050 Scenario – to curb growth in emissions and ultimately reduce them this decade.

Source: IEA (https://www.iea.org/reports/aviation)

Energia e sustentabilidade

Transports

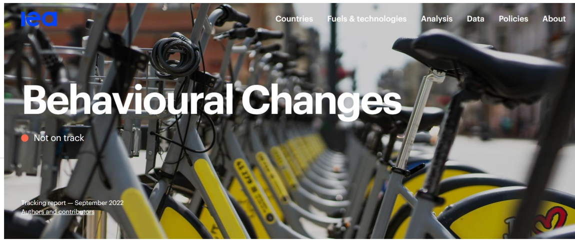


Behavioural changes play an important role in the Net Zero Emissions by 2050 Scenario, cutting CO_2 emissions and reducing energy demand growth. Behavioural changes can both improve wellbeing and public health and address three main challenges to decarbonisation: existing carbon-intensive assets, hard-to-abate sectors and the rapid growth in clean energy supply.

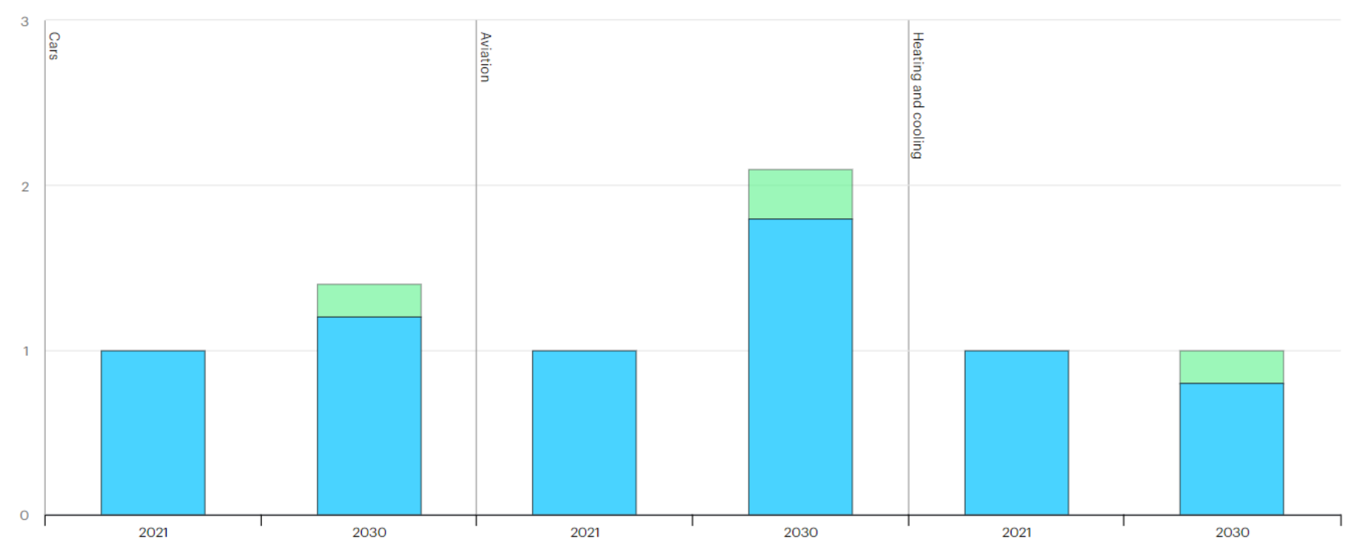
Source: IEA (https://www.iea.org/reports/behavioural-changes)

Energia e sustentabilidade

Transports



Global potential reductions in activity due to behavioural changes in cars, aviation, and heating and cooling in the Net Zero Scenario, 2021-2030



Behavioural changes can help address hard-to-abate sectors, where technological options to reduce emissions are scarce or expensive. This is particularly relevant in aviation due to high activity growth. The unprecedented reduction in flying caused by the pandemic in 2020 still only brought CO_2 emissions slightly below their levels in 2000, highlighting how high and fast emissions have risen.

Source: IEA (https://www.iea.org/reports/behavioural-changes)

Energia e sustentabilidade

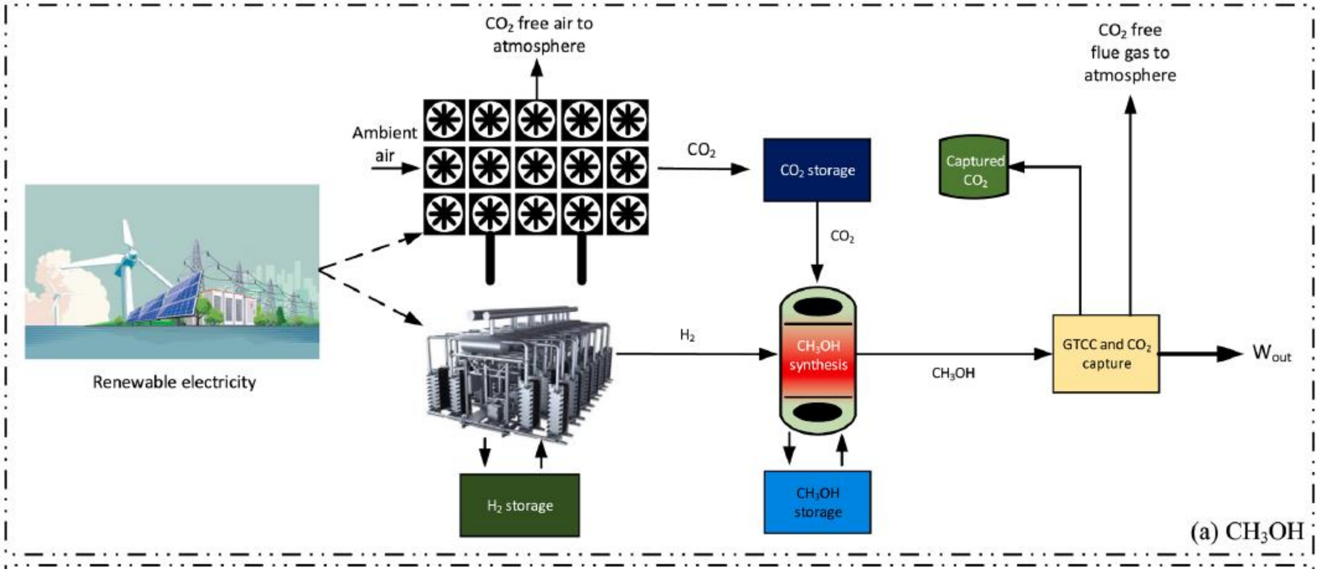
Production of synthetic fuels

Source:
https://www.youtube.com/watch?v=HFKkqqdm5BE&embeds_referring_euri=https%3A%2F%2Fwww.bosch.com%2F&embeds_referring_origin=https%3A%2F%2Fwww.bosch.com&source_ve_path=OTY3MTQ&feature=emb_imp_woyt

Energia e sustentabilidade

Carbon capture and utilisation (CCU)

Production of CO_2-based synthetic fuels



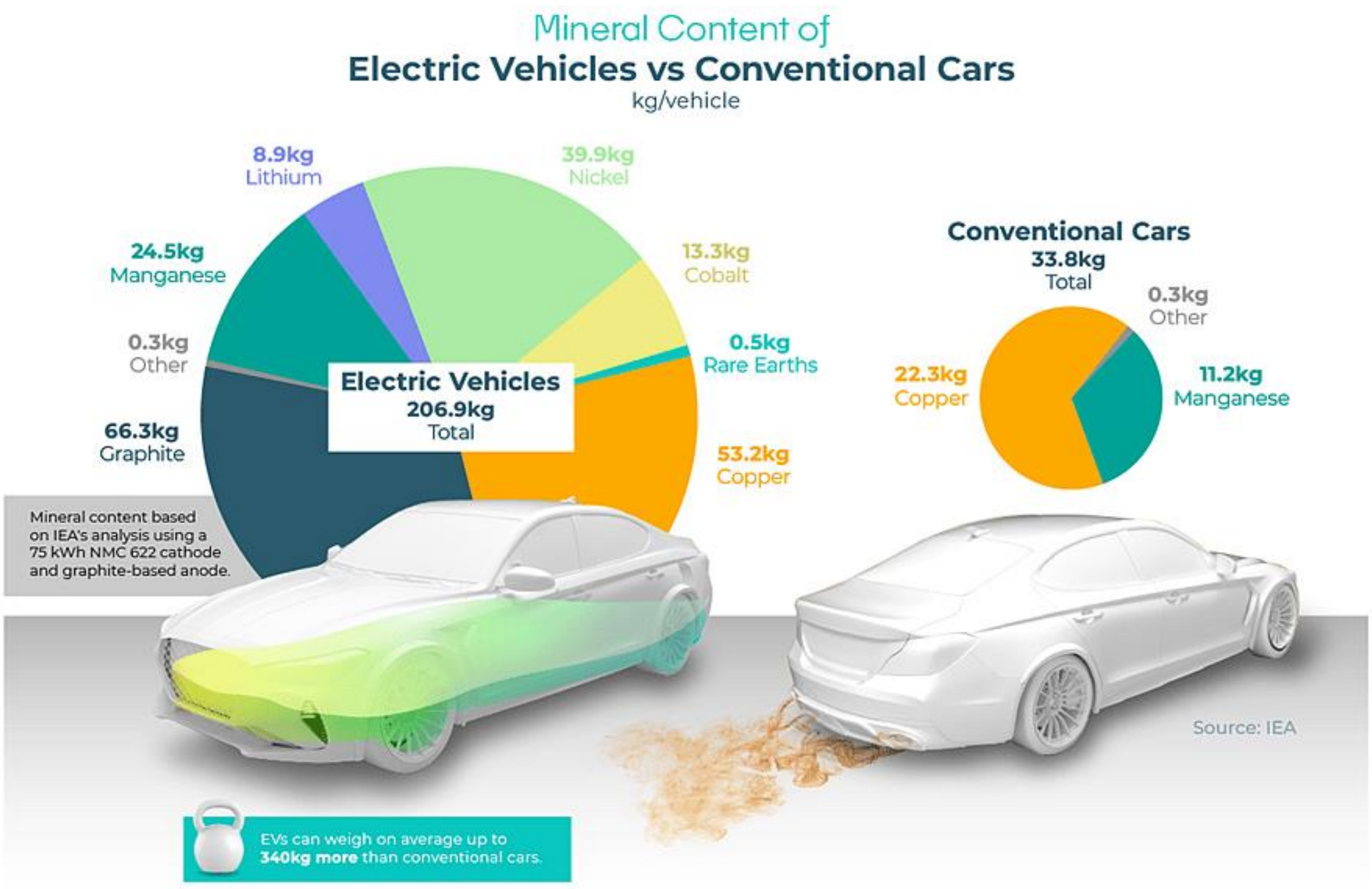
Source: Ishaq and Crawford, CO_2-based alternative fuel production to support development of CO_2 capture, utilization and storage, Fuel 331 (2023)

New utilisation pathways in the production of CO_2-based synthetic fuels, chemicals, and building aggregates are gaining momentum. The current project pipeline shows that around 10 Mt of CO_2 per year could be captured for these new uses by 2030, including around 7 Mt CO_2 in synthetic fuel production.

Source: IEA (https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/co2-capture-and-utilisation#tracking)

Energia e sustentabilidade

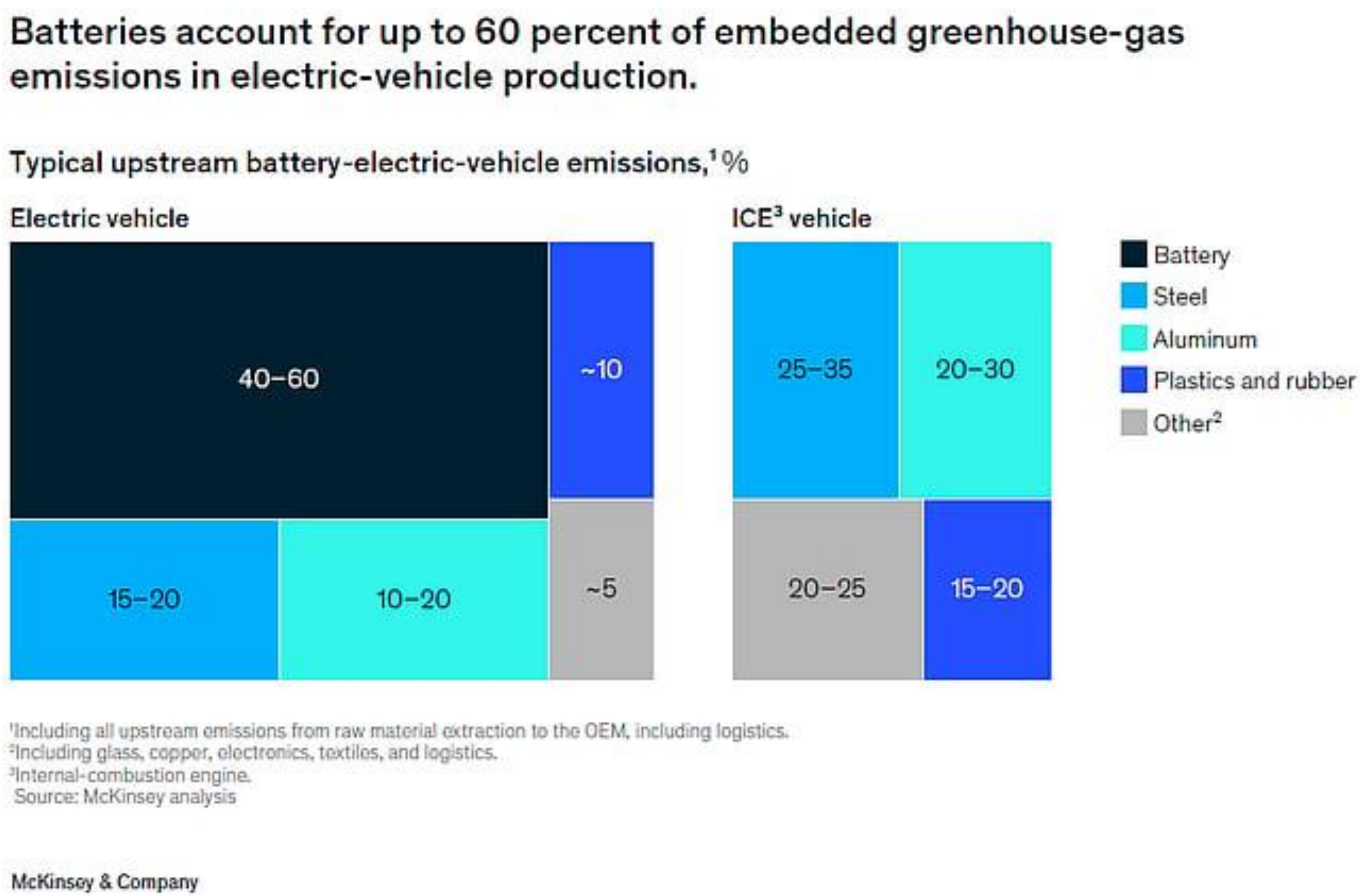
A pegada de carbono dos veículos elétricos



Source: Diário de Notícias (https://www.dn.pt/opiniao/a-pegada-de-carbono-dos-ve%C3%ADculos-el%C3%A9tricos)

Energia e sustentabilidade

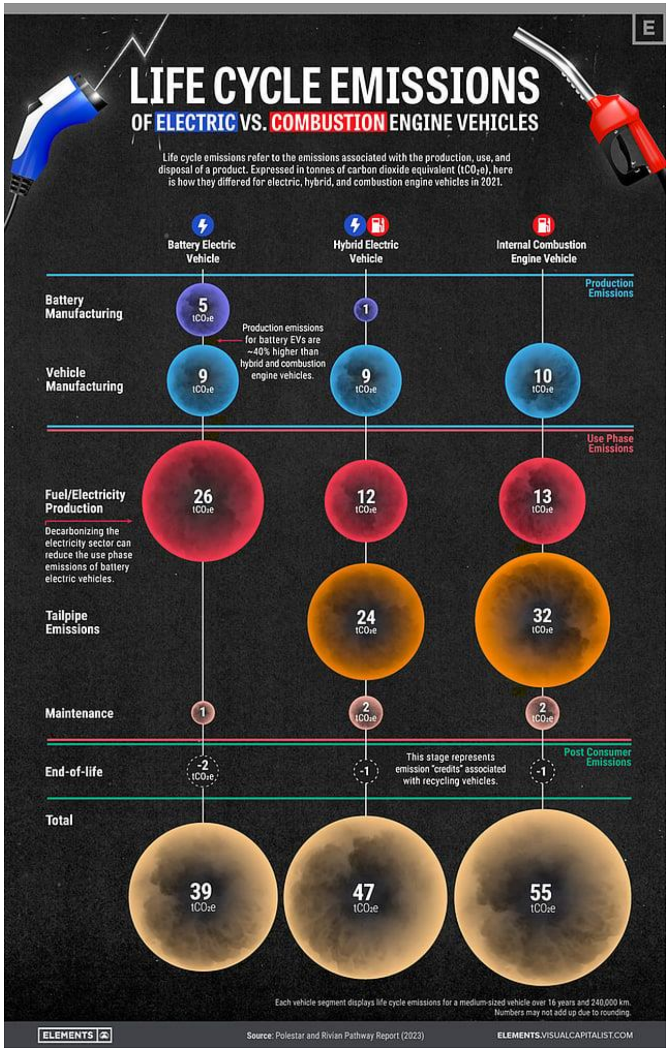
A pegada de carbono dos veículos elétricos



Source: Diário de Notícias (https://www.dn.pt/opiniao/a-pegada-de-carbono-dos-ve%C3%ADculos-el%C3%A9tricos)

Energia e sustentabilidade

A pegada de carbono dos veículos elétricos



Source: Diário de Notícias (https://www.dn.pt/opiniao/a-pegada-de-carbono-dos-ve%C3%ADculos-el%C3%A9tricos)