

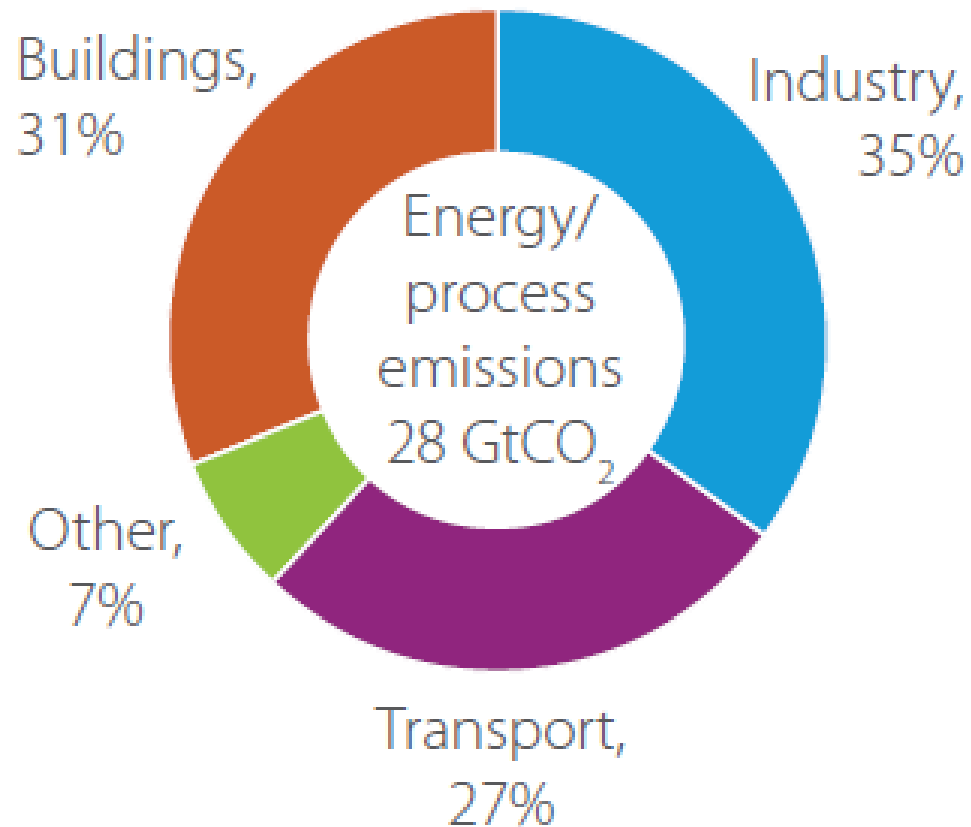
Energia e sustentabilidade

Transports – sustainable mobility



Energia e sustentabilidade

Fontes antropogénicas de CO₂ por setor



Energia e sustentabilidade

Transportes – consumo de energia



Cenário ótimo:

Capacidade máxima de utilização.

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?



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



32 kWh per 100 p-km



9 kWh per 100 p-km



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?

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).

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Transportes – consumo de energia e emissão de CO₂

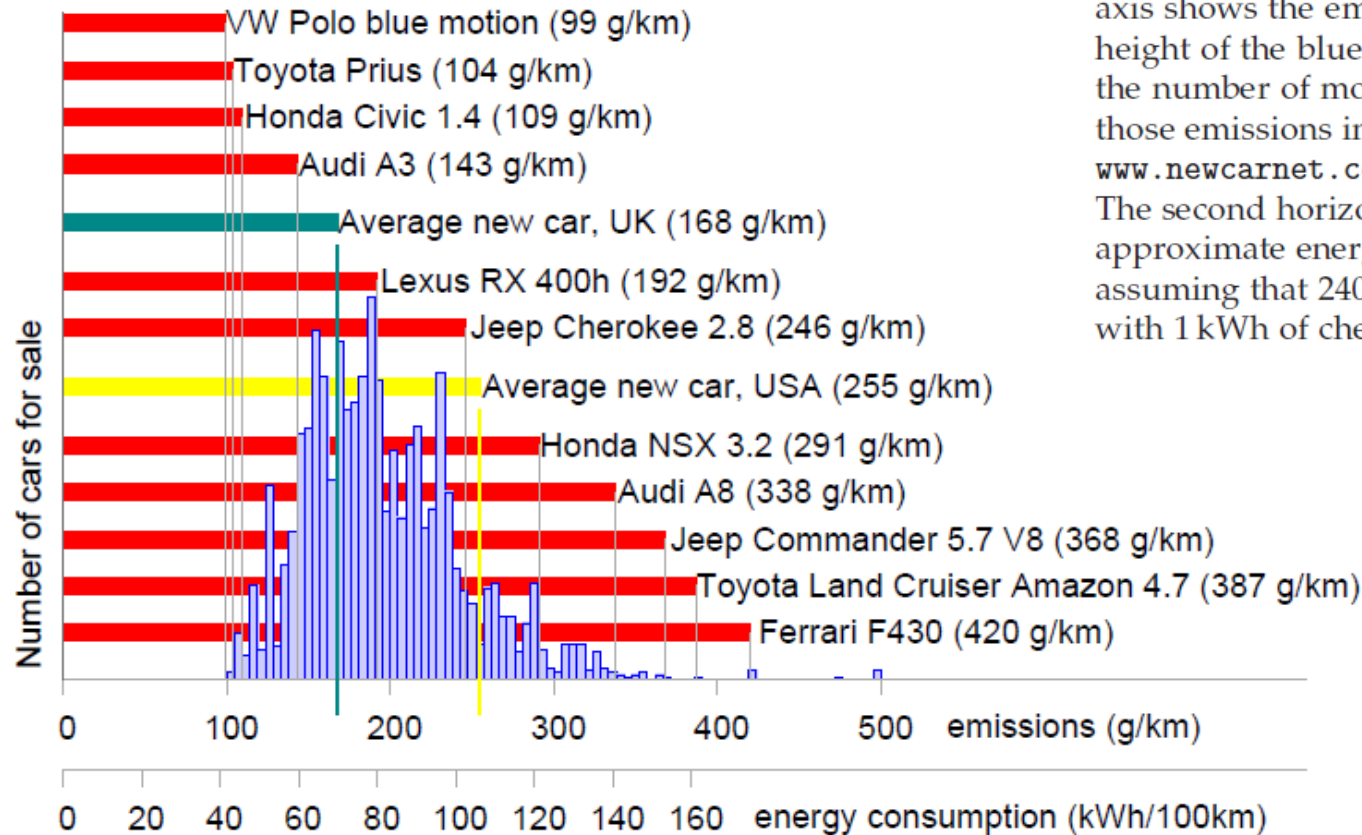
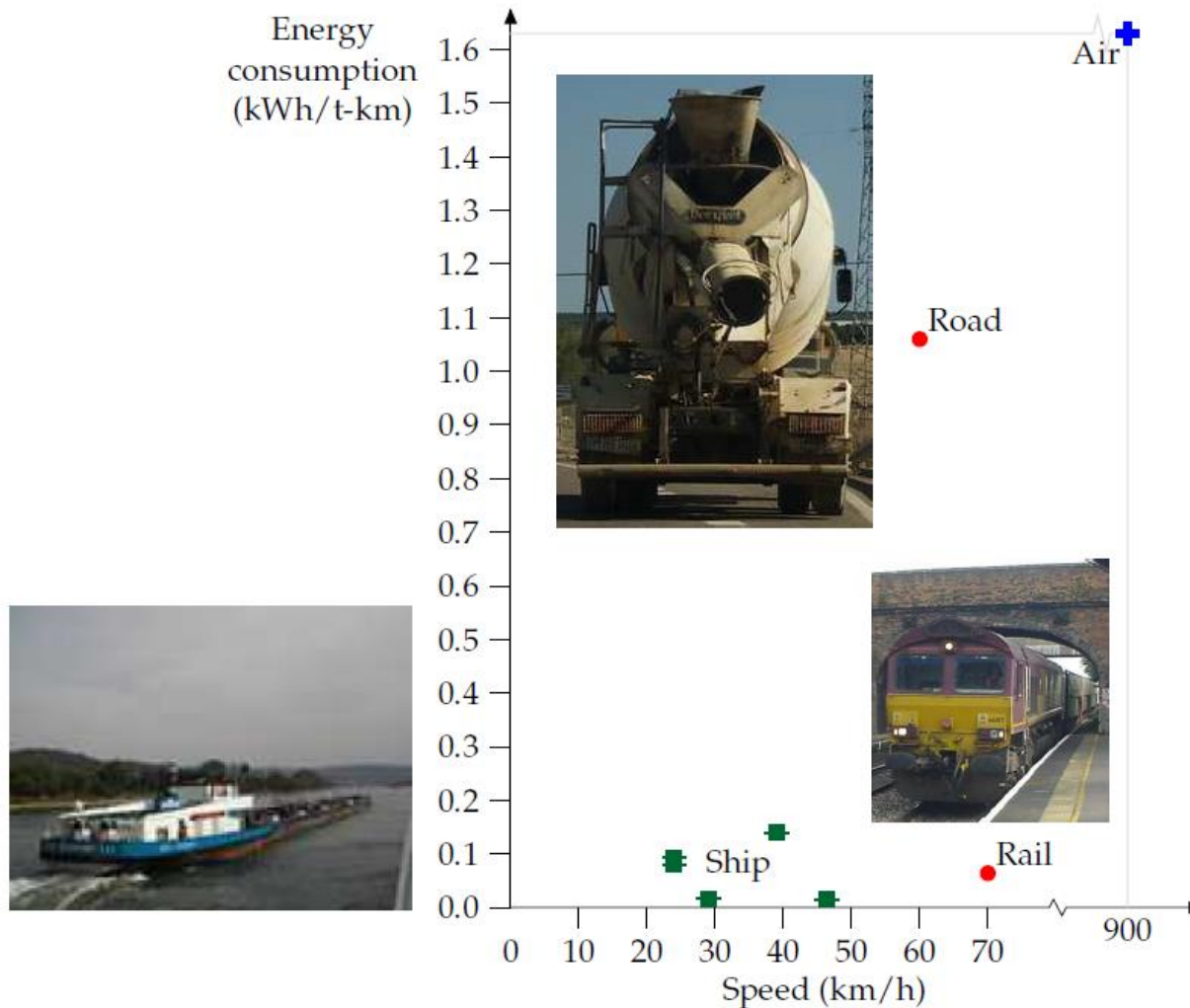


Figure 20.9. Carbon pollution, in grams CO₂ per km, of a selection of cars for sale in the UK. The horizontal axis shows the emission rate, and the height of the blue histogram indicates the number of models on sale with those emissions in 2006. Source: www.newcarnet.co.uk.

The second horizontal scale indicates approximate energy consumptions, assuming that 240 g CO₂ is associated with 1 kWh of chemical energy.

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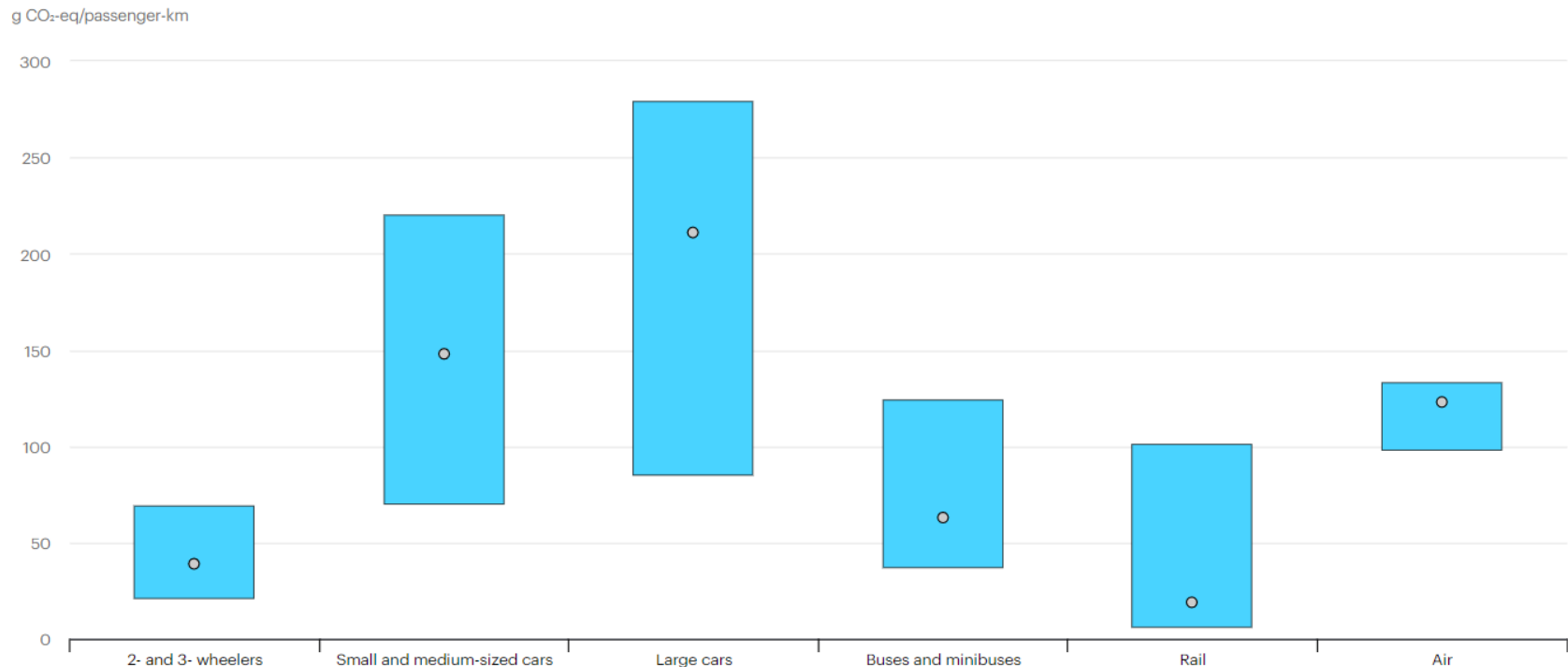
Transportes – consumo de energia vs velocidade



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



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

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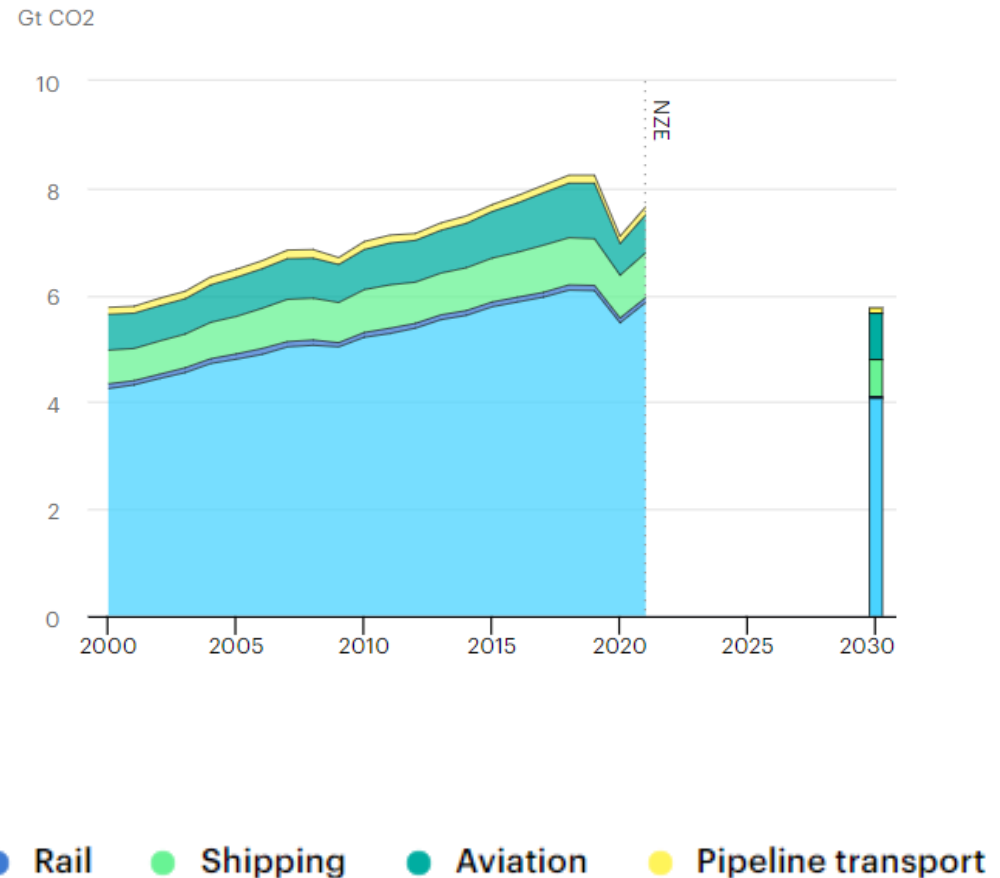
Transports

Transport has the highest reliance on fossil fuels of any sector and accounted for 37% of CO₂ emissions from end-use sectors in 2021.

Net zero Scenario –

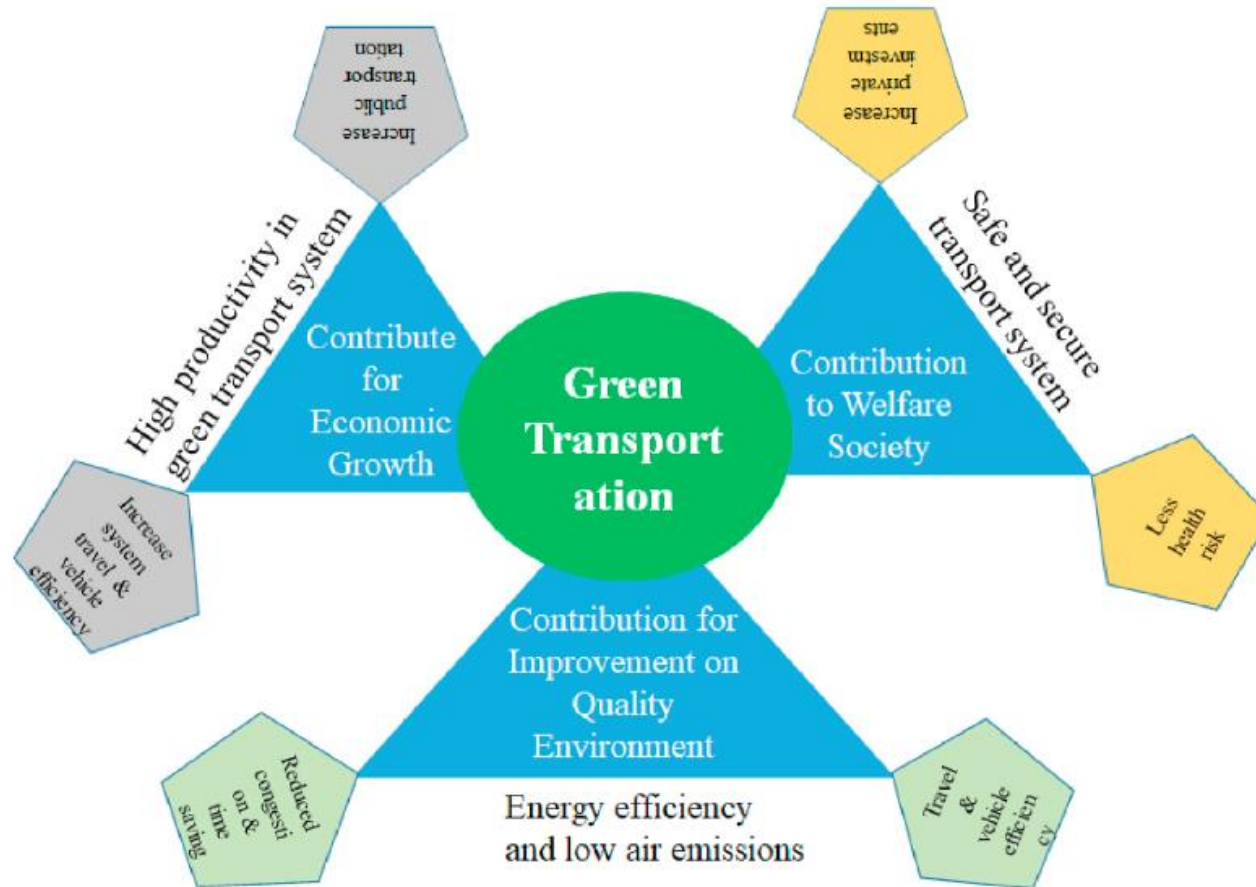
transport sector emissions should fall by about 20% to less than 6 Gt by 2030.

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



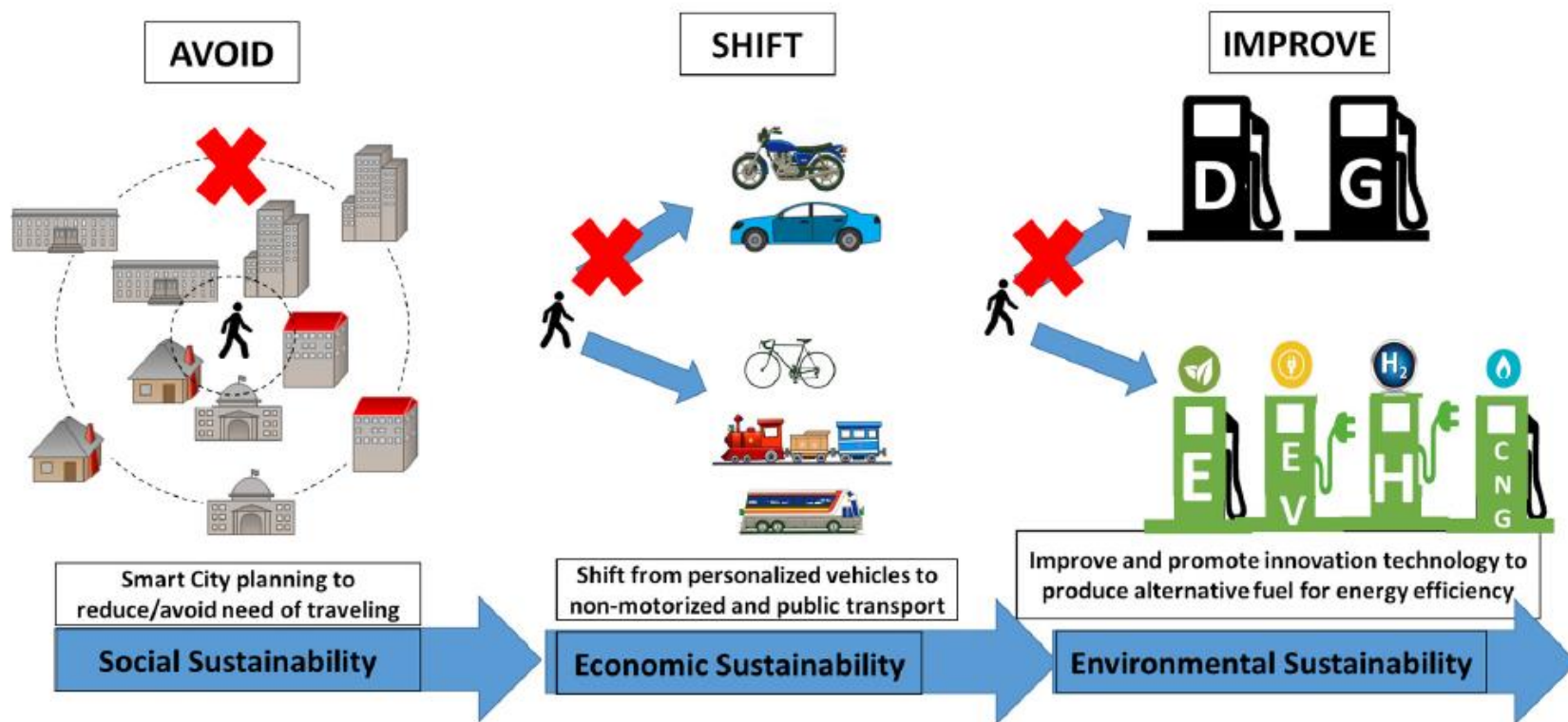
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Parâmetros chave para atingir a sustentabilidade na mobilidade



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Estratégia “Avoid-Shift-Improve”



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Net zero Scenario –

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

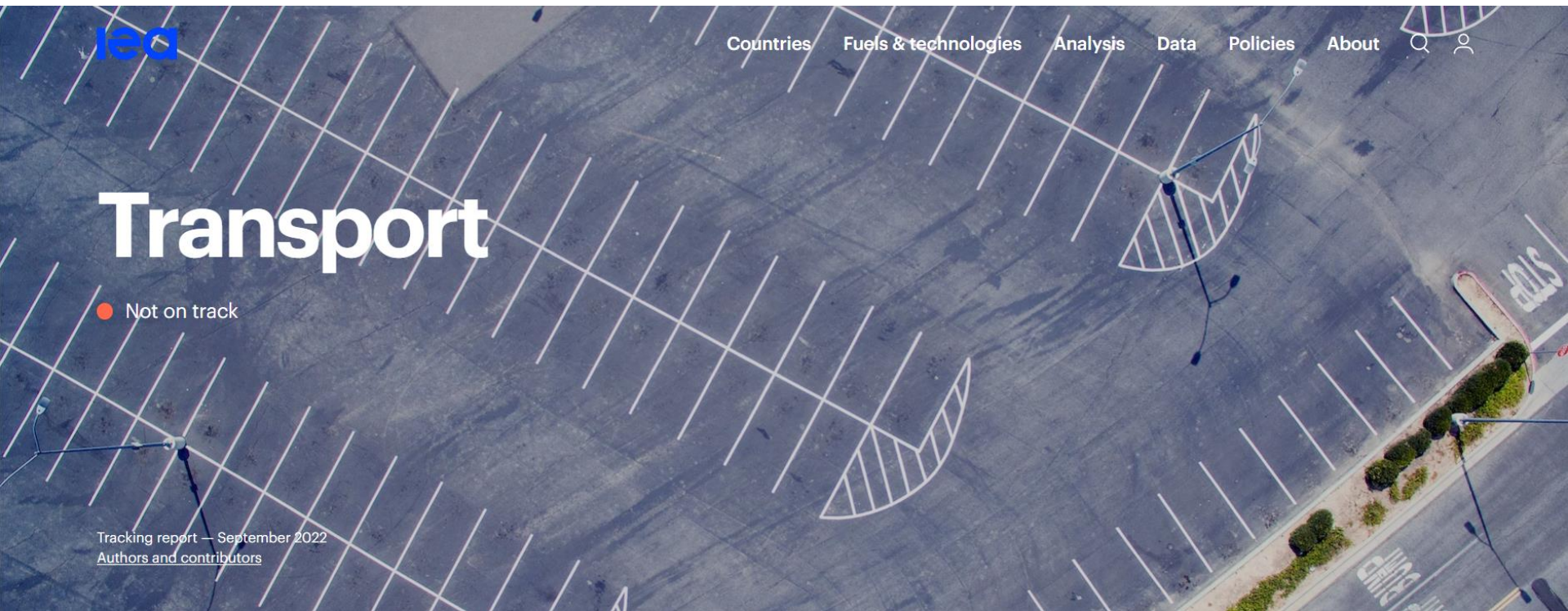


How to reach this?

- 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

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Transports



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

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Transports

Cars and vans

Cars and vans accounted for about 8% of global direct CO₂ 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.

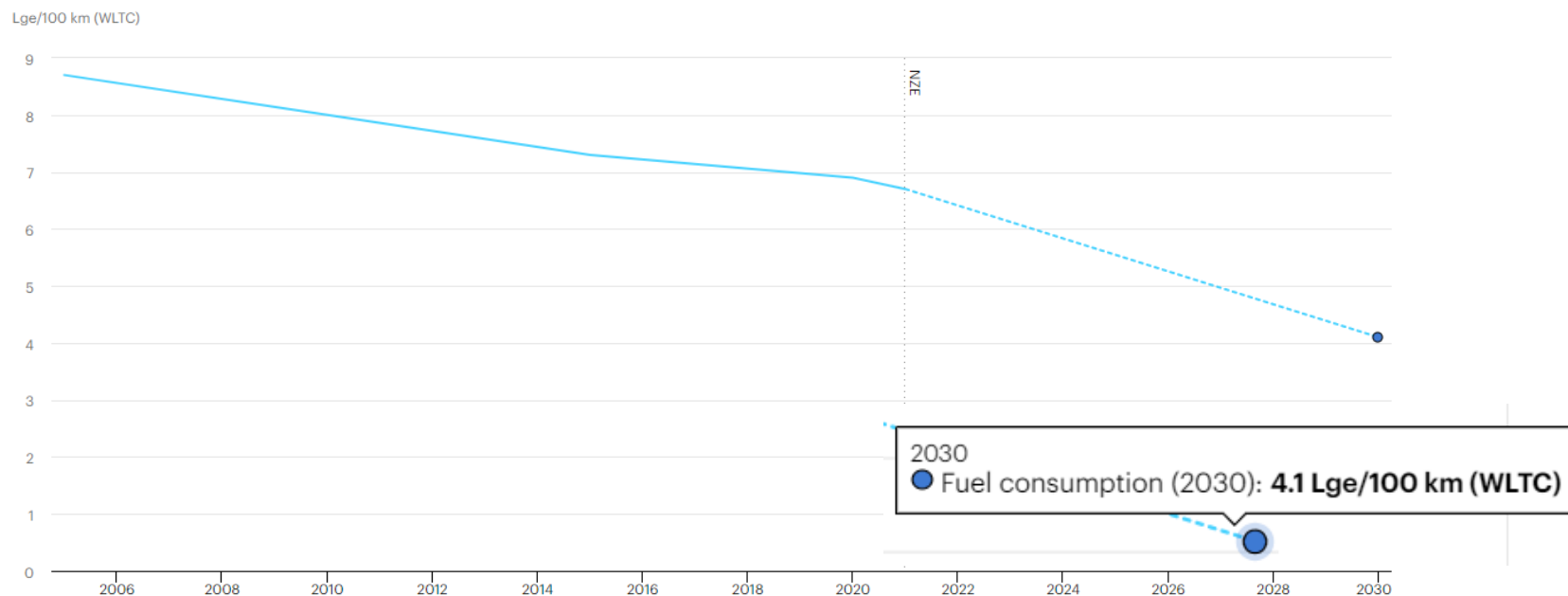
Electrification has more recently emerged as the dominant technology driving down the average fuel consumption of new vehicles. To be on track with the pathway in the Net Zero Emissions by 2050 Scenario, much more rapid improvements in the fuel economy of new conventional (internal combustion engine)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

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Cars and vans

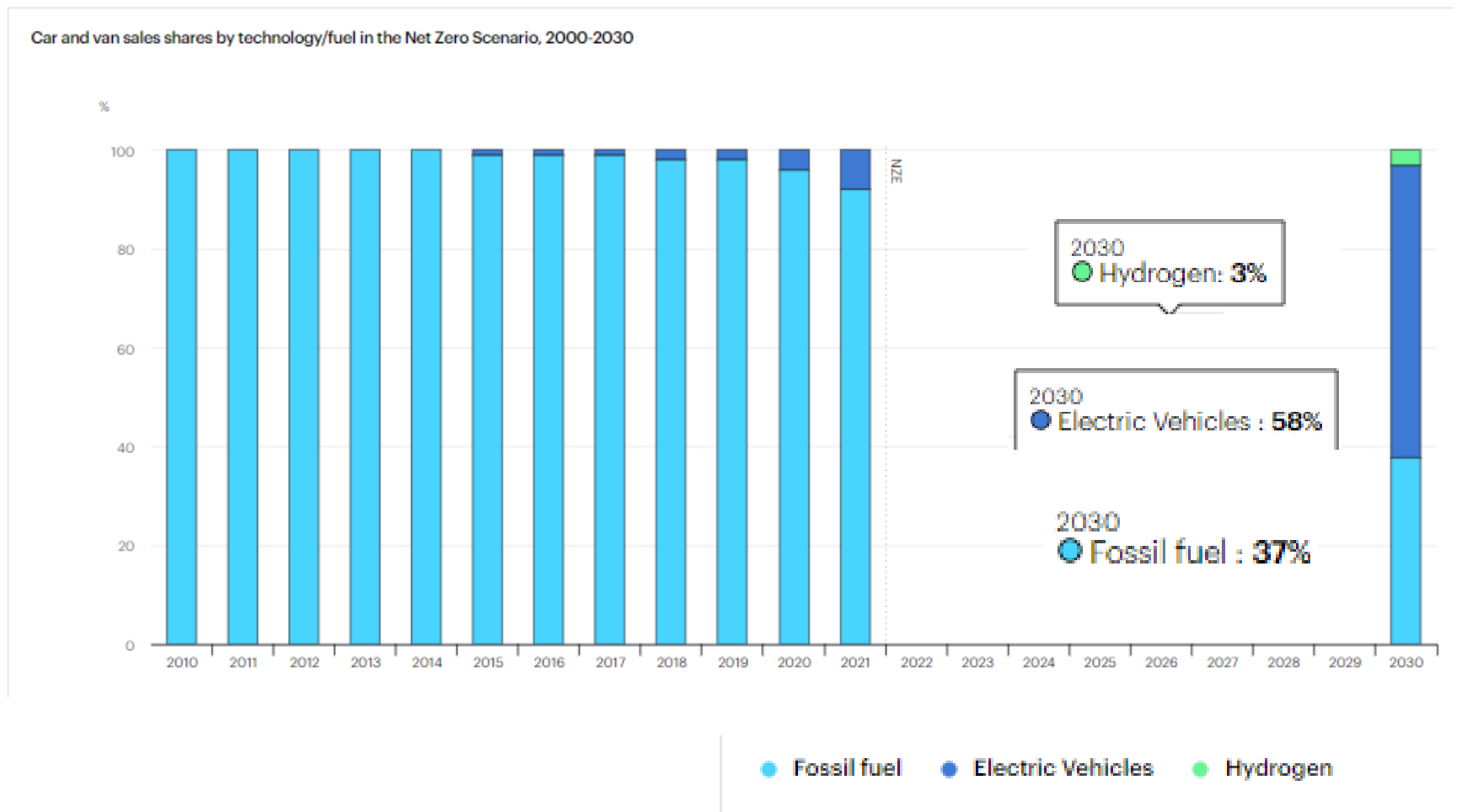
Specific fuel consumption of cars and vans in the Net Zero Scenario, 2000-2030



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Cars and vans



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Fuel economy standards and zero-emission vehicle mandates ratchet 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.

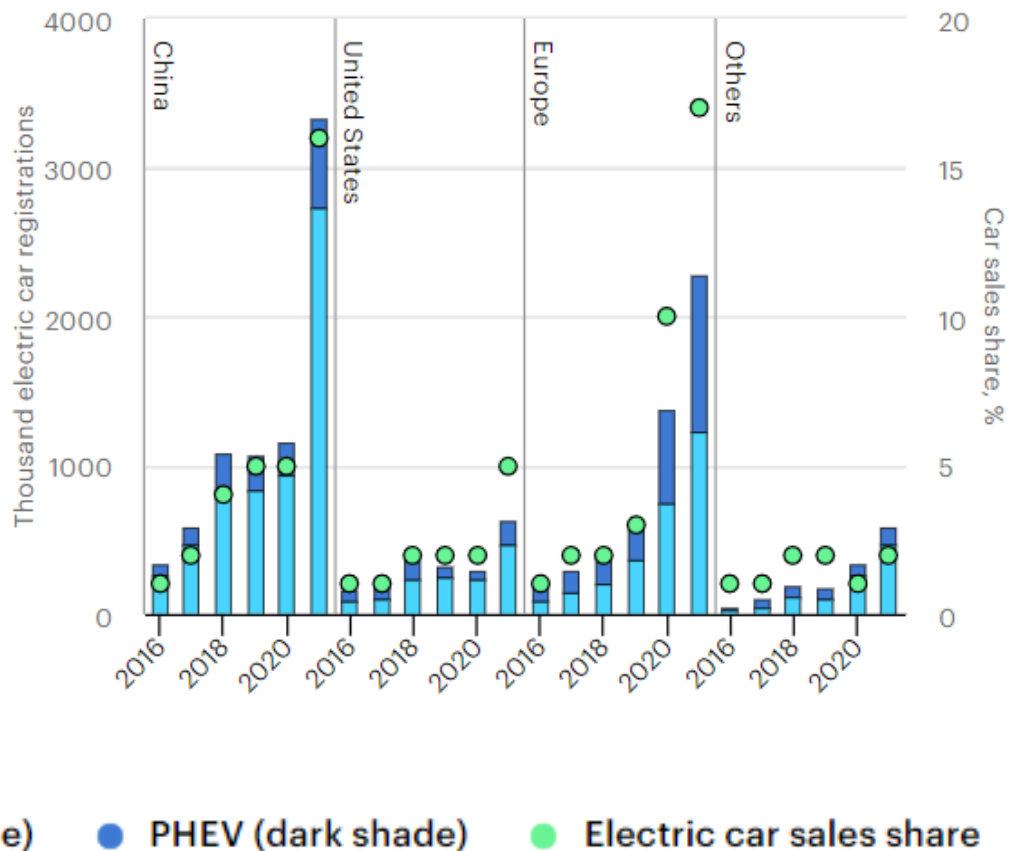
Fit for 55 package is a **set of proposals to revise and update EU legislation** and to put in place new initiatives with the aim of ensuring that EU policies are in line with the climate goals agreed by the Council and the European Parliament

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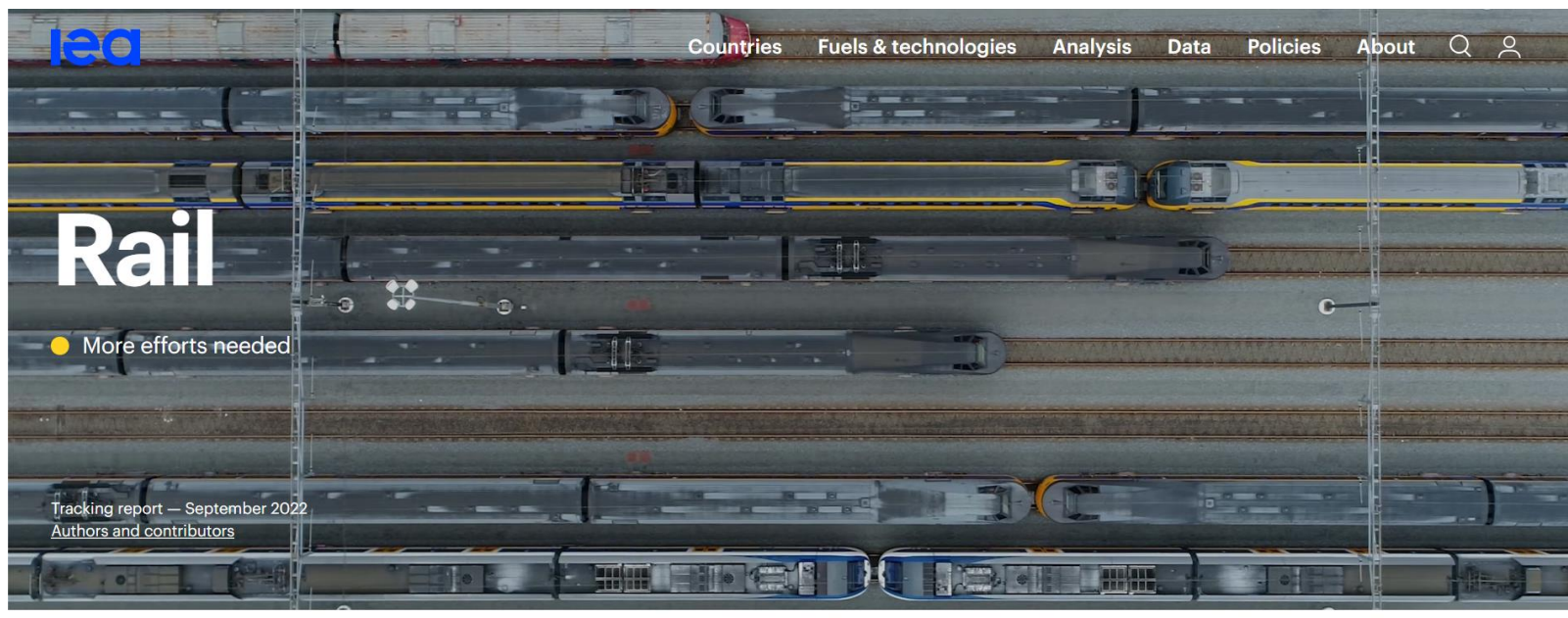
Electric cars

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



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Transports



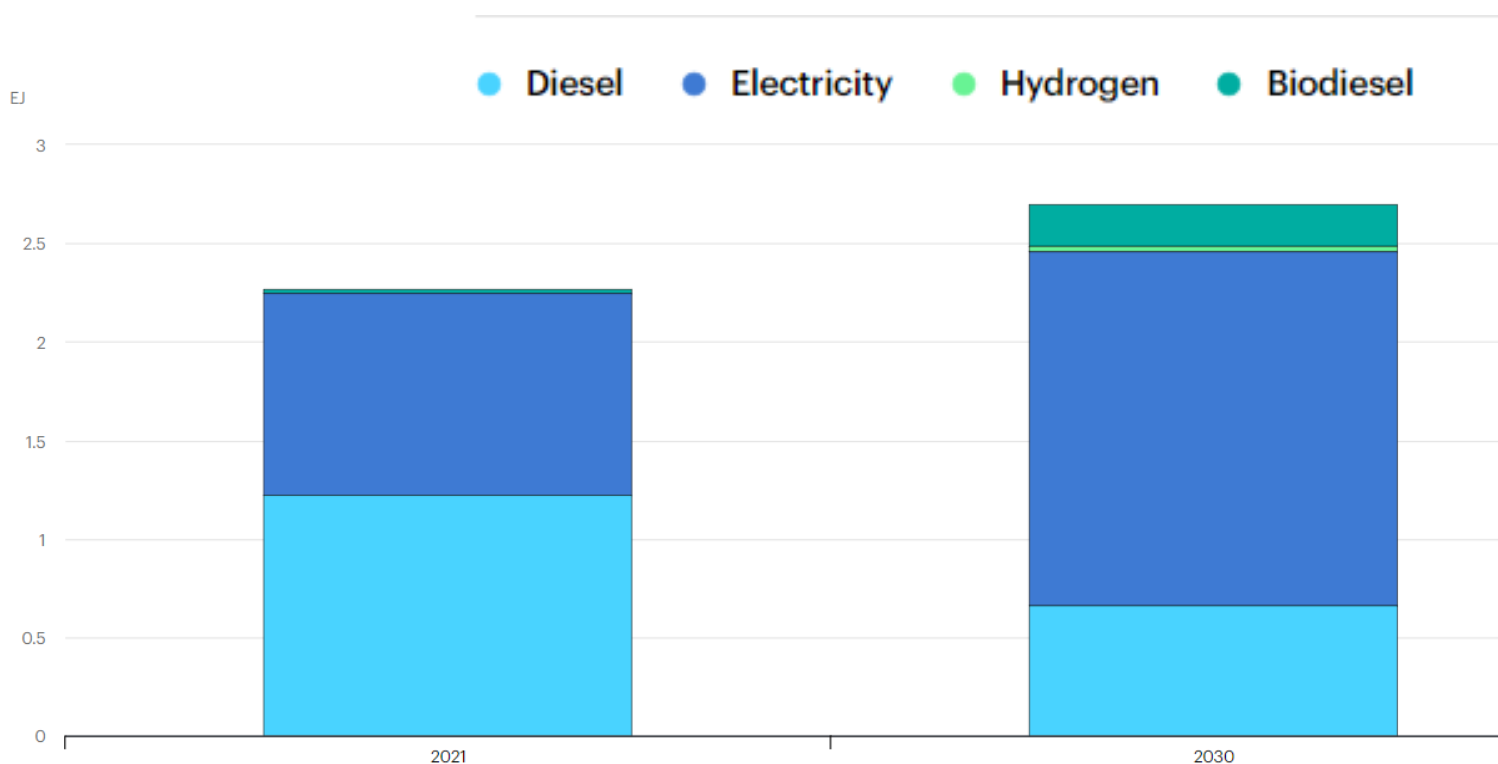
From their peak in 2019, direct CO₂ emissions from rail are not projected to increase beyond just over 100 Mt CO₂. Over the past two decades, direct CO₂ emissions from diesel rail operations increased through 2019 by less than 1% on average annually (electric rail, which accounts for about 80% of passenger rail activity and half of freight movements, does not release any direct CO₂ 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>)

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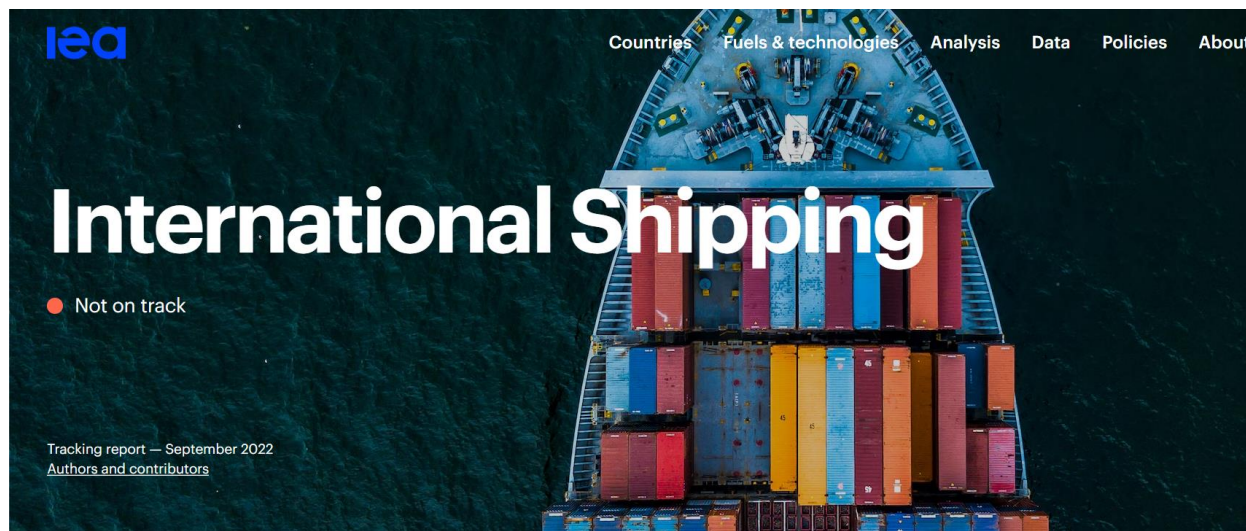
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Energy consumption for rail by fuel in the Net Zero Scenario, 2021-2030



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Transports

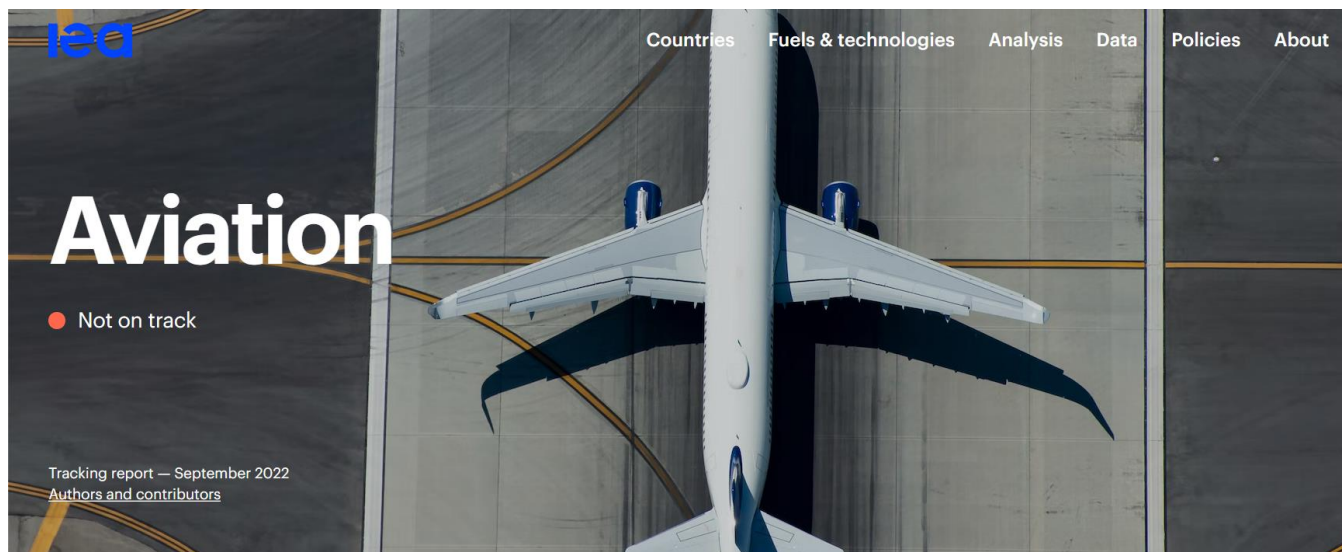


In 2021 international shipping accounted for ~2% of global energy-related CO₂ emissions. While measures approved by the International Maritime Organization are likely to curb the rise of emissions over the 2020s, greater policy ambition is needed to steer the maritime shipping sector onto the pathway 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>)

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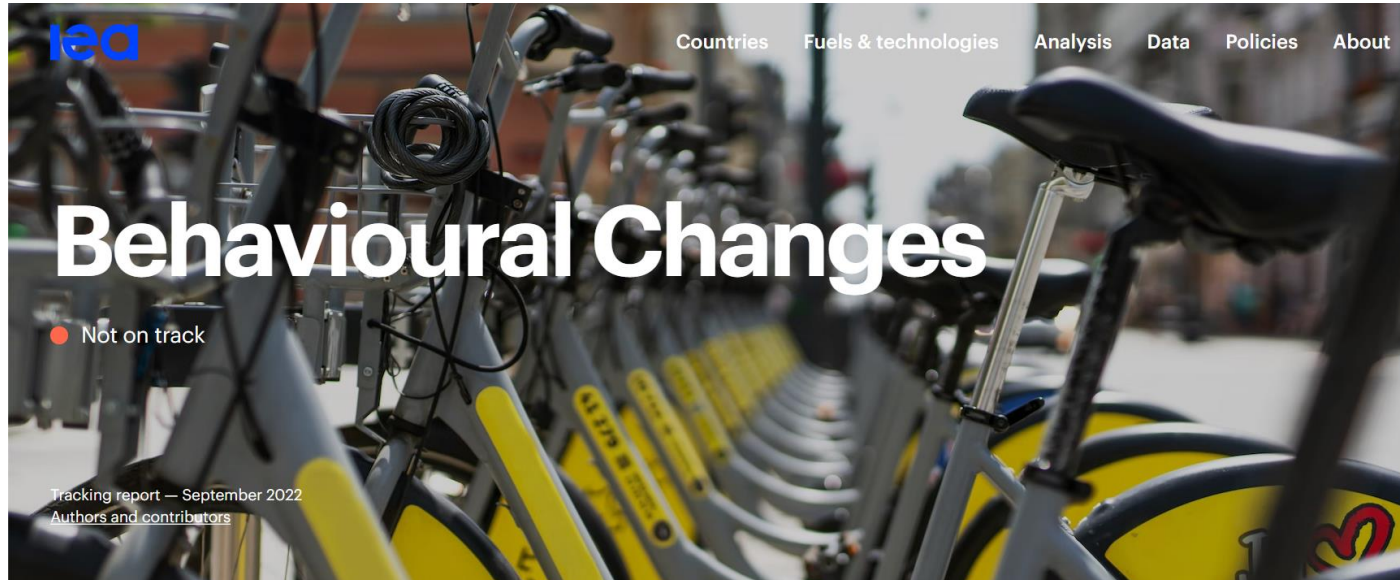
Transports



In 2021 aviation accounted for over 2% of global energy-related CO₂ 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.

Energia e sustentabilidade

Transports

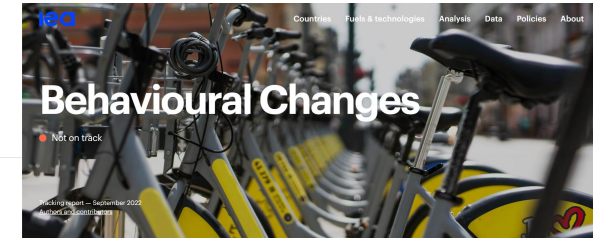
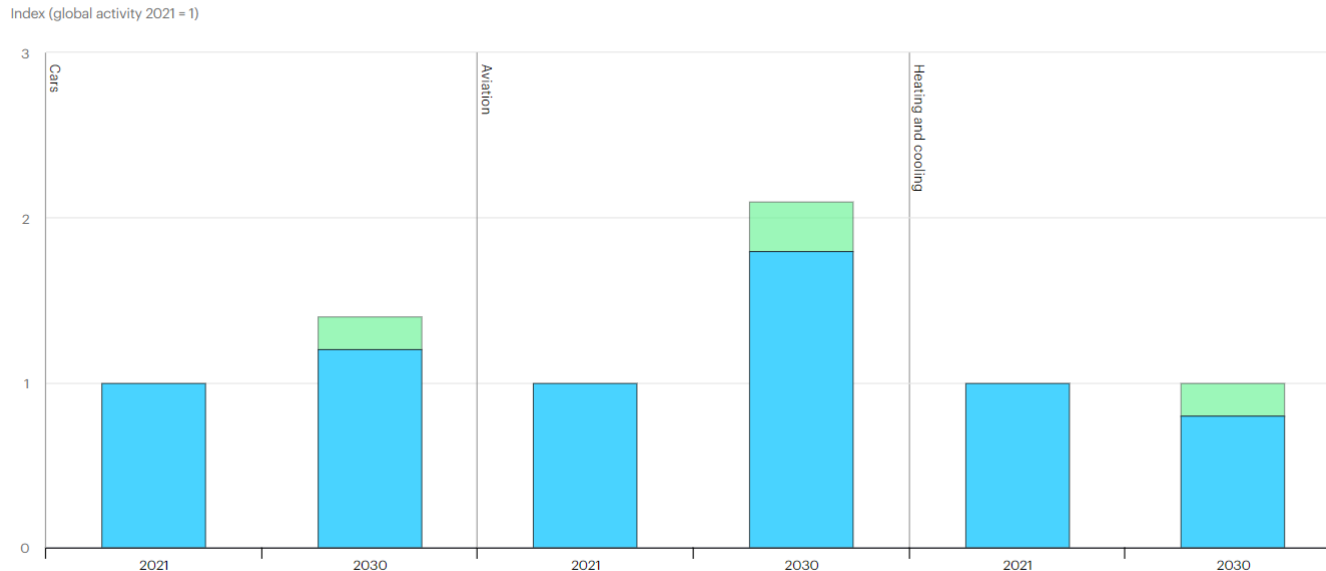


Behavioural changes play an important role in the Net Zero Emissions by 2050 Scenario, cutting CO₂ emissions and reducing energy demand growth. Behavioural changes can both improve wellbeing and public health and address three main challenges to decarbonisation: existing carbon-intensive assets, hard-to-abate sectors and the rapid growth in clean energy supply.

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 CO₂ emissions slightly below their levels in 2000, highlighting how high and fast emissions have risen.

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Production of synthetic fuels



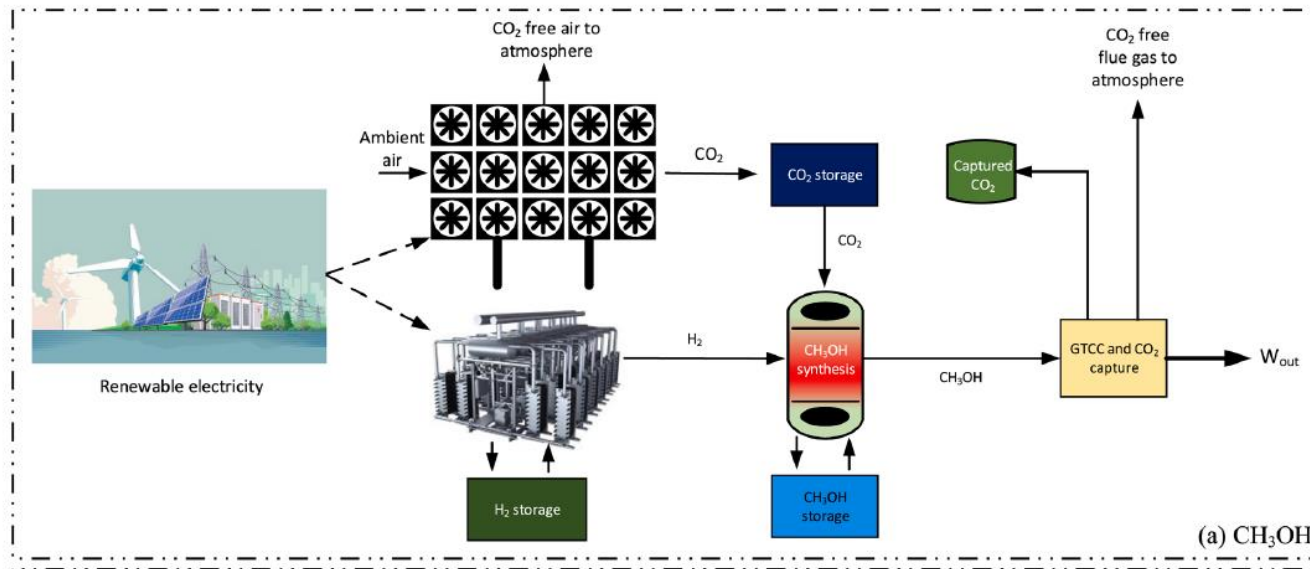
Source:

https://www.youtube.com/watch?v=HFKkqgdm5BE&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

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Carbon capture and utilisation (CCU)

Production of CO₂-based synthetic fuels



Source: Ishaq and Crawford, CO₂-based alternative fuel production to support development of CO₂ capture, utilization and storage, Fuel 331 (2023)

New utilisation pathways in the production of CO₂-based synthetic fuels, chemicals, and building aggregates are gaining momentum. The current project pipeline shows that around 10 Mt of CO₂ per year could be captured for these new uses by 2030, including around 7 Mt CO₂ in synthetic fuel production.