



SVENSKA ARALSJÖSÄLLSKAPET

Swedish Aral Sea Society



A culture of mobility and means of mobility

Björn Frostell, Professor Emeritus, Royal Institute of Technology, Stockholm
Vice president Swedish Aral Sea Society

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Aral Sea Society) and twelve universities in Central Asia**

Basics of Mobility and Transport

Mobility 1



Mobility 2



Mobility 3



Mobility 4



Mobility 5



Mobility 6



Mobility 7



Mobility 8



Mobility definitions

A1. The ability to move freely or be easily moved

A2. The ability to change one's social or socioeconomic position in a community and especially to improve it

Source: The Cambridge dictionary

B1. the quality or state of being mobile or movable

B2. the ability to change one's social or socioeconomic position in a community and especially to improve it

Source: Merriam-Webster Dictionary

C1. the quality of being mobile

C2. the movement of people in a population, as from place to place, from job to job, or from one social class or level to another

Source: Collins Dictionary - American English

In this course, definitions A1-C1 are the ones discussed

Transport definitions

Many definitions exist – the ones shown here regarded as most relevant

A1. to take goods or people from one place to another (verb)

A2. the movement of people or goods from one place to another (noun)

Source: The Cambridge dictionary

B1. to transfer or convey from one place to another (verb)

B2. an act or process of transporting (noun)

Source: Merriam-Webster Dictionary

C1. To transport people or goods somewhere is to take them from one place to another in a vehicle (verb)

C2. Transport is the activity of taking goods or people from one place to another in a vehicle (noun)

Source: Collins Dictionary - American English

Mobility is a main concern in our societies – we live in a mobility culture

The extent of mobility is 35 km per day and almost twice as high for those – especially middle-aged men – with the highest degree of mobility

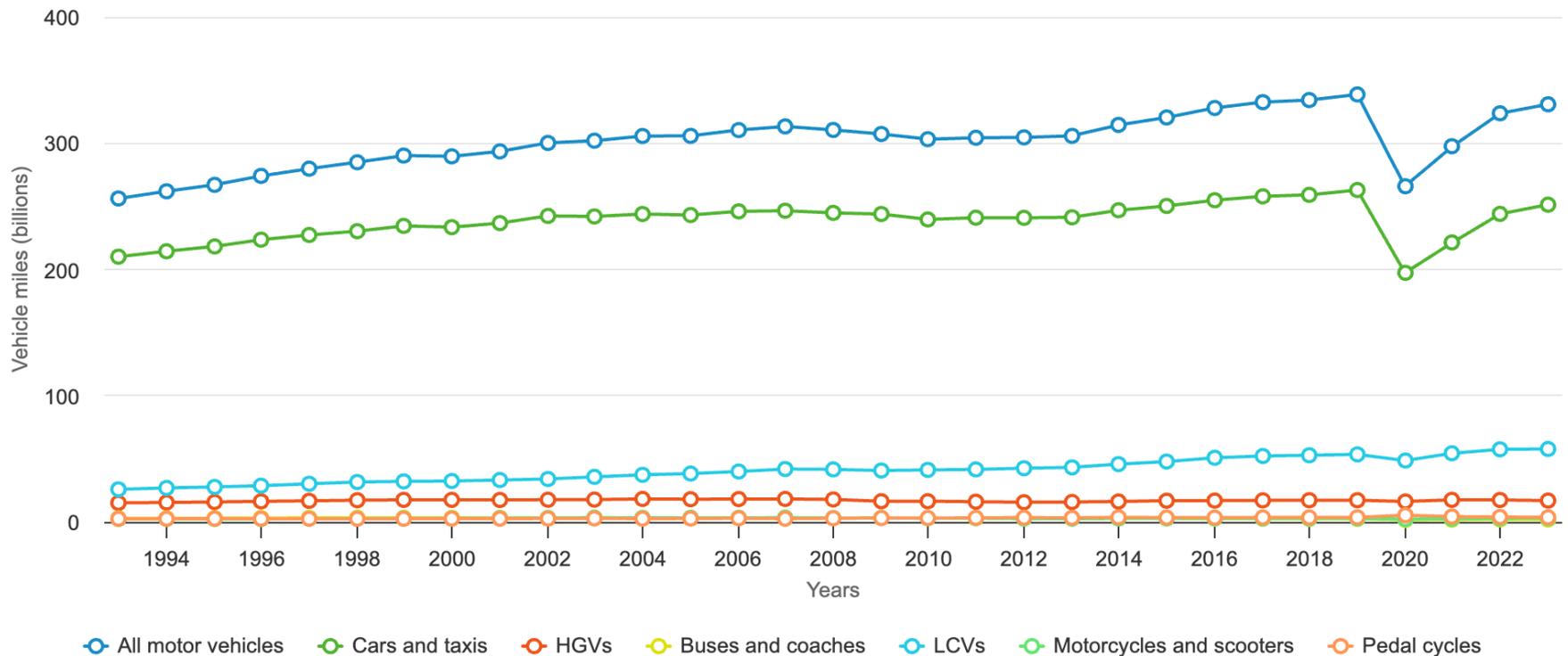
On average **we travel close to one hour per day**. This time is fairly constant over time but the distance covered increases with faster cars, buses, trains, flights and better roads

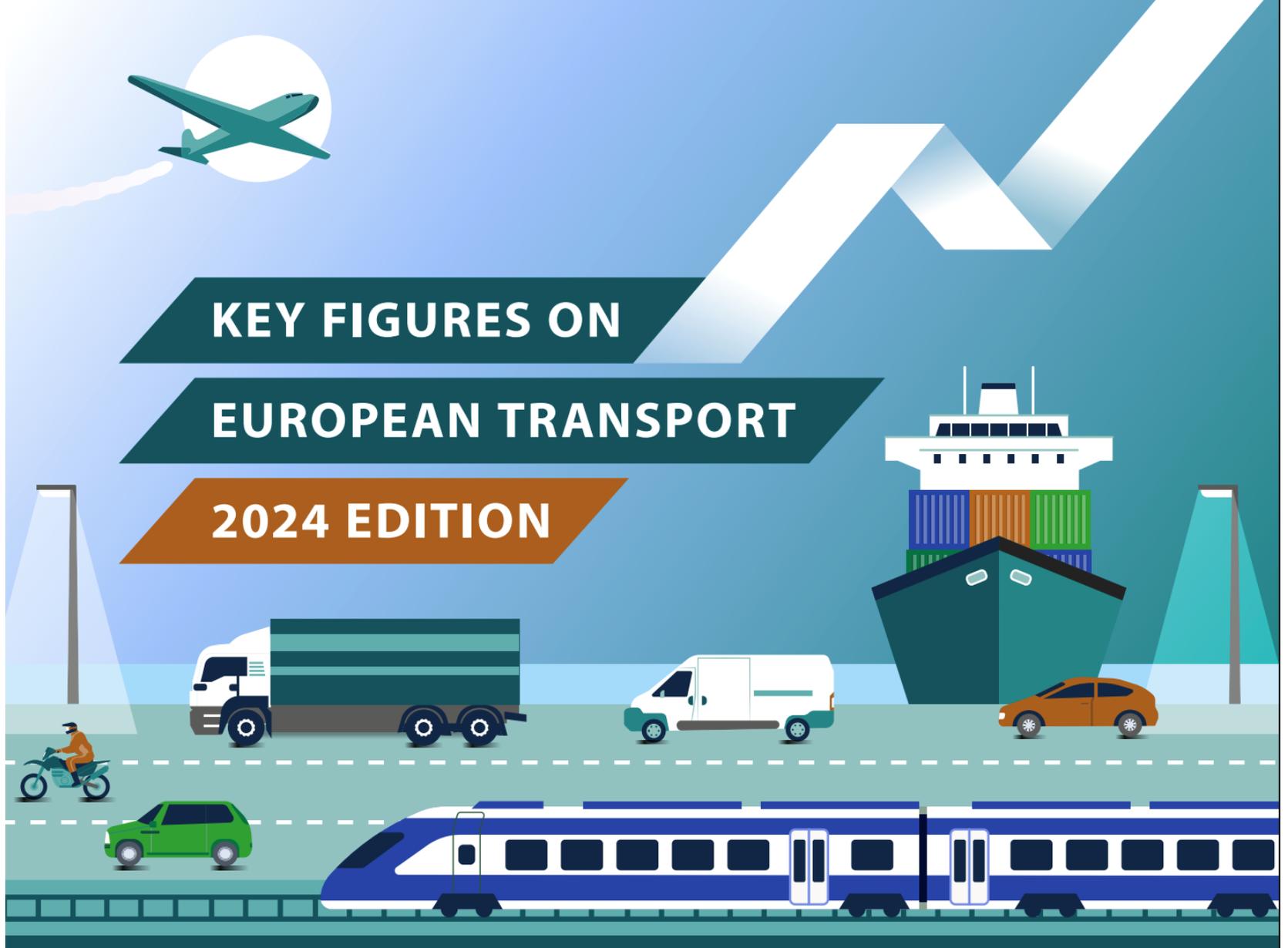
Mobility **increases faster than GDP** in many countries. When we have more money we use much of it for travel

Annual traffic by vehicle type in Great Britain 1994-2023

Annual traffic by vehicle type

Traffic in Great Britain from 1993 to 2023 by vehicle type in vehicle miles (billions)

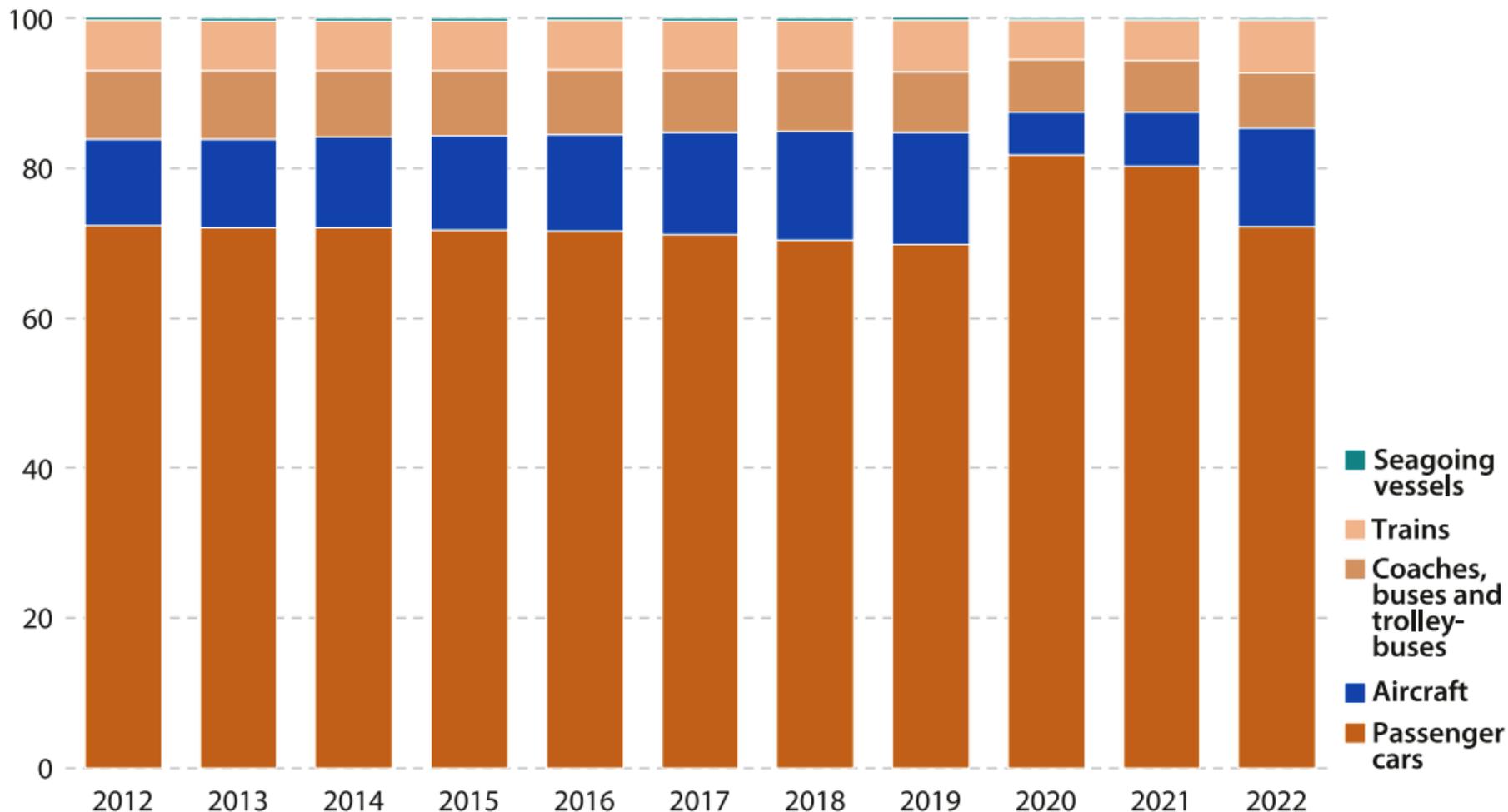




Modal Split of EU Passenger Transport 2012-2022

Changes in the modal split of passenger transport

(% based on passenger-kilometres, EU, 2012–22)

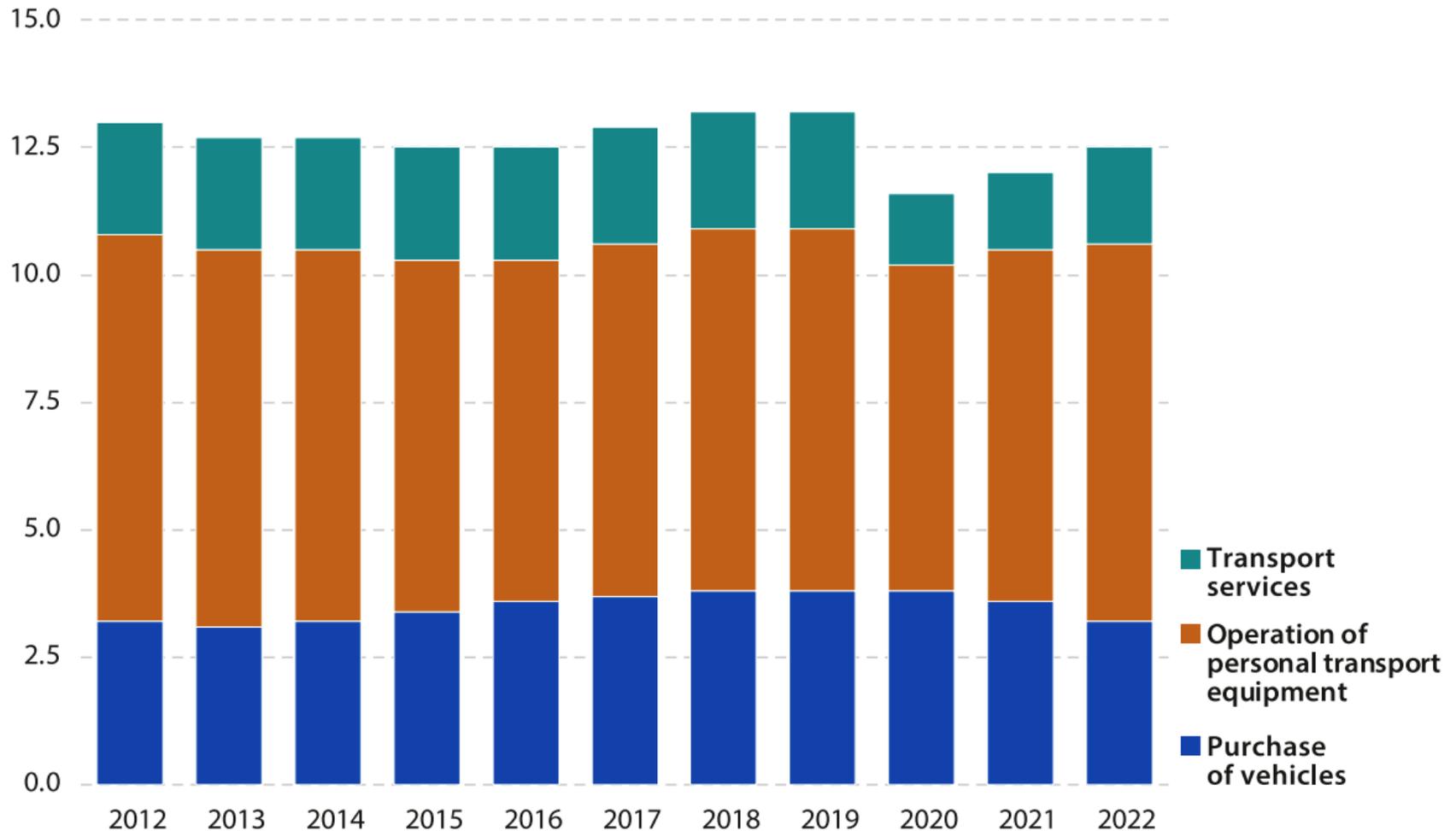


Source: Eurostat (online data code: [tran_hv_ms_psmo](#))

EU Household Consumption on transport 2012-2022

Share of household consumption expenditure on transport

(%, EU, 2012–22)

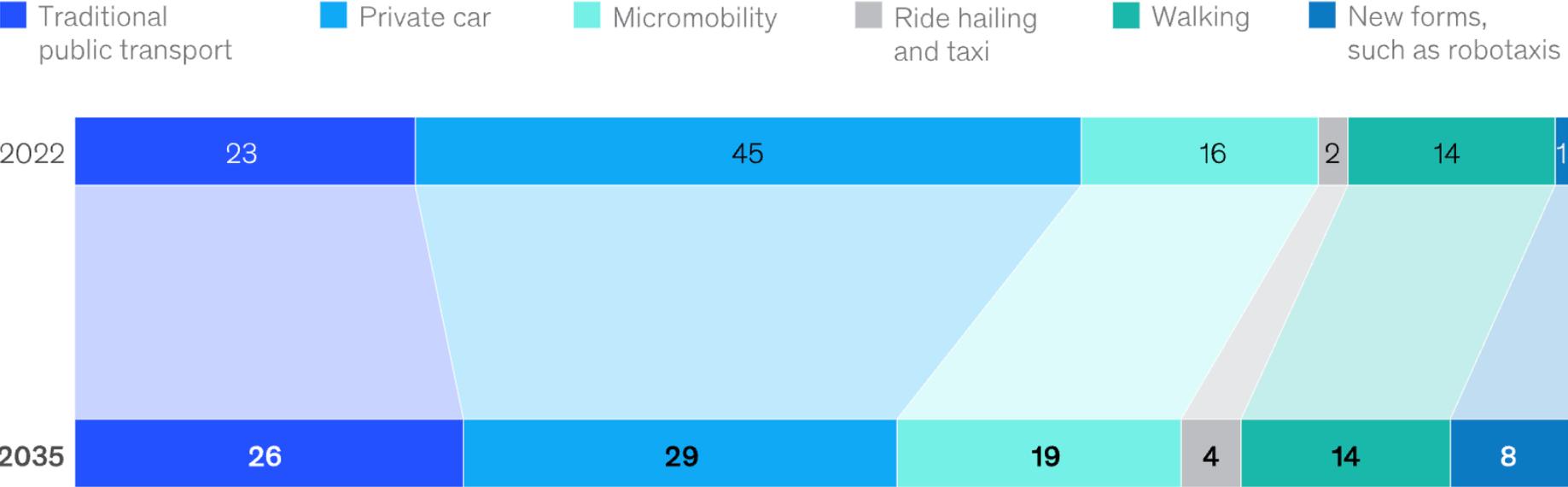


Source: Eurostat (online data code: [nama_10_co3_p3](#))

Forecast of Global Mobility Development 2022-2035

Although private cars will remain the most popular transportation option, their share of total mobility will decline.

Mobility split by mode of transportation, worldwide, %



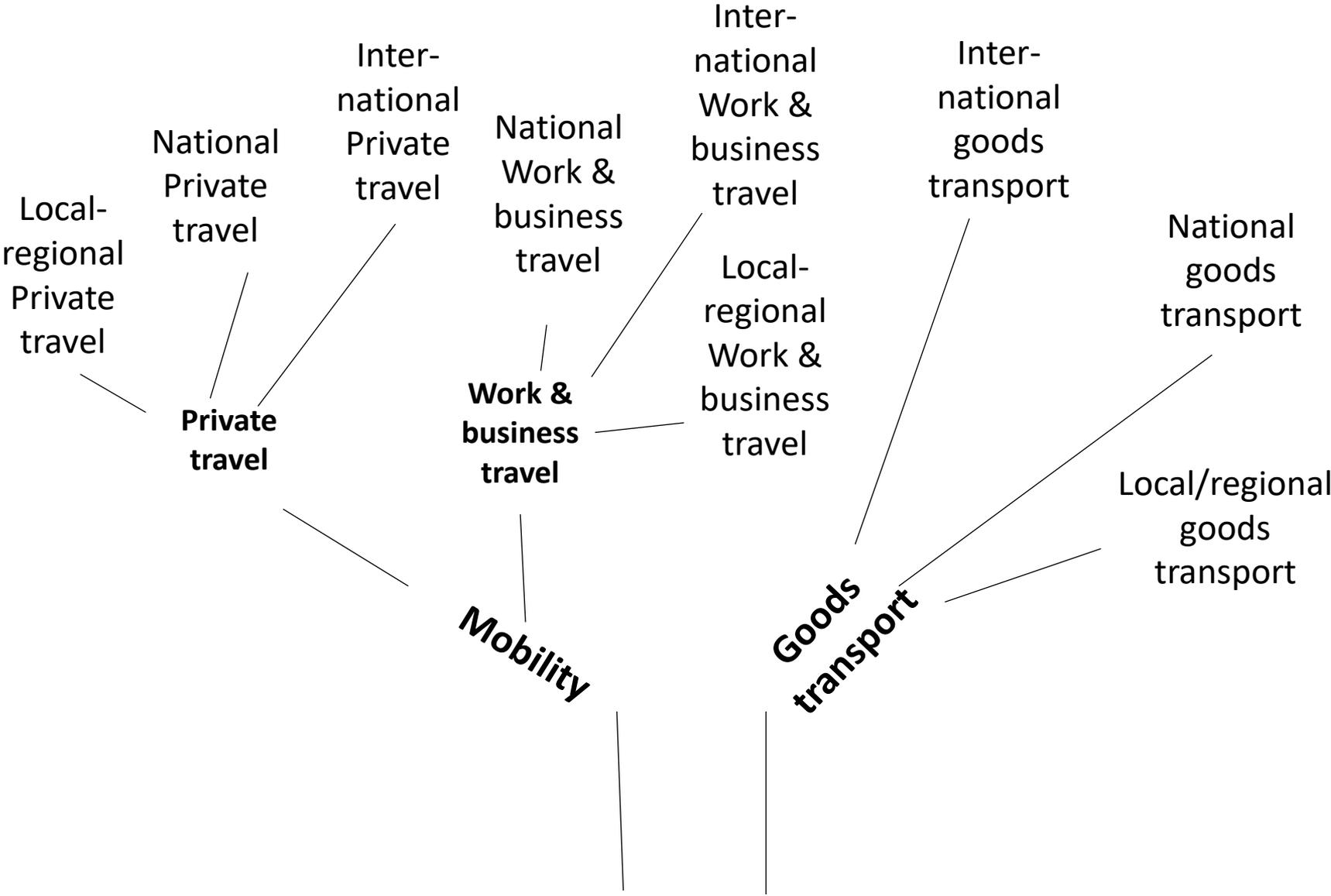
Note: Figures may not sum to 100%, because of rounding.
Source: McKinsey Center for Future Mobility

Mobility is of two kinds

So-called ***forced mobility*** is travelling which is not wanted by the individual but required for work and needed social services. Most typical, this includes commuting between home and work, home and school or home and food purchase. Travelling as part of work has also increased rapidly until recently during the Covid-19 pandemic

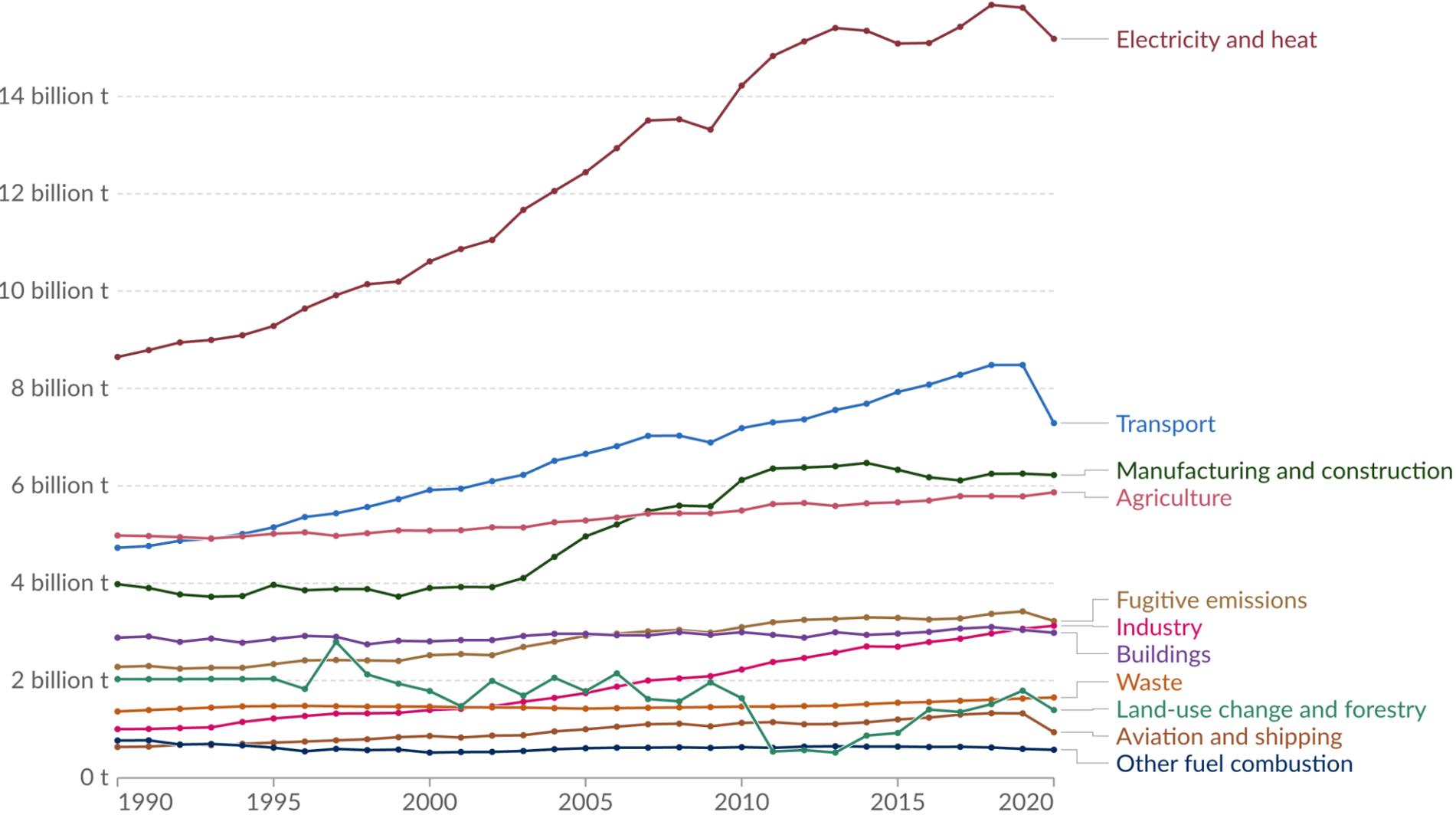
Voluntary mobility is travel chosen by the individual for example in connection with free time and tourism. Voluntary mobility, especially for tourism, is an important part of most peoples' lives when income increases

A Mobility and Transport Tree



Greenhouse gas emissions by sector, World

Greenhouse gas emissions¹ are measured in tonnes of carbon dioxide-equivalents² over a 100-year timescale.



Data source: Climate Watch (2023)

**The personal car
in
Mobility and Transport**



Car use

- Today mobility is completely **dominated by car use**. Within the European Union (EU 27) about 72% of all kilometres travelled are by car (2018)
- In interviews most people refer to comfort and speed as the reason for using a car. But car ownership certainly has more dimensions than practical for transport. For many a car symbolises freedom, independence and status.
- In large cities, car use is now decreasing. We are beginning to pass peak car!

Number of car registrations in EU countries in 2021

With colours showing different energy sources

Light blue = petrol cars; dark blue = diesel cars; red = electric cars;
red-brown = petrol/electric cars; dark brown = diesel/electric cars:
Yellow = natural gas cars + others



Problems with car use

- **Resource use - fossil fuels and CO₂ emissions.** The transport sector accounts for about 27 % of GHG emissions in Western Europe. Cars account for about 12 %
- **Environmental impact** – Pollution of air by car exhausts is serious and causes large negative health effects
- **Accidents** – In 2021, car traffic caused almost 20 000 road fatalities in the EU, appr. 44 deaths per million inhabitants (cf. the Sustainable Mobility milestones mentioned above)
- **Congestion** – there is not enough space for all cars. The infrastructure required by car traffic is immense.

Shortcomings of the conventional car

It depends on fossil fuels. Fossil fuels represent a non-renewable resource that will come to an end sooner or later depending on intensity of use

It is heavy. A gasoline or diesel car often has more than one ton dead weight to transport an average load of appr 100 kg. It is an in-efficient solution to transport needs.

It has a combustion engine. In a conventional car the combustion engine is very inefficient. Typically some 18% (petrol) or 22% (diesel) of the energy in the fuel is used to move the wheels. The rest becomes heat.

The air pollution caused by cars is serious. The emissions comprise CO₂ as well as other substances that harm the environment

Cars are noisy especially at higher speeds

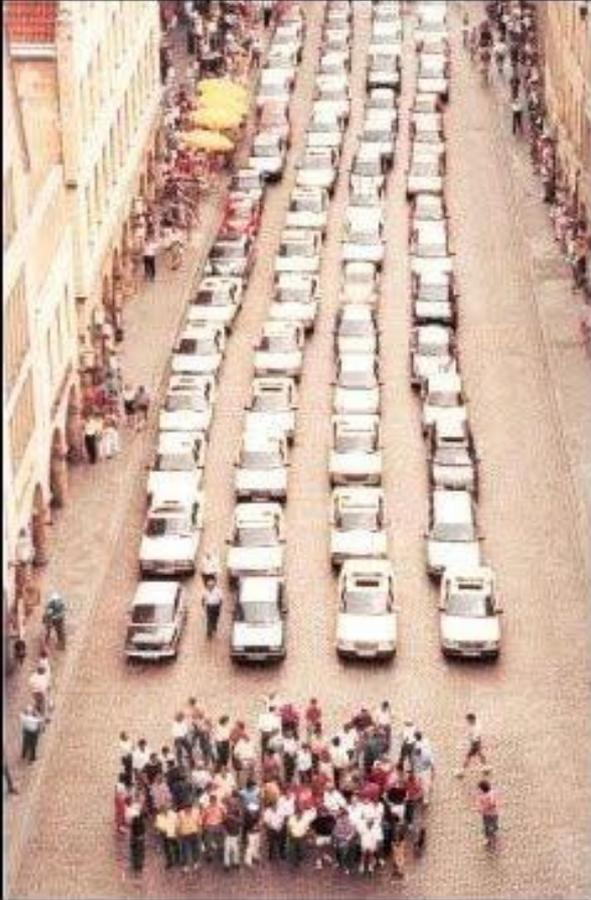
Cars need space. They take up a substantial part of available space in cities

**The needs for a systems
approach to
Mobility and Transport**

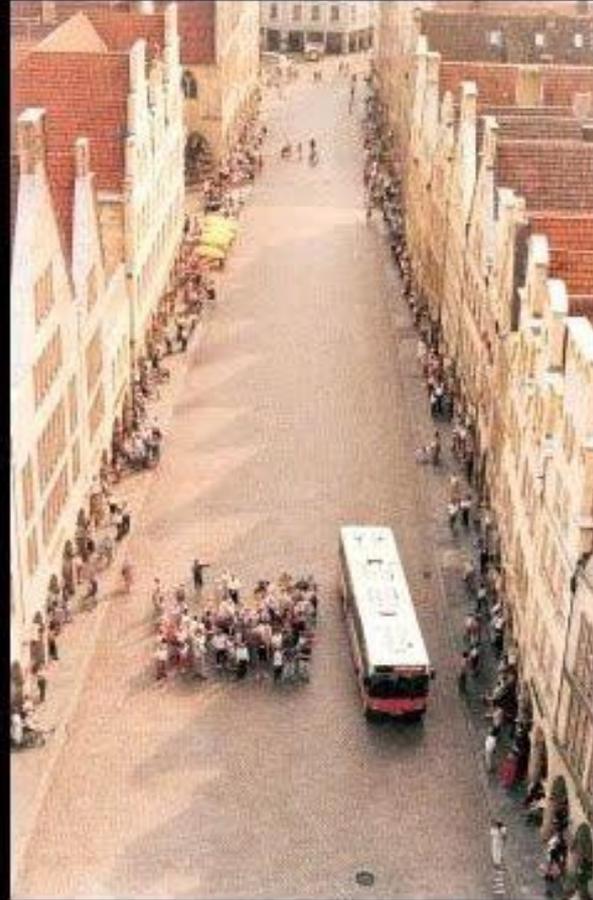
A mobility infrastructure

- The increased preference for cars has obvious consequences for how our cities, villages and countryside looks like. To create an efficient **mobility infrastructure** is a key feature of our societies.
- **Traffic-scapes** are dominating our outdoor environment especially in cities but also in countryside. In cities this is mostly negative for culture and the architecture, possibilities to meet and social relations. In cars, people are isolated and do not interact
- “**Reclaim the cities**” is a counterforce; the increased number of car-free city centres as well. In the countryside roads and railroads are cutting off mobility for animals, and reduce biodiversity. It is sometimes attuned by animal tunnels and bridges

Space required to transport 60 people



Car



Bus



Bicycle

Eisenstadt Austria -before



Eisenstadt Austria – after

30 000 pedestrians per day



Source: Hermann Knoflacher TU Wien

This environment attract people to walk, relax, communicate...

Public transport and car-sharing

- In **public transport** emissions per person kilometre is drastically reduced both when bus is used, and even more so in train or tram
- Traffic infrastructure would be much better with more public and less private transport, and congestion would diminish. Good public transport avoids waiting and time lags
- Halfway between private and public transport is **car sharing** when a group of people, have a so-called car pool. Car sharing has many advantages: cars are used more, the maintenance of the cars is better organised. Car sharing is increasing in big cities, and the number of cars in big cities are decreasing in many countries.



Car2Go: electric car sharing programme

300 electric cars to take & park anywhere in Amsterdam

Rail traffic - a sustainable alternative

- A large part of the energy consumption in cars is caused by friction between the tyres and the road. That is why **rail traffic** is energy-wise so much better than road traffic.
- Electric vehicles on rail, trains and trams, is the most energy-efficient way to move both people and goods on land.
- A well functioning metro, tram and local train systems are important components of a sustainable transport system in a city.
- Train traffic is also the best alternative for freight traffic on land. Fast trains have the possibility to replace much air travel without much time loss and much comfortably running from city centre to city centre, with dramatically reduced environmental impact.



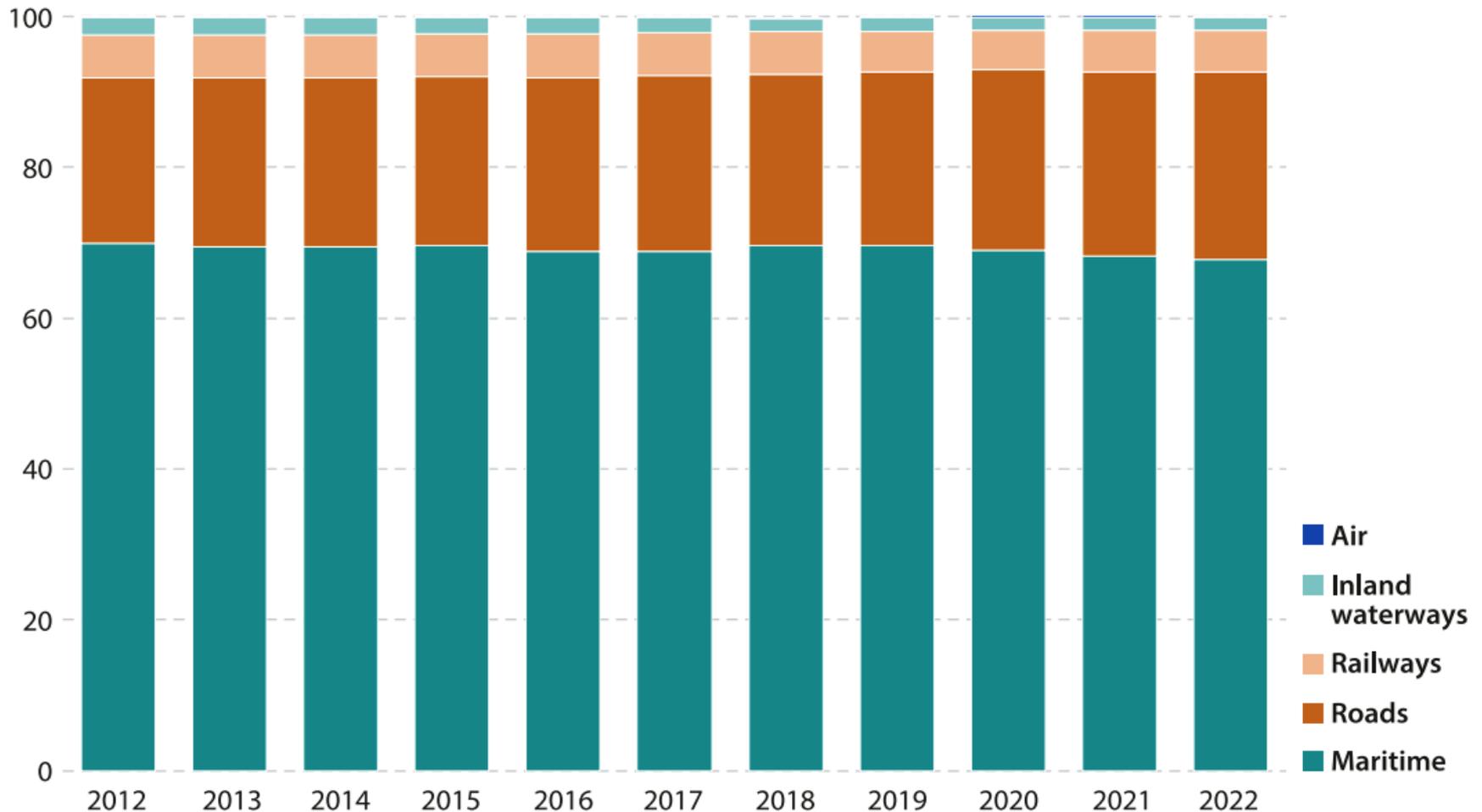


New trams in Marseille

Shipping and Freight Transport



Modal Split of EU Freight Transport 2012-2022



Source: Eurostat (online data code: [tran_hv_ms_fmod](#))

Shipping

- Shipping is expanding fast, both for business and pleasure
- Environmental impacts from shipping include emissions of CO₂ and acidic SO_x, especially from the use of fuel with high sulphur content
- Toilet and other organic waste discharge, directly into the sea without treatment, is a common practice in many areas
- Regulations to reduce environmental impacts of shipping have been only slowly implemented
- The IMO (International Maritime Organisation) has launched a landmark agreement towards achieving net-zero emissions from global shipping by 2050 (Source: European Commission press release 11 April, 2025)

Aviation

Aviation

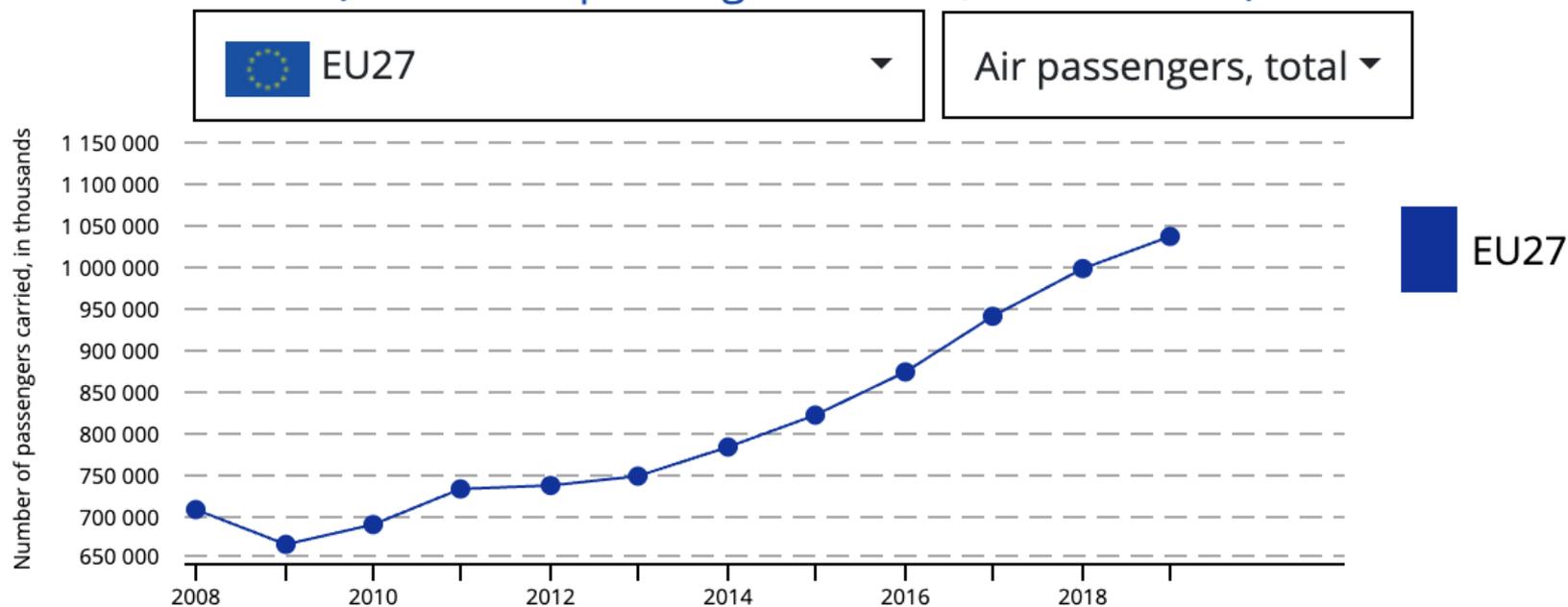
- Aviation accounts for only about 1-2 % of total travel, but still about 1 034 million passengers were carried by air in 2019 in the EU-27. The annual increase was 3.8 %
- Air traffic has the largest environmental impact per person kilometre
- There are small possibilities to reform air traffic into a more sustainable system in the short term, although research is on-going to produce biofuel for airplanes from biomass. Research aiming at electrification of part of aviation is also on-going
- The most reasonable development now is to substitute shorter air travels by fast trains, and use more ICT for business meetings

Diagram showing development of total air passengers per year in EU27 from 2008 to 2019

OBS! Y-axis starts at 700 000 passengers/yr – increase overemphasised!

Air passengers, total

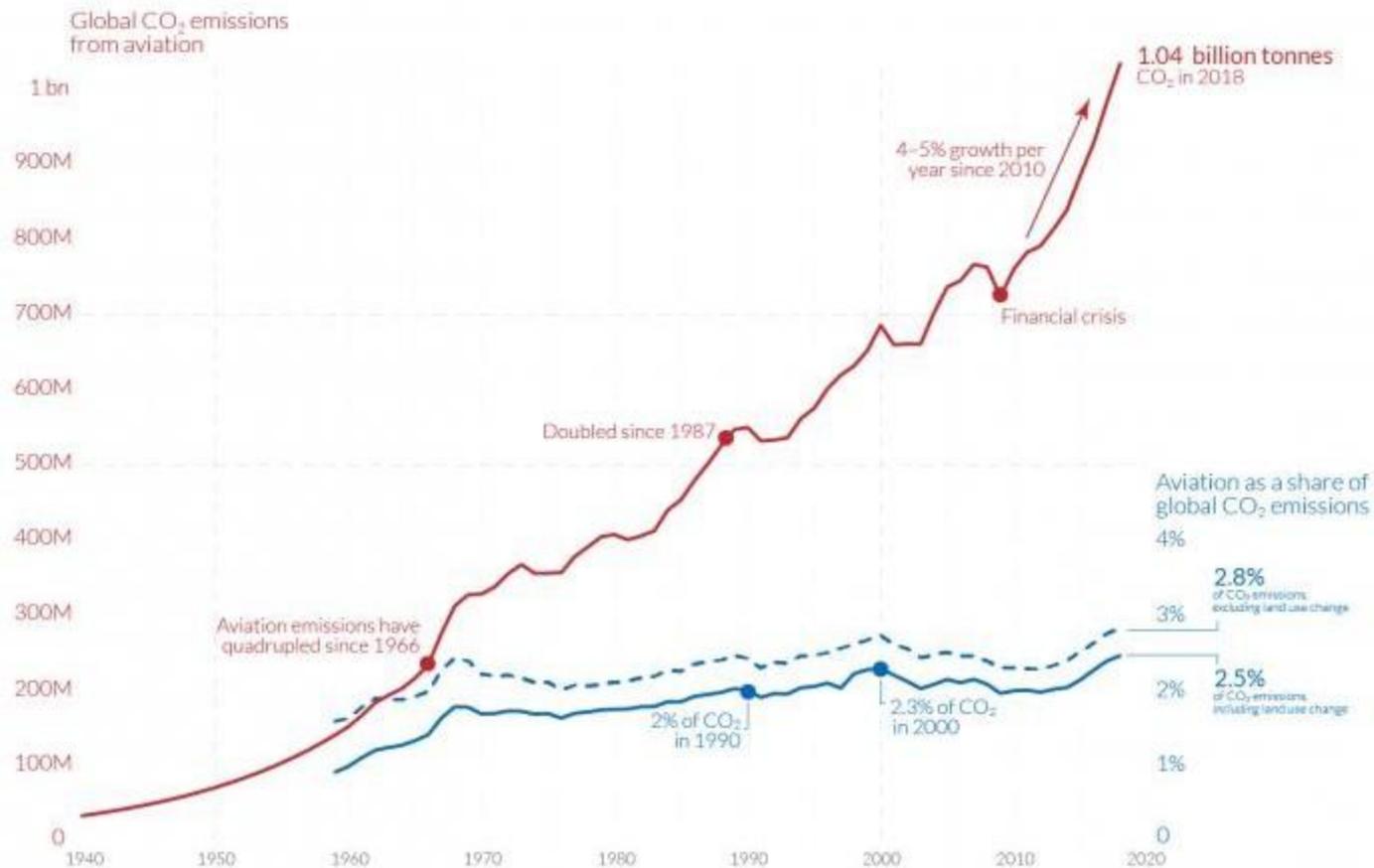
(Number of passengers carried, in thousands)



Source: Eurostat

Global carbon dioxide emissions from aviation

Aviation emissions includes passenger air travel, freight and military operations. It does not include non-CO₂ climate forcings, or a multiplier for warming effects at altitude.



OurWorldinData.org - Research and data to make progress against the world's largest problems.

Source: Lee et al. (2020). The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018; based on Sausen and Schumann (2000) & IEA.

Share of global emissions calculated based on total CO₂ data from the Global Carbon Project.

Licensed under CC-BY by the author Hannah Ritchie.

Aviation accounts for 3.5% of global warming, including non-CO₂ climate impacts. It accounts for around 2.5 % of global CO₂ emissions, but it's overall contribution to climate change is higher. This is because air travel does not only emit CO₂: it affects the climate in a number of more complex ways. (<https://ourworldindata.org/co2-emissions-from-aviation>)

Biking and walking

Biking

- Mean speed of biking is about 20 km/hr; 6 km takes 20 minutes
- Biking has no emissions (except from human respiration)
- Infrastructure for biking (bike paths and parking) is cheap and requires limited space
- It is healthy for the individual, and many bikers like to be “outdoors”, rather than inside a car or bus
- Biking in cities are on the increase in e.g. Paris, London, Copenhagen and Amsterdam. In Stockholm 150,000 commute daily to the workplace by bike, a figure expected to double in ten years.
- There is a huge untapped potential for biking in cities in many parts of the world, e.g. In Central and Eastern Europe



Paris 2010



1. Rental bikes in Paris 2. Biking in Copenhagen 3. Biking in Uppsala 4. Biking in Vienna

Walking may also contributes to Mobility

- Walking can easily move you 5 km per hour, which means that all destinations within 2-3 km are suitable to walk to
- For such shorter distances, walking is an almost perfect combination of Mobility and exercise, especially for people of senior age
- The impacts on environment and on other aspects e.g. congestion of walking are very low
- Walking has another benefit - with the rushy life that characterises most modern life, walking promotes reflective thinking and personal psychological well-being

Mobility and Transport towards Sustainability

How to make mobility more sustainable?

- **Technical solutions**
- **Policy tools**
- **Mobility management**
- **Rethinking – why mobility?**

A sustainable mobility future

- Mobility and transport are central in our societies and have large benefits but at the same time, high environmental costs
- The combustion car has to be largely exchanged for the **electric car**. This will take time. The limited and expensive battery is the main obstacle
- We will also have to **drive car less**, especially in cities; an estimation for Stockholm is 30-50 % less. This corresponds to car driving on 1985 level.
- It is not difficult to live in a city without a car when **public transport and biking are working well**. In Stockholm, half of the households do not have a car today
- **Transport will have to move to train and boat**, while sustainable aviation is so far an unsolved dilemma

The renewable fuels car

- The biofuels include *biogas*, *bioethanol* and *biodiesel*. In some situations the use of biofuels may be the best alternative
- When food waste and other organic waste in a city are used for *biogas* production it may be sufficient for all city buses, thus establishing a sustainable recycling system
- Large-scale production of *bioethanol* is only sustainable if it is not using fossil fuels during production or it is competing with other more important uses of the crop
- Bioethanol is today the dominant biofuel but is not considered to be a long-term solution. Similar considerations are valid for biodiesel
- Both are today mixed in standard fossil fuels to decrease CO₂ emissions from traffic

Uppsala Sweden

Almost 100 buses in the city run on locally produced biogas



Biofuel from waste

A photograph of the Uppsala biogas plant. The image shows several large, cylindrical, corrugated metal storage tanks in the foreground, with a large industrial building in the background. The sky is clear and blue. There are some young trees and a paved area in the foreground.

Uppsala biogas plant uses organic waste as raw material for biogas

The electric car

- In an electric car, emissions from operation of the vehicle are negligible and essentially all climate impact stems from production of the car. This is an important reason why electric cars are seen as the future, especially when electricity and car production emissions are coming down
- Electric cars need expensive and resource consuming batteries – a Swedish study indicated that overall climate performance passes that of a fossil fuel car after 17 years
- An intermediate system is the charging hybrid car; it may use electricity from the grid for shorter (e.g. urban journeys up to 100 km) trips and fossil fuels for longer journeys

Electric Mobility in Sweden March 2025

Swedish population is appr. 11 million inhabitants

➤ Number of rechargeable cars	640 000
➤ Number of fully electric cars	352 000
➤ Number of rechargeable buses	1 675
➤ Number of rechargeable light trucks	30 100
➤ Number of rechargeable heavy trucks	1 060
➤ Number of rechargeable motorbikes	3 100
➤ Public points for charging	7 000+

Electrification is fast, but slower than predicted

Source: <https://powercircle.org/elis-elbilsstatistik/>

National transport policies

- National transport policies exist in all countries, and also at the European level
- Local actors depend on actions taken at the national level as the **regulations and taxation** belong to this level
- The dilemma for policy actions is to balance the needs of transportation against the costs
- An important part of the policies is to make more **sustainable alternatives more attractive** and the less sustainable alternatives less so
- This may be done by **supporting the more sustainable alternatives**. At the national level, it is for example possible to invest in the development of train traffic or fast trains

Policy tools - taxes

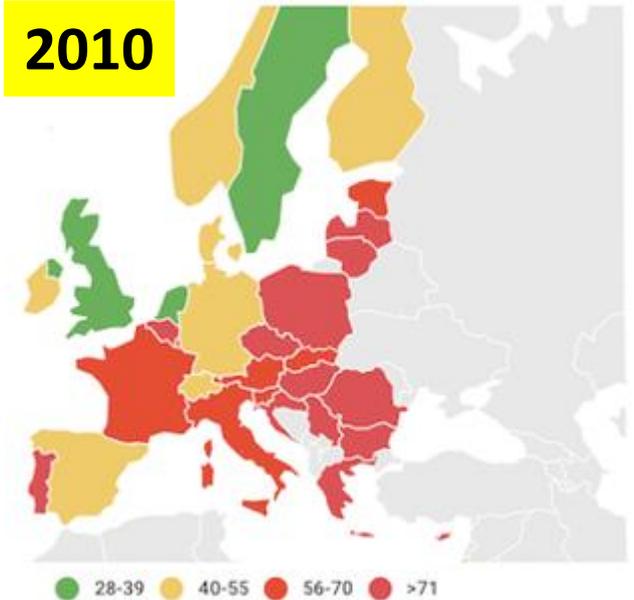
- Taxation of car driving is an important measure to reduce car traffic. The several taxes and charges used include tax when buying a car, tax for mileage, insurance costs and inspection costs
- Most important is tax on fuel and carbon dioxide emissions. If tax on petrol is high, fuel-efficient cars will be more attractive
- Taxation may be differential. Carbon dioxide taxation does not apply to renewable fuels, such as biogas, bioethanol or biodiesel, which increase the market for cars using such fuels
- So-called *green cars*, mostly cars using renewable fuels, may be exempt from some taxation, such as entrance fees to city centres

Increasing road safety

EU road traffic fatalities 2001, 2010 and 2020

Substantial progress in road safety achieved.
Sweden has the lowest number of traffic fatalities per capita in EU

2010



2001



2020



Road safety "Vision Zero" the Swedish approach

Vision Zero constitutes the basis for road safety policy in Sweden since 1997. It embodies a set of principles for designing road safety policy. The most important principles of Vision Zero can be stated as follows:

1. The **level of physical impact that humans can sustain** constitutes the basic design parameter for the road transport system. No accident should exceed the threshold for a serious injury
2. **Vehicle speed** is the most important factor
3. **Roads design** especially the 2+1 roads, and fences between directions
4. **Vehicles design** – safe cars
5. **Rules** are set by the system designers



A Swedish 2+1 road



A Swedish traffic surveillance camera

Policy tools – Regulations on cars and other transportations

- Policies and regulations have been introduced on cars and other forms of transportation to foster sustainability
- Policies and regulations include safety measures such as speed limits, which also reduce emissions that increase steeply with higher speed
- Within the EU, there is a maximum allowed level of carbon dioxide exhausts per kilometre of driving, in 2021 year 95 g/km This emission level corresponds to a fuel consumption of around 4.1 l/100 km of petrol or 3.6 l/100 km of diesel

Mobility Management

- Mobility Management is an established method to **promote sustainable transport**
- The traditional core of mobility management is so-called **soft measures**. These include all kind of user services, such as information, coordination, education, etc.
- The soft measures are combined with, and increase the value of, **hard projects**, that is, infrastructure developments such as building roads, bridges, bike roads, tram lines etc.
- The soft measures are targeting the **mobility behaviour** of the inhabitants of a city or region, while the hard projects are addressing the structure in which they move around.
- A core objective of Mobility Management is to **reduce car use** and thereby car traffic

Sustainable Mobility and Transport Short Summary

Mobility and Transport - the Positive

- To our knowledge, improved mobility and transport has contributed to economic and material well-being through history
- Improved mobility contributes to our possibilities to see the world, get in touch with other people and other cultures, supporting (i) learning about and understanding each other and (ii) improve cooperation
- Improved transport of goods and globalisation of economy has allowed us to spread risks in food supply due to weather and climate phenomena and to place production in a more economic way – thus supporting development all over the world

Mobility and Transport - the Negative

- Global economic activity and resulting ecological impacts have now reached a magnitude that threatens the global climate system and in the long term whole regional ecological systems
- In many economies, we see that the Mobility and Transport sector grows faster than the economy itself and also the climate and ecologic impacts
- The personal car dominates the Mobility and Transport sector despite it is a very, very resource inefficient way of organising mobility
- The electric car - in its current configuration – will only marginally contribute to an ecologic sustainability in the Mobility and Transport sector

Mobility and Transport – to do

- Mobility and Transport needs a **mobility infrastructure** (system optimisation), relying on the use of several different means of mobility, from walking to aviation
- The heavy dependence on the personal car in existing Mobility and Transport systems will have to be decreased in favour of (i) increased use of public transport and (ii) increased use of walking and biking for shorter distances
- Electrification is seen as a promising alternative in future Mobility and Transport
- As short rules of thumb, the following general advice for selection of Mobility mode is proposed (as possible):
 - Shorter than 3 kmWalking or biking
 - From 3 km – 10 km.....Biking or public transport
 - From 10 km - 50 km.....Public transport (bus, Metro)
 - From 50 km – 500 km.....Train, bus, car
 - Longer than 500 km.....Speed trains, aviation

Mobility and Transport - To read

1. The Baltic University Programme Sustainable Development Course.
7a. A culture of mobility. 7b. Means of mobility – technology and systems 7c. Freight 7d. Policies and management of mobility
(<http://www2.balticuniv.uu.se/bup-3/chapter-7>).
2. *Sustainable transport.* https://en.wikipedia.org/wiki/Sustainable_transport.
3. *Mobility and Urban Traffic Infrastructure.* Building Sustainable Societies, Chapter 10. pp 150-168.
(<https://uzwater.ktu.lt/index.php/textbooks#module-b-sustainable-development>).
4. Sinha, R., Olsson, L.-E., Frostell, B. (2019) Sustainable Personal Transport Modes in a Life Cycle Perspective—Public or Private?, *Sustainability*, 11, 7092; doi:10.3390/su11247092.

Thanks for your attention!

bjornfrostell@gmail.com

Questions for the break

- **What socioeconomic changes could cut the need for an ever-increasing need for increased mobility?**
- **Which are the main disadvantages with the electrification of mobility?**