

# Insights in CO2 emission estimation and European experience

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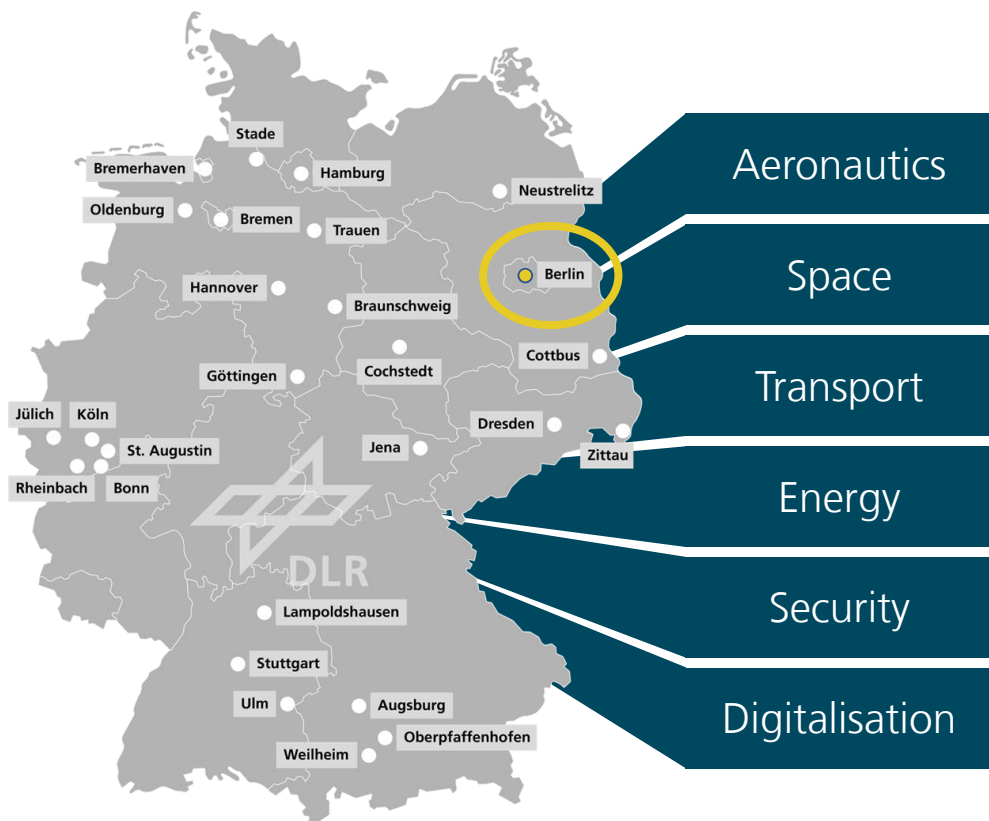


EUROPEAN  
REGIONAL  
DEVELOPMENT  
FUND

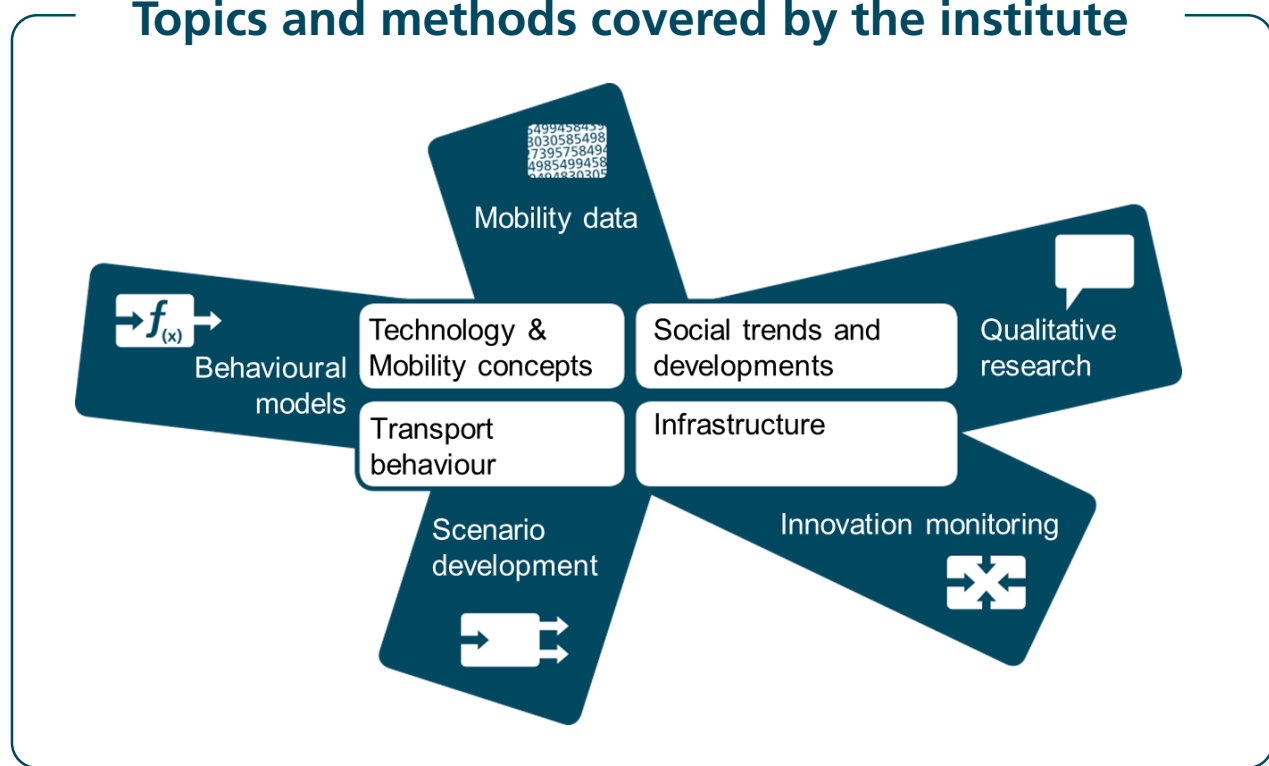




# German Aerospace Center (DLR) Institute of Transport Research



## Topics and methods covered by the institute



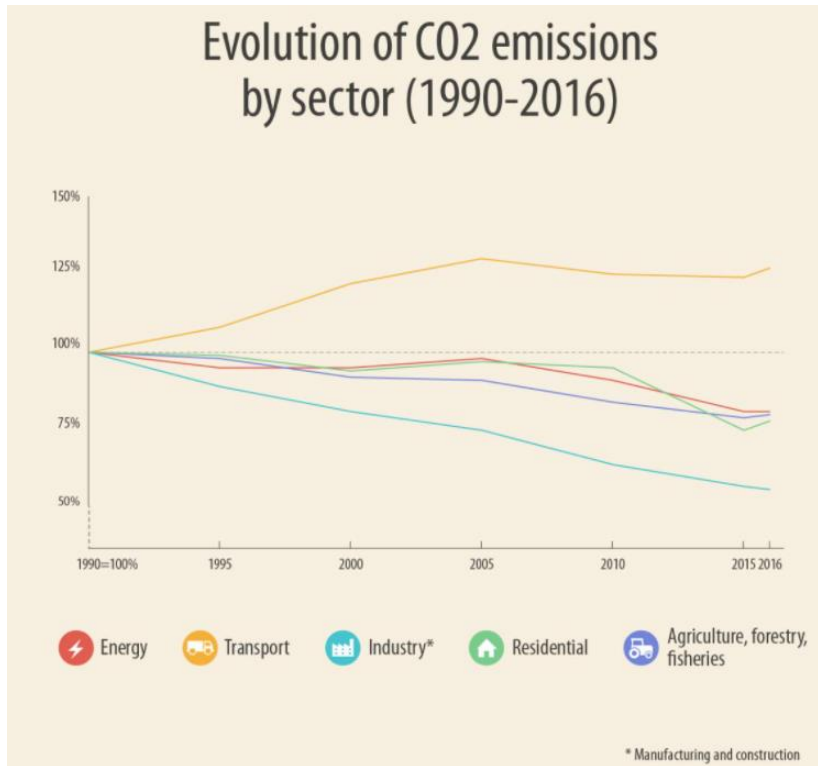
# Why is the topic relevant?



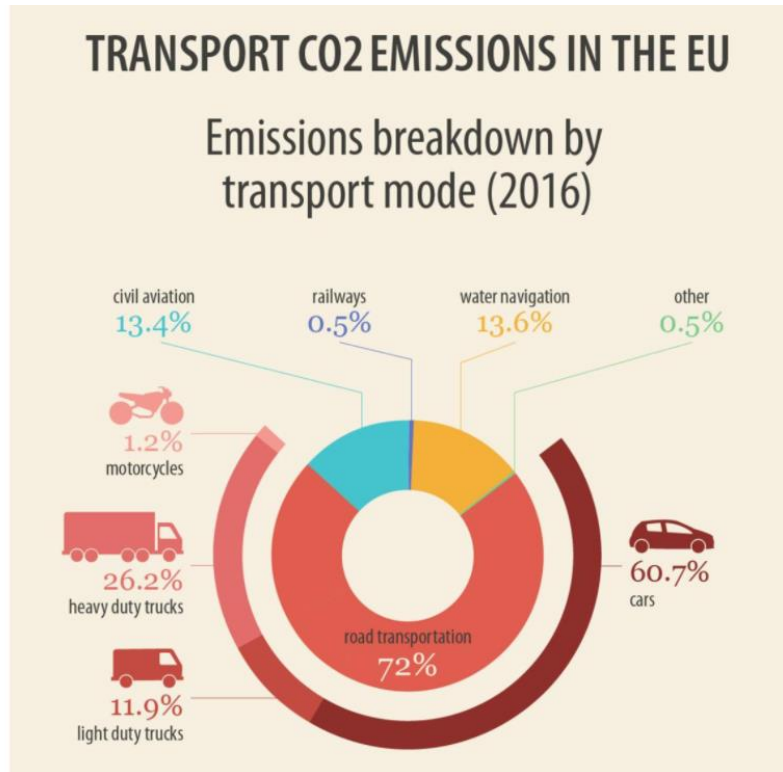
- ⇒ Decarbonisation of all sectors by 2050
- ⇒ Intermediate GHG emission reduction target for 2030: 55 %

A graphic with a light blue background. At the top, the text "European Missions" is written in a large, bold, dark blue font. Below this, a white horizontal line is present. In the bottom left corner, there is an icon of a blue building, a yellow train, and two green trees. To the right of the icon, the text "100 Climate-Neutral and Smart Cities by 2030" is written in a bold, dark blue font.

# Why is the topic relevant?

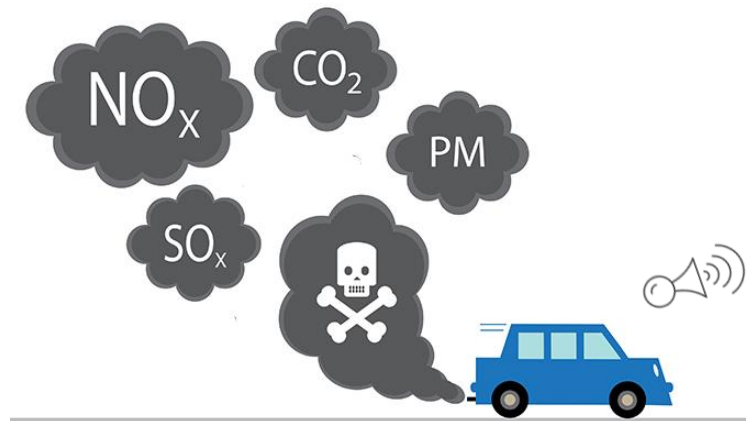


Evolution of CO2 emissions in the EU by sector (1990-2016)  
Source: European Environment Agency

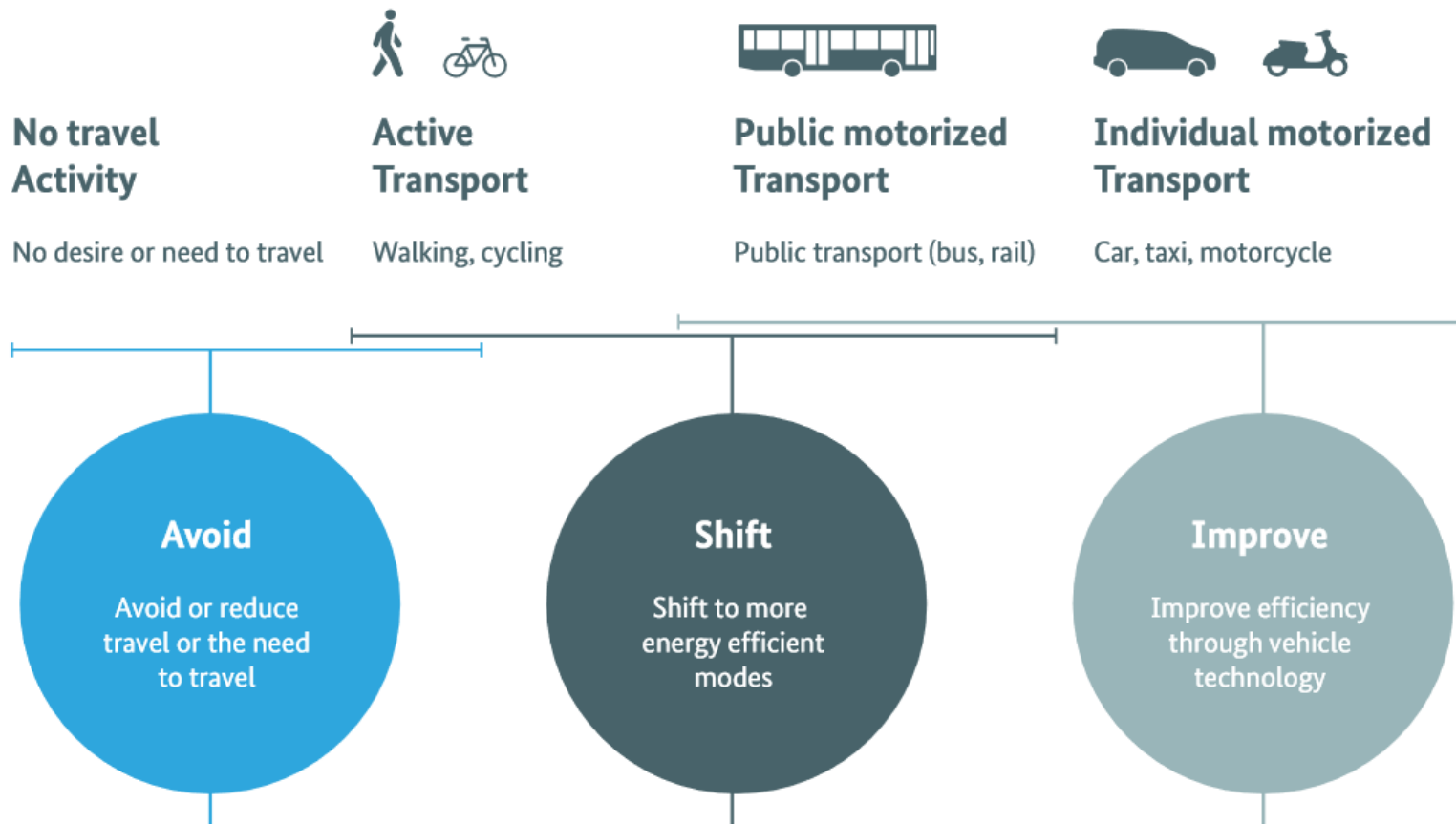


Cars account for 60% of transport CO2 emissions  
Source: European Environment Agency

**Air pollution is the single largest environmental health risk in Europe**



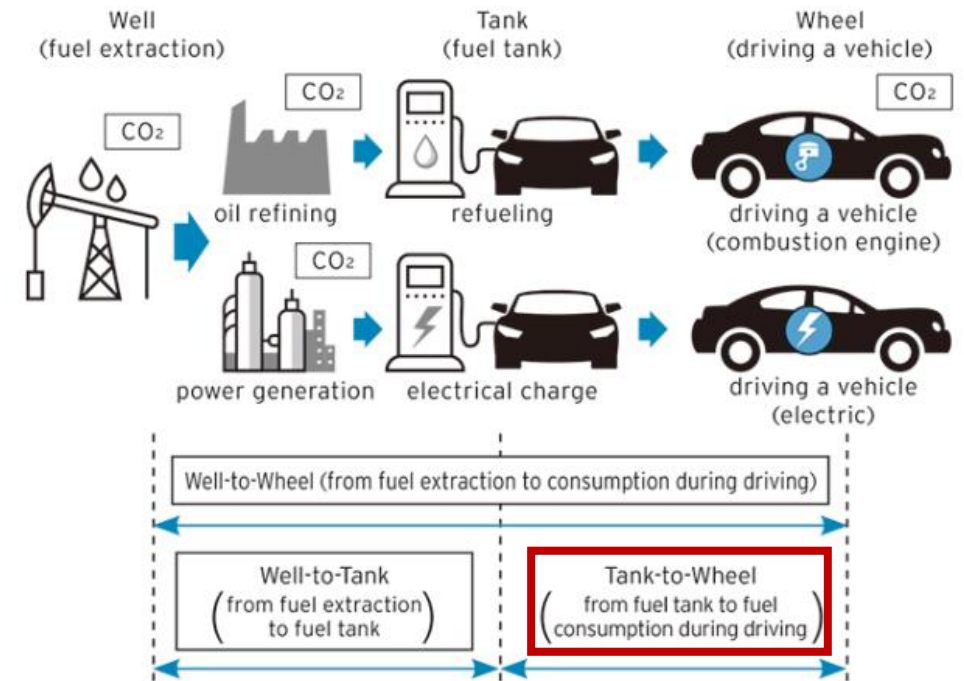
# Avoid-Shift-Improve: The three pillars of reducing the climate impact of the transport sector



Source: [GIZ \(2019\)](#).

# The transport sector's CO<sub>2</sub> emissions refer to tank-to-wheel emissions

- CO<sub>2</sub> emissions of the transport sector refer to a subrange in the energy chain of a vehicle that extends from the point at which energy is absorbed to discharge, i.e. Tank-to-Wheel (TTW).
- Under the TTW perspective and concerning CO<sub>2</sub> emissions battery electric vehicles (BEV) and hydrogen-powered fuel cell electric vehicles (FCEV) are zero emission vehicles.
- The Well-to-Wheel perspective covers the entire energy consumption and CO<sub>2</sub> emissions of a fuel caused by production, supply and use.
- Life cycle assessment (LCA) covers all stages of the life cycle of a vehicle (cradle-to-grave), i.e. Well-to-Wheel + vehicle body cycle (manufacture, maintenance, recycle).



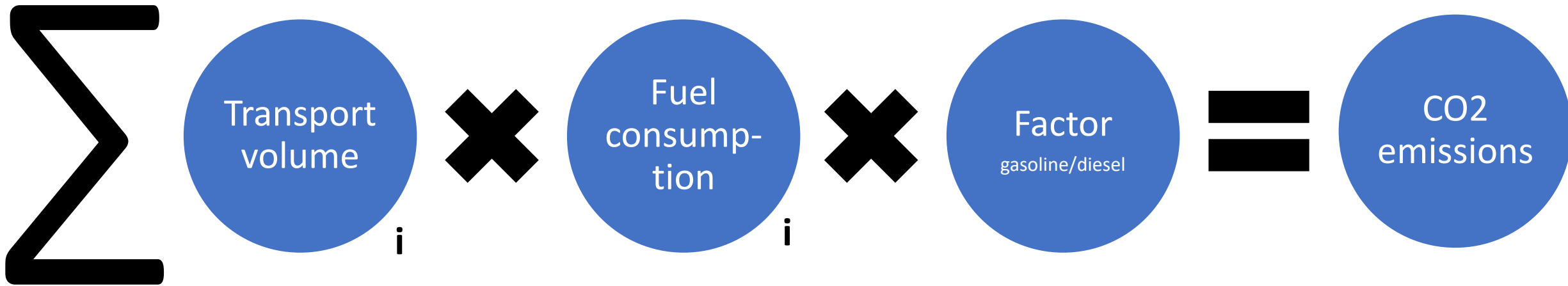
Source: [https://www.mazda.com/en/csr/special/2016\\_01/](https://www.mazda.com/en/csr/special/2016_01/)

Source: [Sacchi et al.](#), [Zheng & Peng \(2021\)](#).

# How to estimate the emissions?

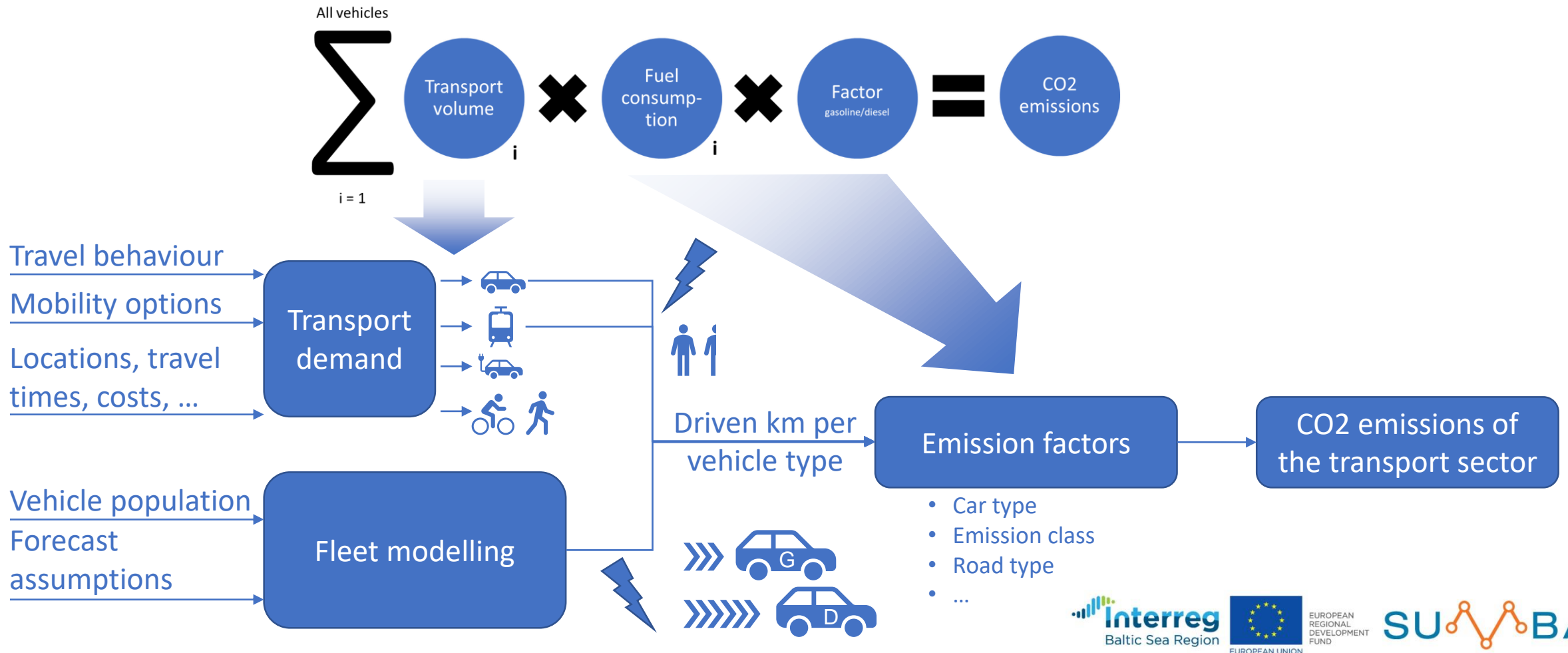
A vehicle's CO<sub>2</sub> emissions depend directly on its fuel consumption:  
Burning one liter of gasoline releases 2.33 kg CO<sub>2</sub>, one liter of diesel 2.65 kg CO<sub>2</sub>. No catalytic converter and no filter will help!

All vehicles



$i = 1$

# Modelling CO2 emissions of passenger transport relies on a number of models and assumptions





# Emission factors

## HBEFA – Handbook of Emission Factors

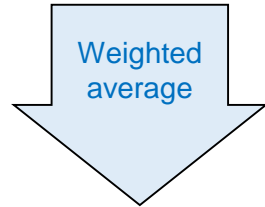
- COPERT and HBEFA are quite similar in features
- HBEFA allows easier access to data
- Norway and France and EC JRC now also support the use of HBEFA
- Both providing “real-world” emission factors
- For some nations uncertainties in fleet composition

⇒ Notice: COPERT and HBEFA stem from the same original data harmonization (ERMES European Research on Mobile Emission Sources)

### Vehicle emission models usage in Europe



# Extracting data for customized passenger car fleets



- HBEFA provides data that allow customizing to your fleet
- Important features are:
  - three road types (urban, sub-urban and highway)
  - Technological subsegments (fuel, EURO class)
  - Bio-fuel share considered or not (CO2)
  - Energy consumed fossil and electricity
  - Cold-start emissions
  - and many more (traffic situation, gradient etc.)
- Before compiling data, one need to decide what features are relevant and how to use them, e.g.:
  - do I need road-type differentiation?
  - will I modify bio-fuel content?
  - will I modify fleet composition?
- **Percent of Subsegment is key for customization!**

VehCat	Year	Compon	RoadCa	Subsegment	%OfSub	EFA	EFA_ag
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin ECE-15'04	6,53E-05	201,7747	172,1947
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin conv other concepts	7,44E-05	201,7747	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Ucat	9,61E-05	201,7747	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin PreEuro 3WCat 1987-90	0,000981	192,9457	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-1	0,007423	192,7969	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-2	0,00969	195,9836	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-3	0,024298	192,1157	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-4	0,163966	181,7266	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-5	0,114961	166,1717	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-6ab	0,124399	163,969	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-6c	0,021374	163,5191	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-6d	0,007574	156,8532	
PKW	2020	CO2(total)	nicht-diffe	PKW Benzin Euro-6d-temp	0,037838	160,554	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-1	0,001546	194,0785	178,3476
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-2	0,004133	187,2148	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-3	0,018826	178,1493	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-3 (DPF)	0,000691	179,9308	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-4	0,01656	183,7499	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-4 (DPF)	0,056089	183,7499	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-5	0,088084	172,9136	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-6c	0,023163	181,3822	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-6ab	0,152949	177,6226	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-6d-temp	0,037963	178,7035	
PKW	2020	CO2(total)	nicht-diffe	PKW Diesel Euro-6d	0,00716	176,4435	
PKW	2020	CO2(total)	nicht-diffe	PKW diesel Euro-5 EA189 nach Soft	0,055676	179,5795	

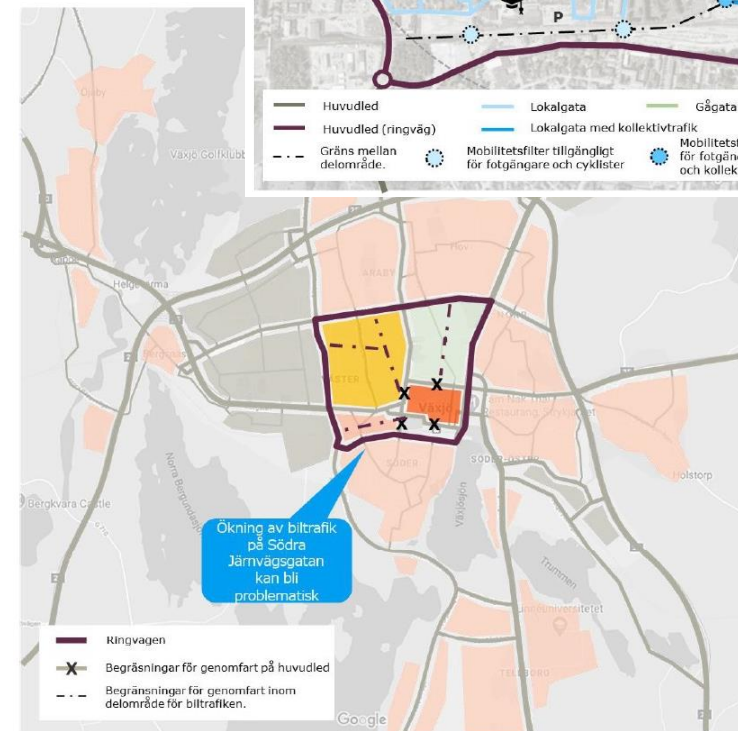
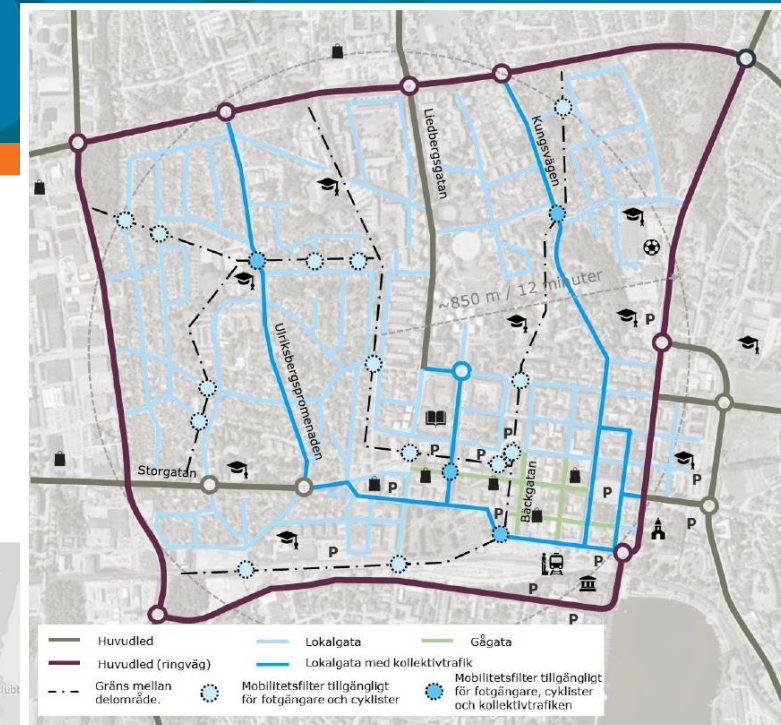
# Circulation plan for the City of Växjö

## Primary goal

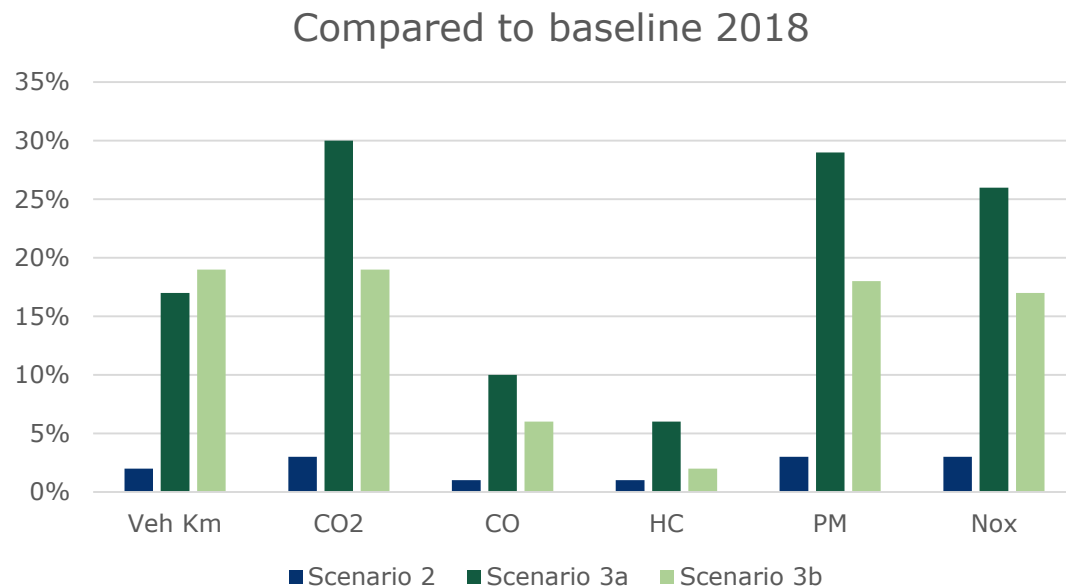
- Promote sustainable travel and a more attractive city by providing a higher traffic safety environment for pedestrians and cyclists by controlling car traffic

## Secondary goal

- Decrease car usage and promote other travel modes
- Improve the opportunities for children to get to school by walking or biking, and to be able to move freely within the city
- Free the traffic environment from car traffic in favor of other traffic modes or purposes



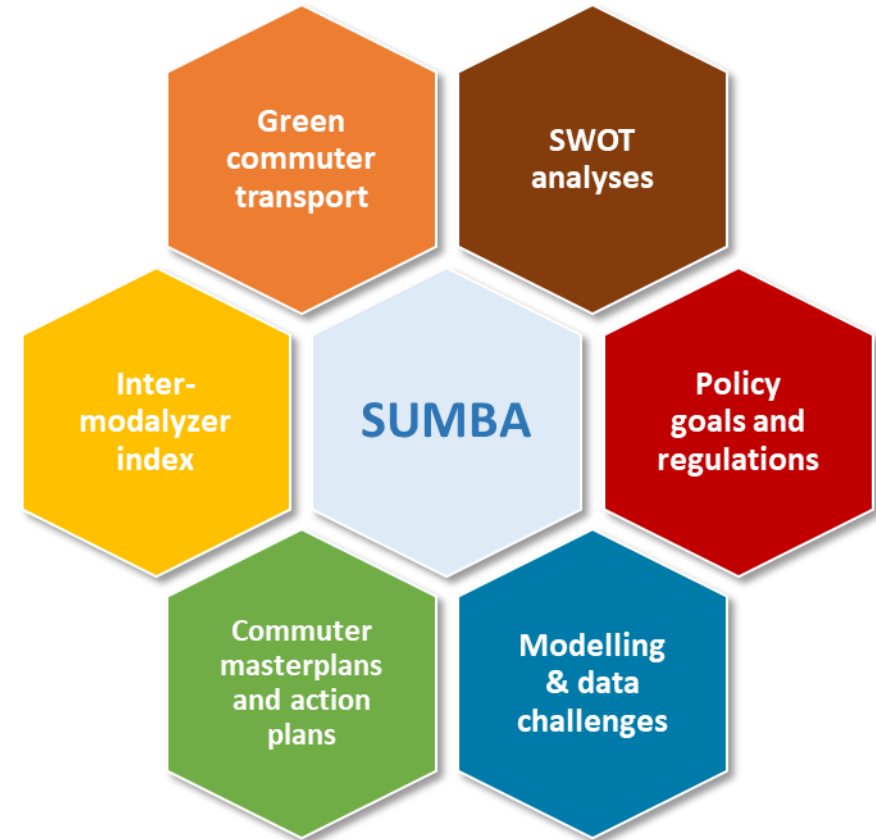
# Circulation plan for the City of Växjö – Results & conclusions



- Transport system is complex and measures can have a variety of effects
- Congestion has a high impact
- Cold start share has a significant effect on the results
- Fleet compositions are endless and can change quickly depending on Government laws and regulations as well as fuel prices

# Take home messages

- CO<sub>2</sub> emissions of the transport sector refer to tailpipe emissions (Tank-to-Wheel).
- Modelling CO<sub>2</sub> emissions of the transport sector can be done in different levels of detail ⇒ Good assumptions are a starting point and can be gradually replaced by more detailed assumptions or models.
- Estimating CO<sub>2</sub> emissions gives you a better understanding of the impacts of your transport system, possible development paths as well as effects of measures.
- If a transport model is already available, much of the work is already done.



# Thank you for your attention - and get in touch!

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