

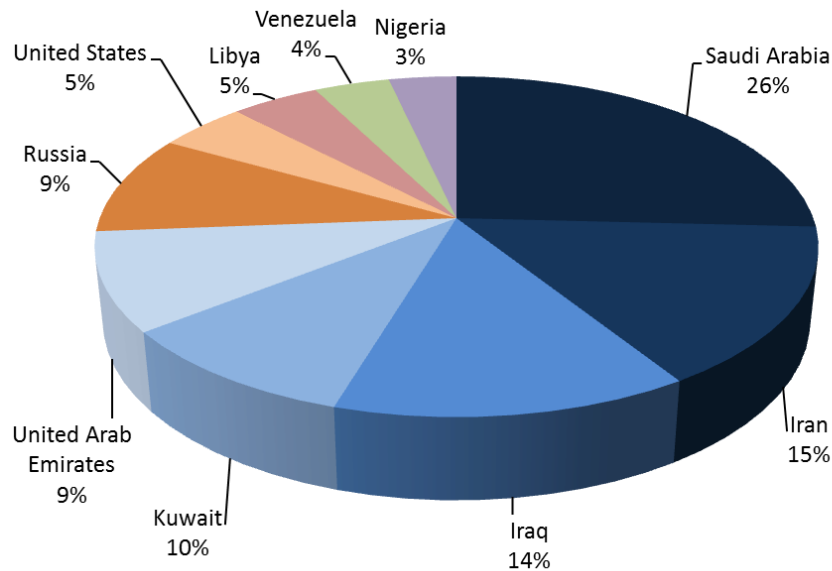
Electrification in Transport: Economic and Environmental Aspects

Amela Ajanovic
Energy Economics Group
Vienna University of Technology

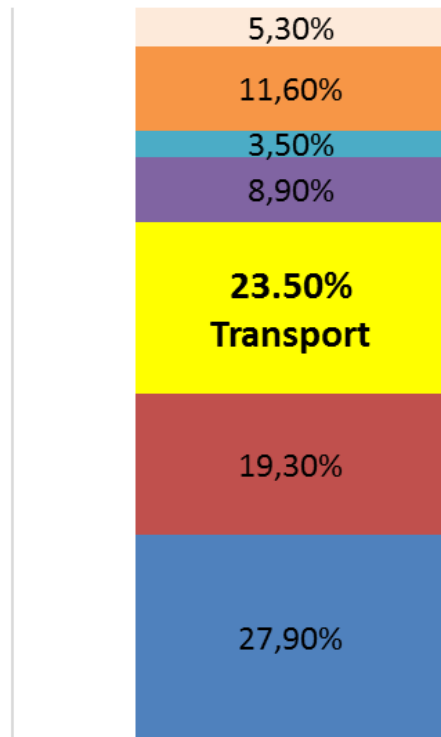
IAEE, Ljubljana, 27.8.2019

- Introduction
- Policy framework
- Electric vehicles
 - Economic assessment
 - Environmental assessment
- Conclusion

- **93%** oil products' share of final energy consumption for transport, making the sector the **least-diversified**



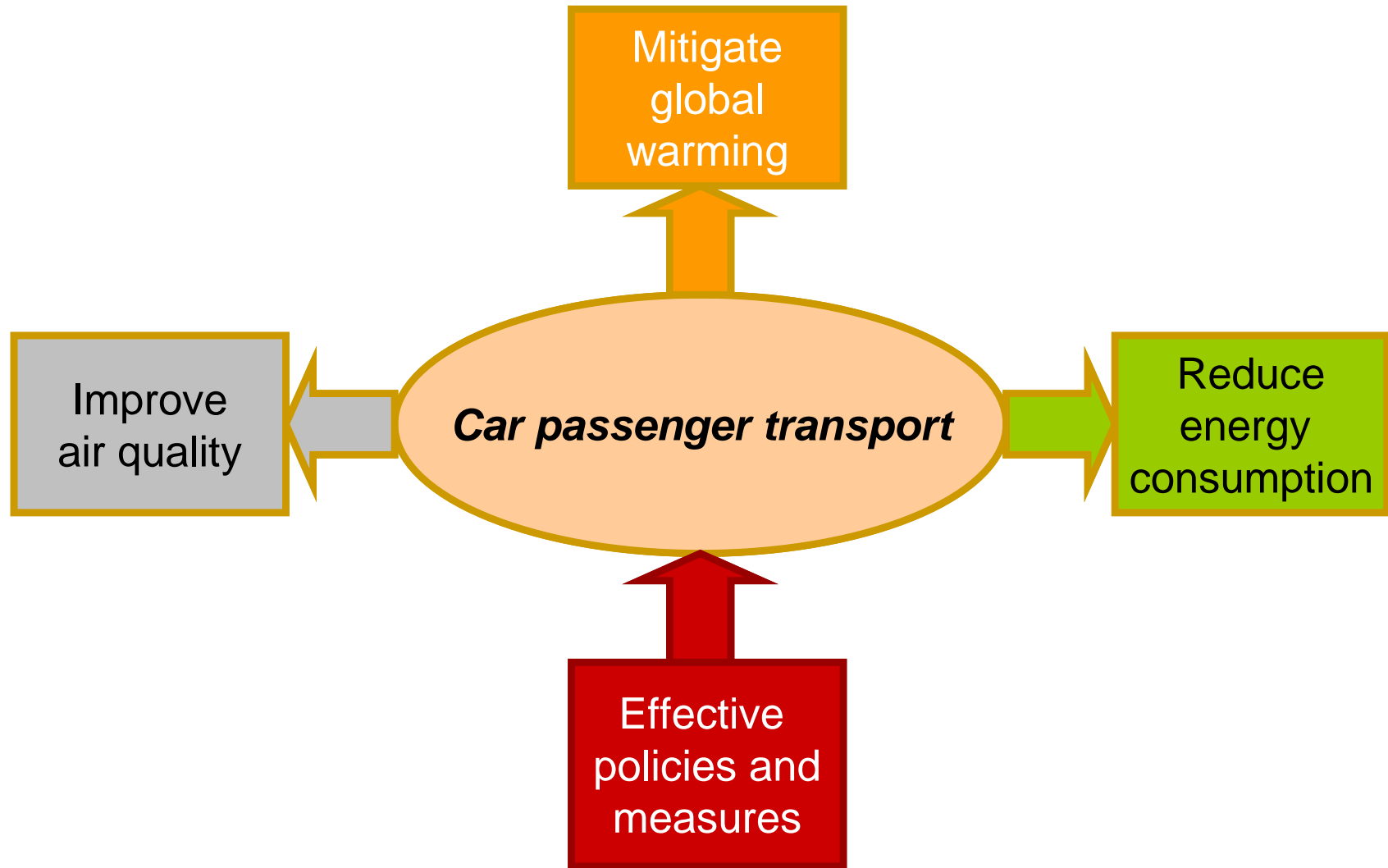
Countries with largest
conventional oil
reserves

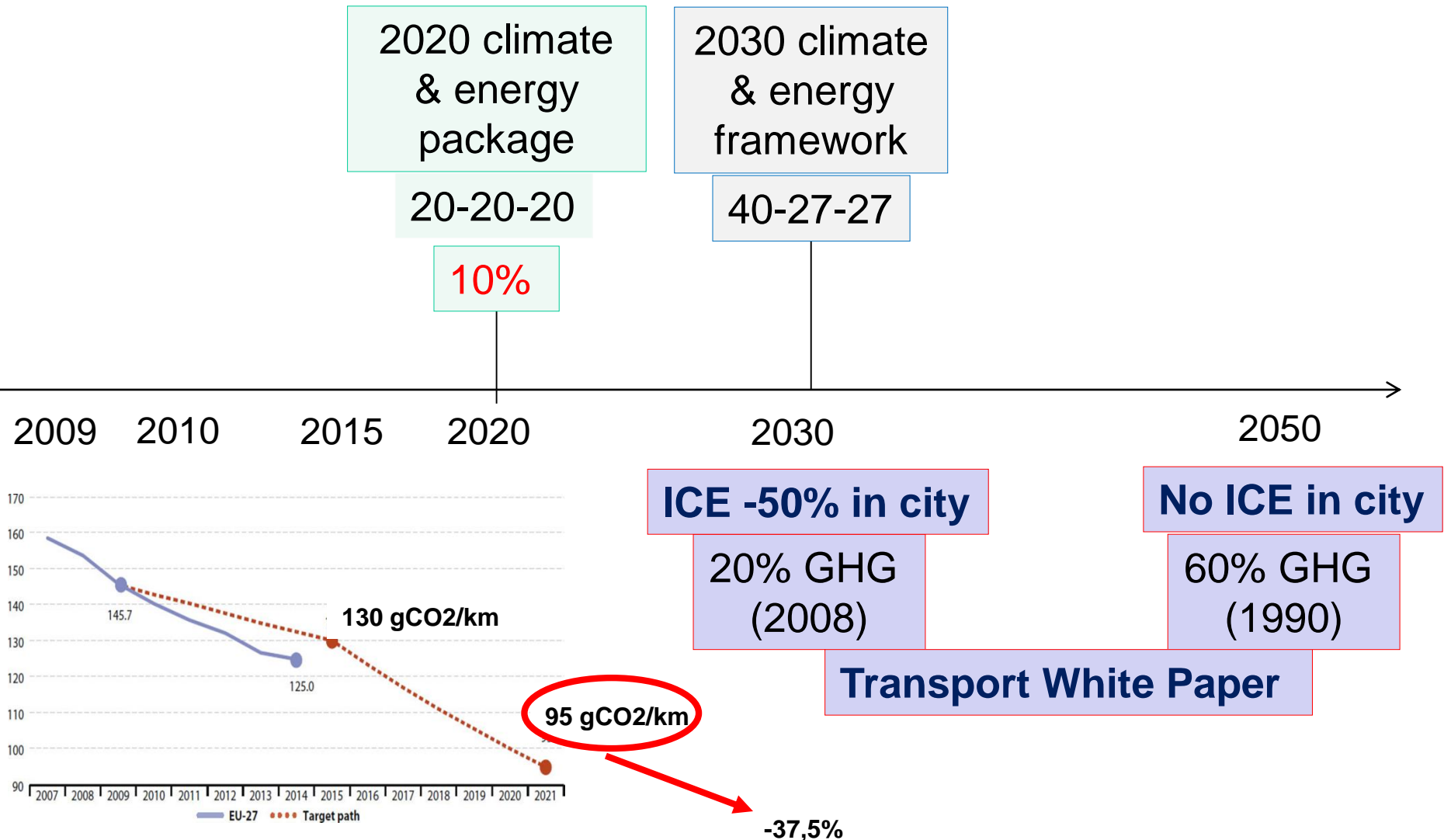


ALL SECTORS

- | | | | |
|----------------------------|----------------------------------|-------------------------|-----------------------|
| ■ Energy industries | ■ Industry | ■ Transport | ■ Residential |
| ■ Commercial/institutional | ■ Agriculture, forest, fisheries | ■ Other sectors | ■ Road transportation |
| ■ Other transport modes | ■ Cars | ■ Other transport means | |

The challenges for EU climate and energy policies

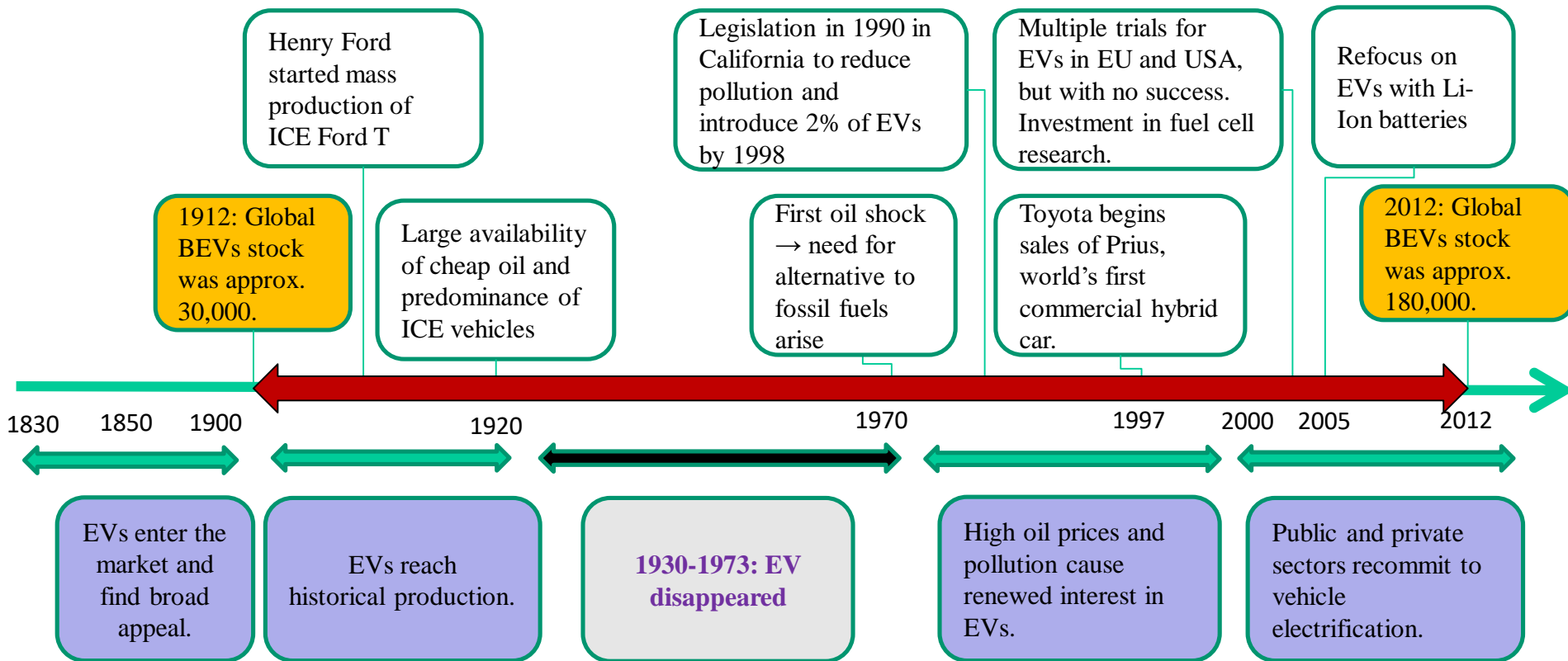


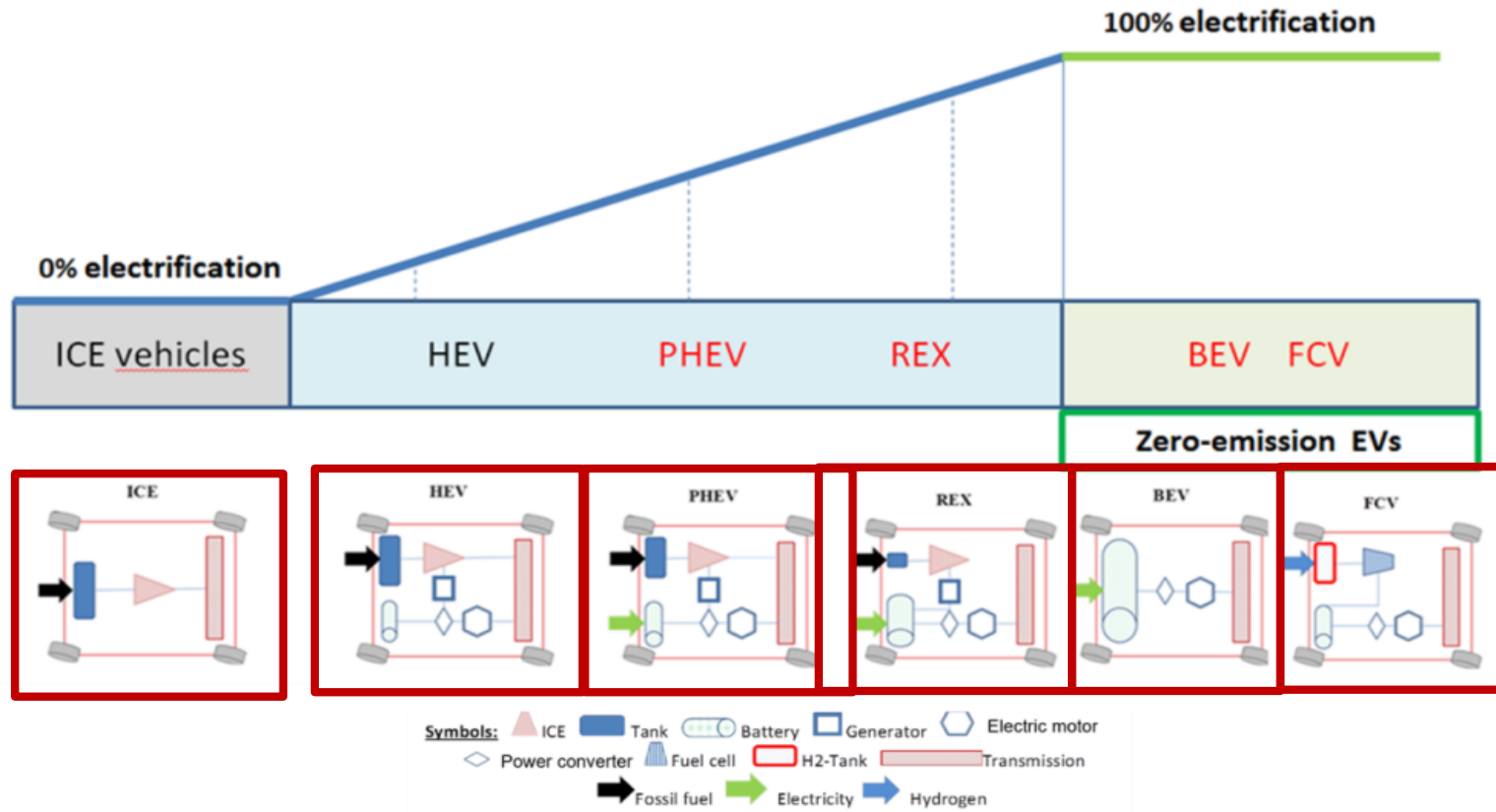


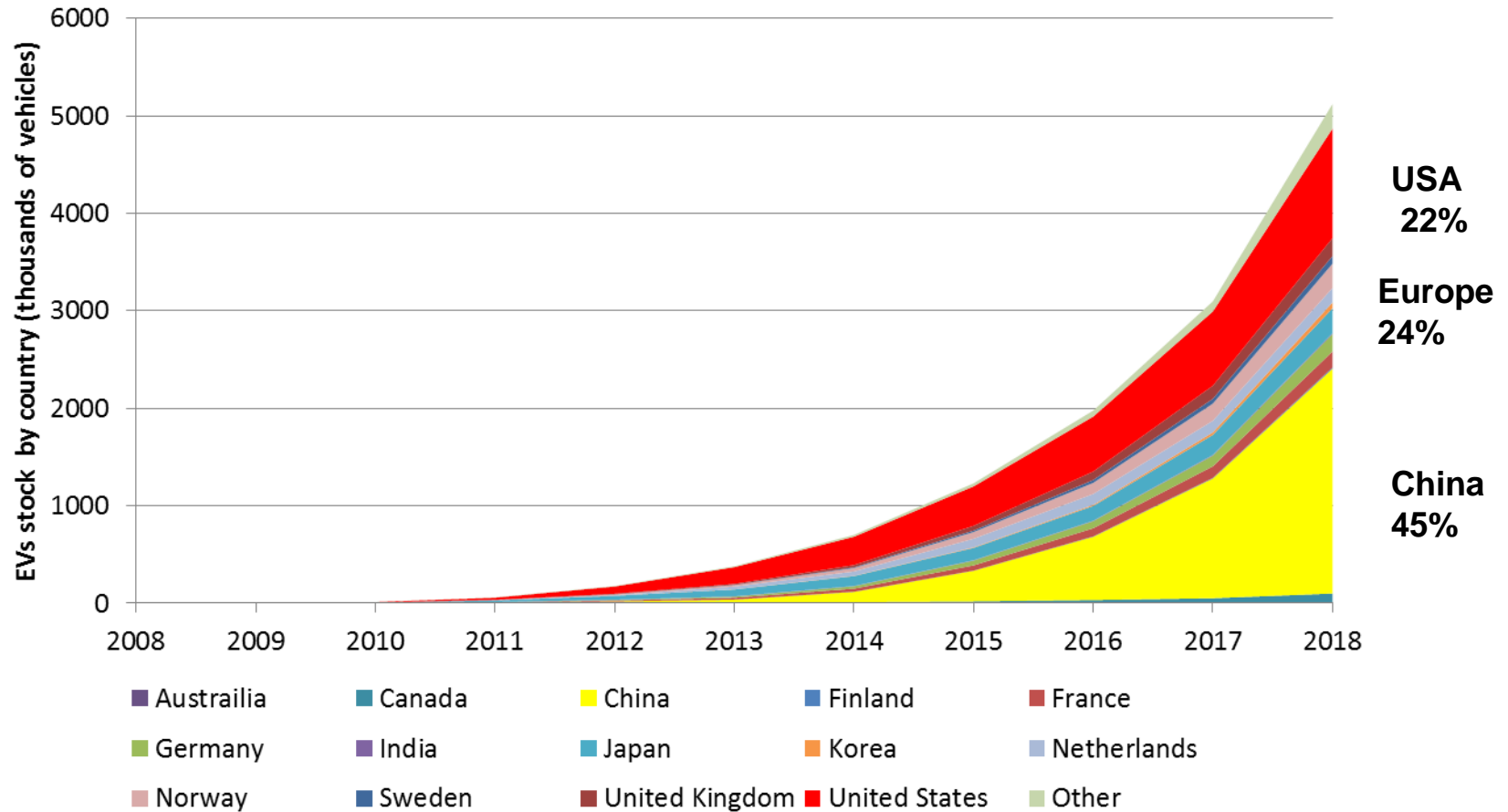
Targets and average CO₂ emissions from new passenger cars in EU countries

Paris Declaration on Electro-Mobility and Climate Change & Call to Action:

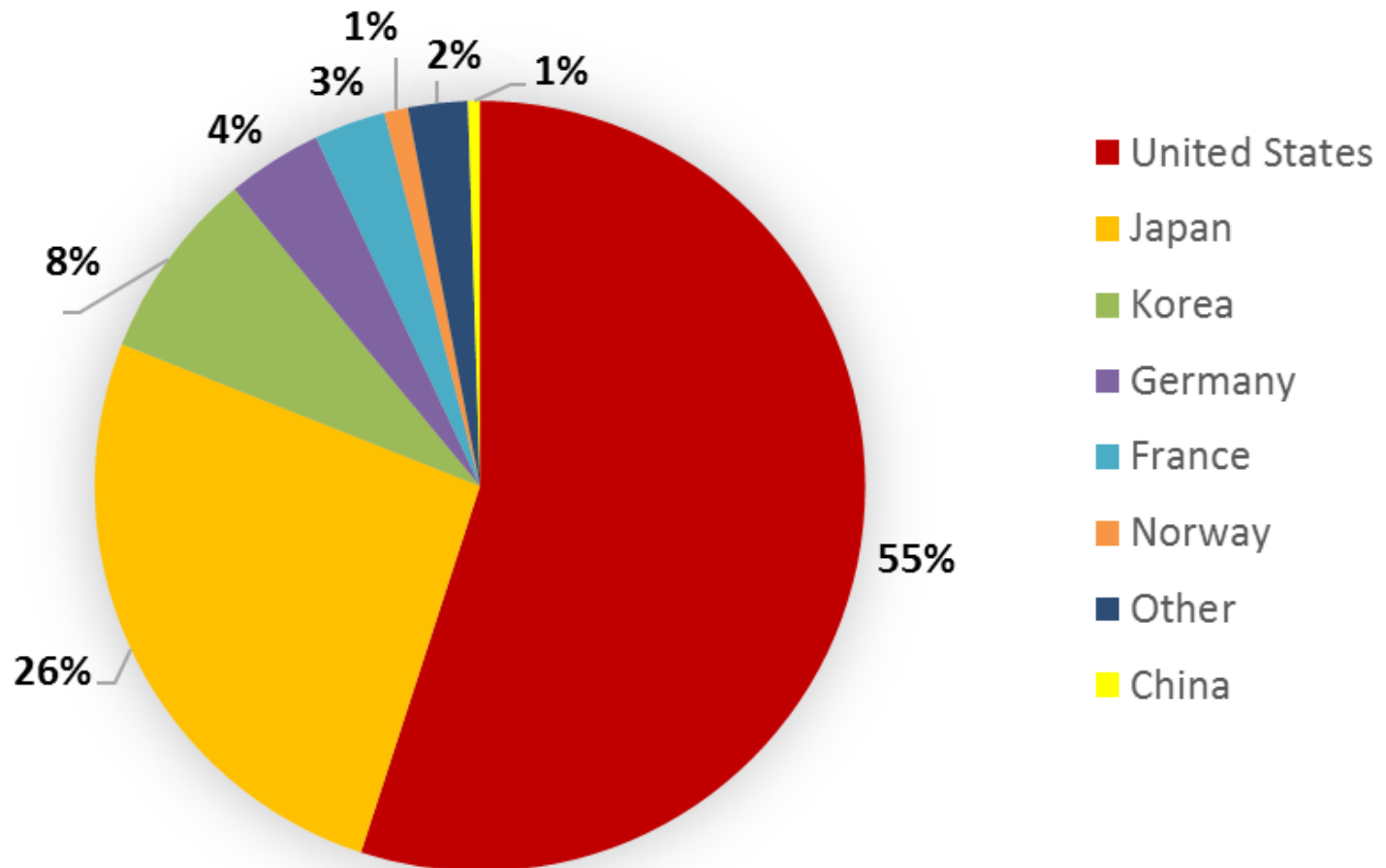
- more than 100 million EVs
- 400 million two and three-wheelers





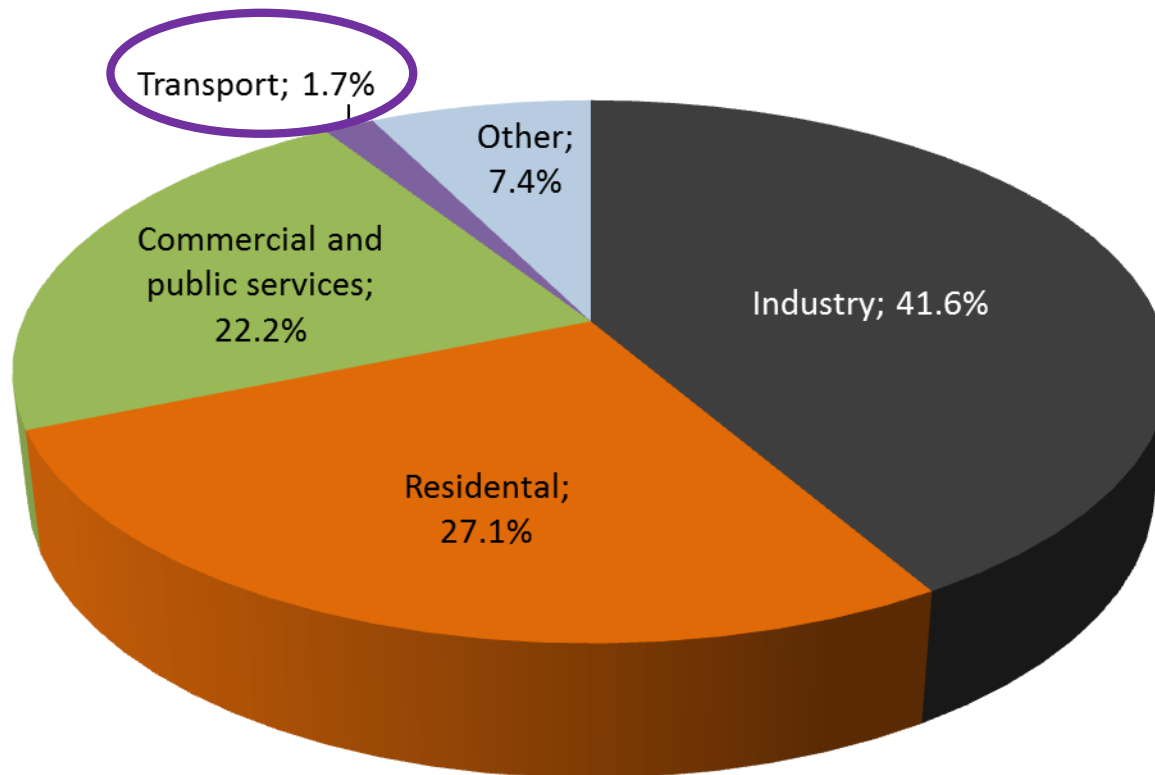


Development of the global stock of rechargeable EVs



Fuel cell electric passenger car stock: 11.200

World total final electricity consumption by sector



Advantages

- ✓ Energy efficiency
- ✓ Energy security
- ✓ Air pollution
- ✓ Noise reduction

Disadvantages

- Costs
- Driving range
- Charging time
- Charging infrastructure

The costs per km driven C_{km} are calculated as:

$$C_{km} = \frac{IC \cdot \alpha}{skm} + P_f \cdot FI + \frac{C_{O\&M}}{skm} \quad [\text{€/100 km driven}]$$

IC.....investment costs [€/car]

αcapital recovery factor

skm.....specific km driven per car per year [km/(car.yr)]

P_ffuel price incl. taxes [€/litre]

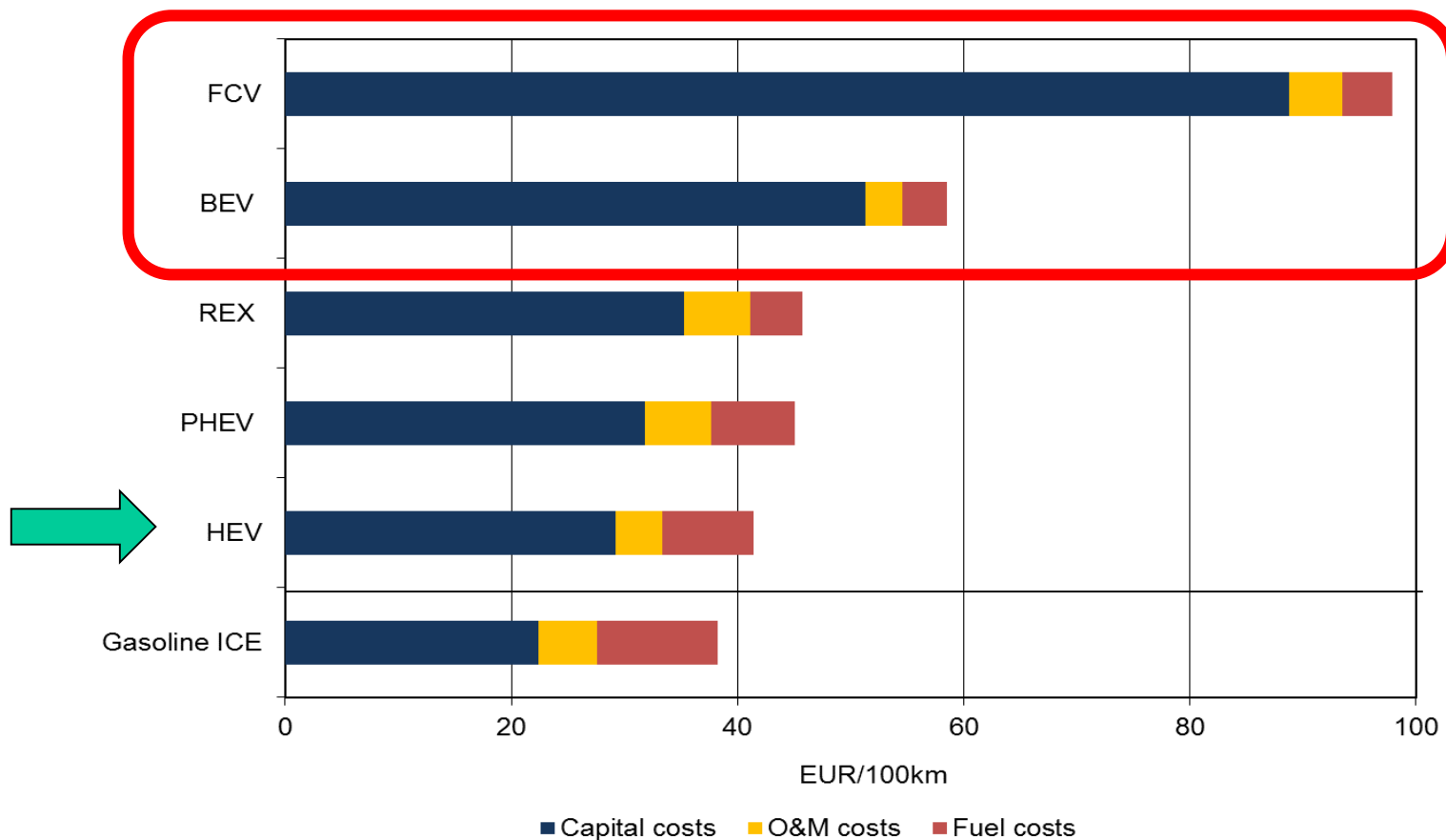
$C_{O\&M}$...operating and maintenance costs

FI.....fuel/energy intensity [litre/100 km; kWh/100 km]

A capital recovery factor (α) is the ratio of a constant annuity to the present value of receiving that annuity for a given length of time. Using an interest rate (z), the capital recovery factor is:

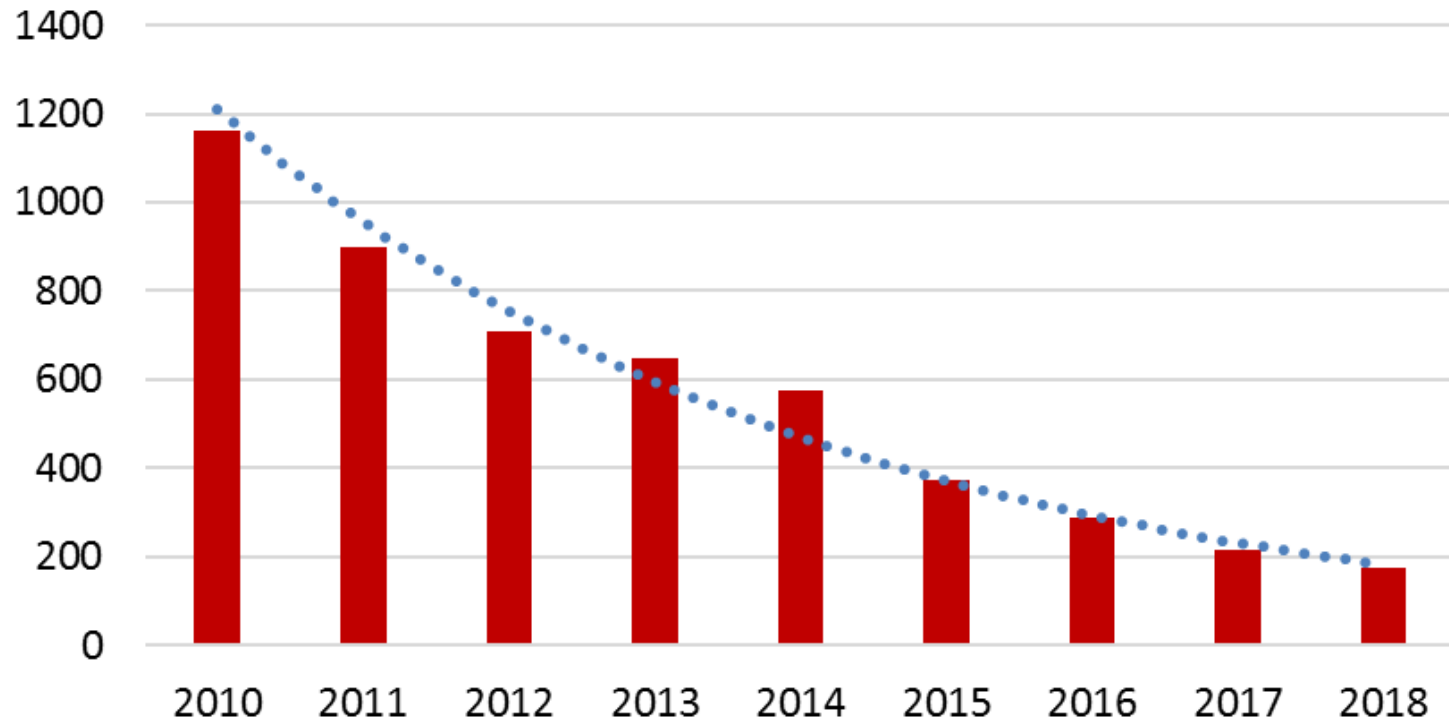
$$\alpha = \frac{z(1+z)^n}{(1+z)^n - 1}$$

n.....the number of annuities received.

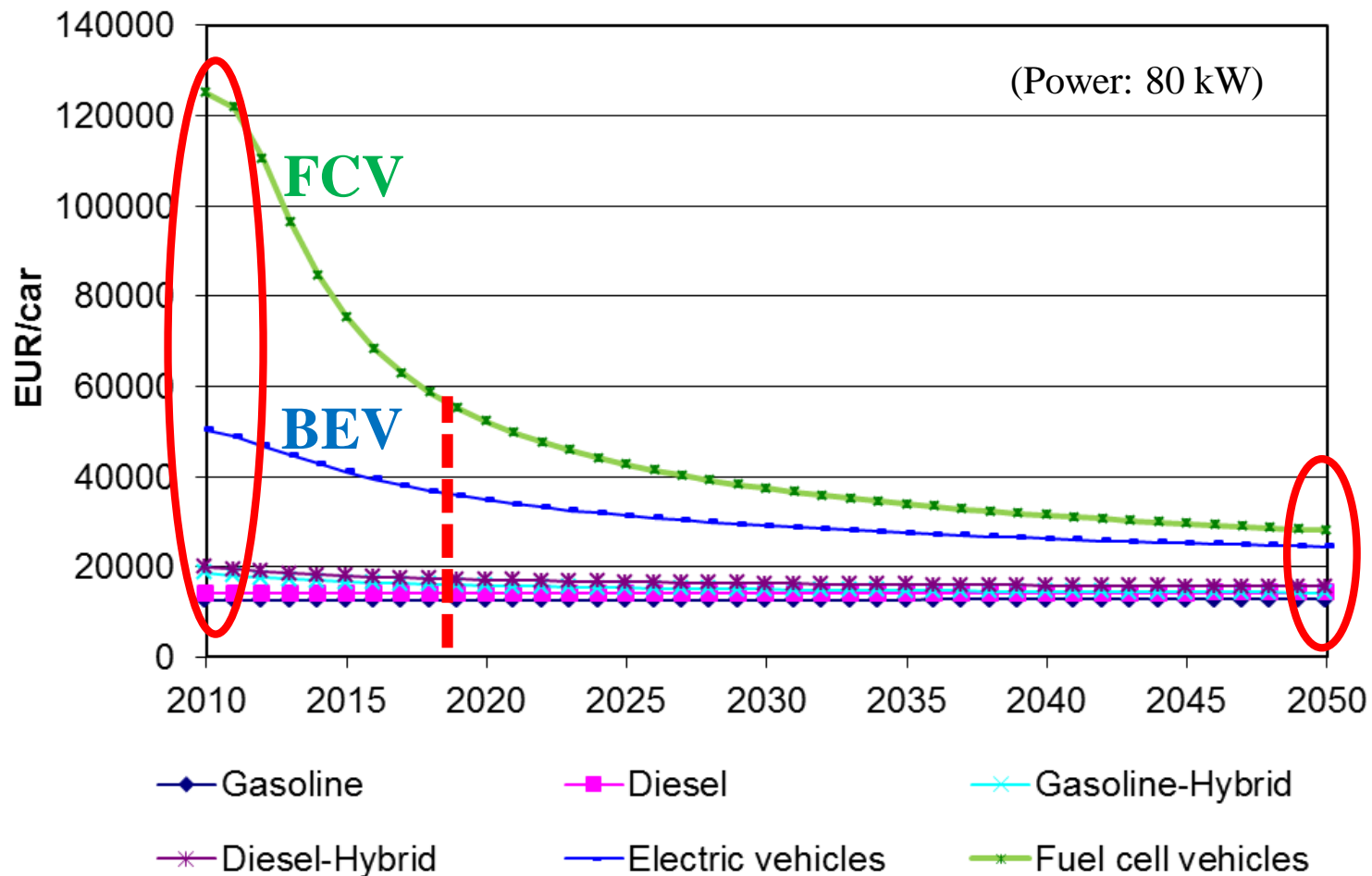


Total costs of service mobility of various types of EV in comparison to ICE cars

Battery pack price (\$/kWh)



Scenario for development of investment costs



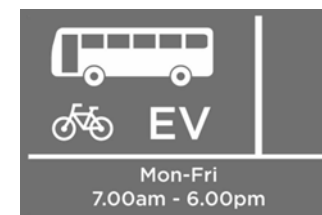
Monetary measures

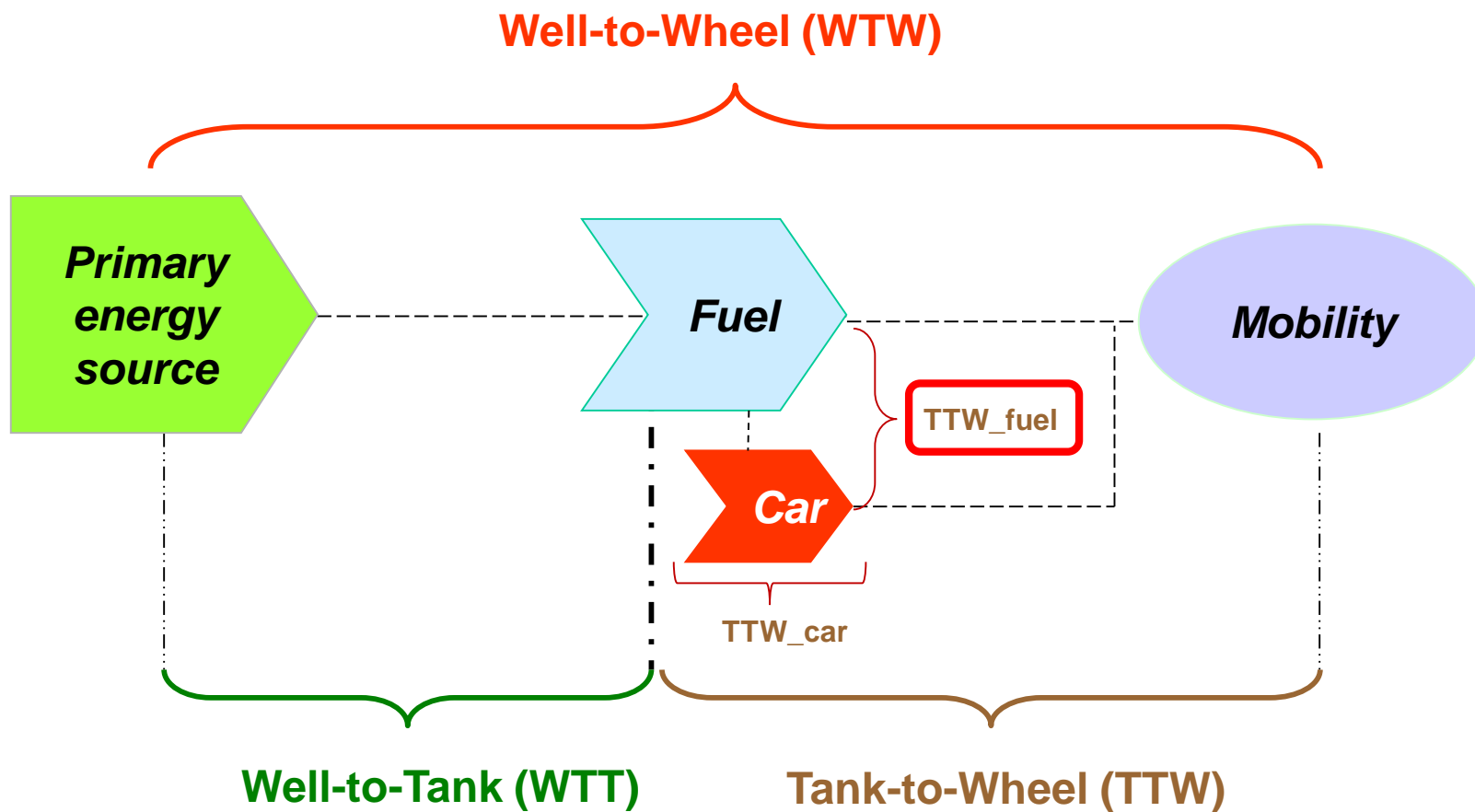
- road taxes
- annual circulation tax
- company car tax
- registration tax
- fuel consumption tax
- congestion charges

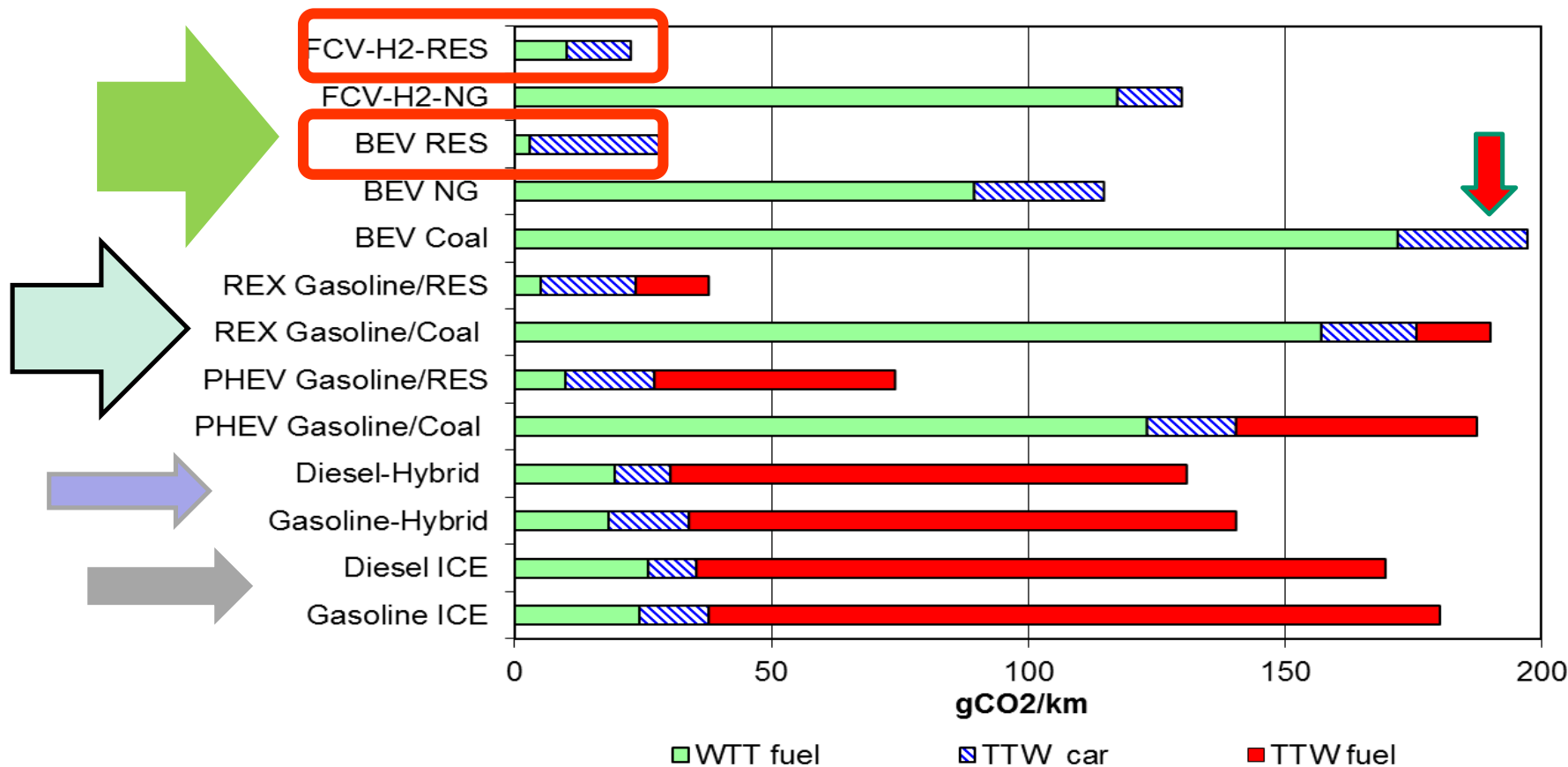


Non-monetary measures

- free parking spaces
- possibility for EVs drivers to use bus lanes
- wide availability of charging stations
- permission for EVs to enter city centers and zero emission zones

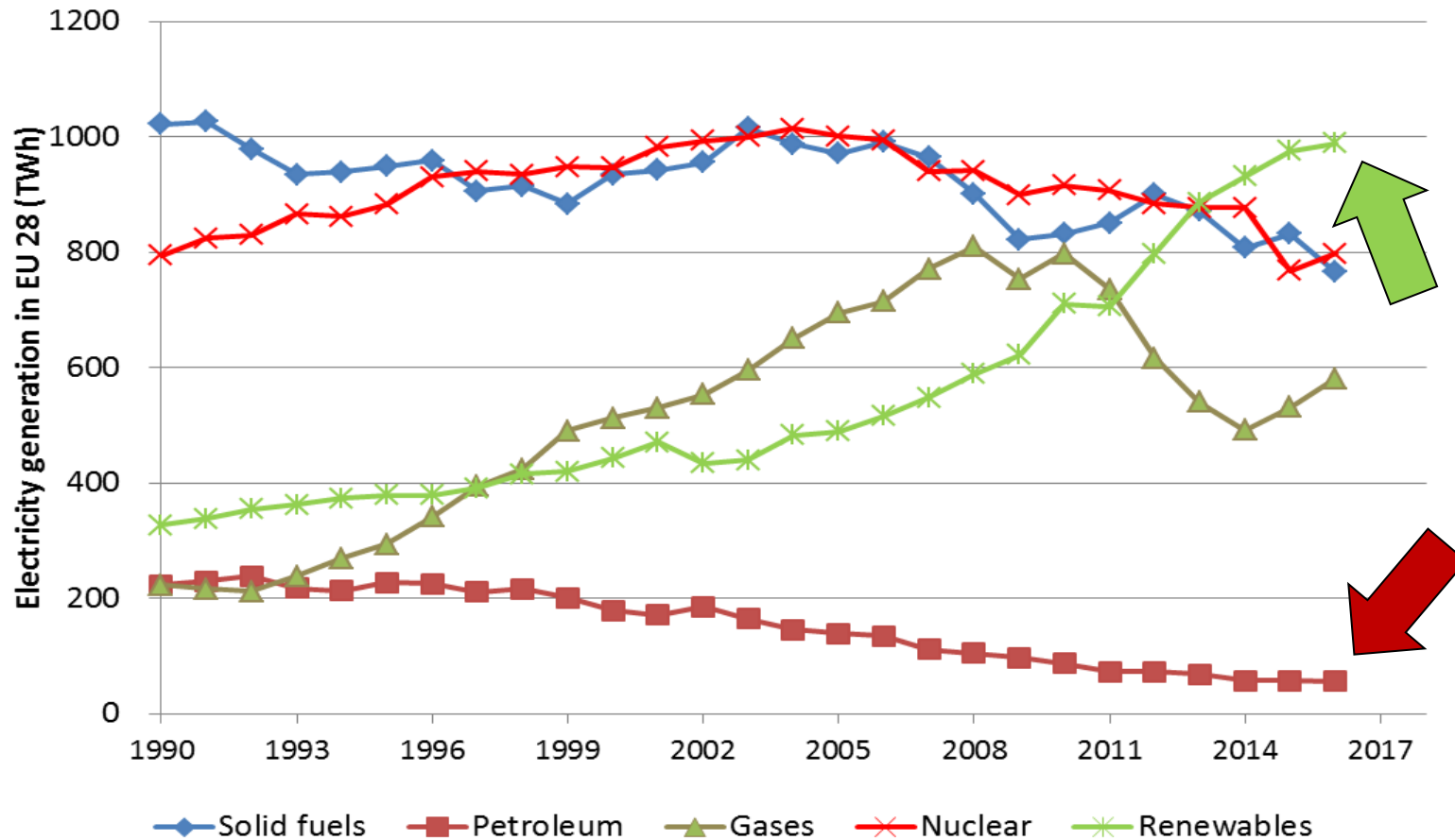




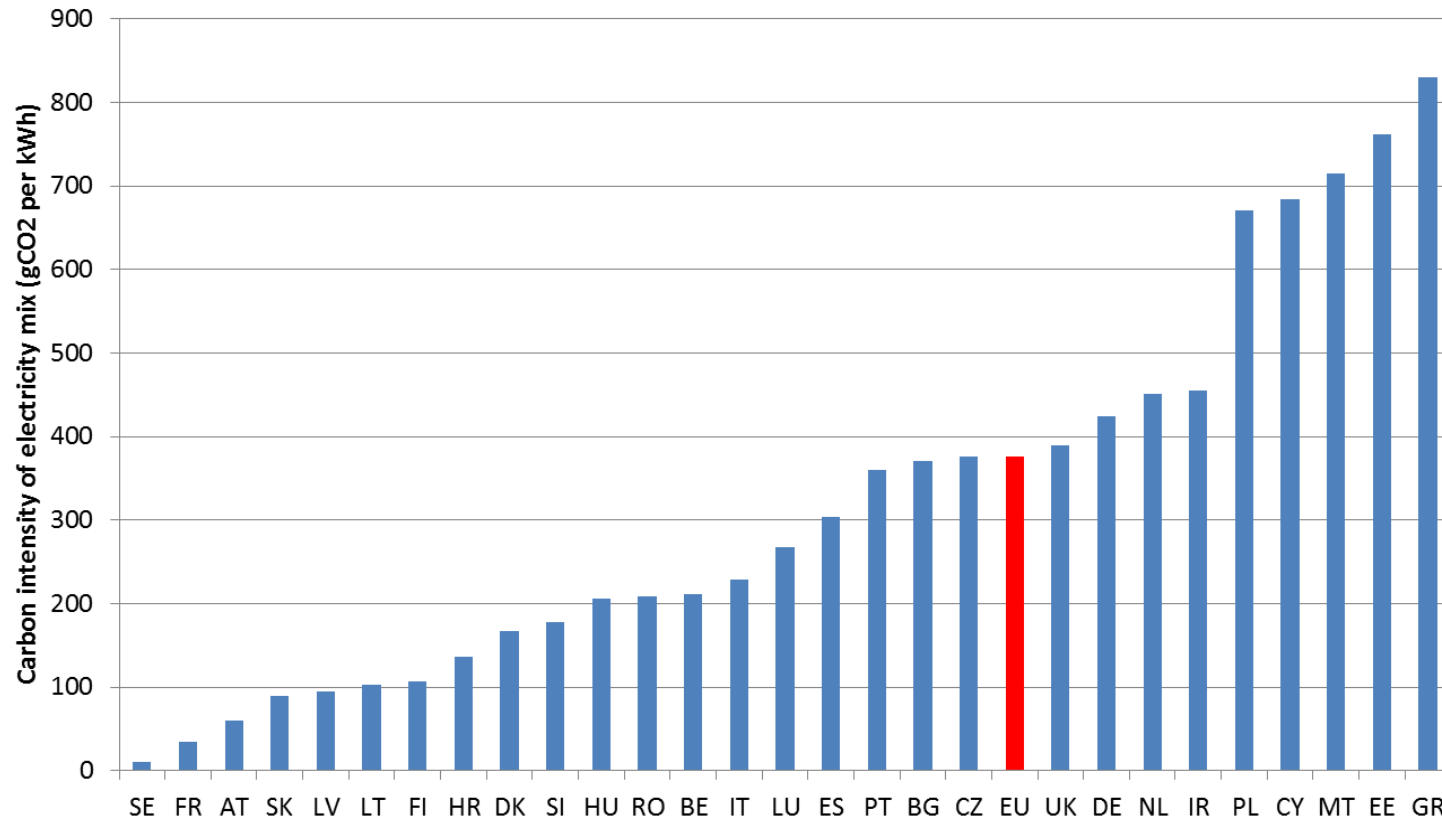


CO₂ emissions per km driven for various types of EV in comparison to conventional cars (power of car: 80kW)

Electricity generation in the EU 28

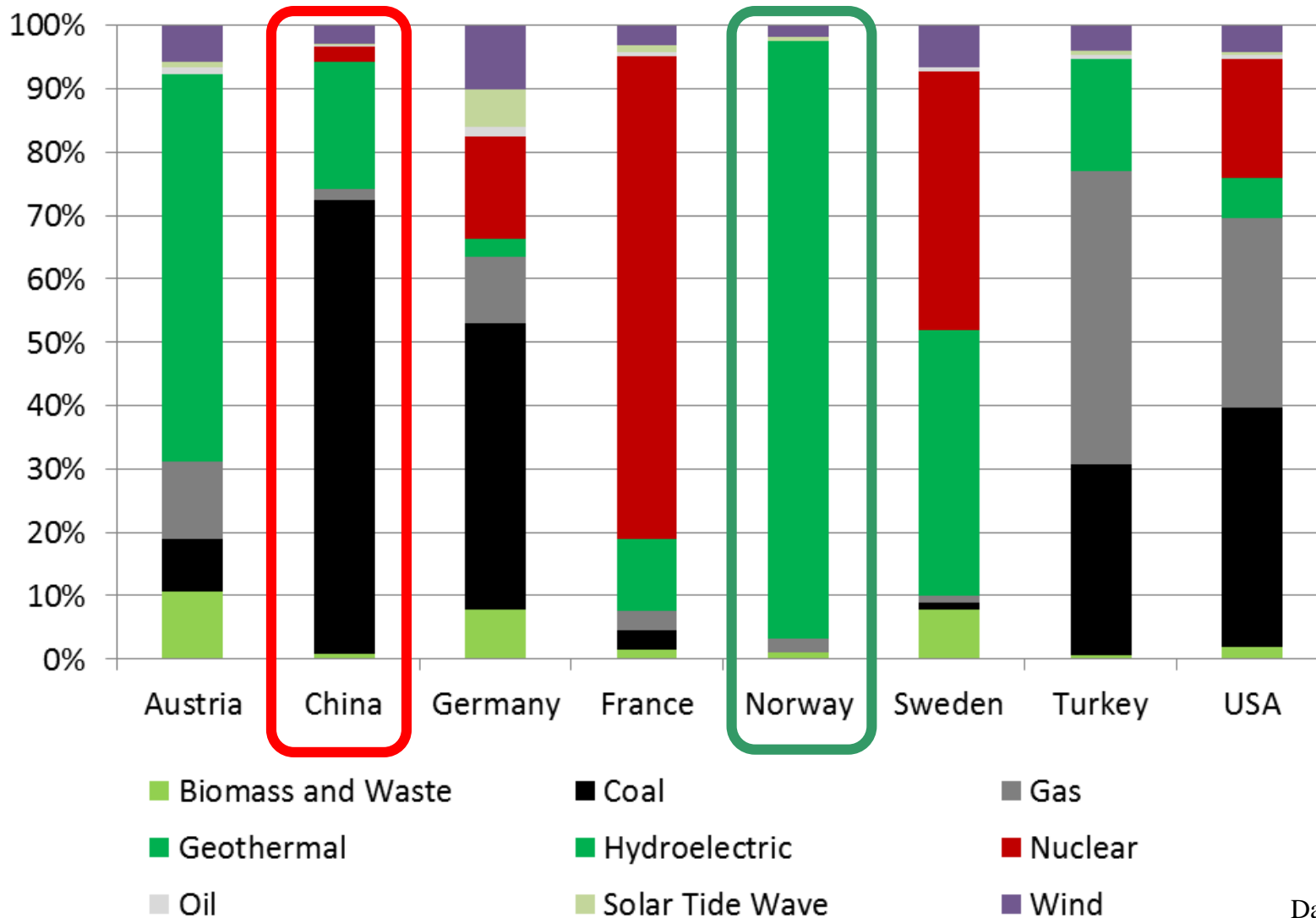


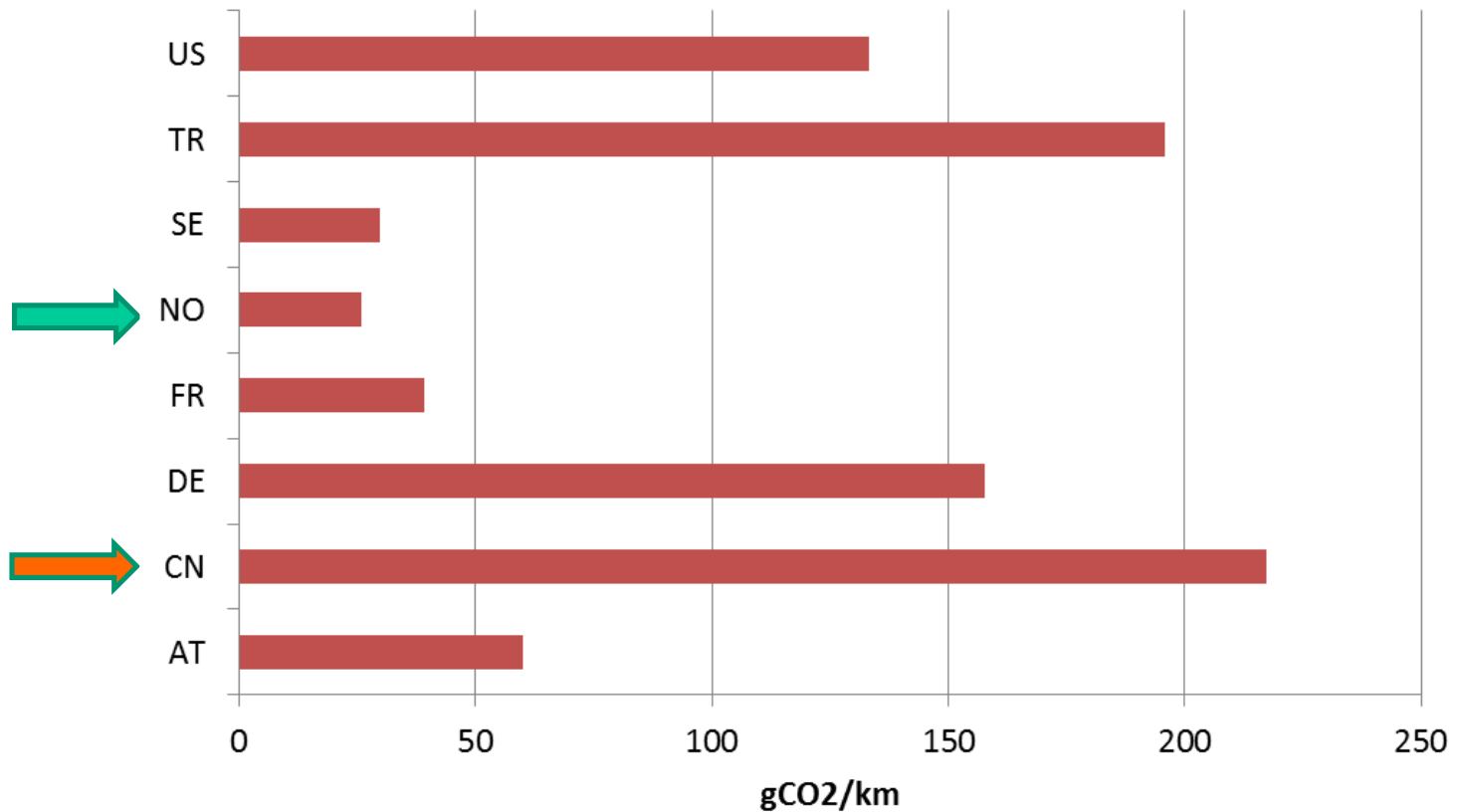
The carbon intensity of electricity mix



CO₂ per kWh electricity generated in different European countries, 2014

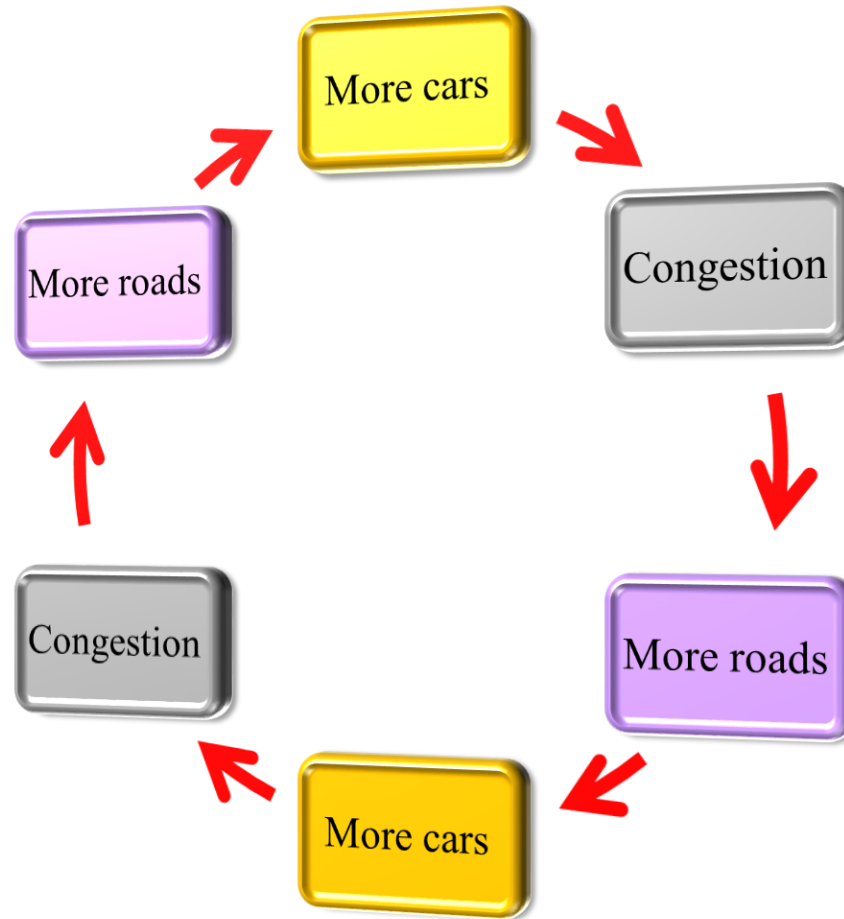
Electricity mix





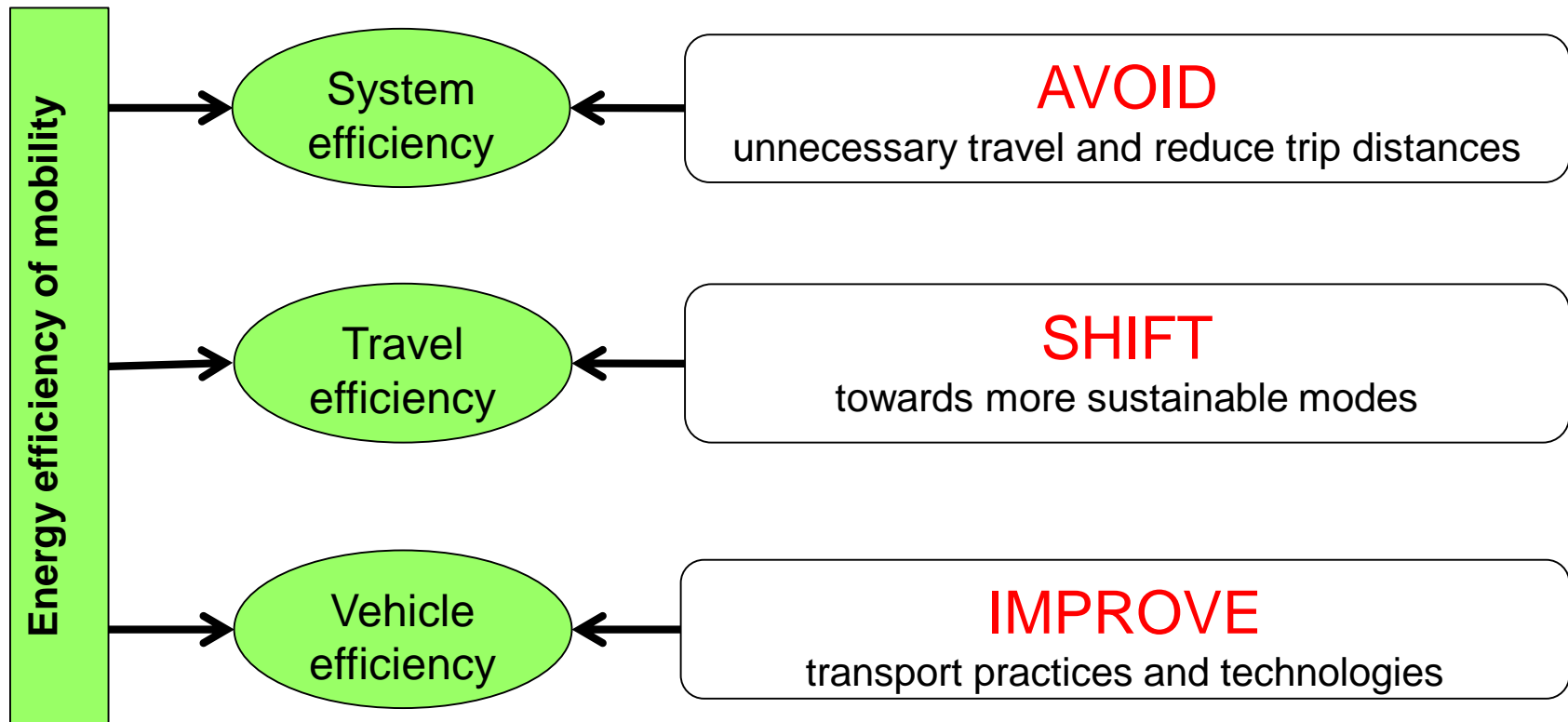
CO₂ emissions per km driven for BEVs powered by grid electricity in different countries

Car-oriented mobility





Car-oriented transport development



- EVs ...cost reductions, improvement of battery characteristics, as well as development of infrastructure
- Most of the policies implemented will be abolished with the increasing number of EVs
- Future policy design should ensure high environmental benefits of EVs.
- Full environmental benefit – only if EVs are powered by electricity generated from renewable energy source
- Challenge to provide clean carbon-free sources for electricity generation.
- New mobility behavior

ajanovic@eeg.tuwien.ac.at

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