Energy Transition in Transport
Role of Electric Vehicles

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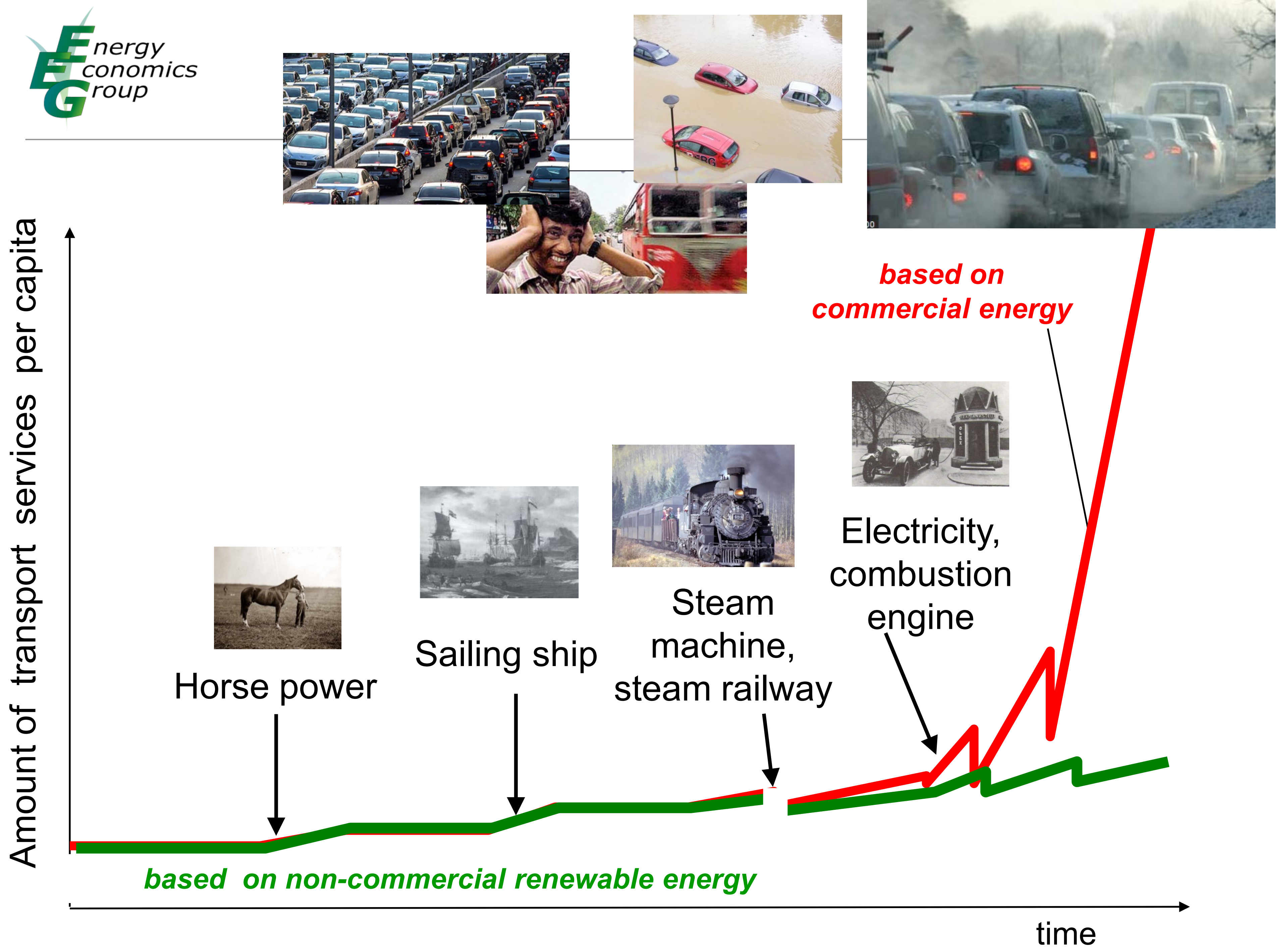

Energy Economics Group
Amount of transport services per capita
based on commercial energy
Electricity, combustion engine
Steam machine, steam railway
Sailing ship
Horse power
based on non-commercial renewable energy
time

Transport sector

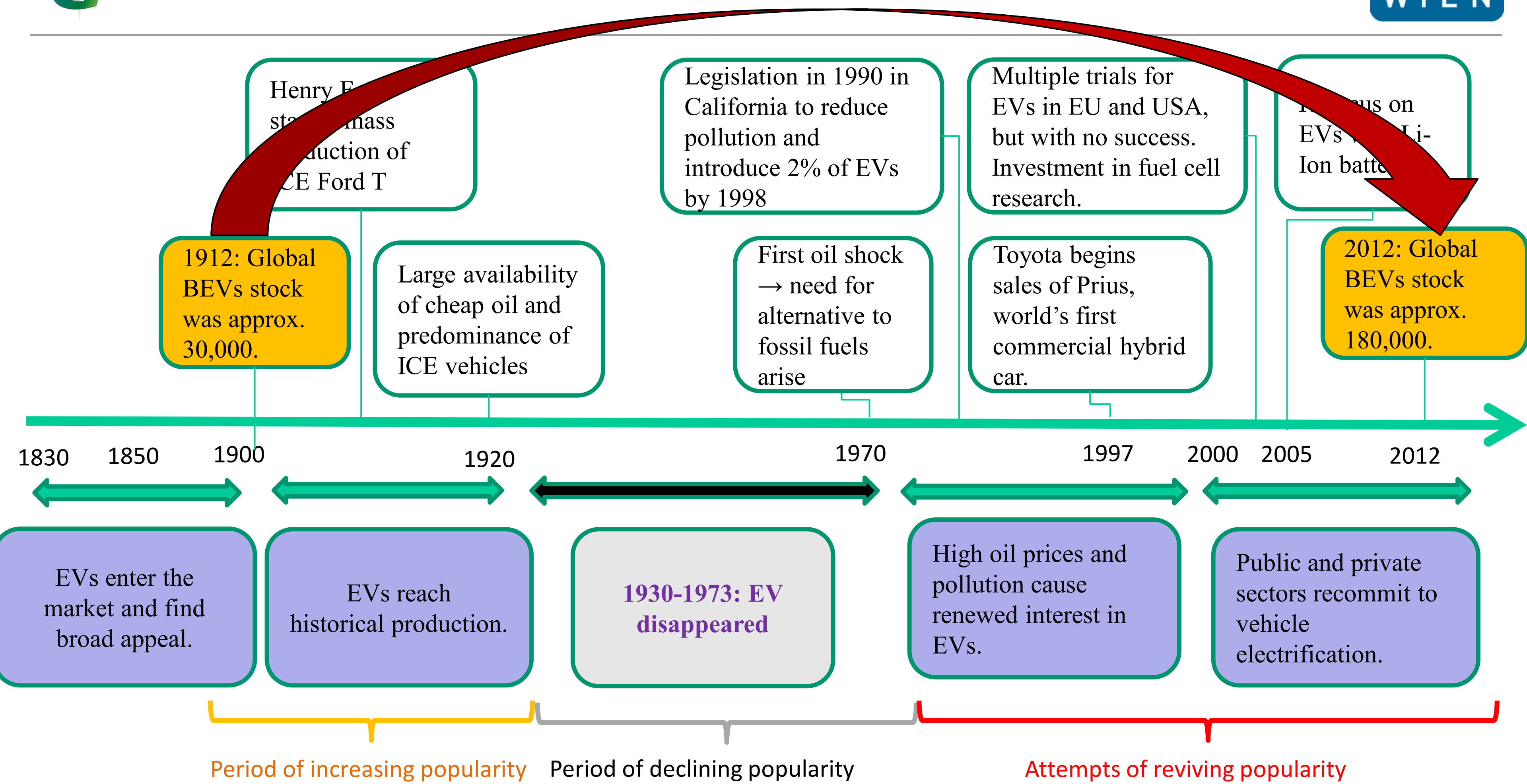
- oil products
- least-diversified
- energy import dependency

Electric vehicles

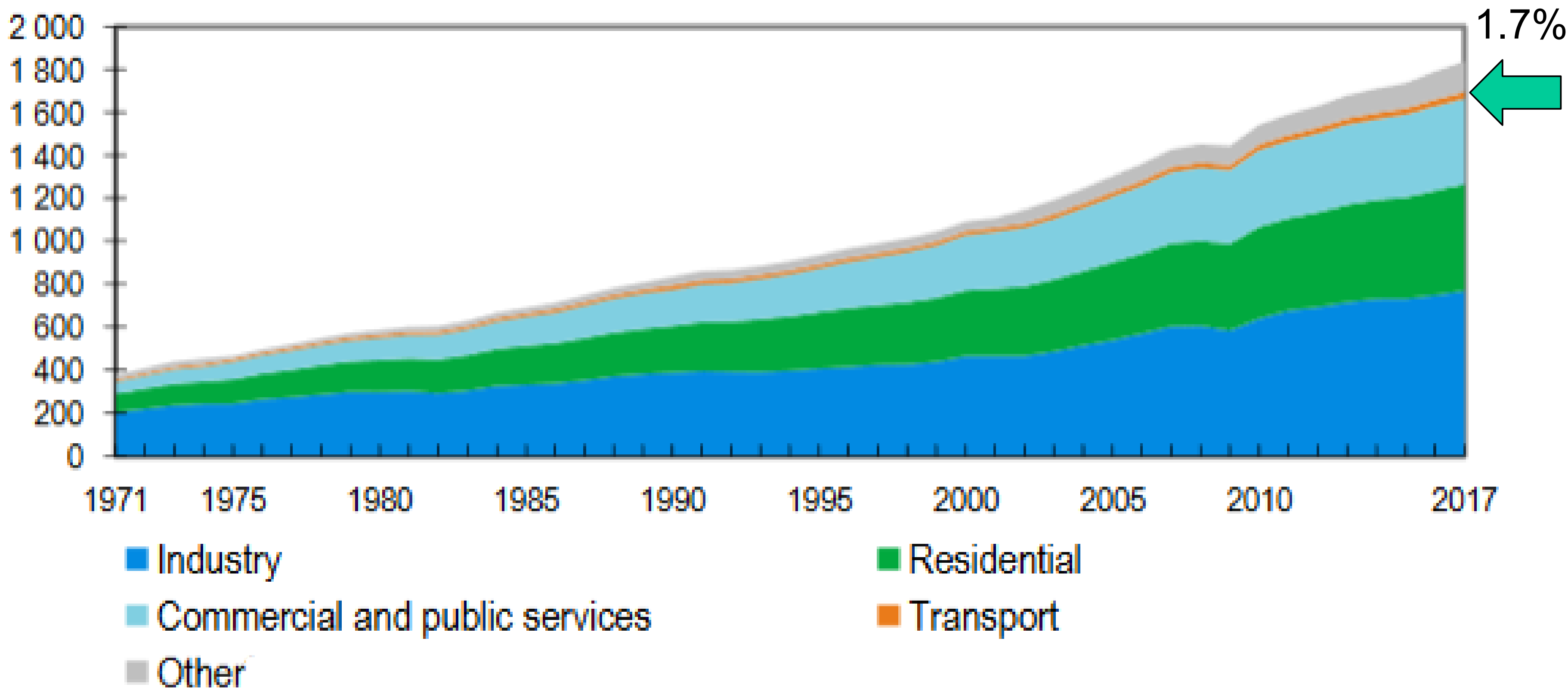
Paris Declaration on Electro-Mobility and Climate Change & Call to Action:

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

Electric vehicles

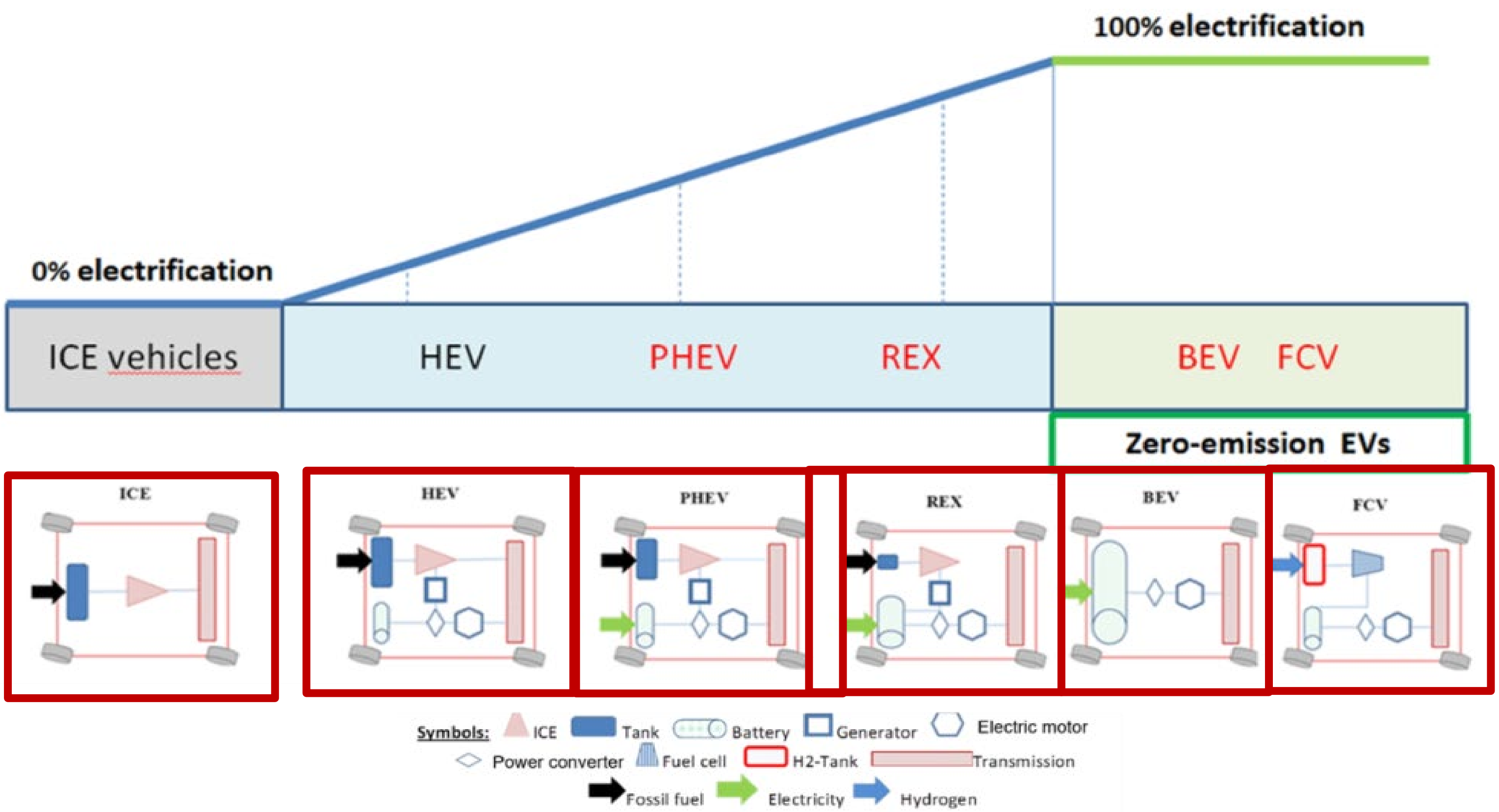


Total final electricity consumption by sector (Mtoe)

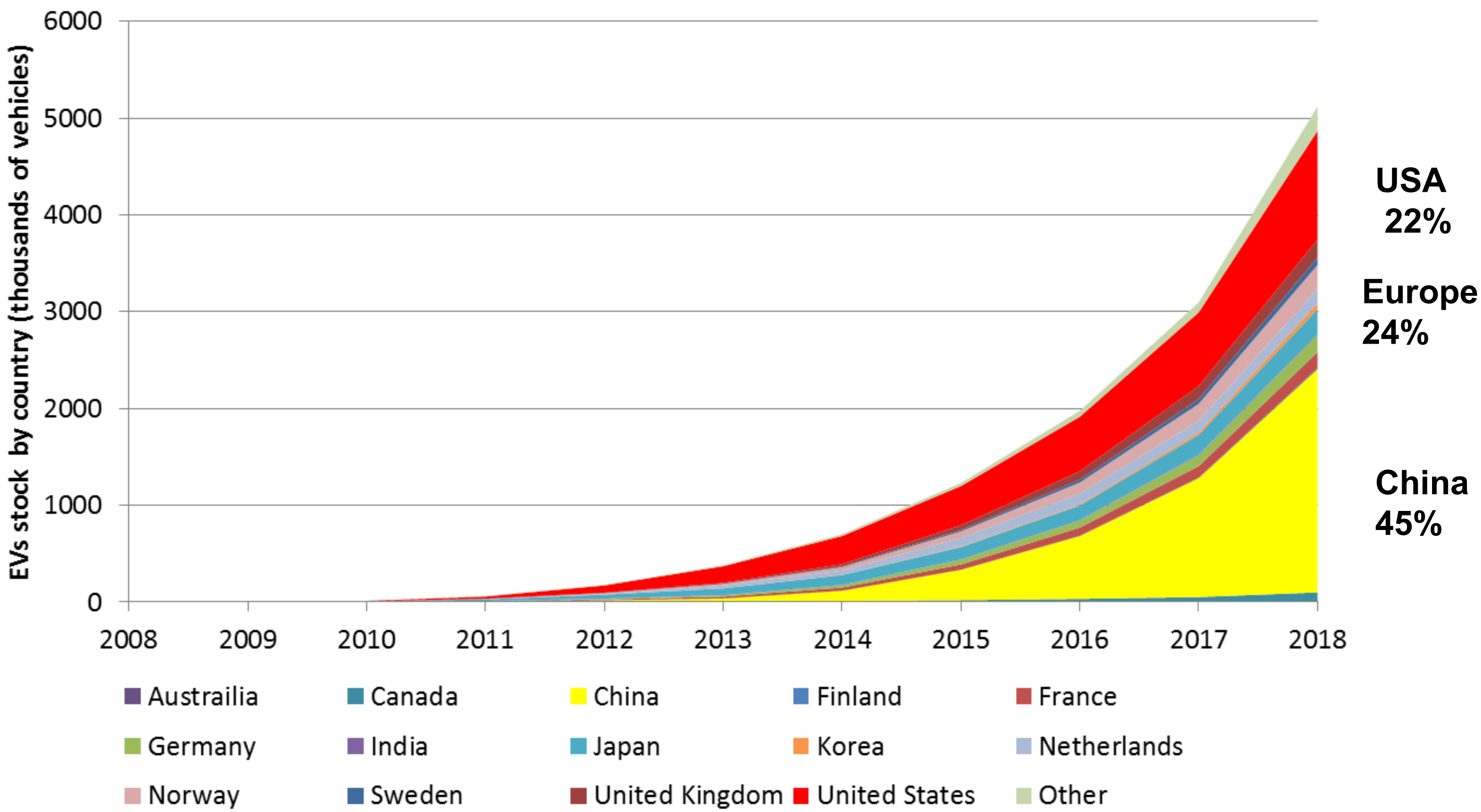


IEA, 2019

Electric vehicles



Electric vehicles



Development of the global stock of rechargeable EVs

Electric vehicles

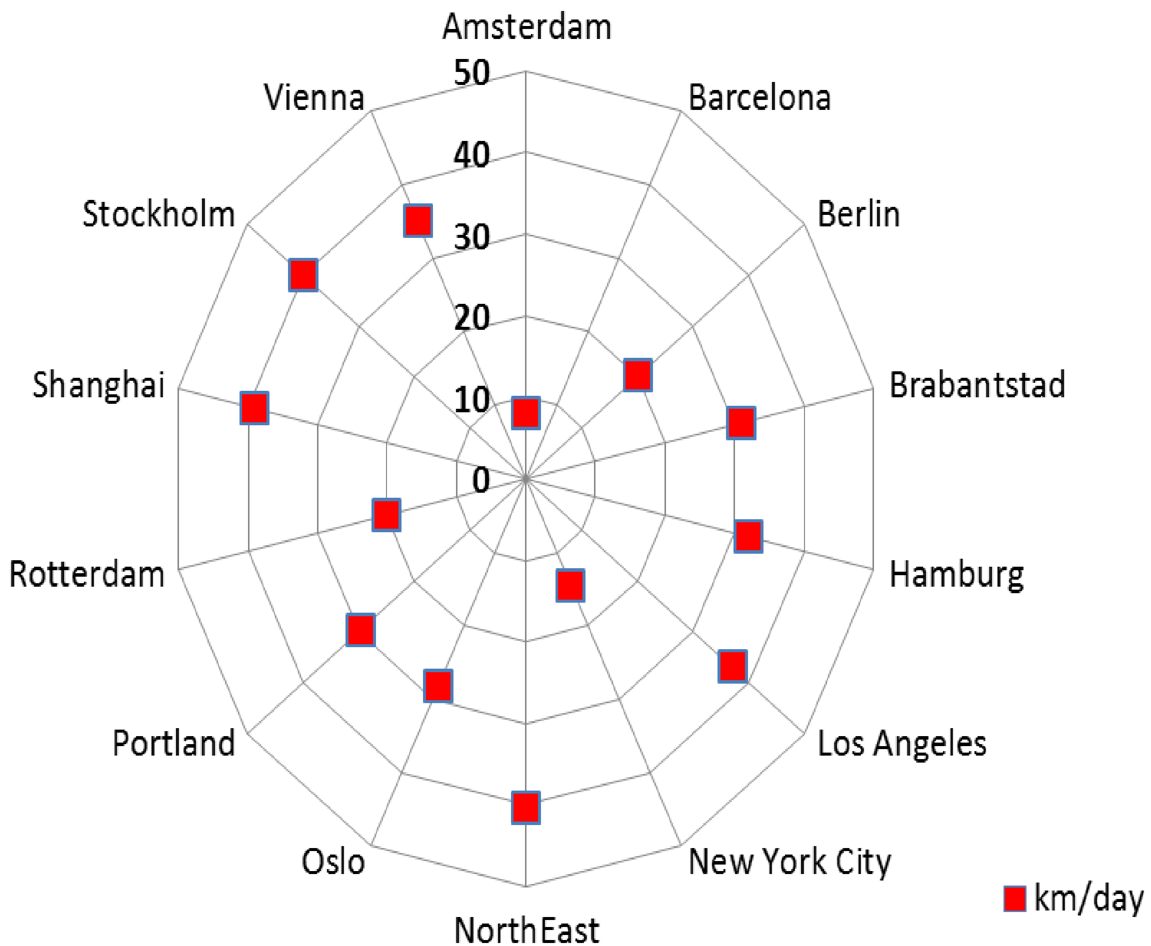
Advantages

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

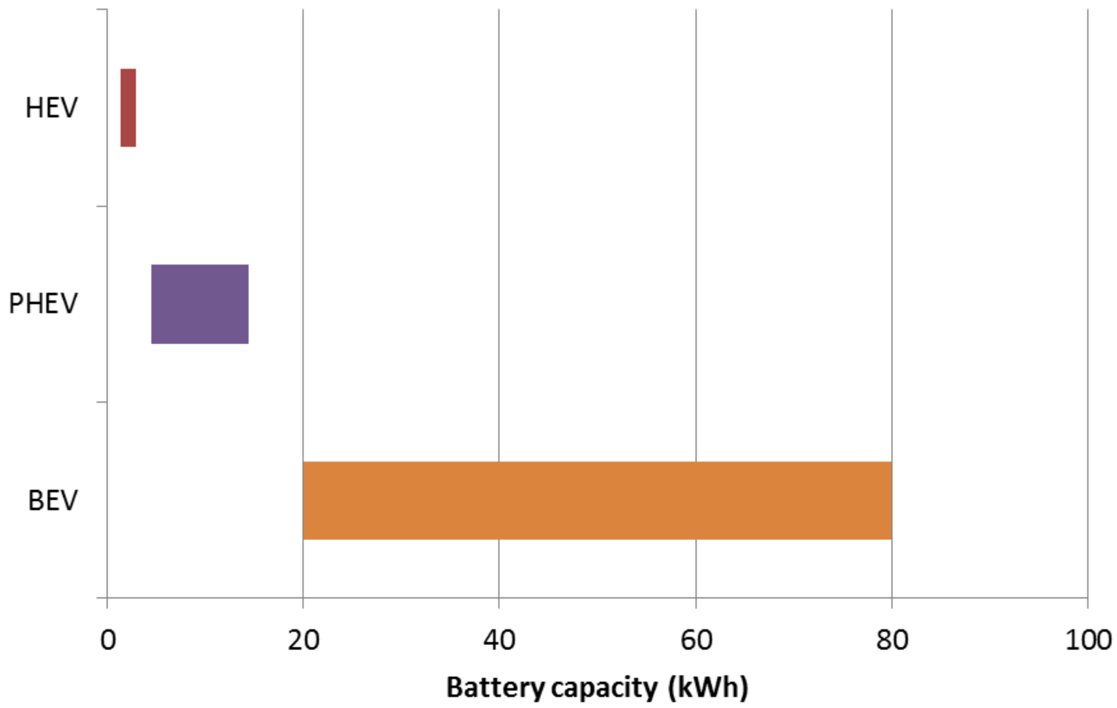
Disadvantages

- – Costs
- – Driving range
- – Charging time
- – Charging infrastructure

Km per day in cities



Battery capacity



Battery capacity for different types of EVs

Economic assessment

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

$$C_{km} = \frac{IC \cdot \alpha}{skm} + P_f \cdot FI + \frac{C_{O\&M}}{skm}$$

[€/100 km driven]

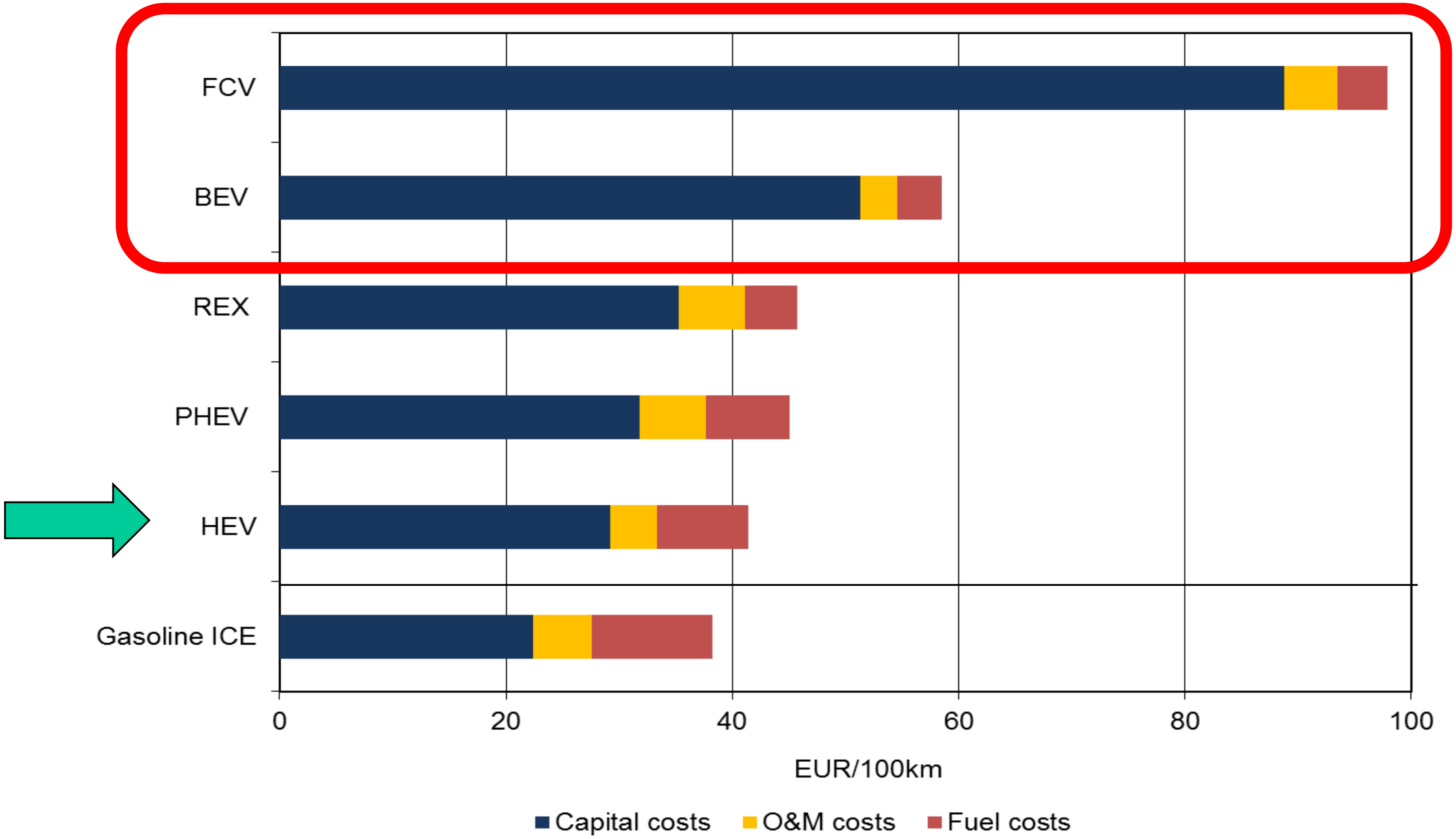
IC……investment costs [€/car]
α……..capital recovery factor
skm…..specific km driven per car per year [km/(car.yr)]
Pf……..fuel price incl. taxes [€/litre]
$C_{O\&M}$…operating and maintenance costs
FI……..fuel/energy intensity [litre/100 km; kWh/100 km]

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:

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

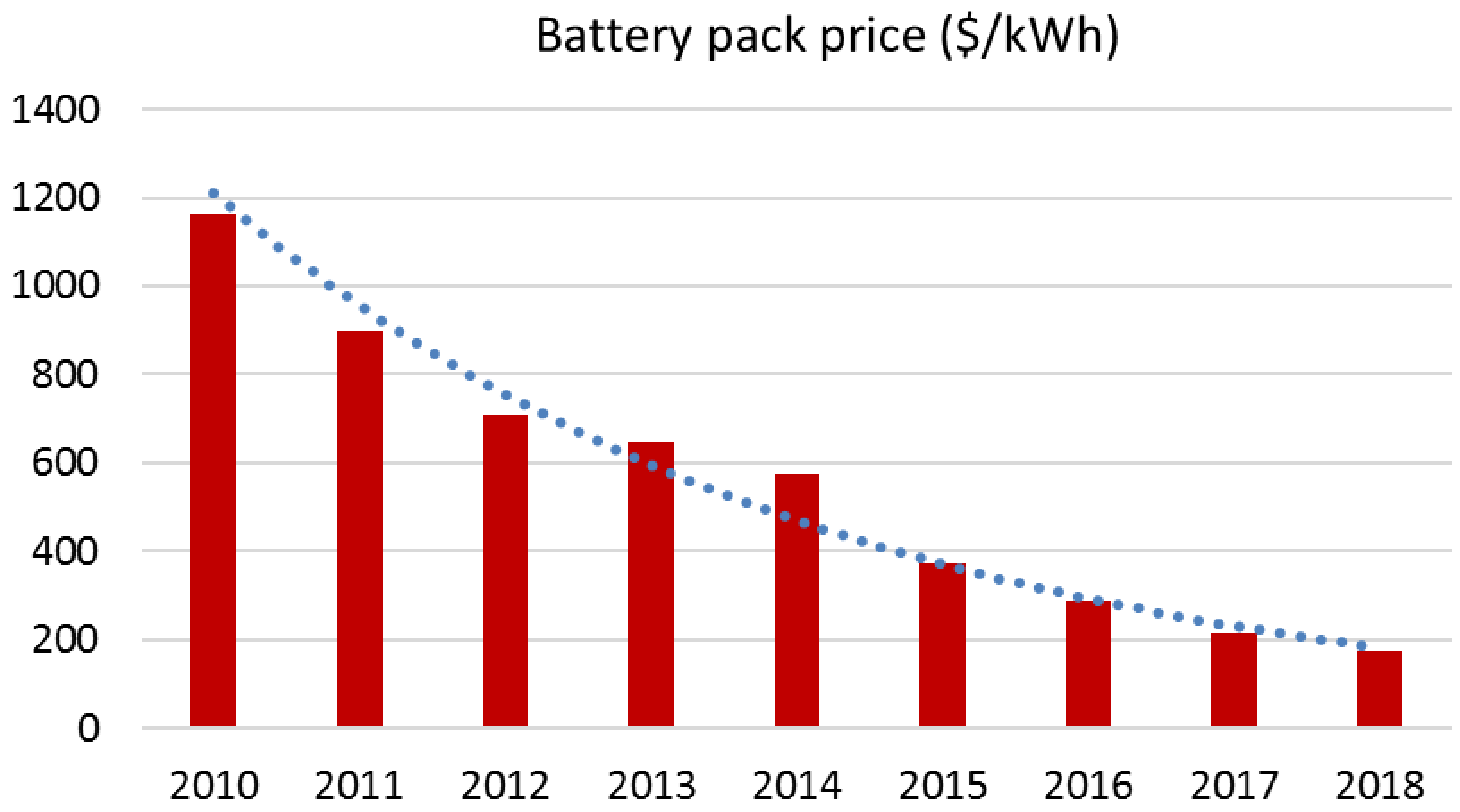
n…..the number of annuities received.

Economic aspects

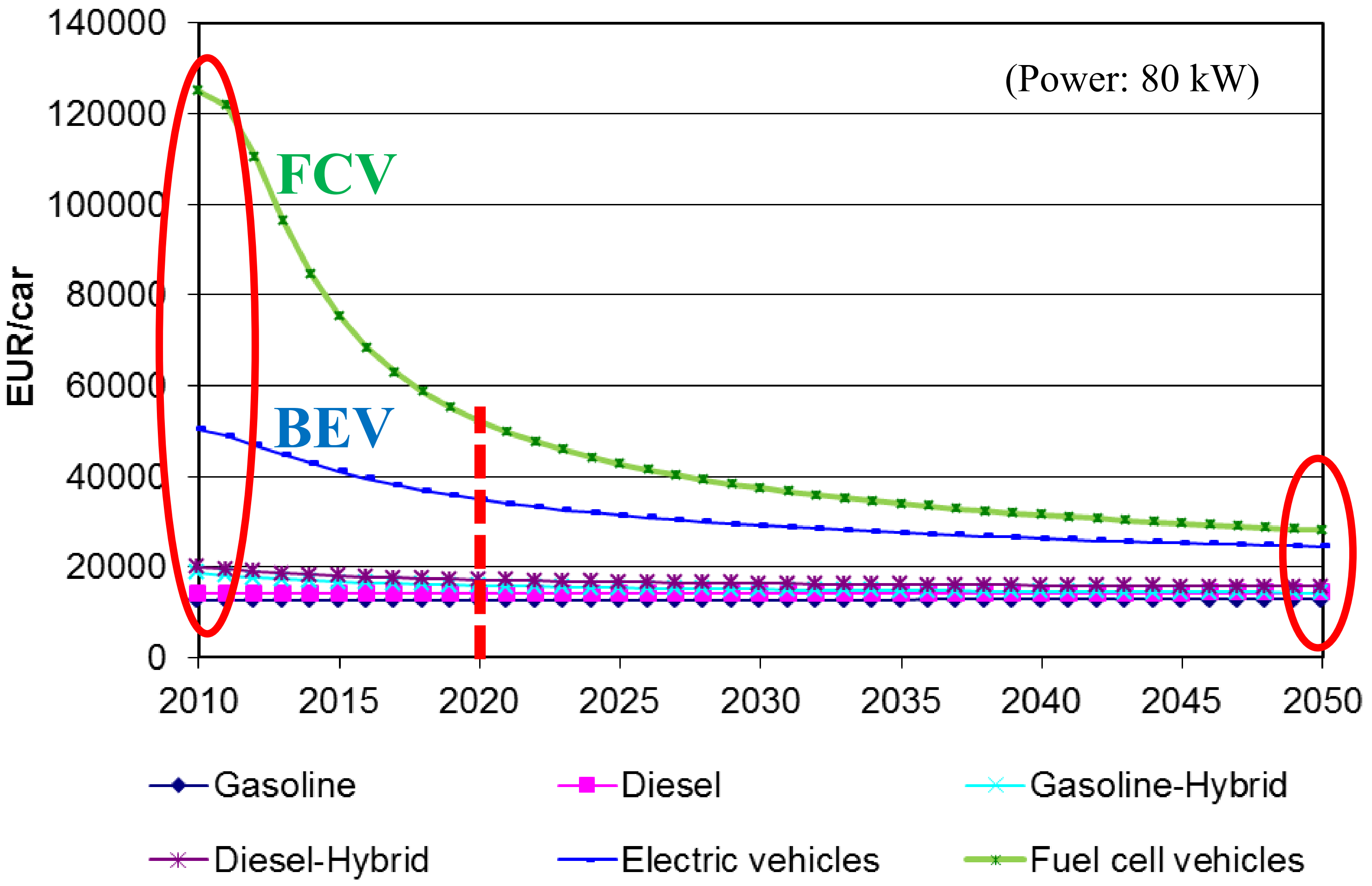


Total costs of service mobility of various types of EV in comparison to ICE cars

Battery


Battery pack price ($/kWh)
1400
1200
1000
800
600
400
200
0
2010
2011
2012
2013
2014
2015
2016
2017
2018

Scenario for development of investment costs



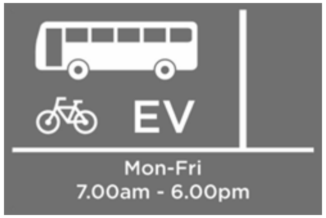
Electric vehicles

Monetary measures

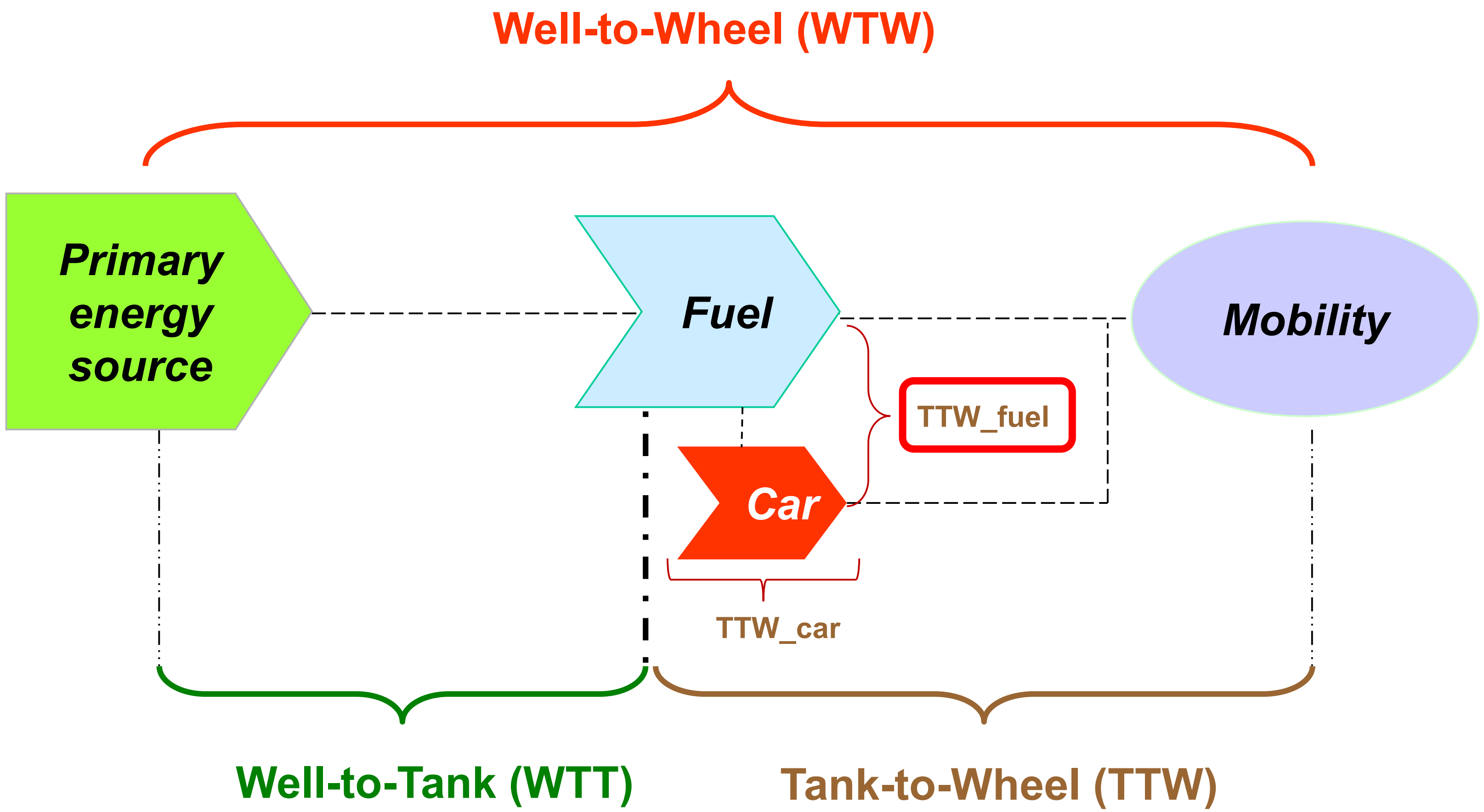
- road taxes
- annual circulation tax
- company car tax
- registration tax
- fuel consumption tax
- congestion charges

Non-monetary measures

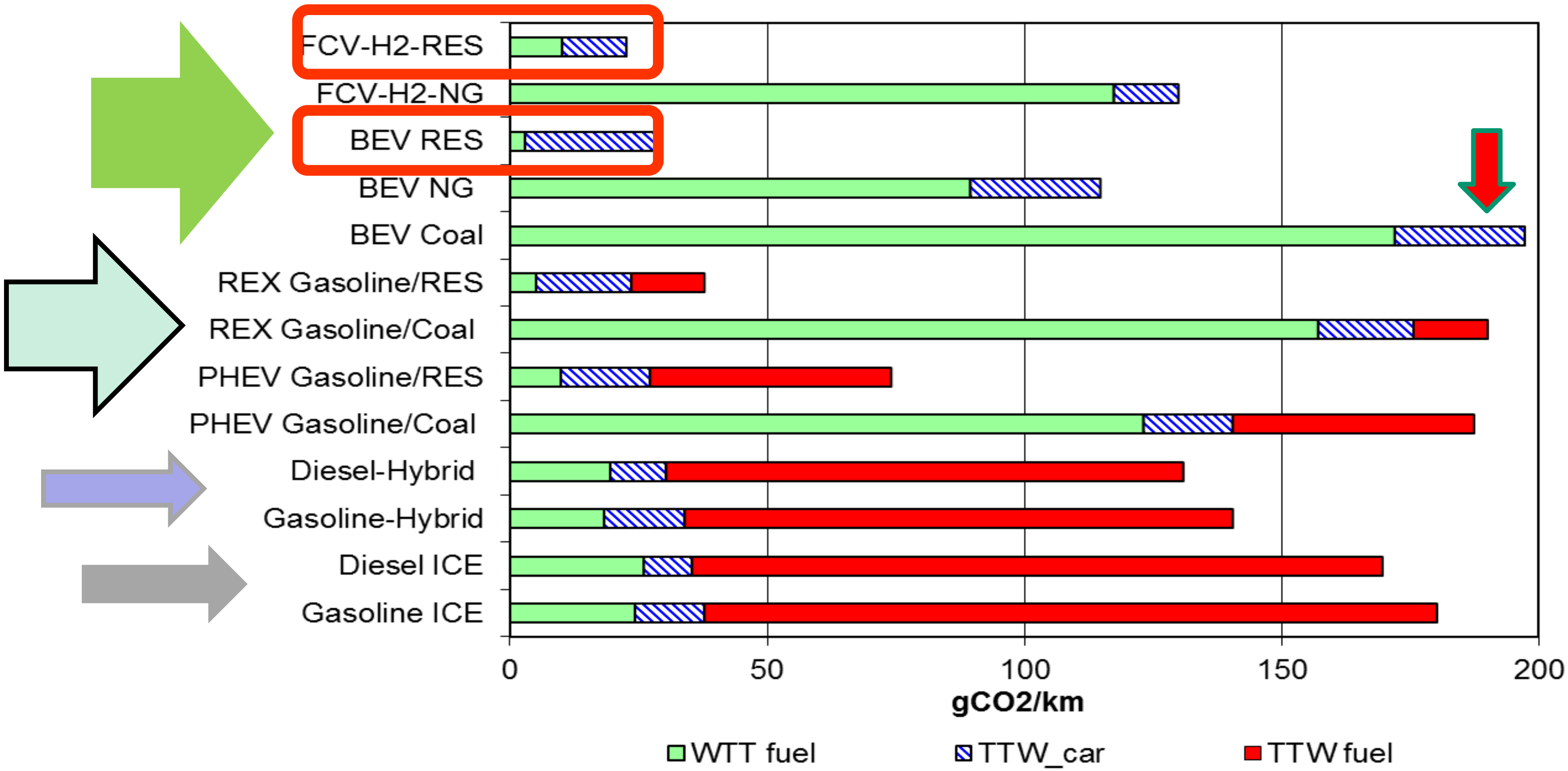
- free parking spaces
- possibility for EVs drivers to use bus lanes
- wide availability of charging stations
- permission for EVs to enter city centers and zero emission zones



Environmental assessment

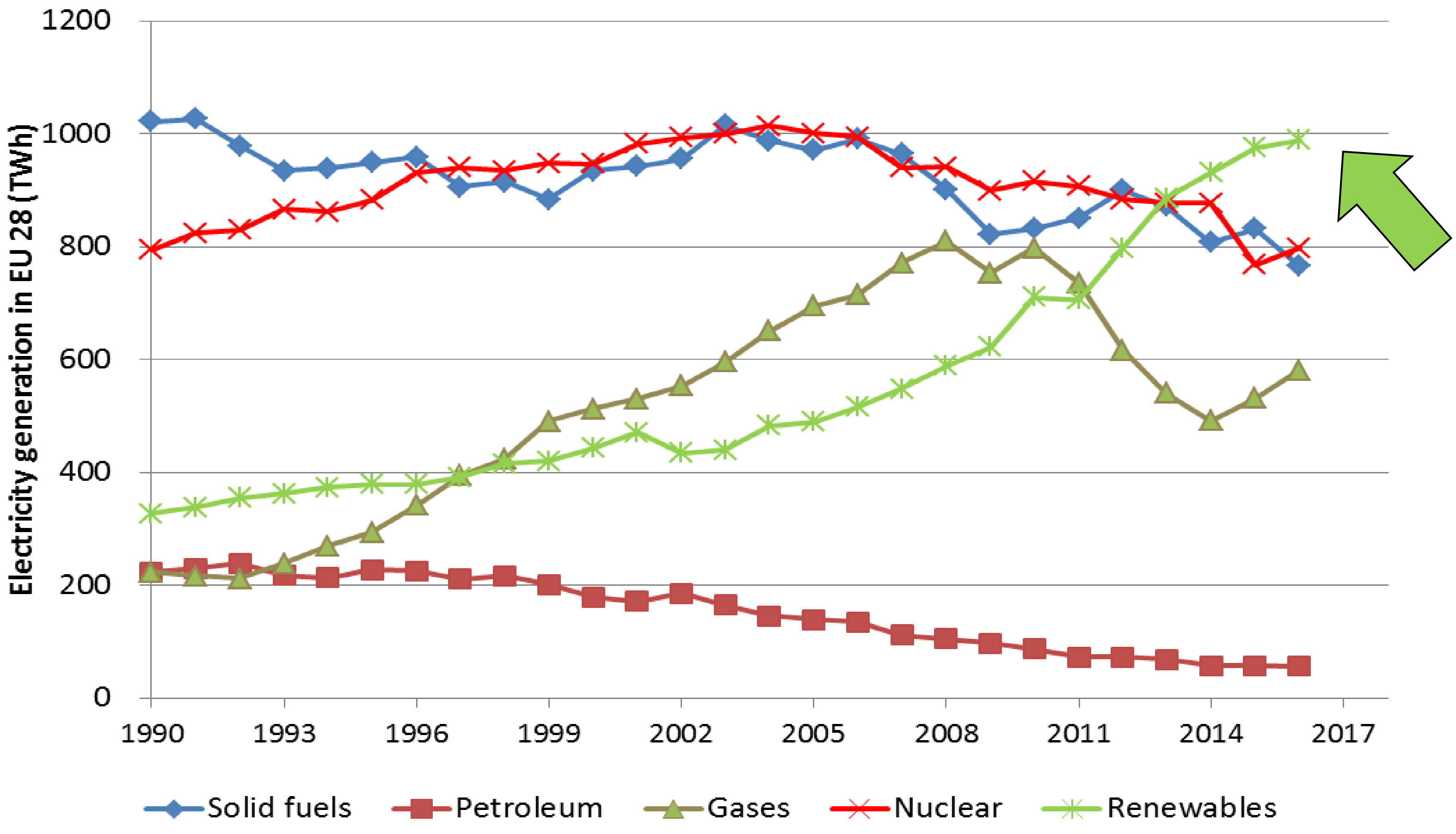


Environmental assessment

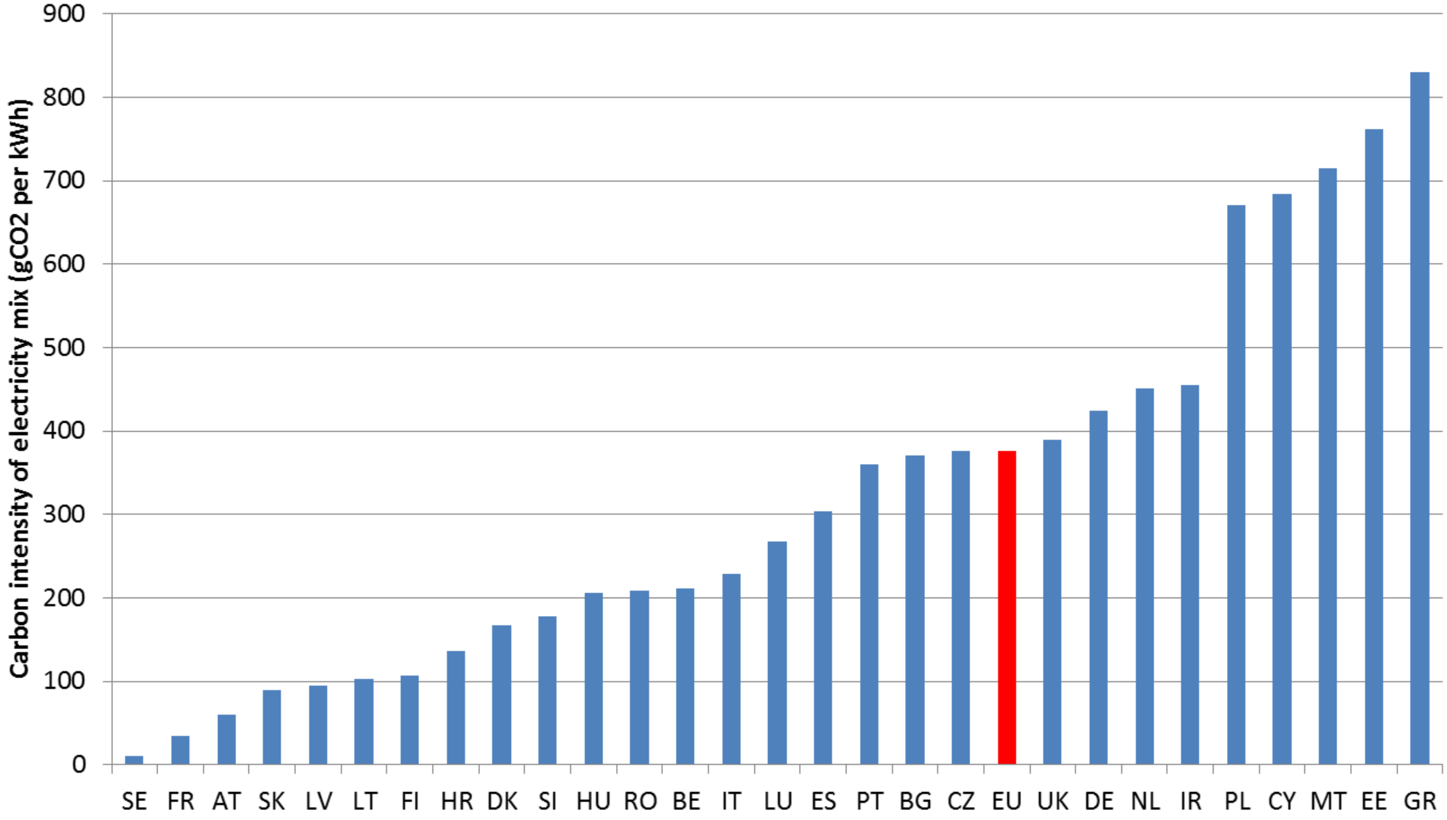


CO_2 emissions per km driven for various types of EV in comparison to conventional cars (power of car: 80kW)

Electricity generation in the EU 28

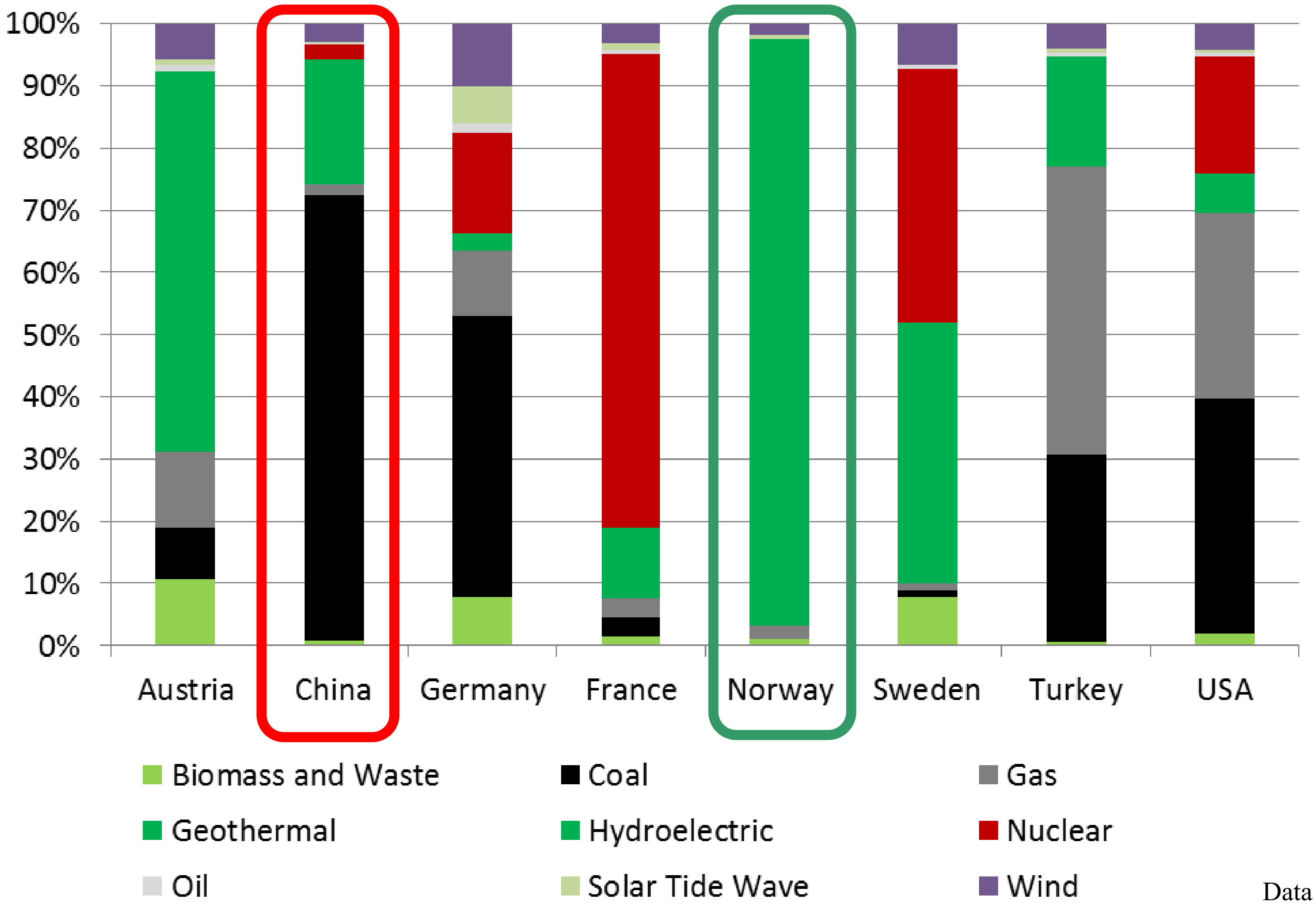


The carbon intensity of electricity mix



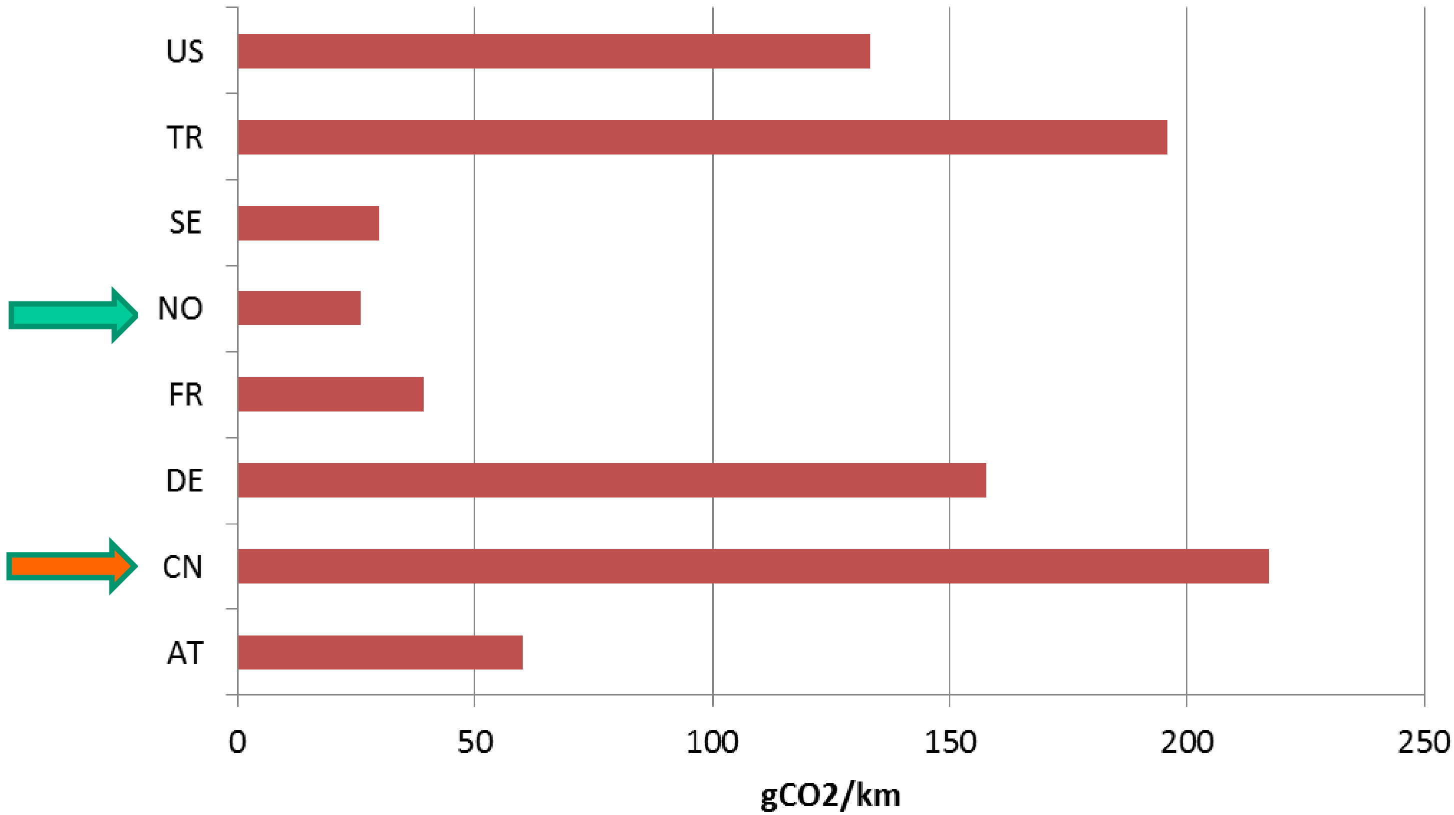
CO2 per kWh electricity generated in different European countries

Electricity mix



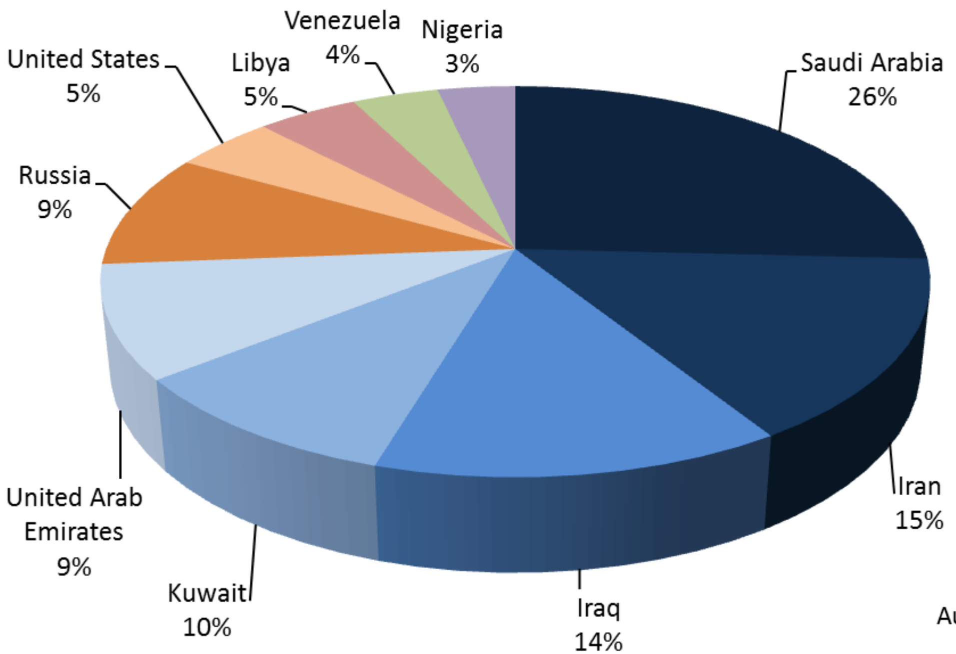
Data source: tsp,2014

Environmental assessment

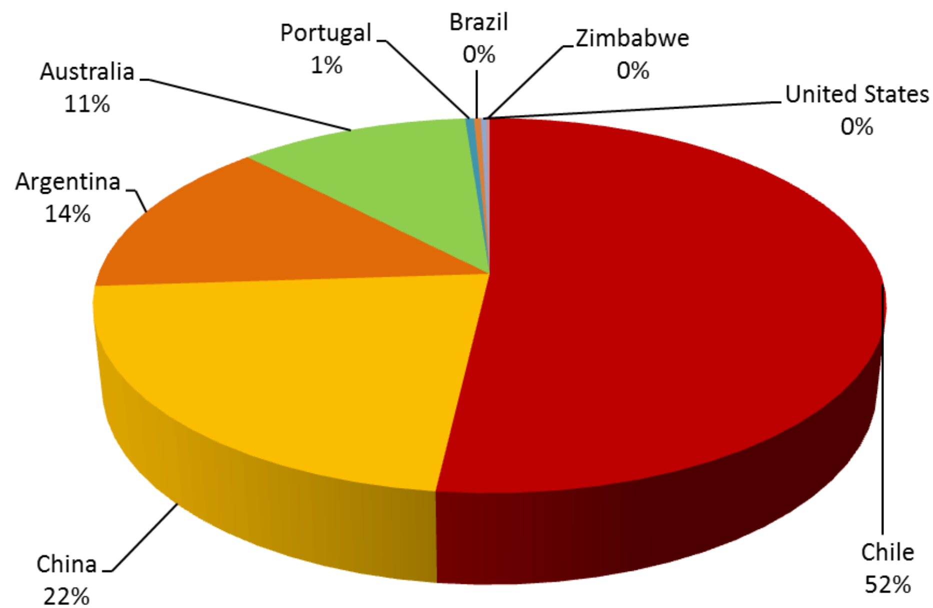


CO_2 emissions per km driven for BEVs powered by grid electricity in different countries

Oil and lithium reserves

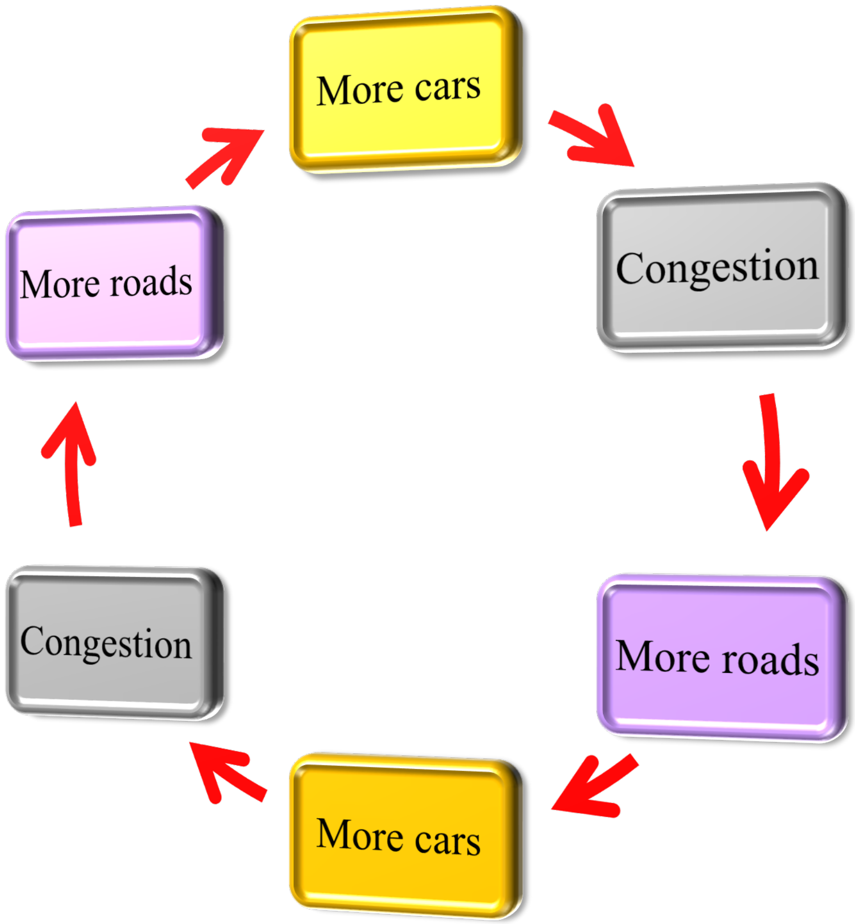


Countries with largest conventional oil reserves



World lithium reserves by country

Car-oriented mobility

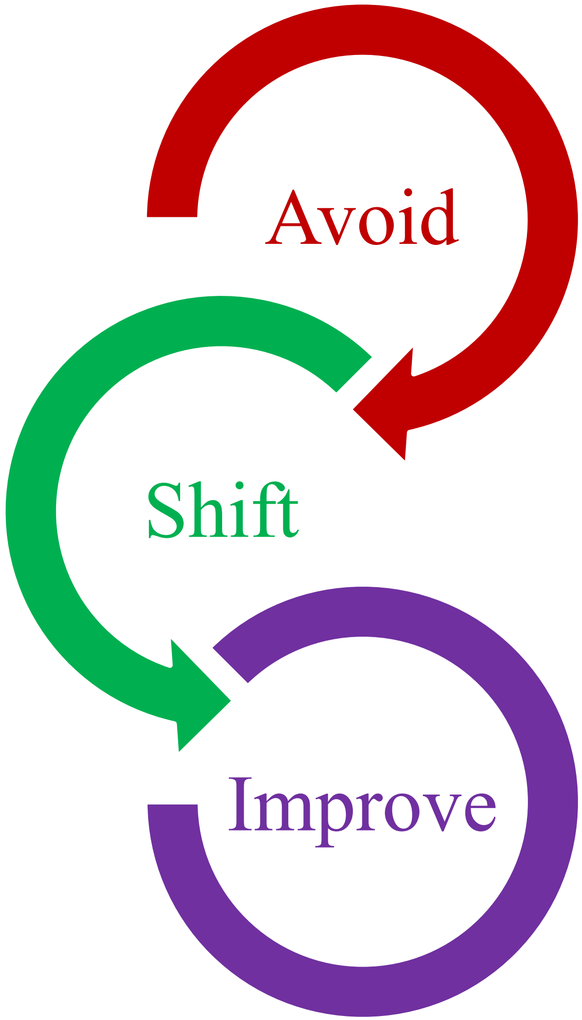


Mobility

Car-oriented transport development

https://simotron.files.wordpress.com

Towards Sustainable Mobility



…unnecessary travel and reduce trip distances

….towards more sustainable modes

…transport practices and technologies

Conclusions

- EVs …part of the solution…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
- New mobility behavior

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Ajanovic A., Haas R. (2019). **Economic and Environmental Prospects of Battery Electric- and Fuel Cell Vehicles: A Review**. Fuel Cells. Wiley Online Library. DOI: 10.1002/fuce.201800171

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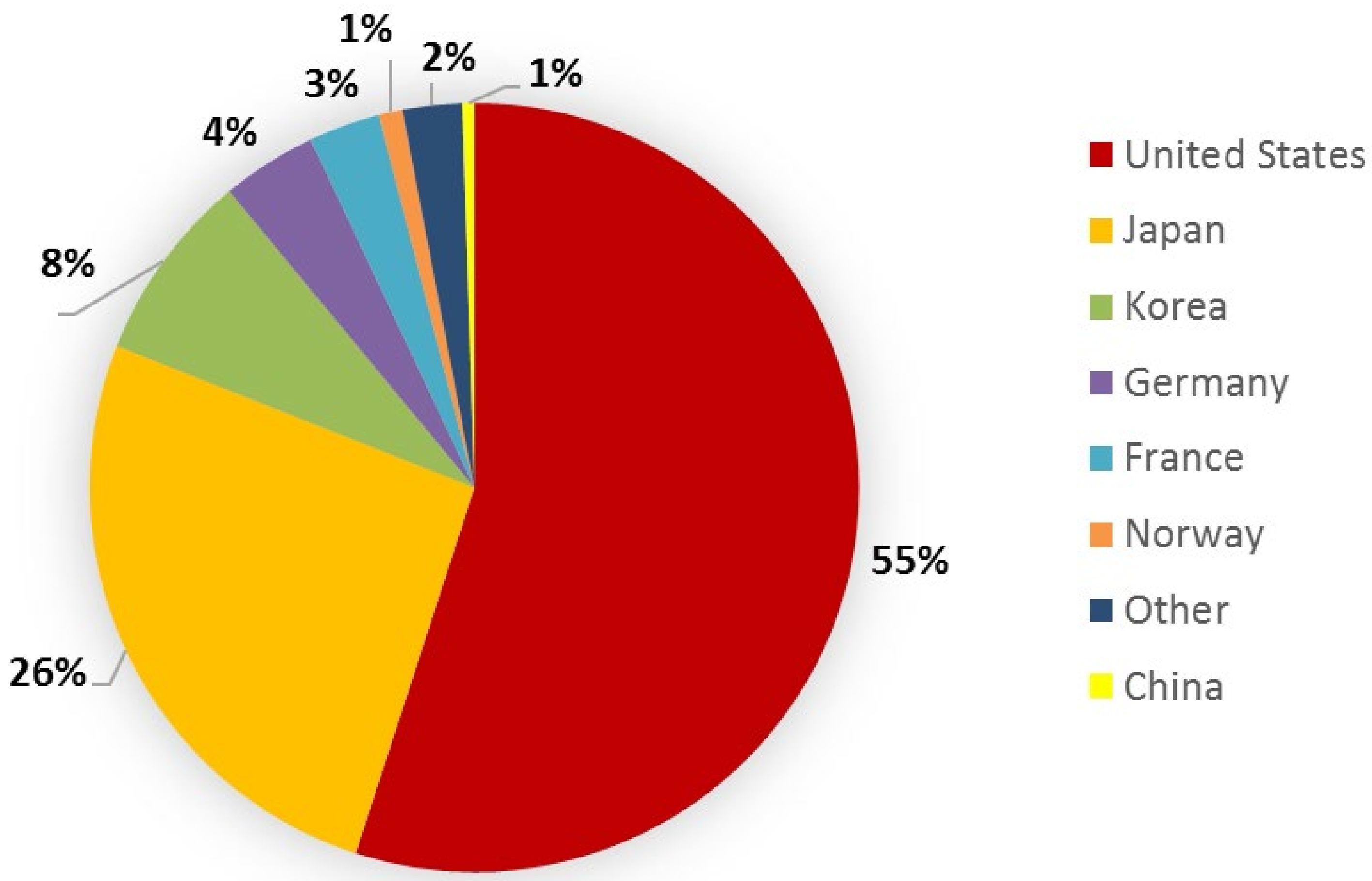
Electric vehicles



Fuel cell electric passenger car stock: 11.200

Main battery cell manufactures