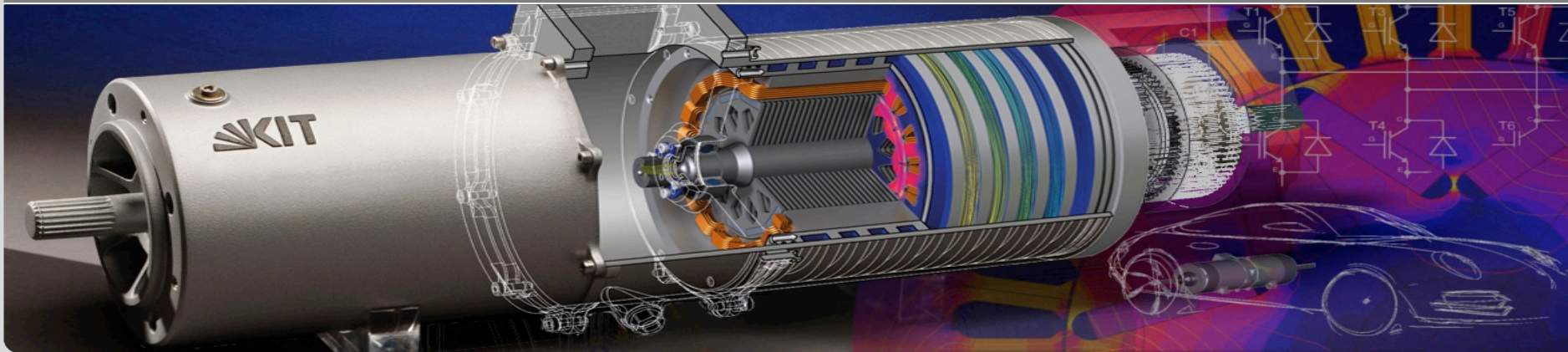


Quantifying Clean Electric Vehicles and Marginal Emissions

Martin Doppelbauer
Univ.-Prof. Dr.-Ing.

Institute of Electrical Engineering (ETI) – Professorship Hybrid and Electric Vehicles (HEV)



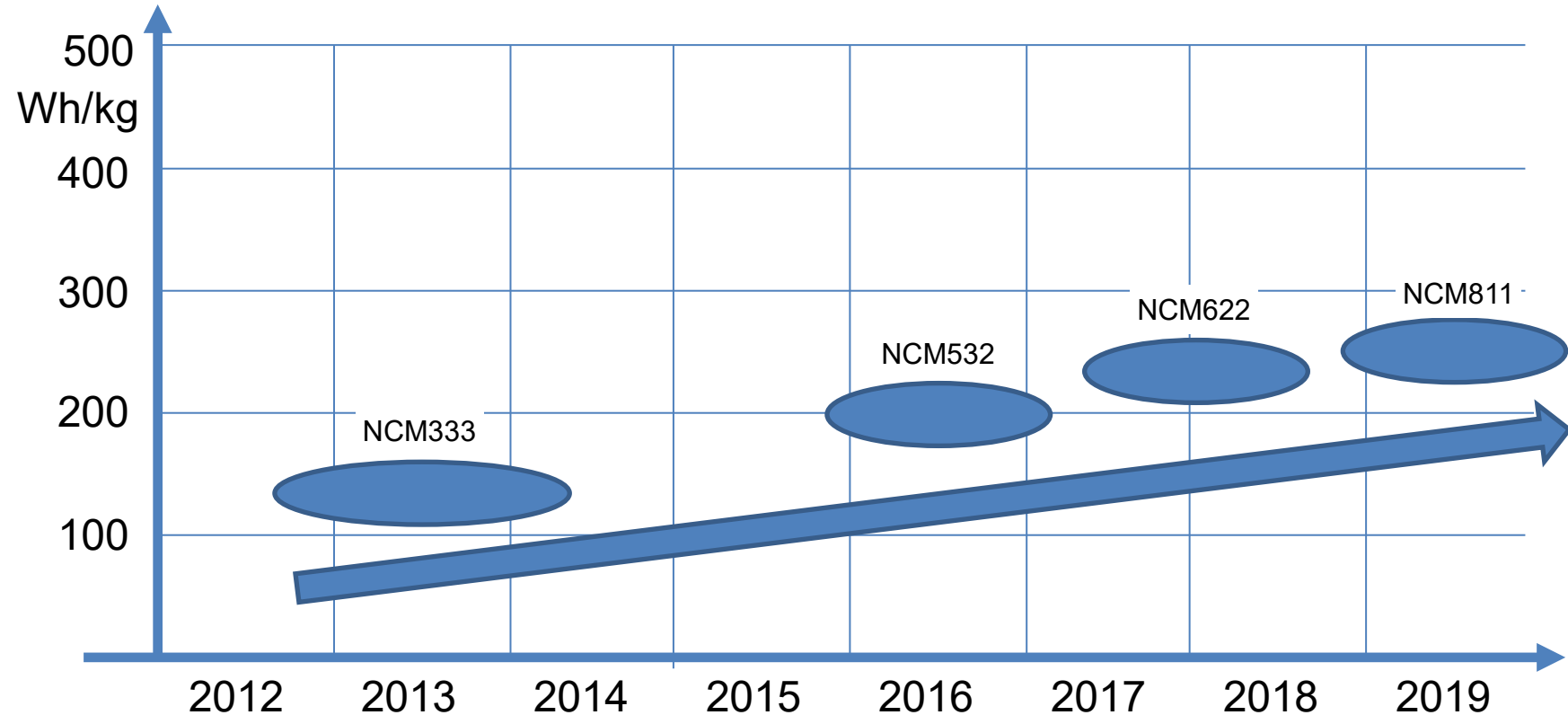
Electric Car Fleet



* Elektrofahrzeuge: ausgewertet wurden Pkw und leichte Nutzfahrzeuge mit ausschließlich batterieelektrischem Antrieb oder mit Range Extender sowie Plug-In Hybride.

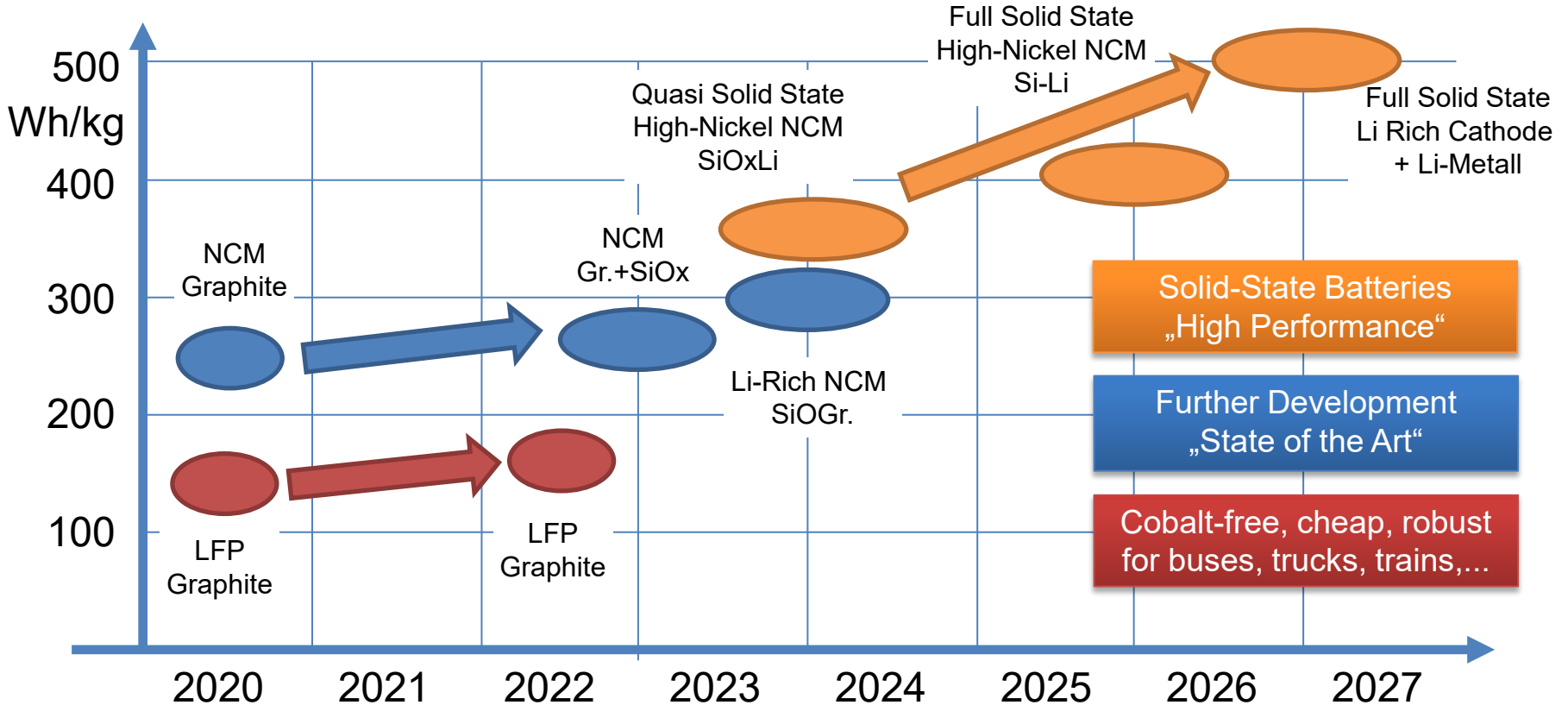
Quelle: ZSW

Historic Battery Development



Data Source: SVOLT, The Automotive Battery 2020, September 2020, München

Future Battery Development



Data Source: SVOLT, The Automotive Battery 2020, September 2020, München

Current Trends in Electric Vehicles

More
Range



150 kWh Battery
1.000 km Range (NEFZ)



120 kWh Battery
770 km Range (WLTP)

Lower
Prices

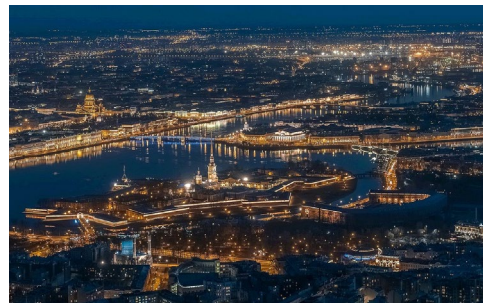
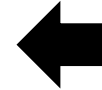


230 km Range (WLTP)
20.500 € before incentives

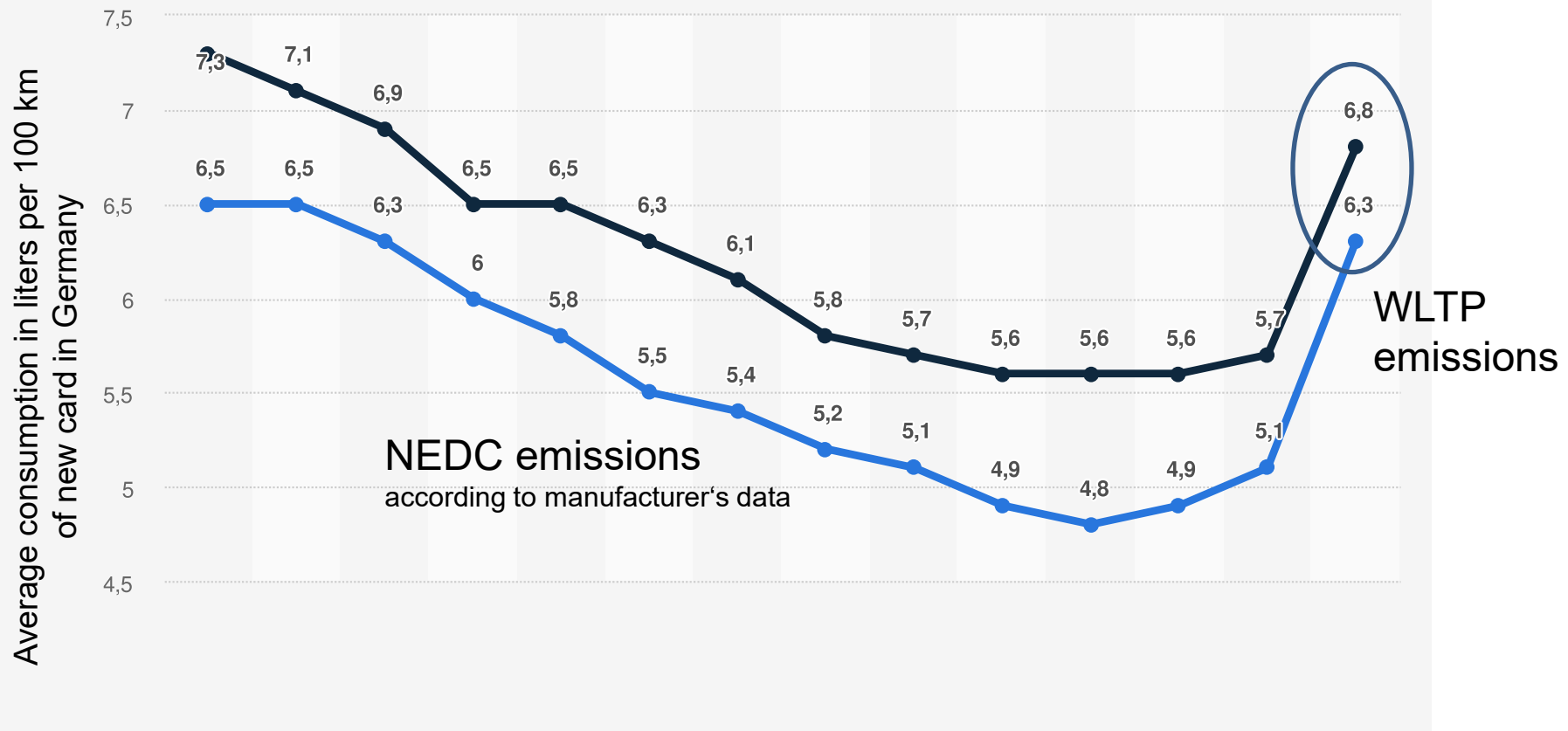


410 km Range (WLTP)
36.000 € before incentives

Marginal Cost – Why They Don't Apply to Electric Cars

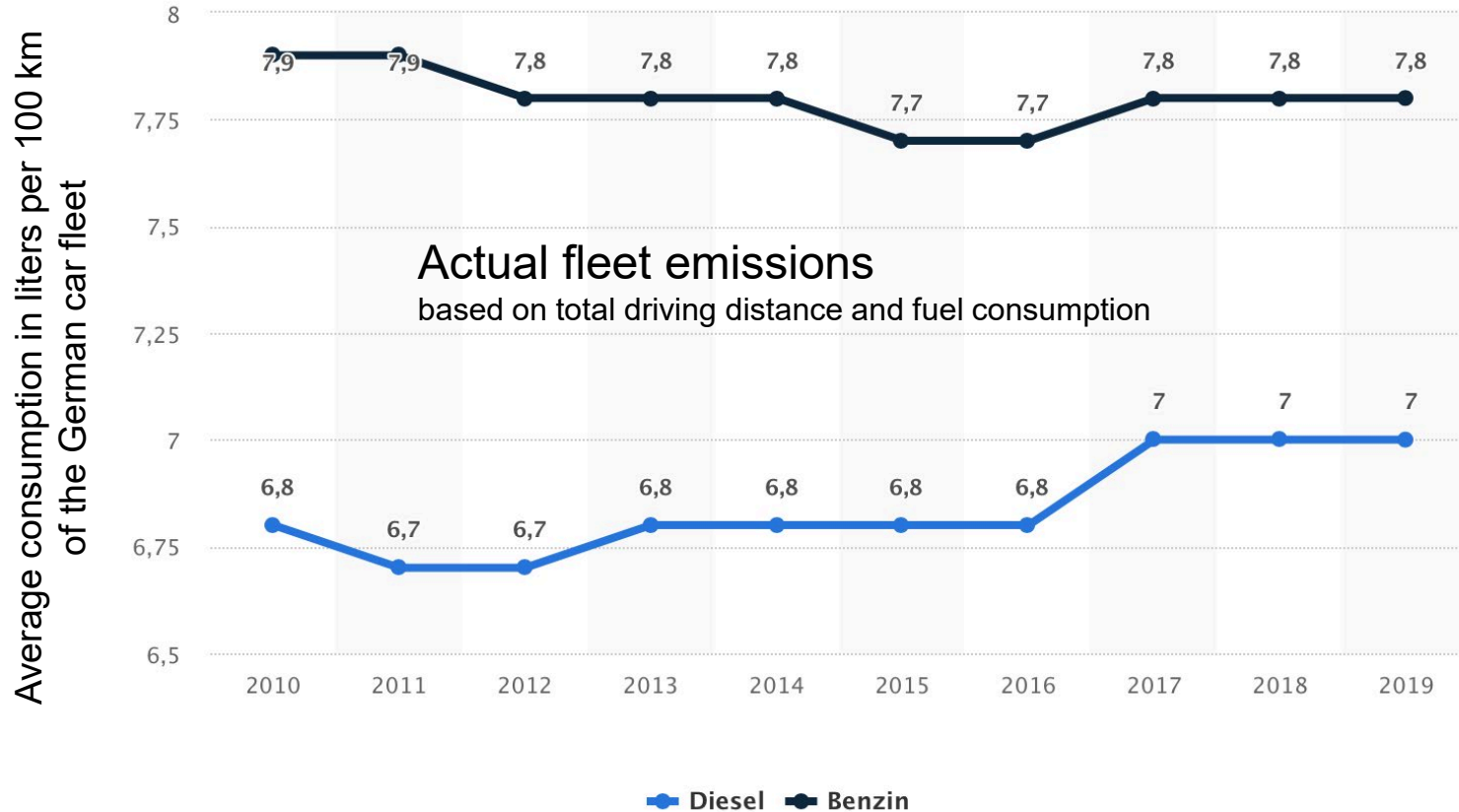


Average New Cars Consumption – Manufacturer's View



Source: Statista.de mit Daten des KBA

Average Car Fleet Consumption – Actual Numbers



Source: Statista.de using data provided by KBA

Marginal Cost – Why They Don't Apply to Electric Cars

- Marginal cost are used to compare alternatives that lead to the same goal
... but we have no alternative to e-cars

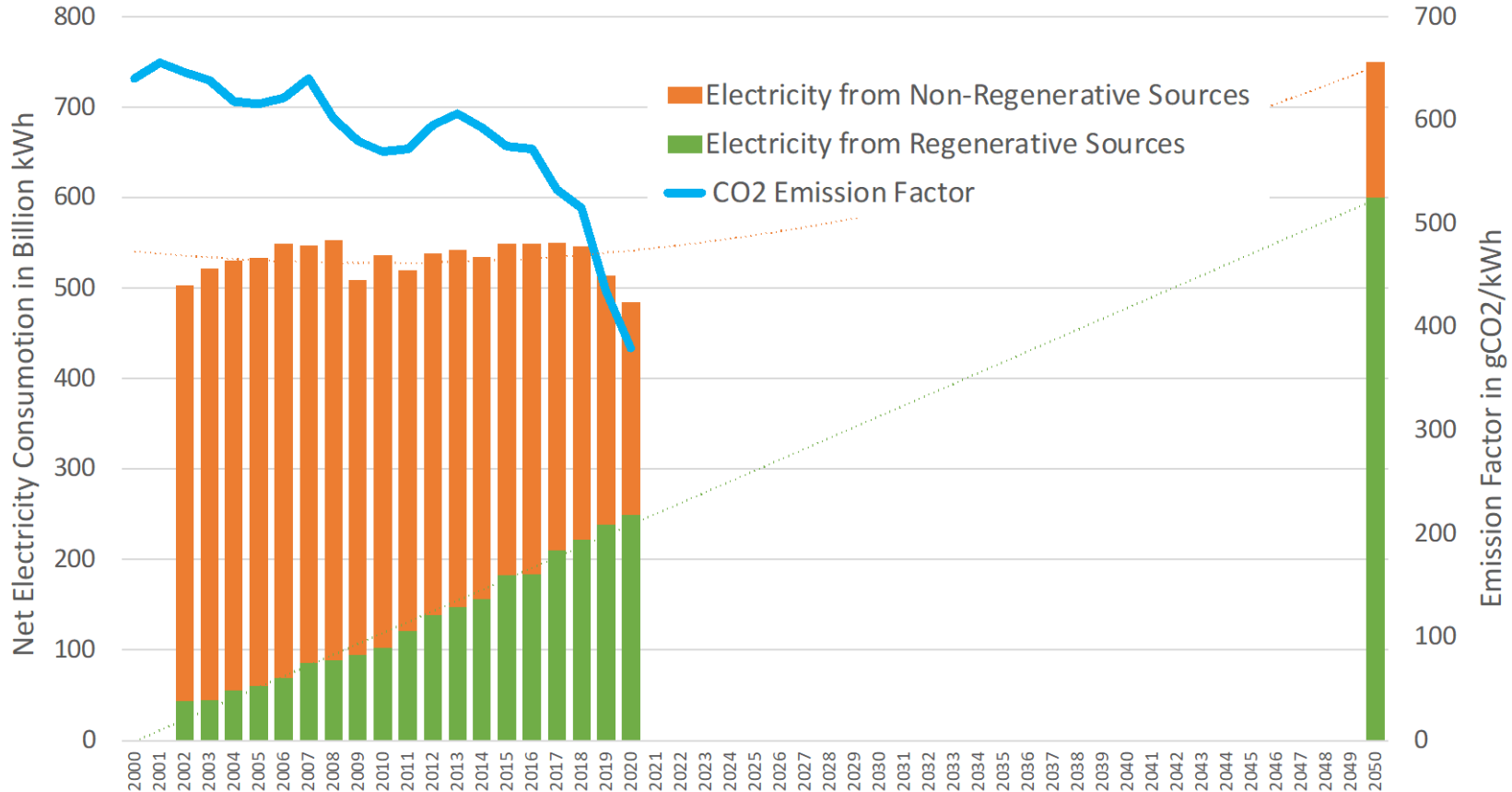
- Marginal cost are used to compare alternatives, they do not reflect the actual costs after the decision has been made ... electric cars use the same electricity as every other consumer

Marginal Cost – Why They Don't Apply to Electric Cars

- EV can actually help the grid and improve renewable energy production
- Historically, the additional EV energy demand has always been smaller than the increase in renewable energy generation

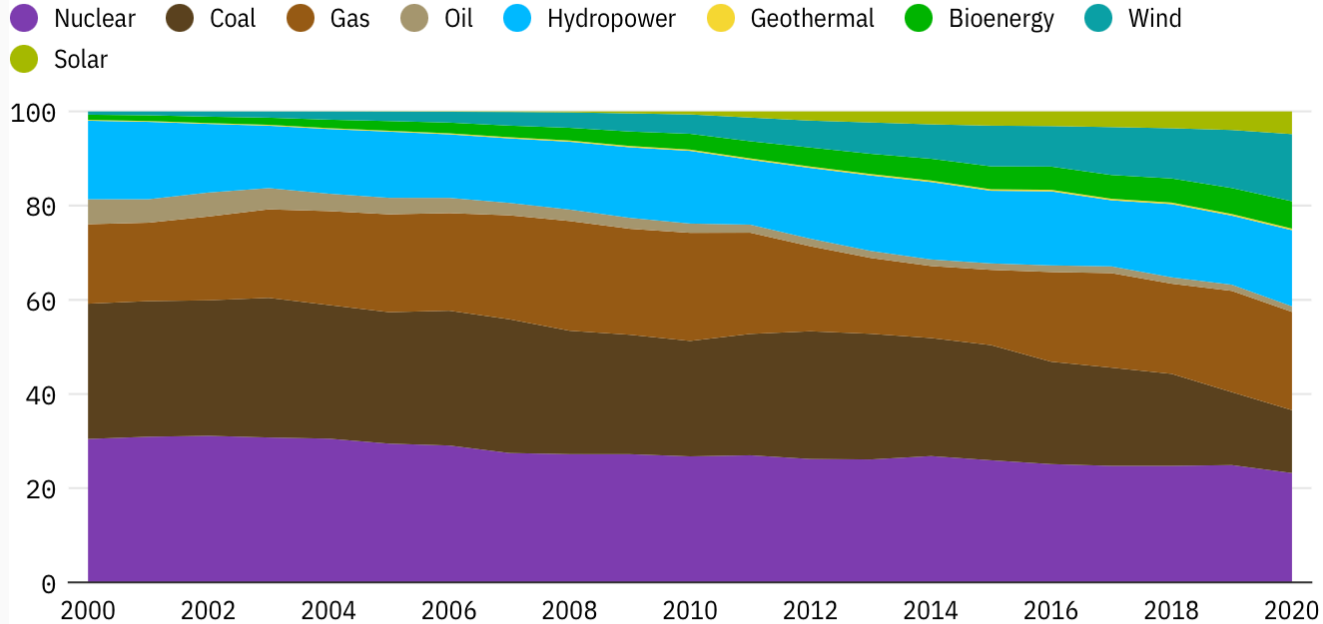
Source: <https://energymonitor.ai/tech/electrification/electrification-using-more-to-emit-less>

Emission Factor and Electricity Production in Germany



Electric Energy Production in Europe

European power generation by technology, 2000–20

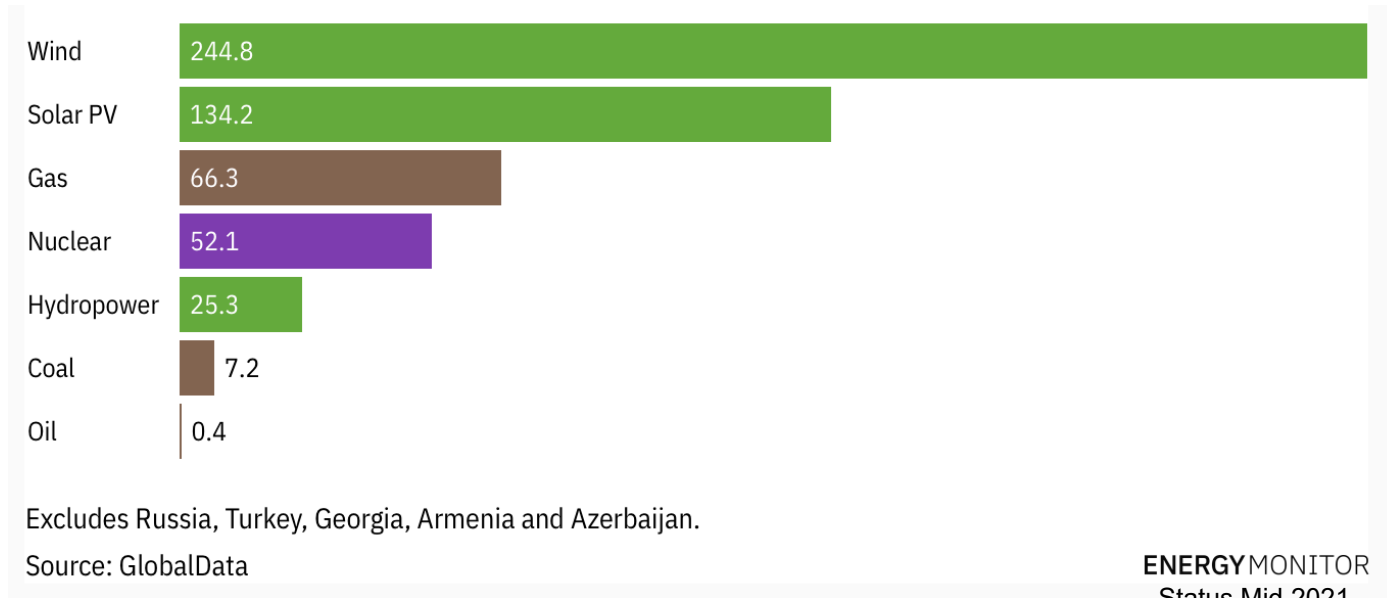


Excludes Russia, Turkey, Georgia, Armenia and Azerbaijan.

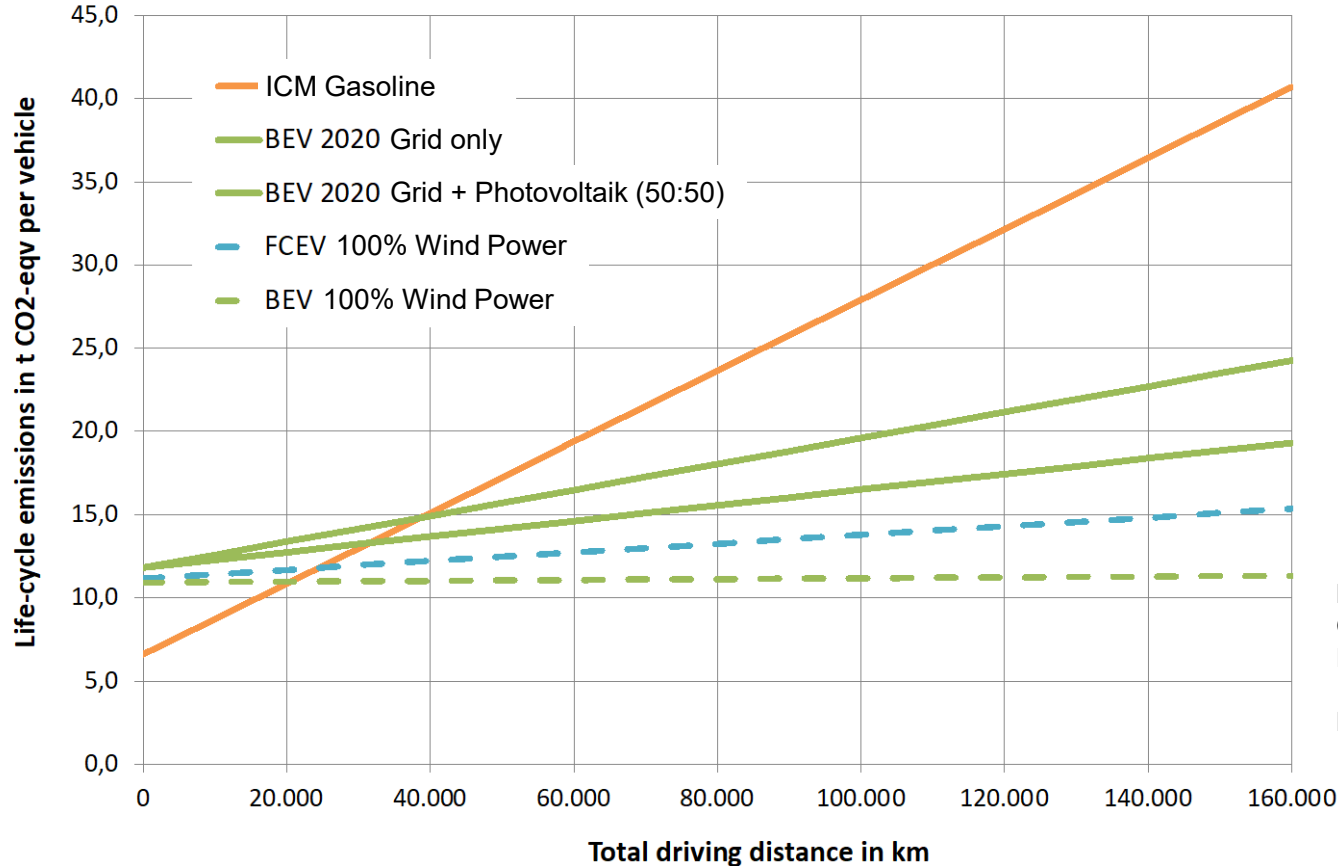
Source: GlobalData

ENERGYMONITOR

Combined capacity of power plants planned and under construction in Europe (in MW)

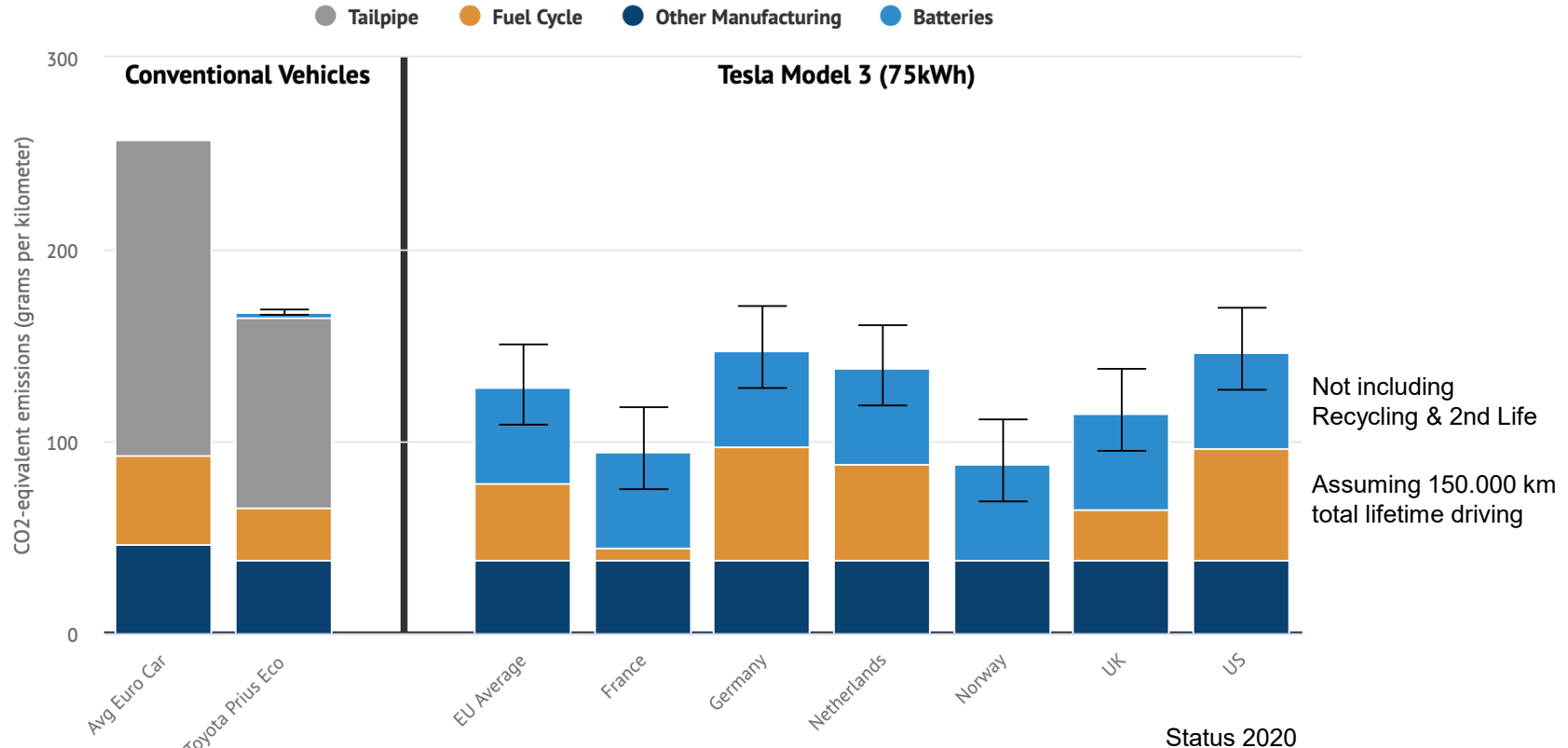


Life-Cycle Analysis Mid-Sized Cars in Germany



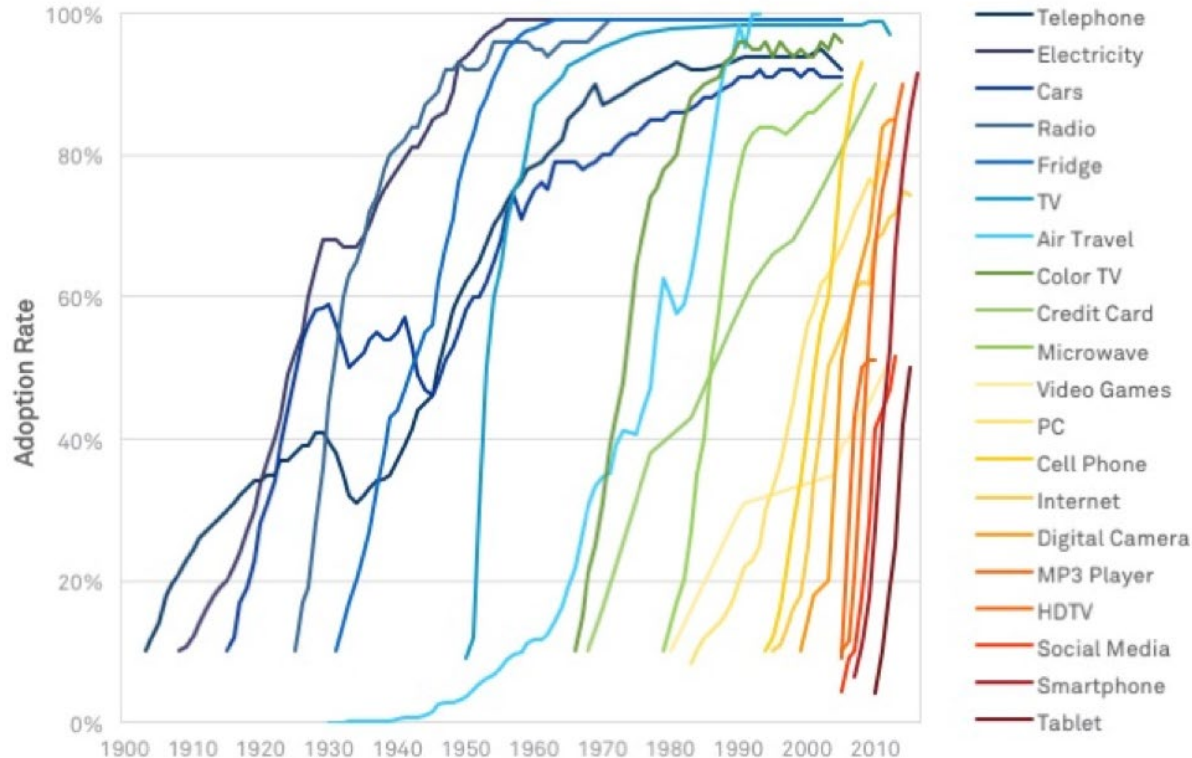
Diesel: 7,0 ltr/100 km
 Gasoline: 7,8 ltr/100 km
 BEV: 23,6 kWh/100km
 (20 kWh + charging losses)
 H2: 1,36 kgH₂/100km
 (1,2 kg + compression losses)

Life-Cycle Analysis Mid-Sized Cars in Europe



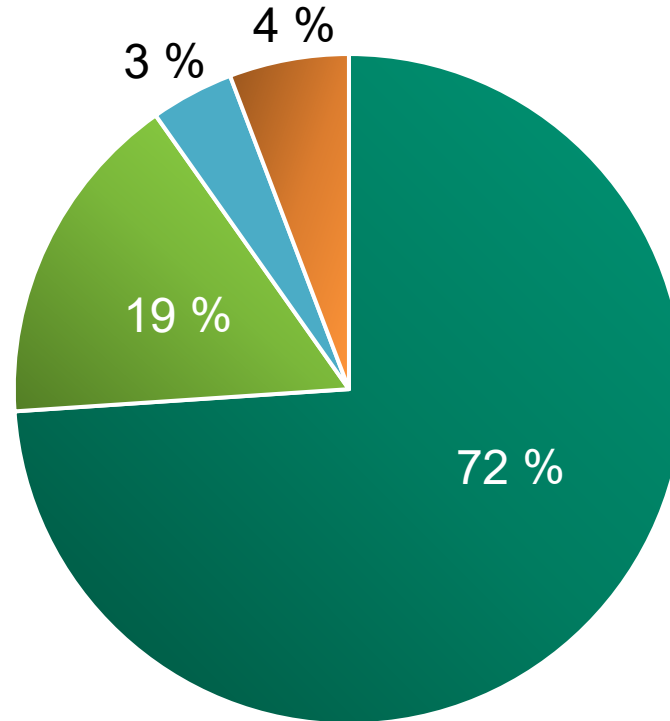
Source: <https://www.carbonbrief.org/factcheck-how-electric-vehicles-help-to-tackle-climate-change>

Adoption Rate of New Technology



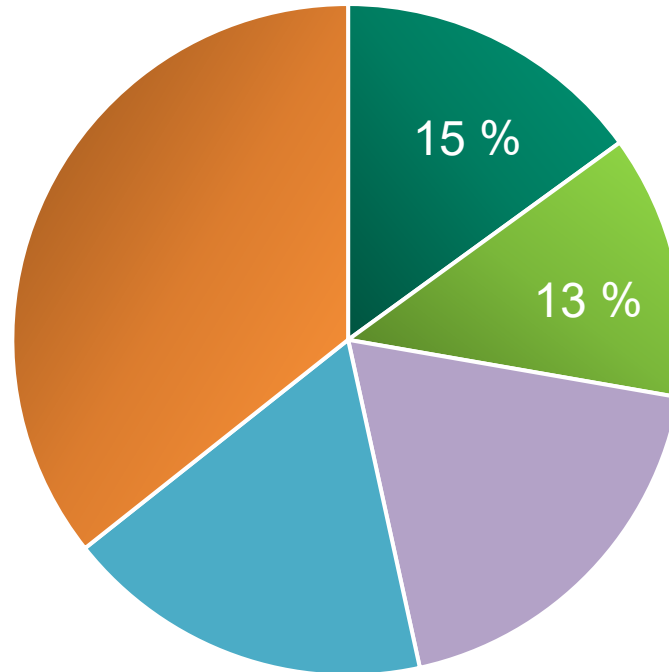
Source: Tony Seba: Clean Disruption – Energy & Transportation <https://www.youtube.com/watch?v=2b3ttqYDwF0>

New Car Sales in Norway in August 2021



■ BEV ■ PHEV ■ Diesel ■ Gasoline

New Car Sales in Germany in August 2021

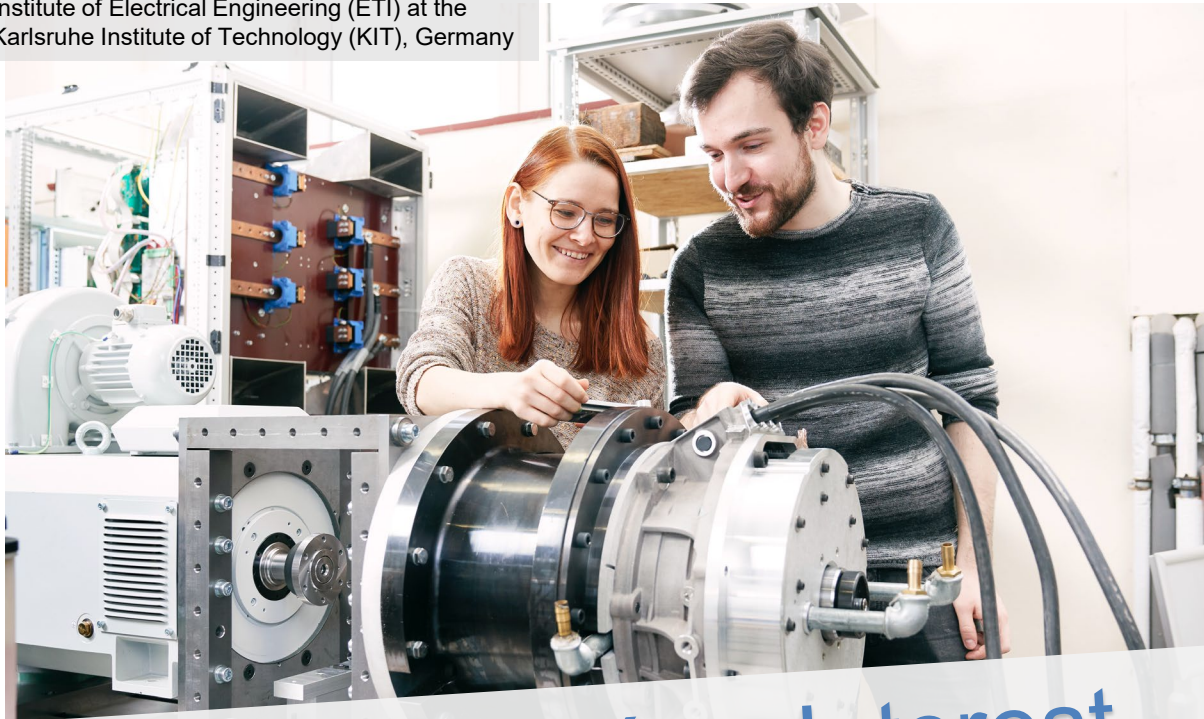


■ BEV ■ PHEV ■ Hybrids ■ Diesel ■ Gasoline

Benefits of Switching to Electric Cars Now

Even in countries that still have a high CO₂-emission factor today:

- Electric cars immediately improve the quality of life
- Emissions from electric cars are constantly improving as the grid improves
- The conversion takes a long time, we must start now
- Electric cars are fun, convenient and cheaper (TCO)



Thanks for Your Interest
Now is the Time for Questions