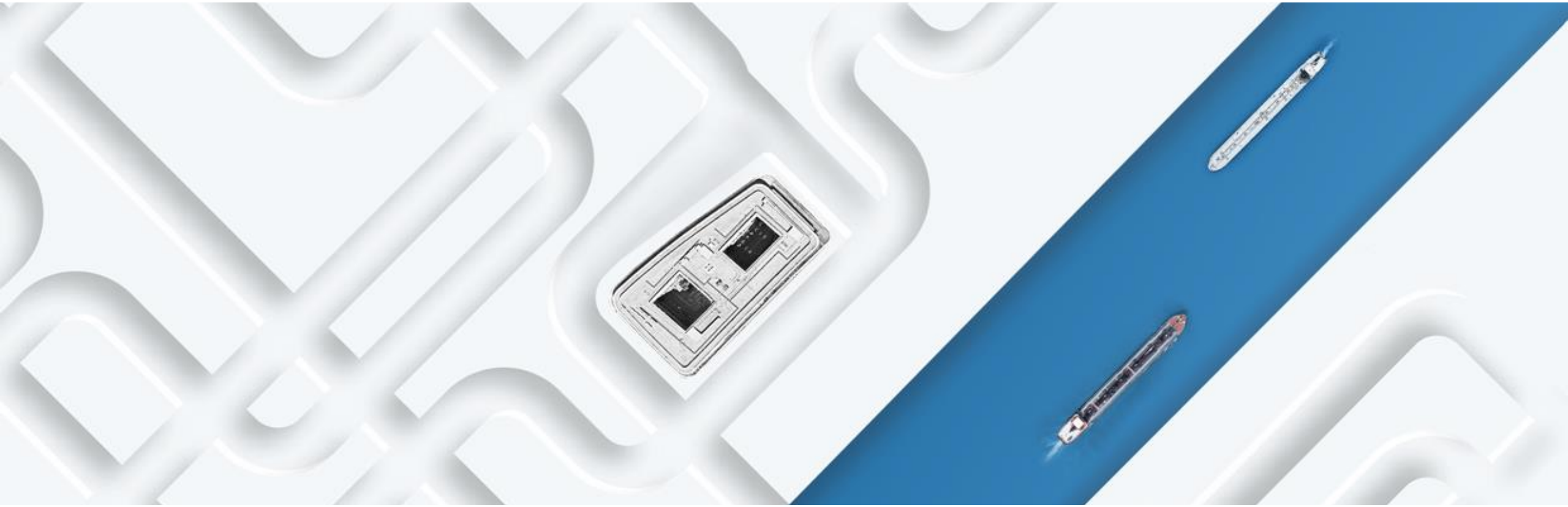
Kompendium 5.0
Electric cars section

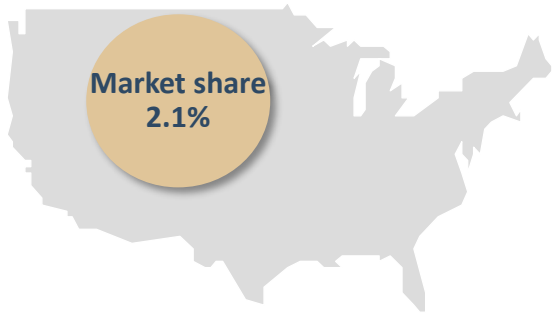


INSTITUT DER DEUTSCHEN WIRTSCHAFT

Electric cars: Very different markets

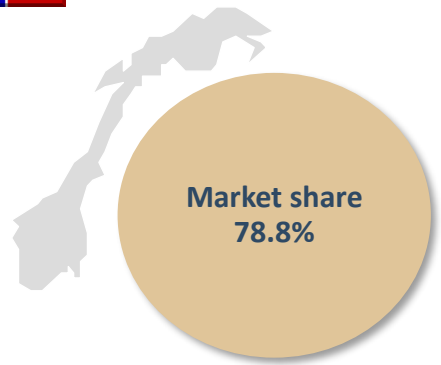
New registrations and best-selling models in the year 2020

New registrations BEV/PHEV: 302,929



1. Tesla Model 3
2. Tesla Model Y
3. Chevrolet Bolt
4. Tesla Model X
5. Tesla Model S

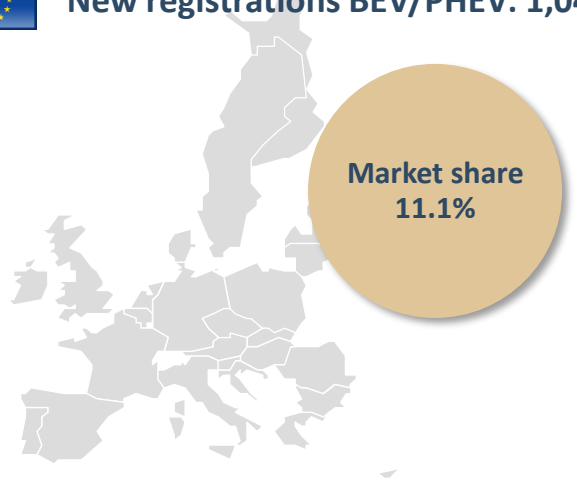
New registrations BEV/PHEV: 105,709



1. Audi e-tron
2. Tesla Model 3
3. Volkswagen ID3
4. Nissan Leaf
5. Hyundai Kona EV

World 2020
3,124,793

New registrations BEV/PHEV: 1,045,831



1. Renault Zoe
2. Tesla Model 3
3. Volkswagen ID3
4. Hyundai Kona EV
5. Audi e-Tron

New registrations BEV/PHEV: 1,246,289

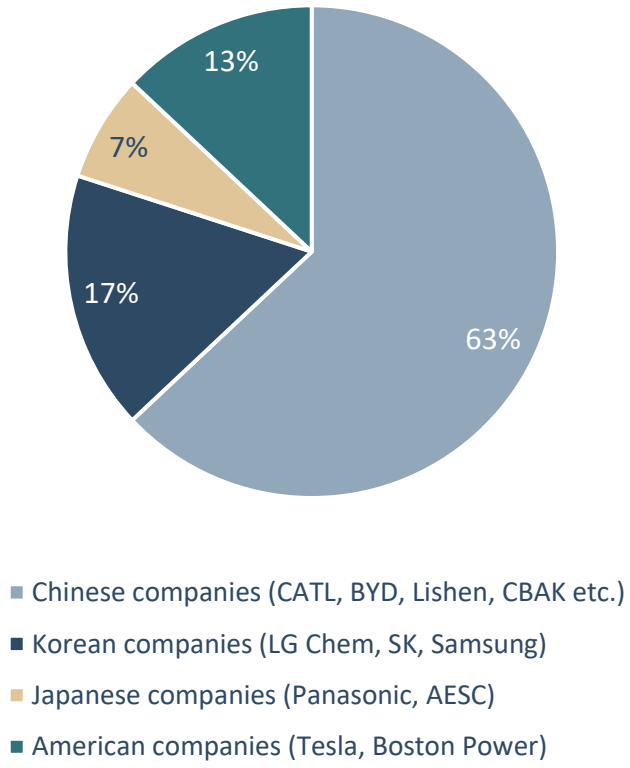
1. Tesla Model 3
2. Wuling HongGuangMini EV
3. Baojun E-Series
4. Great Wall Ora R1 / Black Cat
5. GAC Aion S

Quelle: ACEA, VDA; ev-sales.blogspot, 2021

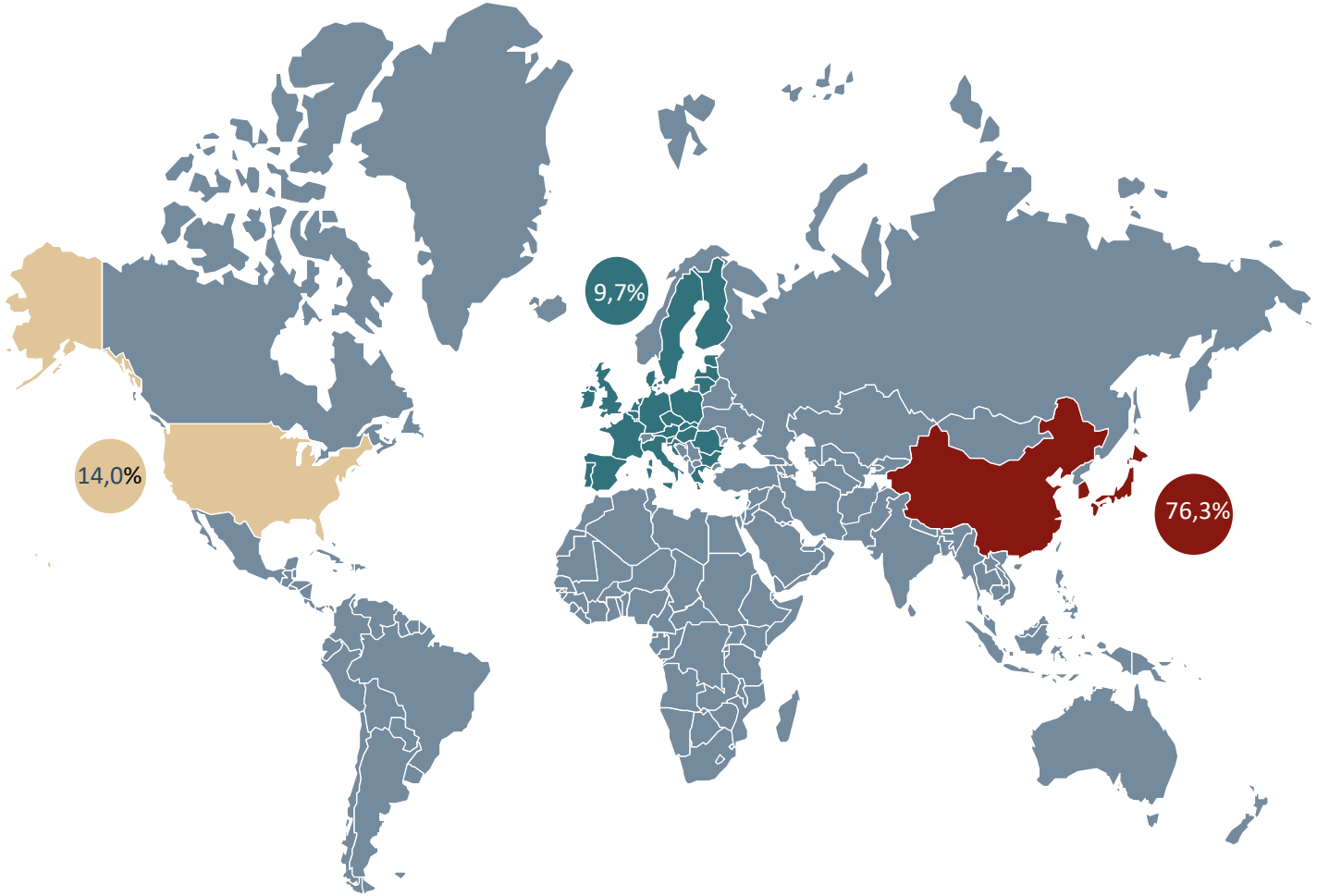
Lithium ion cells: Asia dominates right now

Share of installed, under construction and planned battery cell manufacturing

By homecountry of the company



By production sites

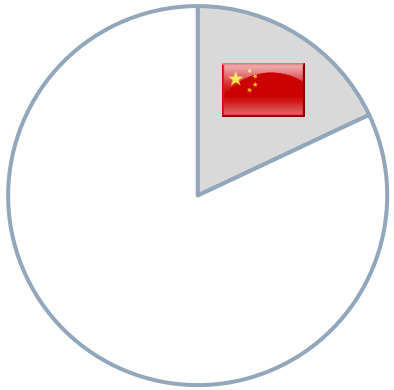


Source: PEM RWTH Aachen, 2019

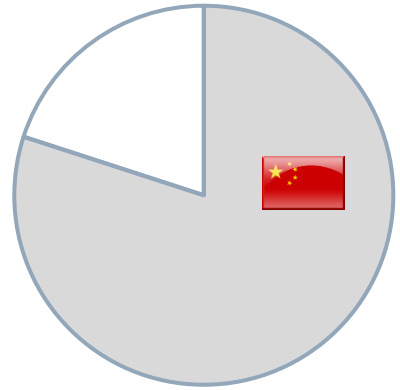
China has secured large parts of the value chain

Share of chinese companies in 2019

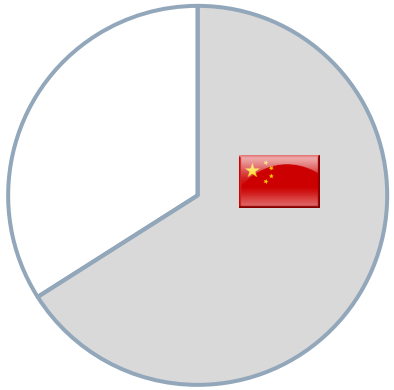
Raw materials (lithium, nickel, cobalt, etc.)



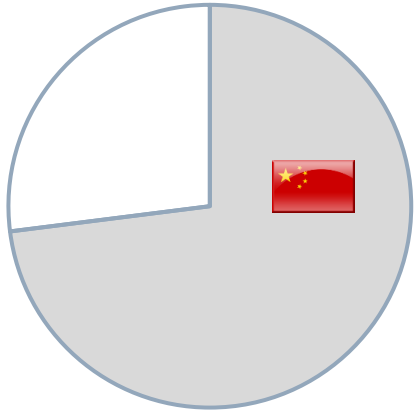
Refining of raw materials (lithium carbonate, cobalt sulphat, etc.)



Production of anodes und cathodes



Battery cell production

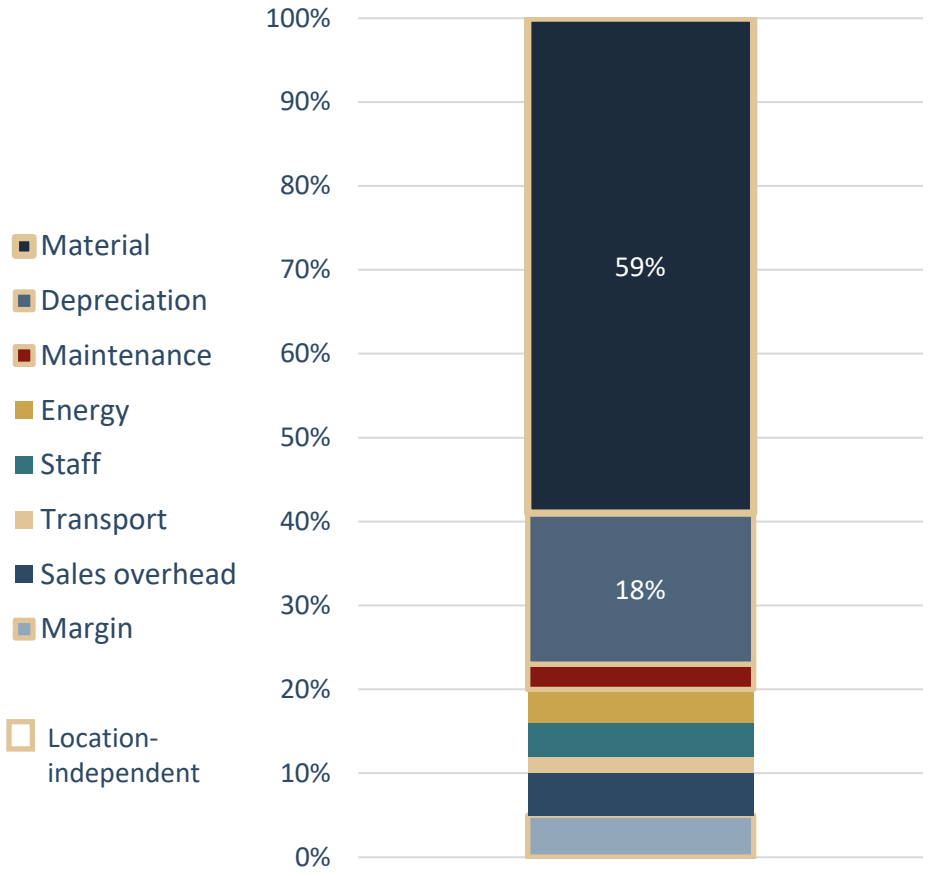


Quelle: Deutsche Rohstoffagentur, 2020; Automobilwoche, 2020

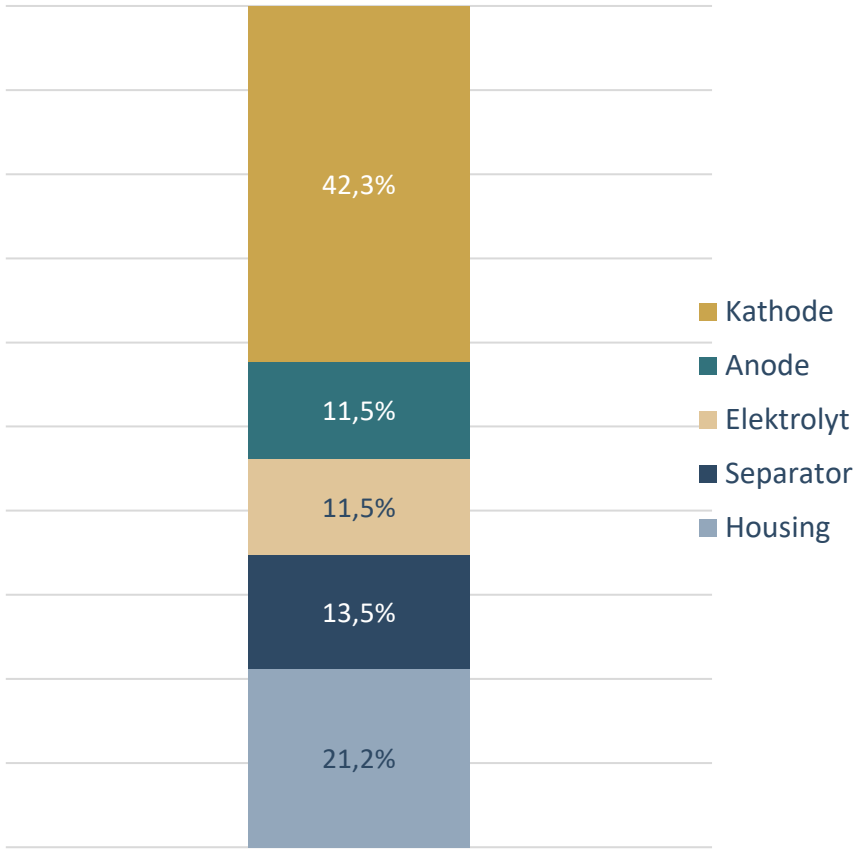
Cell manufacturing: a major part of the costs is location-independent

Cost structure of a battery cell produced in Germany

Total cost structure of manufacturing

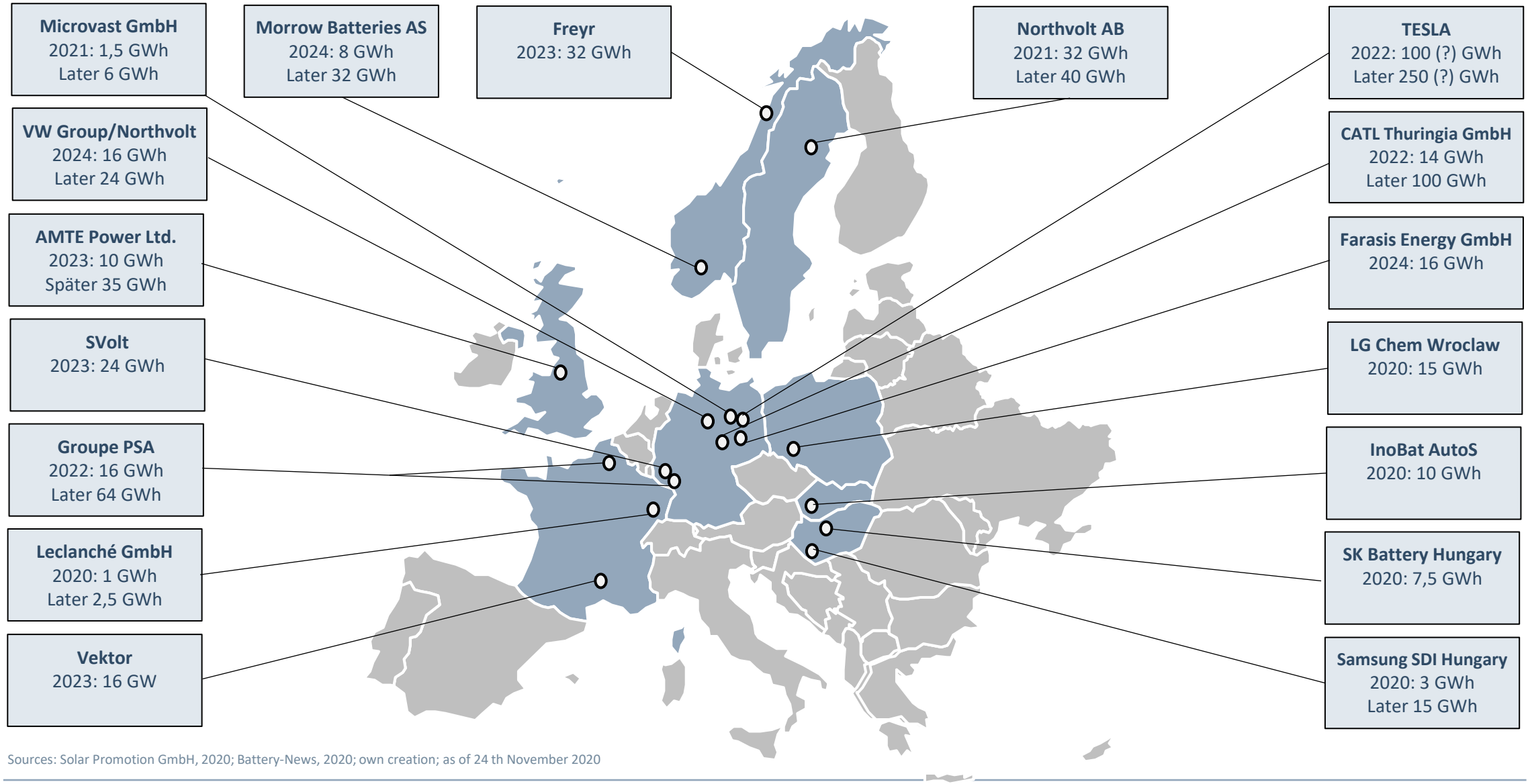


Cost structure of material costs by components



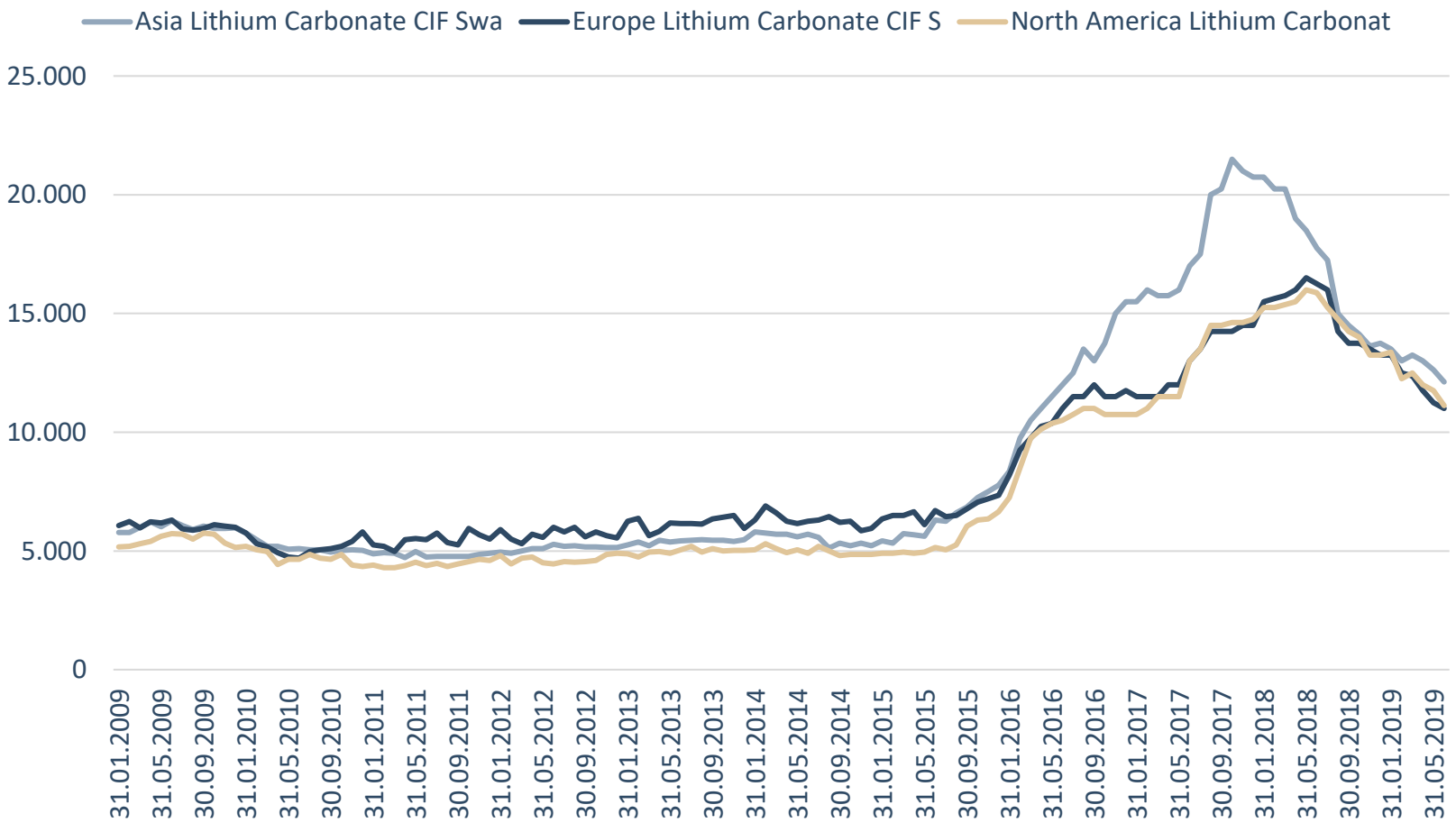
Source: PEM RWTH Aachen, 2019; Avicienne Energy 2017+2018

Massive expansion: planned battery cell production in Europe



Sources: Solar Promotion GmbH, 2020; Battery-News, 2020; own creation; as of 24 th November 2020

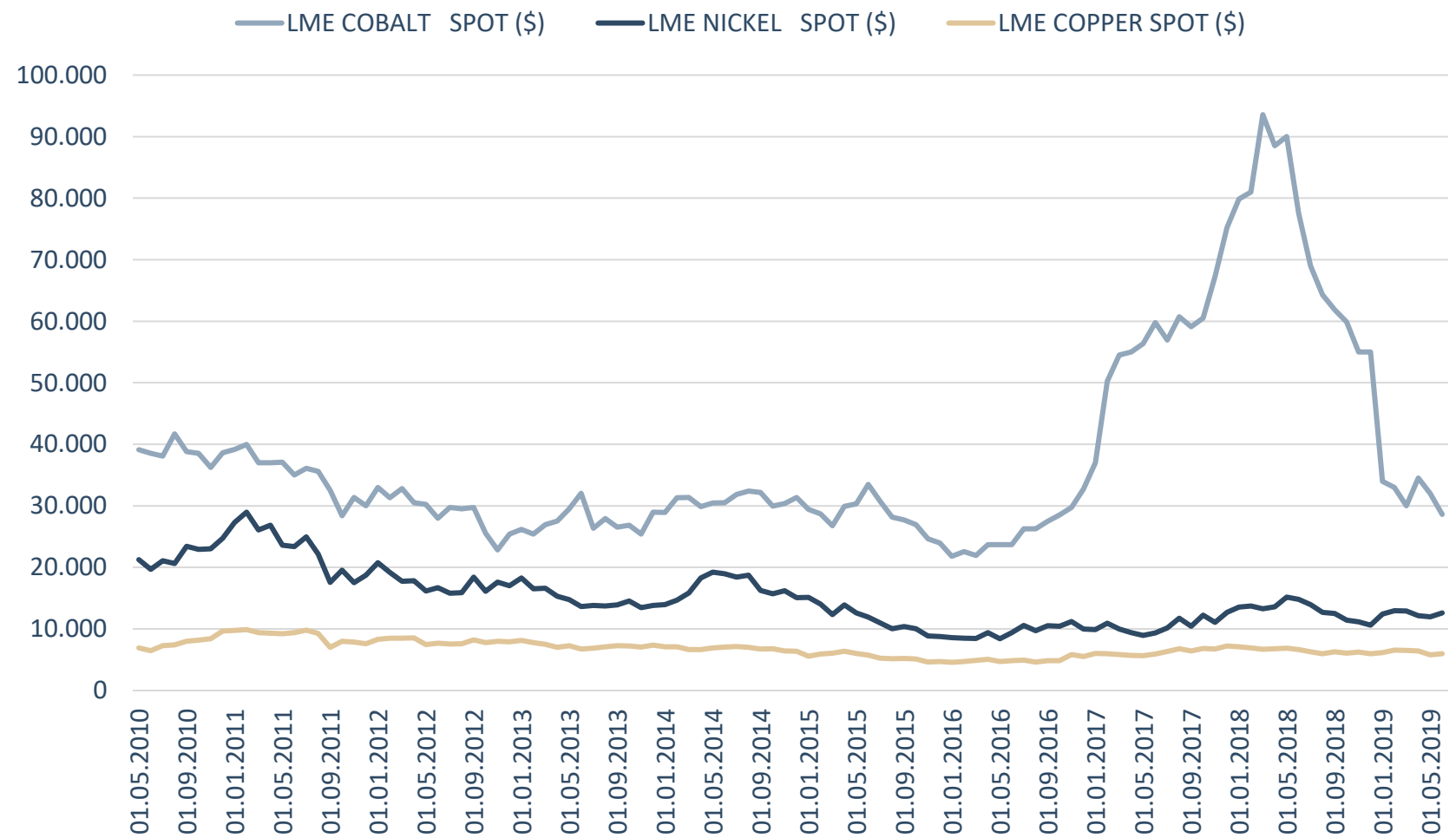
Lithium: price increase completed



- Lithium is highly reactive und is therefore traded in the form of lithium carbonate.
- After a pricing rallye until 2018 the price drops again clearly.
- 80 percent of worldwide lithium production comes from only four companies.

Source: Bloomberg, 2020

Spot prices for important raw materials

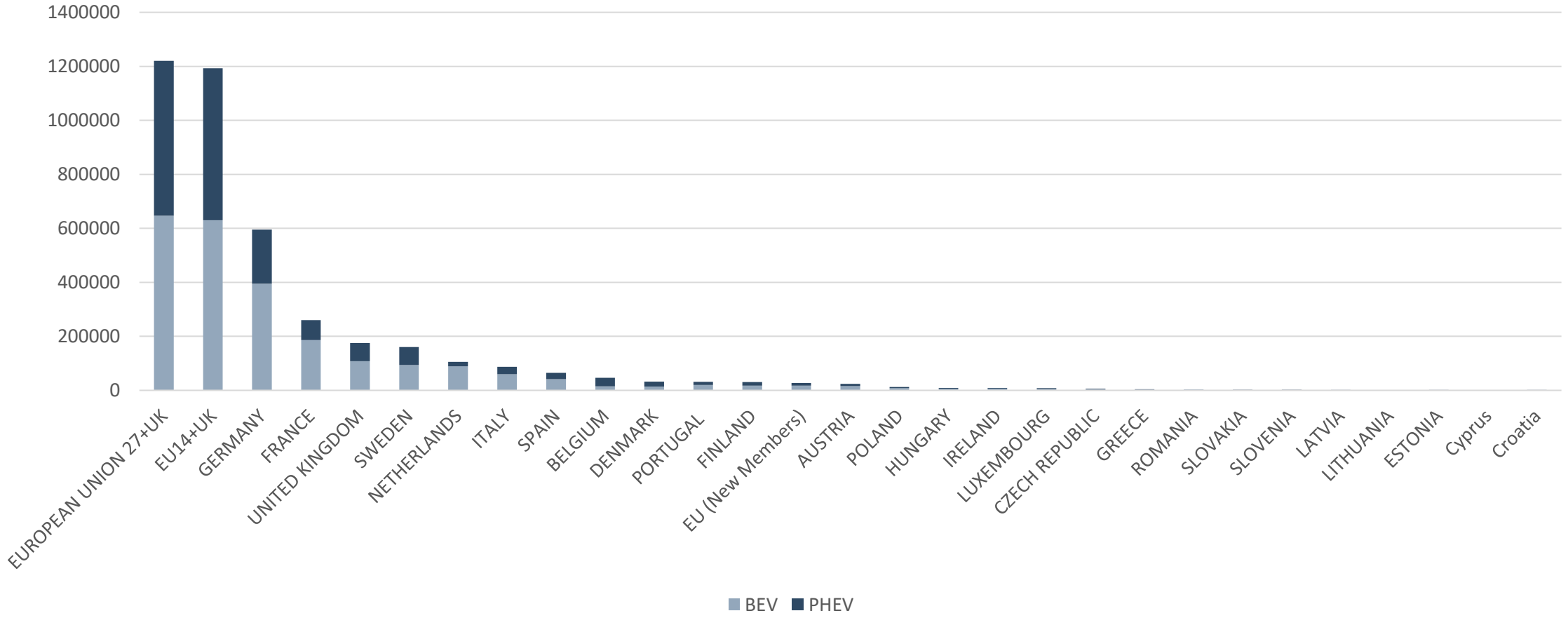


Source: Bloomberg

- Prices for cobalt have risen by a good 200 percent since March 2015 and have collapsed since Mai 2018. They now are on the level of before the price rallye.
- Cobalt is mostly a by-product of nickel and copper production. Falling nickel and copper prices dampen cobalt production.
- Cobalt production and processing are under control of Chinese companies.

Germany counts for 30 percent of new registrations

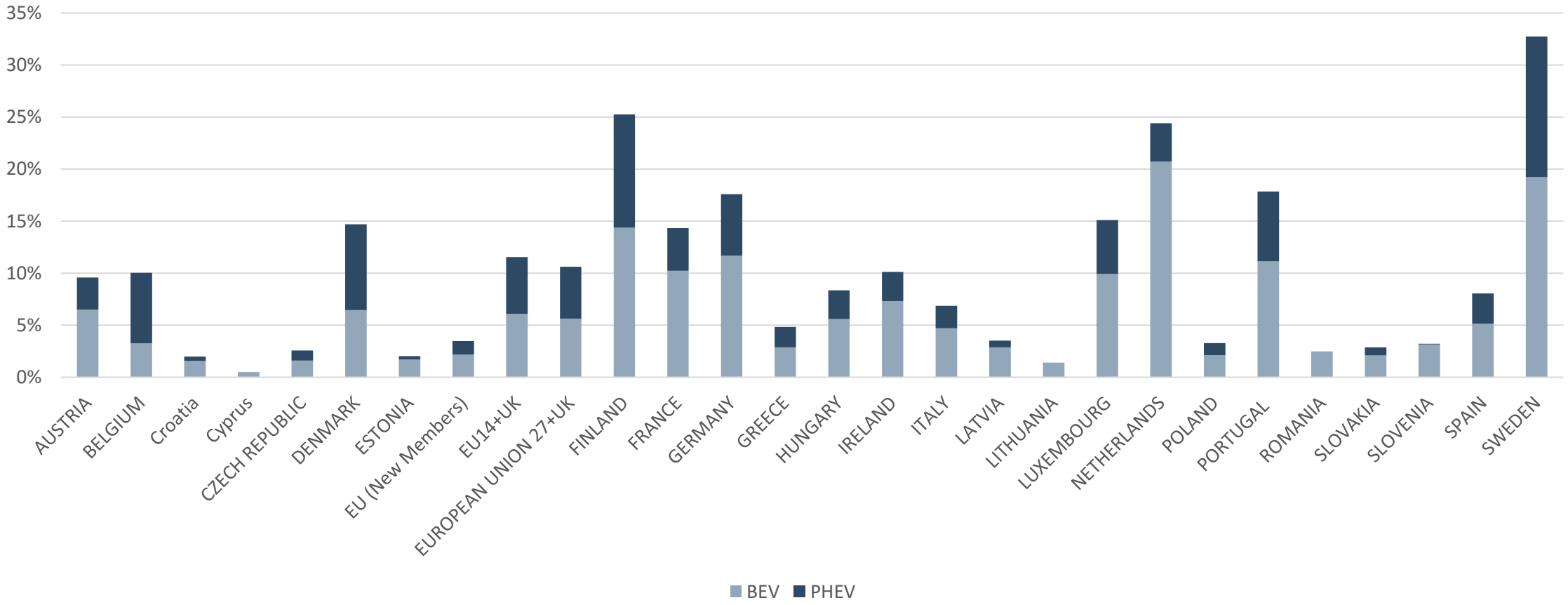
New registrations of electric cars in 2020 in the EU – number of units (Stand: Q3)



* No data for Bulgaria und Kroatia
Source: ACEA, 2020

Registrations of electric cars: Large regional differences

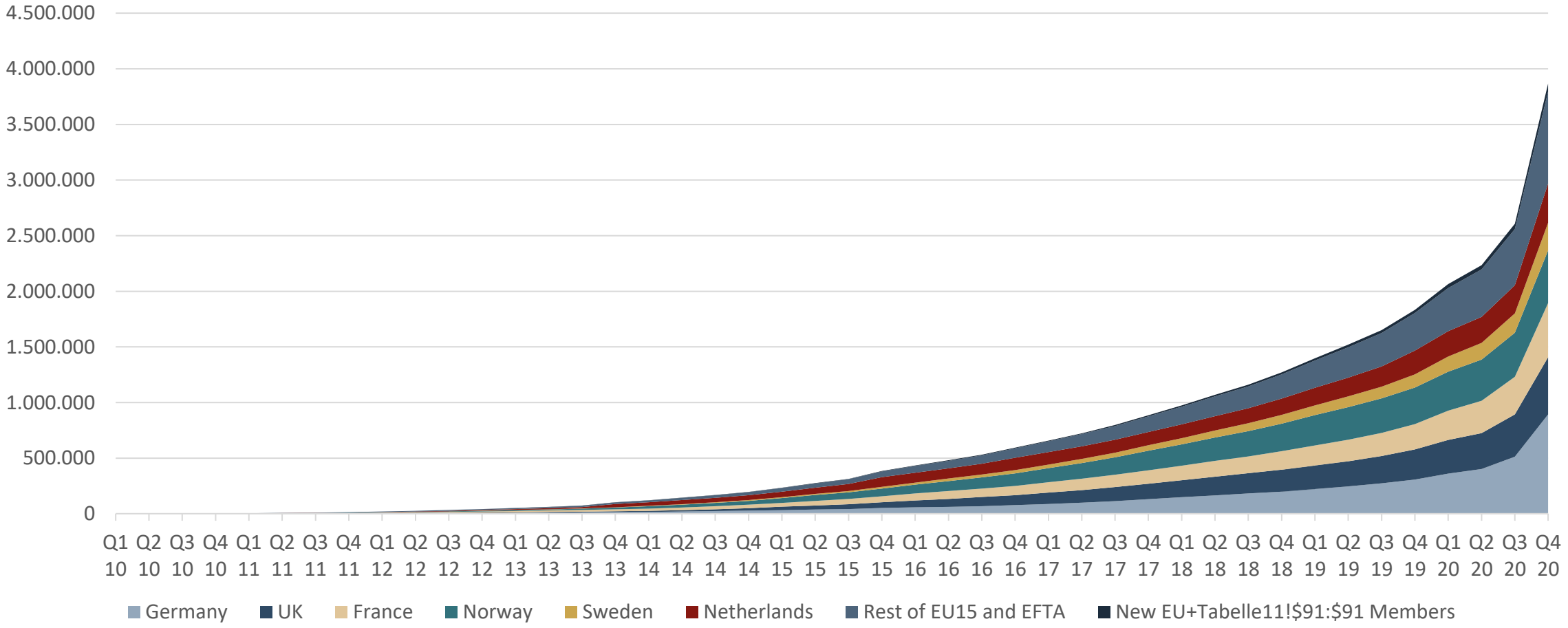
Market share of electric cars in EU 27+UK – indicate in percentage



* No data for Bulgaria und Kroatia
Source: ACEA, 2020

Electric vehicles are concentrated in a few countries

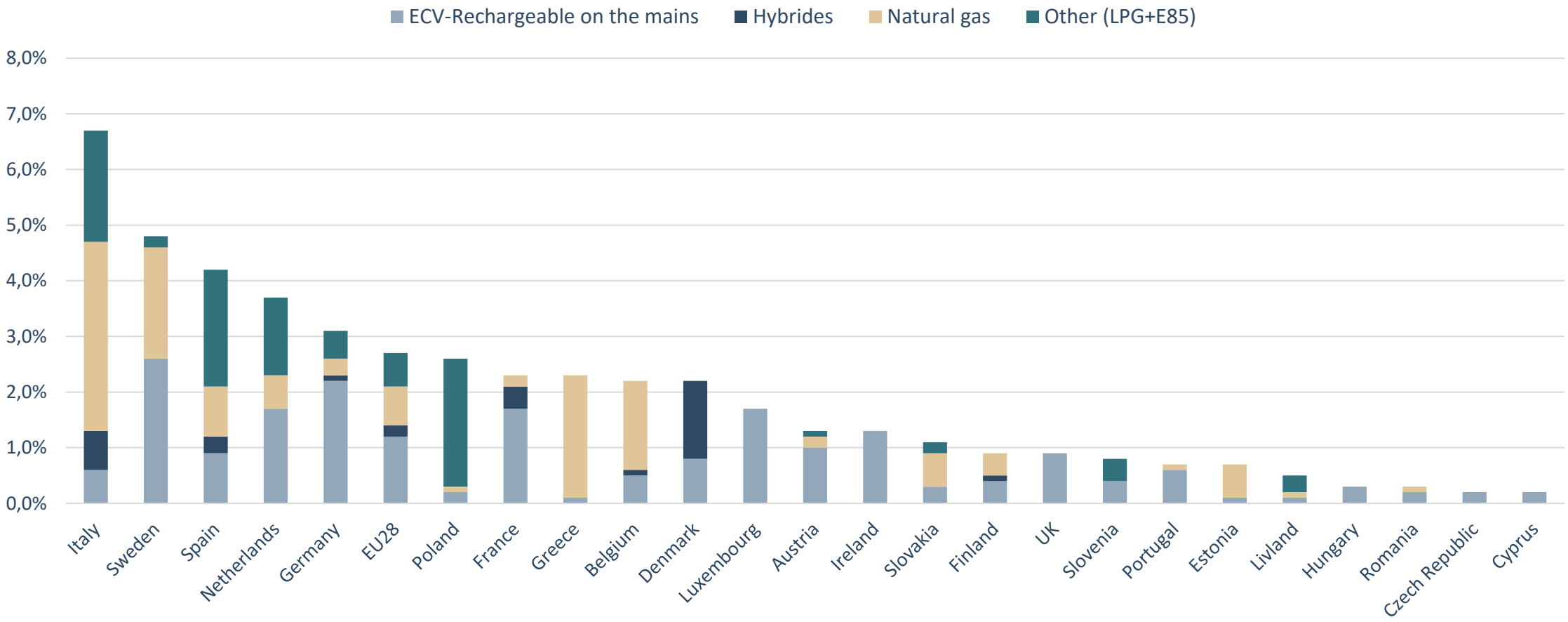
Cumulated new registrations of BEVs and PHEVs in EU and EFTA since January 2010



Source: ACEA, 2021

Agricultural vehicles: Alternative drives still at the beginning of the road

Market shares of agricultural vehicles with alternative drives in EU 27+UK – indicate in percentage

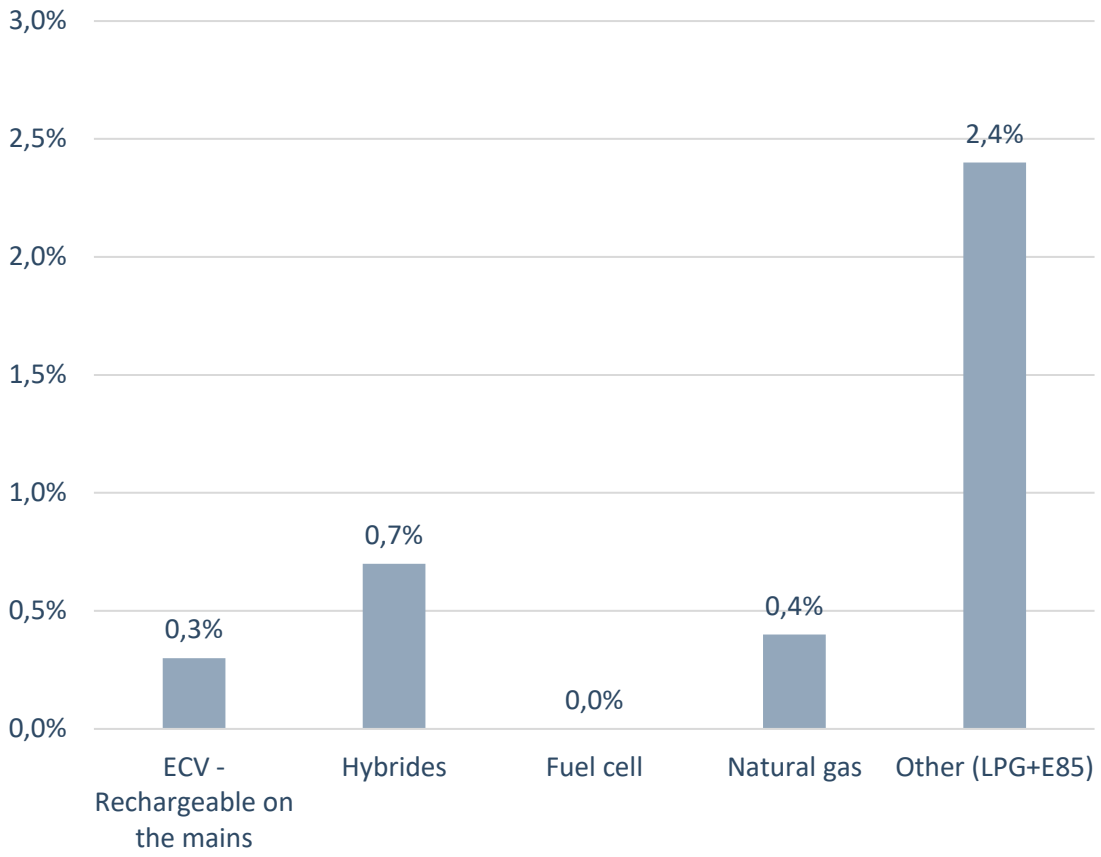


*No data for Bulgaria, Kroatia, Malta, Lithuania
Source: ACEA, 2020

Only a few vehicles on the road

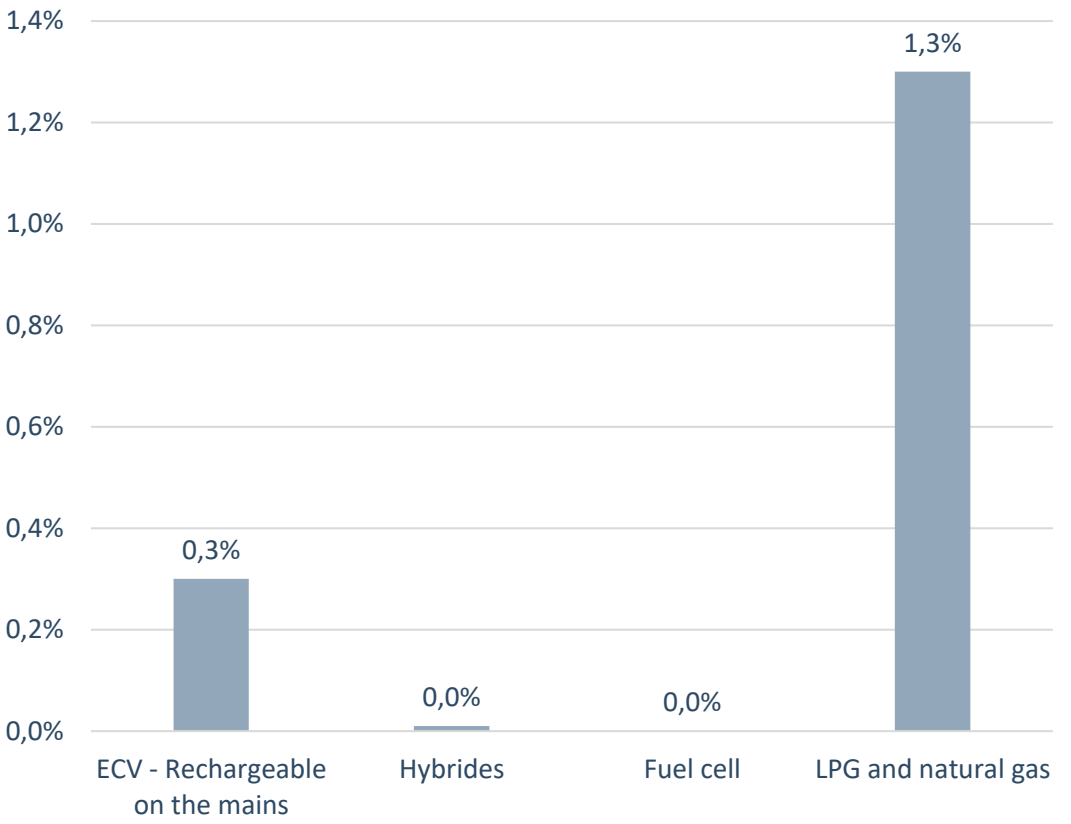
Only a fraction of the fleet has got an alternative drive

Share of alternative drives in the **passenger car fleet** in 2018



Only a fraction of the fleet has got an alternative drive

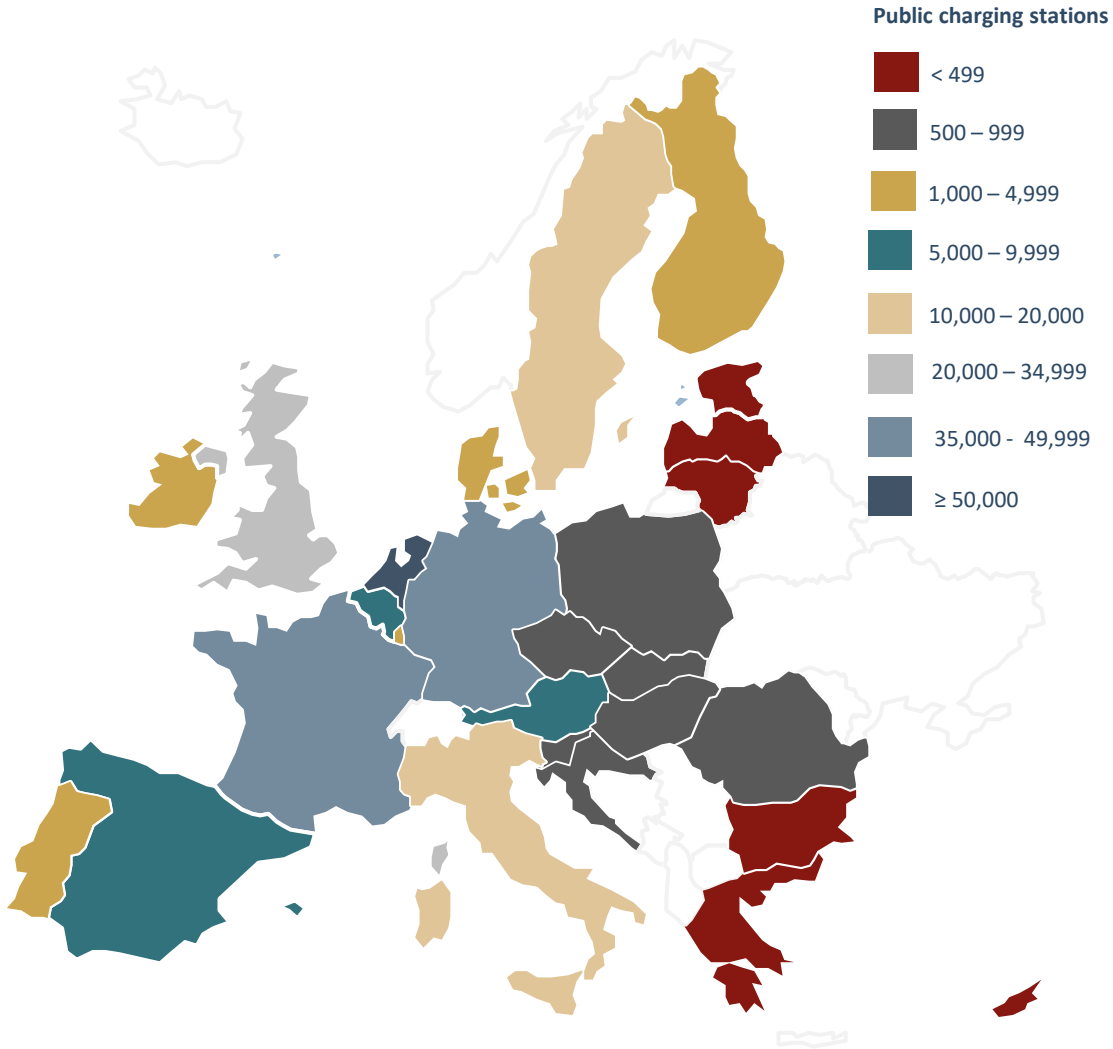
Share of alternative drives in the stock of **light commercial vehicles** in 2018



Source: ACEA, 2020

Charging infrastructure is concentrated in a few countries

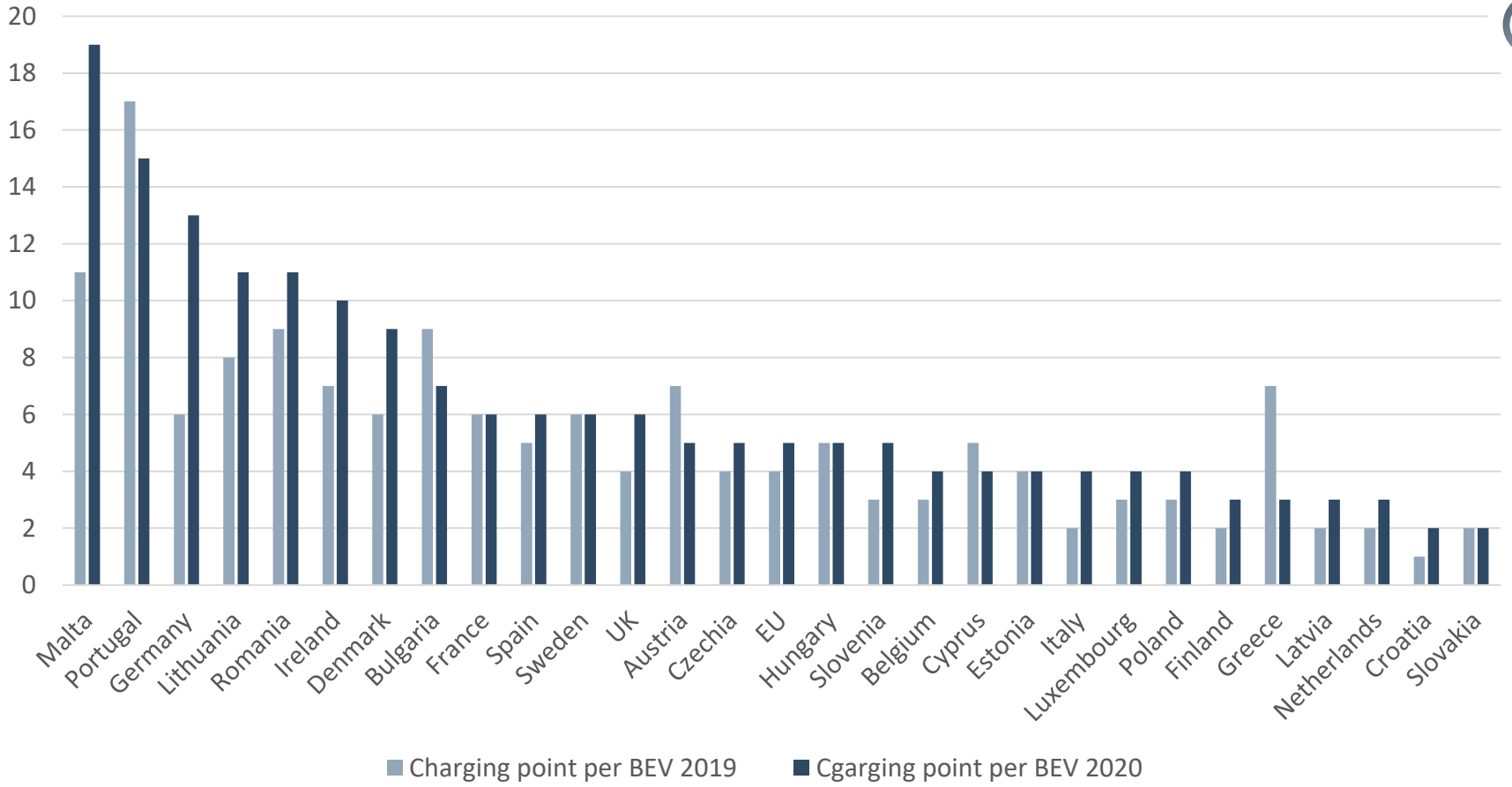
Country	Charging stations 2020	Of which > 22kW	Share in the EU
EU27	199,825	25,288	100%
Niederlande	66,664	2,428	29.69%
Frankreich	46,045	4,045	20.51%
Deutschland	44,669	**7,456**	19.89%
Italien	13,381	1,231	5.96%
Schweden	10,412	1,608	4.64%
Belgien	8,482	476	3.78%
Österreich	8,232	1,347	3.67%
Spanien	8,165	2,120	3.64%
Finland	3,728	484	1.66%
Dänemark	3,254	555	1.45%
Portugal	2,470	494	1.10%
Polen	1,687	648	0.75%
Ungarn	1,295	287	0.58%
Tschechien	1,200	610	0.53%
Irland	1,102	290	0.49%
Luxemburg	1,063	12	0.47%
Slowakei	925	269	0.41%
Slowenien	747	135	0.33%
Kroatien	670	187	0.30%
Rumänien	502	185	0.22%
Estland	424	201	0.19%
Griechenland	334	81	0.15%
Lettland	314	235	0.14%
Bulgarien	195	76	0.09%
Litauen	179	100	0.08%
Malta	101	0	0.04%
United Kingdom	33,470	6,248	Brexit



Sources: ACEA, 2020

Public charging stations - a chicken-and-egg problem

So far, there are only a few BEVs per public charging point

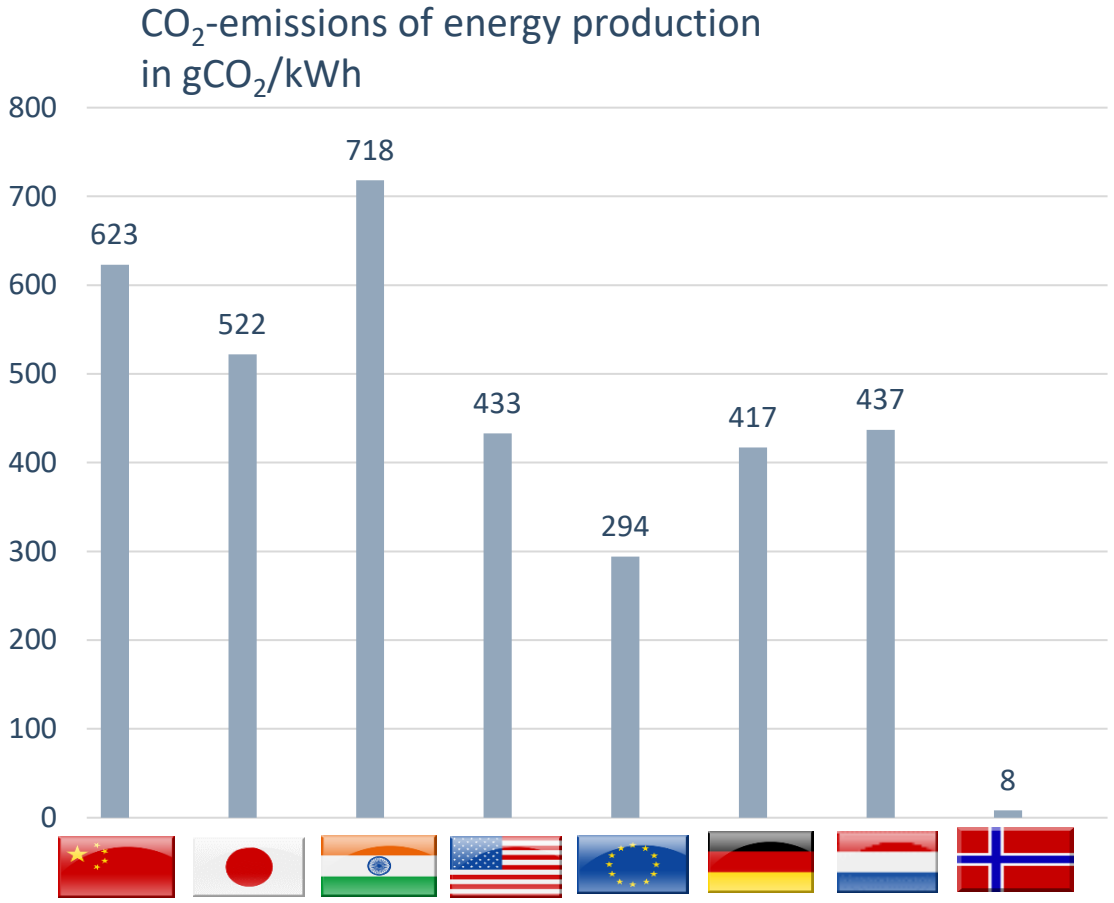


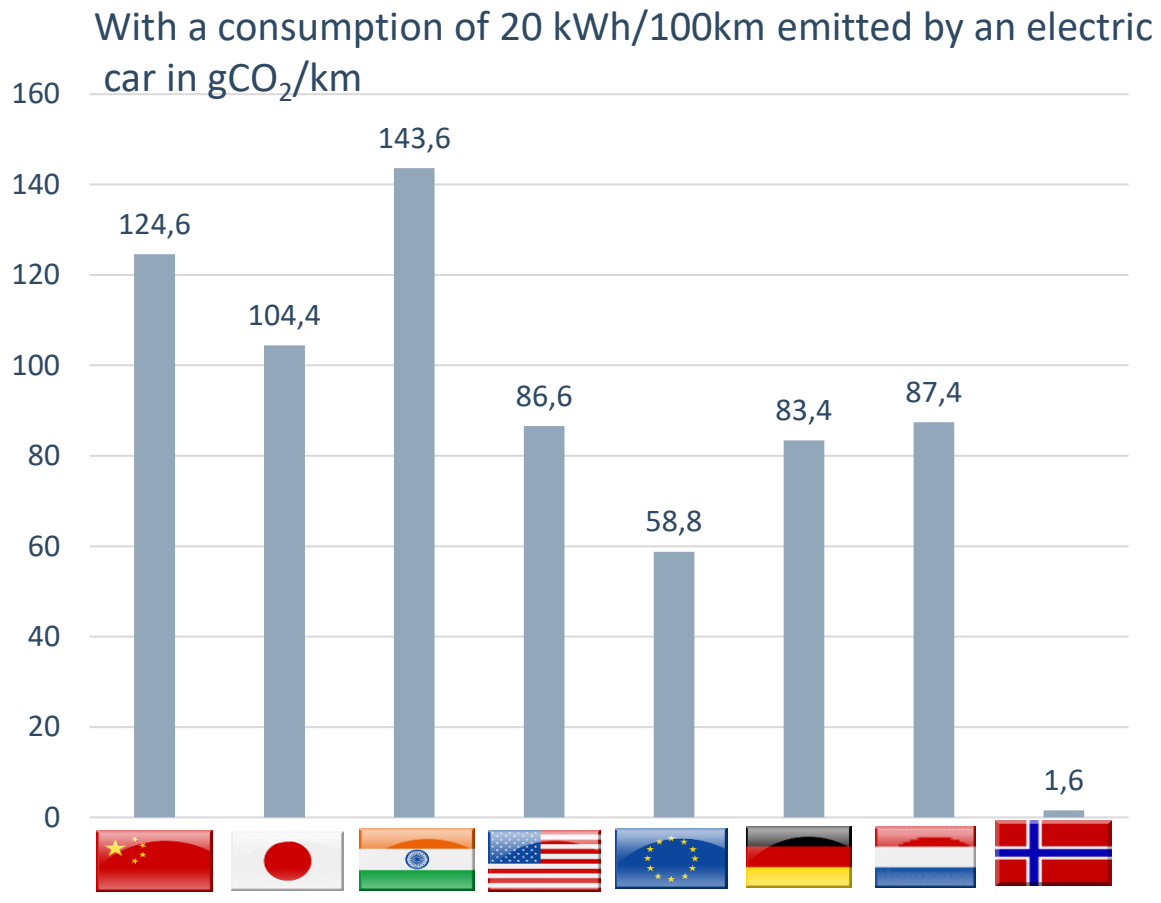
- A dense network of public charging points is needed for BEVs to spread on the mass market.
- However, with only a few charging processes per charging point, their operation is not economically viable.
- The situation is aggravated by the fact that today 80 percent of charging processes take place at non-public charging points.
- Problem: The lamppost parker needs the public network, but the current owner of a BEV usually does not.

Quelle: EAFO, 2021

Energy mix decides on climate friendliness

CO_2-emissions of energy production and electric cars

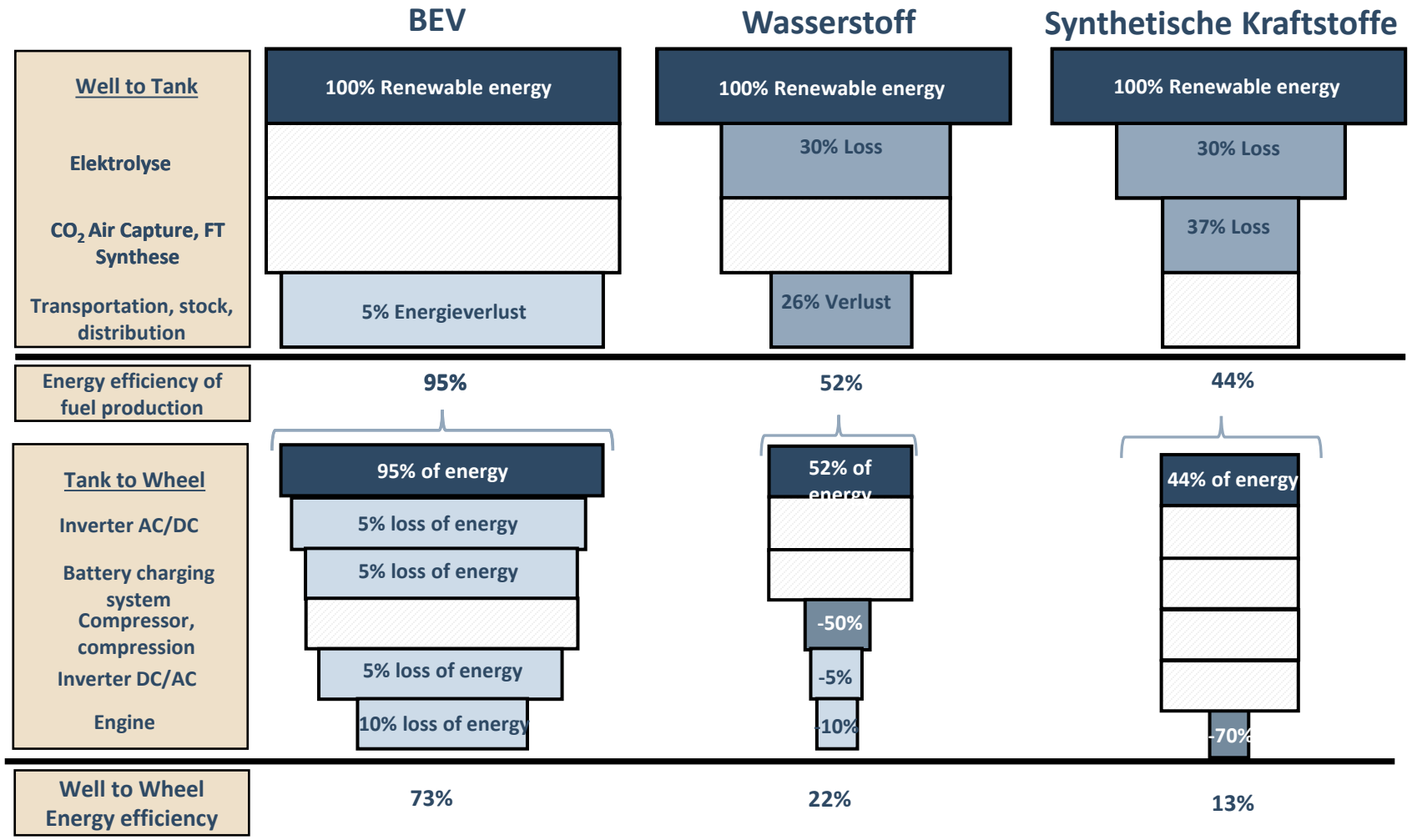




Source: IEA, CO_2-Emissions from Fuel Combustion, 2019, own calculations

Efficiency edge for BEV, but efficiency is not all

Energy efficiency in the Well to Wheel perspective by diverse energy storage systems



But:

- Technical efficiency is different from system efficiency.
- Hydrogen and synthetic fuels achieve higher weight- and volume-specific energy densities.
- Both are better suited for the indispensable energy import.
- Synthetic fuels can decarbonize vehicle stock.
- Even in the most optimistic scenarios, direct electrification is not sufficient to meet the climate targets in transportation.

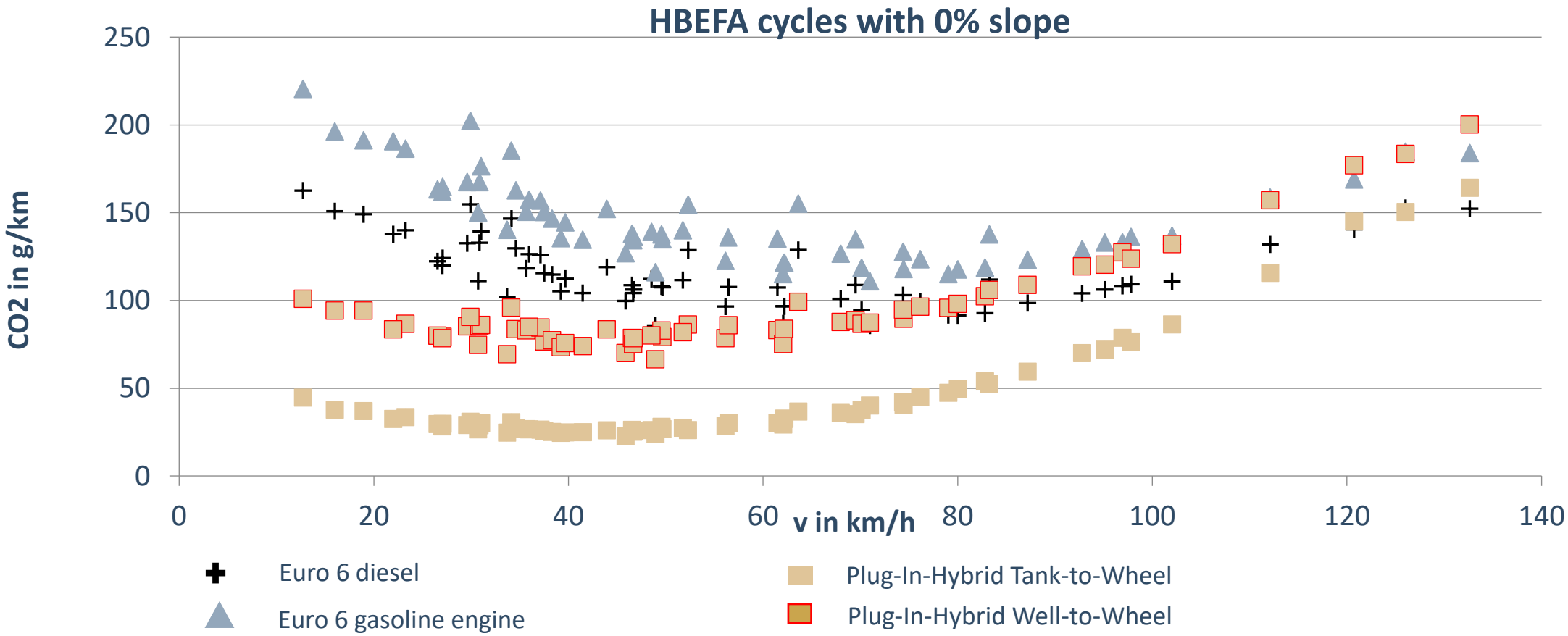
Conclusion

All alternatives will be needed to achieve the climate targets in transport.

Source: Transport & Environment, 2019

The speed makes the difference

CO_2-emissions of middle class passenger cars with different drive variants and driving speeds



Source: TU Graz, 2018