



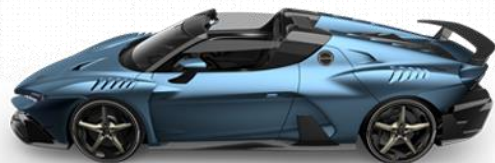
AIIT con PoliTo e ACI

“Veicoli elettrici, sfide progettuali ed opportunità”

Antonio Casu
CTO Italdesign Giugiaro

Electric Vehicle Integration

20/02/2020



ULTRA-LIMITED SERIES PRODUCTION



COMPLETE VEHICLE DEVELOPMENT



DEVELOPMENT OF INTEGRATED MOBILITY SOLUTIONS

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EVs Architecture and Technologies



Actual BEVs and PHEVs Stock



Some Reasons...



Technological Tasks:
Safety Relevant Aspects



EVs Outlook

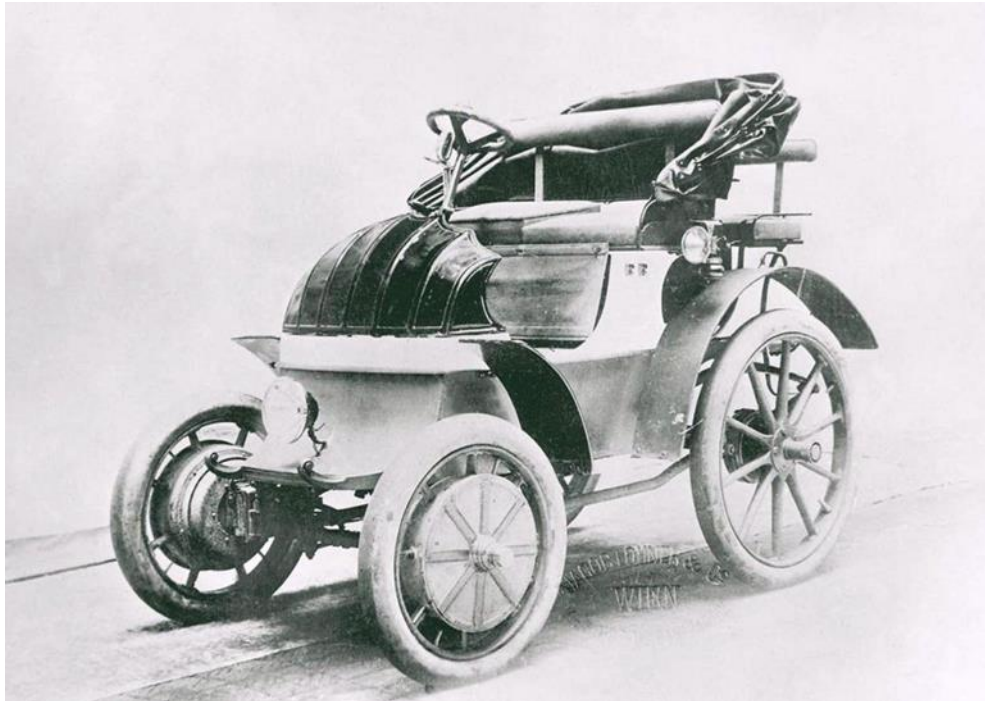


Main E-traction Competences



EVs Architecture and Technologies

Electric car history



Lohner-Porsche 1899 in-wheel electric motors

Automobil-Ausstellung
Berlin 1899.

VEREINIGTE ELECTRICITÄTS-A.-G.
 und
JACOB LOHNER & CO.

KAISERL. und KÖNIGL. HOF-WAGEN-FABRIK
 AUTOMOBIL-CONSTRUCTEURS.

CARROSSIERS de la COUR I. et R. de l'AUTRICHE HONGRIE
 CONSTRUCTEURS d'AUTOMOBILES.

WIEN * BUDAPEST.

Electrische Automobile **System Egger-Lohner** Voitures Électriques

Internationale Motor-Wagen-Ausstellung 1899
Goldene Medaille.

Internationaler Wettbewerb der elektrischen Automobile
I. Preis

Phaeton C2.

25 km/h

5HP

110-210 Ah
550 kg

1350 kg

Electromotor Egger 3-5 HP, 500 Touren.
 Accum.-Batterie Gewicht circa Kg. 550.
 44 Zellen, Capacität. Amp.-St. 110-120.
 Fahrtdauer in der Horizontalen mit einer
 Ladung 3-6 St.
 Geschwindigkeit bis 25 Kilometer.
 Bremsung: Electricisch und mechanisch.
 Gewicht Kg. 1350 complet.

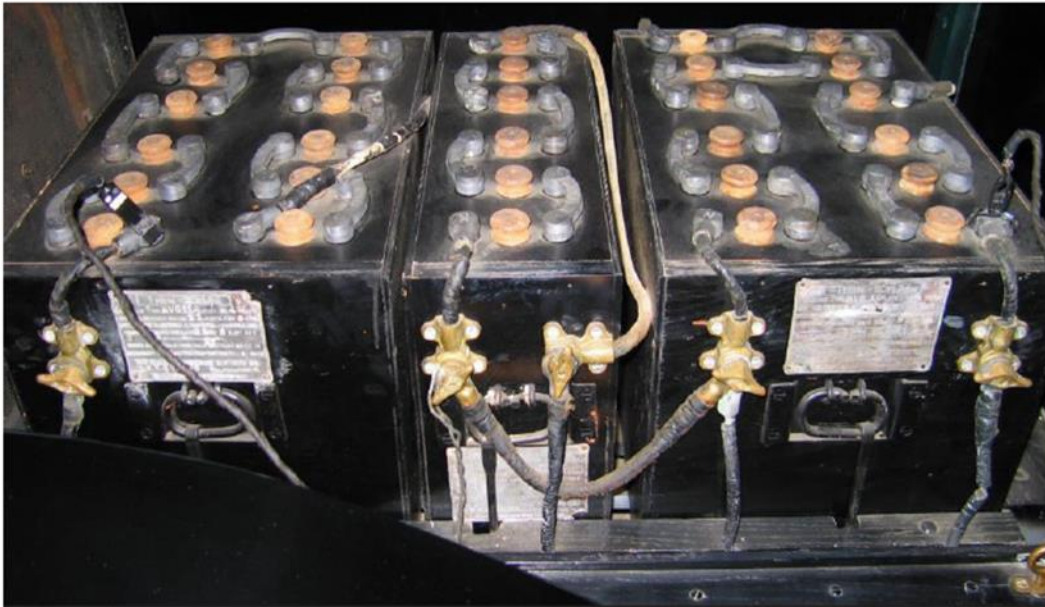
Moteur Électr. Egger 3-5 HP, 500 Tours.
 Accumulateurs Poids env. Kg. 550.
 44 Elements, Capacité Amp.-H. 110-210.
 Parcours en palier avec une charge
 3-6 Heures.
 Vitesse Maximale 25 Kilomètres.
 Freins Électriques et à Rubans.
 Poids total Kg. 1350.

LOCO WIEN. fl. 4.400 = Mk. 7.400 = Fcs. 9.300. PRIX à Vienne

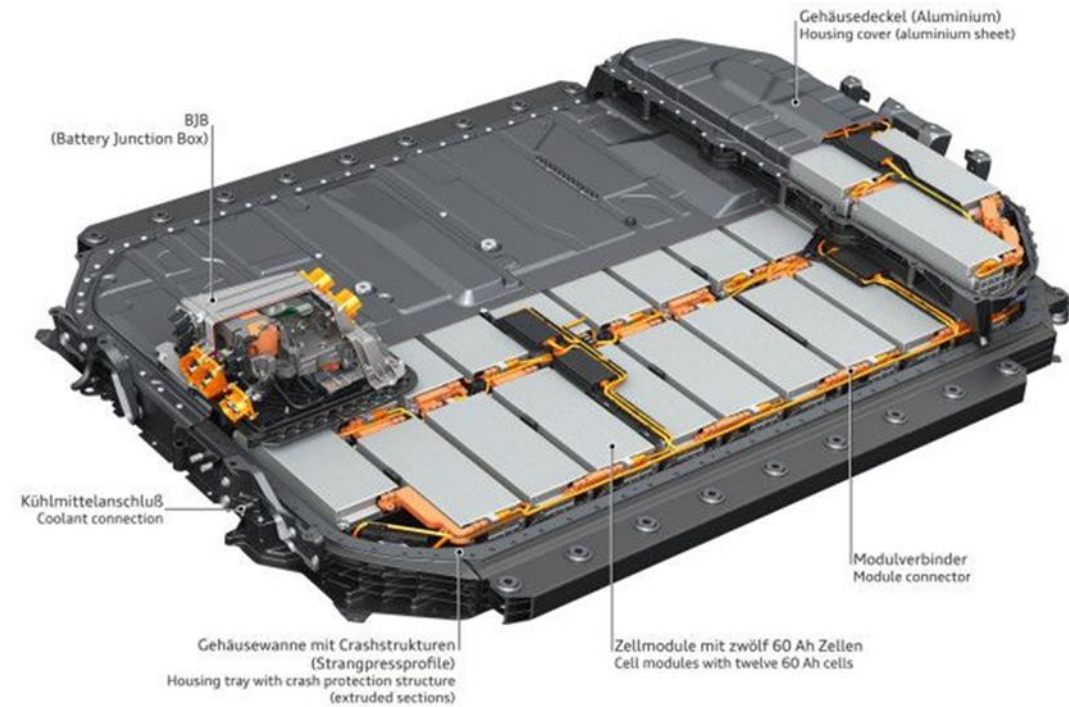
LIEFERZEIT 3 MONATE * TERME DE LIVRAISON 3 MOIS.

EVs Architecture and Technologies

Battery Pack complexity



Baker Electric Queen Victory Battery Pack (1910)

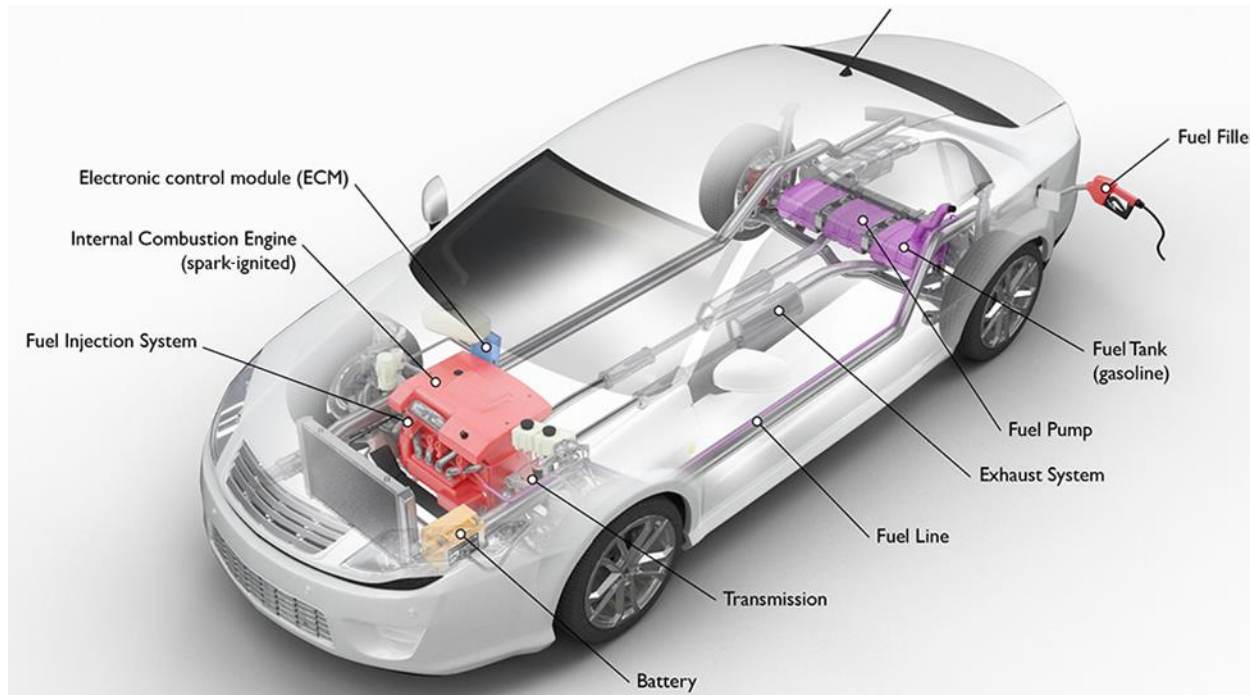


Audi E-tron Battery Pack (2017)

EVs Architecture and Technologies

Internal Combustion Engine

Internal Combustion Engine



Source: afdc.energy.gov

NOTE

Energy density: 13 kWh/kg

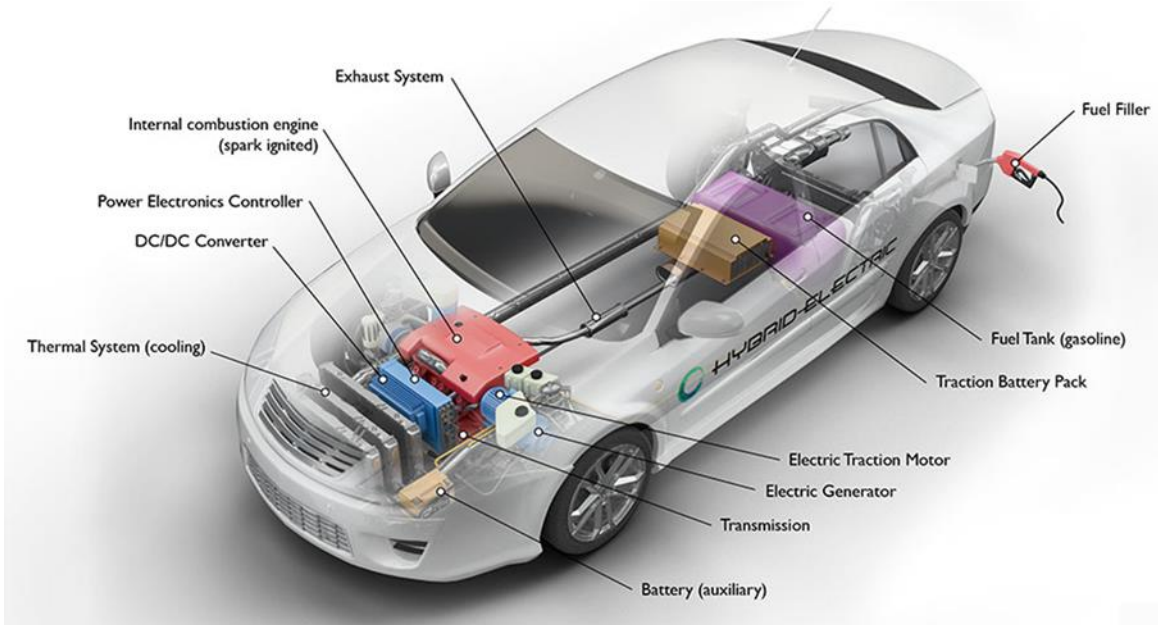
Average range: 900 km

Well known technology

EVs Architecture and Technologies

Hybrid Electric Vehicles

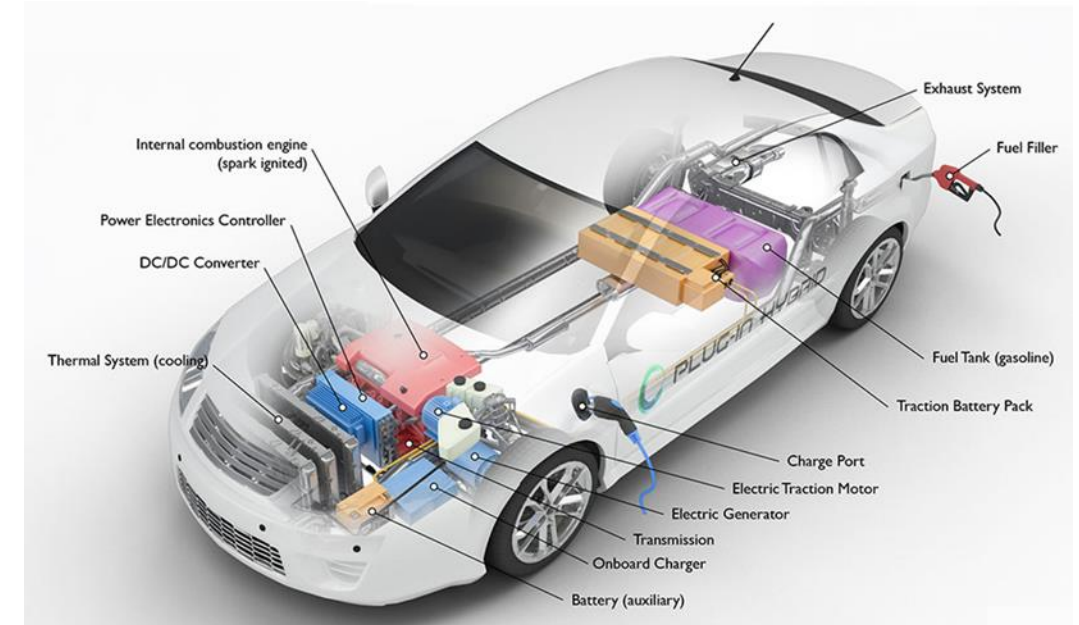
Hybrid Electric Vehicle



Source: afdc.energy.gov

- *Battery Pack Energy < 2 kWh*
- *Power provided to the wheels from ICE, EM, or both*

Plug-in Hybrid Electric Vehicle

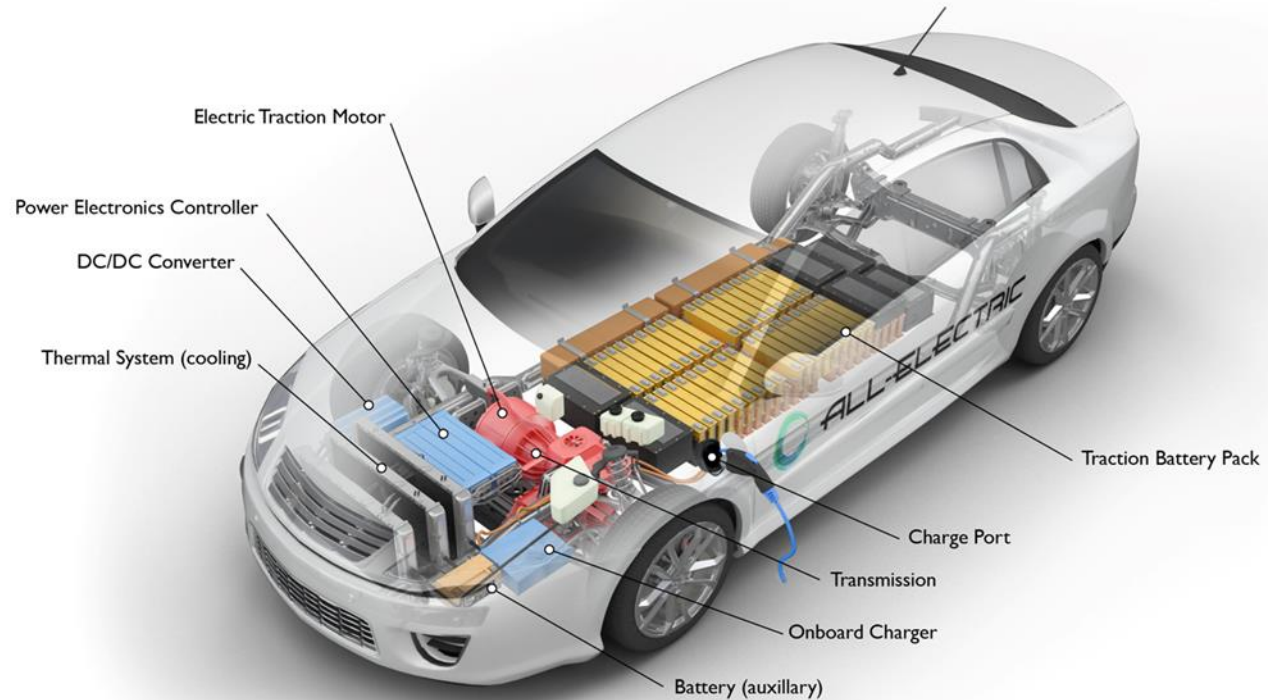


- *Battery pack energy \approx 10 kWh*
- *Possibility to travel powered only by the battery charging it from an external outlet*

EVs Architecture and Technologies

Battery Electric Vehicle

Battery Electric Vehicle



Source: afdc.energy.gov

NOTE

Energy density: 280 Wh/kg

Average range: 300 km

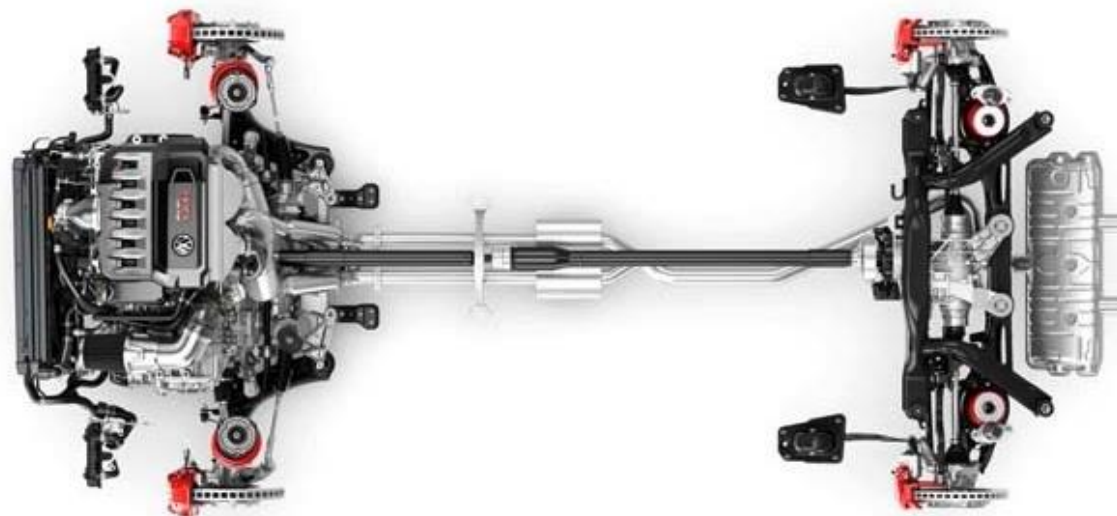
Technological constraint: Battery pack weight and size



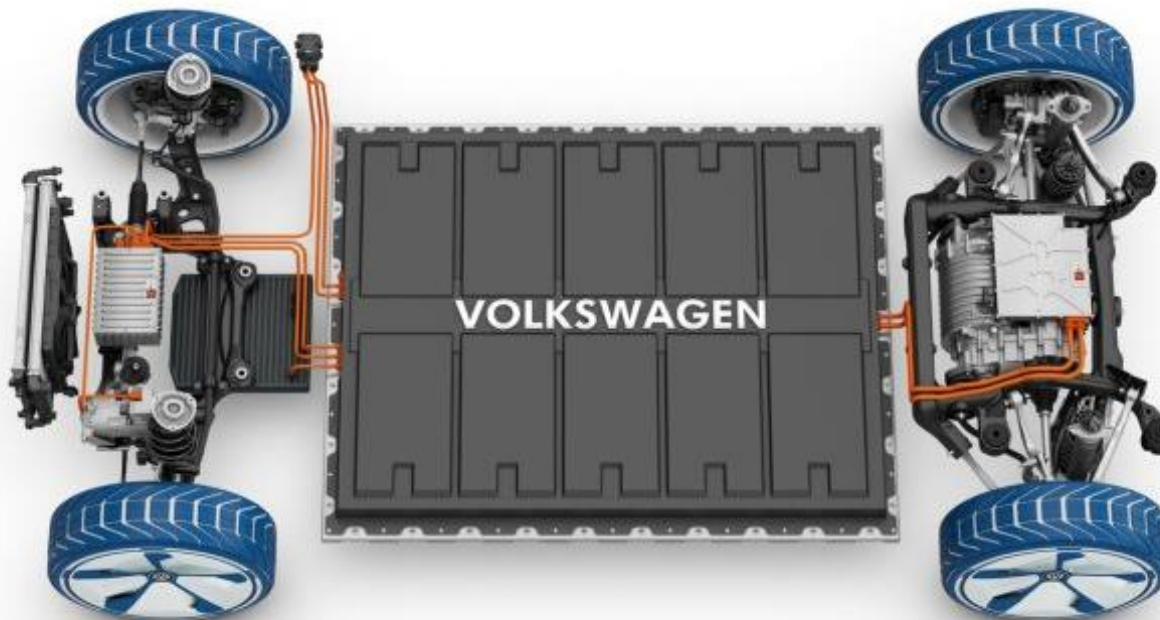
EVs Architecture and Technologies

Technologies Comparison

VW Golf GTI
(ICE)



VW MEB
(EV)



EVs Architecture and Technologies

AUDI e-tron



Elektrischer Antriebsstrang Electric drivetrain 07/19

Optionaler Ladeanschluss für AC-Laden
Optional charging point for AC charging

Wassergekühltes Hochvolt-Ladegerät
Water cooled HV-charger

Wassergekühltes
Hochvolt-Ladegerät (optional)
Water cooled HV-charger
(option)

E-Maschine hinten mit
Leistungselektronik
Rear electric motor with
power electronics

E-Maschine vorne mit
Leistungselektronik
Front electric motor with
power electronics

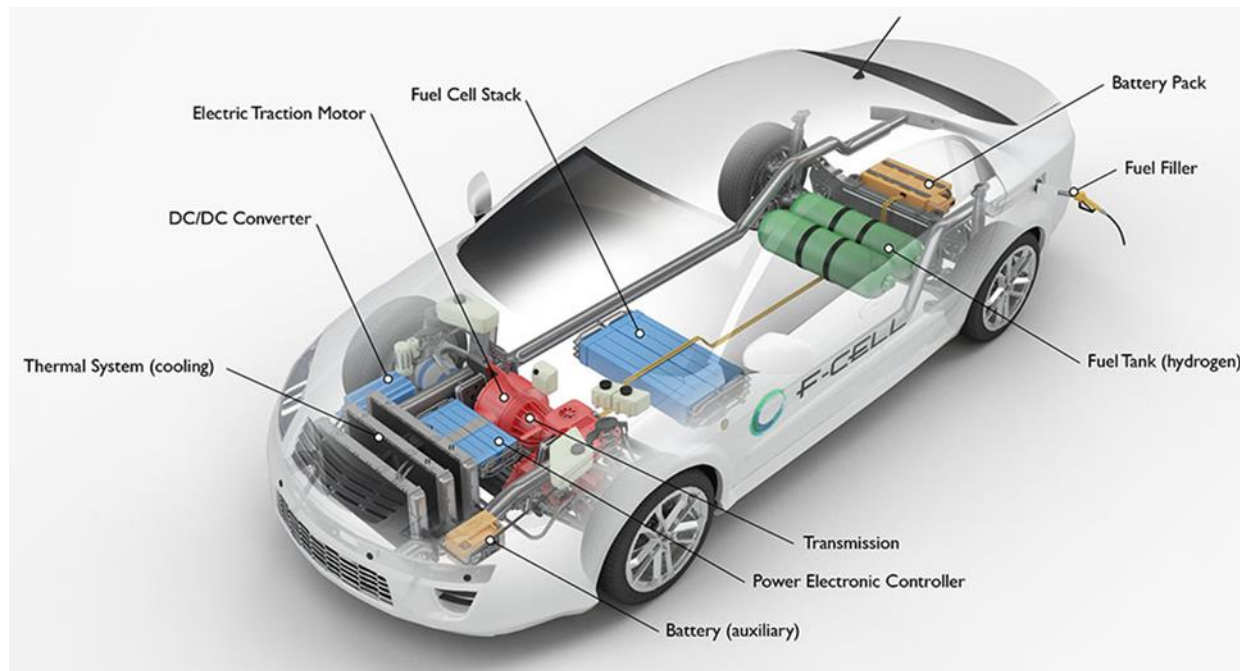
Flüssigkeitsgekühlte Lithium-Ionen-Batterie mit 71 kWh
Liquid cooled lithium-ion battery with 71 kWh

Ladeanschluss für AC- und DC-Laden
Charging point for AC and DC charging

EVs Architecture and Technologies

Fuel Cell Electric Vehicle

FCEV



Source: afdc.energy.gov

NOTE

Energy density: 40 kWh/kg (700 bar)

Average range: 500 km

Constraint: In-vehicle Hydrogen storage

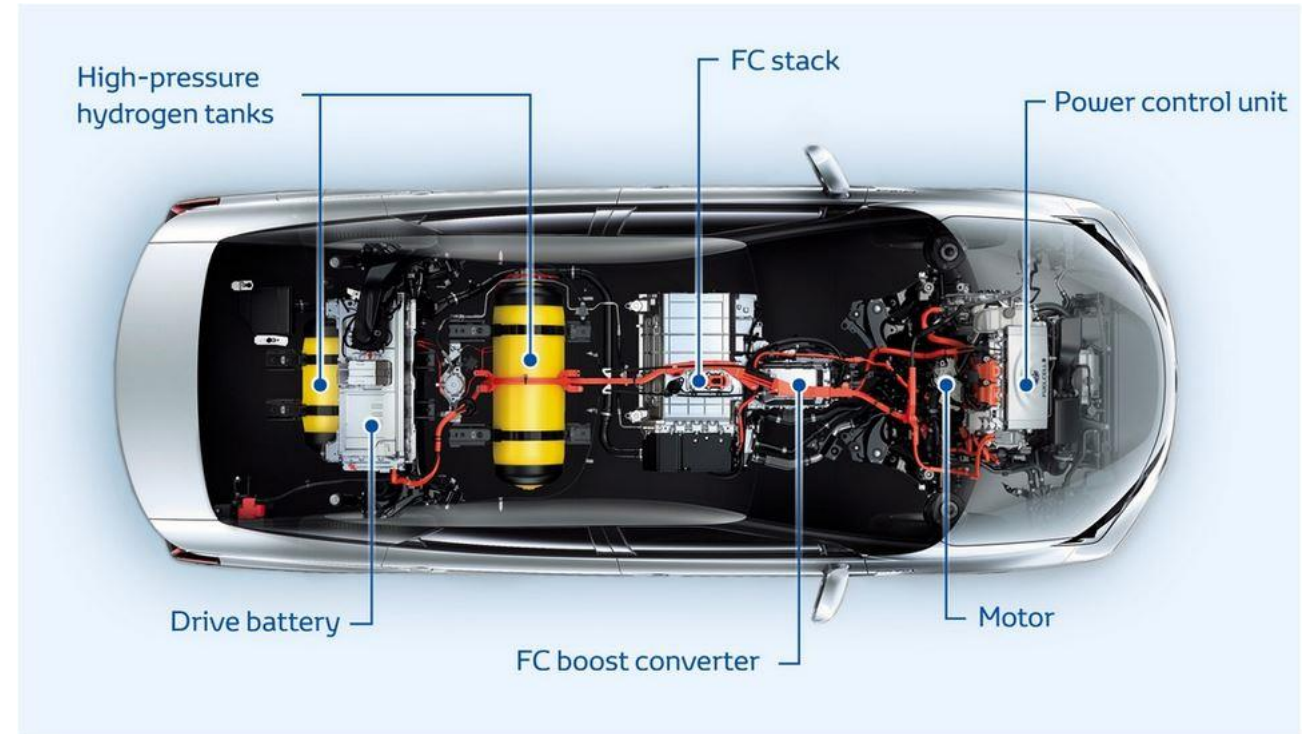


EVs Architecture and Technologies

TOYOTA Mirai

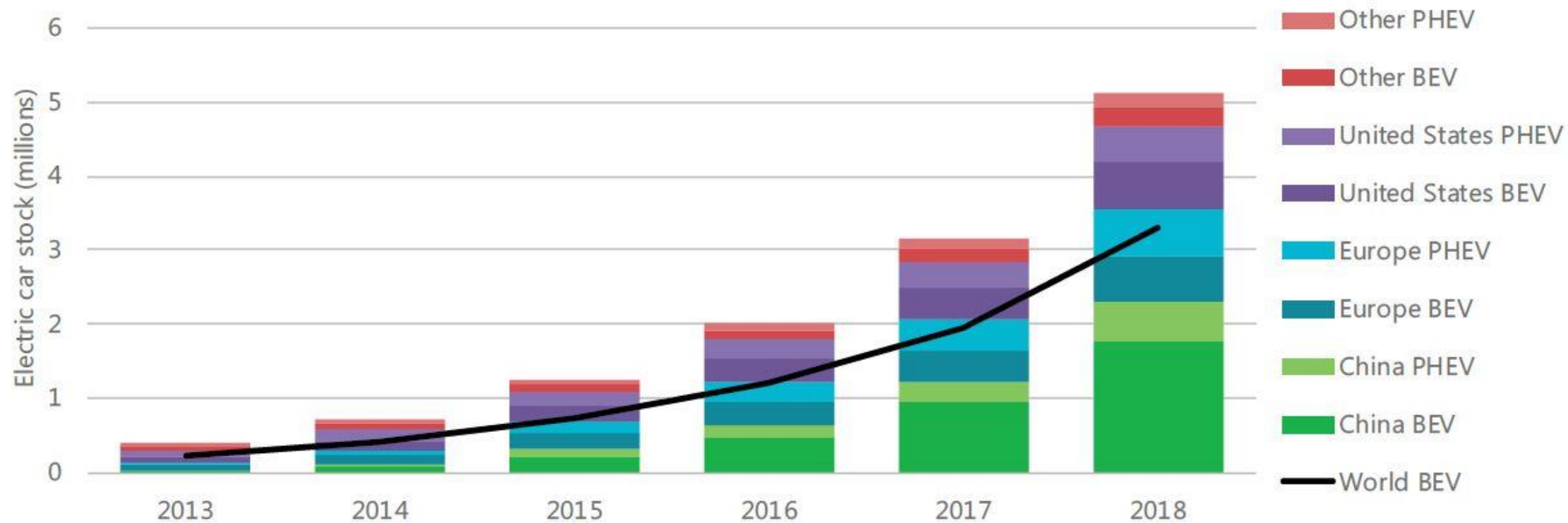


MIRAI
FUEL CELL VEHICLE





Actual BEVs and PHEVs Stock



Electric cars stock: 2013-2018 Source: International Energy Agency (2019)



Some Reasons... Appeal



Alfa Romeo 156 (1997)



Toyota Prius (1997)



Some Reasons...

Range Anxiety

RANGE ANXIETY	
Word Mark	RANGE ANXIETY
Goods and Services	IC 035. US 100 101 102. G & S: Promoting public awareness of electric vehicle capabilities
Standard Characters Claimed	
Mark Drawing Code	(4) STANDARD CHARACTER MARK
Serial Number	85078275
Filing Date	July 6, 2010
Current Filing Basis	1B
Original Filing Basis	1B
Owner	(APPLICANT) General Motors LLC LIMITED LIABILITY COMPANY DELAWARE 300 Renaissance Center Detroit MICHIGAN 482653000
Attorney of Record	Timothy G. Gorbatoff
Type of Mark	SERVICE MARK
Register	PRINCIPAL
Live/Dead Indicator	LIVE

"Range anxiety". (Richard Acello, San Diego Business Journal)

Requested and obtained trademark by GM.



Some Reasons...
Costs



Starting price ca. 11 k€



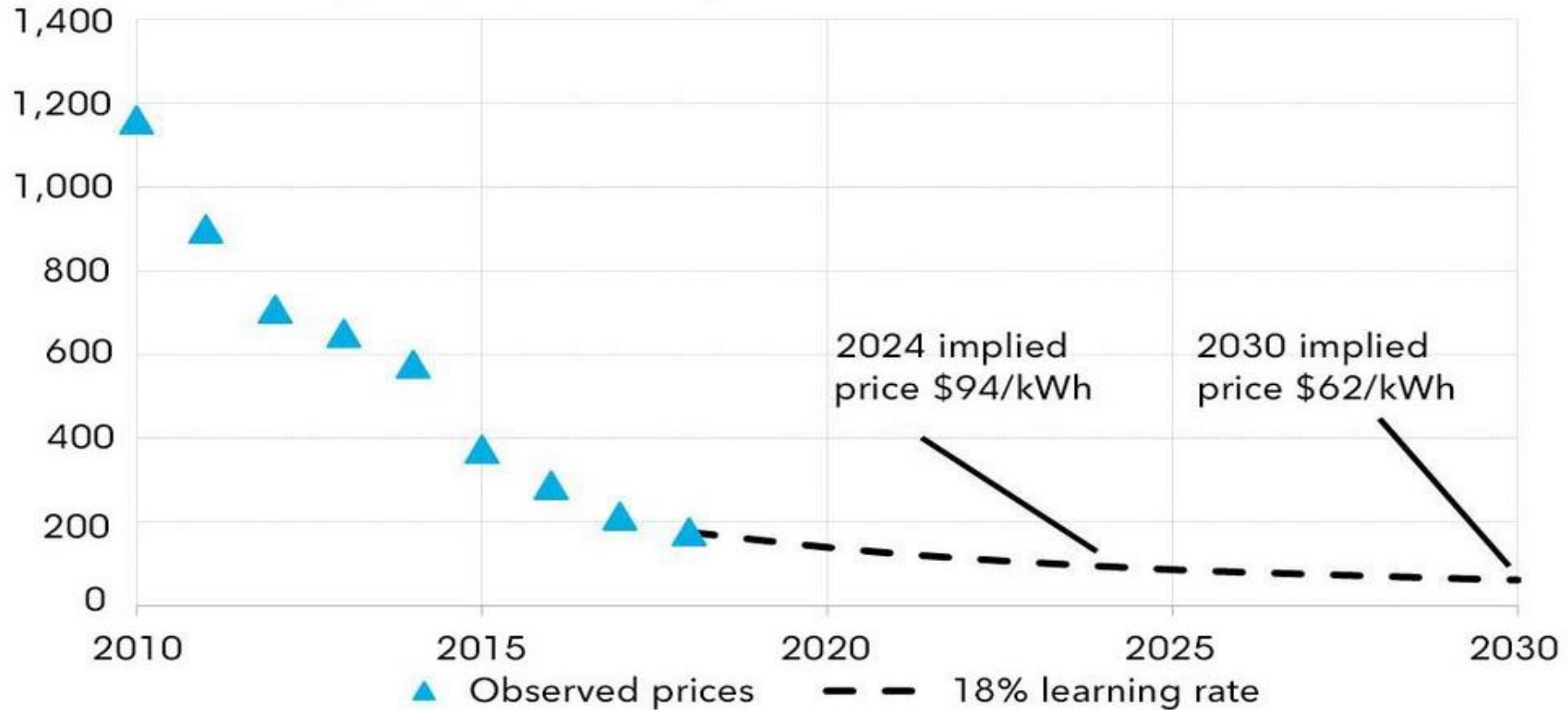
Starting price ca. 23 k€

Some Reasons...

Costs

Lithium-ion battery price outlook

Lithium-ion battery pack price (real 2018 \$/kWh)



Source: BloombergNEF

Technological Tasks

Safety relevant aspects



Noiseless

Pedestrian injuries could occur due to silent electric motor operation



Use of e-Sound speaker



Fire hazard

Li-ion batteries could catch on fire upon a violent crash accident



Development of new materials



Electric hazard

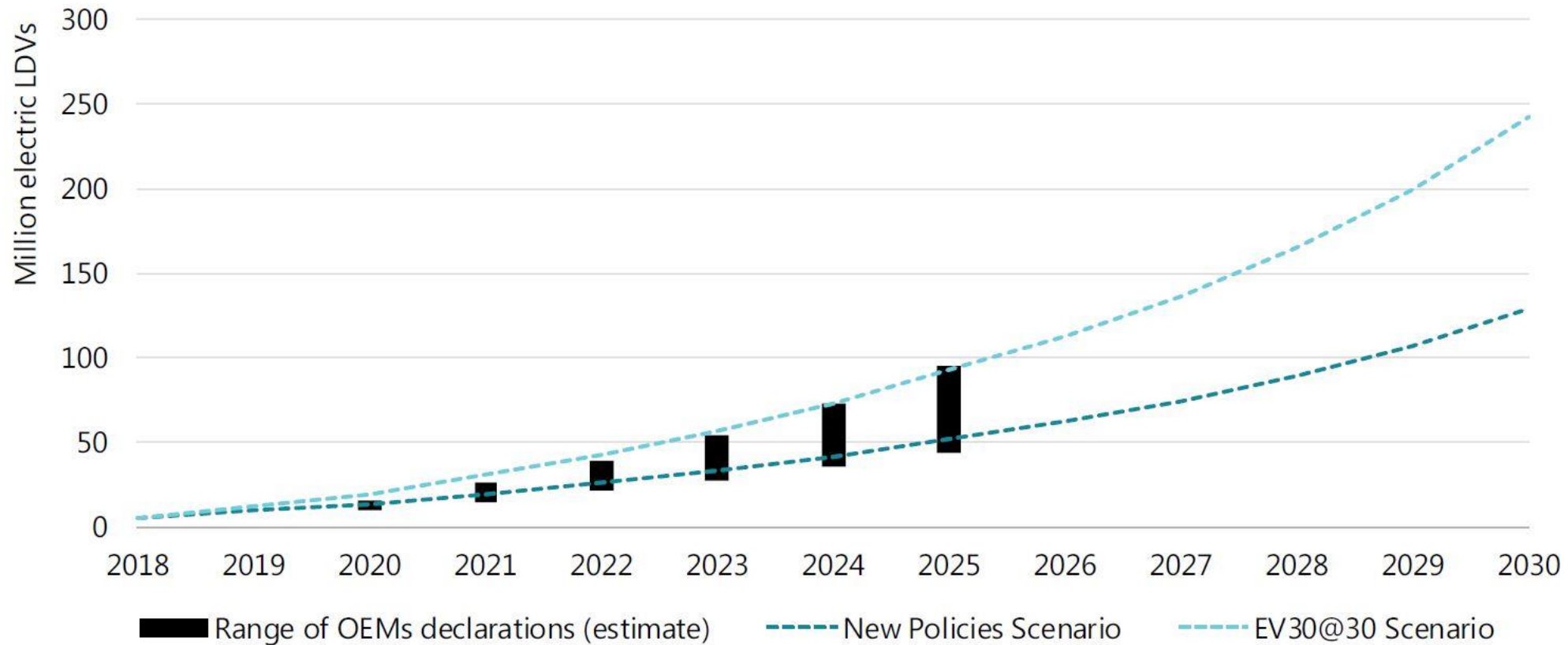
Loss of high voltage isolation could occurs upon a violent accident



HW & SW control systems

EVs Outlook

BEVs stock estimation



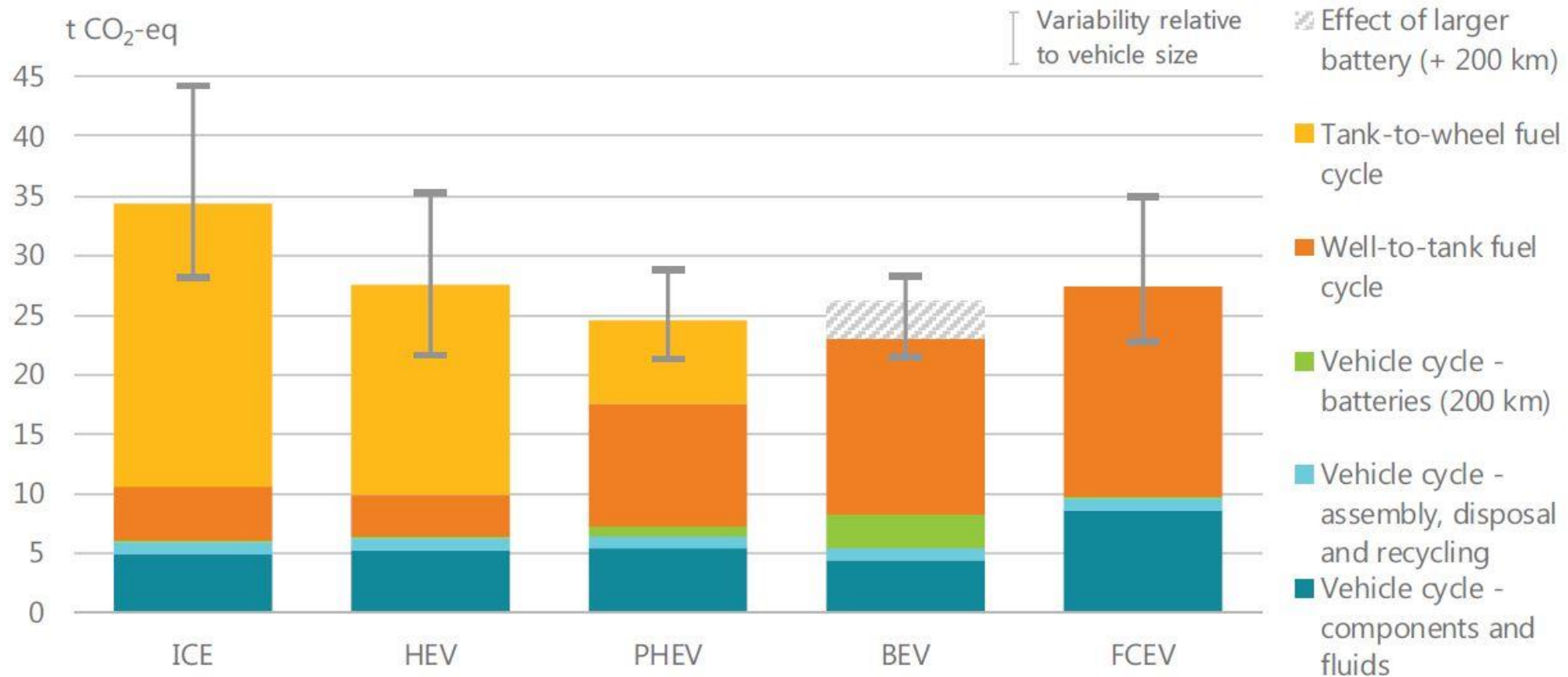
Source: International Energy Agency (2019)

New Policies Scenario according to actual announced policy ambitions.

The EV30@30 campaign redefines the ambition of the CEM's Electric Vehicles Initiative (EVI), setting the objective to reach a 30% sales share for EVs by 2030.

EVs Outlook

Vehicles CO₂ emission







Source: International Energy Agency (2019)



EVs Architecture and Technologies

Technologies Comparison

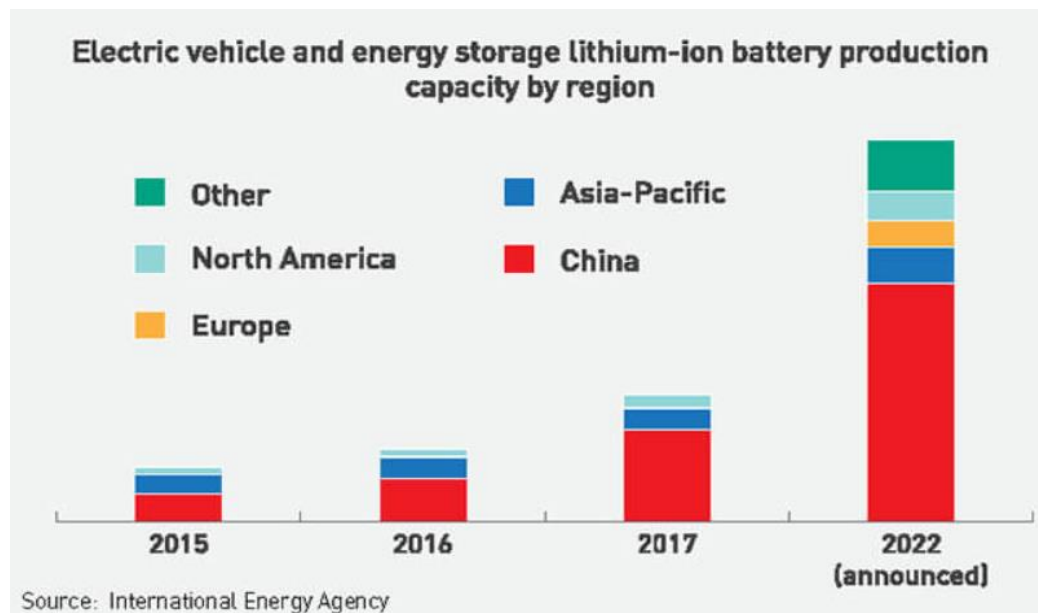
	ICE	BEV	FCV
Range [km]	900	300	500
Energy Density [Wh/kg]	13k	280	40k [700bar]
Efficiency [%]	25	65	40
Technical Notes	Well Known technology	HV battery size and weight.	Pressurized hydrogen storage; System integration
Costs			 



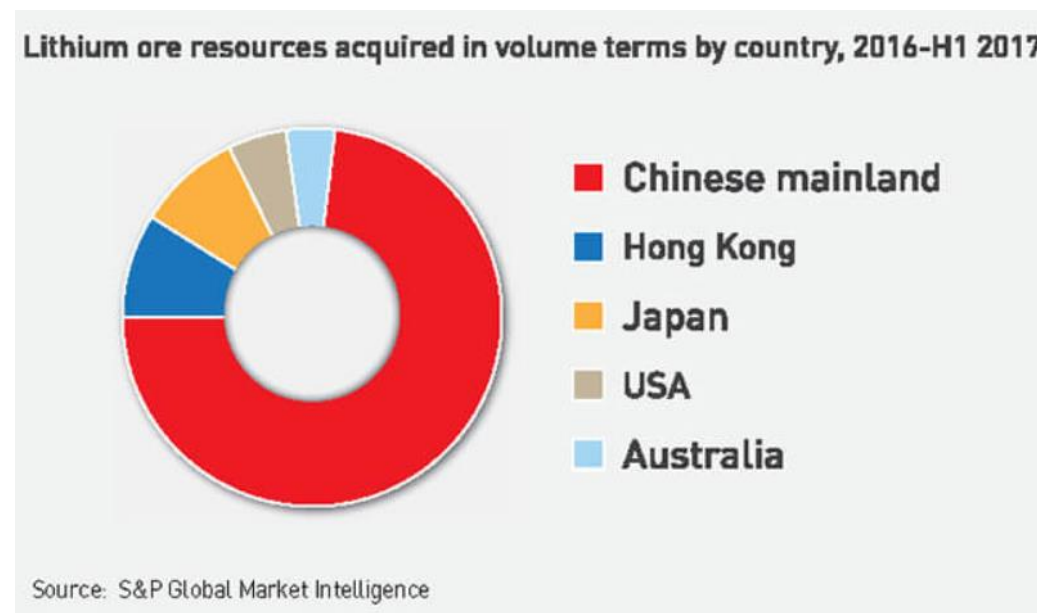
EVs Outlook

Battery: worldwide production

Battery production



Lithium raw materials sourcing



EVs Outlook

Battery: european strategy

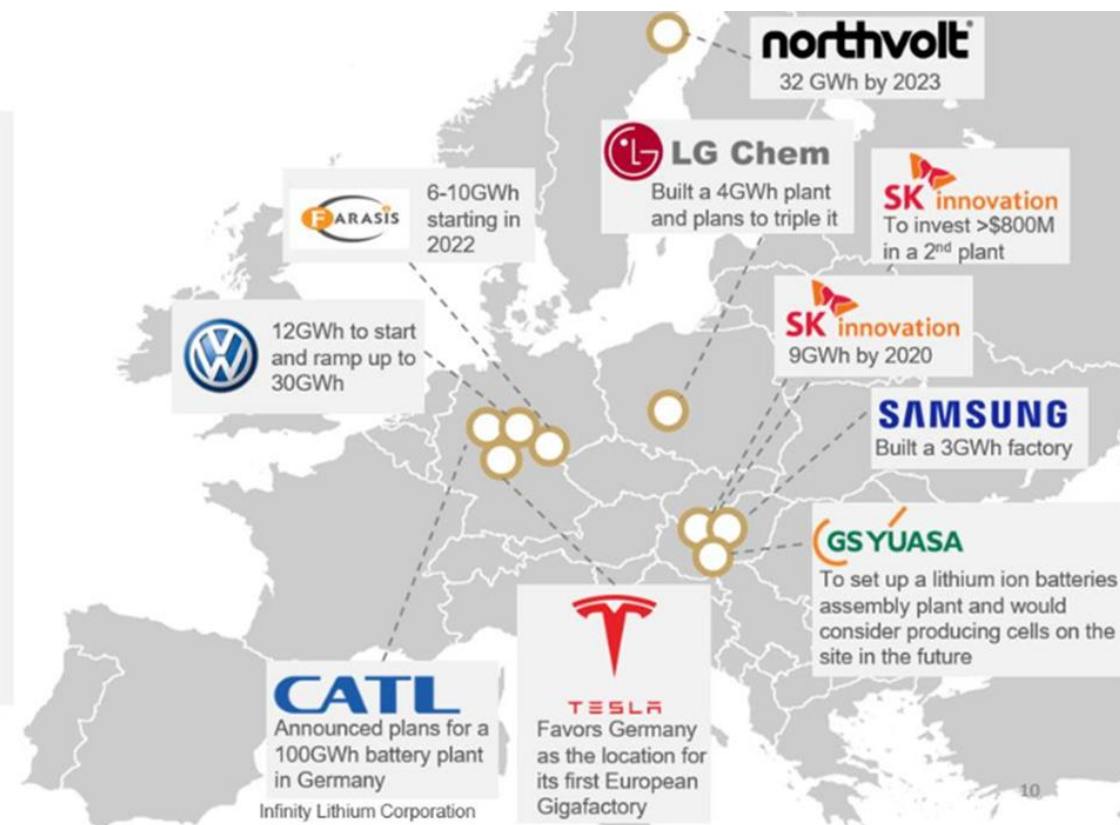


To create a competitive manufacturing value chain in Europe with sustainable battery cells at its core. To prevent a technological dependence on EU competitors.

New Li-ion battery factories planned in Europe

And...

- BYD** is looking at launching battery production in Europe
- 金沙江资本 GSR Capital** signed a deal to build a factory that would launch production in 2023
- Blackstone Resources** to invest \$230M in German EV battery factory plan
- Germany, France, and the UK** to develop a consortium to develop cell production with companies including Saft (Total) and PSA

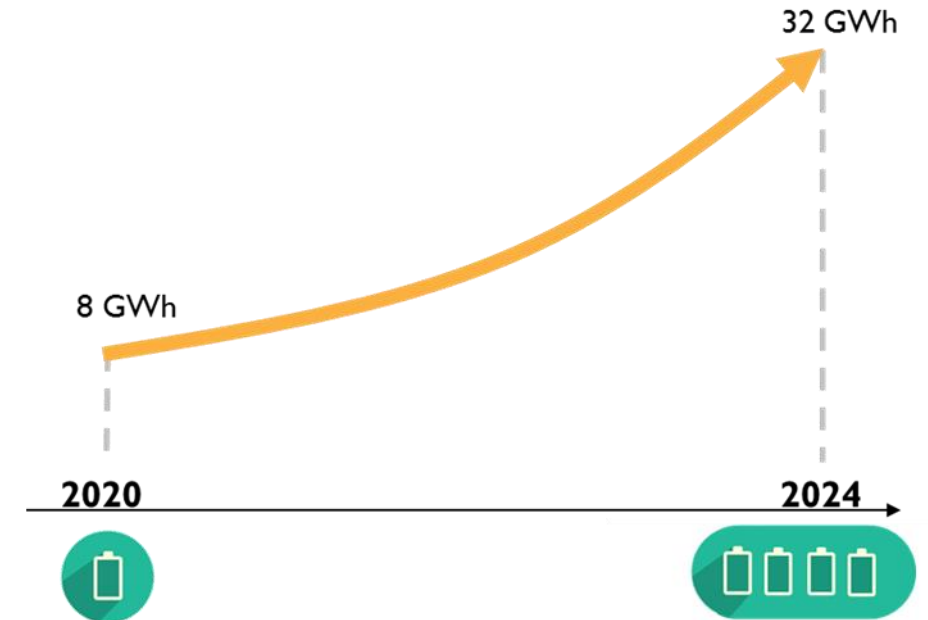


EVs Outlook

Northvolt



“green” Li-ion production roadmap



EVs Outlook

Tesla GigaFactory 4



- Tesla Gigafactory **Berlin** will manufacture batteries, battery packs and powertrain;
- The expected cost for the factory is around €4 billion;
- Tesla claims an estimated annual production 20 GWh (by 2022)

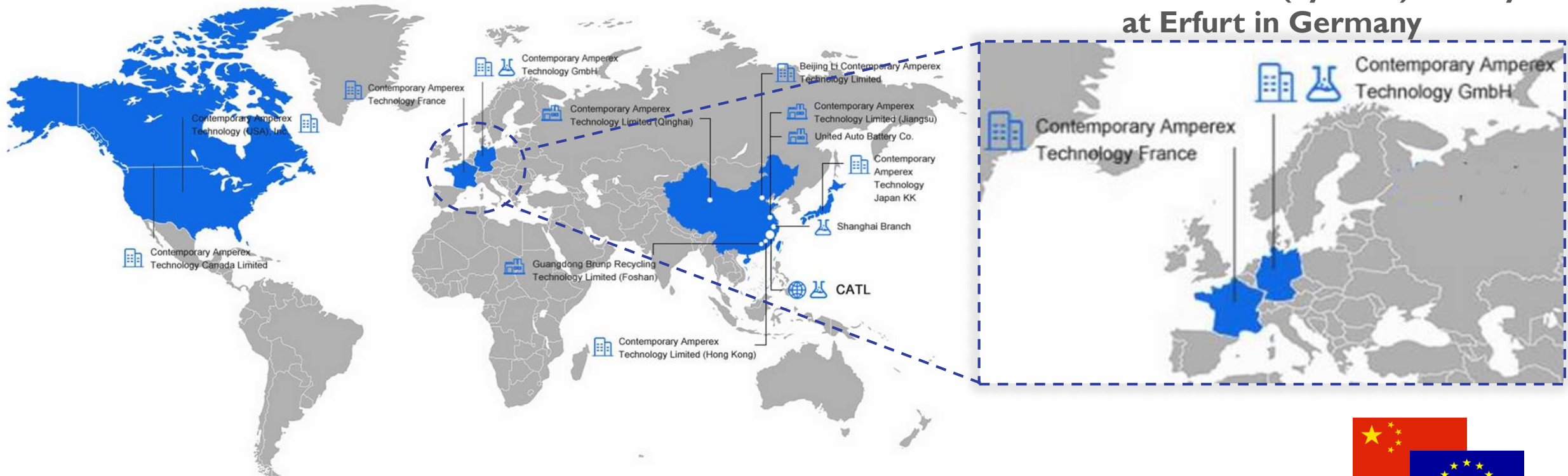


EVs Outlook CATL



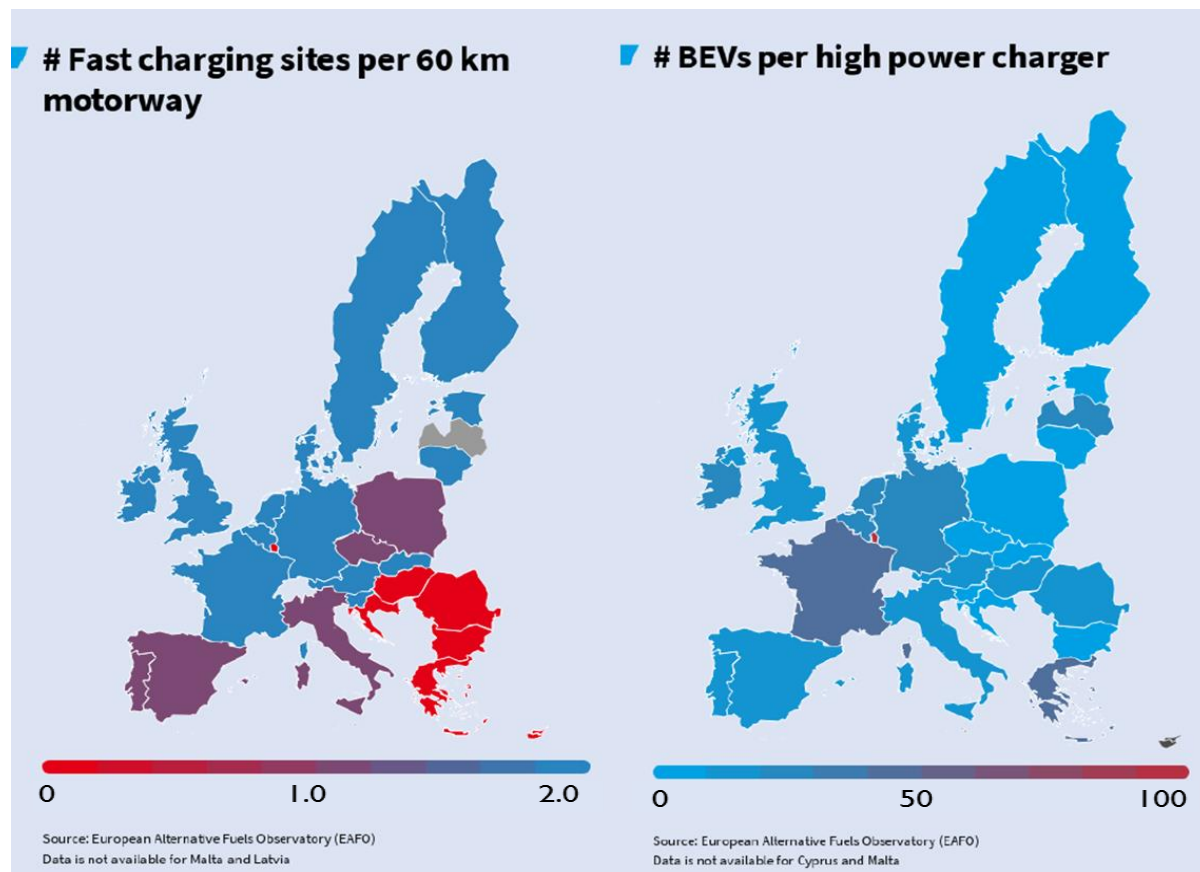
🌐 Headquarters 🏭 Manufacturing Facilities 🏢 Branch Offices 🧪 R&D Centers

**One new 14 GWh (by 2022) factory
at Erfurt in Germany**

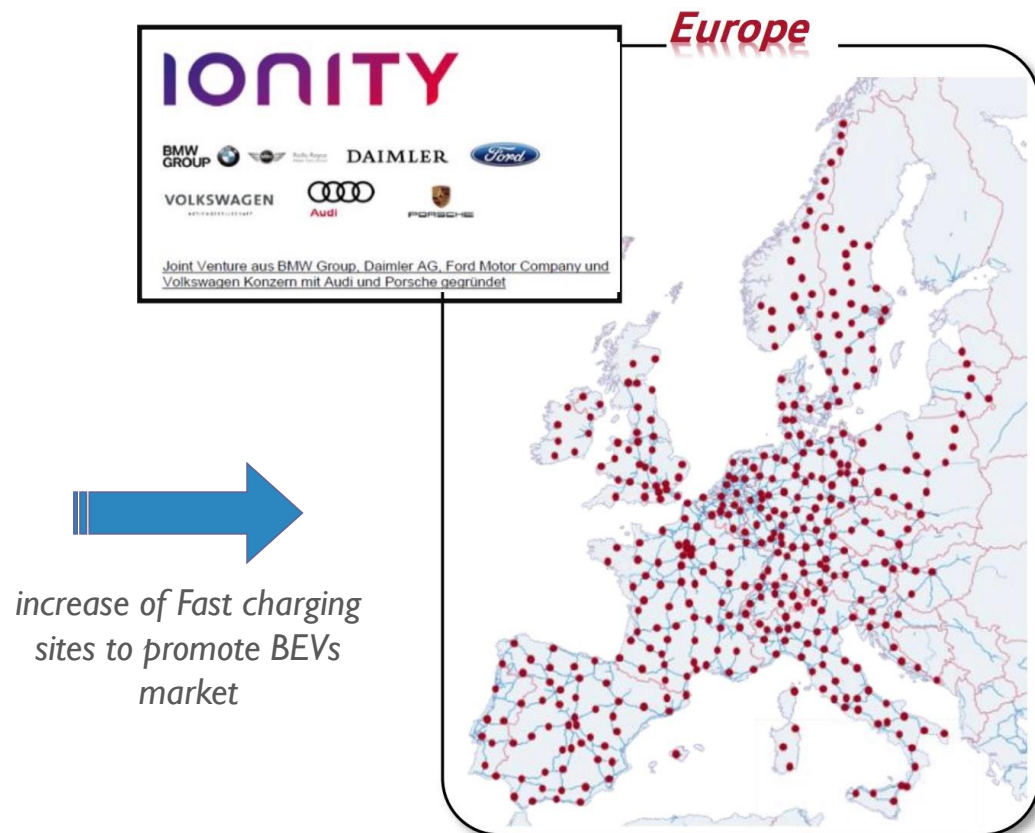


EVs Outlook

EU fast charging network



- Poor fast charging infrastructure in the EU countries with less BEVs



- 400 sites until end of 2019 planned
- Roughly 6 charge points per site

Main E-traction Competences

The coming of new technological tasks requires both new competences and new professional figures, as well as introduces peculiar contents into the “classical” automotive competences:

INNOVATION

NEW FIGURES



Energy storage specialist:
Deep knowledge in battery and fuel cell system development and management.



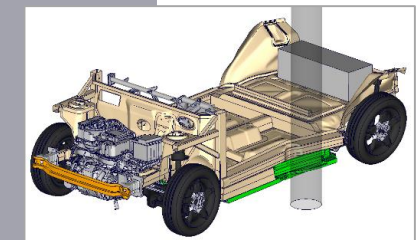
Electrical and electronics engineer:
Definition and integration of the electrical powertrain.

NEW CONTENTS

Functional safety analysis
Focused on High Voltage E-Powertrain Hazard analysis and Risk assessment.



Structural analysis
New constraints and issues due to the battery pack impact on the vehicle structure



Thank you

