AIIT con PoliTo e ACI

"Veicoli elettrici, sfide progettuali ed opportunità"

Antonio Casu

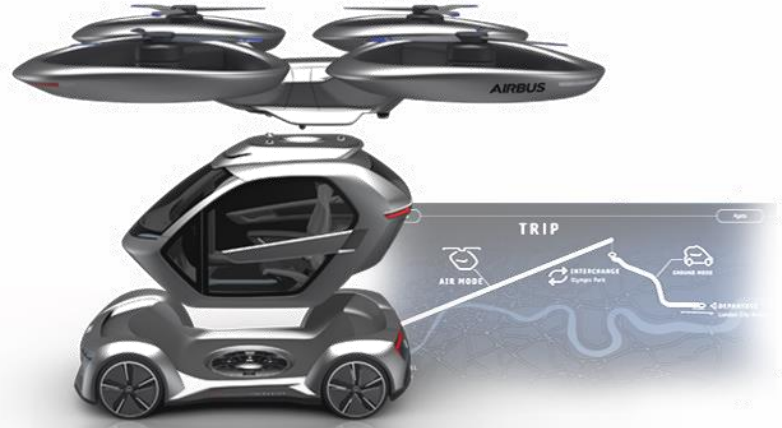
CTO Italdesign Giugiaro

Electric Vehicle Integration

20/02/2020

ULTRA-LIMITED SERIES PRODUCTION

COMPLETE VEHICLE DEVELOPMENT

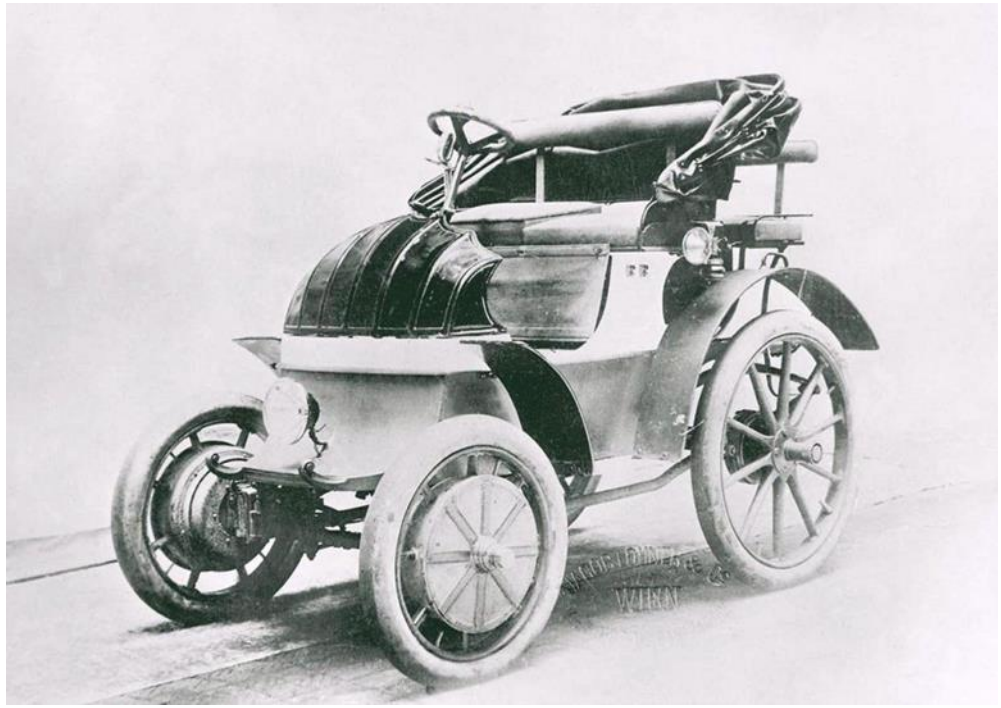


DEVELOPMENT OF INTEGRATED MOBILITY SOLUTIONS

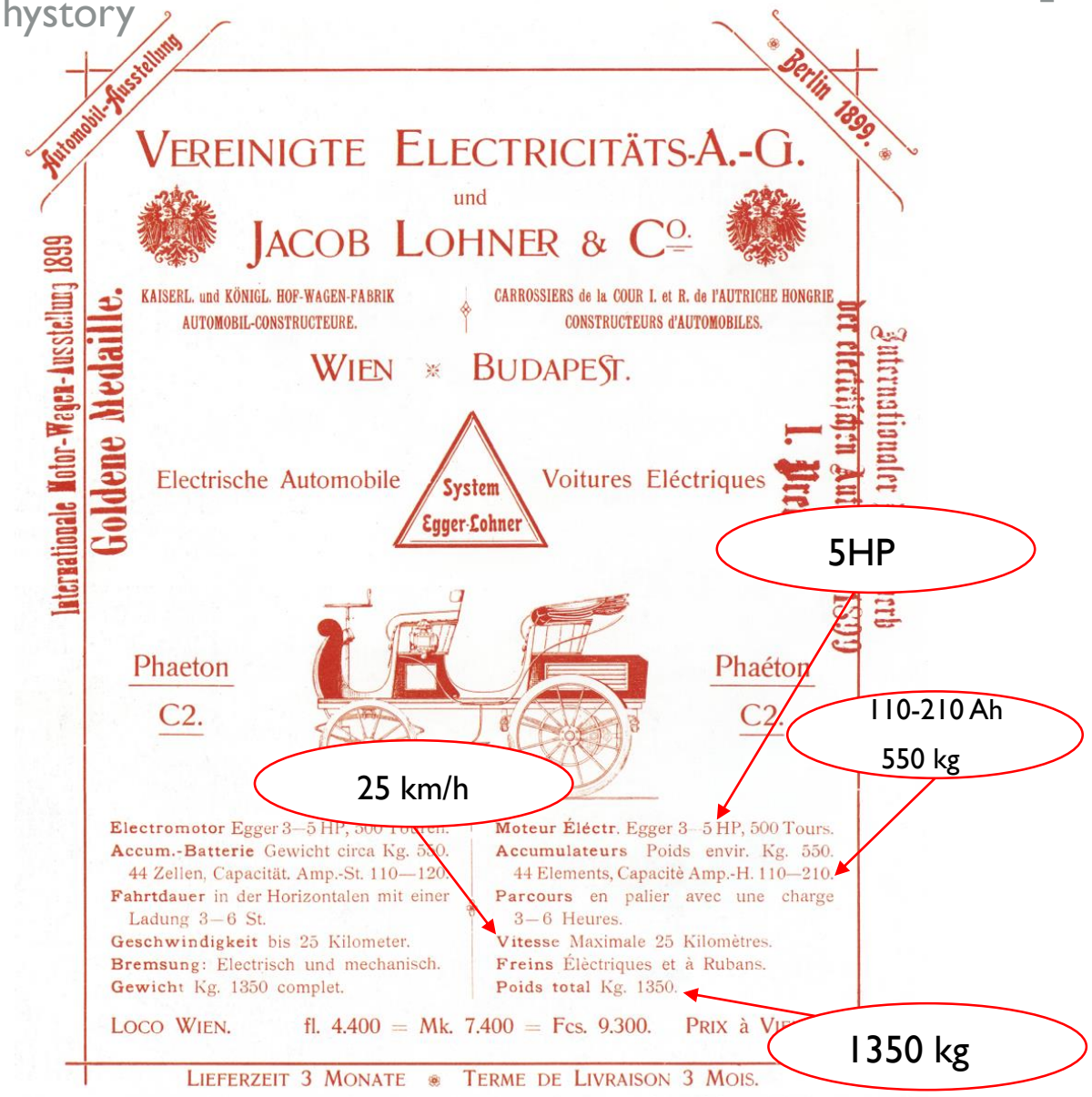
Content

EVs Architecture and Technologies

Electric car hystory

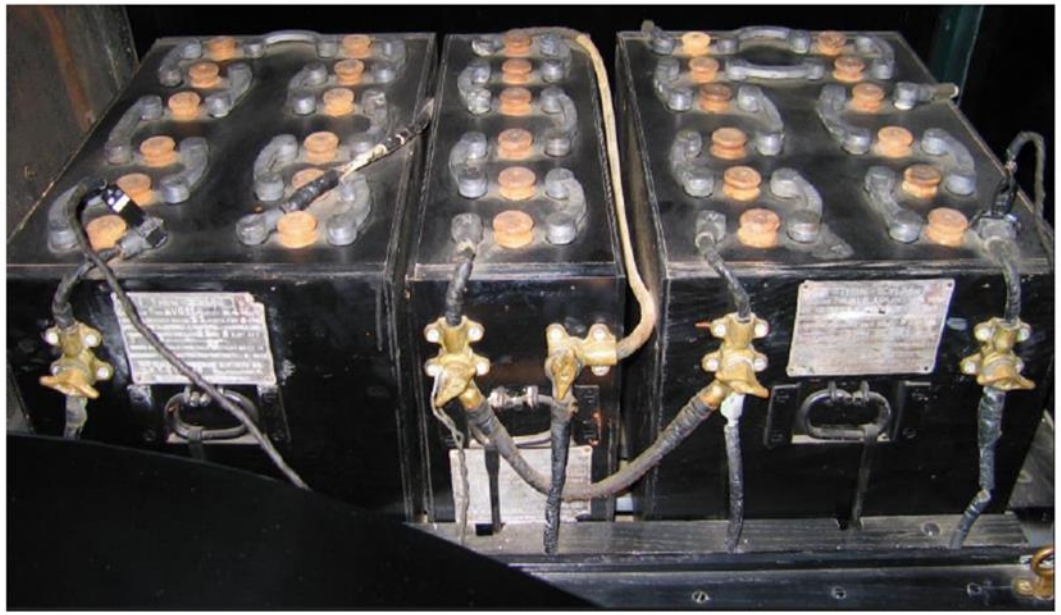


Lohner-Porsche 1899 in-wheel electric motors

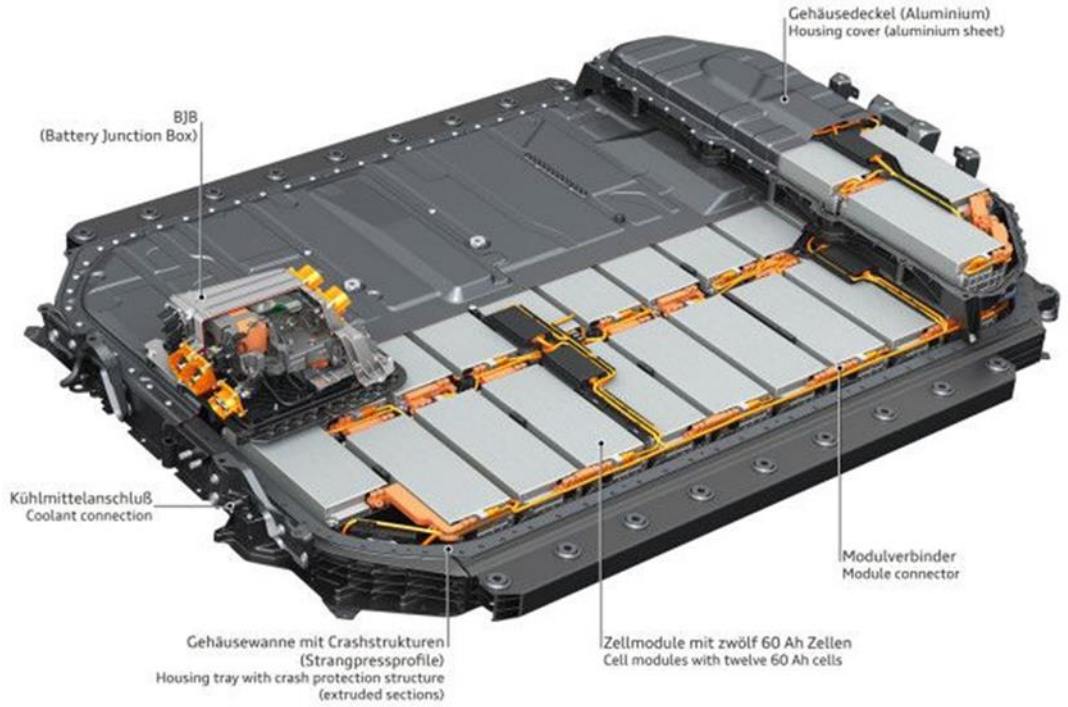


EVs Architecture and Technologies

Battery Pack complexity

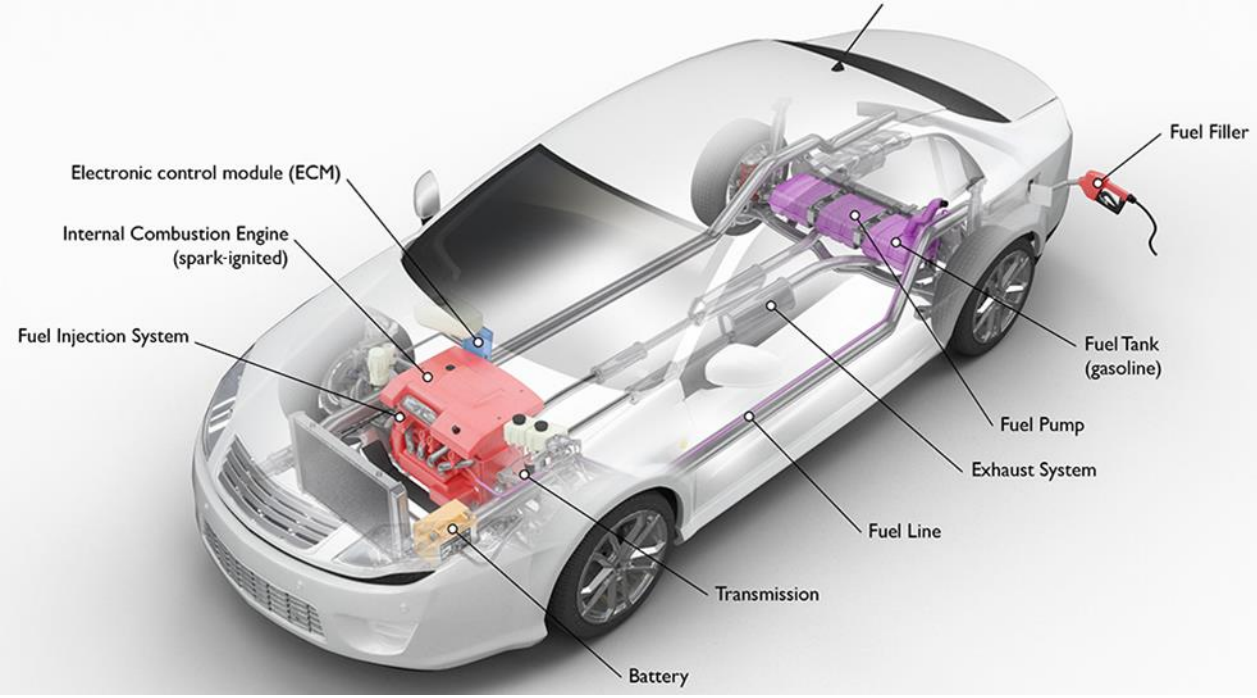


*Baker Electric Queen Victory Battery Pack **(1910)***



*Audi E-tron Battery Pack **(2017)***

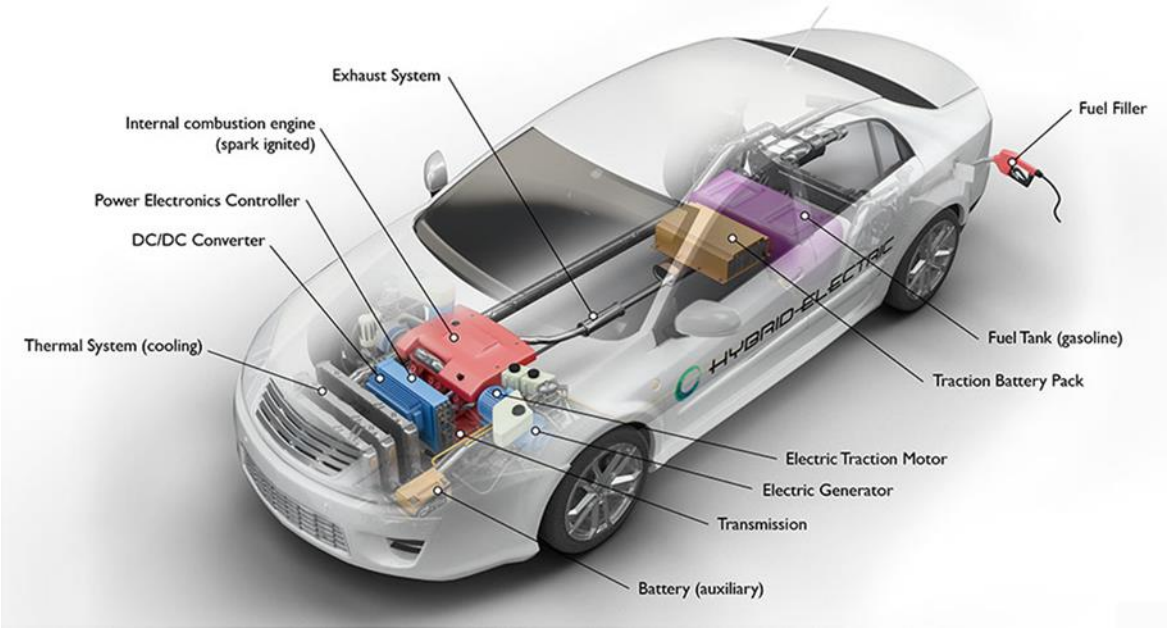
Internal Combustion Engine



Source: afdc.energy/gov

NOTE
Energy density: 13 kWh/kg
Average range: 900 km
Well known technology

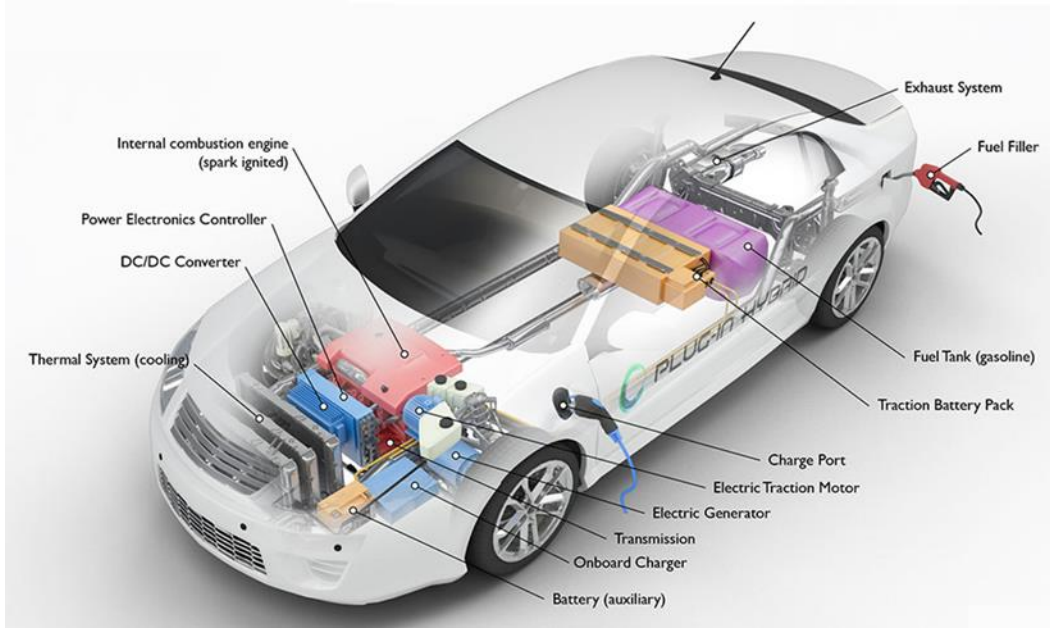
Hybrid Electric Vehicle



Source: afdc.energy/gov

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

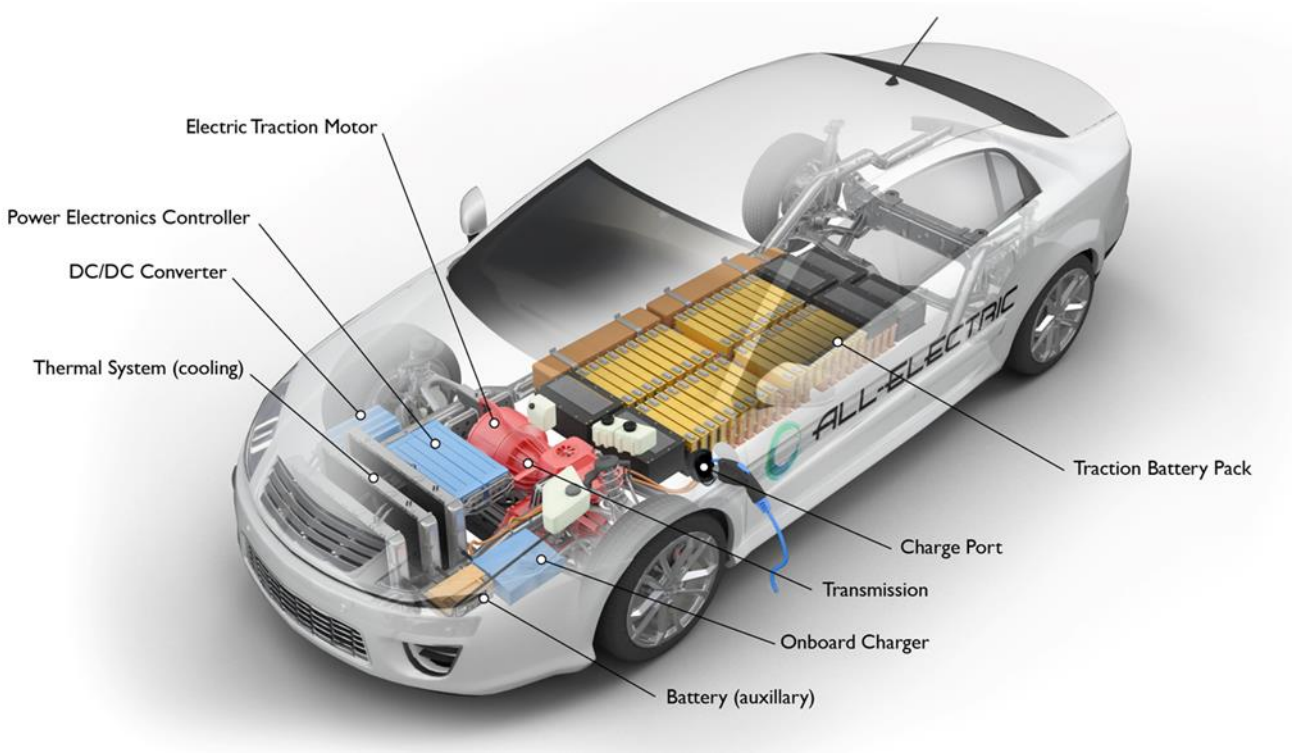
Plug-in Hybrid Electric Vehicle



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

PUBLIC

Battery Electric Vehicle



Source: afdc.energy/gov

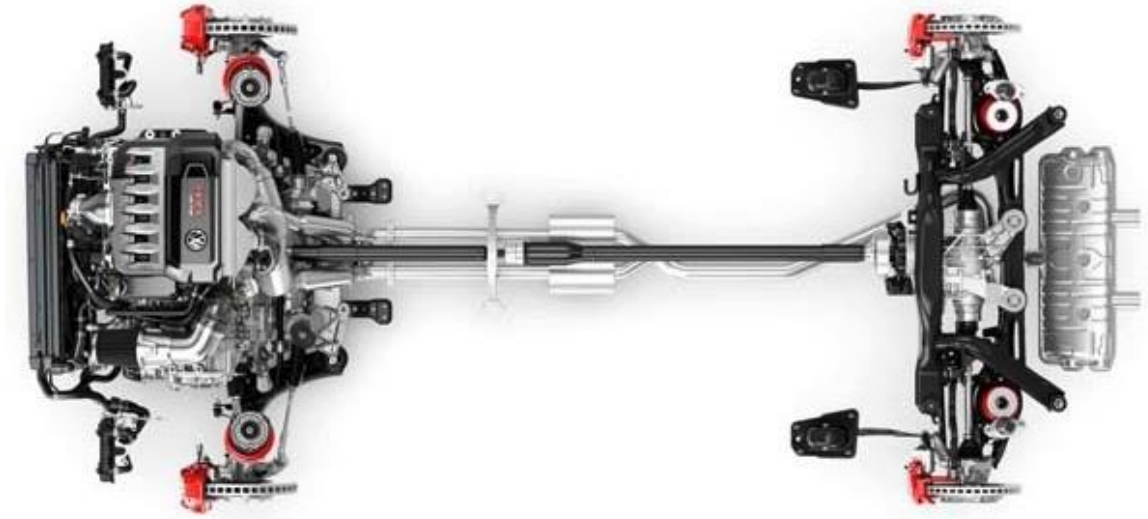
NOTE
Energy density: 280 Wh/kg
Average range: 300 km
Technological constraint: Battery pack weight and size

EVs Architecture and Technologies

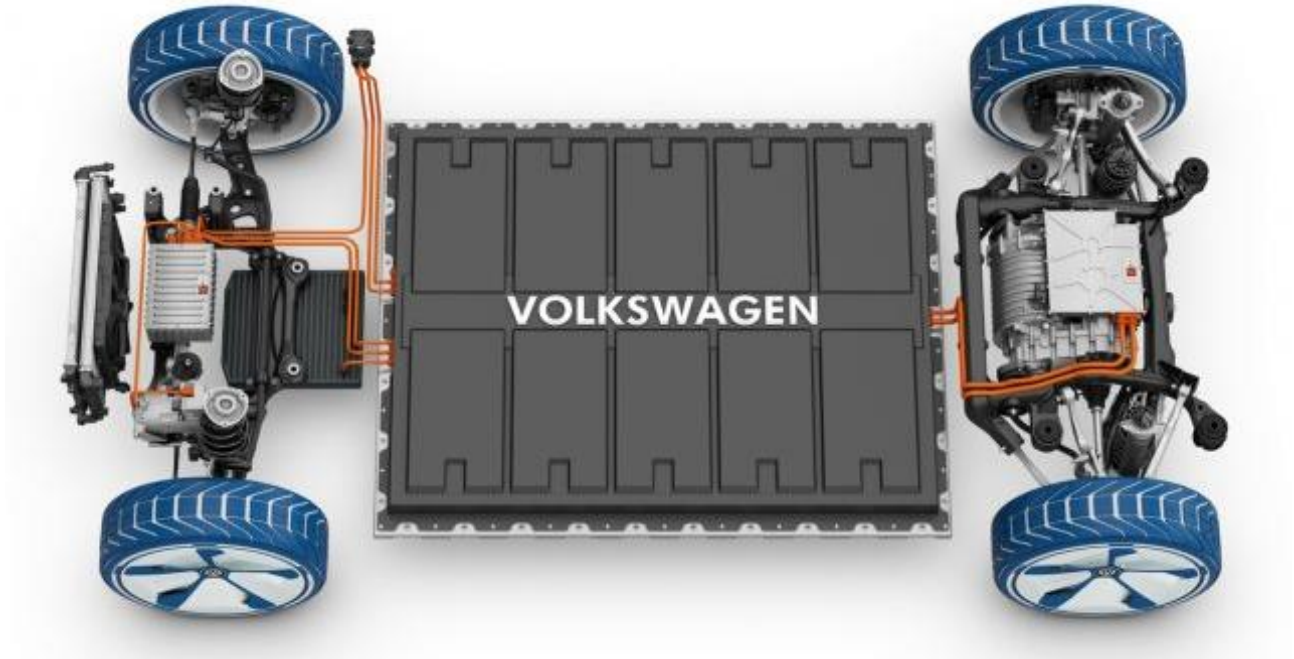
Technologies Comparison

PUBLIC

VW Golf GTI
(ICE)



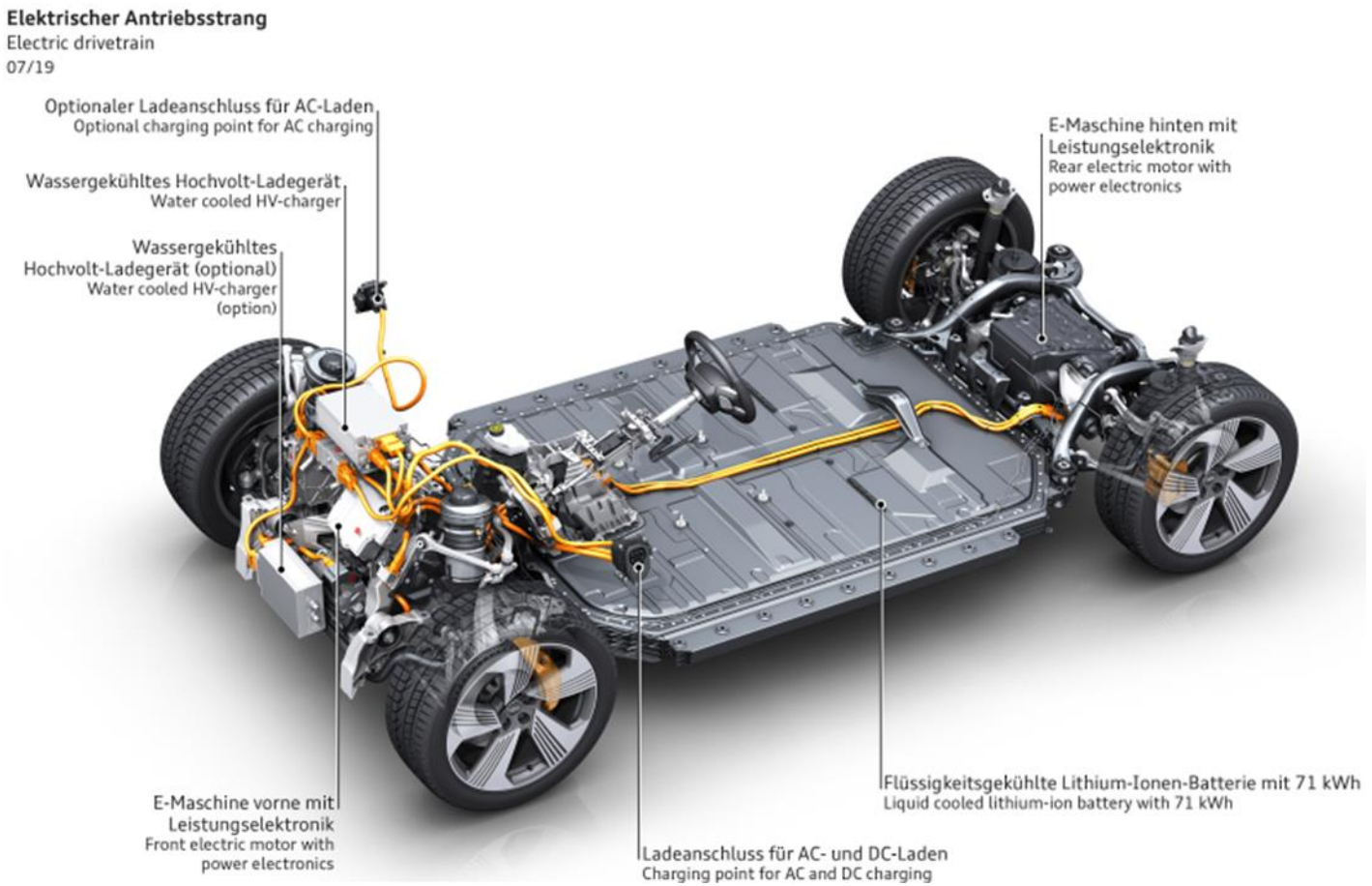
VW MEB
(EV)



Source: Volkswagen AG

EVs Architecture and Technologies

AUDI e-tron



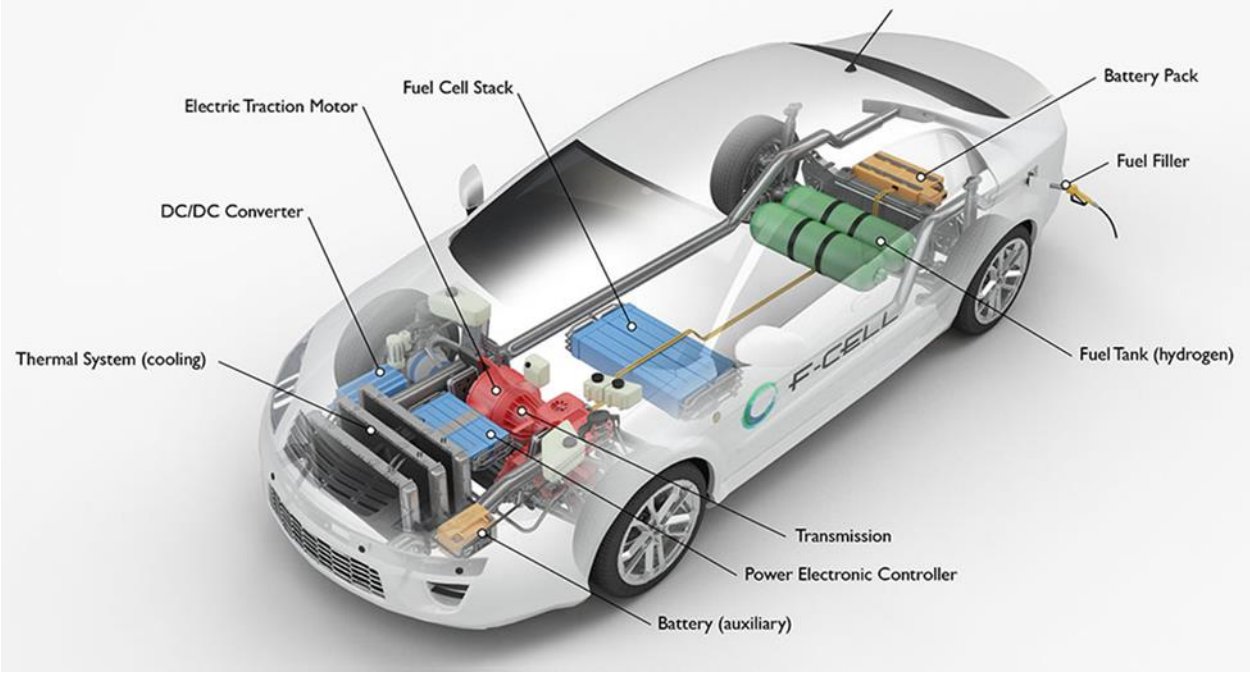
e-tron

Source: Audi AG

EVs Architecture and Technologies
Fuel Cell Electric Vehicle

PUBLIC

FCEV



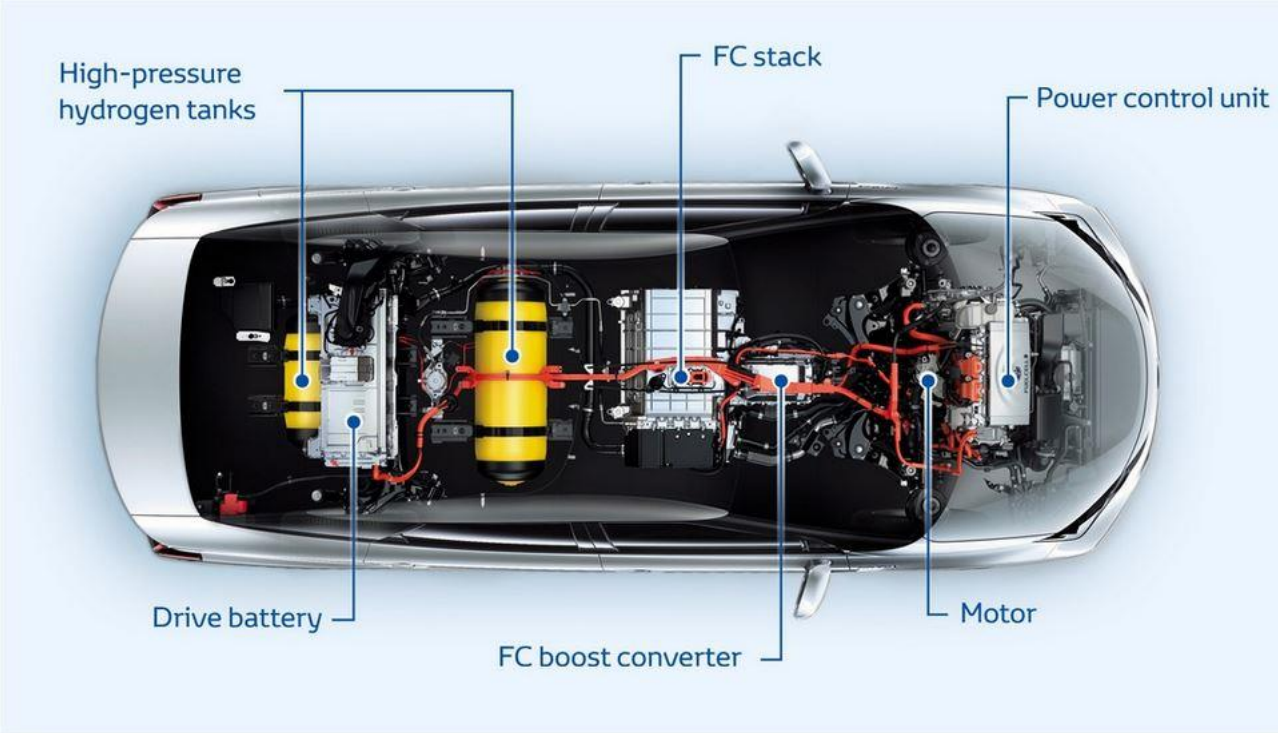
Source: afdc.energy/gov

NOTE
Energy density: 40 kWh/kg (700 bar)
Average range: 500 km
Constraint: In-vehicle Hydrogen storage

EVs Architecture and Technologies
TOYOTA Mirai

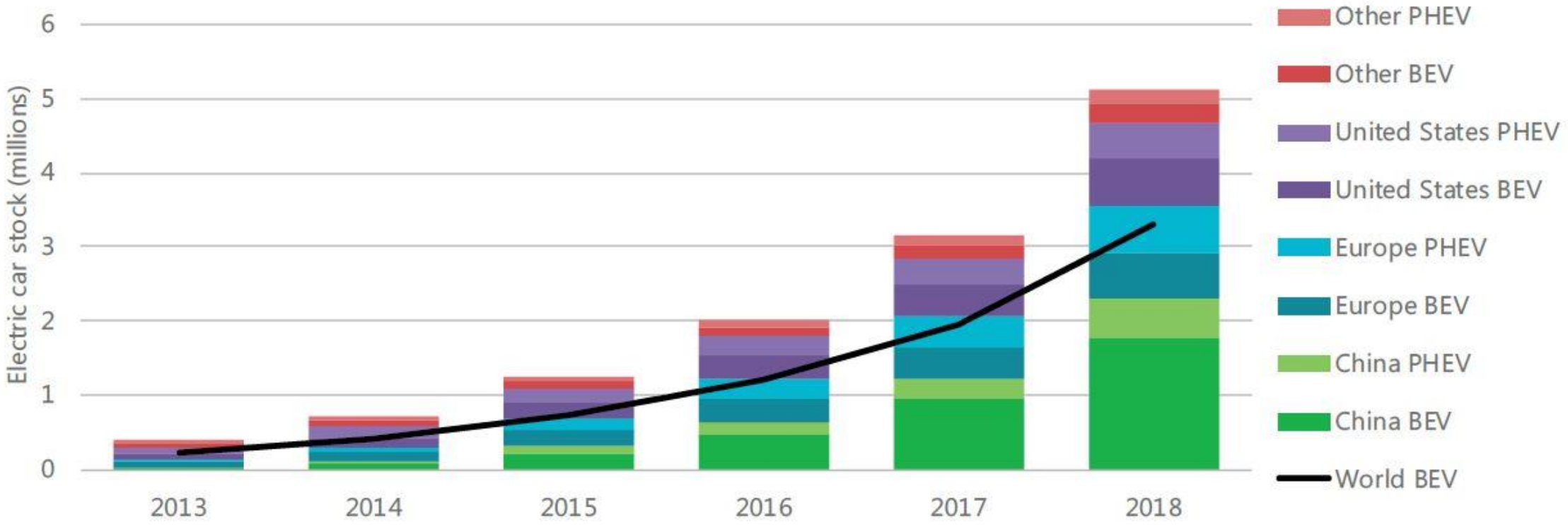
MIRAI

FUEL CELL VEHICLE



Source: Toyota Motor Company

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

PUBLIC

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

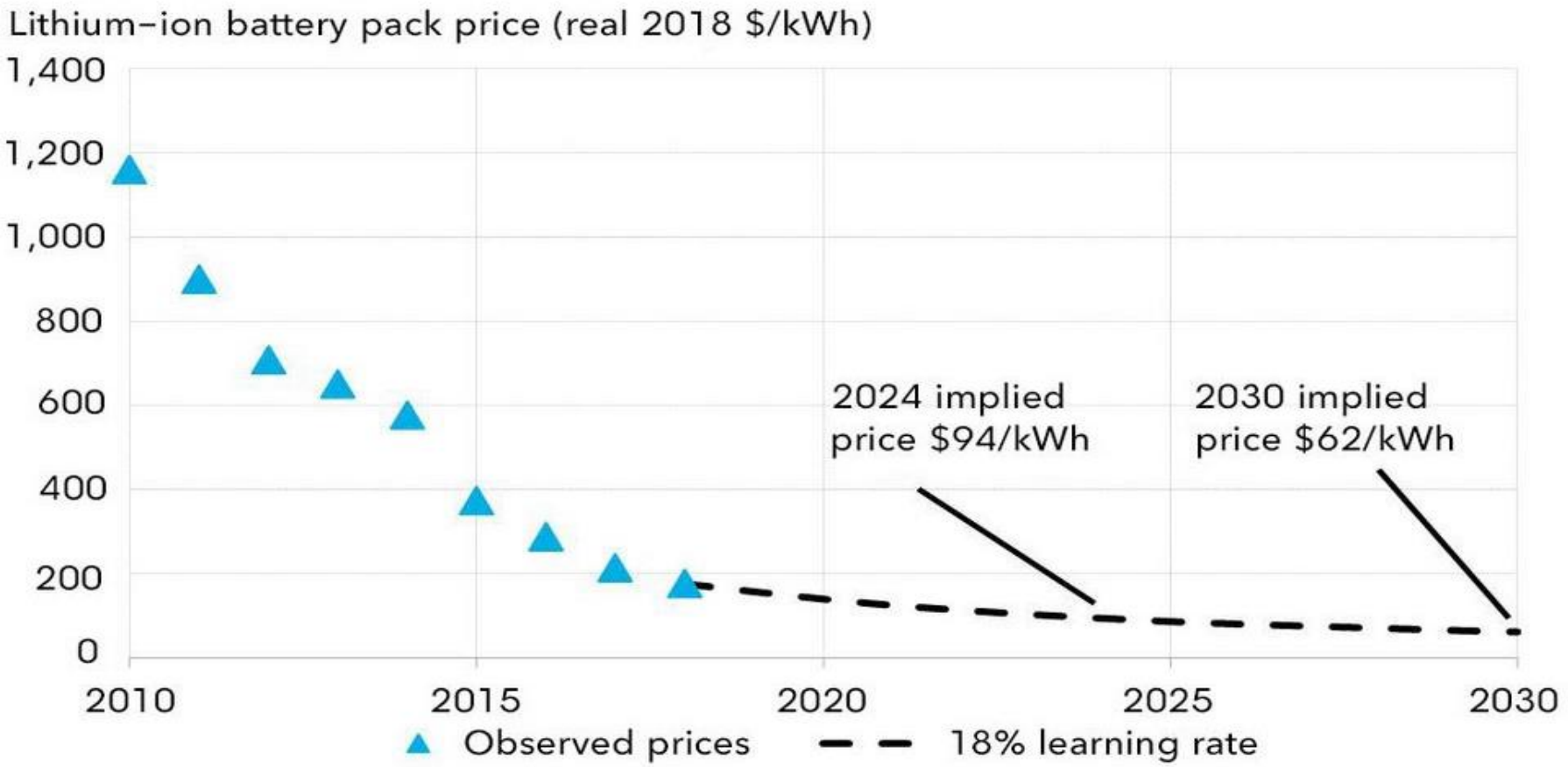
Starting price ca. 11 k€

Starting price ca. 23 k€

Some Reasons…

Costs

Lithium-ion battery price outlook



Source: BloombergNEF

Technological Tasks

Safety relevant aspects

Noiseless

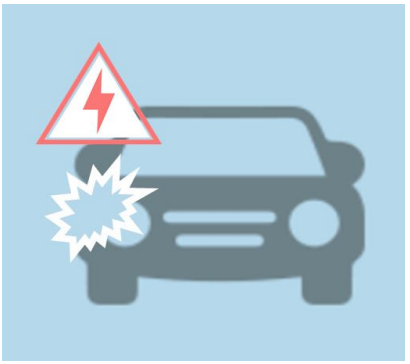
Pedestrian injuries could occur due to silent electric motor operation

Use of e-Sound speaker

Fire hazard

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

Development of new materials



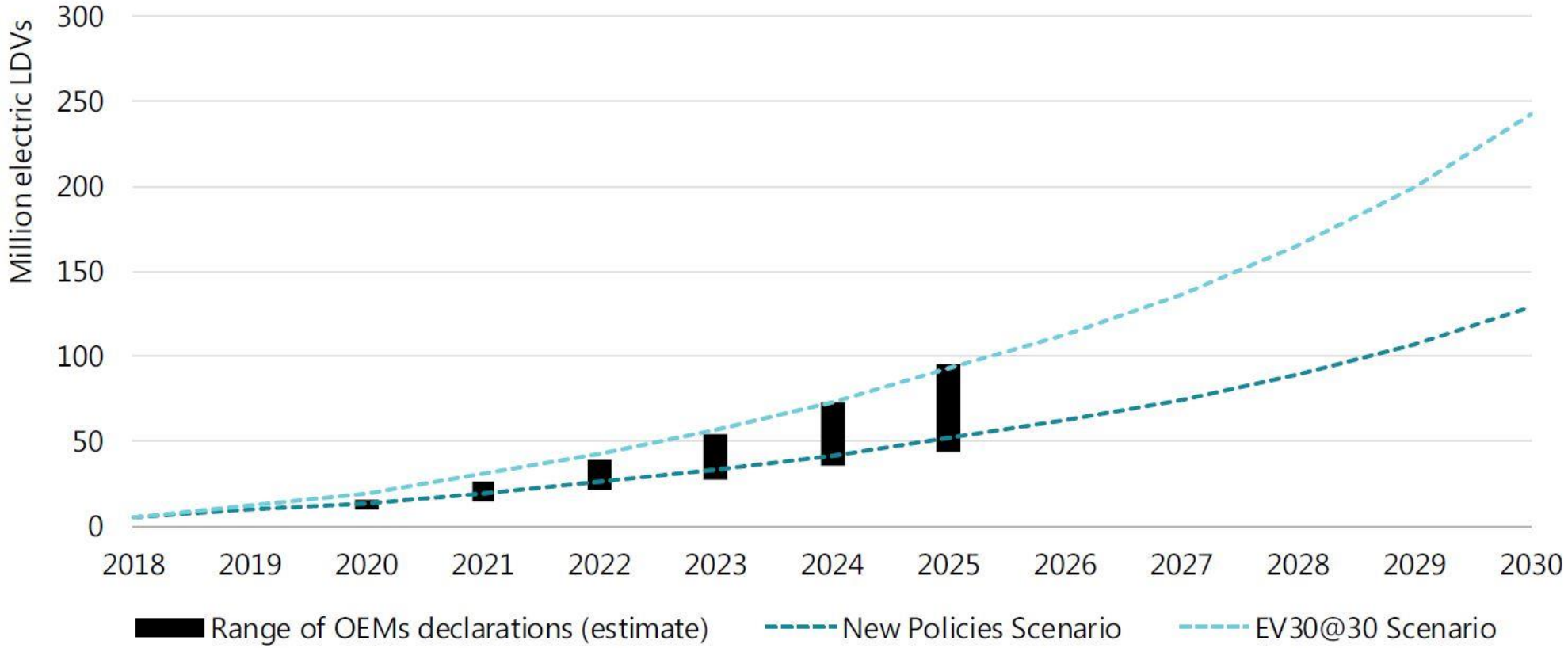
Electric hazard

Loss of high voltage isolation could occurs upon a violent accident

HW & SW control systems

EVs Outlook

BEVs stock estimation

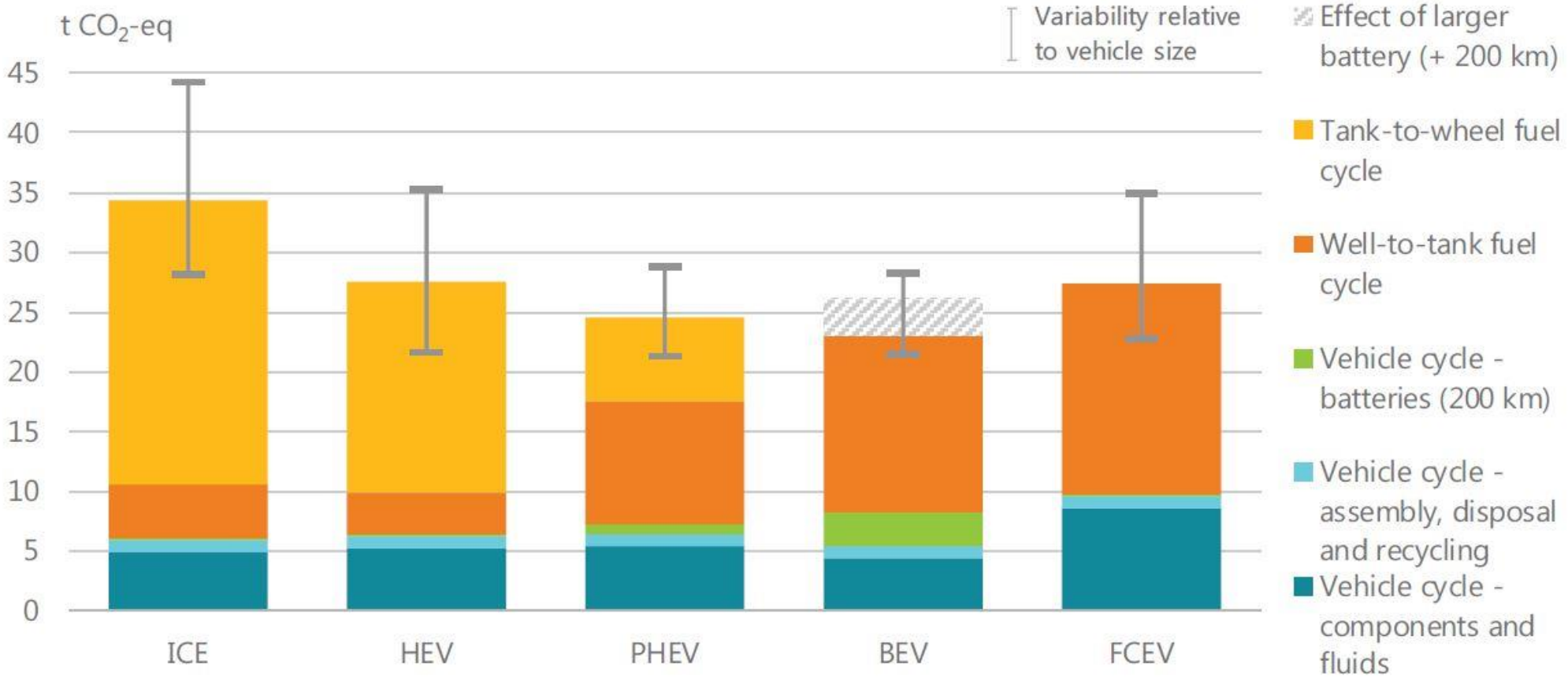


Source: International Energy Agency (2019)

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 CO_2 emission



Source: International Energy Agency (2019)

EVs Architecture and Technologies

Technologies Comparison

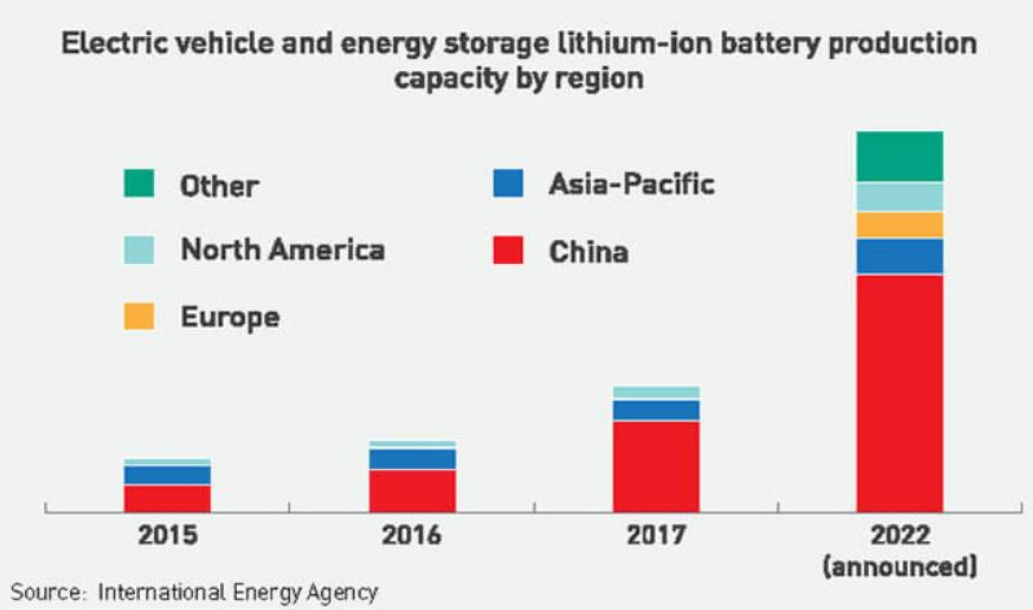
	ICE	BEV	FCV
***Range** [km]*	900	300	500
***Energy Density** [Wh/kg]*	13k	280	40k [700bar]
***Efficiency** [%]*	25	65	40
Technical Notes	Well Known technology	HV battery size and weight.	Pressurized hydrogen storage; System integration
Costs			 

EVs Outlook

Battery: worldwide production

PUBLIC

Battery production



Lithium raw materials sourcing

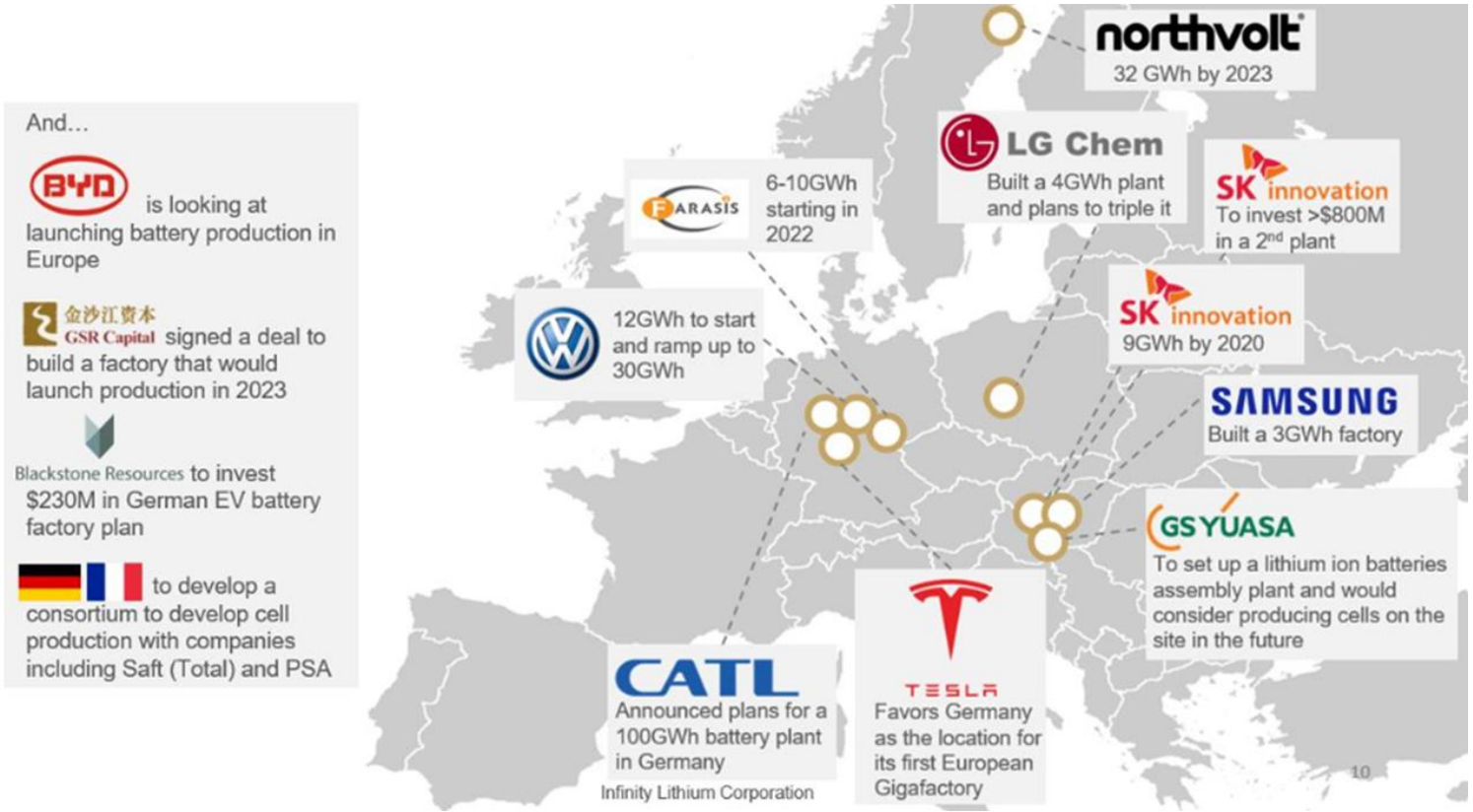
ITALDESIGN

EVs Outlook

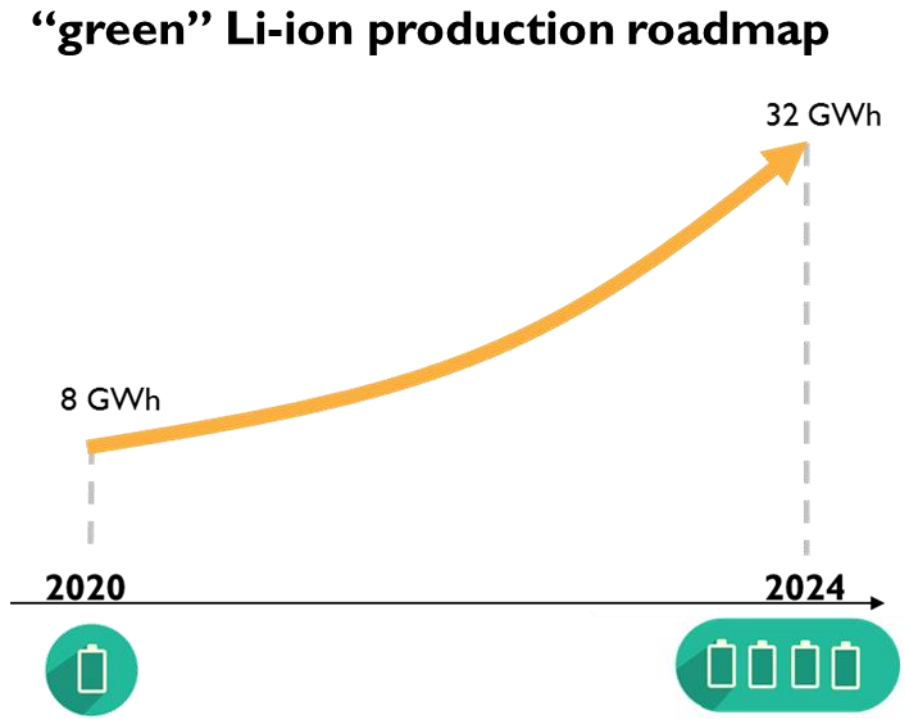
Battery: european strategy

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



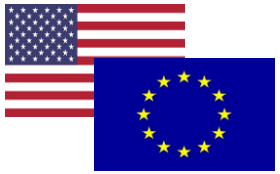
EVs Outlook
Northvolt



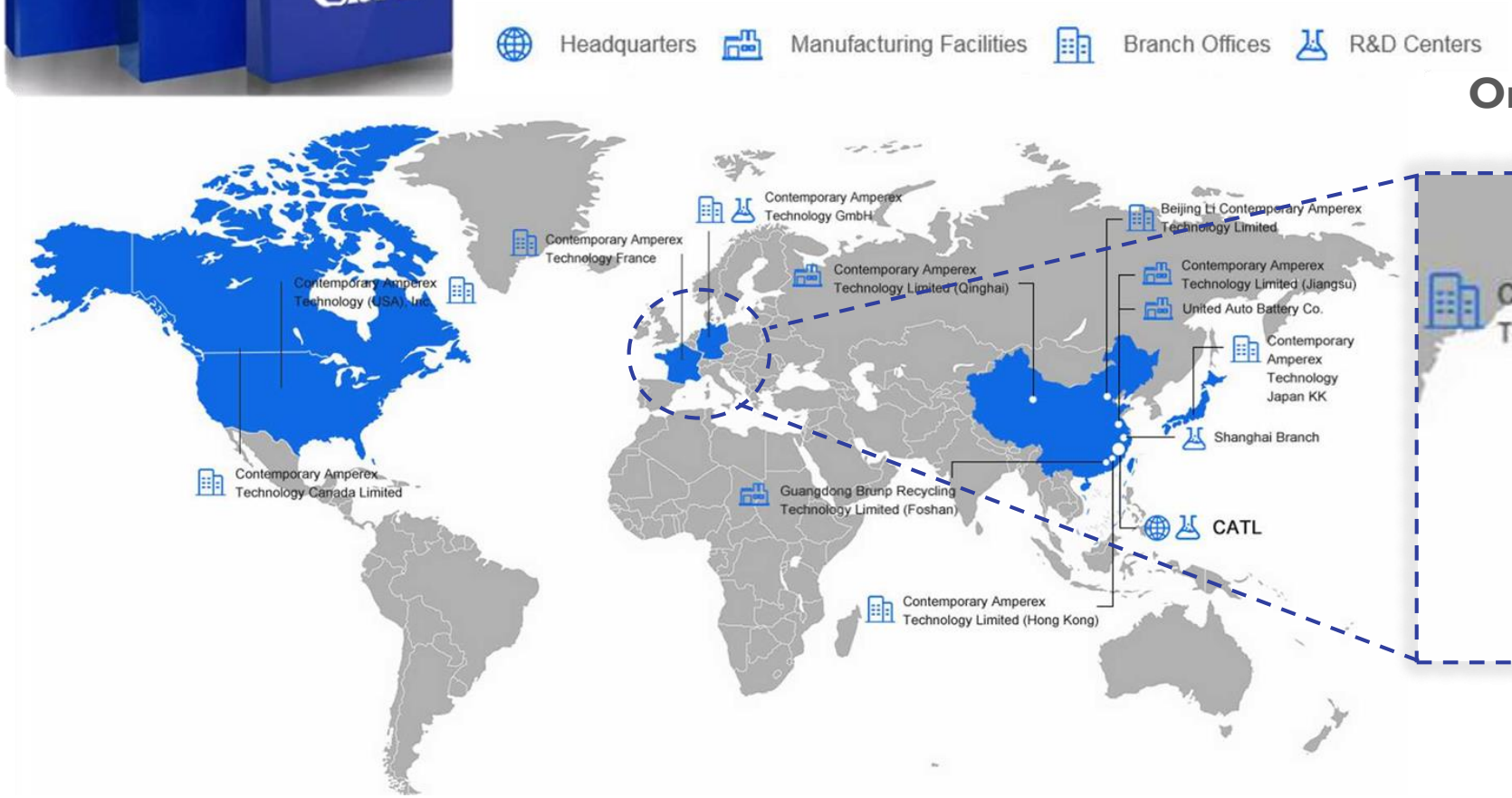
EVs Outlook

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)



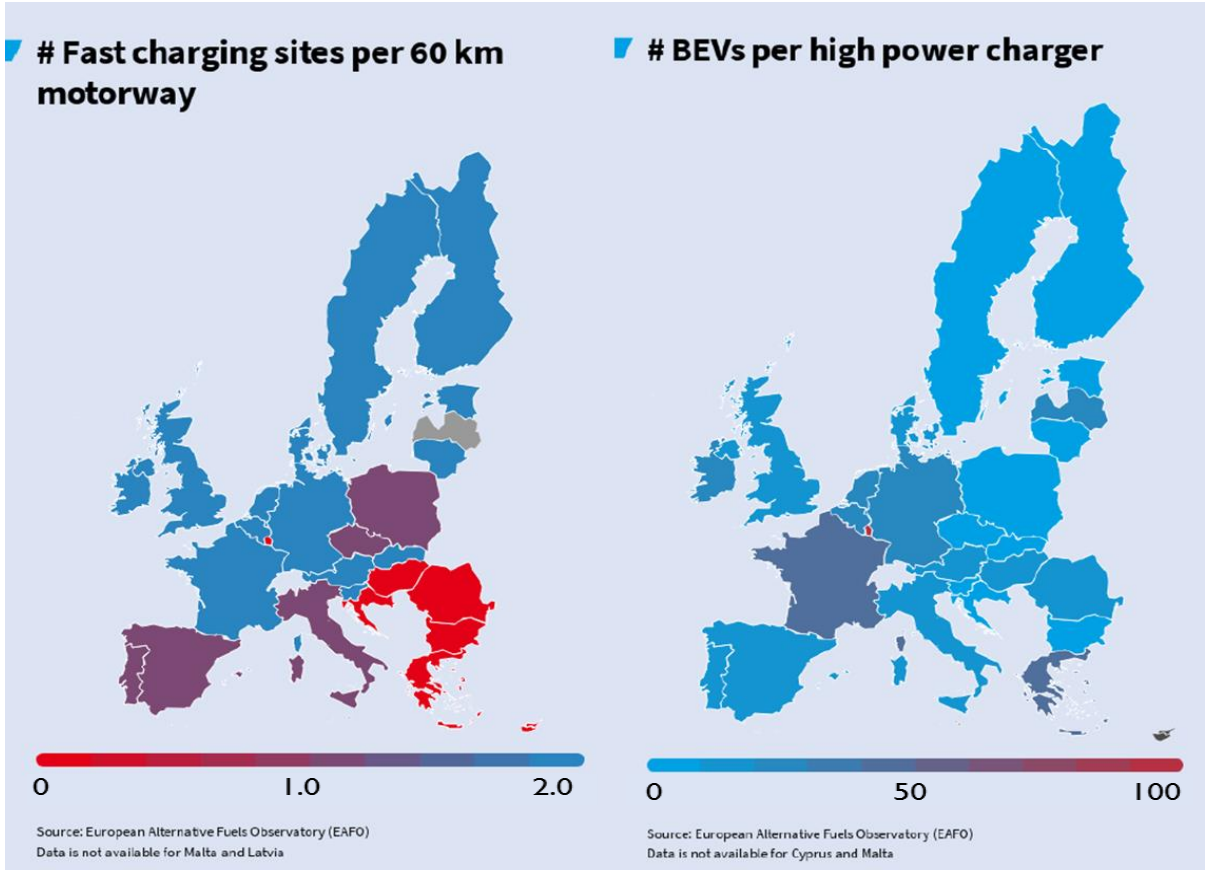
EVs Outlook
CATL



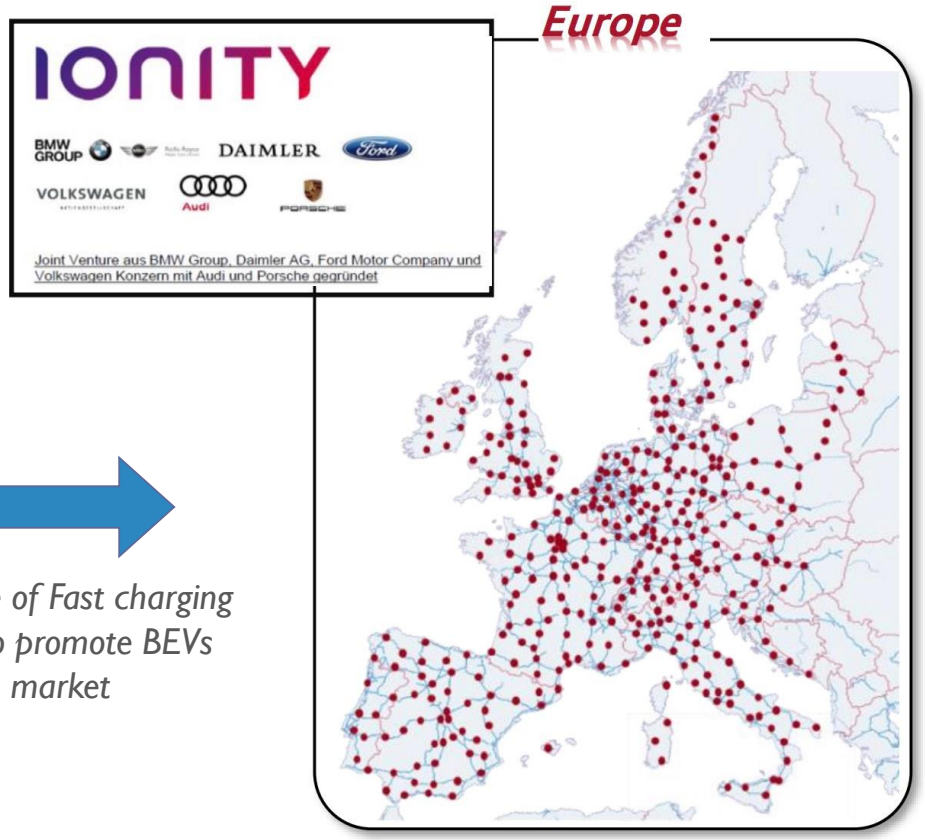
One new 14 GWh (by 2022) factory at Erfurt in Germany

EVs Outlook

EU fast charging network



increase of Fast charging sites to promote BEVs market



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

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

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

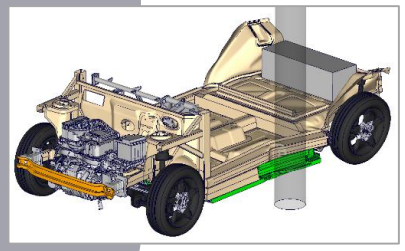
Energy storage specialist:
Deep knowledge in battery and fuel cell system development and management.

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