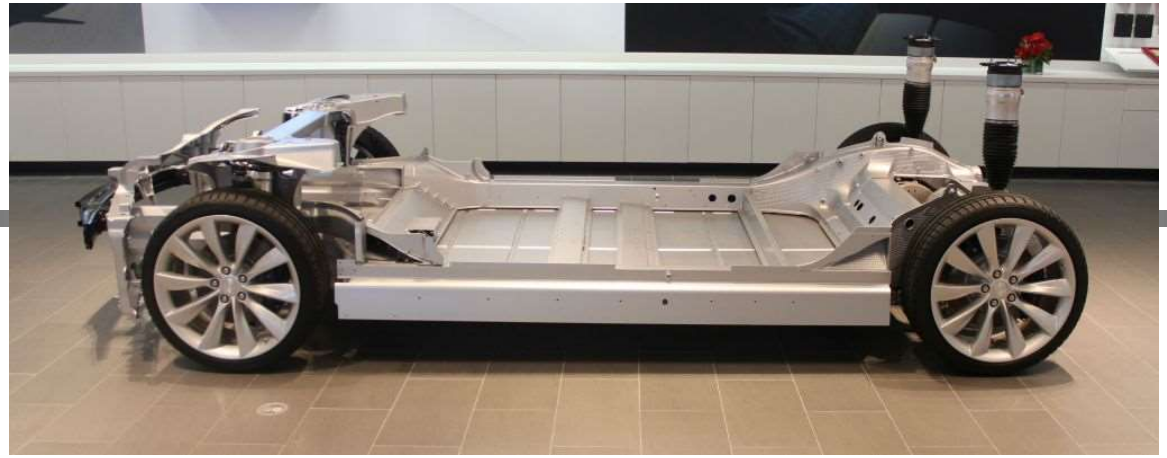
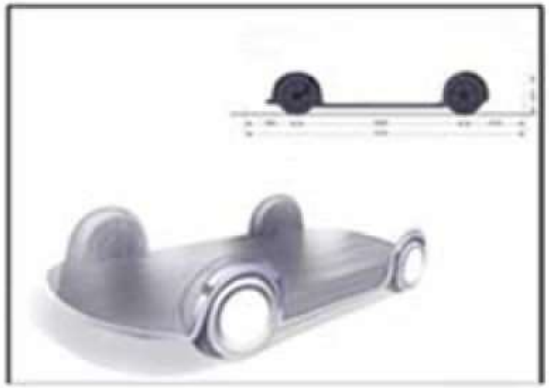
전기차 플랫폼

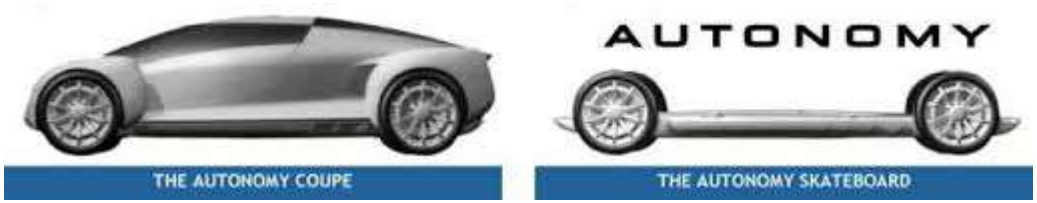
- 글로벌 자동차 제조업체들
  - 공동개발을 통해 공유: 플랫폼 개발 비용 절감
- 기존 내연기관에서 빠져야 하는 부분(파워트레인, 연료탱크 등)에 배터리를 채우려고 시도
  - Tesla의 초기 Roadster: Lotus chassis 기반
- Tesla Model S (2009)
  - 차량하부에 무거운 배터리 배치: 차량 무게중심이 낮아져 안정감이 높아지며 핸들링 향상
  - Box on Box(배터리 플랫폼): 배터리 위 공간에 대한 활용도 높음→차량 라인업 확장
  - Skateboard Platform: 전기차 표준?
  - 배터리 수율이 안좋음 (스케이트보드 몸통 속 배터리가 차지하는 비율, 70%이하)
  - 배터리팩의 구조적 가치: 차 구조에 기여?

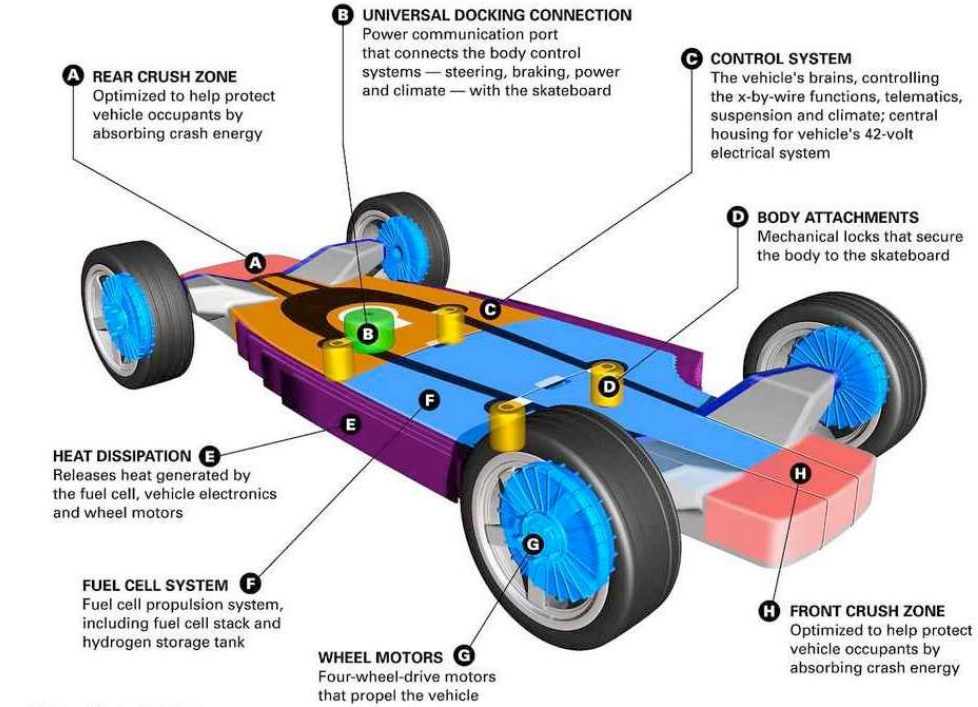




GM's AUTOnomy Project (2002)

– 수소연료 자율주행 컨셉카 디자인





Electric vehicles = Disruptive
Hybrid technology = Sustaining
Fuel cell technology = Disruptive
GM AUTOnomy = Disruptive

"The fuel cell is as big a change from the internal-combustion engine as the internal-combustion engine was from the horse."

Key Challenges

Industry Wide

- Distance Constraints
  - 300 mi trip limit
  - Lack of infrastructure for fuel cell recharging / refueling
- Cost Constraints
  - Cell itself is 10 time too expensive
  - Low fuel costs in US lower ROI for US consumers
- Technology Itself Unclear
  - Compressed Gas vs. Liquid vs. Solid State
  - Hybrids: interim or long-lasting?

Specific to GM

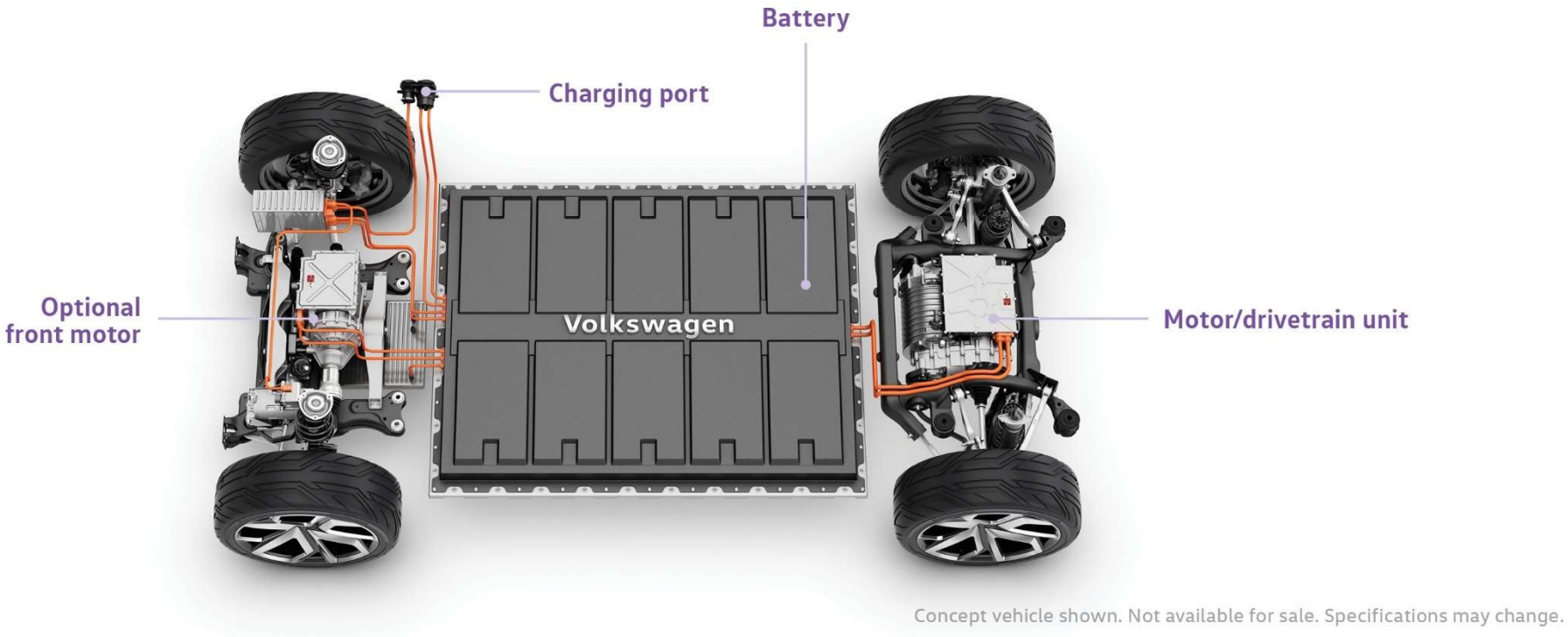
- "Industry Leader" Goal
  - Current Hy-Wire approach threatens status quo at GM
  - Pressure from the press for updates
  - Annual prototype roll-out
  - Large scale volume expectations
- In-house Development Preference
  - Independence from outside suppliers
  - Recruiting and building the right team
  - Limitation of leaps of thought by team

Global EV Platforms

- Volkswagen Group MEB
- GM Global EV Platform
- Toyota Electric New Generation Architecture e-TNGA
- Renault-Nissan-Mitsubishi CMF-EV
- Hyundai-Kia E-GMP Global EV Platform

Automotive IQ Guides: Electric Vehicle platforms (2019.10.07)
Top Five: Global EV Platforms (2020.06.18)

Volkswagen



https://www.youtube.com/watch?v=9rxcZMZ3bIo

MEB (Modular Electric Platform) structure & benefits

MEB platform

The all-new e-platform gives many customer advantages and allows different sizes and ranges to be fitted to later ID.3 and ID models

Wide wheelbase, Short overhangs

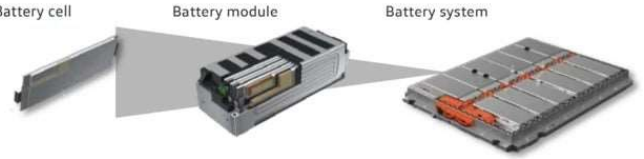
Rear-wheel drive for optimised weight distribution

Large, narrow wheels for aerodynamics

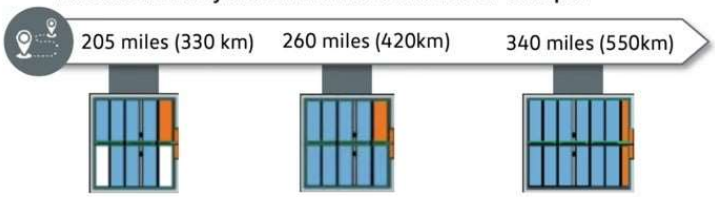
Large boot

New central computer system

Battery construction



Forecasted battery sizes on the later series ID.3 for example:

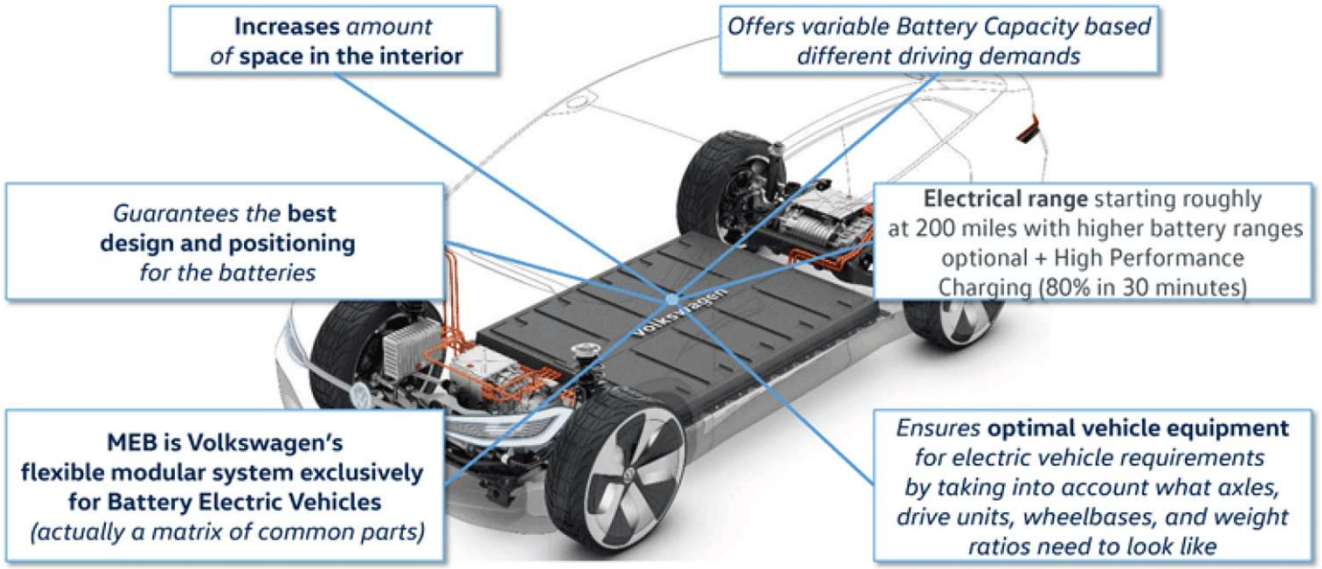


7 Modules = 45 kWh

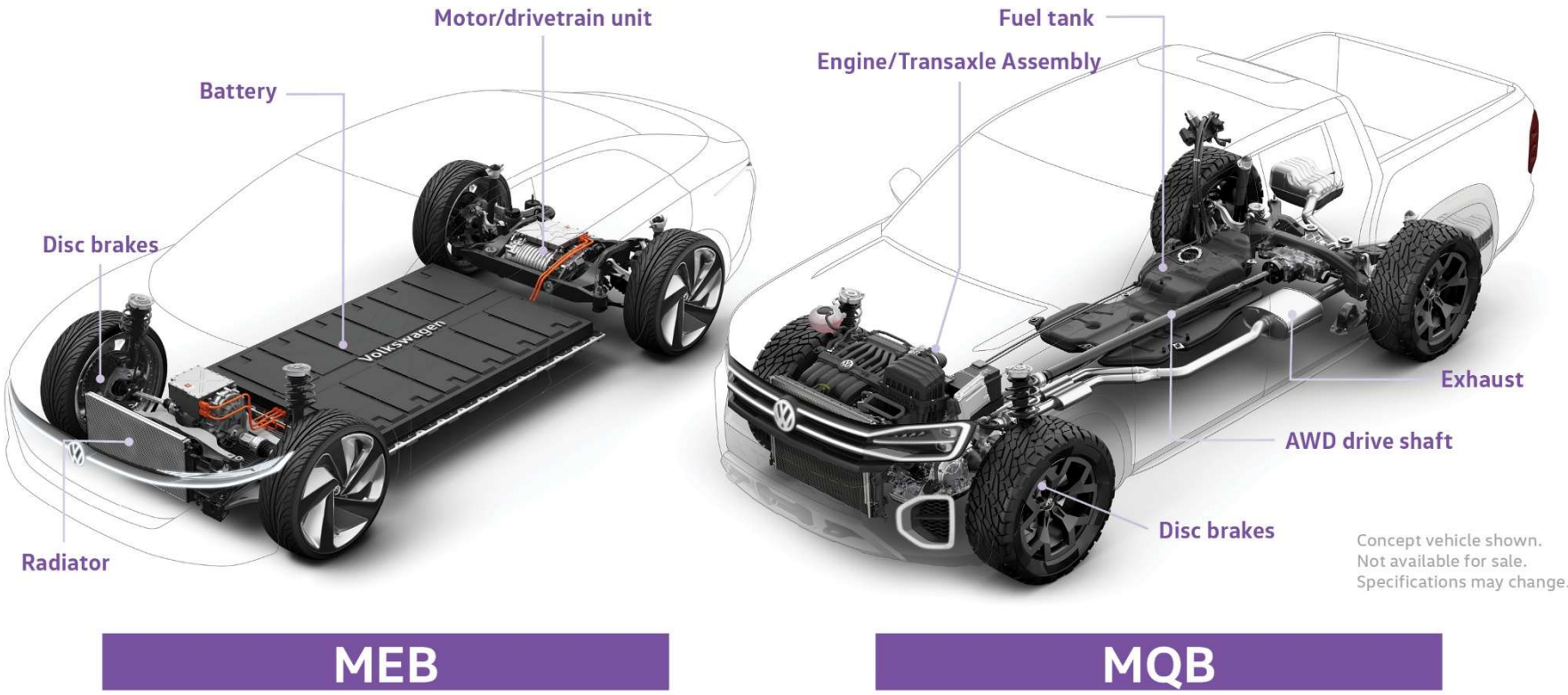
9 Modules = 58 kWh

12 Modules = 77 kWh

18



MEB vs. MQB

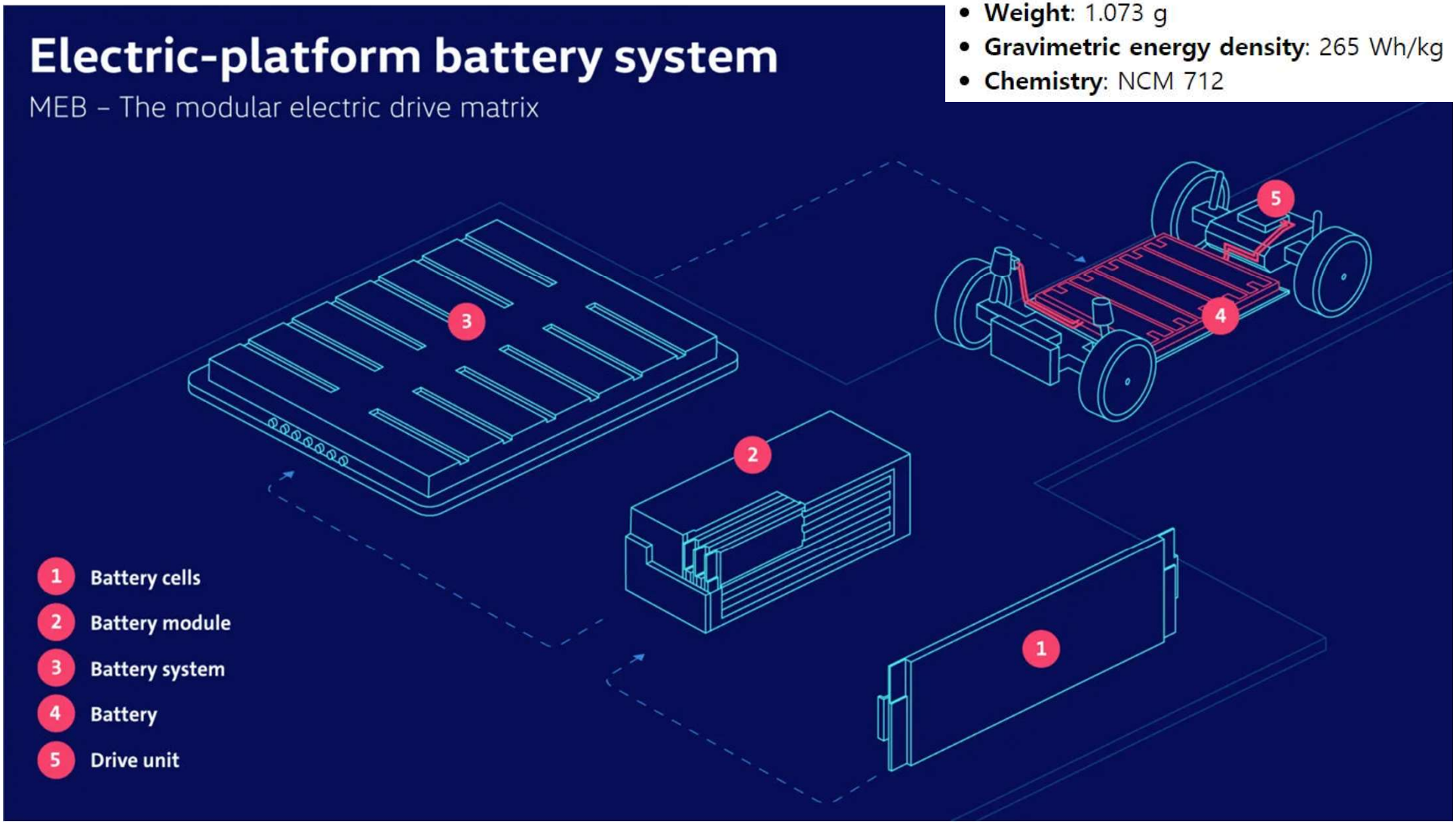

Motor/drivetrain unit
Battery
Disc brakes
Radiator
Volkswagen
Fuel tank
Engine/Transaxle Assembly
Exhaust
AWD drive shaft
Disc brakes
Concept vehicle shown.
Not available for sale.
Specifications may change.
MEB
MQB

THE MEB PLATFORM (1)

– MEB is built around the battery

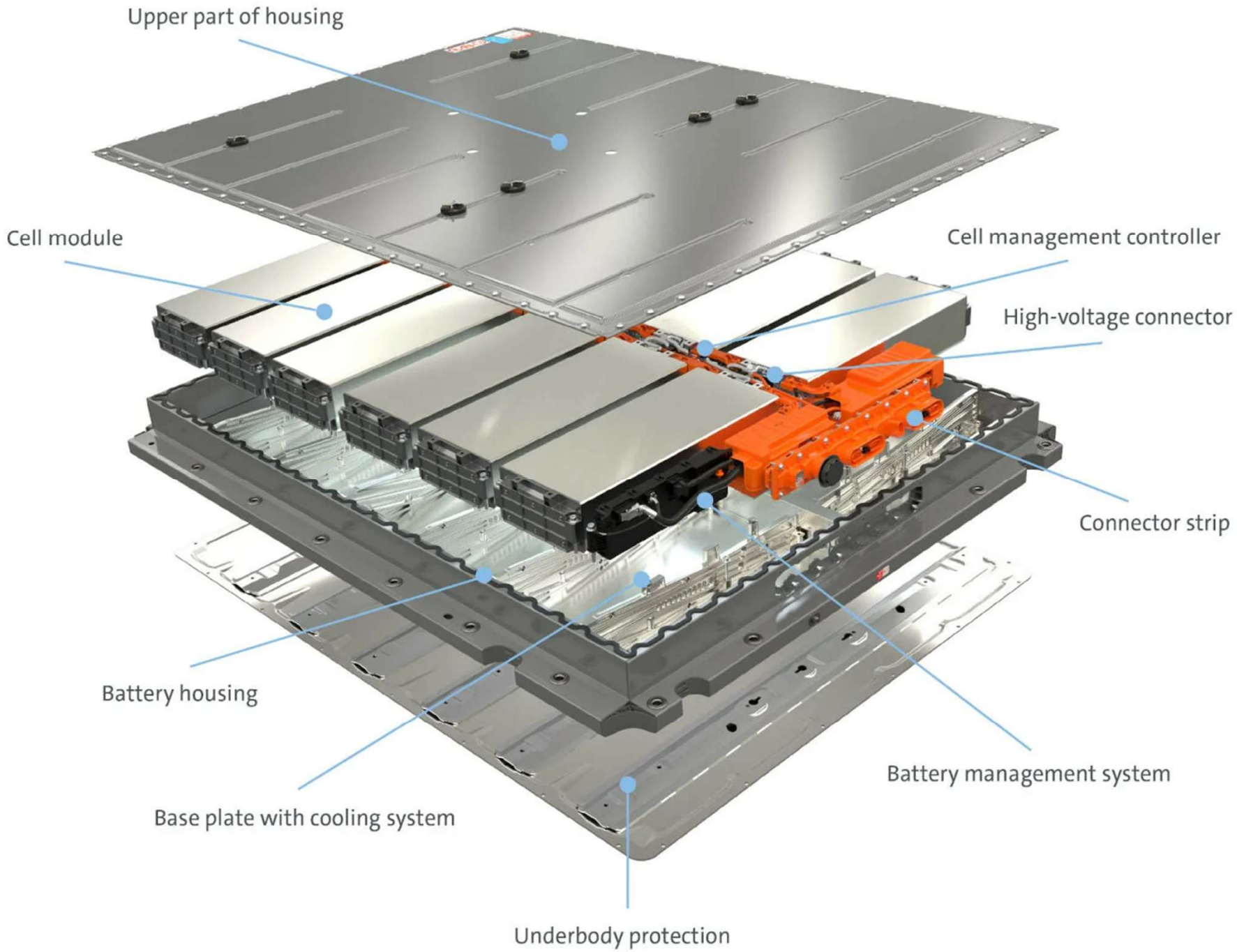
Battery cell

- **Manufacturer**: LG Chem
- **Model**: LGX E78
- **Voltage**: 3,65 V
- **Capacity**: 78 Ah
- **Weight**: 1.073 g
- **Gravimetric energy density**: 265 Wh/kg
- **Chemistry**: NCM 712



Battery Pack: Modules (24 cells)

	low	medium	high
Total capacity (kWh)	55	62	82
Usable capacity (94%)	52	58	77
Modules	8	9	12
Cells	192(96s2p)	216(108s2p)	288(96s3p)
Total Cell Weight (kg)	206	232	309
TMS	Active liquid cooling		

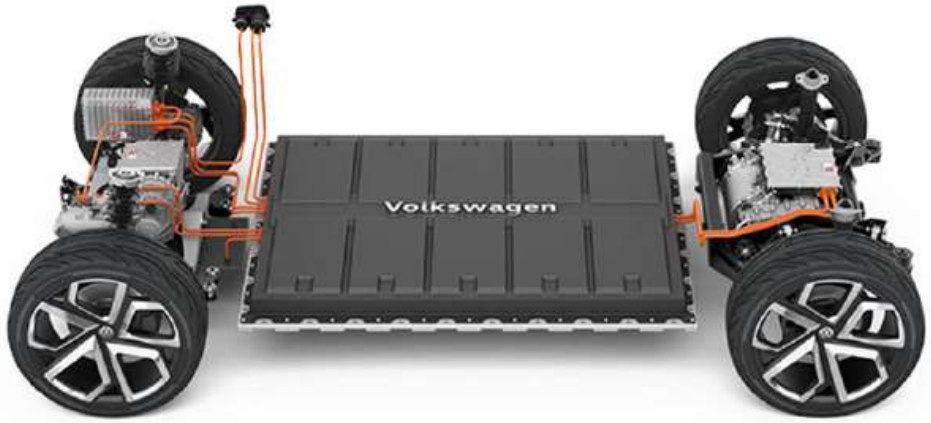

Upper part of housing
Cell module
Cell management controller
High-voltage connector
Connector strip
Battery housing
Battery management system
Base plate with cooling system
Underbody protection

THE MEB PLATFORM (2)

larger wheelbase
short overhangs

bigger
wheel diameter

no centre tunnel



rear drive
+ 4WD

trunk volume
~ ICE

central computer unit

Volkswagen

THE MEB PLATFORM (3)

larger wheelbase
short overhangs

bigger
wheel diameter

no centre tunnel

rear drive
+ 4WD

trunk volume
~ ICE

More space in driver's
area and in the back;
higher seating position

central computer unit

Volkswagen

THE MEB PLATFORM (4)

larger wheelbase
short overhangs

bigger
wheel diameter

no centre tunnel

rear drive
+ 4WD

trunk volume
~ ICE

different body shapes

More space in driver's
area and in the back;
higher seating position

central computer unit

Volkswagen

THE MEB PLATFORM (5)

I.D. LINE UP.

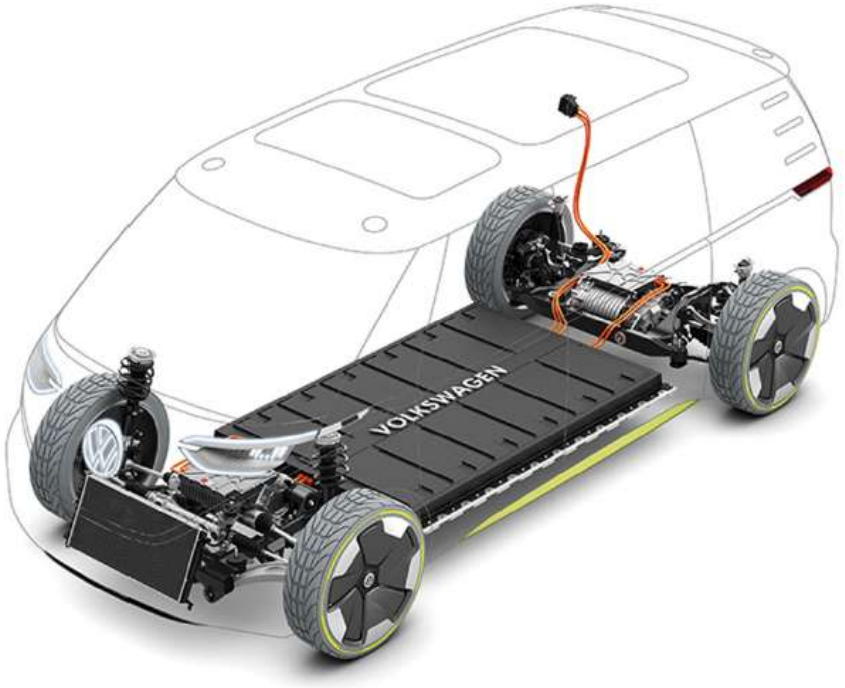
The first family members.

Volkswagen

THE MEB PLATFORM (6)

MEB-based model: 1) Five-passenger ID model

MEB-based model: 2) Eight-passenger MPV ID Buzz



Volkswagen's ID family development plan

- 2020: To produce 600,000 EVs based on the MEB platform (announced at Auto Shanghai).
- 2022: To increase the number of EV models to 20 (currently two); sales target of 1mn units
- 2025: To increase the number of EV models to 50 and raise annual production volume to 3mn units (25% of total)
- 2028: Sales of 15mn units and 55 MEB-based EV models → Sales of 22mn units and 70 EV models






	<Neo - 2019>	<Crozz - 2020>	<Vizzion - 2022>	<TBD - 2022>	<Aero - TBD>	<Buzz - 2022>
Segment	Hatchback - C	SUV - C	Sedan - E	SUV - B	Sedan – D	MPV - D
Site	Zwickau	Zwickau	Zwickau	Emden	Emden	Hanover
Notes	First ID model	Coupe-style crossover	Luxury model	Under EUR20,000	Similar to Passat (sedan/wagon)	LCV version to be launched

- Concurrent development of sedan/hatchback/SUV/MPV models (design for manufacturing)

Significance of MEB platform

- At CES 2019, Volkswagen announced that it would manufacture and sell its MEB platform.
- The company's first MEB customer is e.GO Mobile, an EV start-up based in Germany.
- Based on a partnership with Volkswagen, Ford (F US/CP: US$10.41) plans to introduce 16 EV models by 2022.
- In an effort to make forays into the Chinese market, the company is also providing its MEB platform to joint ventures involving Chinese automakers, including SAIC (600104 CH/CP: RMB27.38) and FAW.

e.Go's Moove electric minibus Moove

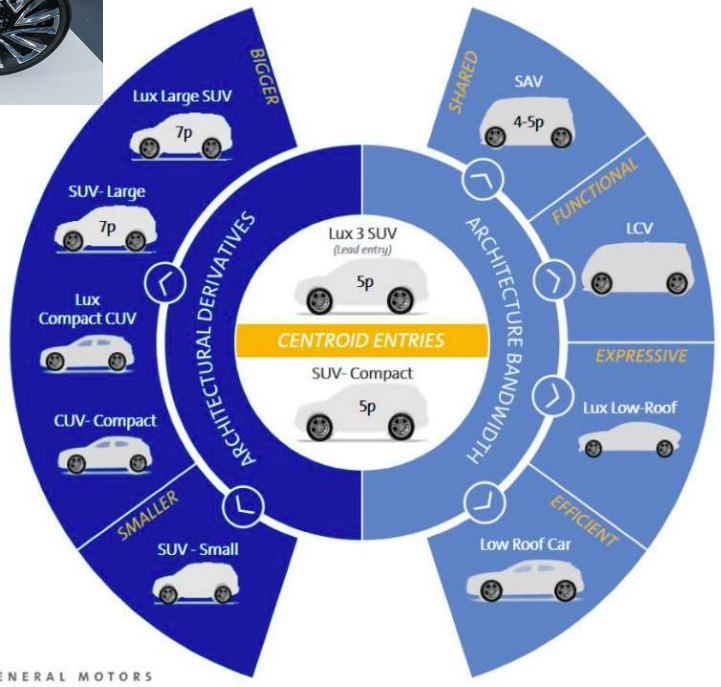
Volkswagen to expand partnerships based on its platform

Audi: PPE (Premium Platform Electric)

- 800-volt architecture with efficient cooling systems
  - charge at rates of up to 350 kilowatts, making 80-percent charges in about 20 minutes possible

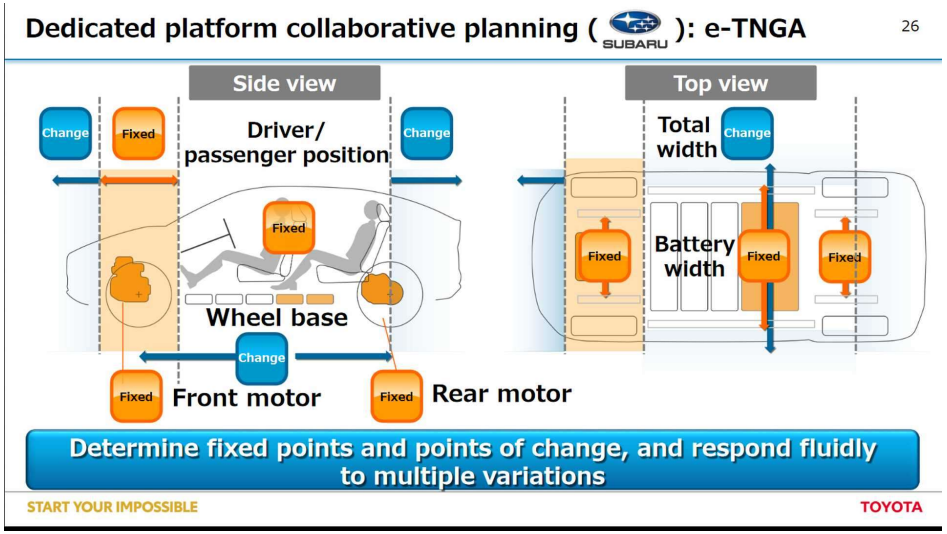
GM: Ultium (2020.03.04)

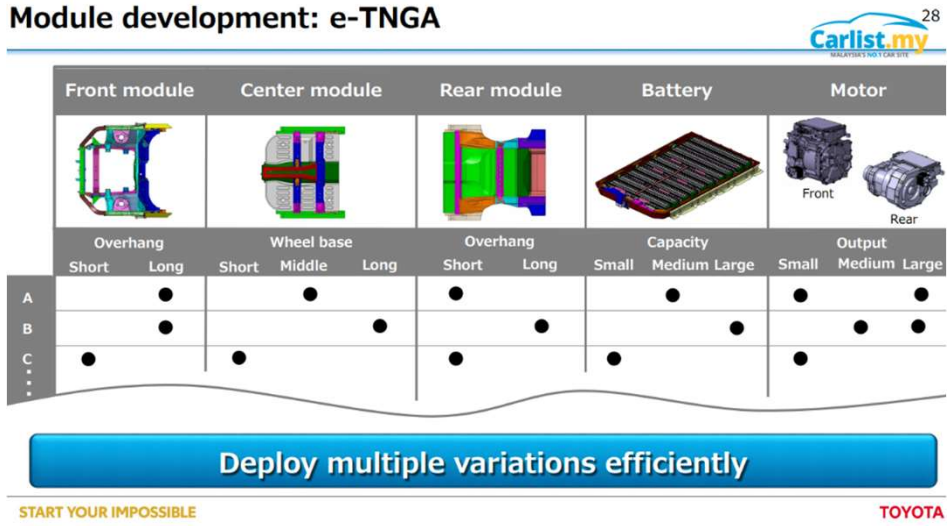
- all-new modular platform and battery system



https://www.youtube.com/watch?v=5YeJUsB1ehg

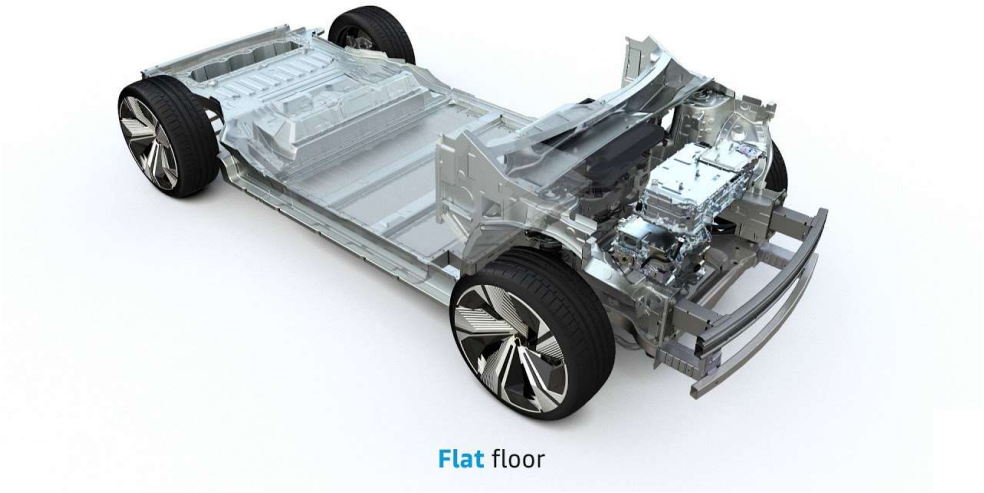
TOYATA: e-TNGA



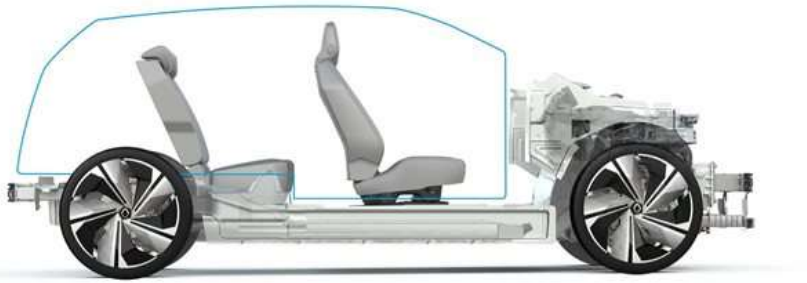


https://newsroom.toyota.eu/toyota-to-preview-all-new-battery-electric-suv/

CMF-EV (New Modular Electric Platform)



Flat floor



Augmented roominess

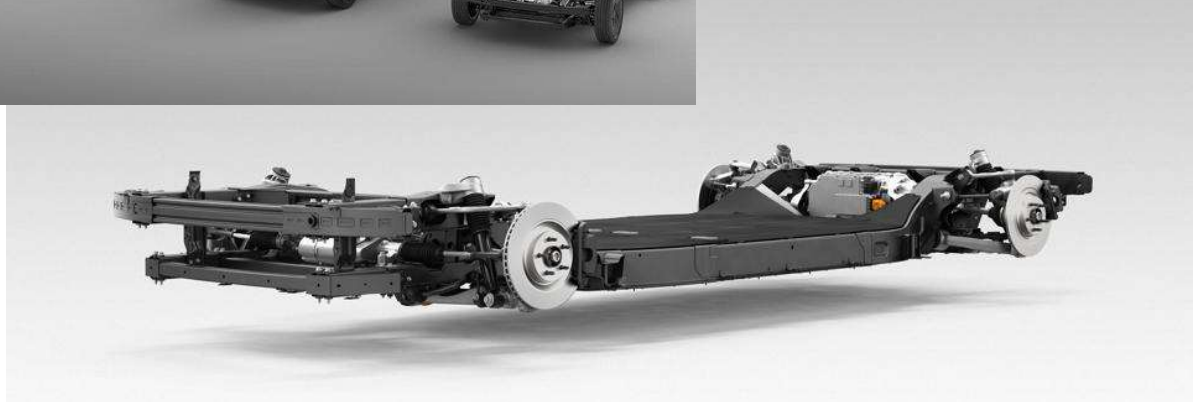
https://www.youtube.com/watch?v=yUSDe9QIlho

전기차 시대의 차세대 플랫폼 E-GMP

- EV 전용 E-GMP(Electric-Global Modular Platform)
  - 배터리와 모터를 위한 최적의 공간을 만들 수 있기 때문에 성능과 상품성은 대폭 높아짐
  - 차급에 따라 배터리 용량을 다르게 적용하면서 여러 모델에 쉽게 적용

https://www.youtube.com/watch?v=BTvai7268Zs

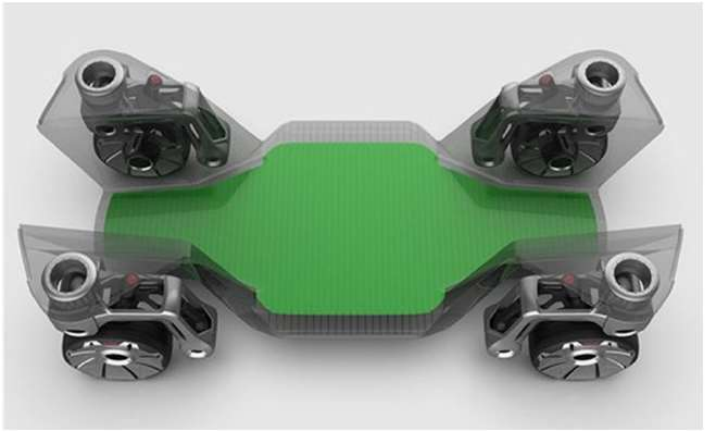
– Hyundai, Kia Invest 100 Million Euros In Arrival EV Start Up (2020.01.16)
– Hyundai Adds Electric Vehicle ‘Skateboard’ Project With L.A. Startup Canoo To $87 Billion Mobility Push (2020.02.11)



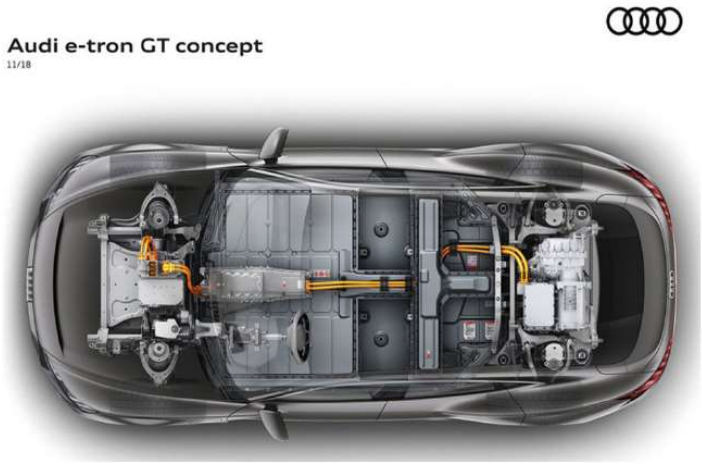
Platform War to Unfold

- Porsche-Audi: The PPE platform will be used to build a variety of B/C/D-segment models (SUVs, sedans, wagons, and hatchbacks).
- Mercedes-Benz-BMW: To launch volume-production models under the Mercedes EQ brand name (EVA platform)
- HMC-Kia: Set to launch new EV models built on a dedicated platform named E-GMP in 2020
- GM (GM US/CP: US$38.80): Will also release new EVs based on its third-generation EV platform (EV3) in 2021

HMC's E-GMP platform

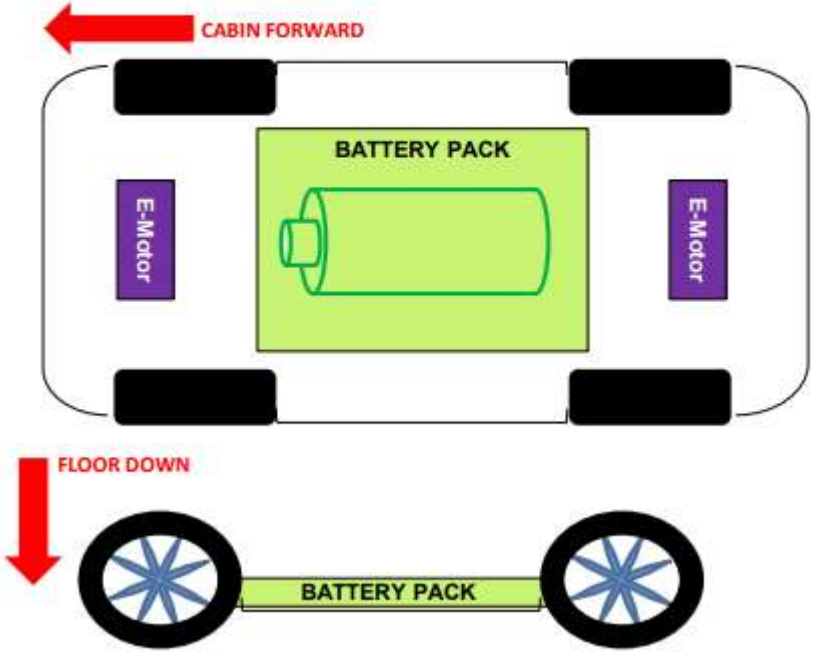


Audi's e-tron GT concept (PPE platform)

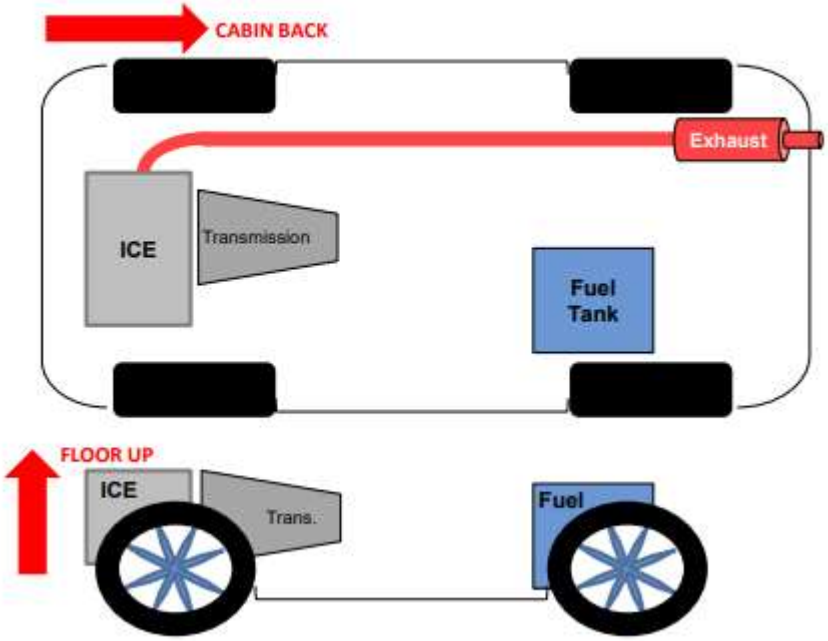


BEV vs. ICE

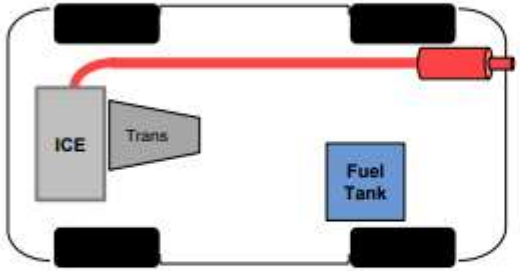
Desirable attributes of a BEV include low centre of gravity (handling), flat low floor (interior packaging), cabin forward (more cabin space for same vehicle length).



ICE attributes include a high shaped floor to accommodate ICE components and the cabin set back to provide crash protection. OEMs need separate architectures to avoid compromises.

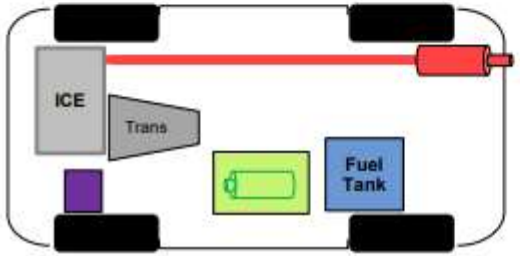


The industry is walking from ICE to BEV via a 4 step process which leads to compromise, complexity and the largest step (platform changeover) not taking place until the end.



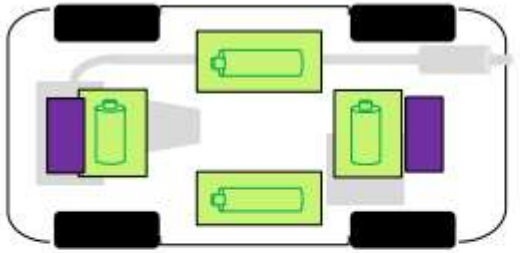
Step 0

ICE: Vanilla Internal Combustion Engine Vehicle



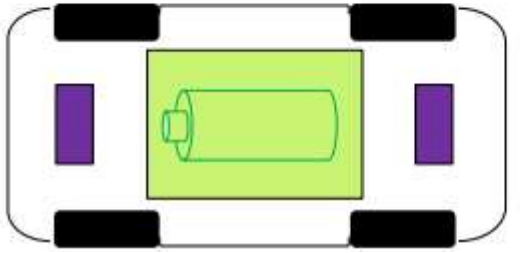
Step 1

PHEV: Cram in E-Motor and Battery Pack, adding weight and taking up space



Step 2

BEV on ICE Platform: Attempt BEV by stripping out ICE and trying to fit sufficient EV components in their place without tearing up sheet metal



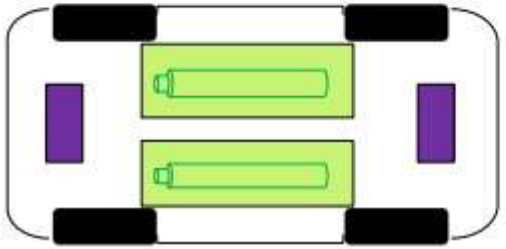
Step 3

BEV: To overcome major compromises in BEV on ICE Platform, build dedicated BEV on BEV Platform with all new architecture

Starting with a BEV (E-FIRST) and walking back to what is affordable today is a better approach in our view. An approach with flexibility and which sees OEMs transition to dedicated BEV platforms sooner rather than later.

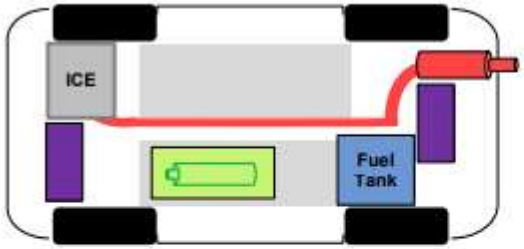
Step 0

BEV: Design optimal BEV Platform, 1 large battery pack (55kWh+), no compromise and prepared for the End Game



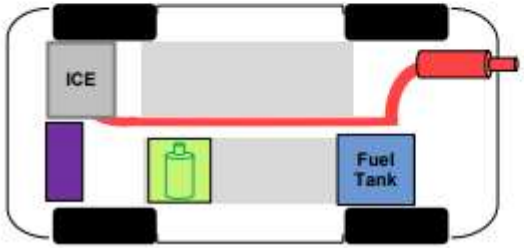
Step 1

E-First BEV: 2 large battery packs (55kWh+). Small adjustments to design to accommodate ICE components and necessary crumple zones



Step 2

E-First PHEV Performance: Maintain electric drive, add ICE components back in. Dual E-Motor, 15-25kWh battery, small ICE as generator

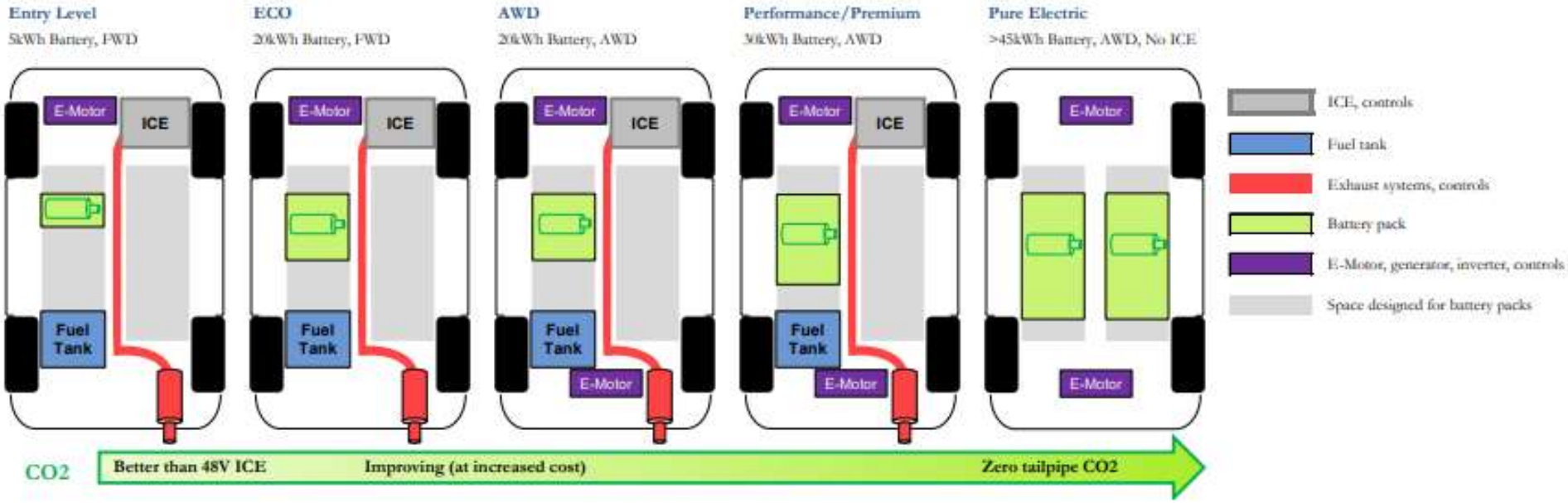


Step 3

E-First PHEV Entry Level: Maintain electric drive, add ICE components back in. Single E-Motor, 4kWh battery, small ICE as generator

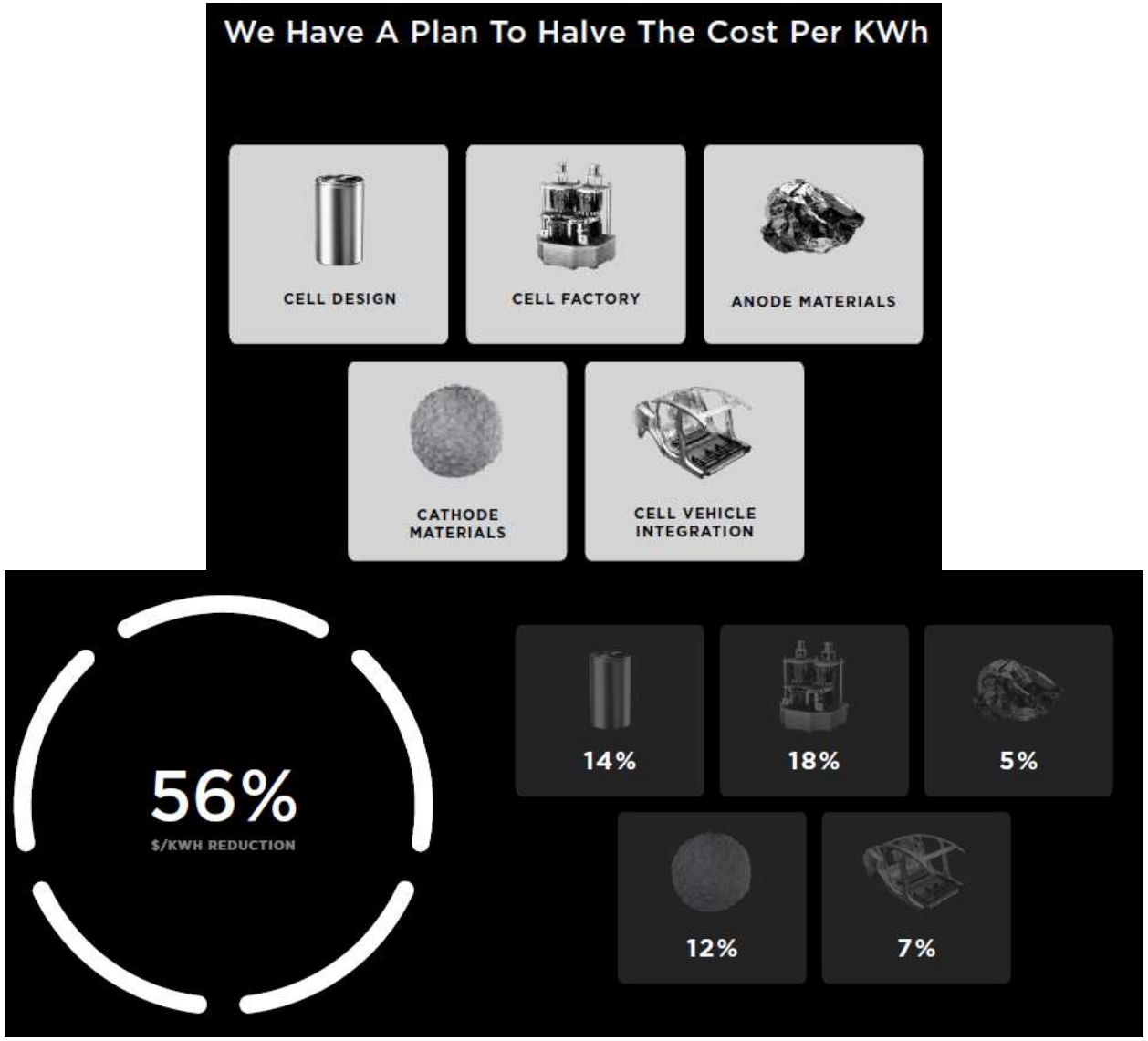
Same Platform and Architecture

E-FIRST enables OEMs to produce vehicles comparable on cost with 48V (though better on CO2), PHEVs and BEVs all off the same platform while offering all the advantages of a dedicated BEV platform to the customer and none of the compromises inherent in BEVs sourced off traditional ICE platforms.

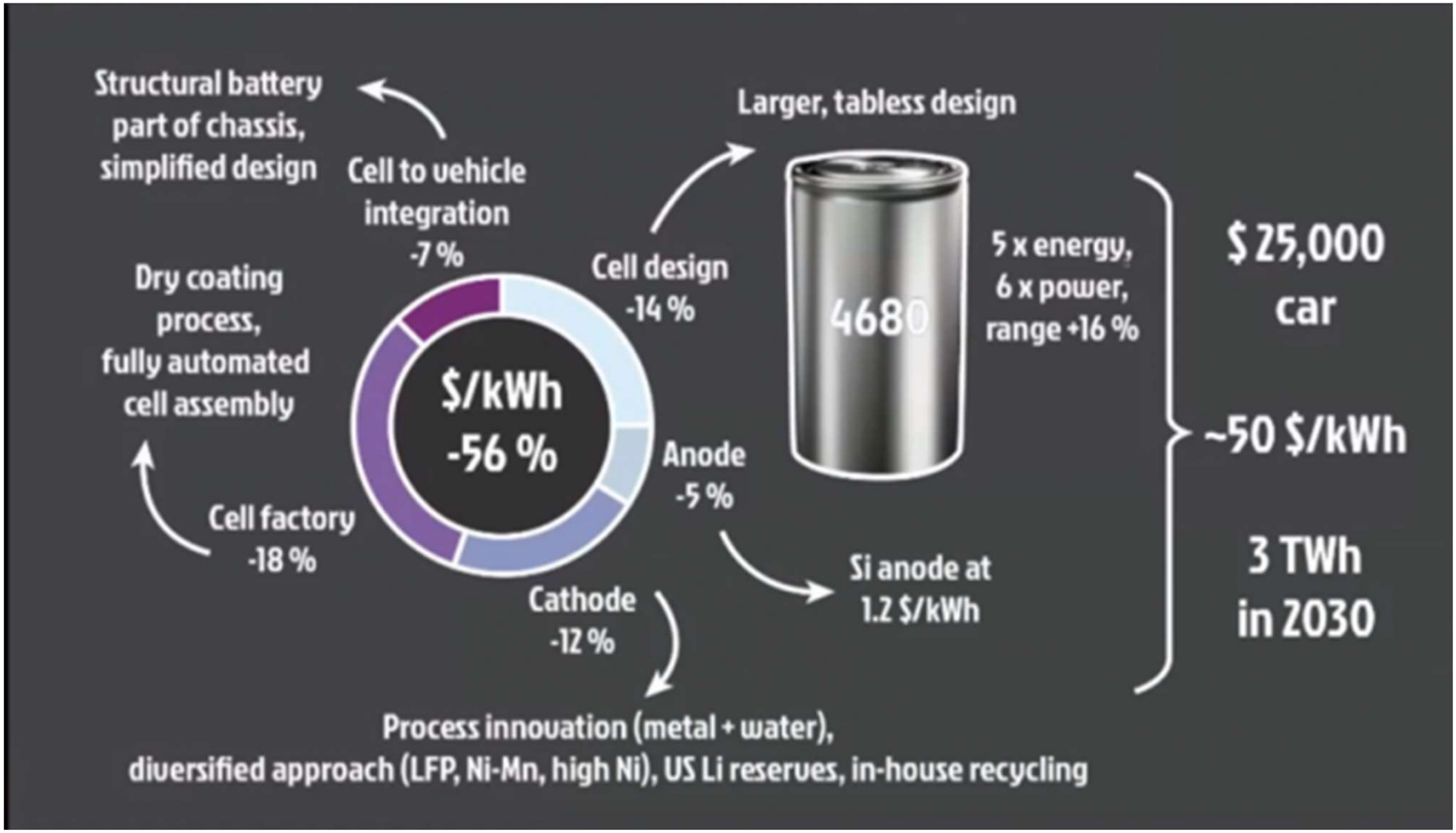


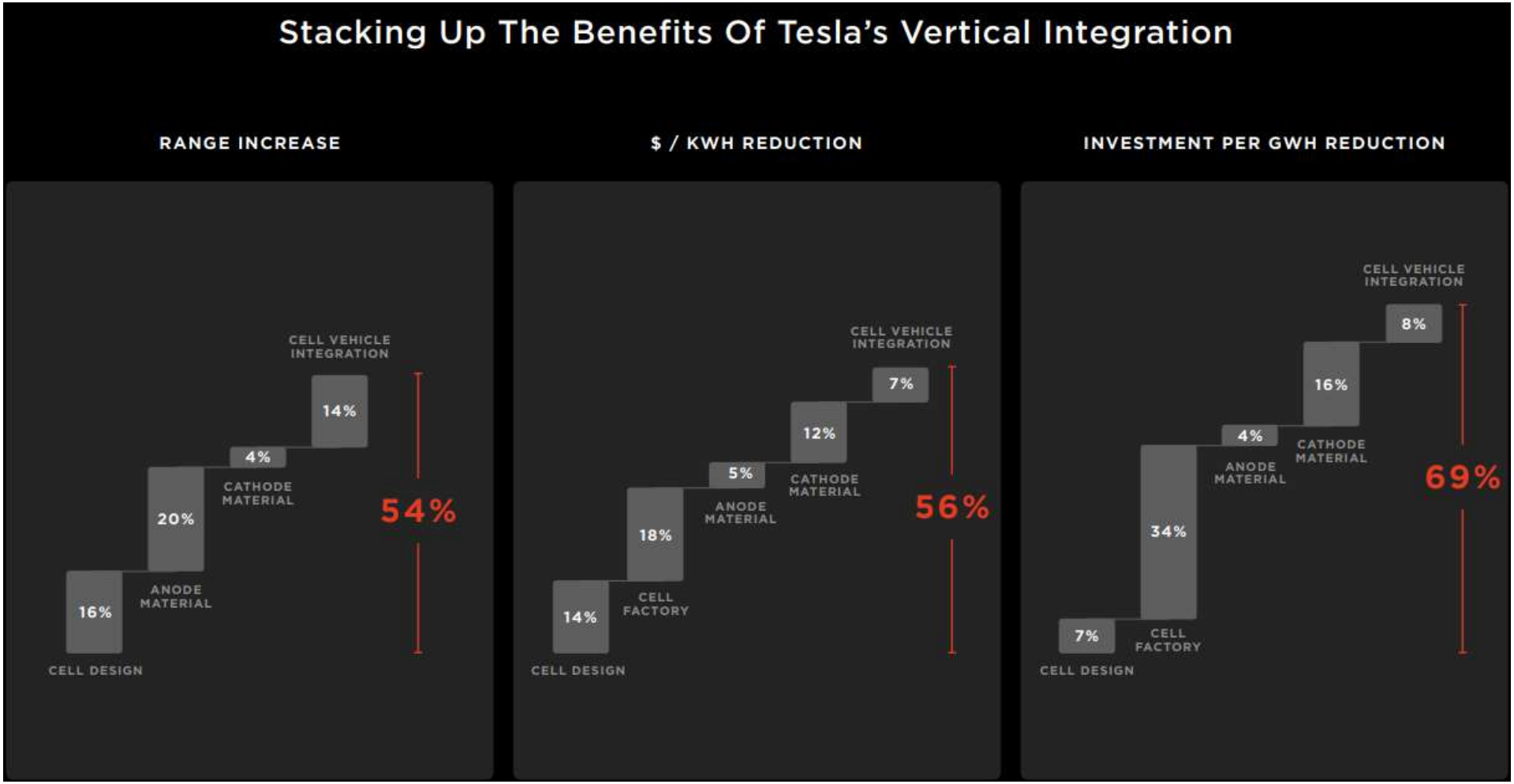
Source: Evercore ISI Research, Ad Punctum

Tesla Battery Day (2020.09.22)

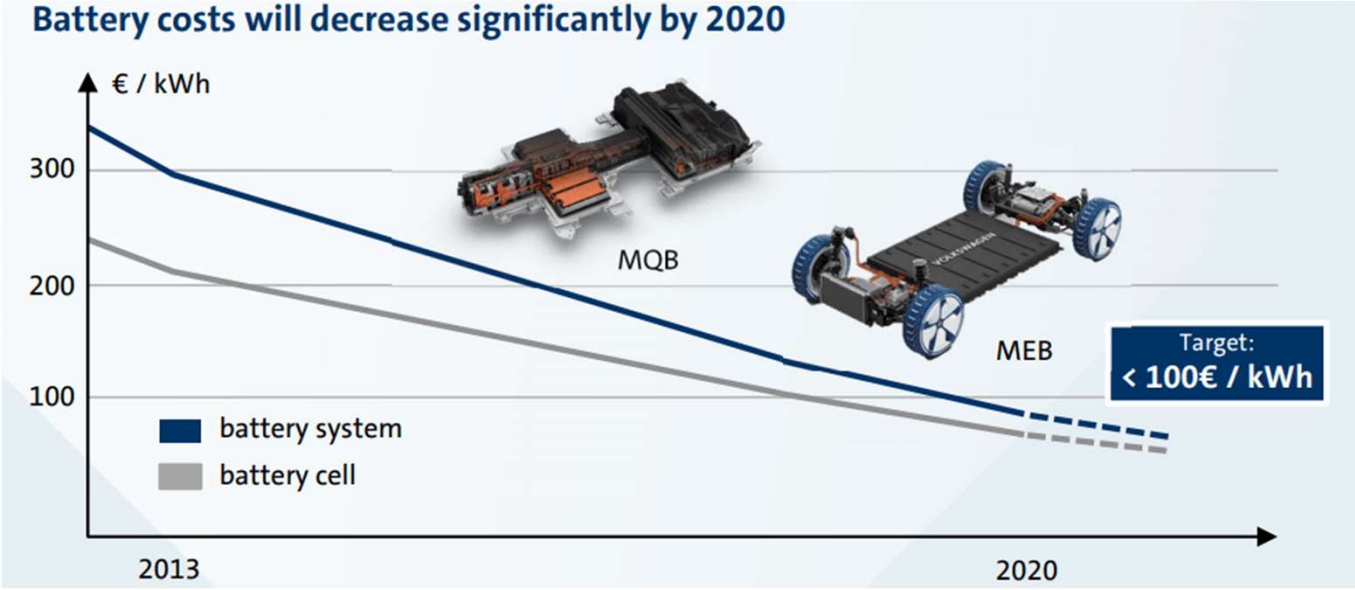


Summary


Structural battery part of chassis, simplified design
Cell to vehicle integration -7 %
Larger, tabless design
Cell design -14 %
Dry coating process, fully automated cell assembly
$/kWh -56 %
4680
5 x energy, 6 x power, range +16 %
$ 25,000 car
~50 $/kWh
3 TWh in 2030
Anode -5 %
Si anode at 1.2 $/kWh
Cell factory -18 %
Cathode -12 %
Process innovation (metal + water), diversified approach (LFP, Ni-Mn, high Ni), US Li reserves, in-house recycling


Stacking Up The Benefits Of Tesla's Vertical Integration
RANGE INCREASE
CELL VEHICLE INTEGRATION
14%
4%
CATHODE MATERIAL
20%
ANODE MATERIAL
16%
CELL DESIGN
54%
$ / KWH REDUCTION
CELL VEHICLE INTEGRATION
7%
12%
CATHODE MATERIAL
5%
ANODE MATERIAL
18%
CELL FACTORY
14%
CELL DESIGN
56%
INVESTMENT PER GWH REDUCTION
CELL VEHICLE INTEGRATION
8%
16%
CATHODE MATERIAL
4%
ANODE MATERIAL
34%
CELL FACTORY
7%
CELL DESIGN
69%

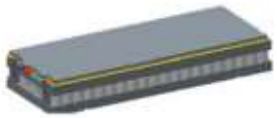
Battery Cost



VOLKSWAGEN

AKTIENGESELLSCHAFT

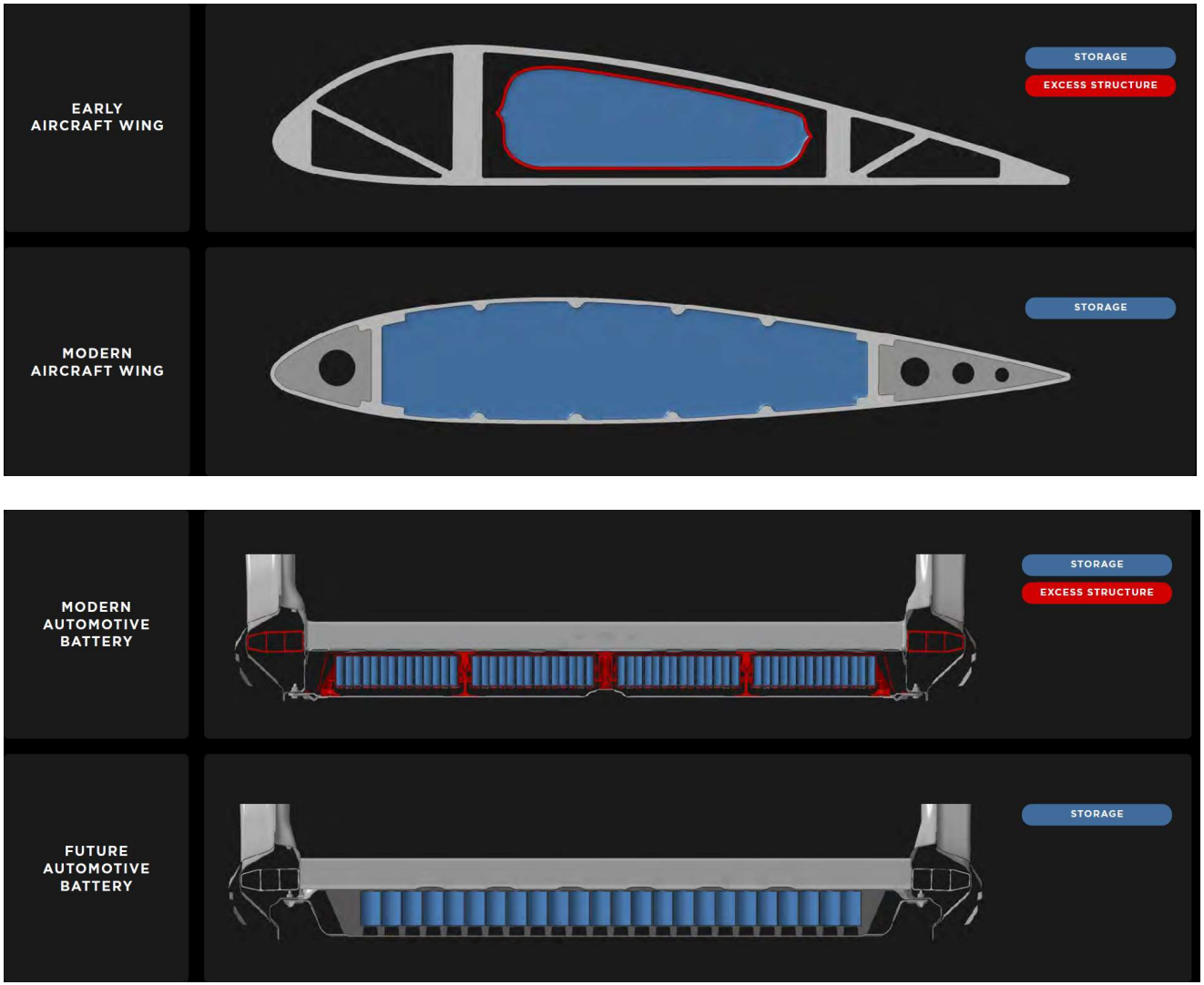
Analysis of the value chain to achieve the target of <€100 / kWh

Commodity	Raw material	Cell / Formats	Module incl. assembly	Case, electronics and sub components assembly
		 Pouch		
Lithium Nickel Manganese Cobalt Graphite ...	e.g. NMC **(Lithium Nickel Manganese Cobalt Oxide)** 1.1.1 6.2.2 8.1.1	 Prizmatic  Round		

70% added value | **10%** | **20%**

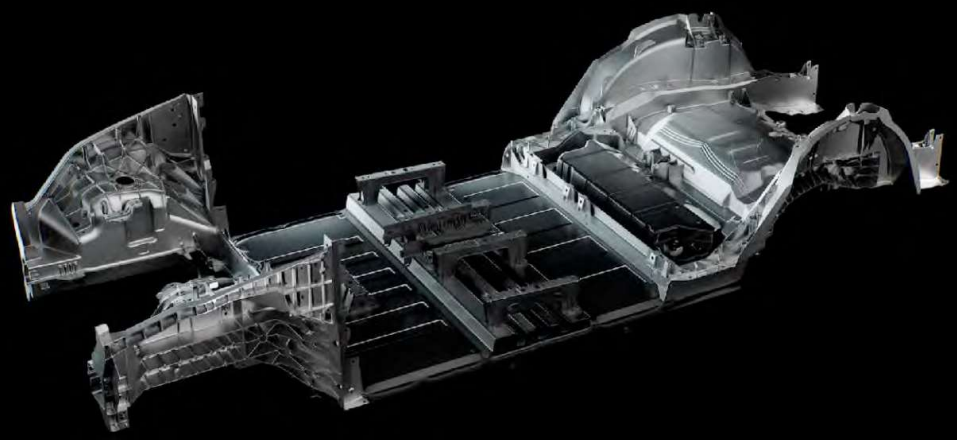
Main factor to achieve target

Improve Mass And Range: Structural Fuel Tanks vs. Structural Batteries



Revolution In Body + Battery Engineering

10% MASS REDUCTION | 14% RANGE INCREASE OPPORTUNITY | 370 FEWER PARTS



Simpler, Smaller, Integrated Battery + Body Factory Of The Future

55% REDUCTION IN INVESTMENT PER GWH

35% REDUCTION IN FLOORSPACE

CURRENT

FUTURE

Cell to Pack → Cell to Body

- 배터리 셀을 패킹한 후 팩 제조→ 배터리 셀 자체를 차량바디에 그대로 적용
- 기존 보다 더 큰 4680셀로 배터리를 채움(배터리 용량↑ 밀도↑) → 효율&주행거리↑, 공간(trunk, frunk)↑, 차체강성에 도움
- Unibody 구조 플랫폼: 기존의 완성된 차량의 배터리팩을 조립하는 형태→차량의 뼈대를 만들때부터 배터리가 탑재될 공간을 만듬
- Model Y 프레임용 대형주조기 도입(Fremont공장, 2020.08)
  - 일체형 후면바디 제작
  - 기존에 뼈대를 만들고 70개 부품을 접합한 형태 → 4개 요소(배터리팩이 포함된 하체, 양쪽 문 2개, 지붕)
  - 2022년 하반기 독일 베를린 기가팩토리에서 생산할 계획

Honeycomb Structure

- 배터리 용량과 사이즈를 유연하게 조절 가능
  - (skateboard) 추가된 팩의 사이즈만큼 하부공간 조절, 2개 단위, 폭 조절 안됨 → 배터리 셀 행과 열의 수를 한줄씩 조절 가능
- 안전
  - 최소한의 재료로 수납공간을 극대화, 강성 보존
  - 셀과 셀 사이를 격리, 열관리 및 화재 시 더 안전
  - 그 자체로 섀시 구조를 제공, 배터리팩 강성 + 차량자체 강성 상승 효과
- 비용절감
  - 부품수가 약 370개 정도 적은 제조비용, 잠재적 수리비용, 조립 공정의 자동화