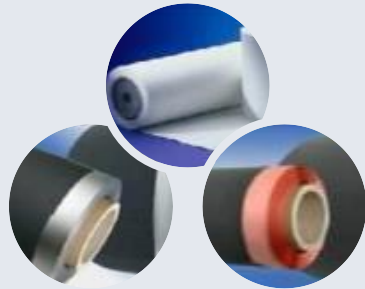

BATTERY CELL TECHNOLOGY.
20.11.2019

DR. PETER LAMP
HEAD OF RESEARCH & DEVELOPMENT
BATTERY CELL TECHNOLOGY, FUEL CELL

BMW GROUP SUSTAINABLE MOBILITY. INHOUSE DEVELOPMENT & PRODUCTION OF BATTERY SINCE 2008.

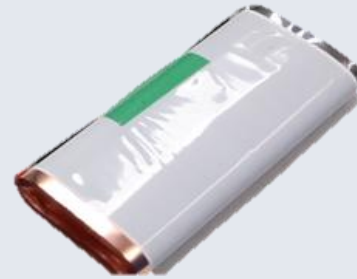
FULL
SPECIFICATION
AND DESIGN
COMPETENCE

1



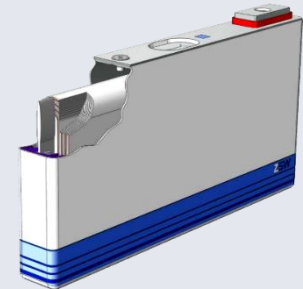
Subcomponents/Electrodes

2



Jelly Roll

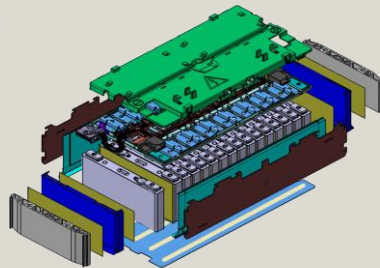
3



Battery Cell

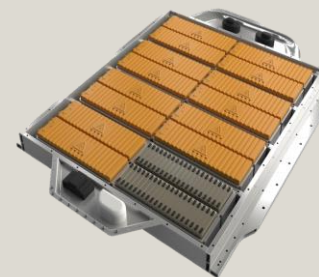
DEVELOPMENT
& PRODUCTION
INHOUSE

4



Subsystem/Module

5



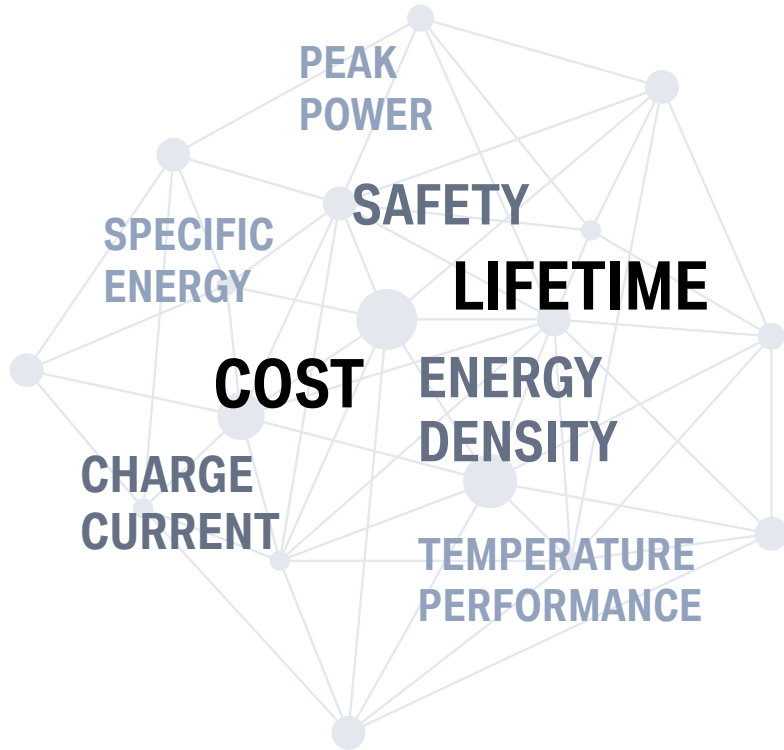
Battery Pack

6

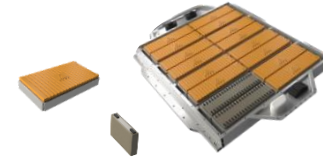


xEV Vehicle

STRONG INTERACTION FROM MATERIAL TO VEHICLE – OEMS NEED TO BE INVOLVED IN CELL & MATERIAL DEVELOPMENT.

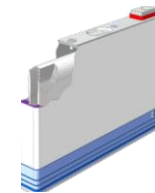


Battery Pack



**20% OF COST
ADDRESSED**

Battery Cell



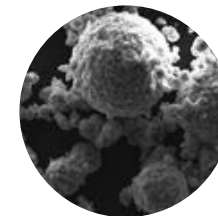
**80% OF BATTERY
COST IS CELL COST**

**Jelly Roll /
Electrodes**



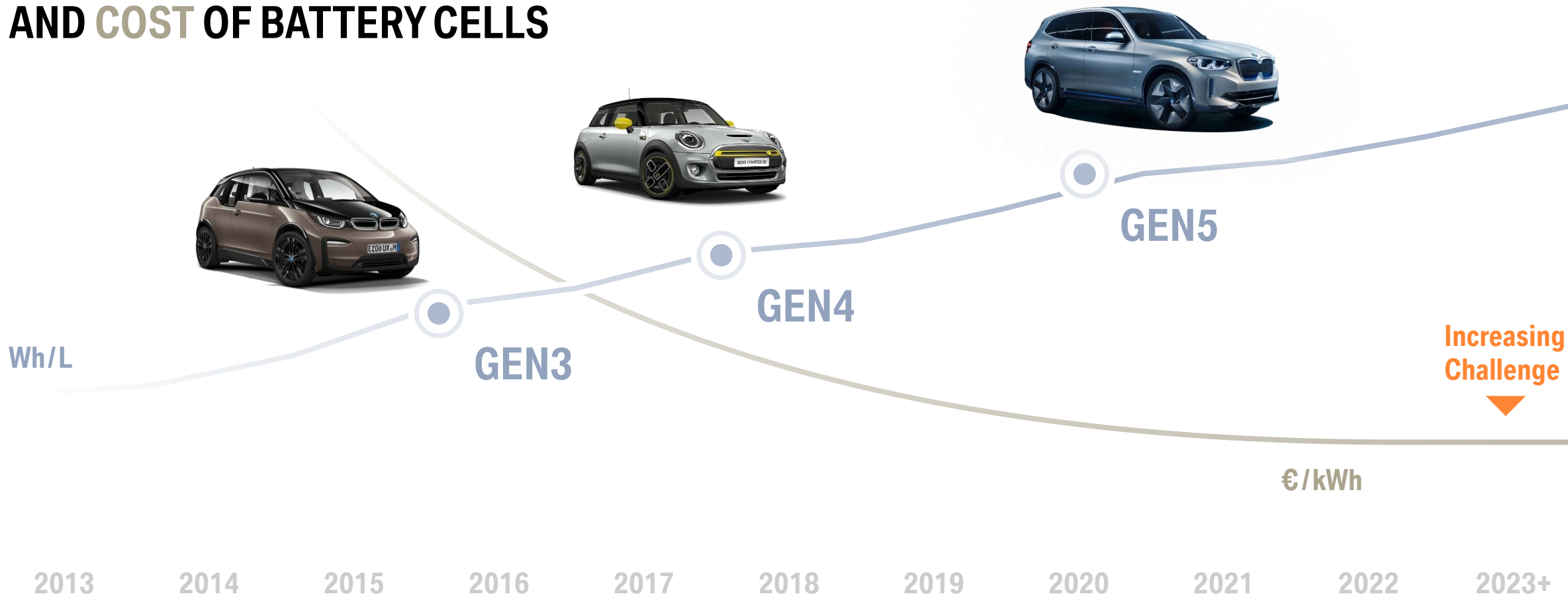
**80% OF
CELL COST IS
MATERIAL COST**

**Active
Materials**

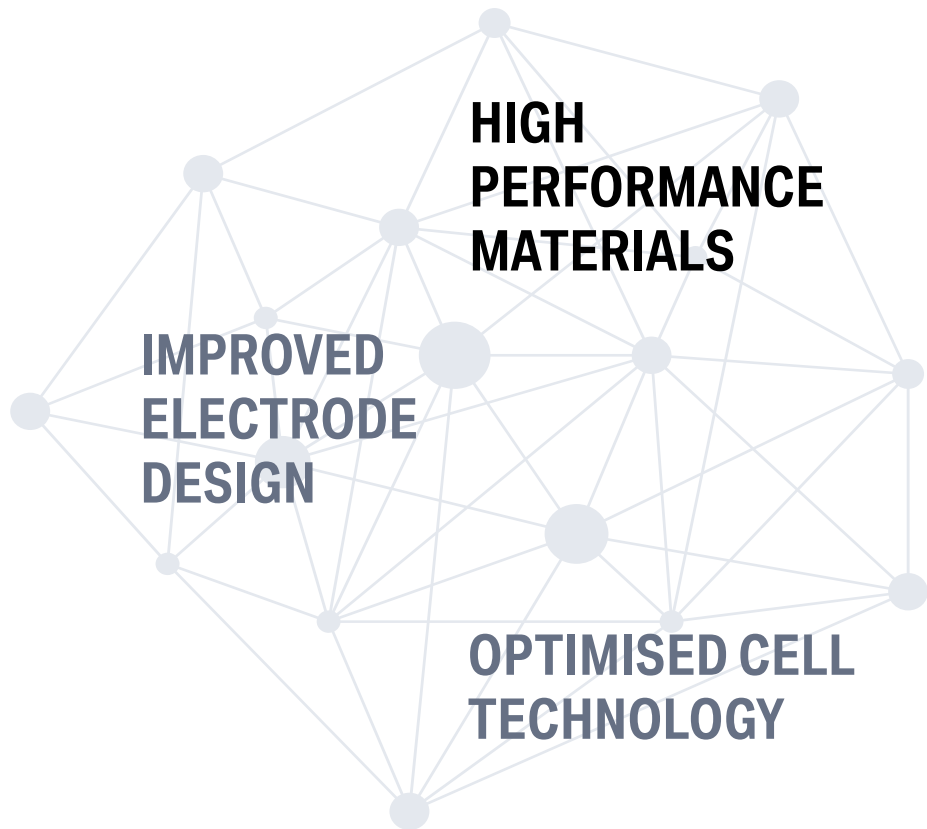


HUGE PROGRESS ON CELL ENERGY DENSITY AND COST. FURTHER COST REDUCTION NECESSARY.

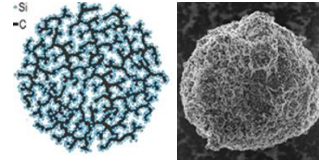
DEVELOPMENT OF ENERGY DENSITY AND COST OF BATTERY CELLS



ENERGY DENSITY INCREASE MAINLY DRIVEN BY MATERIAL IMPROVEMENTS.

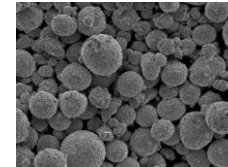


Anode Material



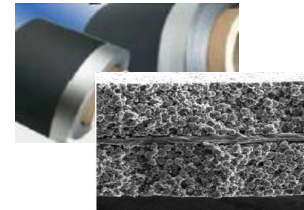
Graphite	360 mAh/g
Graphite + SiOx	500-600 mAh/g
Si – C Composite	1200 mAh/g

Cathode Material



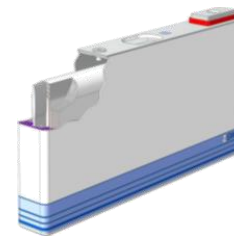
NMC	
111	150 mAh/g
532, 622	180 mAh/g
811	210 mAh/g
> 90% Ni	230 mAh/g

Electrode design



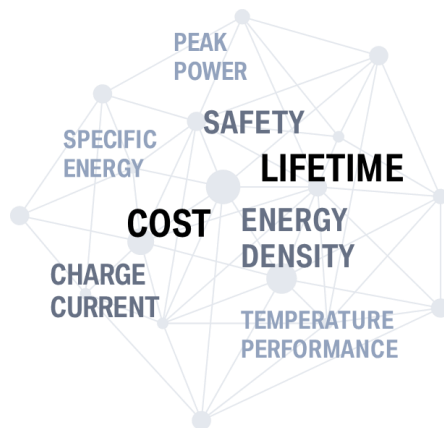
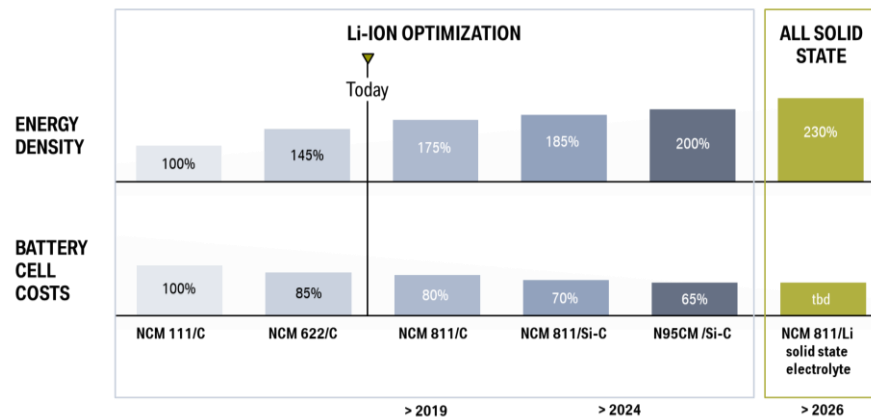
- Increased loading
- Optimization coating area

Cell design



- Increased volume utilization (stacking vs. winding)
- Reduced foil thickness
- Increased cell size (reduction of non active material)

ROADMAP FOLLOWS CATHODE AND ANODE MATERIAL DEVELOPMENT. IMPROVEMENTS IN OTHER COMPONENTS IMPORTANT.



CATHODE:

- 811 close to market
- > 90% Ni in final development
- Beyond?

ANODE:

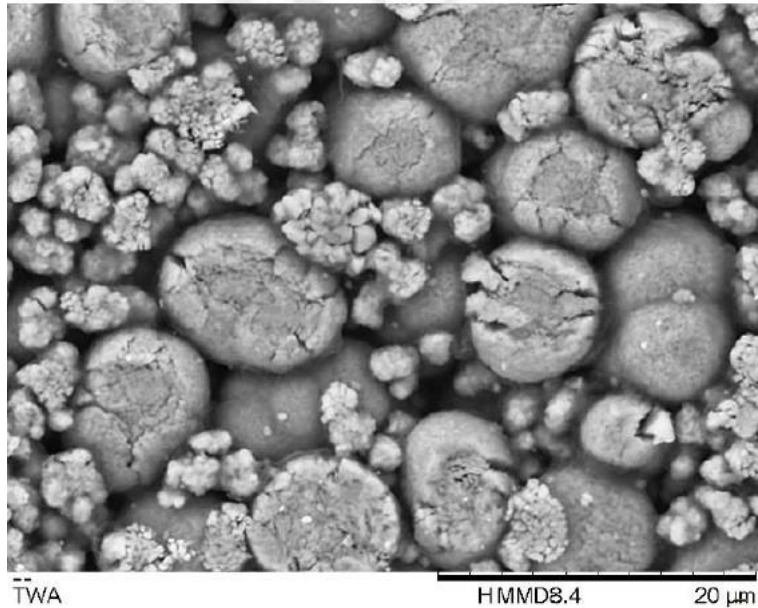
- SiOx possible but cost?
- Si-C in final development; industrialization, cost?
- Li-metal? Only with solid electrolyte.

ADDITIONAL COMPONENT DEVELOPMENT NEEDED TO MEET TARGETS:

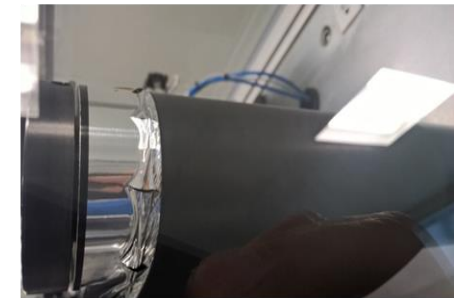
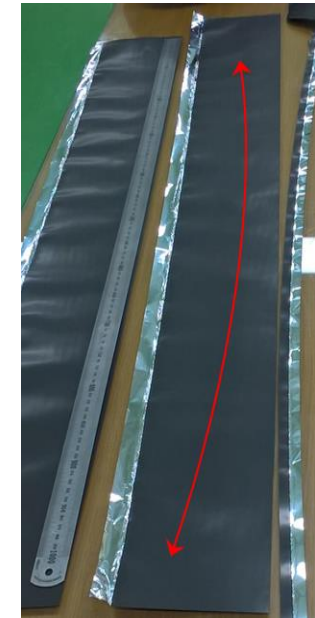
- Separator with enhanced thermal stability
- Electrolytes and additives to reduce and/or slow down energy release under abuse conditions
- Binder and conductive agents to be optimized for new materials/material surfaces for good electrical/mechanical properties

FULL CHEMISTRY SYSTEM HAS TO BE DEVELOPED IN COMMON TO ACHIEVE COMPETITIVE SYSTEM.

MATERIAL AND PROCESS DEVELOPMENT HAVE TO BE DONE IN PARALLEL.



- Particle structures can be damaged.
- Cathode material powder densities and binder / conducting agents have to be optimized.
- Substrates foils have to be carefully selected.
- Calendaring processes have to be improved.



BMW GROUP STRATEGY: KEEPING KEY KNOW-HOW IN OUR OWN HANDS. FULL CELL DEVELOPMENT FROM MATERIALS TO TARGET CELL.

11/2017

START OF CONSTRUCTION

200 MIO. €

4 YEARS OVERALL COST

8000 M²

BCCC TECHNICAL CENTER

4000 M²

BCCC OFFICE SPACE

UP TO 200

EMPLOYEES IN THE DEPARTMENTS

1000 M²

DRY ROOM AREA

12/2019

START OF PRODUCTION



BCCC PROVIDES ALL NECESSARY DEVELOPMENT TOOLS AND STEPS. INTERNATIONAL NETWORK IS THE ESSENTIAL INPUT.

COOPERATIONS



INSTITUTES



ACADEMIA



STARTUPS

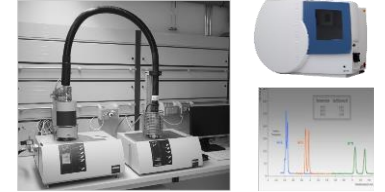


OEMS

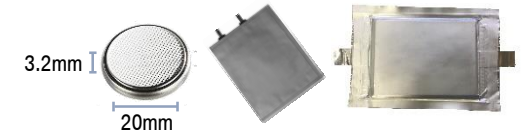


INDUSTRY

Material characterization



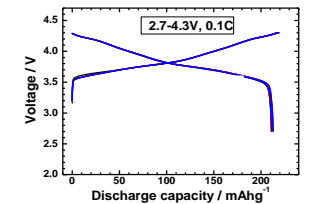
Chemistry development



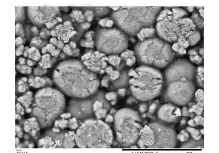
Recipe development



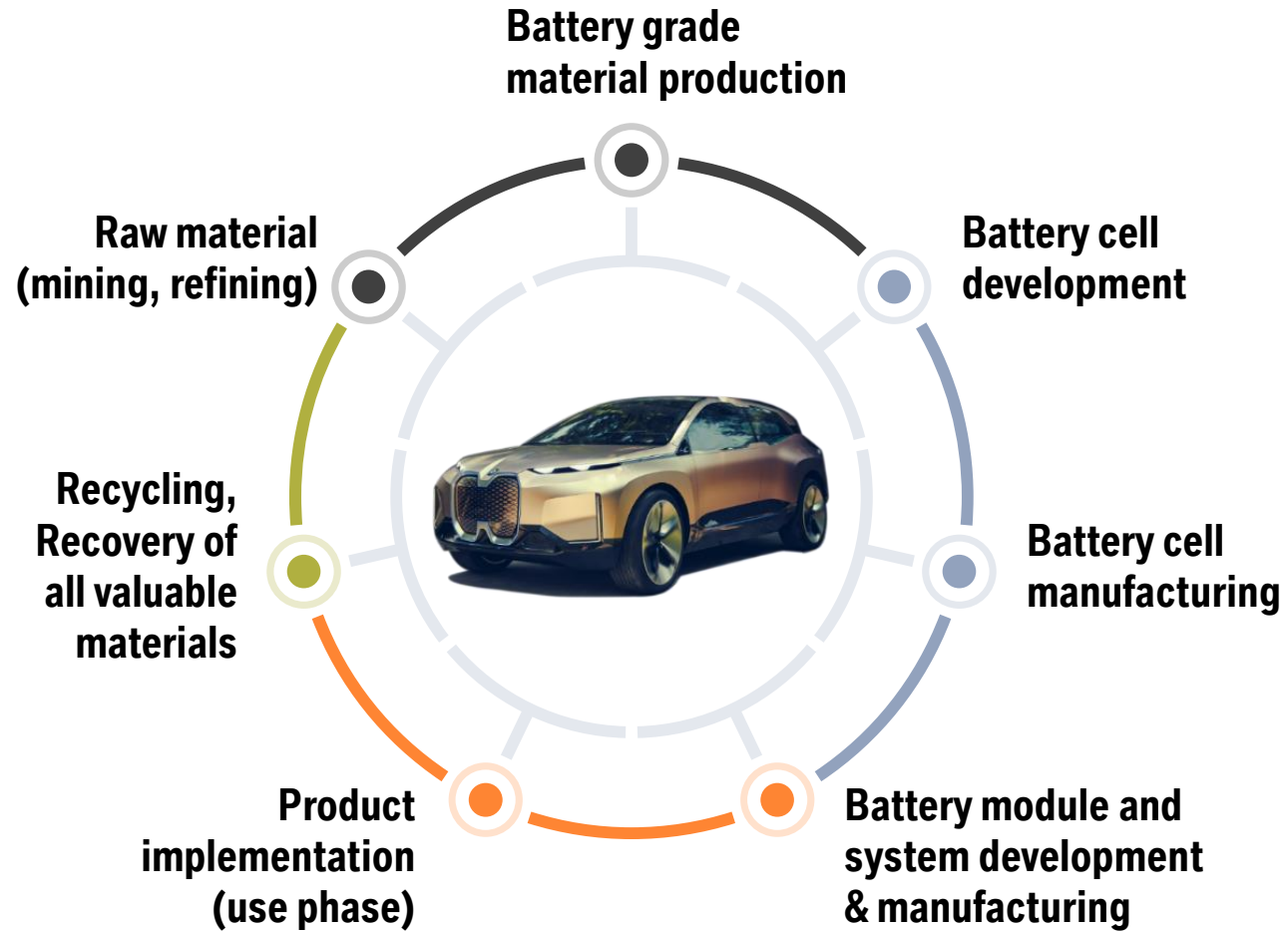
Performance and safety test



Post mortem analysis



BMW GROUP SUSTAINABLE MOBILITY. FULL CONTROL OF BATTERY VALUE CHAIN – CLOSING THE LOOP.



THANK YOU
FOR YOUR ATTENTION!

