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.

- Cost
- Specific Energy
- Charge Current
- Temperature
- Performance
- Safety
- Lifetime
- Energy
- Density
- Peak Power

Battery Pack

Battery Cell

Jelly Roll / Electrodes

Active Materials

20% of cost addressed

80% of battery cost is cell cost

80% of cell cost is material cost
HUGE PROGRESS ON CELL ENERGY DENSITY AND COST. FURTHER COST REDUCTION NECESSARY.

DEVELOPMENT OF ENERGY DENSITY AND COST OF BATTERY CELLS

Battery Cell Technology © BMW Group
ENERGY DENSITY INCREASE MAINLY DRIVEN BY MATERIAL IMPROVEMENTS.

HIGH PERFORMANCE MATERIALS

IMPROVED ELECTRODE DESIGN

OPTIMISED CELL TECHNOLOGY

### 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
- NMC 532, 622: 180 mAh/g
- NMC 811: 210 mAh/g
- NMC > 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
- INDUSTRY

Material characterization
Chemistry development
Recipe development
Performance and safety test
Post mortem analysis

2.7-4.3V, 0.1C
Voltage / V
Discharge capacity / mAhg

Number of cycle

3.2mm
20mm
BMW GROUP SUSTAINABLE MOBILITY.
FULL CONTROL OF BATTERY VALUE CHAIN – CLOSING THE LOOP.

- Raw material (mining, refining)
- Battery grade material production
- Battery cell development
- Battery cell manufacturing
- Battery module and system development & manufacturing
- Recycling, Recovery of all valuable materials
- Product implementation (use phase)
THANK YOU
FOR YOUR ATTENTION!