AUTOMOTIVE CELLS Co

ON THE ROAD TO GIGASCALE CELL MANUFACTURING

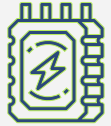
Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

RheinlandPfalz
MINISTERIUM FÜR WIRTSCHAFT, VERKEHR, LANDWIRTSCHAFT UND WEINBAU

OUR ENERGY CONSUMPTION MUST FREE ITSELF FROM FOSSIL FUELS.

We are beginning a transition from the **internal combustion engine,**

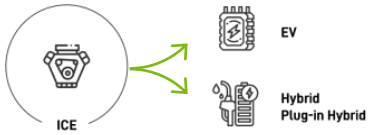
to a combination of **electric drivetrains.**



EV

Hybrid
Plug-in
Hybrid

This transition faces **4 strategic challenges**.



FOUR STRATEGIC CHALLENGES

CHALLENGE 1

THE MARKET SIZE

How can we meet demand in terms of quantity?

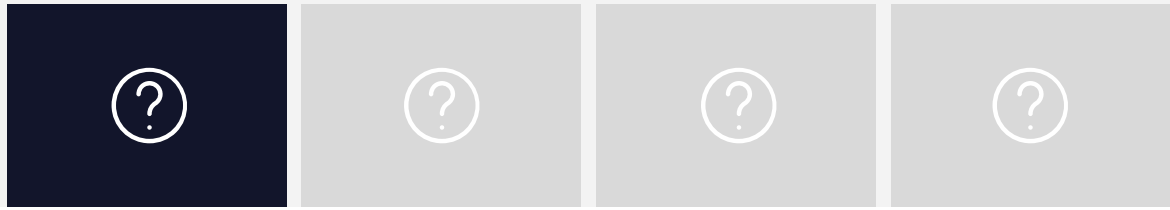
2030

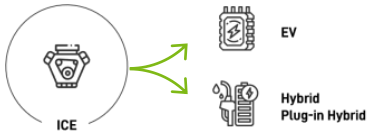
9 to 12,000,000

electric vehicles

(estimated production in Europe - Source S&P)

60% + 40%





FOUR STRATEGIC CHALLENGES

CHALLENGE 2

INDUSTRIAL TRANSITION

How to anticipate and support industrial change?

2030: **9** to **12,000,000** electric vehicles, i.e.

624 to **919** GWh

Annual installed capacity

Which requires **15** to **25** Gigafactories

For an average annual production of 35 GWh per site.

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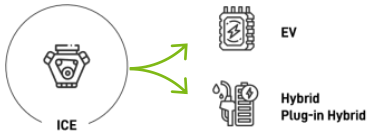

FOUR STRATEGIC CHALLENGES

CHALLENGE 2

INDUSTRIAL TRANSITION

How to anticipate and support industrial change?

2030: 9 to 12 000,000 electric vehicles, i.e.

624 to 719 GWh Annual installed capacity

Which requires 15 to 25 Gigafactories

For an average annual production of 35 GWh per site.

52,000

Employees to recruit and train for new jobs

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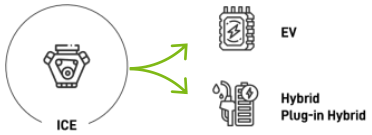


FOUR STRATEGIC CHALLENGES

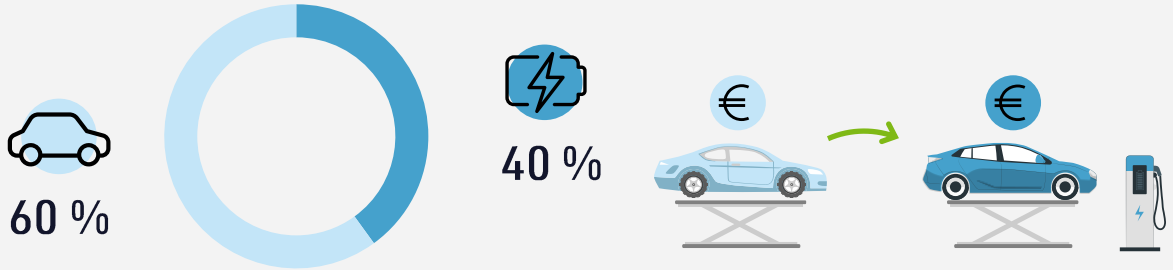
CHALLENGE 3

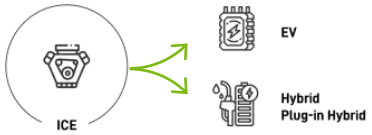
ACCESSIBILITY

How can electric vehicles be made affordable for everyone?

The price of electric vehicles is rising, due to the increasing cost of batteries (40% of the total cost of the vehicle).

How can we facilitate a transition at equivalent consumer cost?





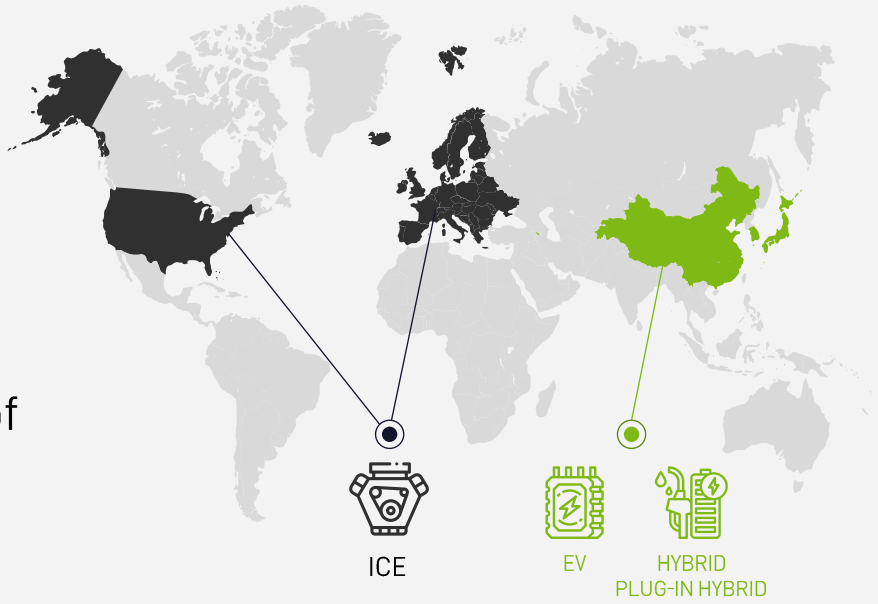
FOUR STRATEGIC CHALLENGES

CHALLENGE 4

KNOW-HOW

How can we acquire the industrial know-how needed for electric vehicles?

The internal combustion engine is a mastered technology in Europe, but electric motors are a specialty of Asian markets.



WE NEED A EUROPEAN BATTERY INDUSTRY.

- Requires a production infrastructure
- Requires a massive investment
- Backed by a research ecosystem
- Capitalizes on the talents of basins undergoing reconversion

AND...

- Aware of the climate and environmental emergency.

→ Reasonable cost, guaranteeing accessibility for all

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saft | STELLANTIS | Mercedes-Benz

- A design and production tool
- Financial support
- Technologies
- Talent
- AND...
- CSR commitment

→ Produce at the best possible cost

An industrial tool

→ 3 Gigafactories
→ 1 Pilot Plant
→ 1 R&D Centre

Financial support

→ 7,3 B€

Technologies

→ Gen 3 and 3+ in production from 2023

Talent

→ 1,750 employees at the end of 2023

AND...

CSR commitment

→ Roadmap

Controlling its own carbon and social impact.

Produce at the best possible cost

→ Data roadmap and industrial processes

120 GWh / year **2,5M vehicles / year**

OUR AMBITION
SINCE 2020

"To become the **EUROPEAN LEADER** in automotive battery cells and modules ...

... and provide **CLEANER, MORE EFFICIENT** mobility **FOR ALL**".

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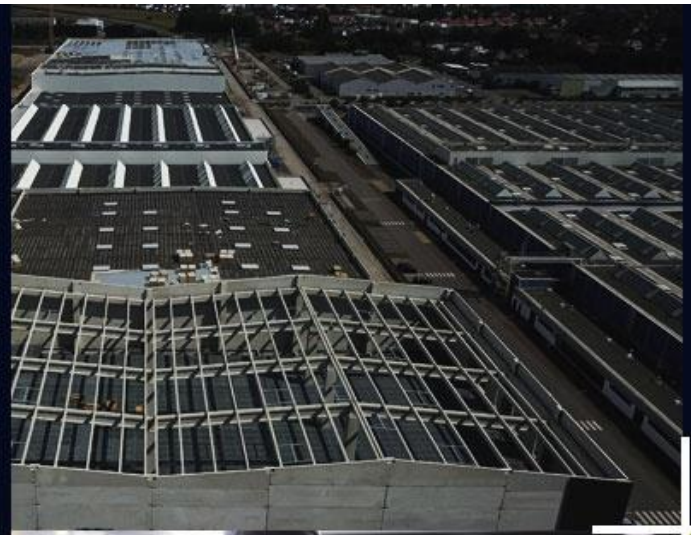
COMMITMENT ON SUSTAINABILITY: BROWN FIELD APPROACH

REDUCED CAPEX COMPARED TO GREENFIELD APPROACHES



SHORTER IMPLEMENTATION TIME

ACCESS TO A SKILLED WORKFORCE

SIGNIFICANTLY REDUCED CARBON FOOTPRINT COMPARED TO NEW BUILDS

INAUGURATION BILLY BERCLAU BLOCK1- 30.05.2023

1st ACC Gigafactory

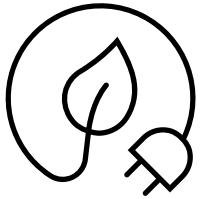
KAISERSLAUTERN
GIGAFACTORY AND ENGINEERING CENTER

- A 41 ha site. Brown field next to Stellantis-Opel factory
- ~15 GWh p.a. production capacity from end 2025
- 3 production blocks by 2030 > 40 GWh p.a.
- Engineering Center for higher TRL and factory related research

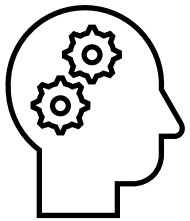
Rendering ACC Kaiserslautern Block1

KEY PARAMETERS FOR A SUCCESSFUL GIGASCALE CELL PRODUCTION

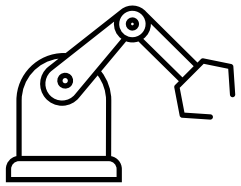
- Buy our materials at best price
- Adhering to ethical sourcing requirements



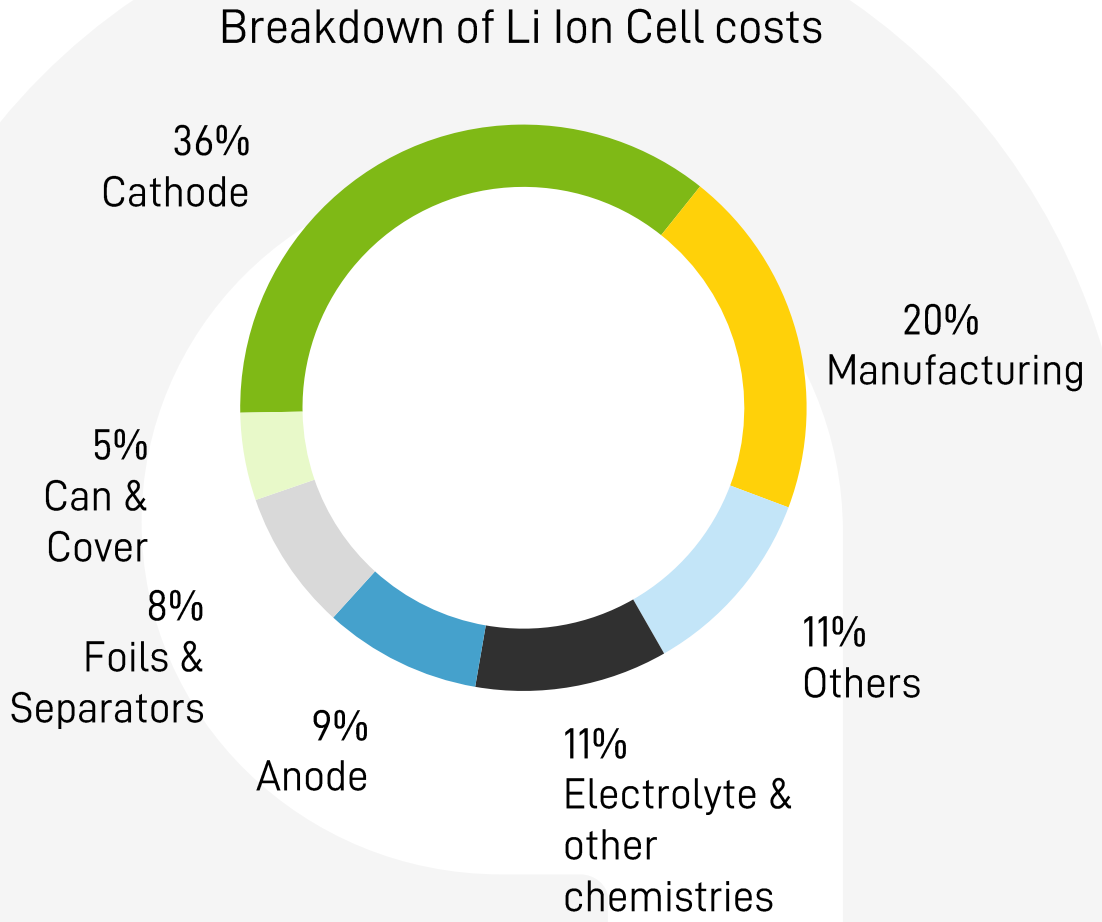
- Availability of green energy at affordable cost on time
- Highly efficient energy utilization



- Suitable work force at all levels in the necessary quantity on time

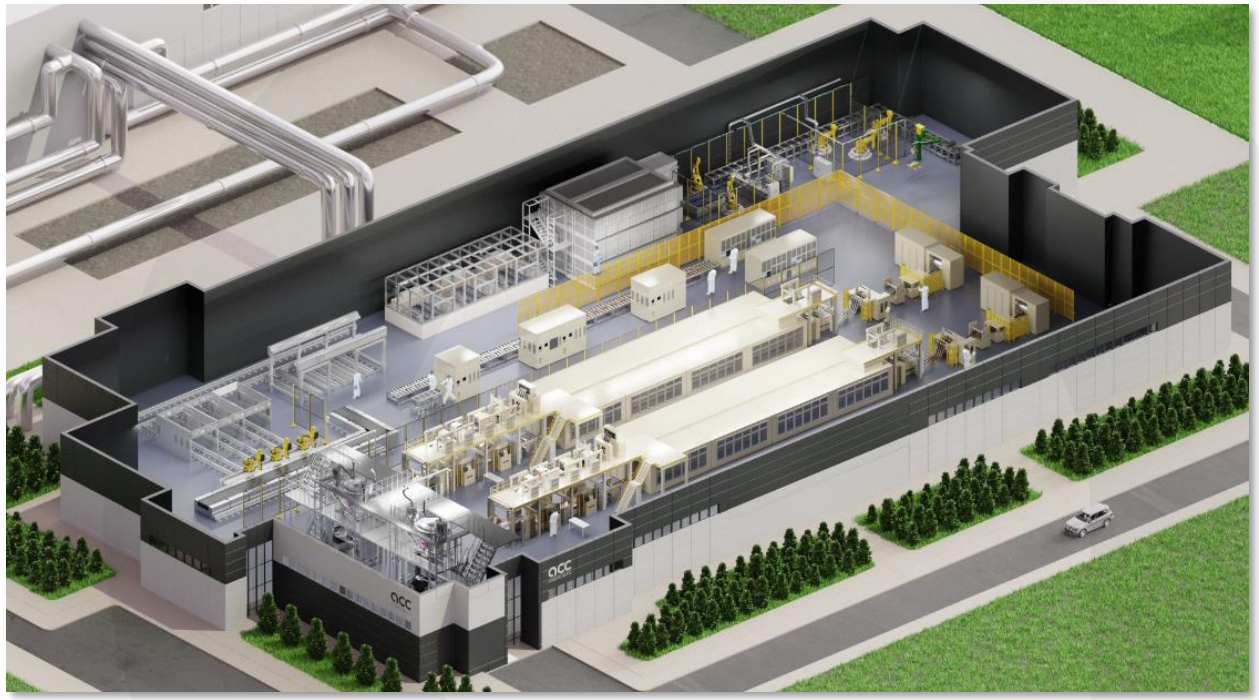


- Maximized Overall Equipment Efficiency (OEE)
  - Only good parts
  - As fast as possible
  - Minimized down time



OPTIMIZED CELL PRODUCTION PROCESS

- Continuous chemical process
- ~250 interdependent process & material parameters
- Collect and use data
- R&D towards higher energy density, more efficient battery with less environmental impact.



- ➢ Sustainable cell production is a highly complex challenge
- ➢ It requires optimization in every detail to be successful

SENSITIVITY ANALYSIS ON EFFECTS ON MANUFACTURING COSTS

Reference Cell:

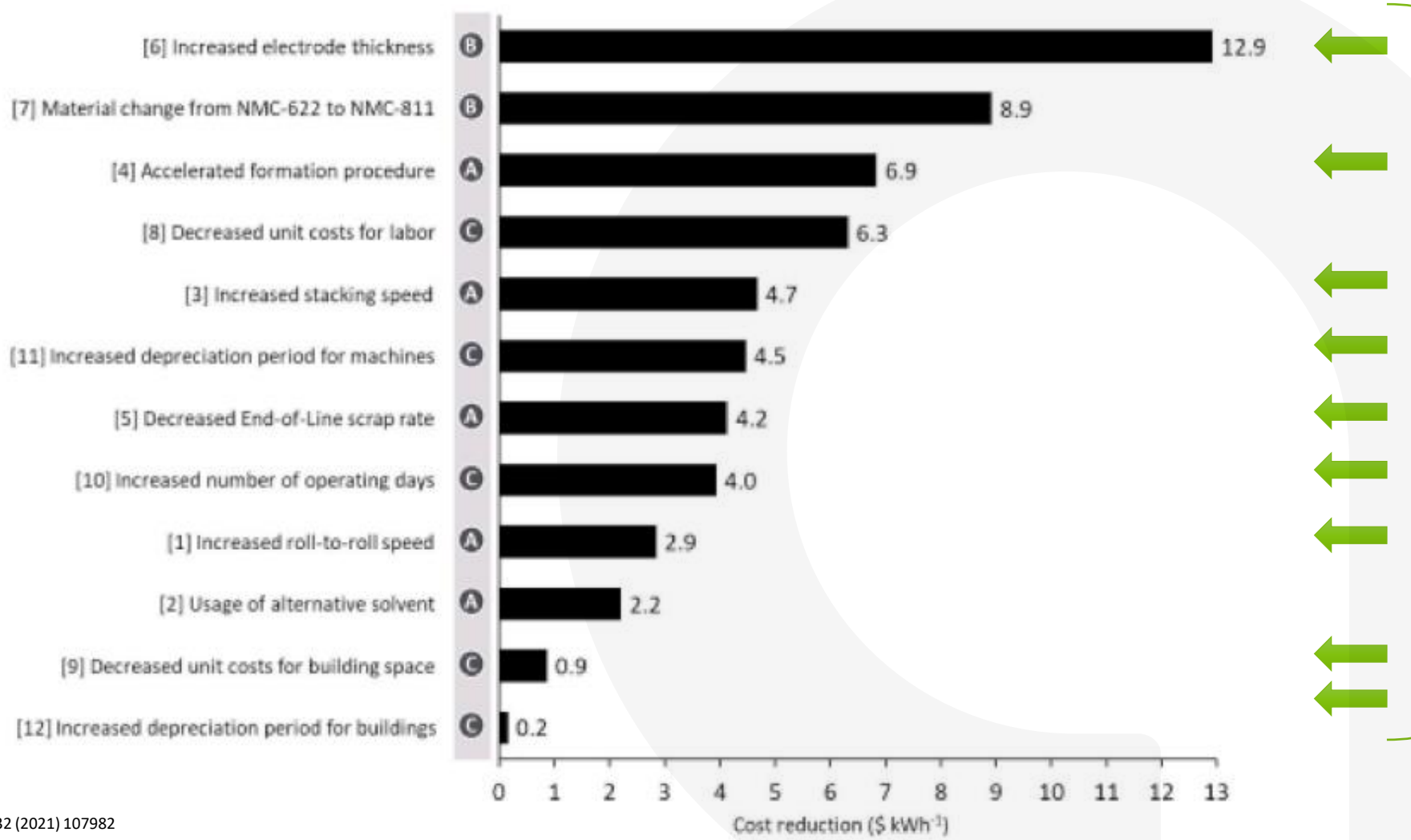
Pouch

200 Wh

NMC811/Gr

Wet process only

30 electrodes each



Source: F. Duffner et al., Int. J. Production Economics 232 (2021) 107982

Fig. 4. Cost reduction per simulation parameter (single simulation-parameter approach) in $ kWh^{-1} @ 35 GWh annual factory capacity; [n] number of single simulation parameters; Categorical affiliation: Ⓐ Process-related, Ⓑ Material & design-related, Ⓒ Location-related.

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EQUIPMENT AND SERVICES

- Internationally leading products and services
  - Process implementation demonstrated on a large(r) scale
  - Ideally in the automotive battery sector or corresponding industry sectors
- General Contractors Concepts. Ready and able to scale-up production in time
- Economically competitive on a global scale
  - Lowest total cost of ownership
  - Minimized initial CAPEX
- Preferably Europe localized

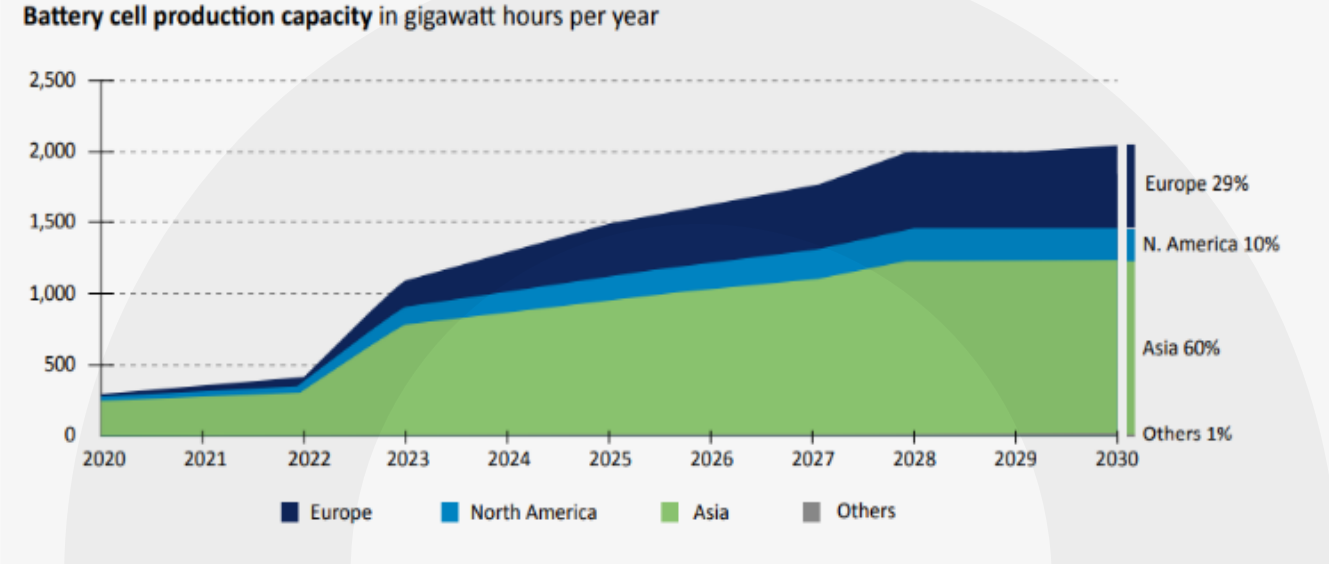

Figure 5: Development over time of the annual production capacity of battery cells in Europe. Source: Analysis of the scientific monitoring of battery cell production based on publicly available information sources.

➢ ACC is targeting to strengthen local supply base for equipment and services

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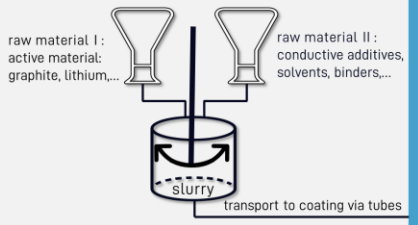
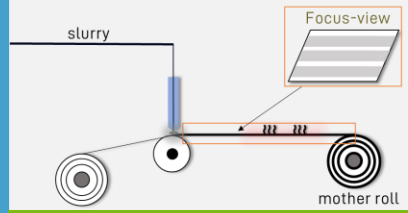
LASER APPLICATIONS IN THE LITHIUM ION CELL PRODUCTION

Mixing

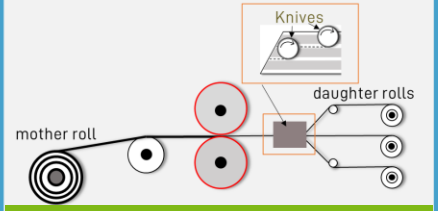


Coating



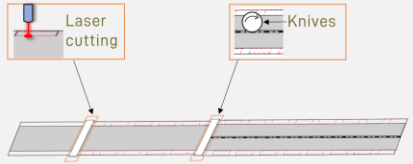
LASER THICKNESS MEASUREMENT

Calendering - Slitting



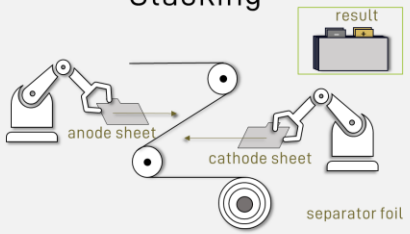
LASER SLITTING OF BARE FOIL

Notching

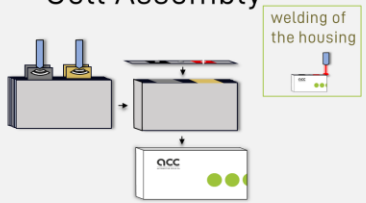


LASER CUTTING BARE FOIL

Stacking

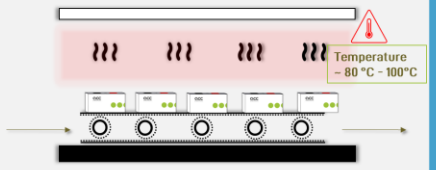


Cell Assembly



TAB/ TERMINAL WELDING

Baking



1st Filling

1st Electrical Formation

2nd Filling

FILING HOLE WELDING

2nd Electrical Formation

LASER MARKING

Module Assembly

MODULE/ PACK ASSEMBLY WELDING

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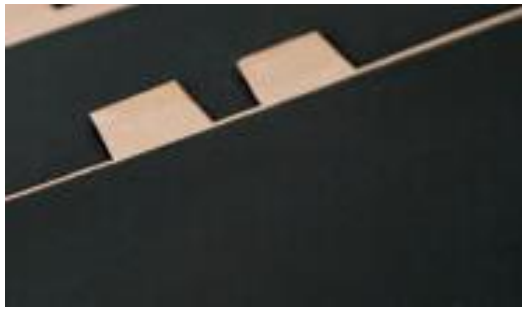
LASER APPLICATIONS IN LITHIUM ION CELL PRODUCTION



THICKNESS MEASUREMENT

LASER SLITTING

LASER CUTTING

TAB/ TERMINAL WELDING

LASER MARKING

MODULE/ PACK ASSEMBLY WELDING

GENERAL BENEFITS

- Process speed & machine utilization efficiency
- High precision and quality (e.g. burrless edges for Laser cutting)
- Smaller footprint to compare alternative tech. e.g. laser cutting vs. mech. cutting
- Easy maintenance

IMPROVEMENT POTENTIALS

- High initial costs
- Particle creating during Laser welding
- Heat affected zones and potentially high thermal stress

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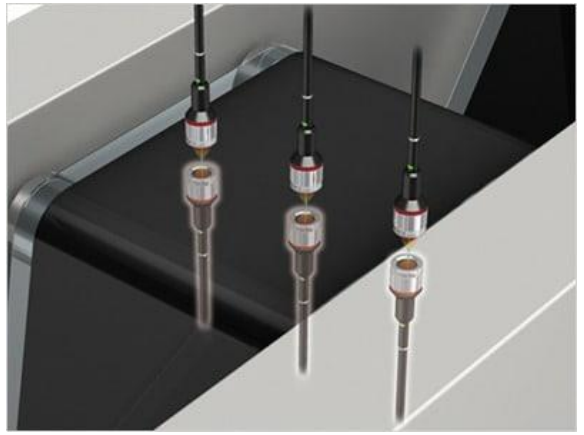
FURTHER POTENTIAL LASER APPLICATIONS IN PRODUCTION

Laser heating/ drying of Electrodes

Current tech : Convection heating with IR heating

Potential improvement of laser heating as subsitute of IR heating :
- Flexibles heating area to avoid inhomogeneities during electrode drying
- Potential reduction of drying chamber length

Thickness measurement Laser Picture: keyence.eu

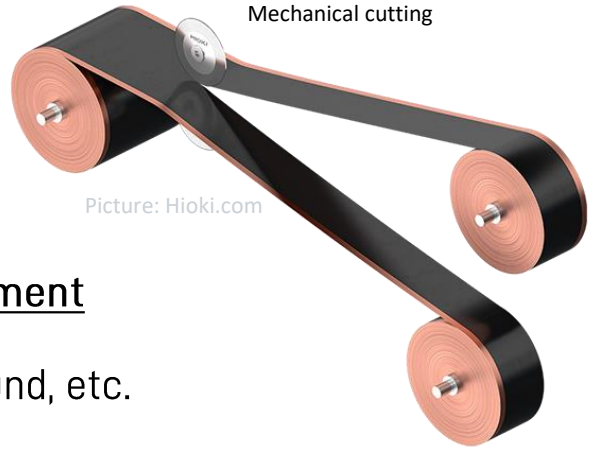


Laser cutting of Electrodes

Current tech : Mechanical Cutting

Potential improvement of Laser cutting:
- Lower foot print
- Higher accuracy

Mechanical cutting



Picture: Hioki.com

Picture: precitec.com

Laser application for metrology: e.g. Thickness measurement

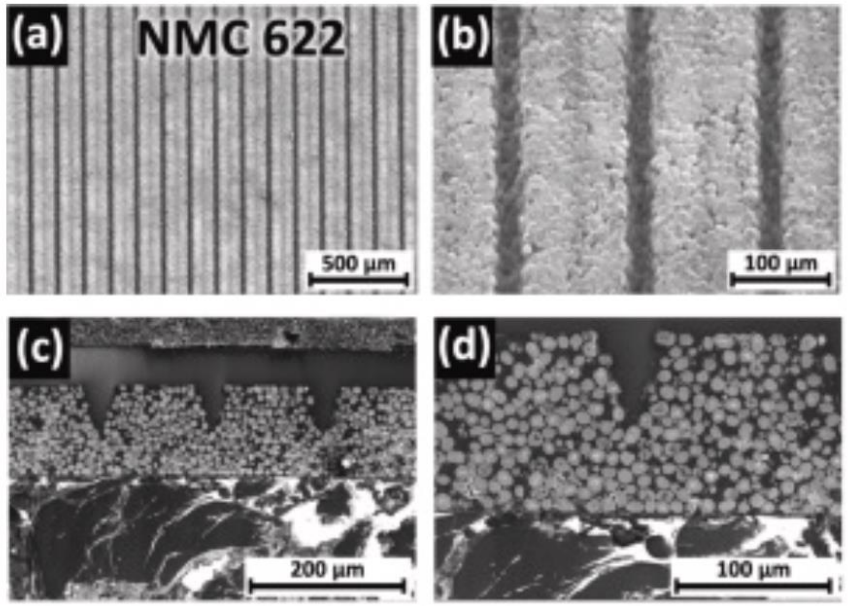
Current tech : Laser triangulation/ Xray, Radiation, Ultrasound, etc.

Potential of TeraHerz:
- No radiation protection required
- No errors due to differential measurement

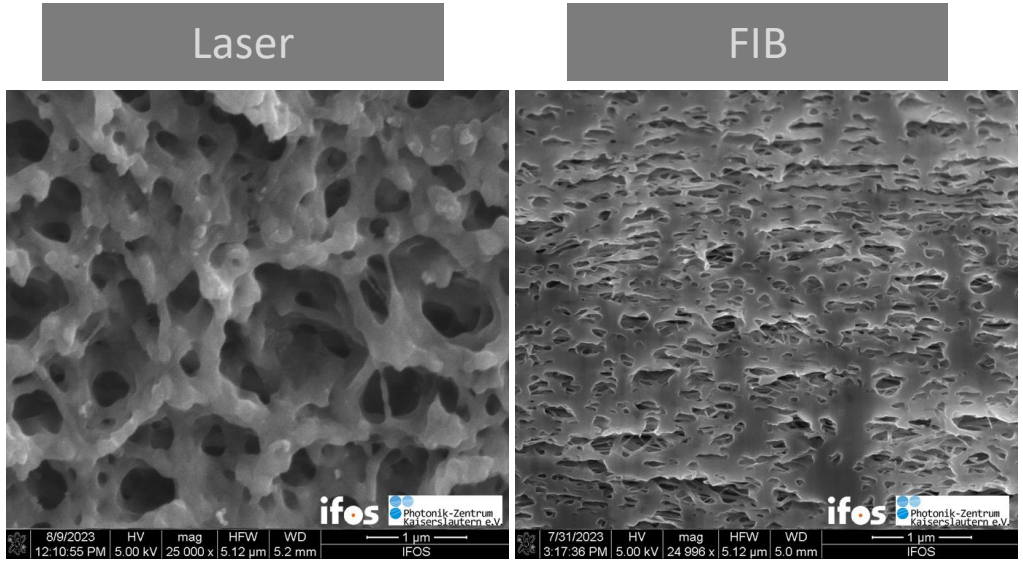
FURTHER POTENTIAL LASER APPLICATIONS IN PRODUCTION AND RESEARCH

Laser ablation for structuring Li-ion electrodes for fast charging and its impact on material properties, rate capability, Li plating, and wetting

doi.org/10.1016/j.jpowsour.2022.231464



Non intrusive Laser Cutting in Material Analytics to characterize separator microstructure



Noncontact laser ultrasonic inspection of weld defect in lithium-ion battery cap

In-line inspection of battery caps because it facilitates high-speed, noncontact, and nondestructive inspection

doi.org/10.1016/j.est.2023.108838

Operando monitoring Lithium-ion battery temperature via implanting femtosecond-laser-inscribed optical fiber sensors

For Battery monitoring and its state-of-health evolutions.

doi.org/10.1016/j.measurement.2022.111961

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ACC on the way to become a European cell manufacturing champion

Commercial contracts up to 320 GWh by 2030

Inauguration of first ACC Gigafactory in May 2023- Kaiserslautern Gigafactory anticipated in 2025

Anticipated European Production capacity 120 GWh/a in 2030

ACC is committed to promote the localization of its supply chain, also with respect to equipment and services- pending commercial attractiveness

Laser technologies have established themselves in various applications within cell production value chain and are expected to expand into new applications

Thank you for your attention

Accelerating Sustainable Mobility For All

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

RheinlandPfalz
MINISTERIUM FÜR WIRTSCHAFT, VERKEHR, LANDWIRTSCHAFT UND WEINBAU