Sustainable Battery Production

Webinar on Decarbonisation of Transport – Light Duty Vehicles
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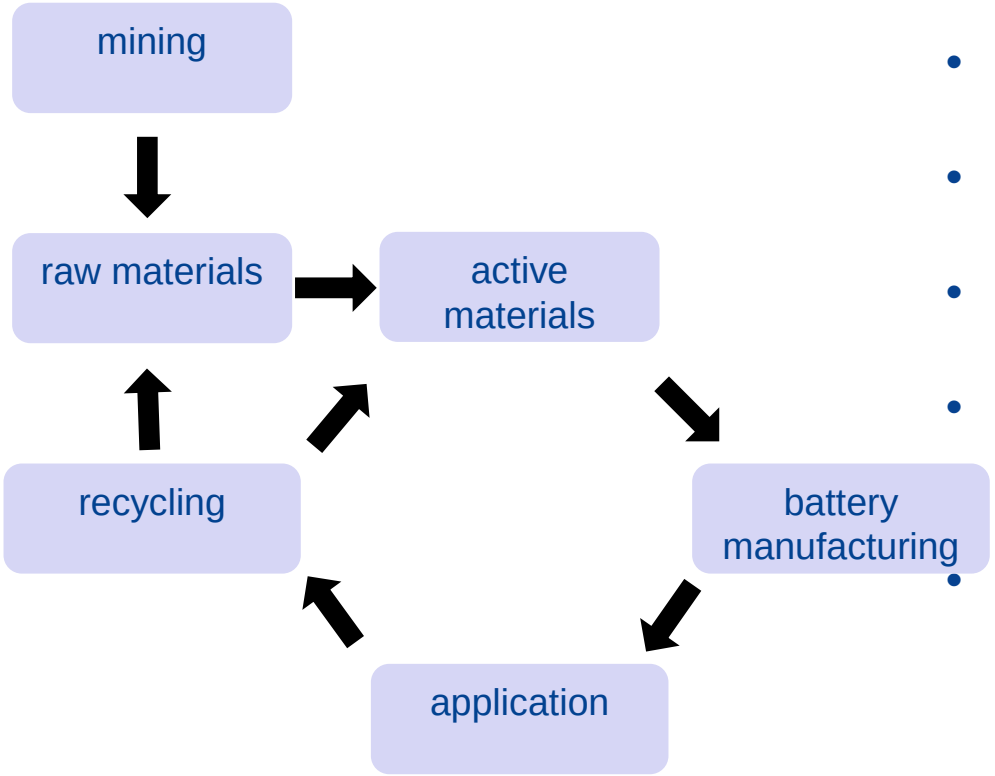
Baden-Württemberg

Announcements of Lithium ion batteries production in Europe

Company	State	GWh in 2030
ACC, Saft, PSA	France/Germany	32
CATL	Germany	24
Farasis	Germany	10
Leclanché	Germany	N/A
Microvast	Germany	8
Northvolt/VW	Germany	24
TerraE/BMZ	Germany	8
Varta	Germany	150 million cells
GS Yuasa	Hungary	N/A
SDI	Hungary	35
SK Innovation	Hungary	8
Freyr	Norway	32
LG Chem	Poland	70
Northvolt	Sweden	40
GSR Capital/Zorlu	Turkey	25

Cell production of > 310 GWh/year in Europe announced

Sustainability of Lithium ion industry dependent on multiple parameter



- Raw materials and responsible sourcing
- Energy consumption and energy mix in cell production
- Energy demand and energy mix for charging
- **Circular economy**, recycling & second life use
- Transport along whole value chain

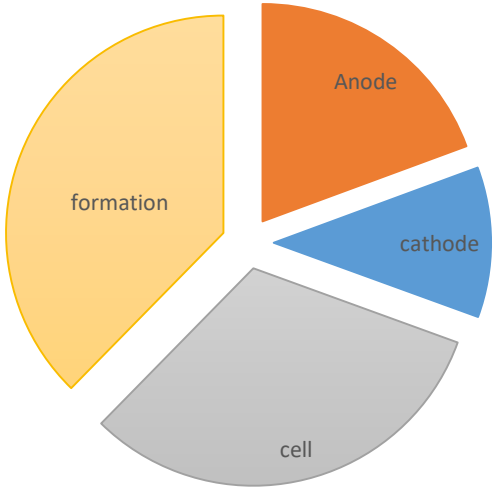
Raw materials demand for 500.000 50 kWh Batteries

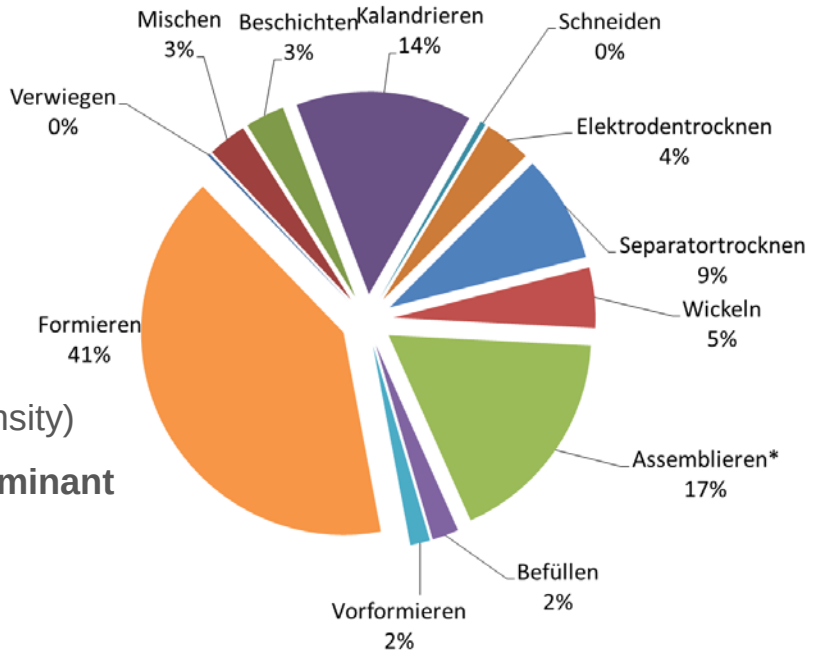
500.000 50 kWh batteries Graphite 350 mAh/g ⇒ Graphite/SiOx 500-600 mAh/g ⇒ Si/C composites 1500 mAh/g				Graphite Anode	21.900 tons
Positive					
Cathode material	**Cathode AM tons**	**Lithium tons**	**Nickel tons**	**Cobalt tons**	**Manganese tons**
NCM622 180 mAh/g	38.500	2.800	14.000	4.700	4.400
NCM811 210 mAh/g	33.000	2.400	16.000	2.000	1.900

Increase of energy density: reduction of raw materials

State of the art cell production

Energy consumption per cell and reduction potential





- Anode preparation > cathode preparation (reduced slurry density)
- **Energy consumption for cell assembly and formation dominant**

Sustainable cell production

- NMP free slurry – aqueous coating for cathodes
- Extrusion; dry coating
- Increased loading

- Increased cell size (reduction of passive materials)
- In line inspection and data processing
- reducing dry room space
- micro environments
- energy management

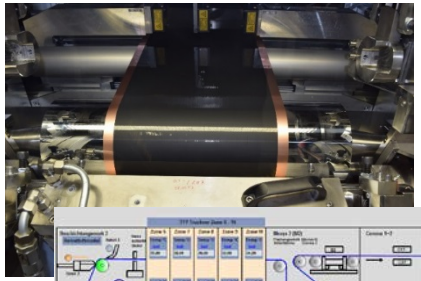
- recuperation

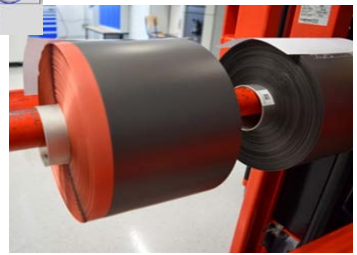
Data based quality control for electrode and cell production

ProZell QS-Zell

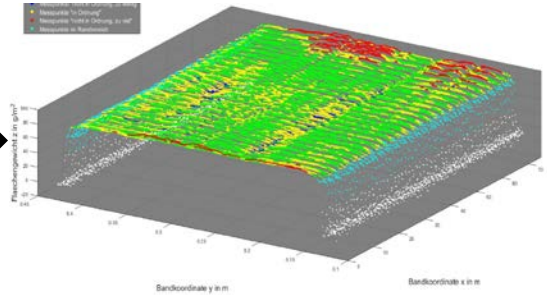
GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

live data acquisition during coating

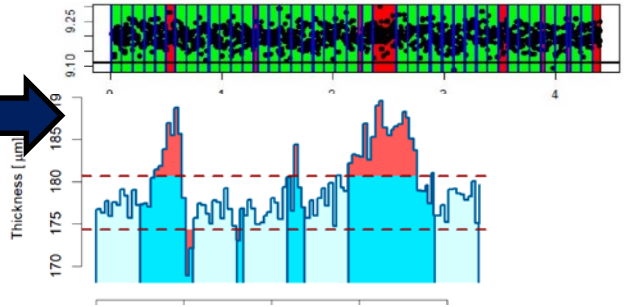




Inline loading measurement and data processing



Analysis, marking and attribution of defect areas



- Standardized data export from central production control
- Fully automated data processing
- Continuous attribution of metadata (ok/nok) in-line
- Solution for connecting data of the entire process stream

>> Early detection and reducing of scrap

Meyer, O. et.al. (2019), Development and Implementation of Statistical Methods for Quality Optimization in the Large-Format Lithium-Ion Cells Production. Energy Technol.. doi:10.1002/ente.2019002443

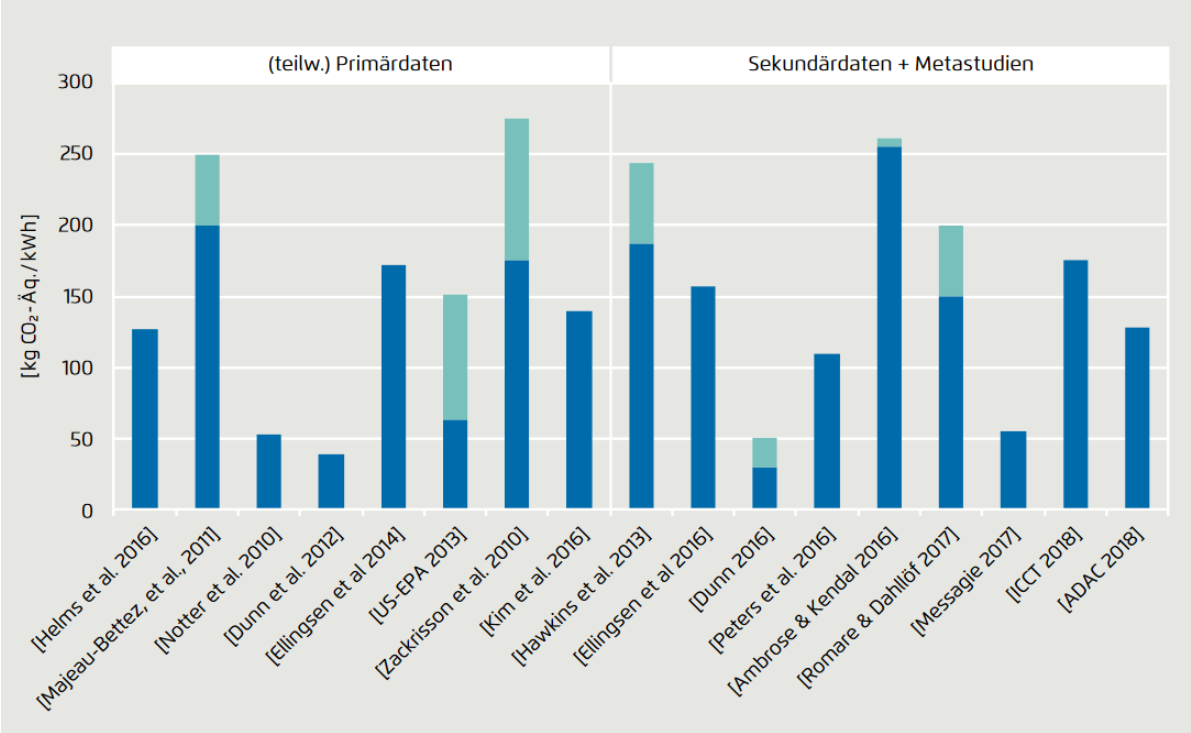
Sustainability – autonomous energy supply

- high energy demand for cell assembly (conservative 50 kWh_{el}/kWh_B)*
- carbon foot print dominated by energy consumption for cell manufacturing
- carbon foot print determined by energy mix

Targets:

- reduction of energy consumption for production (coating, dry room, formation)
- use of new materials with higher capacity
- Emission reduction by use of non fossil energy mix

Greenhouse gas emissions of battery manufacturing /1 kWh battery



https://www.agora-verkehrswende.de/fileadmin/Projekte/2018/Klimabilanz_von_Elektroautos/Agora-Verkehrswende_22_Klimabilanz-von-Elektroautos_WEB.pdf

Towards sustainable battery value chain

- increase energy efficiency of battery production
- increase the amount of renewable energy as power source as much as possible
- maximize the productivity of batteries in their application life
- establish second life use of end of life batteries
- establish efficient recycling routes for circular recovery of battery materials

// Energy with a Future

// Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

Thank you for your attention

Stuttgart:
Photovoltaics (Solab),
Energy Carriers,
Administration finances, human resources & legal issues

Widderstall:
solar test field

Ulm:
Electrochemical Energy Technologies- main building & ZSW lab for battery technology (eLaB)