

BATTERY

Next generation and improved circular sustainable
battery technology value chain



Battery production

DNVA

27 February 2024

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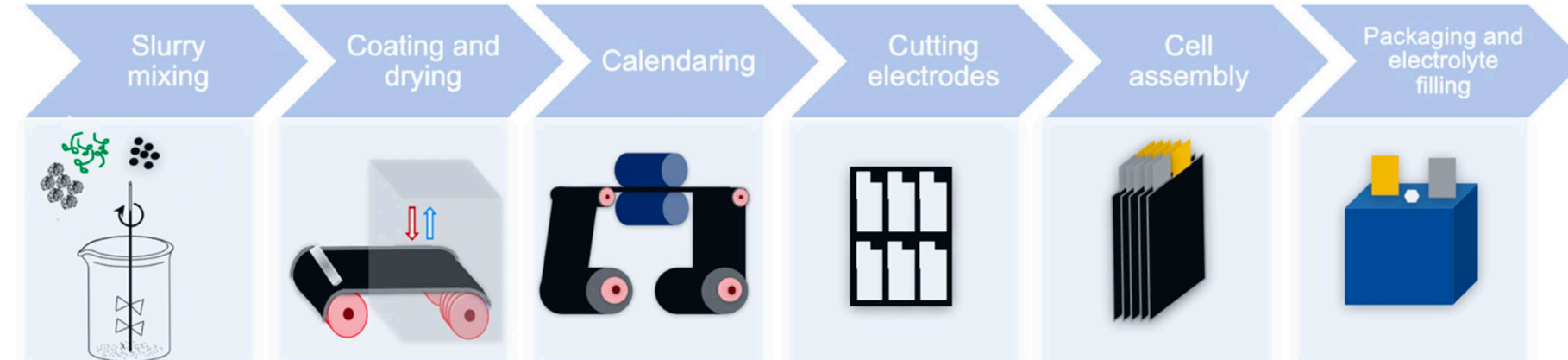
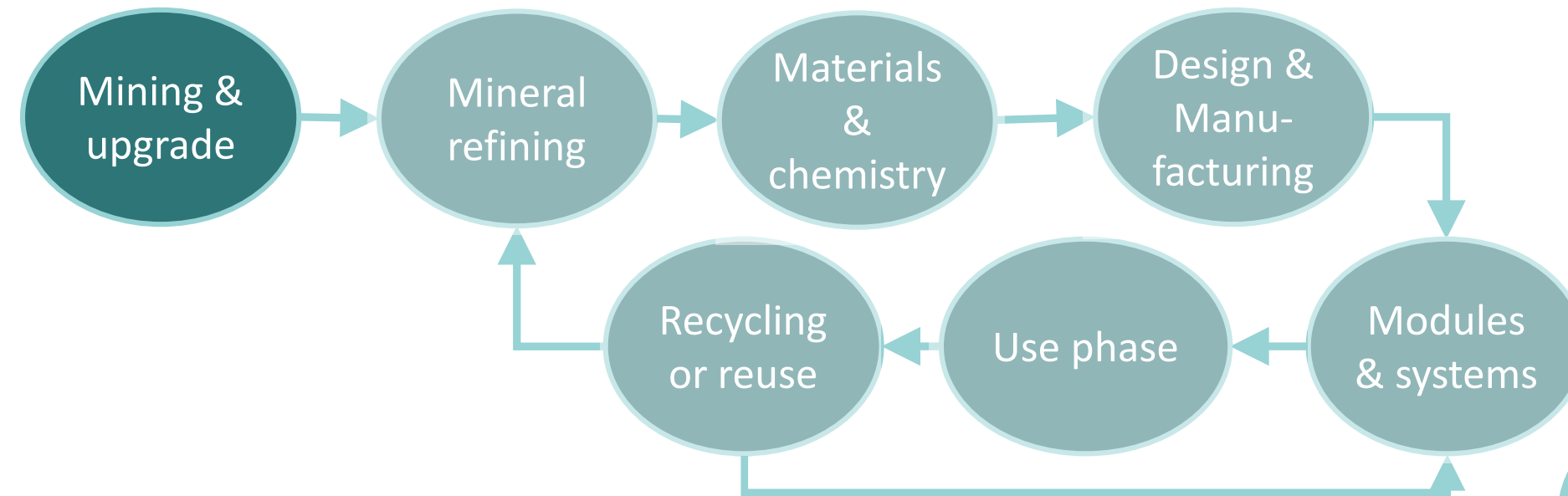
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Professor Odne Burheim

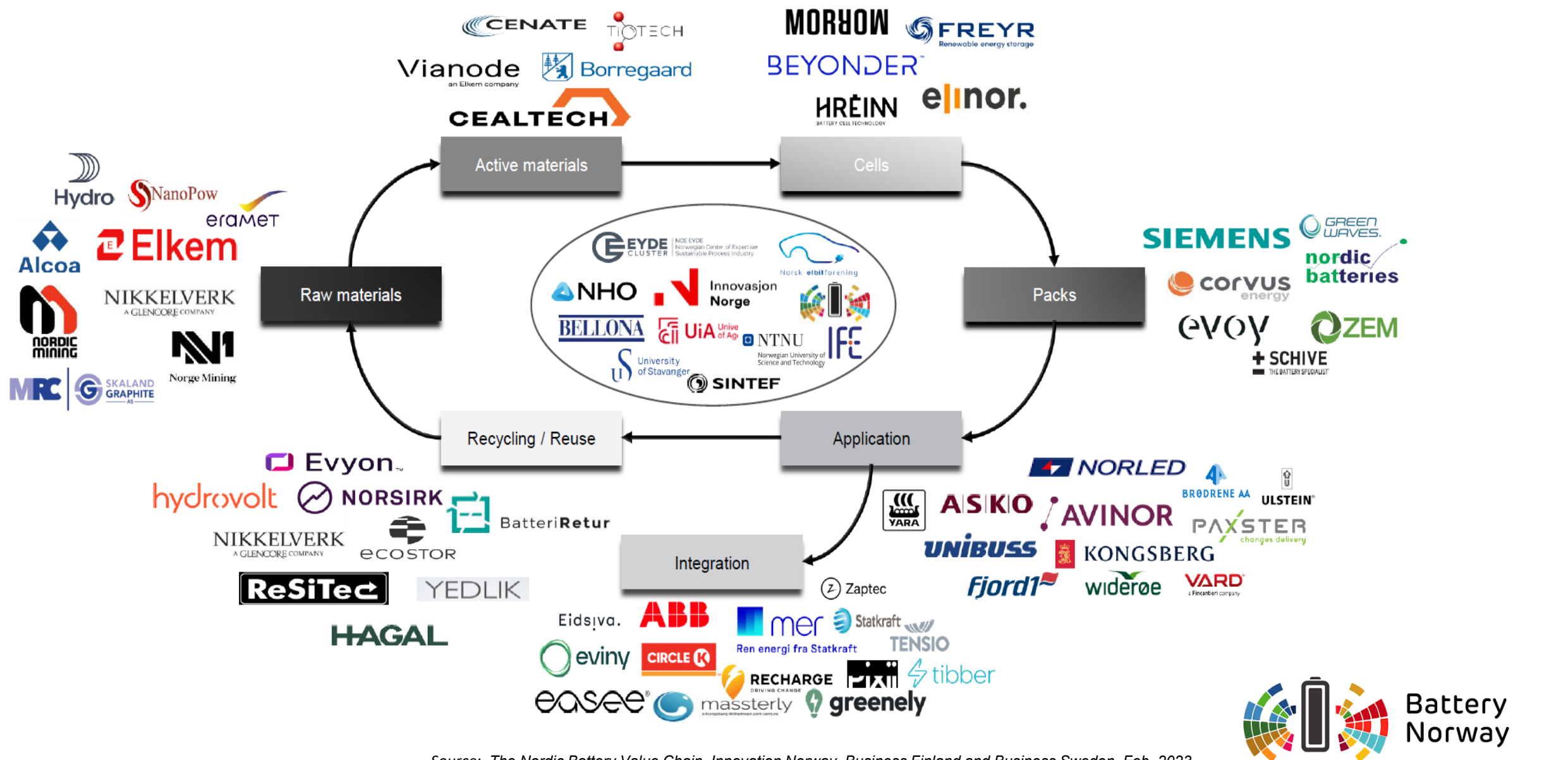
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Value chain and business sector



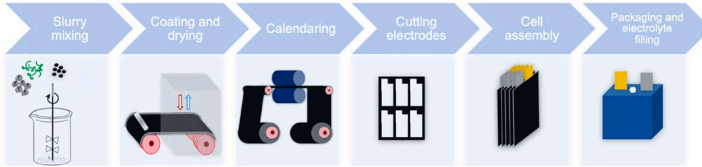
- Always strong in new materials
- Systems understanding and application ca 2010 (Think → ferry)
- Battery cell production ca 2018 –
- Mining and recycling follows 2018

Value chain and business sector

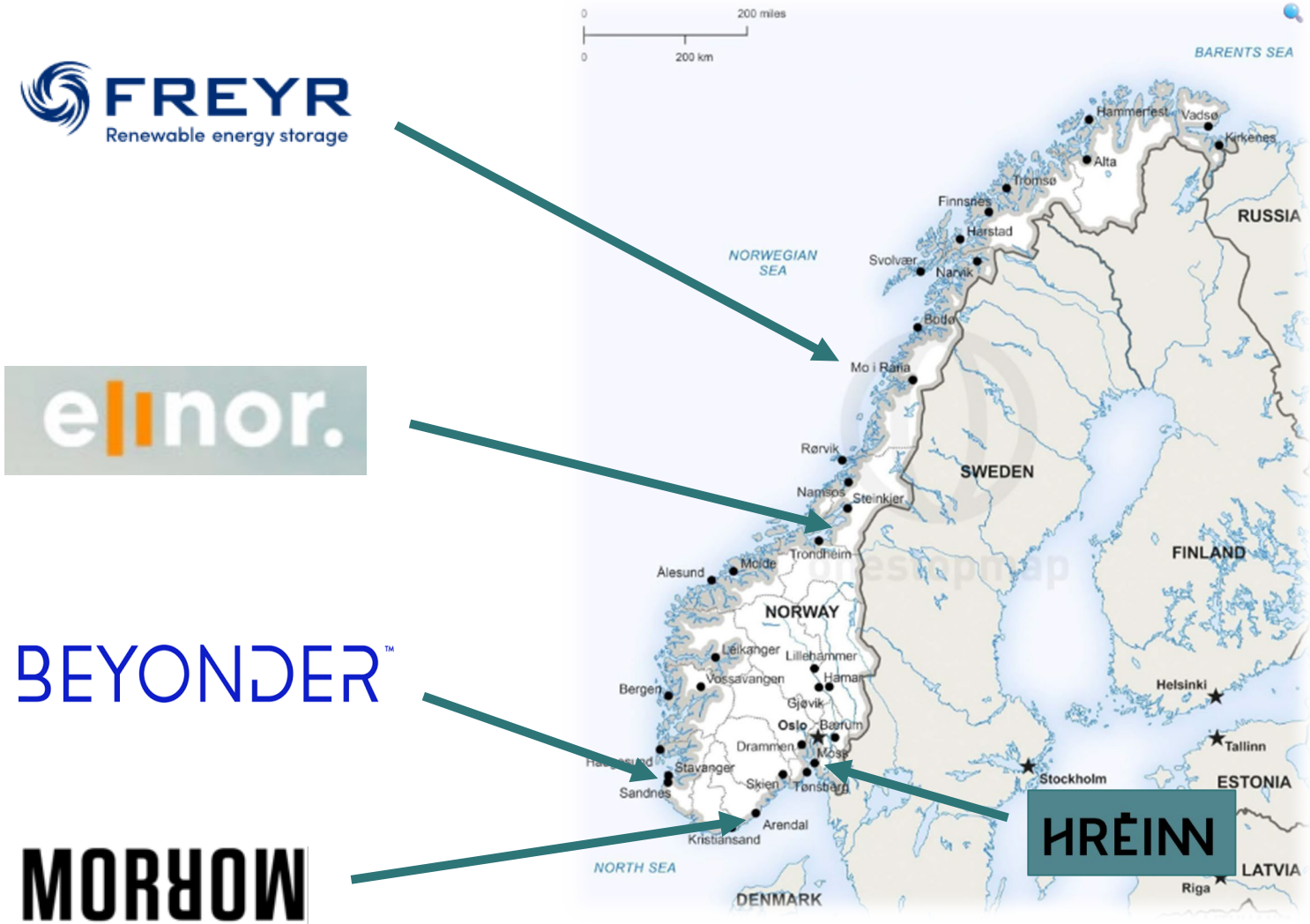


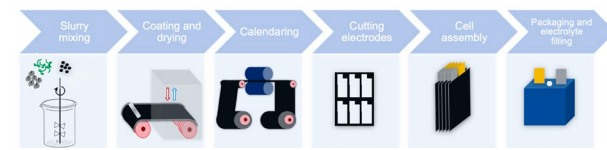
Source: The Nordic Battery Value Chain, Innovation Norway, Business Finland and Business Sweden, Feb. 2023

Value chain and business sector



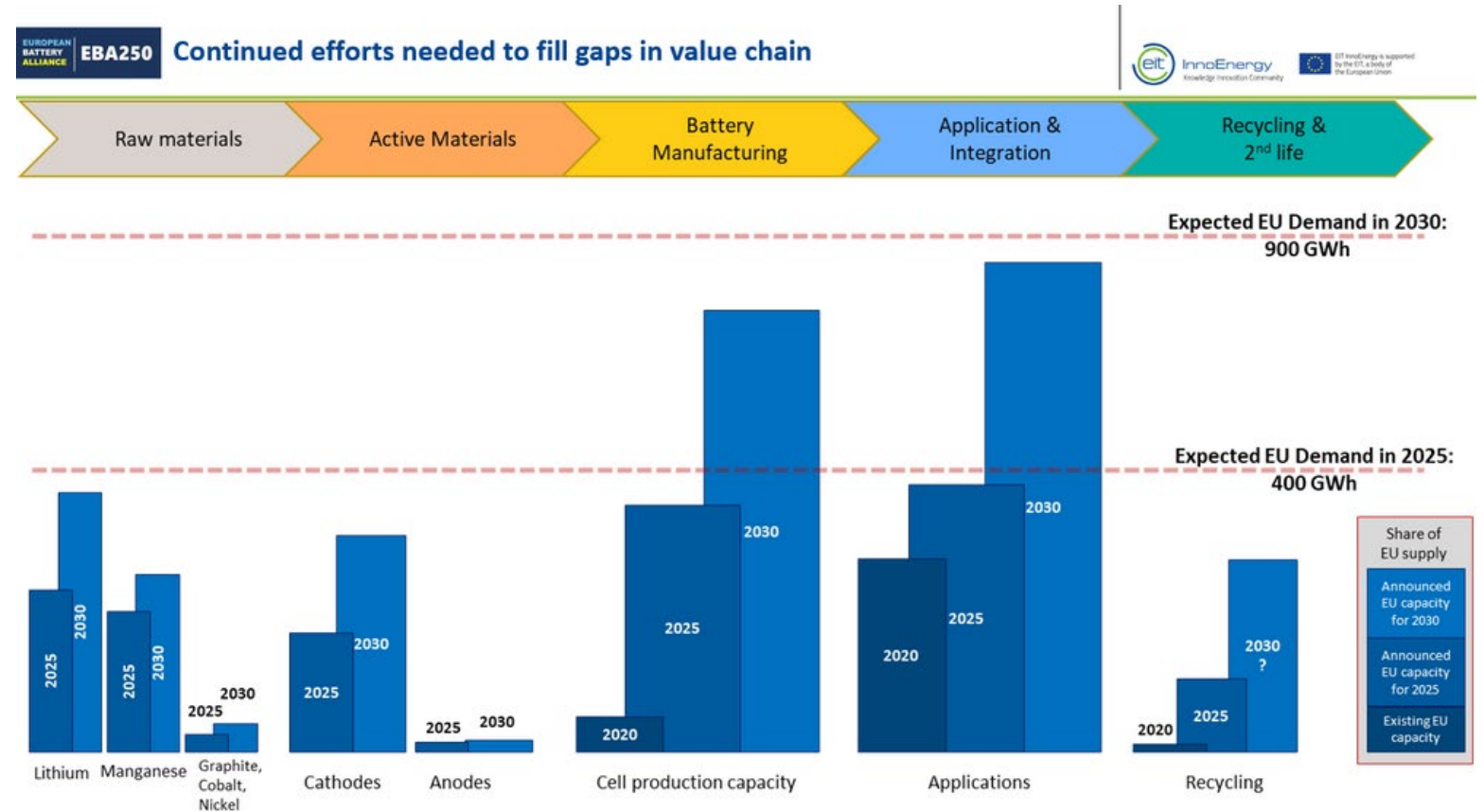
Cell Production: Five Active Projects



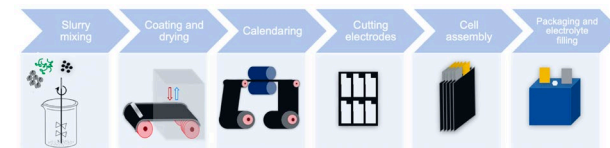


Continued efforts needed to fill gaps in value chain

- Significant influx of new industry in the following sectors:
 - Raw materials
 - Electrodes
 - Battery cell production
- Despite the growth, the announced capacity at all levels remains below the maximum expected demand in the EU by 2025
- There is still considerable market potential within several segments



Aspects around manufacturing



Battery production is energy intensive...

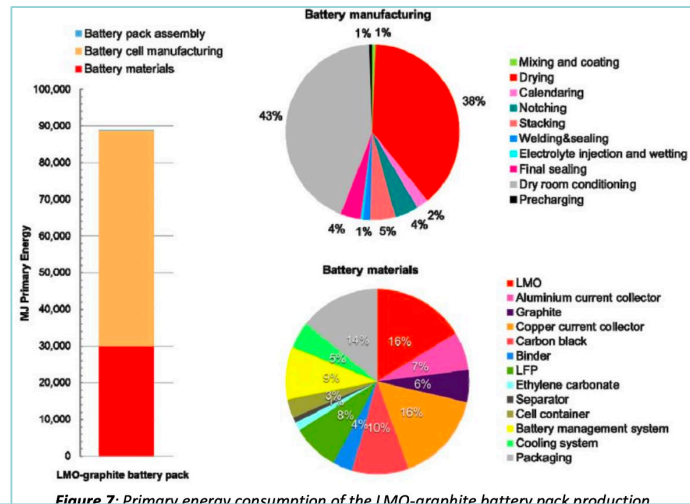


Figure 7: Primary energy consumption of the LMO-graphite battery pack production

Long traditions for mining and advanced energy intensive mineral production

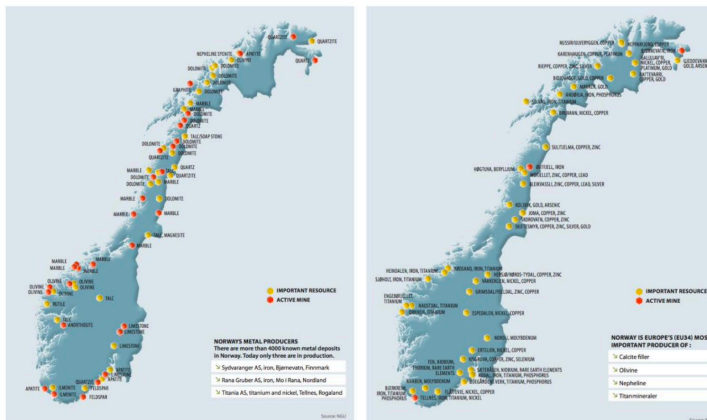
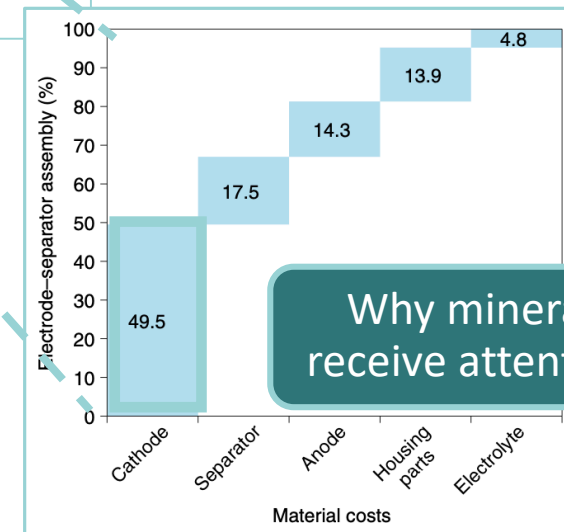
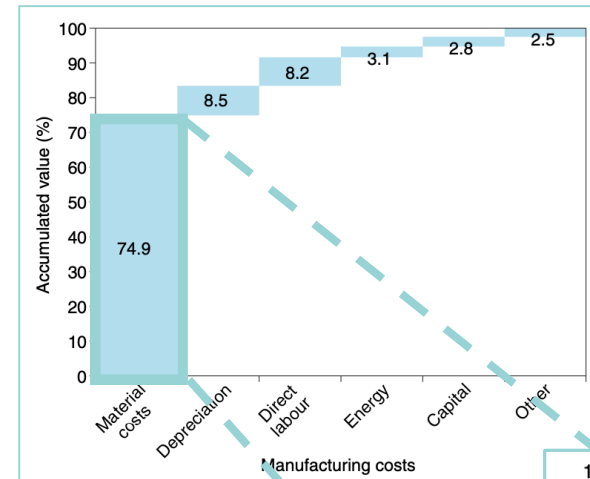


Figure 1: Norway's metal producers and Norway's main minerals

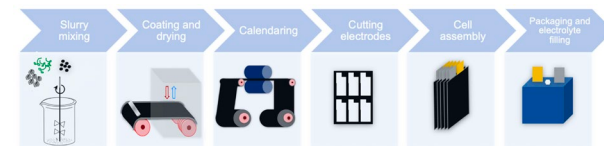
...but materials cost more!



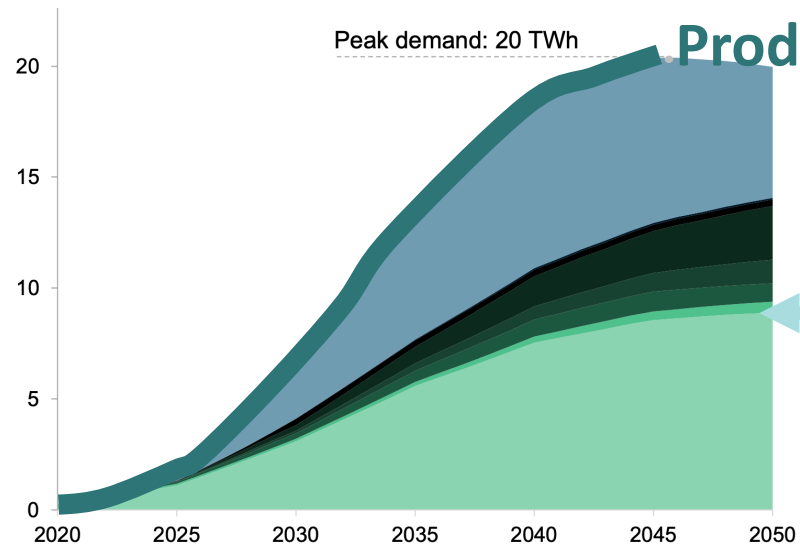
Why minerals receive attention!

Norway by 2030??

- 10 factories;
- turnover ca 30 G€/yr
- 75% is material cost
- 40% is cathode; ca 10 G€/yr



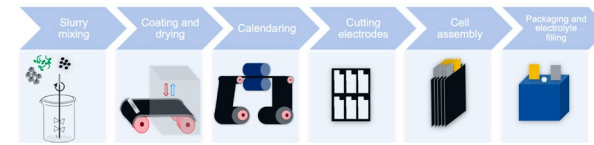
Exponential growth; doubling every 3 year



Production

10 TWh equates to
100-150 million cars

20 TWh equates to
Ca 500 Giga battery factories...
...or 2 000 billion \$
..or 2 Norwegian oil funds
...or 2km wide
factory Oslo-Trondheim

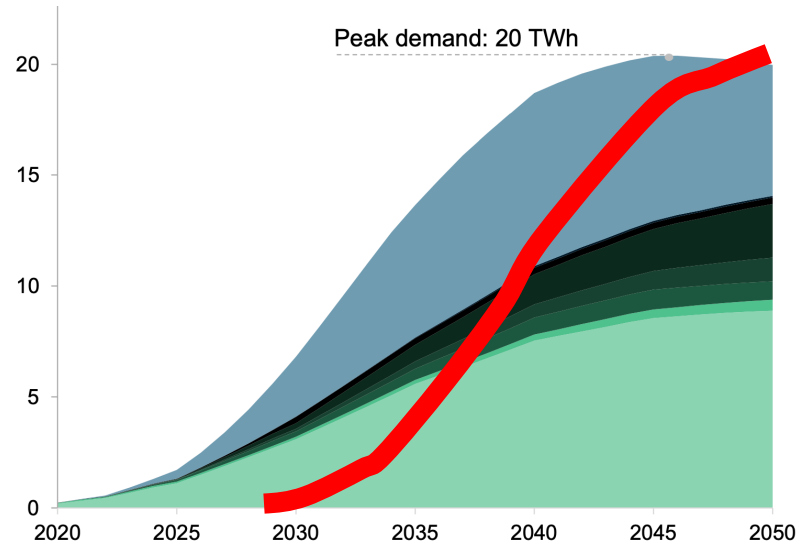


Growth in production

→ growth in recycling

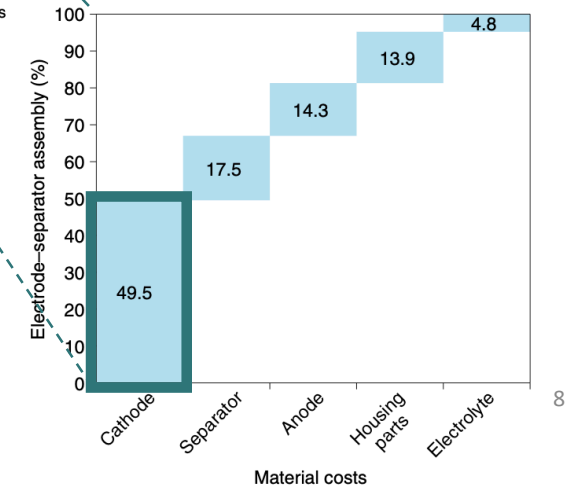
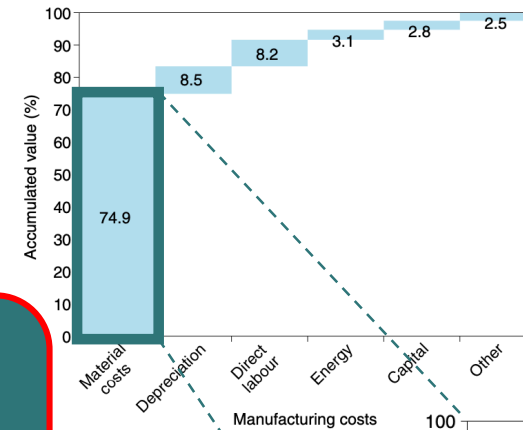
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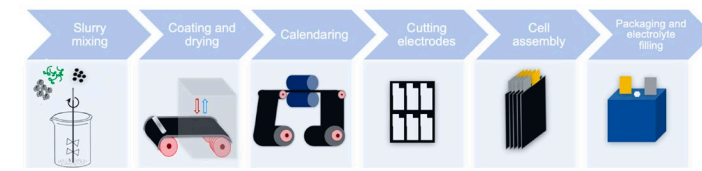
20 TWh equates to
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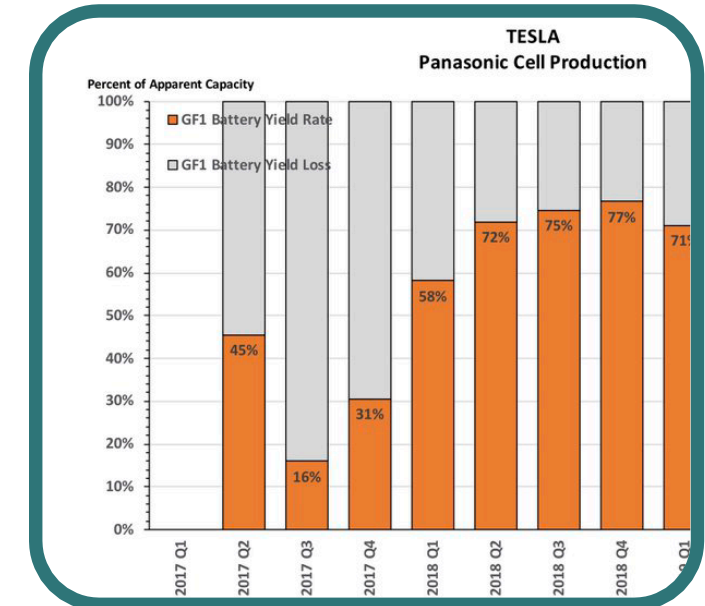
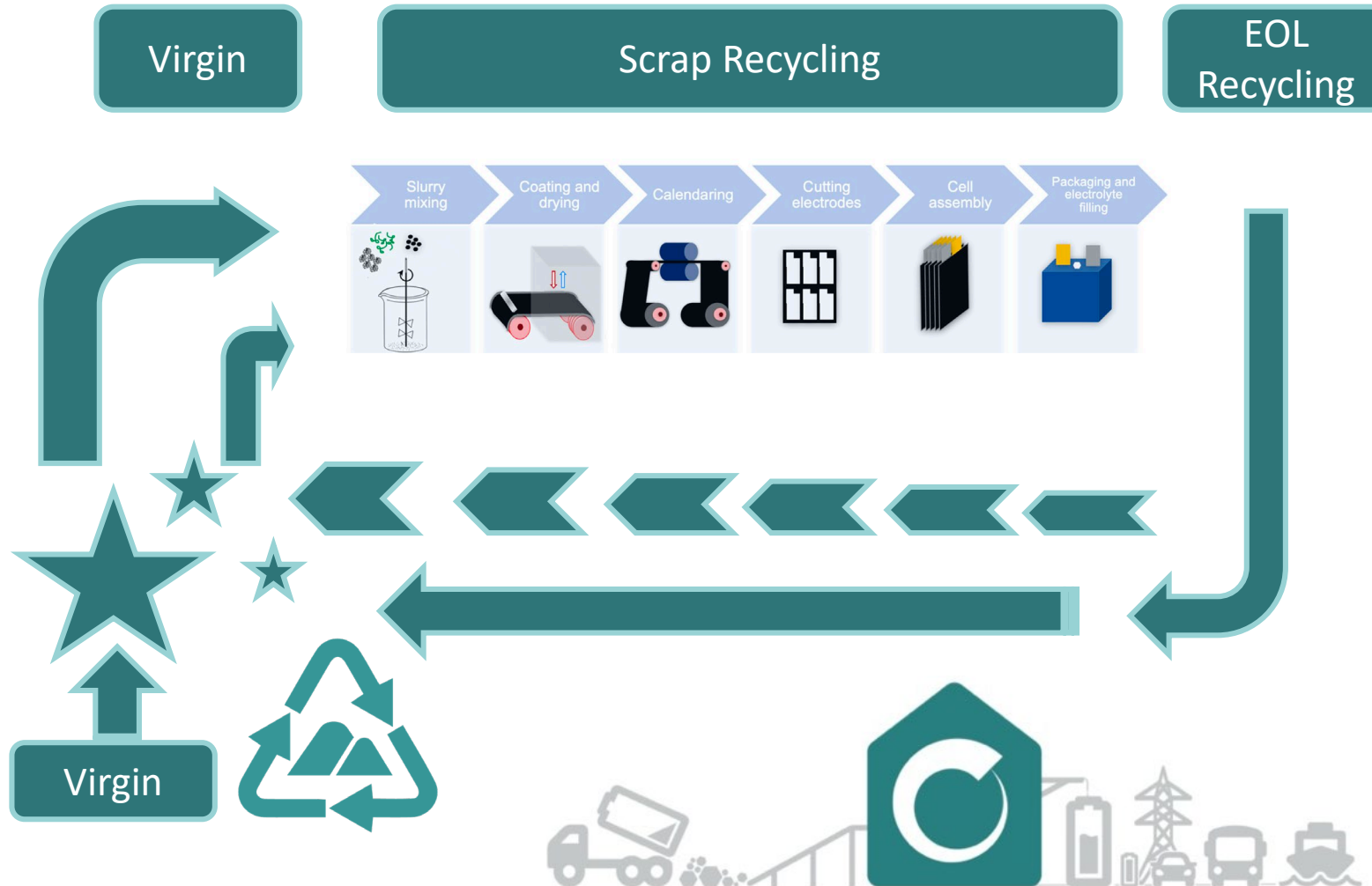
Recycling

Recycling as big
10 years ahead...
...or?

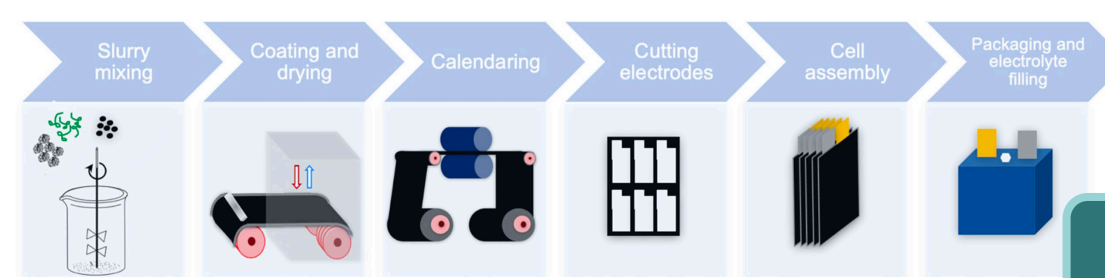




Manufacturing means recycling



Manufacturing & Energy



Article

A Flexible Model for Benchmarking the Energy Usage of Automotive Lithium-Ion Battery Cell Manufacturing

Asanthi Jinasena ^{*}, Odne Stokke Burheim ^{*} and Anders Hammer Strømman ^{*}



SIMS EUROSIM 2021

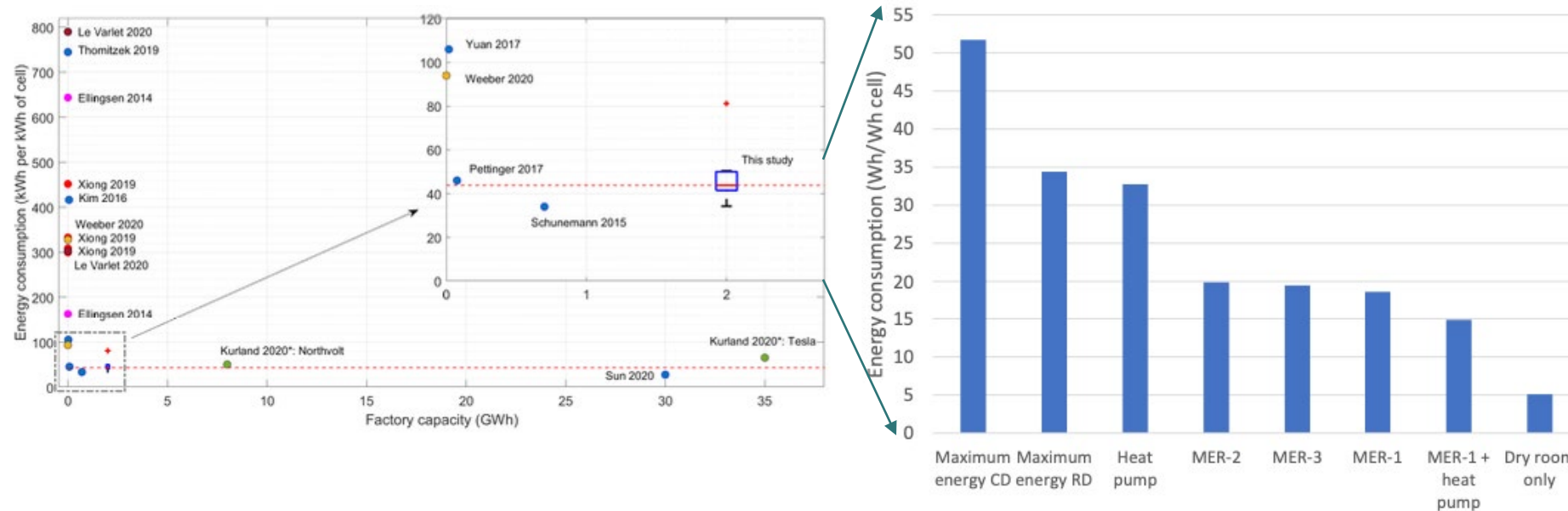
Energy Reduction in Lithium-ion Battery Manufacturing using Heat Pumps and Heat Exchanger Networks

Håkon Guddingsmo^{*} Petter Martinussen^{*} Daniel Stjernen^{*} Asanthi Jinasena Anders Hammer Strømman Odne Stokke Burheim

0.1-200 MWh
factories - now

Lab
factories

New
toolboxes





Manufacturing Process & Technology

Main research questions and potential topics

Transform from “how can we make batteries” → “how should we make batteries”

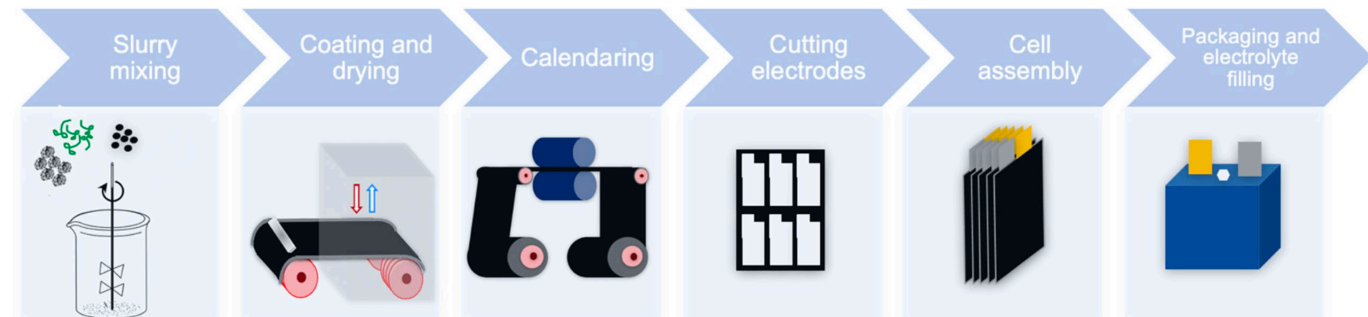
In the context of 5-6 small manufacturing lines (1-200 MWh/yr)

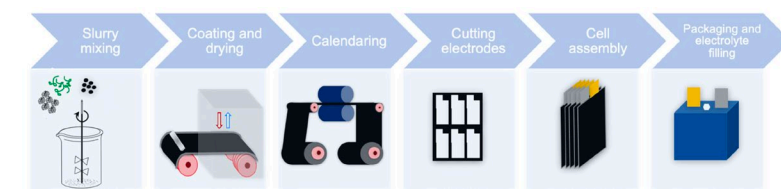
→ increase yield, reduce scrap, increase quality, reduce environmental footprint, etc.

Cell design and materials for easier remanufacturing and recycling, while improve quality.

Potential topics:

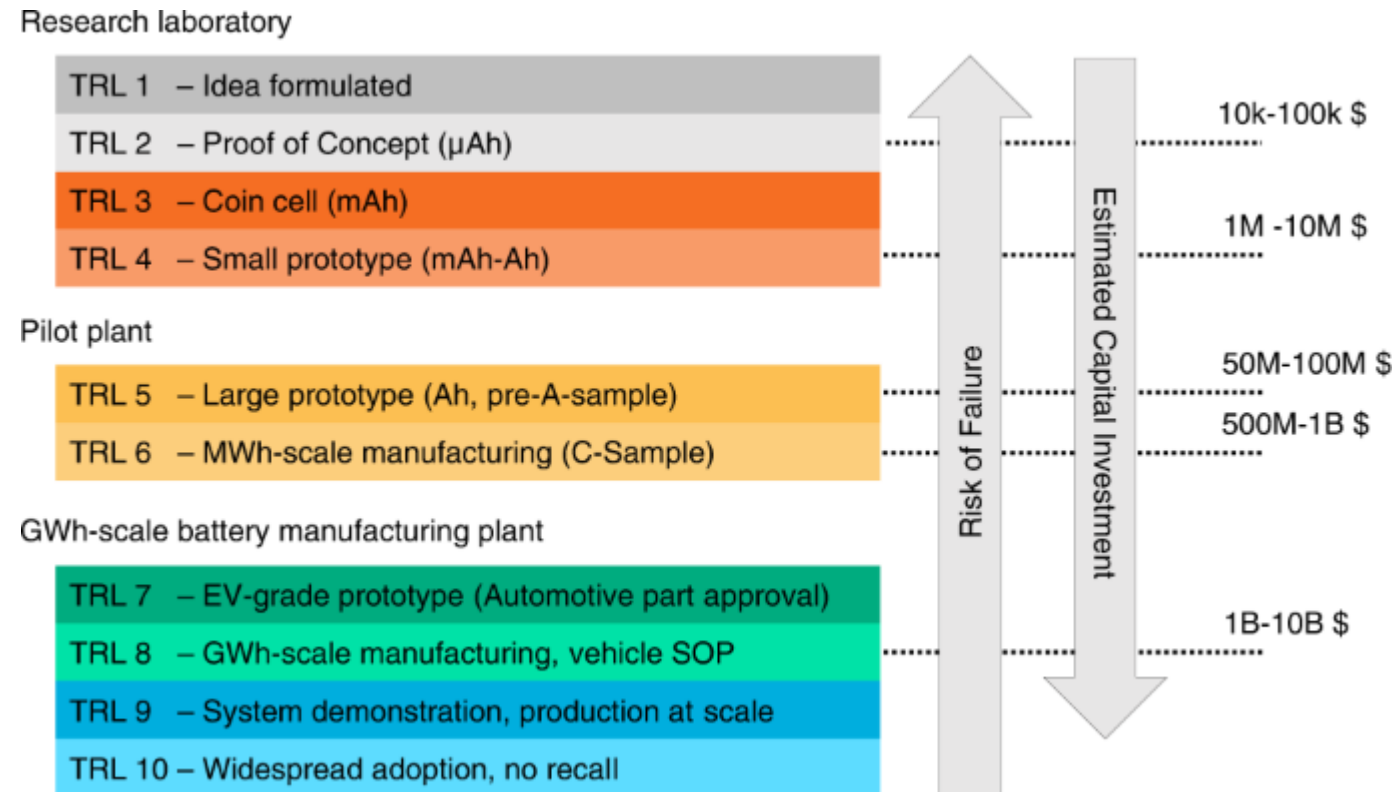
- Cell design
- Enable and simplify remanufacturing processes
- Energy efficient manufacturing
- Scrap handling
- Knowledge transfer

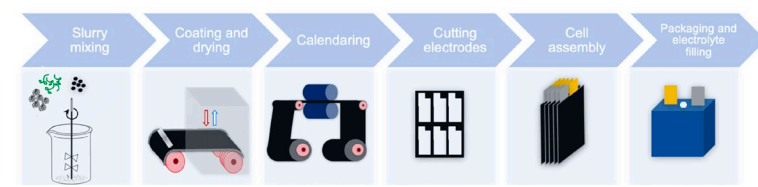




Getting to giga-factories

- TRL scale proposed for battery manufacturing
- Risk of failure and estimated capital investment are inverse directions
- Manufacturers need to prove production performance of A, B, C and D cells
 - Numbers of cells increase from 100 to 10 000
- Often tend to overlook the pilot plant as essential step between research labs and GWh-scale battery plants





Production of batteries

What is our competitive advantage?

- Production of batteries with renewable batteries
 - Lowest footprint, sustainable batteries
 - Upcoming EU regulation will be essential for Norwegian battery production
- World-class process industries
- Materials expertise
- Experience in electrification



Thank you for your attention

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