Model platform for addressing data gaps in life cycle assessment of lithium-ion batteries

EVS35
OSL2022

- Background and context
- Model platform design and progress
- Relevance in terms of upstream data and upscaling effects
- Upcoming work and take away message

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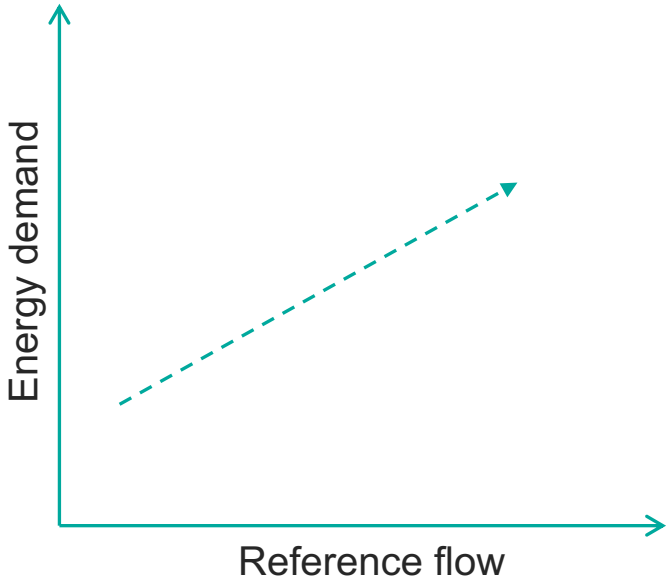
Background and context

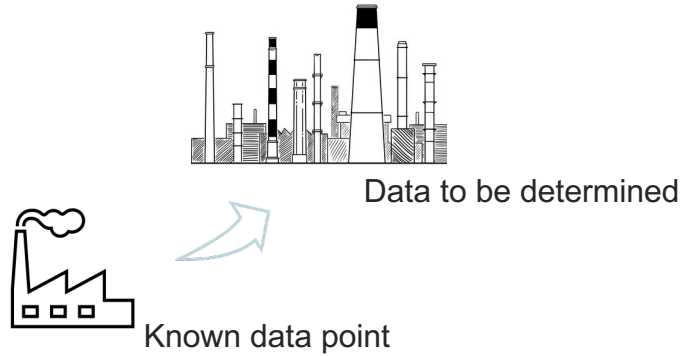
Literature on LCA of LIBs

- Previous LCA studies on lithium-ion battery cells present a very large range of results for contributions to climate change: **38 - 356 kg CO_2-eq./kWh** (Ellingsen et al. 2017)
- Limited original data sources (Peters et al. 2018)

Background and context

How scaling is done in LCA studies



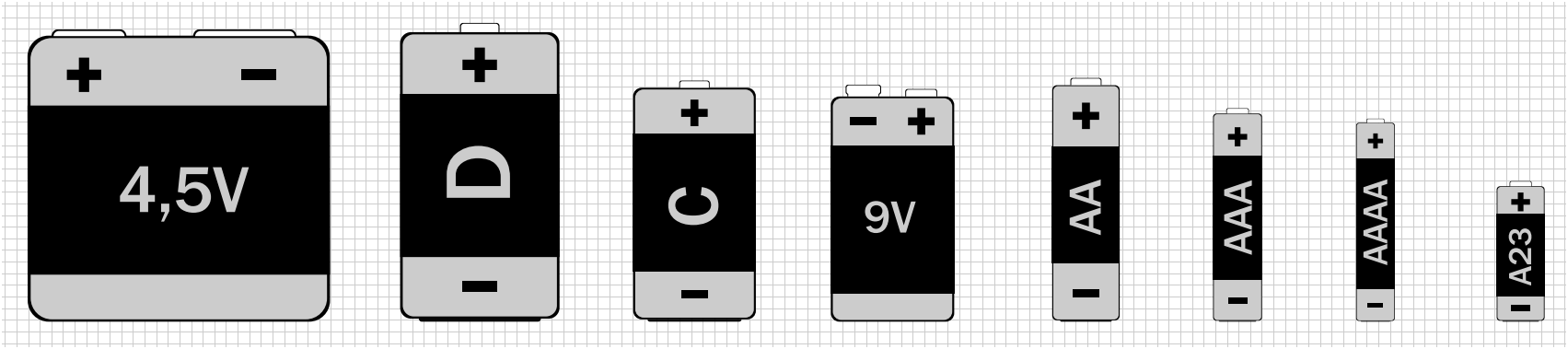


↳Linear relationship

↳Assumption of one relationship that determines all inventory flows

Background and context

Varying battery types and chemistries available



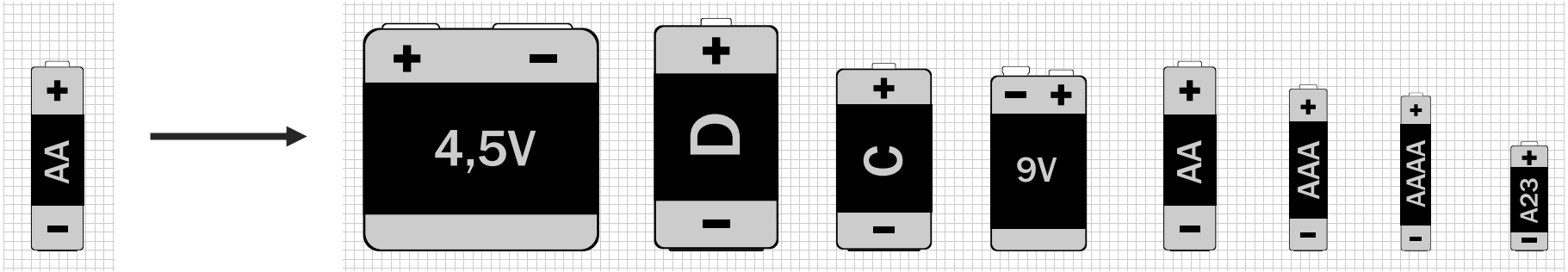
Background and context

Summary

- Large **variation** in results
- Limited **sources** of data
- Assumption of a single relationship (or **slope**)
- **Increasing** number of battery cell types and chemistries

Model platform

Objective

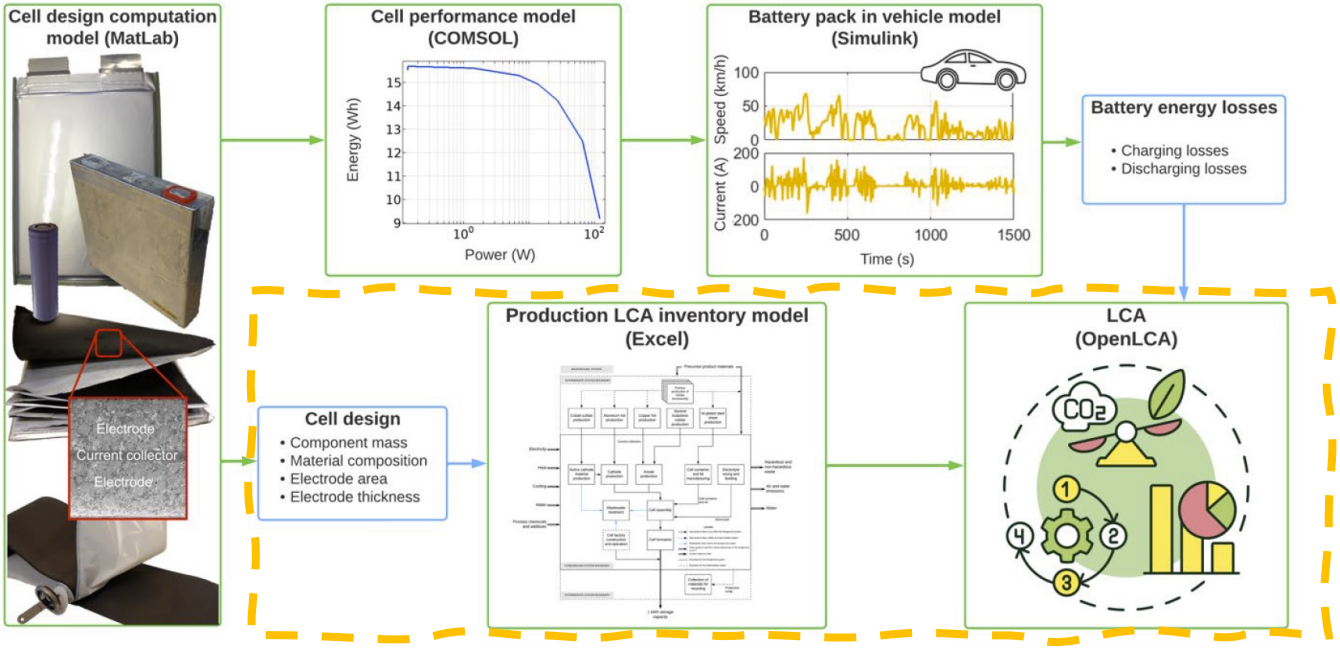


Data available!

Data that could be generated

Model platform design

Overview



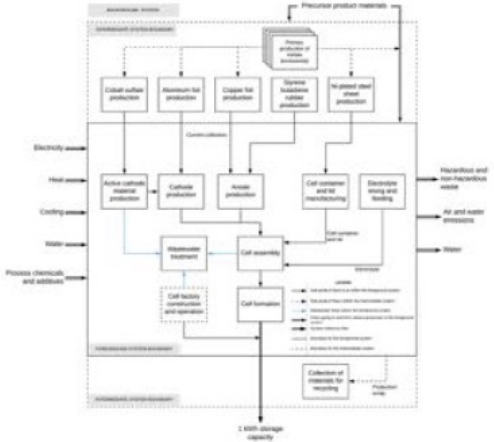
Model platform design

Production inventory model

Cell design

- Component mass
- Material composition
- Electrode area
- Electrode thickness

Production LCA inventory model (Excel)



LCA (OpenLCA)

Model platform design

Parameterization of energy demand

	Reference cell	Parameterized cell
Mixing		
Cutting		

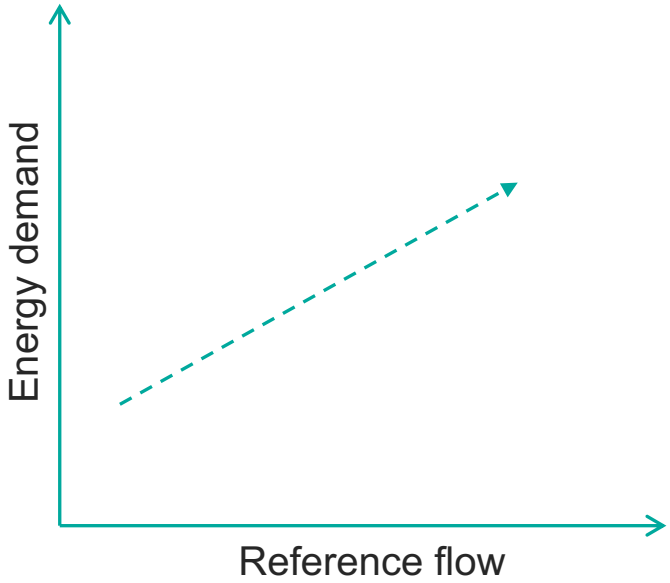
$$Scaling\ ratio, R_{property\ 1} = \frac{S_{property\ 1}}{S_{ref,property}}$$

$$Energy\ demand, E_o = R_{property\ 1} . E_{ref,activity}$$

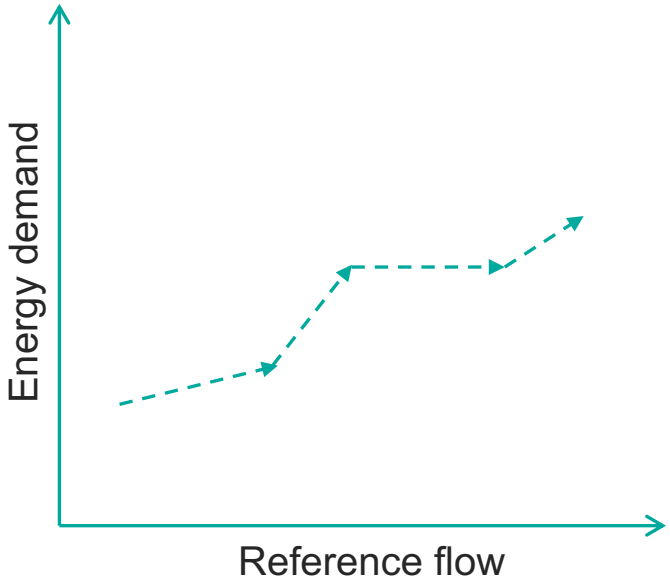
Model platform design

Parameterization based on different cell processing properties

E.g., Cathode production

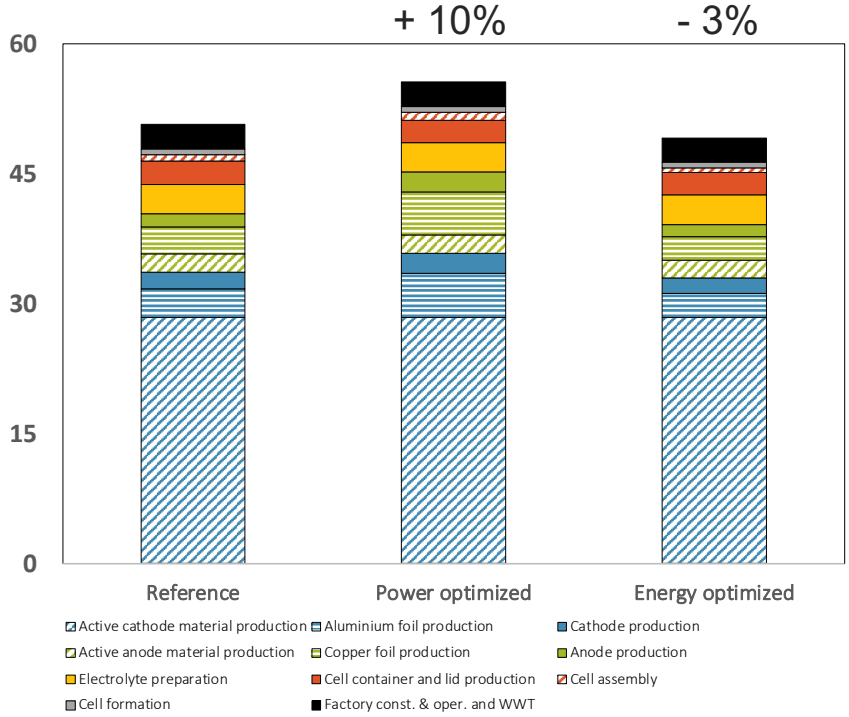


E.g., Cathode production



Model platform design

Preliminary results – Global warming impacts (kg CO_2eq./kWh)



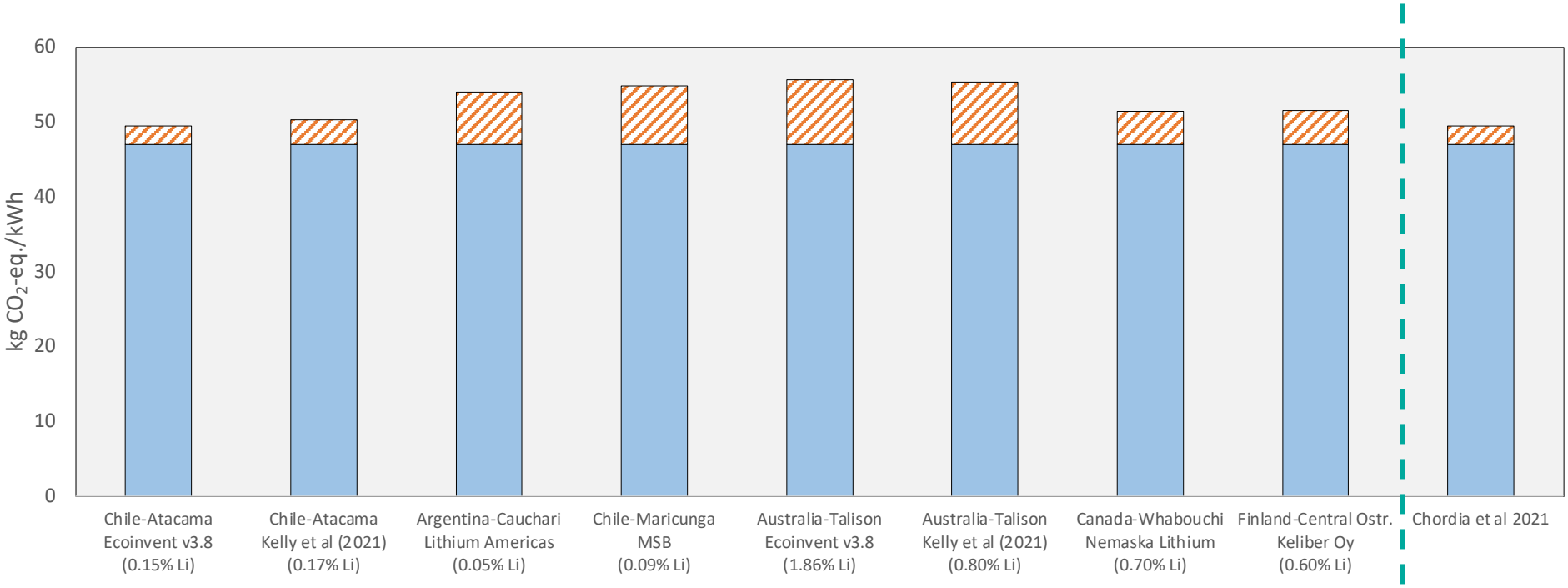
↳Cell type: 21700

↳Chemistry: NMC- 8:1:1

↳Swedish energy mix

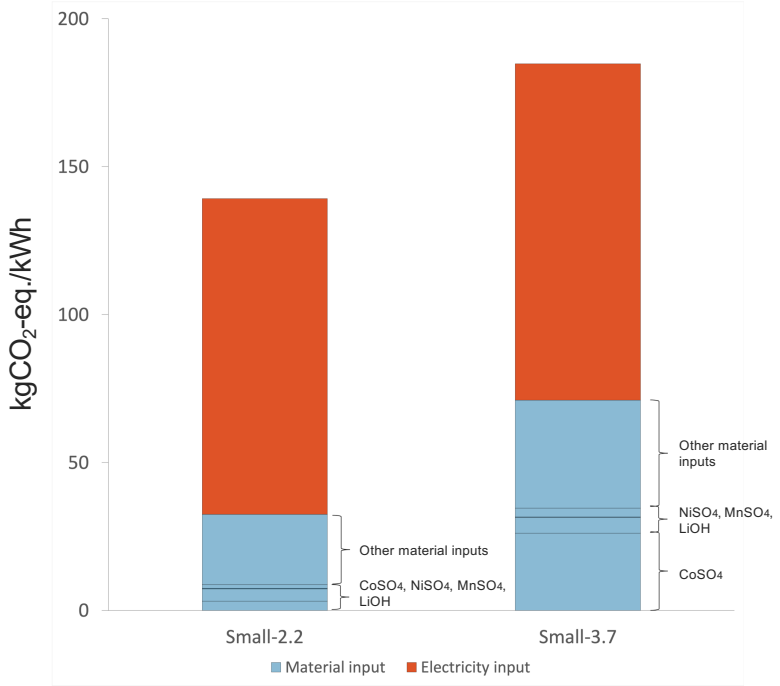
Relevance

Supply route – source of lithium can account for 5-15% of impacts



Relevance

Changing background system accounted for 30% increase in impacts



↳Figure 2: Chordia et al (2021)

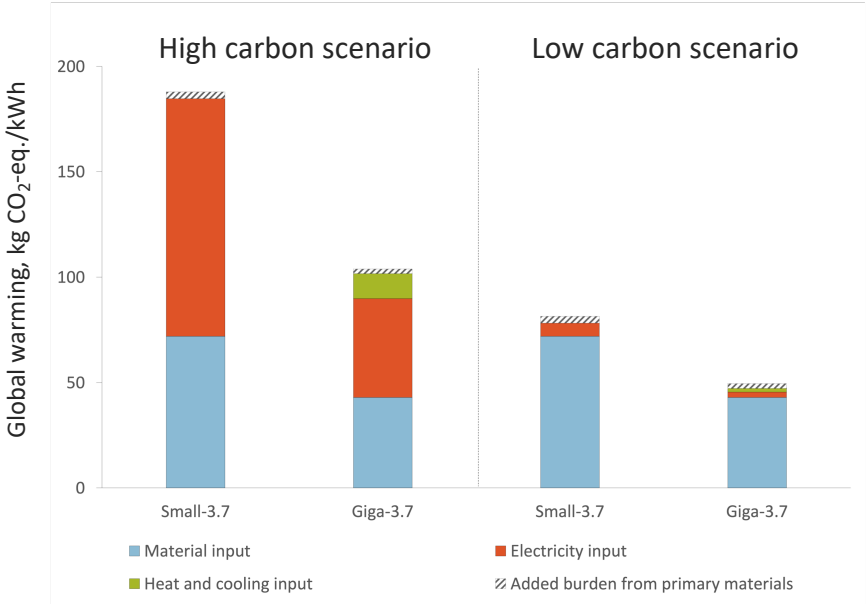
↳Chemistry: NMC- 1:1:1

↳South Korean energy mix

↳Cobalt sulfate data primary cause

Relevance

Upscaling reduced impacts by 45%

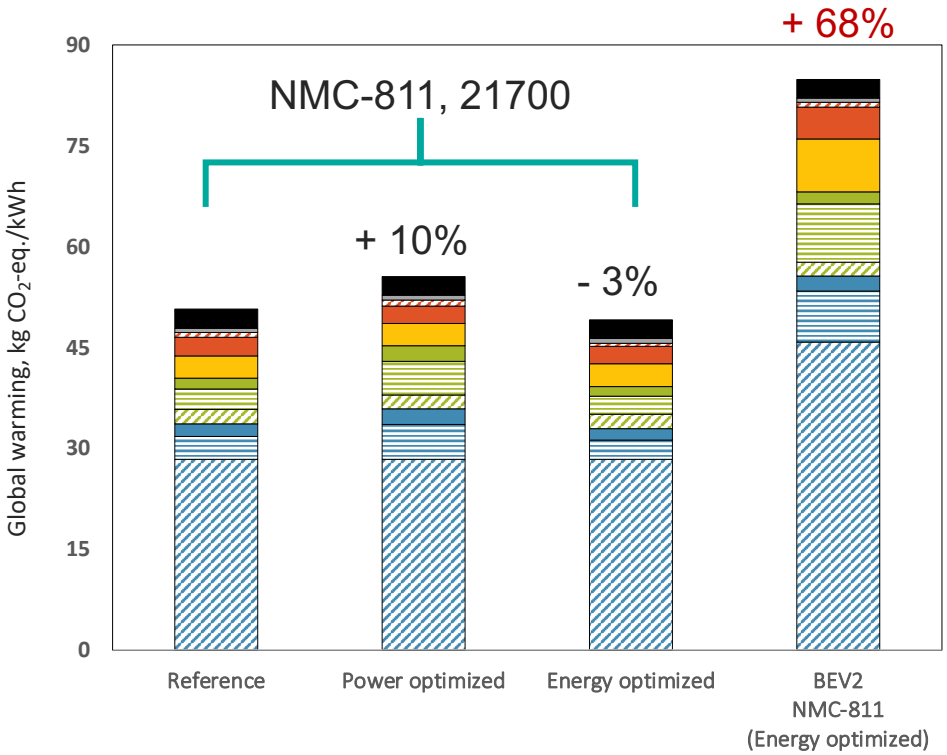


↳Figure 3: Chordia et al (2021)

↳Chemistry: NMC- 8:1:1 and NMC- 1:1:1

↳South Korean (high carbon) and Swedish (low carbon) energy mix

Upcoming work



↳Can changing cell type impact results so much… ?

Take away message

↳Model platform design

↳Connects cell composition data (Matlab) to cell performance (COMSOL) and Battery pack in vehicle model (Simulink)

↳Parameterization of inventory flows

↳Life cycle impact assessment

↳Ambition to fill data gaps in modeling of LIB

↳Ambition to expand to future cell chemistries

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