Water footprint of the manufacturing of a traction lithium ion battery pack

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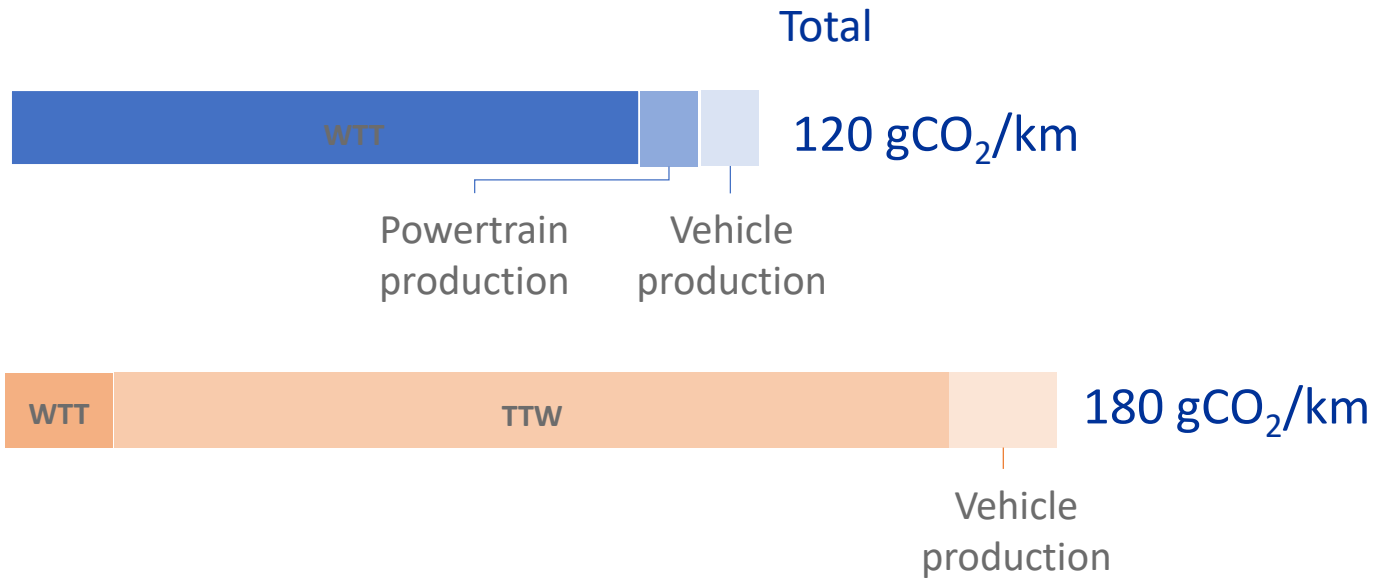
Environmental performance of EVs
Life cycle GHG emissions

BEV (EU electricity mix)



Diesel (Euro 5)

(Messagie 2014)

High metal content of batteries

Impact of mining & refining activities on water

→ what is the water footprint of a traction Li-ion battery?

For a cleaner production,

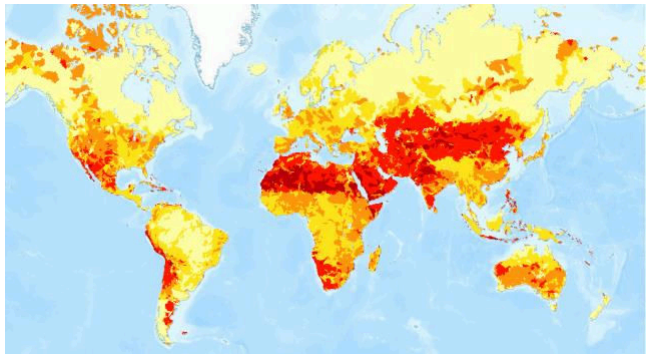
→ Is it possible to reduce the water footprint of a traction Li-ion battery?

Water footprint: standardized method (ISO 14046)

Water quality **&** **Water scarcity**

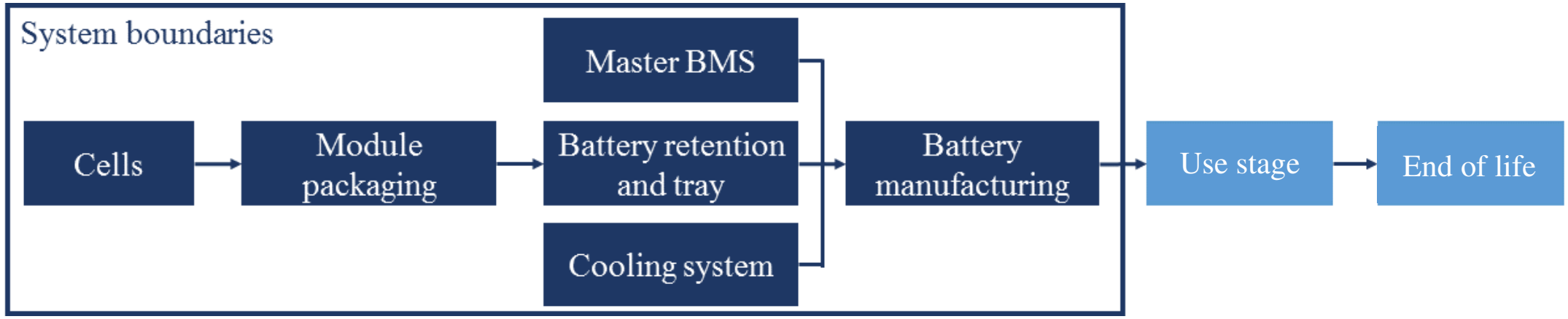
- Freshwater and marine eutrophication
- Freshwater ecotoxicity
- Freshwater acidification

- Quantitative aspect
- Regionalized indicator
- Many methods exist (Boulay 2015)



Goal and scope

1. Impact on water quality of a traction battery?
2. Influence of impact assessment methods on water scarcity results?



Functional unit = a 20 kWh battery pack, at factory gate

HIFI-ELEMENTS

High Fidelity Electric Modelling and Testing

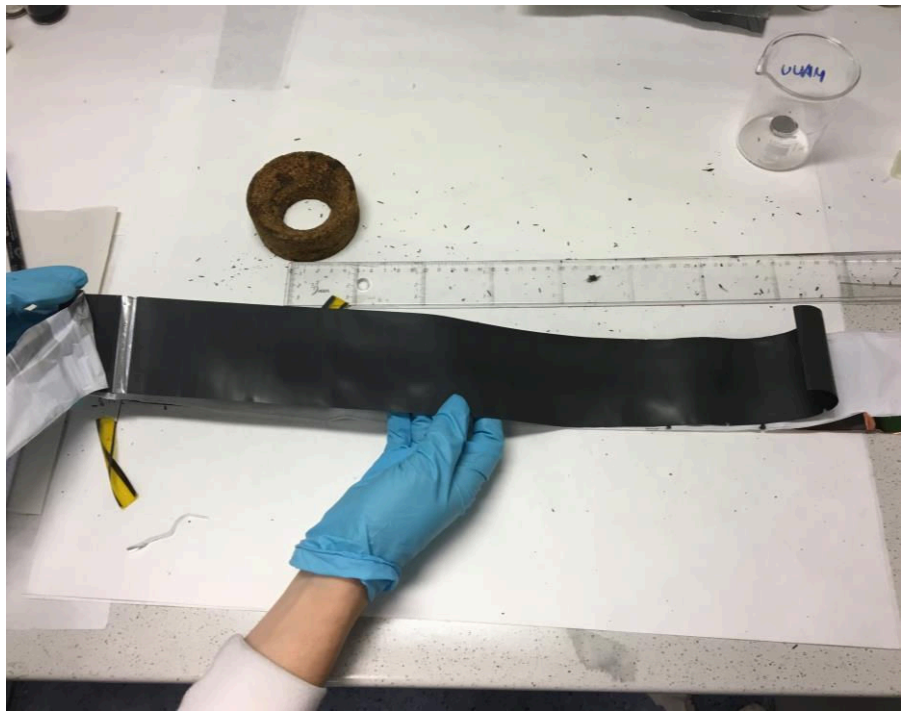
- Develop, validate and publish a recommendation for standardization of model interfaces for e-drive components
- Implement a seamless workflow linking extended versions of existing tools

→ Environmental assessment of the battery

Battery

- NCA cathode
- Samsung Li-Ion 21700 cylindrical cells model INR21700-48G

  Dismantled to retrieve inventory
- 36 cells in a prototype module used to develop and validate modelling techniques
- 32 modules in a 20kWh pack based on Ellingsen 2014
- Manufactured in Korea

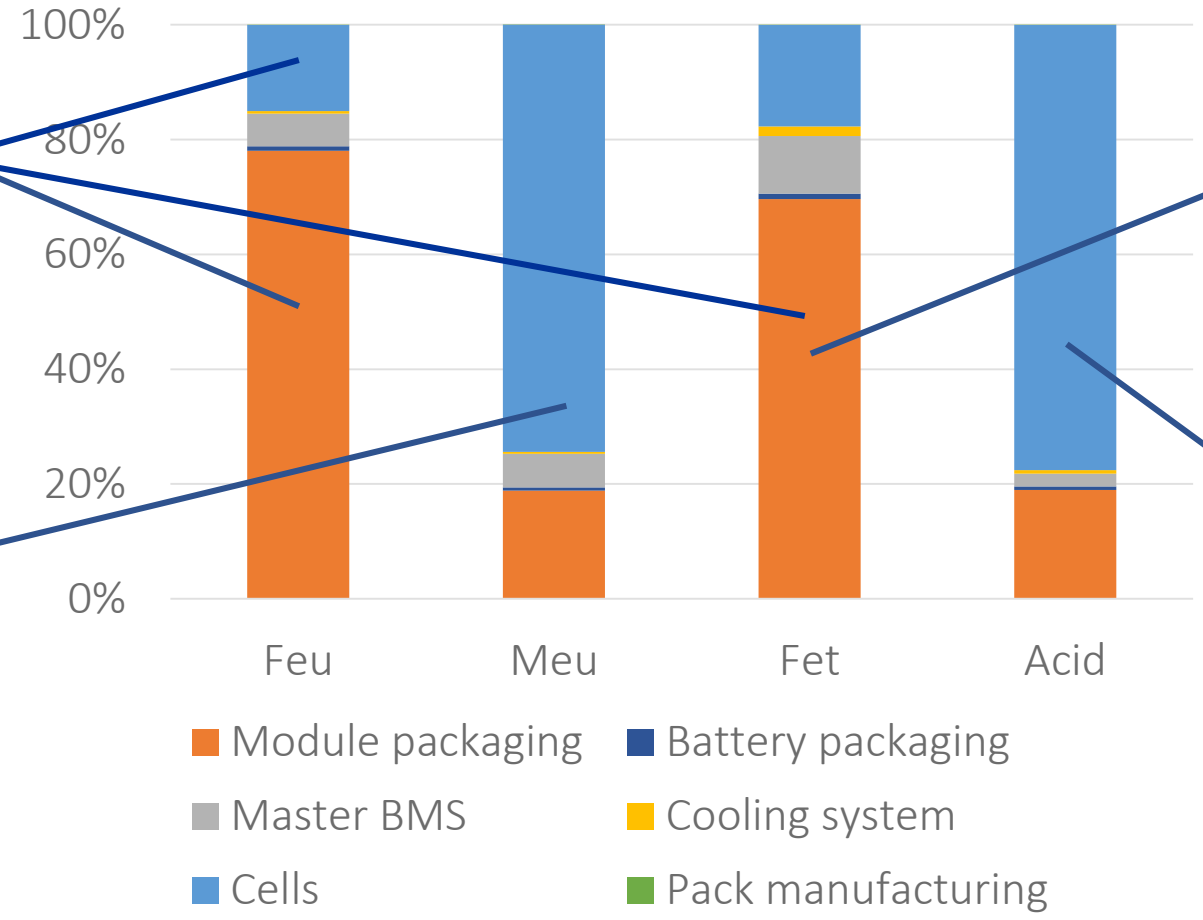


Impact on water quality: mining wastes

Gold mining (sensors and integrated circuits)

0.9g gold/kWh

Electricity production, diesel and hard coal combustion during nickel mining



Korean electricity mix (hard coal ashes)

Nickel and copper mining (acid mine drainage)

Impact on water quality: mining wastes

- Sulfidic tailings + hard coal ash + dross from aluminum electrolysis = 84% of impact on Fet
- Sulfidic tailings impoundment leachate
- Acid mine drainage

- Site specific because differences in ore composition and grade, climate and local environmental regulations

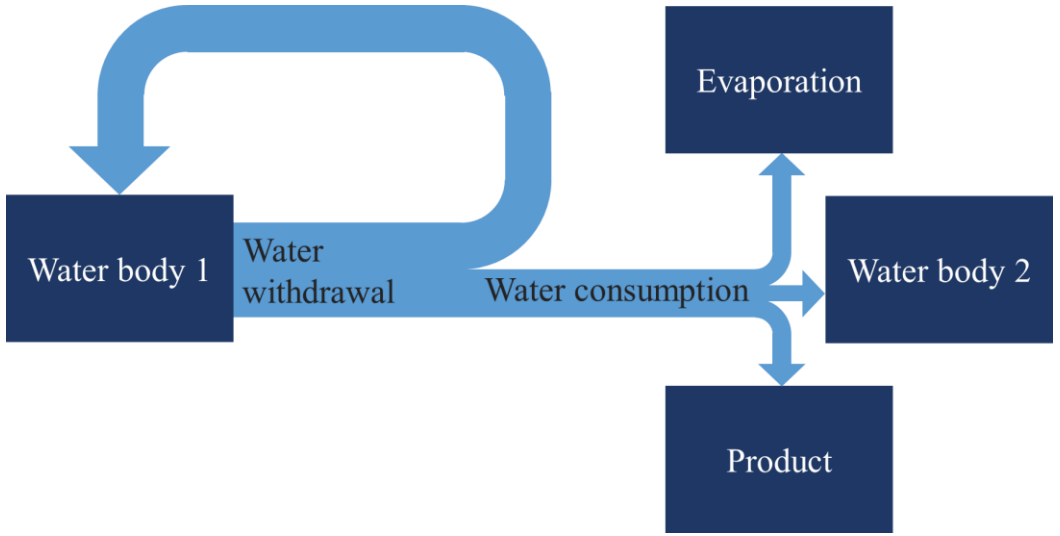
Limitations of toxicity assessment

- Estimated for more than 25 000 substances released in air, water and soil (but not for lithium in UseTox)
- No cross effects of exposure to several substances
- Uncertainty = 3 orders of magnitude

→ Helps to identify major sources of pollution but no to compare those sources

Water scarcity methods

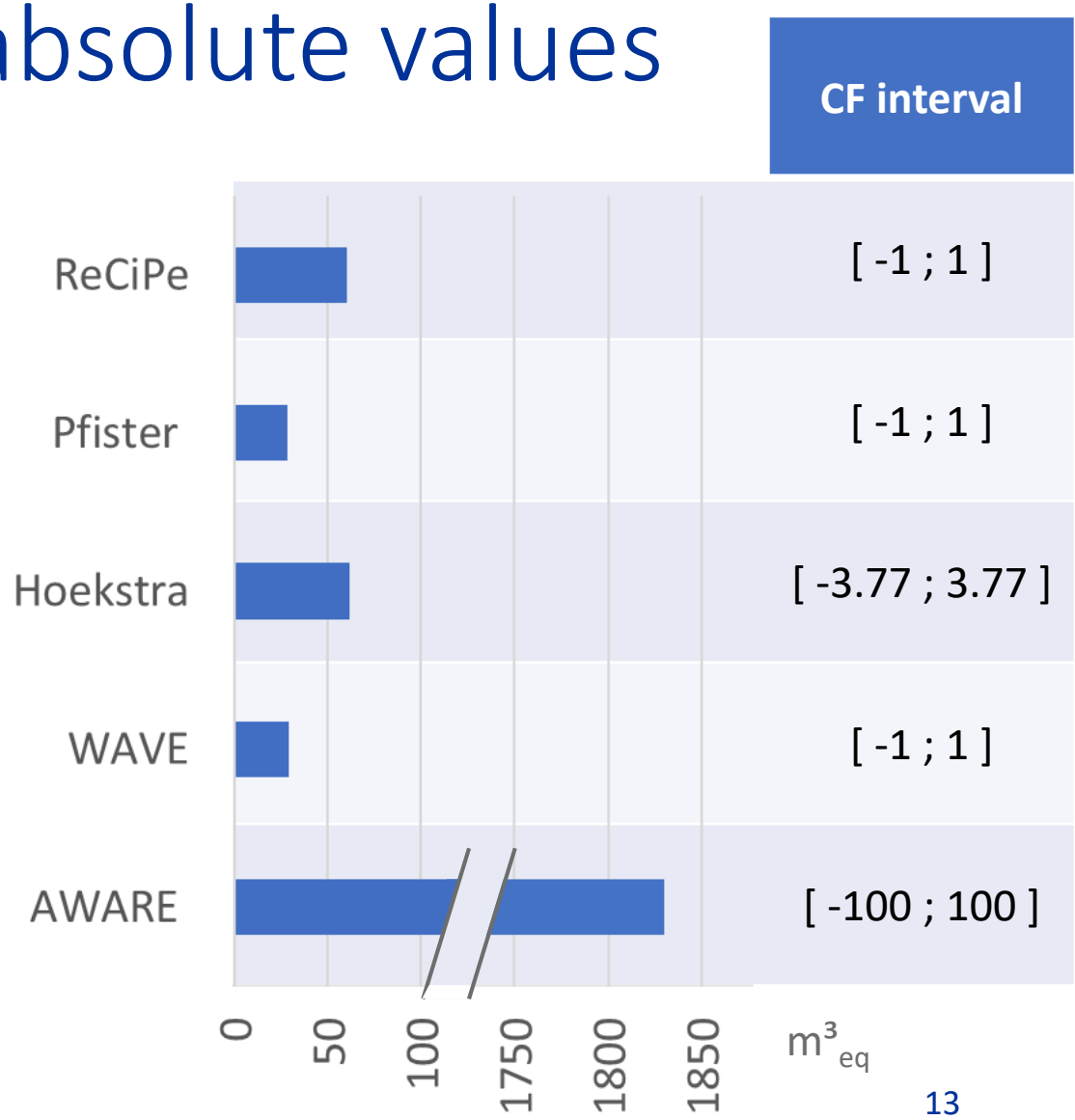
- ReCiPe 2016 by Huijbregts et al. — Water consumption inventory
- Water Stress Index (WSI) by Pfister et al. *
- Swiss ecoscarcity by Frischknecht et al. * — Withdrawal-to-availability ratio
- Water Accounting and Vulnerability Evaluation (WAVE) method by Berger et al. *
- Hoekstra et al.'s method — Consumption-to-availability ratio
- Available WAter REmaining (AWARE) by Boulay et al. * — Demand-to-availability ratio



* based on WaterGAP model

Impact on water scarcity: absolute values

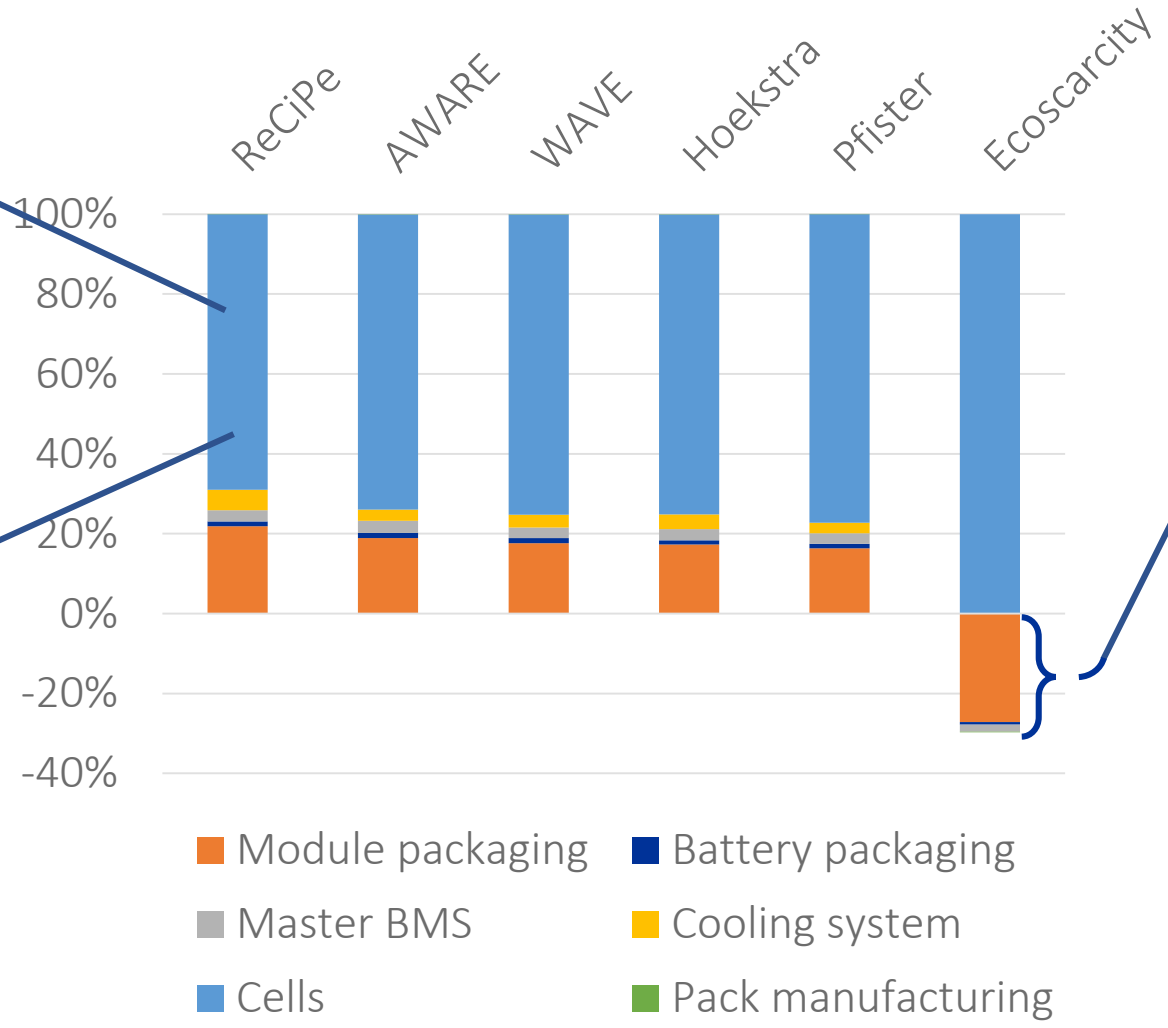
- Ecoscarcity not comparable (in points)
- Water consumption inventory = 61 m^3
- Discrepancy in absolute results:
  from 29 m^3eq to 1830 m^3eq
- Methodological choice of amplitude of characterization factors



Impact on water scarcity: relative results

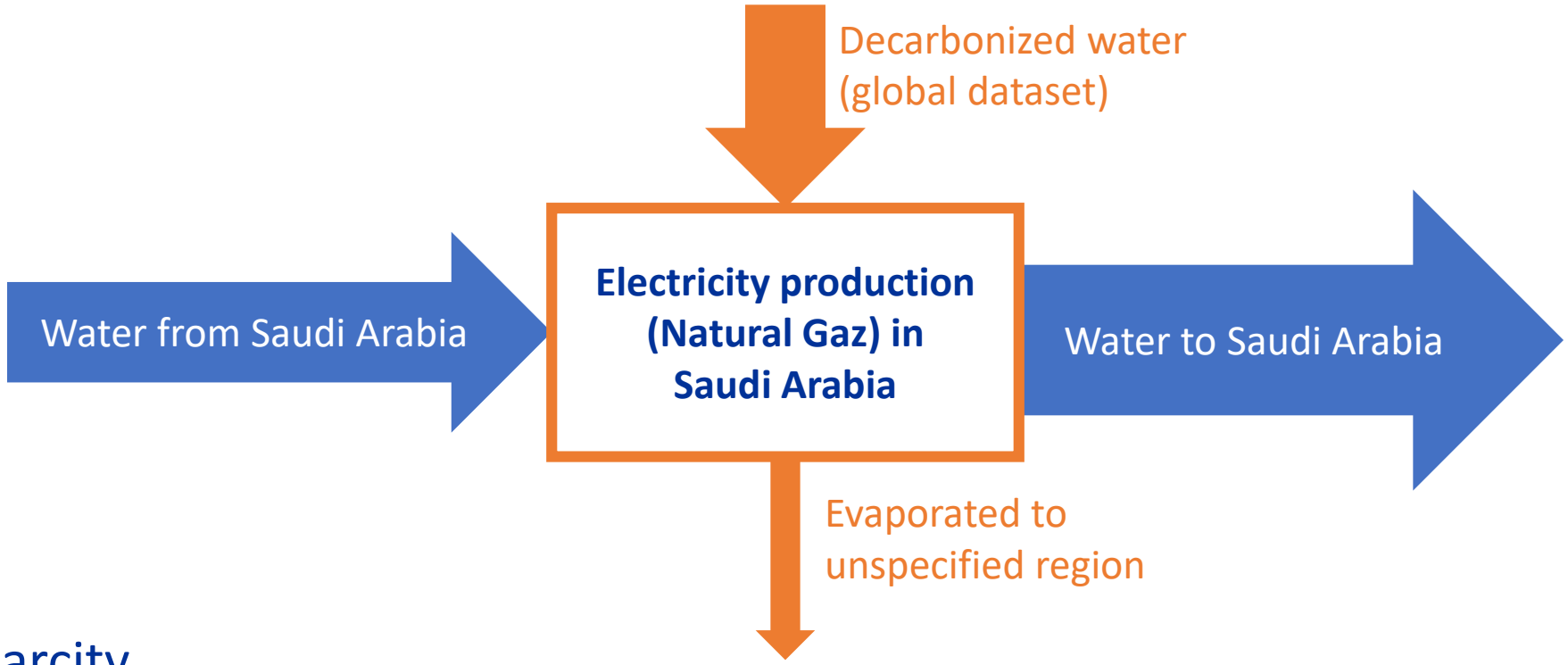
Direct water use in cell manufacturing (59%)

Cathode active material = Korean electricity mix = 8%



Saudi Arabia electricity production in global electricity production dataset

Negative impact of Saudi Arabia electricity production



In Ecoscarcity,

impact of 1m³ in Saudi Arabia = 15M higher than impact of 1m³ in unspecified region

Impact on water scarcity: 6 methods

Converge:

- Identification of main contributors
- Electricity production= important background data

Diverge:

- Absolute value
- CF amplitude

Conclusion

1. Water quality driven by mining wastes (gold, cathode active material, copper)

2. Water scarcity driven by direct water use in cell manufacturing, cathode active material and Korean electricity mix

Recommendations for LCA practitioners

- Assess water quality & water scarcity
- Choose water scarcity method according to goal
- Use 2 methods with different modelling approaches
- Avoid global datasets for a regional impact category
- Improve data quality (nickel, …)

Recommendations for battery manufacturers

1. Reduce use of “water polluting metals” :
   - Use secondary metals
   - Make sure of the recyclability of the battery but  assess recycling process
   - Assess the exact supply chain

2. Reduce direct water use during cell manufacturing

HIFI-ELEMENTS

High Fidelity Electric Modelling and Testing

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