

Main results

- smart IoT sensor **measured** data can be used to determine **company-specific hourly carbon emission factors** that substantially differ from static emission factors (see Fig. 1)
- to improve Scope 2 emissions accounting, company-specific data which aggregates **temporal, spatial** and **technological** aspects should be used
- use of company-specific measured data could **minimize**:
 - **greenwashing risks**;
 - green energy **double counting** (improving the market-based accounting method)
- companies could **improve** their **performance** under **location-based** accounting if precise data on consumed electricity sources would be available to them

Background

Emission factors provided in LCA databases or based on national electricity production describe **static** and **averaged** situation. According to GHG Protocol, accounting of emissions can be based on two different principles:

market-based mix depends on purchased electricity and the remaining part for which no guarantees of origin are issued (residual mix)

location-based mix based on the generation location, each produced electricity is attributed to that territory

This **study** aims to explore how an **increase in the granularity** of company-specific electricity consumption measured data can **improve the precision and traceability** of related **Scope 2** emissions for more qualitative operational decisions in companies.

Methodology

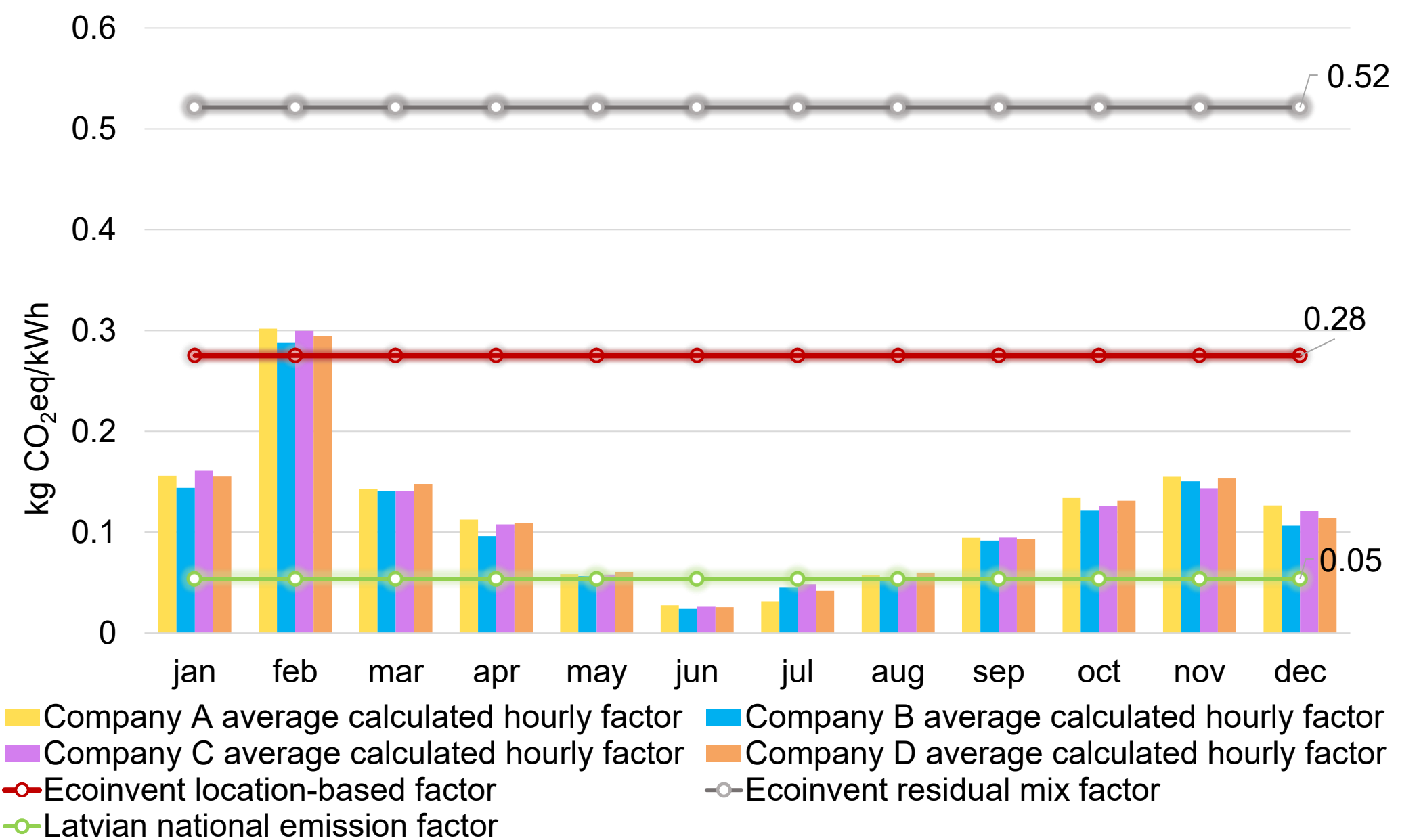
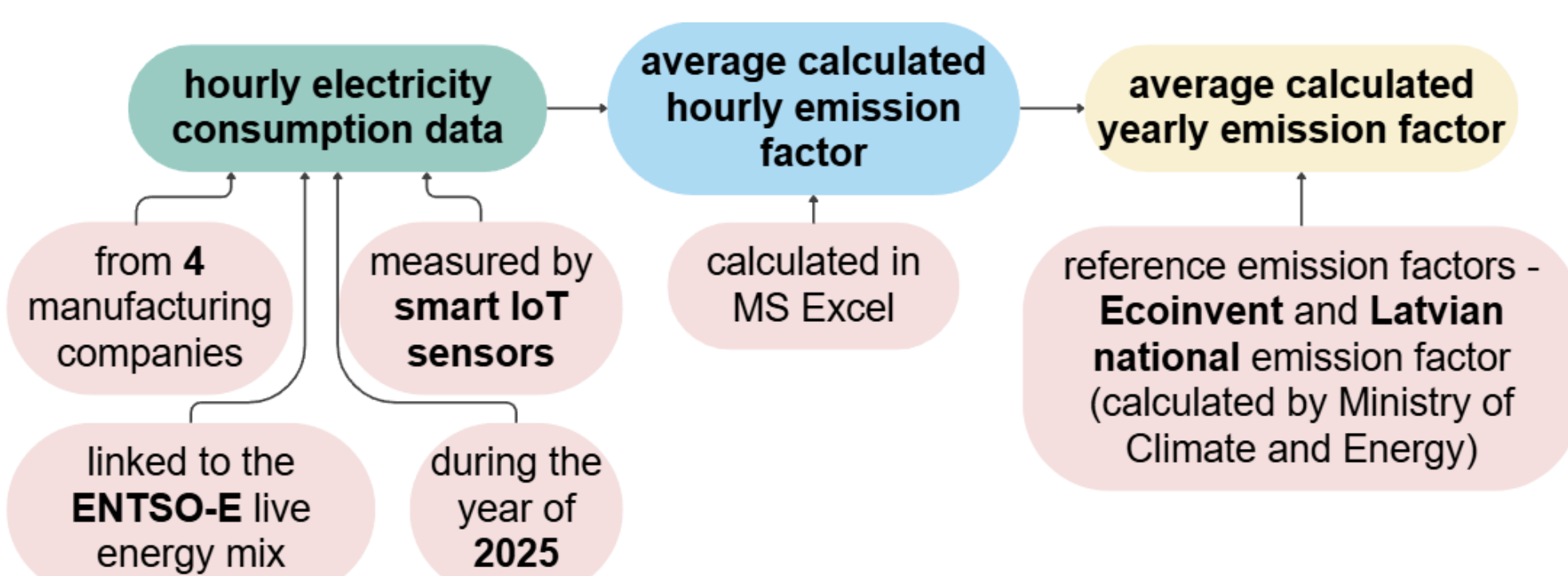


Fig. 1. Average calculated hourly emission factors for all companies, Ecoinvent location-based factor, Ecoinvent residual mix factor and Latvian national emission factor in 2025

The average calculated yearly emission factor for companies A, C and D is 0.12 kg CO₂eq/kWh, and for company B 0.11 kg CO₂eq/kWh, therefore the difference between company-specific hourly emission factor and Ecoinvent location-based factor is around 0.16 kg CO₂eq/kWh leading to around **56% CO₂eq emission overestimation**.

If company-specific factors are compared to Ecoinvent residual mix factor, for all companies the use of this factor (see also Fig. 2) leads to emission overestimation more than fourfold. But, if Latvian national emission factor is applied, emission underestimation occur due to the companies' use of imported non-renewable electricity.

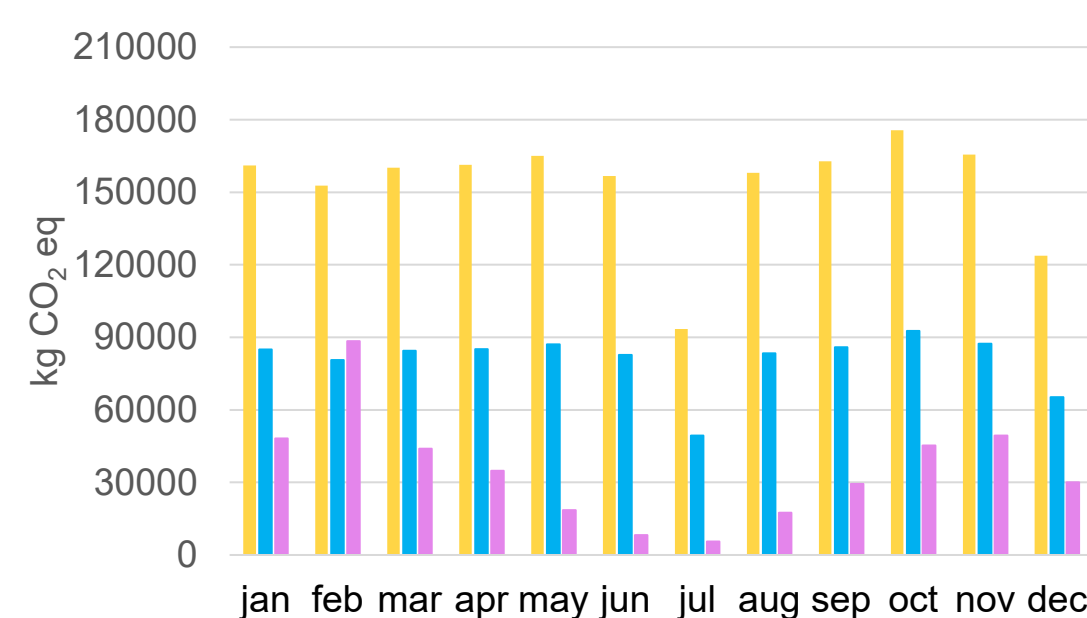


Fig. 2a. Comparison of emissions calculated for Company A

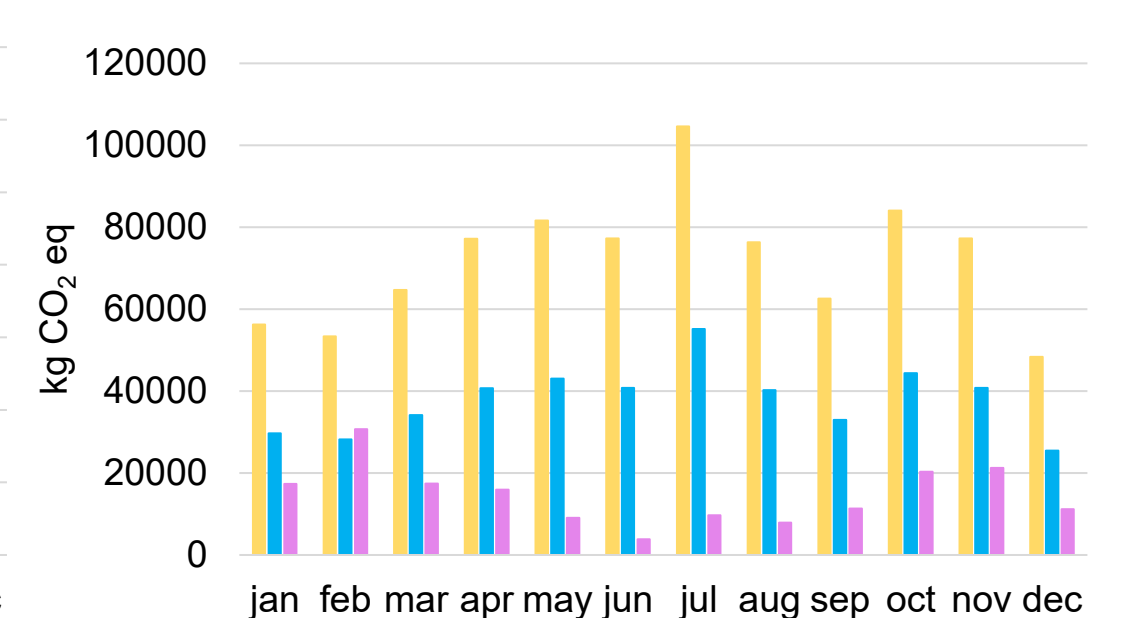


Fig. 2b. Comparison of emissions calculated for Company B

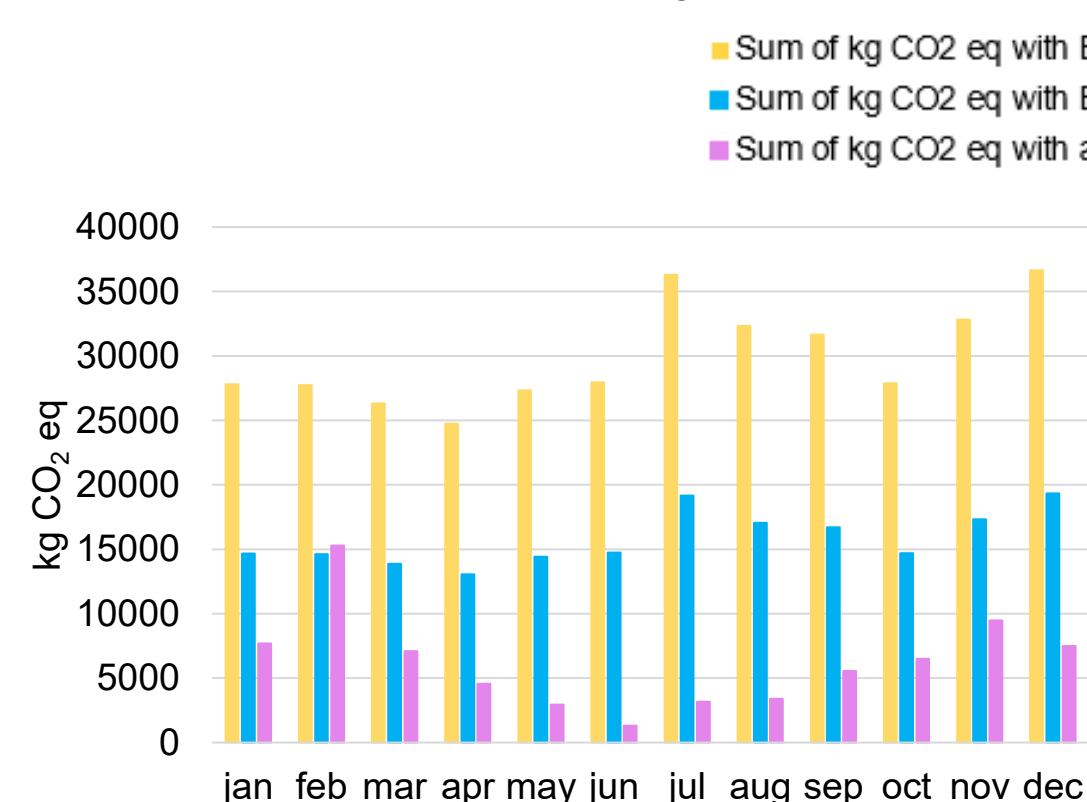


Fig. 2c. Comparison of emissions calculated for Company C

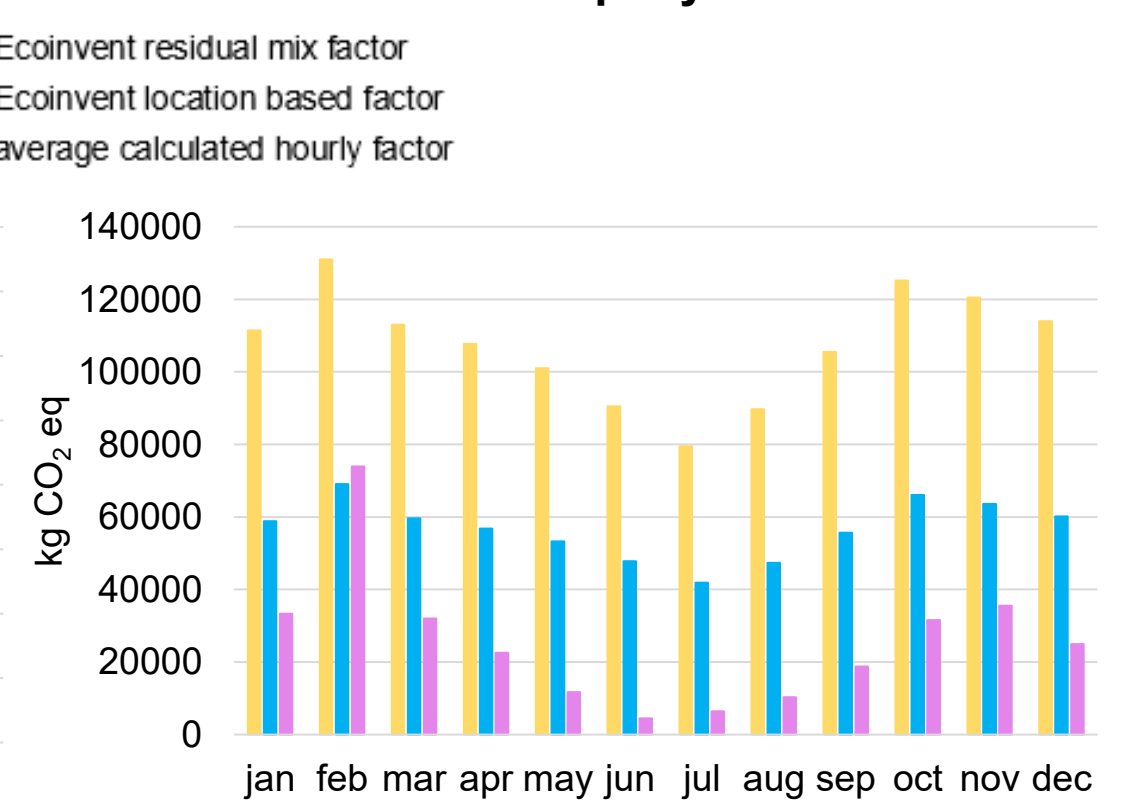


Fig. 2d. Comparison of emissions calculated for Company D

Conclusion – future research topics

smart IoT sensor system's use in manufactured products **dynamic environmental documentation**

measured data further analysis (with machine learning) to **predict future grid conditions** for operational decisions

to assure third parties the data are not altered, it may be necessary to explore combination of measurement taking and recording on **distributed ledger**