Fraunhofer IZM

Fraunhofer Institute for Reliability and Microintegration IZM

Electronic Packaging Days 2025

Nils F. Nissen

Going Green Combines Environmental, Reliability and Business Aspects

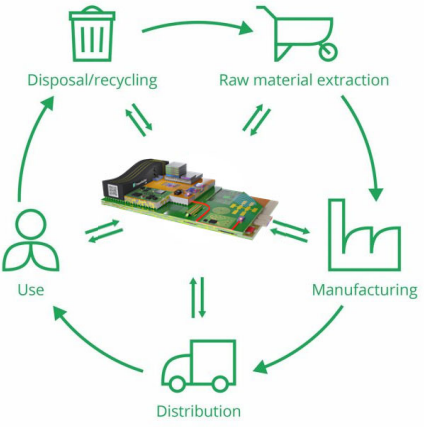
Hyperscalers are „Focused“ Customers Environmentally

- Priority 1: Performance, energy costs, thermal management
- Priority 2: Carbon Footprint of energy
- Priority 3: Water Footprint, if regionally relevant
- Priority 4: Embedded Carbon Footprint / full carbon neutrality

Our environmental portfolio is much broader

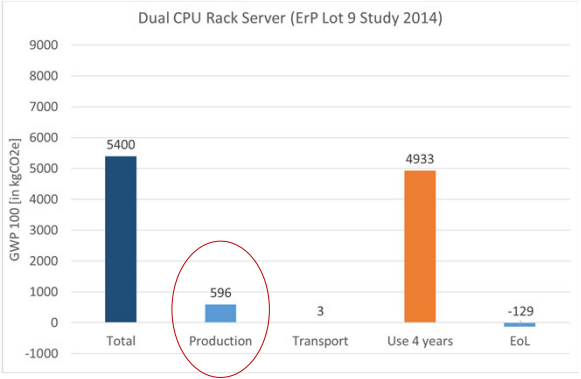
including

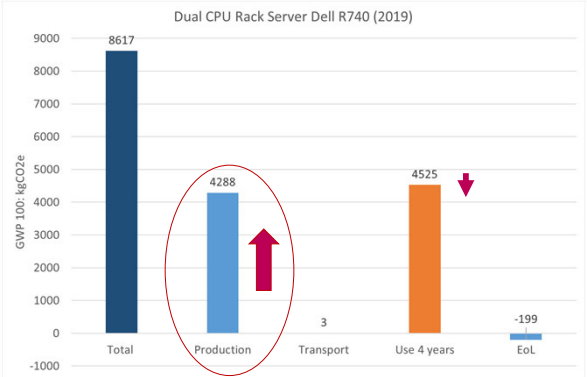
- full life cycle assessment, in conjunction with cost analysis
- technology assessment, selection and lab-to-fab prediction
- product level analysis and optimization
- application scenarios, market scenarios
- recycling, repair, re-use; circularity and eco-reliability
- regulatory developments and trainings



Lifecycle Assessment of Servers in 2014 and 2019

Environmental impact already shifting from use to hardware production



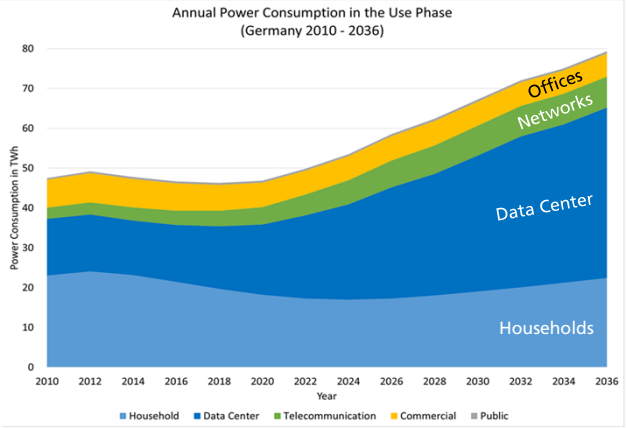


Power Consumption of ICT in Germany

Public Study from Project »Green ICT @ FMD«

greenict
Forschungsfabrik Mikroelektronik Deutschland
Forschungsfabrik Mikroelektronik Deutschland
Gefördert durch:
Bundesministerium für Forschung, Technologie und Raumfahrt

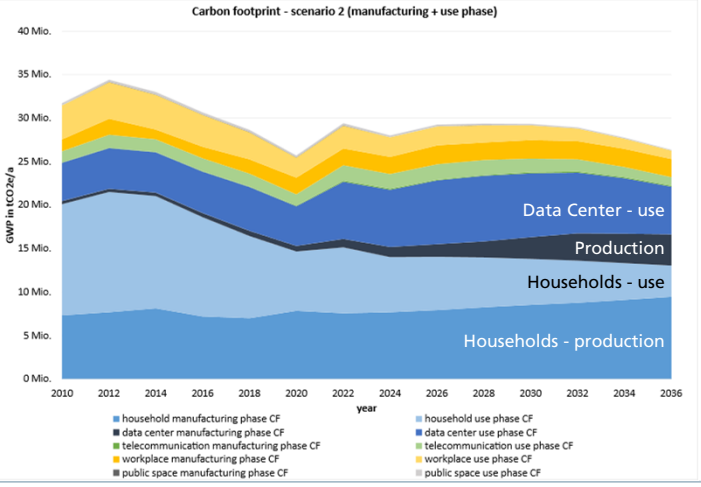
- Decline of power consumption between 2012 and 2020 – despite increase in devices and usage
- **Increase** after 2020 is mainly **driven by data centers**
- Telecommunication networks increasing, but much lower absolute contribution
- Trend in households to reverse slightly upwards after 2026



Lutz Stobbe, et al., "Power consumption and carbon footprint of ICT in Germany 2010 – 2036", english version dated 29.7.2025

Carbon Footprint of Use and Production of ICT in Germany

Public Study from Project »Green ICT @ FMD«



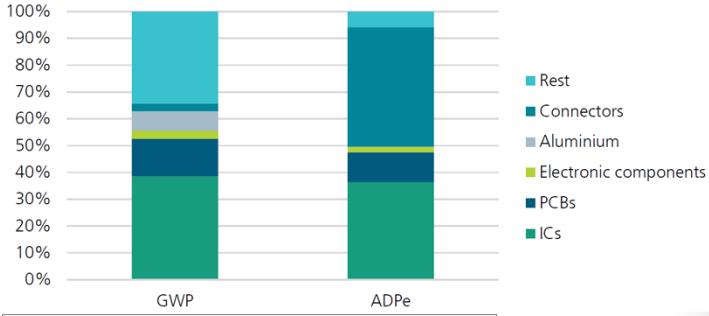
Aggregate emissions of all ICT used in Germany until 2036

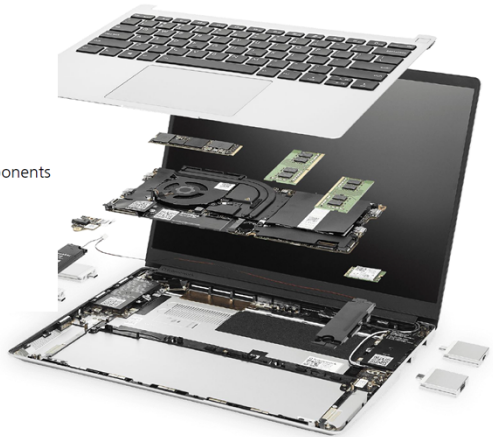
- Overall positive trend
- Currently stagnant emissions at increased performance
- German energy mix expected to continuously improve better than the main countries producing the electronics

➢Focus on hardware is increasingly relevant

GWP: Global Warming Potential
CF: Carbon Footprint
„Scenario 2“: German energy mix projection with 280g CO_2e/kWh in 2030; 180g CO_2e/kWh in 2036

Example Environmental Profile: Framework 13 Laptop



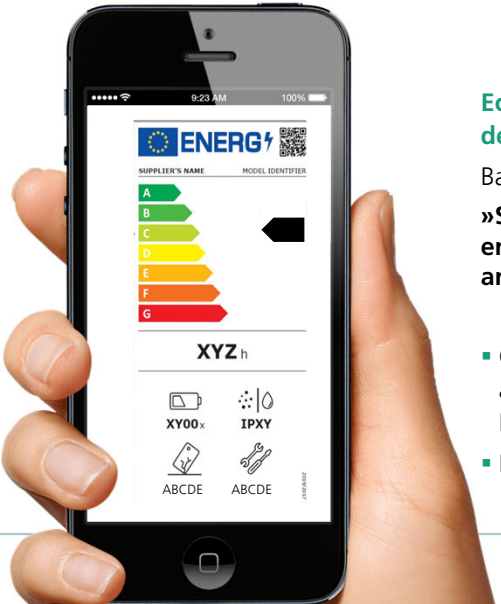


GWP: Global Warming Potential
- Climate active emissions, Carbon Footprint

ADPe: Abiotic Depletion Potential elements
- Resource consumption (excl. fossil und biogenic sources)
- Note: no credits for material recycling applied

Baur, S.-J., Proske, M., Poppe, E. (2023). Life Cycle Assessment of the Framework Laptop 2022. LCA Report (ISO 14044 and ISO 14067). Berlin: Fraunhofer IZM.

EU Ecodesign Regulation for Smartphones and Tablets in Effect June 2025



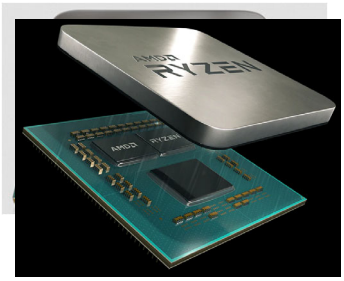
Ecodesign rules and energy efficiency labelling developed by Fraunhofer IZM for the EU

Base approach:

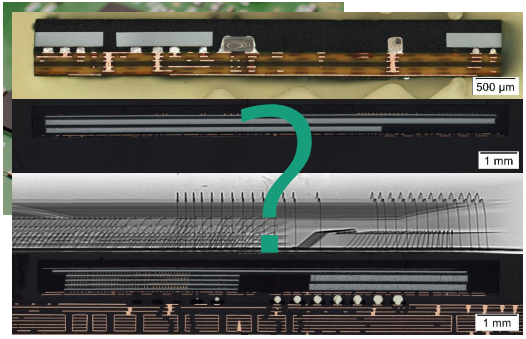
»Since energy consumption is not a main driver of environmental impact: lifetime extension, reparability and robustness must be the focus for ecodesign«

- Circularity approaches and metrics such as reparability scores are blueprints for the new Ecodesign of Sustainably Products Regulation (ESPR)
- Excellent visibility as neutral technical experts

Why do we need to look into components?



Heatsink, socket, cooler, dimensions
→ Attention, one of the main ICs!

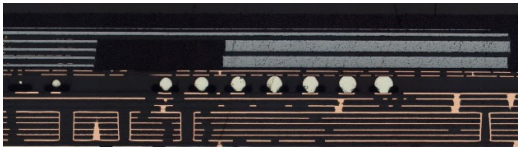


„Half-Visible“ Revolution

„Invisible“ Revolution

Environmental Assessment and Optimization of Electronics

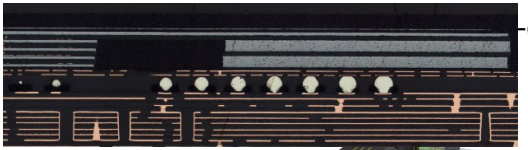
Centered on Advanced Packaging – but Investigating all System Levels



- Technology specific assessments
- Material to component to system level
- Developing ecodesign options
- Life time & reliability & cost trade-offs
- Environmental legislation and standardization

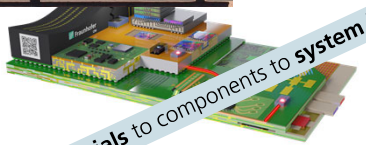
Environmental Assessment and Optimization of Electronics

Centered on Advanced Packaging – but Investigating all System Levels



-design requirements.

Source: https://www.hlrs.de/de/loesungen/systeme/hunter



»from **materials** to components to **system level** scenarios«

»from **sensors** to **servers**«

Contact

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