

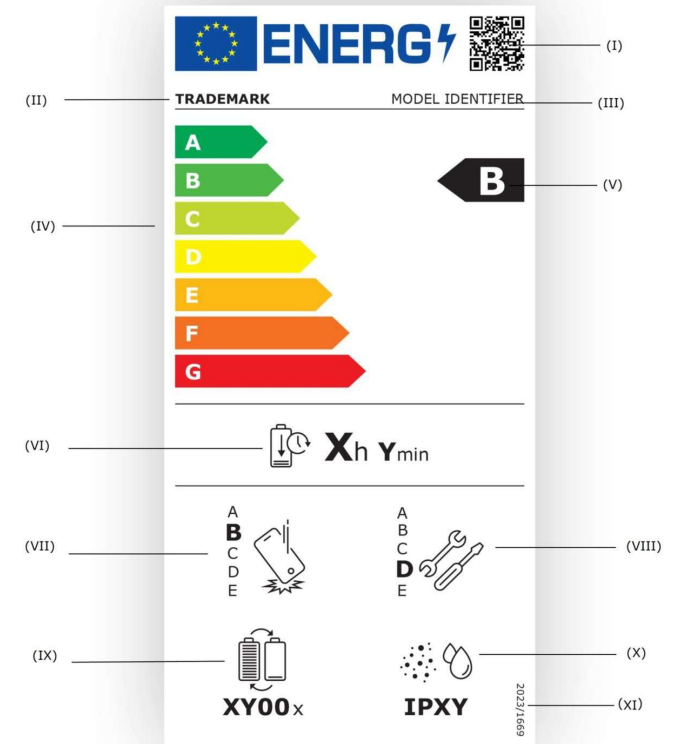
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Decarbonize Product Life Cycles beyond Energy Efficiency EU Ecodesign and Energy Label Policies for Smartphones, Tablets and Computers

Fraunhofer IZM, Karsten Schischke, David Sánchez, Sarah-Jane Baur, Jana Rückschloss

EU product policy trend

Going beyond energy efficiency

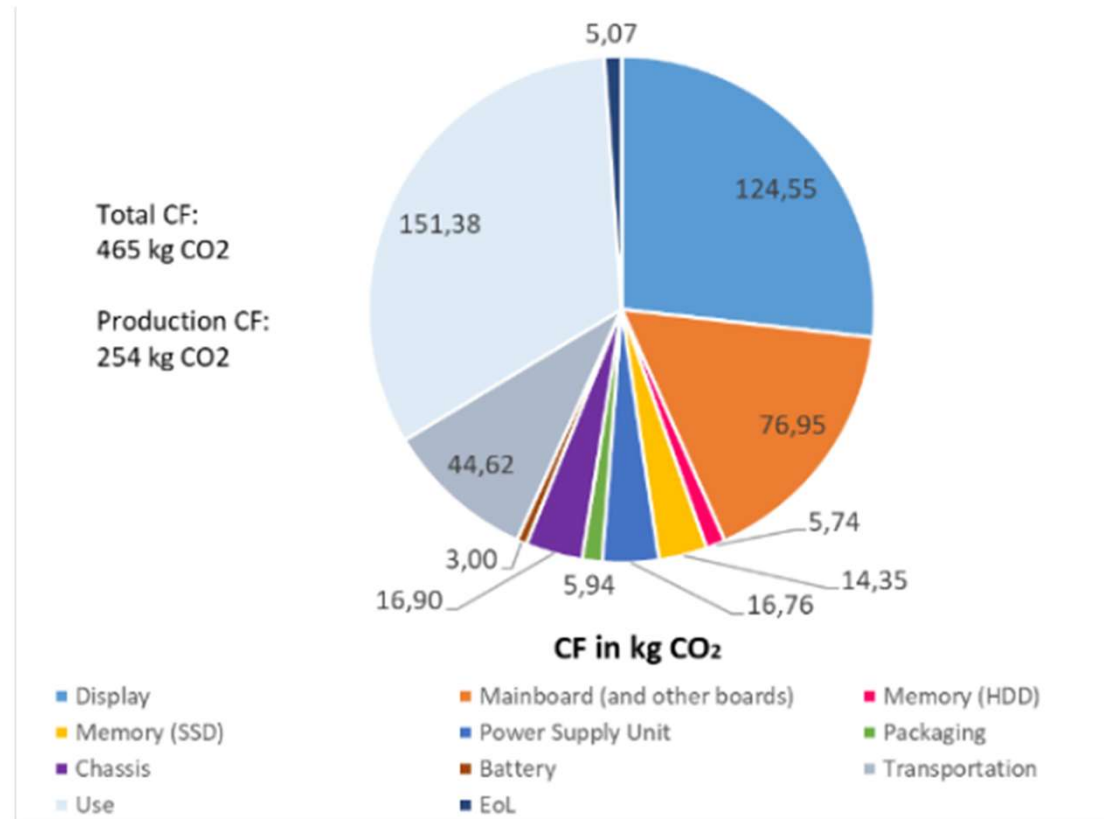


Why a focus on lifetime extension as decarbonization strategy?

ICT life cycle GHG emissions typically dominated by manufacturing



Carbon footprint of a typical integrated desktop computer ('All-in-one')



Why are products taken out of service when?

Lifetime data

Notebooks

- Priority parts (see EN 45554)
- Average service lifetime 5 years
- Average repair rate ~40% (but much higher in first years, much lower later on)
- Annual defect rates:
 - Drop/fall damage: 1%
 - Battery defects: 0,3%
 - Water/moisture damage: 0,2%

Relevance value		Failure likelihood		
		Low	Medium	High
Functional relevance	High	Mainboard	RAM*	Keyboard Display Battery Storage
	Medium	Touchpad Switch Power supply Fan	Connectors	
	Low			Housing

* typically an upgrade issue for memory / storage with a very low capacity

Why are products taken out of service when?

Lifetime model

The average service lifetime L is:

$$L = \sum_{t=1}^T S(t)$$

where $S(t)$ is the probability that a laptop is still functional at the end of year t .

For each year t , the survival probability is:

$$S(t) = \prod_{k=1}^t (1 - \omega(k))$$

where $\omega(t)$ is the total obsolescence rate in year k , representing the share of products facing end of service life for any reason.

Total obsolescence rate $\omega(t)$ in year t is calculated as follows:

$$\omega(t) = \left(\sum_{i=1}^n \lambda_i(t) \right) \times (1 - r(t)) + o(t)$$

whereas

- t : year index, $t=1, \dots, T$
- T : maximum observation horizon (here: 10 years)
- i : component index (e.g., in case of notebooks: battery, display, keyboard/trackpad, ports, fans)
- $\lambda_i(t)$: failure rate of component i in year t (e.g., “Battery ... 0.06”)
- $r(t)$: repair rate in year t (e.g., “repair rate ... 0.5”)
- $o(t)$: probability other obsolescence reasons in year t

The combined formula for the average service lifetime L , including the survival function and obsolescence rate calculation reads as follows:

$$L = \sum_{t=1}^T \left(\prod_{k=1}^t \left(1 - \left(\sum_{i=1}^n \lambda_i(k) \right) \times (1 - r(k)) + o(k) \right) \right)$$

Why are products taken out of service when?

Lifetime model

Priority parts

- defect rates per year

Repair rate

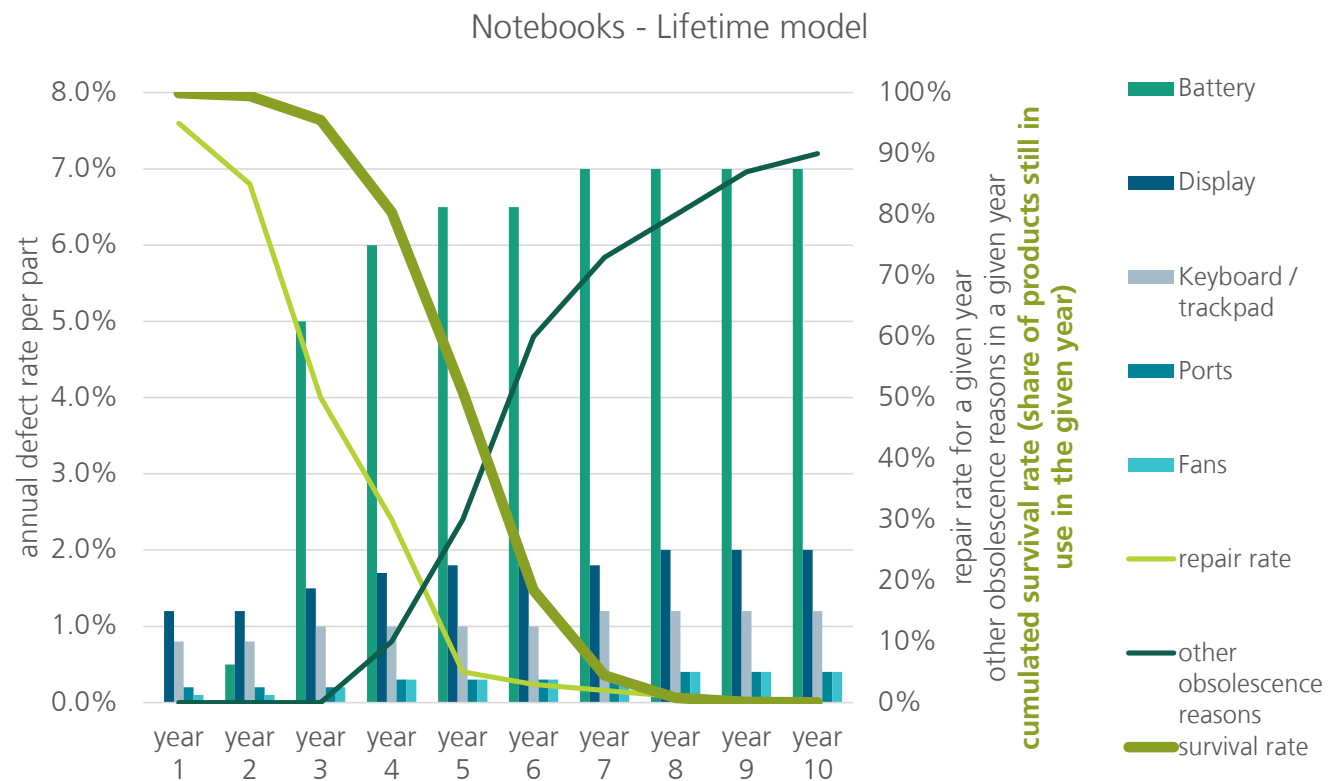
- decreasing over time

Other obsolescence reasons

- software, features

Survival rate

...determines average service lifetime



Modelled lifetime extension effect of policy measures

Lifetime related policy measures under consideration for computer products

	Notebook	Integrated Desktop Computer	(other) Desktop Computers
Ecodesign measures (minimum requirements)			
Reparability	+0.1 years	+0.11 years	+0.13 years
Resistance to accidental drops	+0.04 years	n/a	n/a
Water ingress protection	+0.01 years	n/a	n/a
Battery endurance	+0.05 years	n/a	n/a
Battery management	+0.03 years	n/a	n/a
Key abrasion resistance	+0.01 years	n/a	n/a
Operating System updates	+0.3 years	+0.31 years	+0.3 years
Energy Labelling measures			
Repairability Index	+0.1 years	n/a	n/a
Drop resistance classes	+0.04 years	n/a	n/a
Battery endurance indication	+0.05 years	n/a	n/a
Liquid ingress classes	+0.01 years	n/a	n/a

(preliminary data; does not include combination of options, which extends modelled lifetime further)

Modelled GHG emissions effect of policy measures

Lifetime related policy measures under consideration for computer products

Life Cycle GHG emissions per unit per year of use (kg CO₂e)

Policy Option / measure	Notebook	Integrated Desktop Computer	(other) Desktop Computers
1 Business as Usual (BAU)	55.57	99.03	86.13
2 Self-Regulatory Initiative (SRI)	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
3 Ecodesign			
Reparability	54.86	97.98	85.16
Resistance to accidental drops	55.20	99.03	86.13
Water ingress protection	55.48	99.03	86.13
Battery endurance	55.14	99.03	86.13
Battery management	55.31	99.03	86.13
Key abrasion resistance	55.48	99.03	86.13
Operating System updates	53.21	95.79	83.93
4 Energy Label			
Repairability Index	54.86	99.03	86.13
Drop resistance classes	55.20	99.03	86.13
Battery endurance indication	55.14	99.03	86.13
Liquid ingress classes	55.48	99.03	86.13

(preliminary data; does not include combination of options, which reduces carbon emissions further)

Conclusions

Lessons learnt and heads up

- **Limited impact of single measures** — many requirements (e.g., display replaceability, water ingress, drop resistance) affect only a small share of devices.
- **Combined measures drive meaningful lifetime extension** — durability, repairability, software support, and reduced obsolescence together create substantial lifetime gains and support decarbonization.
- **Delayed decarbonization** — lifetime extending requirements take effect with a delay of roughly one product cycle.
- **Shrinking sales intended** — lifetime extension comes with a positive GHG effect only, if production and sales volume shrink accordingly
- **Decarbonization takes effect elsewhere** — in case of ICT manufacturing is located largely outside the EU, therefore less products produced means less emissions generated in countries where production is located.

Contact

Karsten Schischke
Department Environmental and Reliability
Engineering
+49 30 464 03-156
karsten.schischke@izm.fraunhofer.de

Fraunhofer IZM Berlin
Gustav-Meyer-Allee 25
13355 Berlin
Germany
+49 30 46403-100

www.izm.fraunhofer.de

Fraunhofer IZM-ASSID
Ringstraße 12
01468 Dresden-Moritzburg
Germany
+49 351 795572-12

Fraunhofer IZM Außenstelle Cottbus
Karl-Marx-Straße 69
03044 Cottbus
Germany
+49 355 383 770-12



Fraunhofer Institute for Reliability
and Microintegration IZM