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Adtran

Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist.

Kenneth E. Boulding, 1910-1993, English-born American economist, educator, interdisciplinary philosopher, and inventor of the Circular Economy concept

Ökobilanzierung von IKT-Systemen

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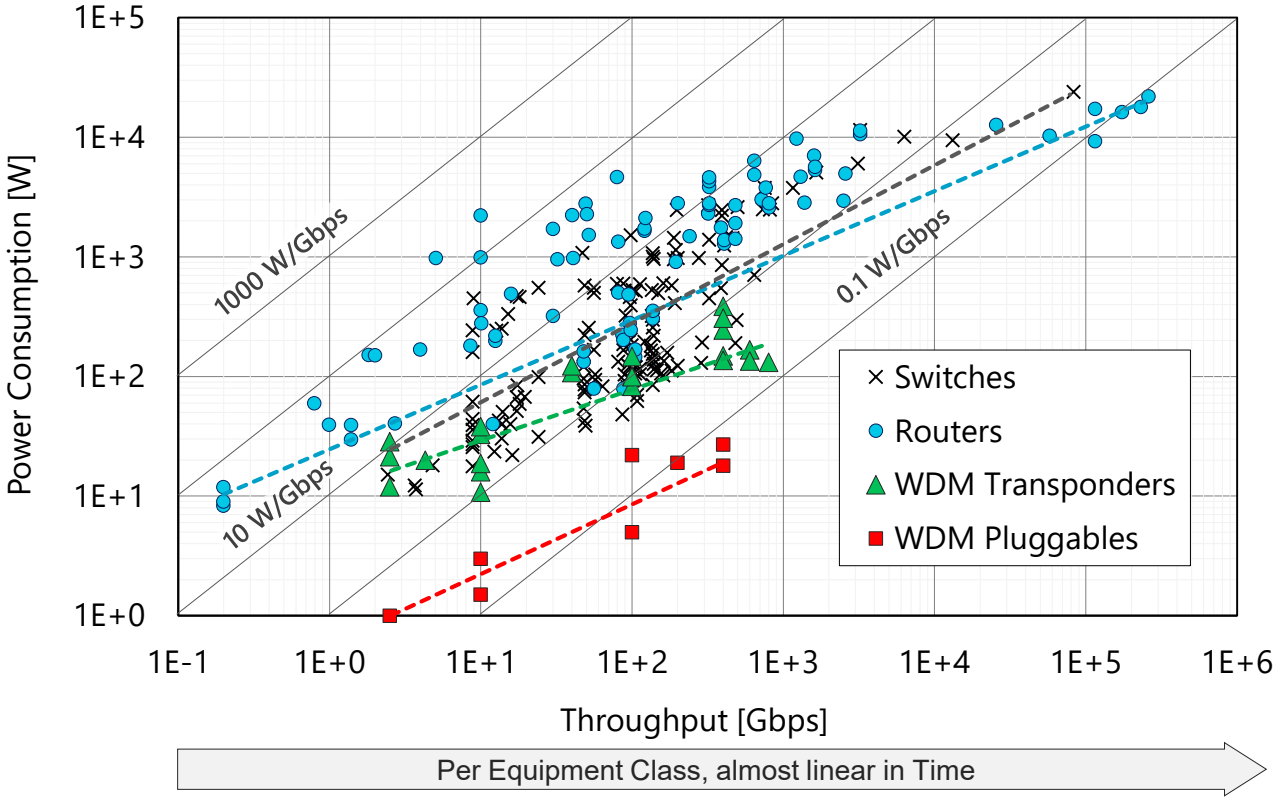
Content

- ICT environmental-impact overview
- ICT LCAs…
- Conclusions

ICT environmental-impact overview

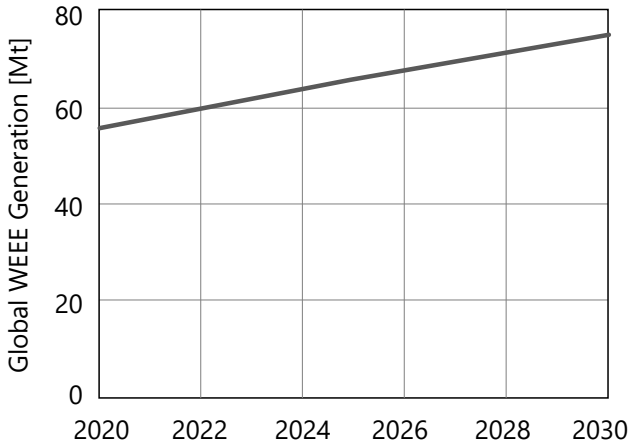
ICT and power consumption



- Following Internet bandwidth increase, *router, switch and WDM power consumption is exponentially increasing*
- *Energy efficiency increase cannot cope with bitrate increase – and is saturating*
- Different for end-user equipment (e.g., laptops)

[H. Mellah, B. Sansò, June 2011, DOI: 10.1109/WoWMoM.2011.5986484], [Vereecken et al., IEEE COMMAG, Vol. 49, No. 6, 2011], [Tucker et al., ECOC 2008, based on METI, 2006, Nordman, 2007], [ADVA research and specifications]

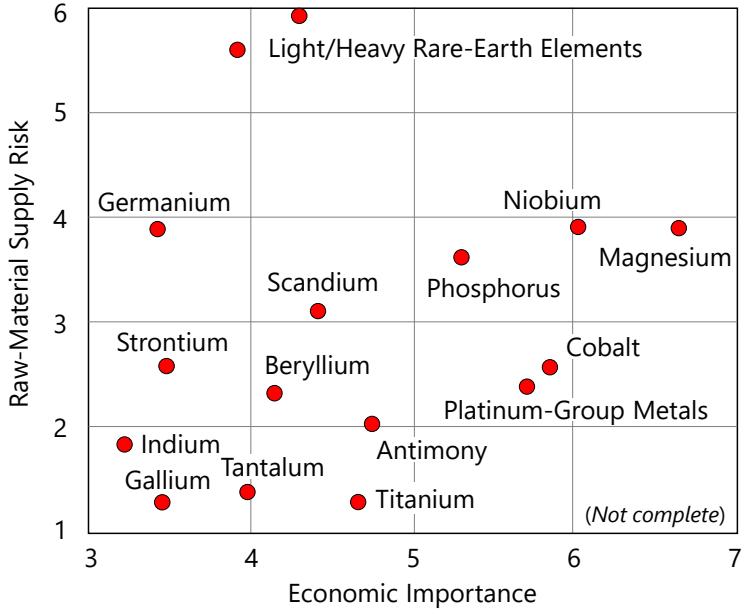
ICT and circular economy



EEE reuse and WEEE recycling are limited

- Very complex material compounds
- Functional obsolescence

(W)EEE: (Waste) Electronic and Electrical Equipment



ICT requires and consumes critical raw material

[O.S. Shittu, I.D. Williams, P.J. Shaw, Waste Management, Vol. 120, Feb. 2021, pp. 549-563, https://doi.org/10.1016/j.wasman.2020.10.016]
[Study on the EU's list of Critical Raw Materials (2020) Final Report, Technical Report, September 2020, DOI: 10.2873/11619]

ICT LCAs…

ICT lifecycle assessments (LCA)

Cradle-to-grave approach to quantization of environmental impact

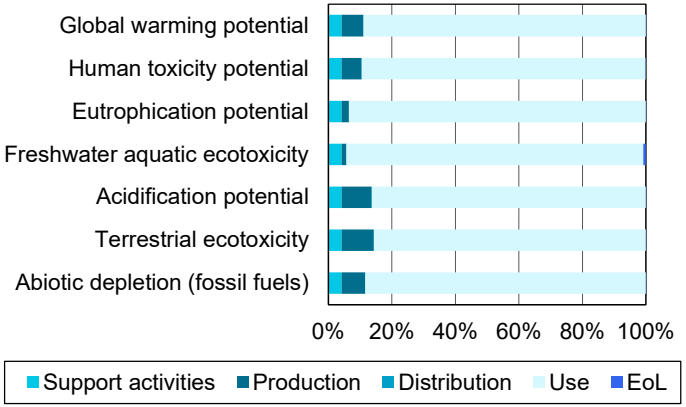
Support activities	• Own (R&D etc.) efforts, admin, business travel etc. • Reflects the share of relevant GHGP Scope 1, 2 and 3 activities
Production	• Raw material extraction and processing, inbound transport plus manufacturing of equipment • LCA data bases (EcoInvent, GaBi, et.), supplier data (e.g., for ASICs), own assessments / specifications
Distribution	• Transportation modes (air, water, land) and distances • Packaging (adds <3% for ICT equipment, in general up to 10%)
Use	• Lifetime (e.g., 8 years), operation mode / utilization • Region, where the equipment is powered by which electricity mix (e.g., grid mix, 100% renewables)
End of life	• Collection (reverse logistics) and sorting, disassembly and recycling (WEEE must not be landfilled) • Reuse etc. lead to Cradle-to-Cradle approach (has its own challenges…)

See, e.g., [ETSI TS 103 199, Life Cycle Assessment (LCA) of ICT equipment, networks and services. General methodology and common requirements]

LCA example: XGS-PON OLT

Life cycle phase	Explanation
Support activities	Estimation of Adtran's R&D efforts, admin, business travel etc. They are allocated based on the emissions generated during the use of product assuming average effort per development of each product in terms of GWP.
Production	Raw material extraction and processing, inbound transport plus production of equipment
Distribution	Final products are transported by lorry, 3.5-7.5 metric ton EURO 5, (300 km) and by freight aircraft (900 km)
Use	Use in Europe: constant emission factor of electricity grid mix - 0.347 $kgCO_2e/kWh$; operating lifetime - 10 years, operating modus - 24/7
End of life	Proper collection and recycling of WEEE

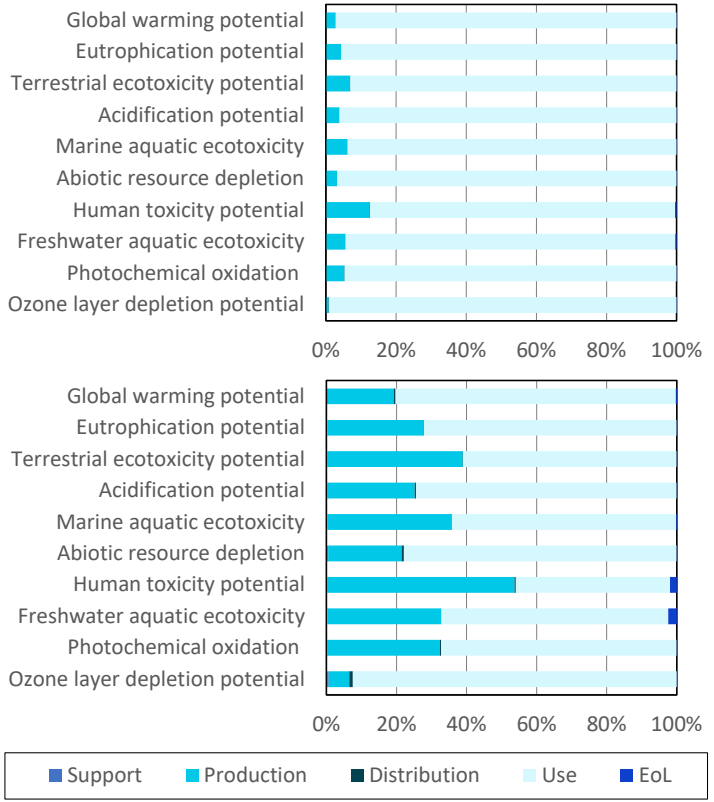
Life cycle inventory (LCI) and global warming potential (GWP)				
Support activities	**Input**		**GWP [kg CO_2e]**	**Details**
	Relevant Scope 1, 2 and 3 categories		356	
Production	**Material**	**Weight [kg]**	**GWP [kg CO_2e]**	**Details**
	Steel	2,29	5,56	
	Aluminum	0,497	3,54	
	PCBA	1,57	571	Printed circuit board assembly
	Other	0,240	19,9	
Distribution	**Weight [kg]**	**Distance [km]**	**GWP [kg CO_2e]**	**Details**
	4,6	300	0,70	Freight truck
	4,6	900	4,10	Freight aircraft
Use	**Power consumption [W]**	**Total energy usage [MWh]**	**GWP [kg CO_2e]**	**Details**
	253	22,2	7696	10 years, 24/7
End of life	**Material**	**Weight [%]**	**GWP [kg CO_2e]**	**Details**
	Metal	65%	0,310	Recycled content approach (100/0)
	Printed circuit board	27%	0,043	
	Plastic	2,1%	0,303	
	Other	5,7%	0,357	



- *OLTs show strong use-phase dominance in their LCA*
- *Independent of specific product line*
- *For, e.g., smart phones, the LCA is dominated by production*

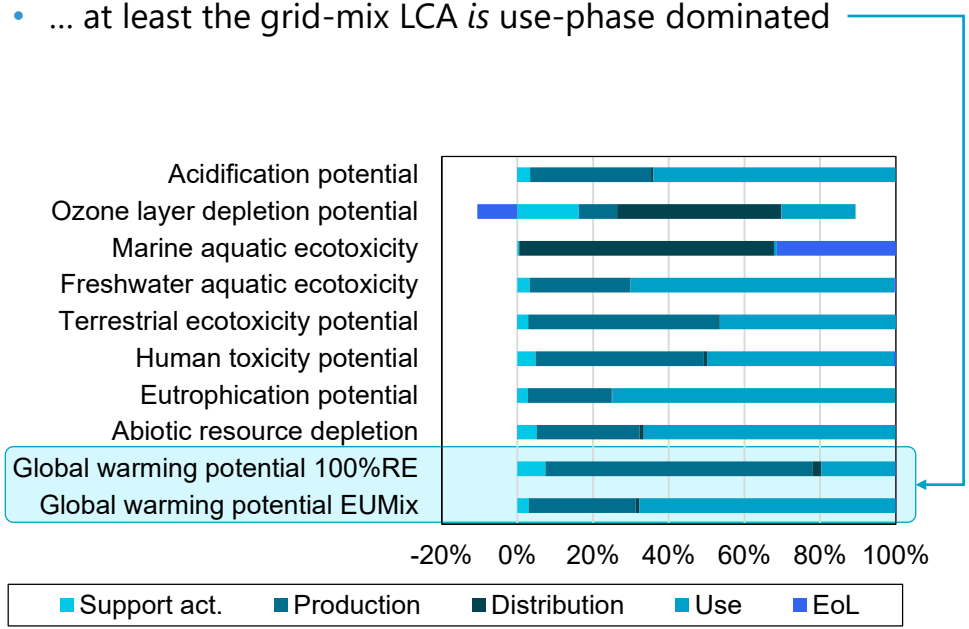
Infrastructure-ICT coherent WDM transport equipment

- Again, this type of equipment is use-phase-dominated
- LCAs depend on type of electricity used in use phase!
- The emission factors, especially for grid-mix electricity, are quickly evolving (i.e., time-dependent)
- The grid-mix analysis (top diagram) used emission factors from 2018/2019, it would look slightly different today already
- ***How to keep large sets of LCAs up-to-date?*** (e.g., for complete portfolios)
- Similar for the production part (we recently saw a significant change with a DB update…)



Another ICT example (an OTDR…)

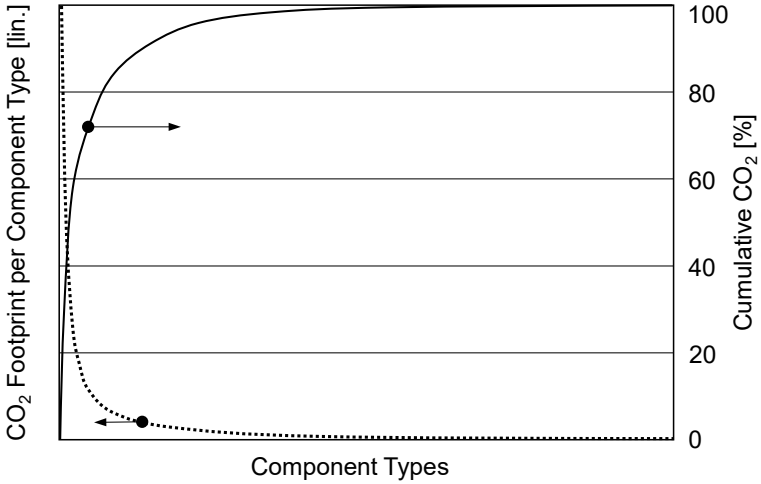
- This OTDR has use mode like WDM equipment or PON OLTs (24/7 always on)
- **Question remains whether to extend lifetime (second life, etc.) or not, since** …
- … at least the grid-mix LCA *is* use-phase dominated



More LCA challenges…

ICT LCA ***is*** challenging

- Complexity
  - BoMs can range up into 10,000s of components
  - Complexity of individual electronic / photonic modules
- Data availability and precision
  - Not all components listed in DBs
  - Need dimensions, weight, material, node size, …
  - Significant uncertainty for dominating components – ASICs



- Usage in complex networks not considered by LCA so far (layer interdependencies, resulting utilization, etc.) – *it is doubtful that this would make sense*
- Without further assessment, LCA does not yet give unambiguous ecodesign guidance

Conclusions

Conclusions

- Environmental impact of ICT equipment given by energy and raw-material consumption
- For certain ICT equipment, environmental impact is dominated by the use phase
- It remains unclear from LCA if devices should be replaced for energy-efficiency reasons
  - The indicator L.UPR_{10} can be used to answer this question (ITU-T Q7/5)
  - See my other talk…
- LCA of ICT equipment has its challenges
  - Complexity of the individual LCA (large BoMs, complex components, questionable data, …)
  - Currentness of large LCA sets with evolving emission factors

Thank you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