

CONNECTED DEVICES AND RELATED SERVICES ENVIRONMENTAL IMPACTS

Order of magnitude and methodological
recommendations



Introduction

Introduction

1. BIBLIOGRAPHY

Perform an international state-of-the-art bibliography regarding connected devices LCA

Identify, classify and analyze published studies, and perform a cartography of covered devices and sectors

2. ANALYSES AND SPECIFICITIES FOR THE LCA METHODOLOGY

Perform the detailed analysis of a restrained number of the most relevant publications to identify characteristics, strong and weak points, and define if they can be considered as reference studies

3. RECOMMANDATIONS

Improve practices related to LCA of digital services:

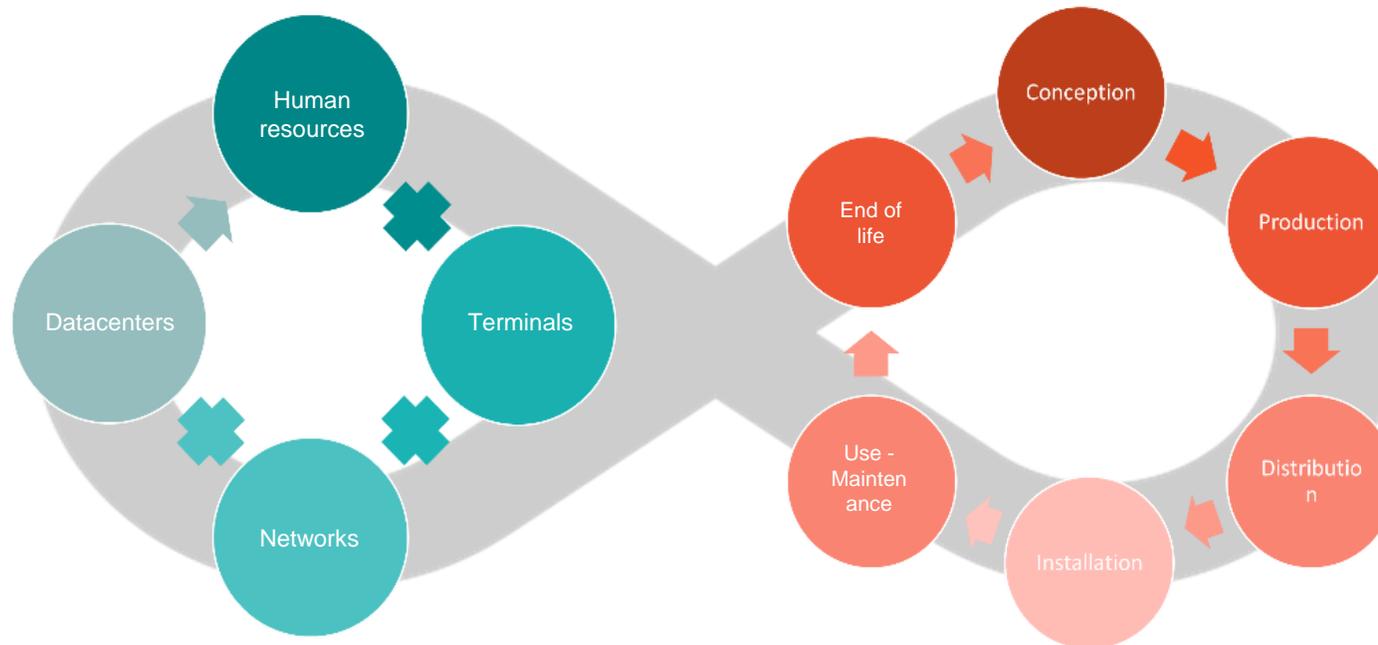
- Provide recommendations
- Identify robust data to be used
- Discuss around related issues

Surveillance

Follow the new evolution on knowledge and know-how along the project

Introduction

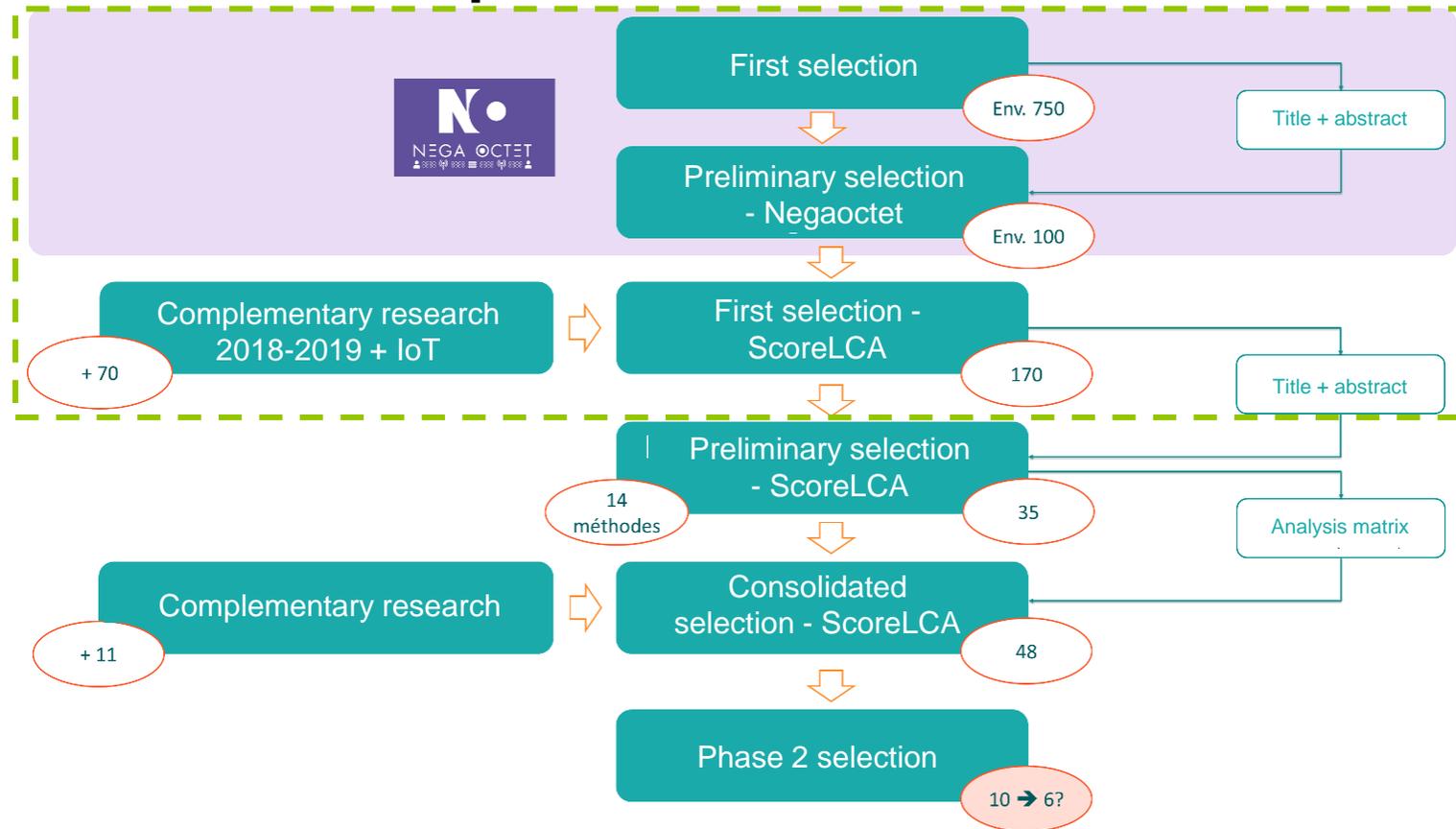
- ❑ **Digital service** : Definition from the *Alliance GreenIT* : « A digital service is constituted of a set of software, hardware, networks, infrastructures, and other digital services. It fulfill a functional unit such as « book a train ticket », « send an e-mail to friends », etc. »



Phase 1 – Bibliography

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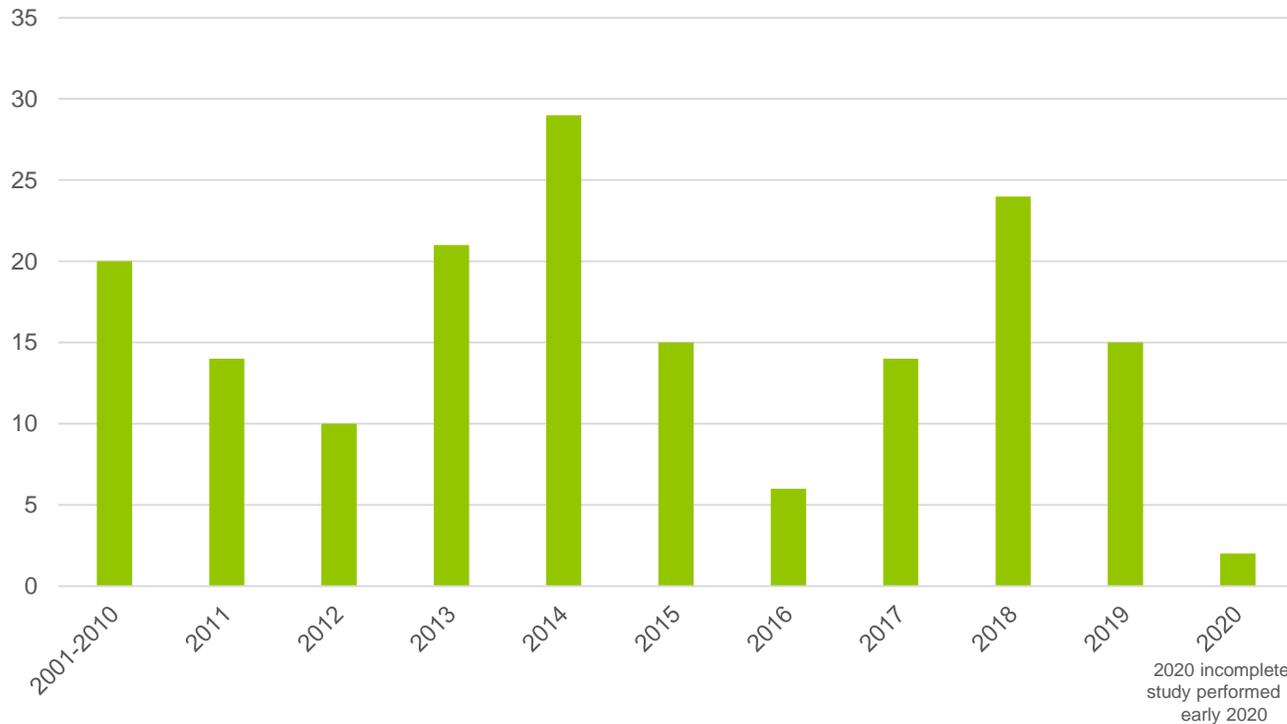
Publication selection process



Phase 1 – Bibliography

Temporal and type of publication repartition

Temporal repartition of publications



Conference Paper – Editorial	2	1%
Book	1	1%
White paper	3	2%
Method - Standard – Reference document - PCR	14	8%
Tool	6	4%
Publication	132	77%
Publication – Document review	3	2%
Private publication	2	1%
CSR report	1	1%
Thesis	6	4%
Student project	1	1%

- ✓ Many publications, but inconsistent temporal repartition
- ✓ Weak number of publication in recent years despite a growing interest from the public and governments → latency?

Phase 1 – Bibliography

Type of studies

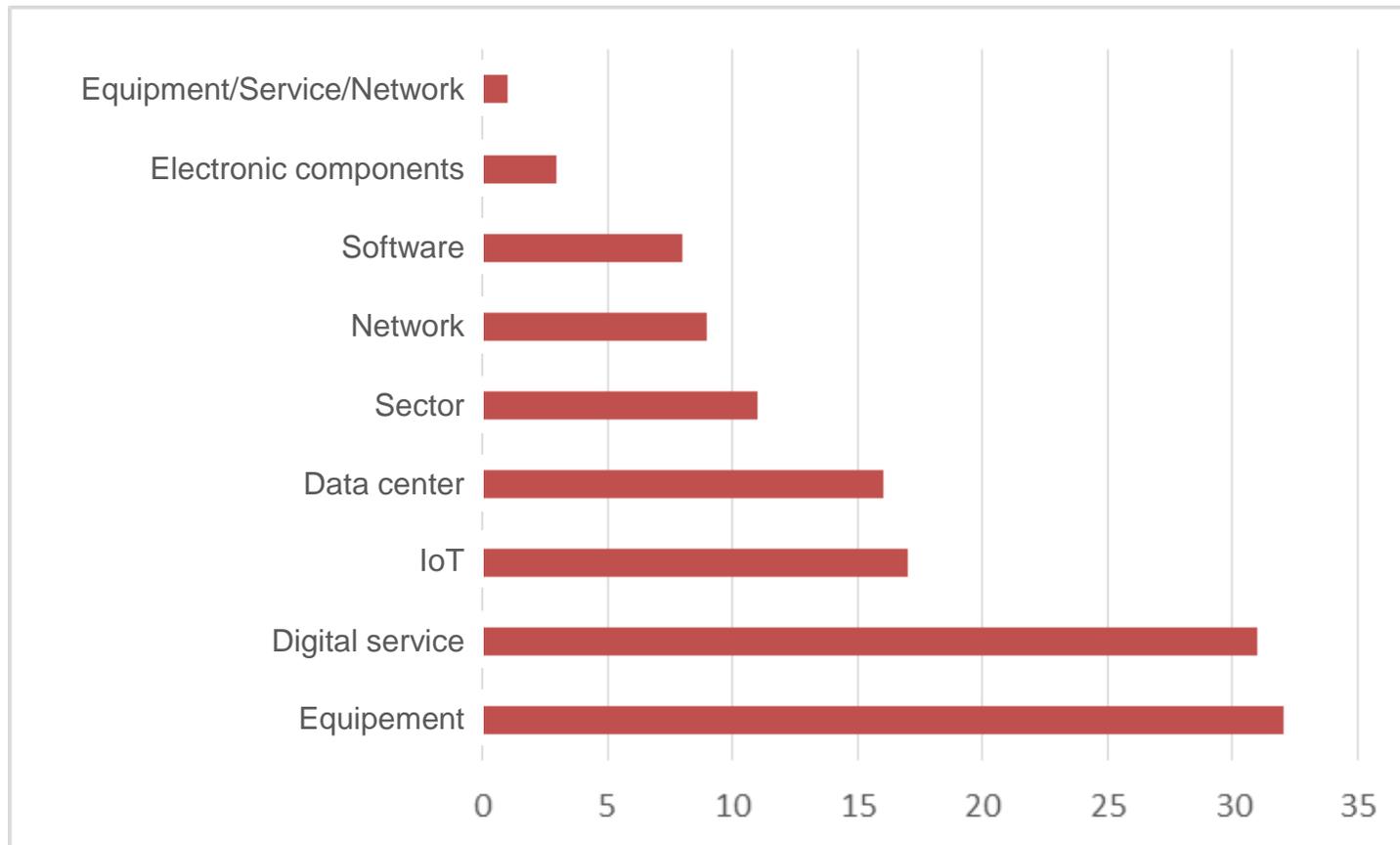
	Nombre de Titre
Technical documentation	8
Survey	2
Environmental study	93
Qualitative method	6
Monocriteria – Carbon footprint	16
Monocriteria– Energy	12
Multicriteria – LCA	46
Multicriteria – Simplified LCA	4
Multicriteria – Energy/Carbon	8
Multicriteria – Energy/resources	2
Preliminary study	4
Method	5
Tool	4
Prospective/Trajectory	10
Good practices	2

✓ Many studies are LCA or mono/bi criteria

✓ LCA is the most recognized method, even by monocriteria studies that highlight a lack of resources

✓ There is a non-negligible number of prospective studies

Phase 1 – Bibliography Families

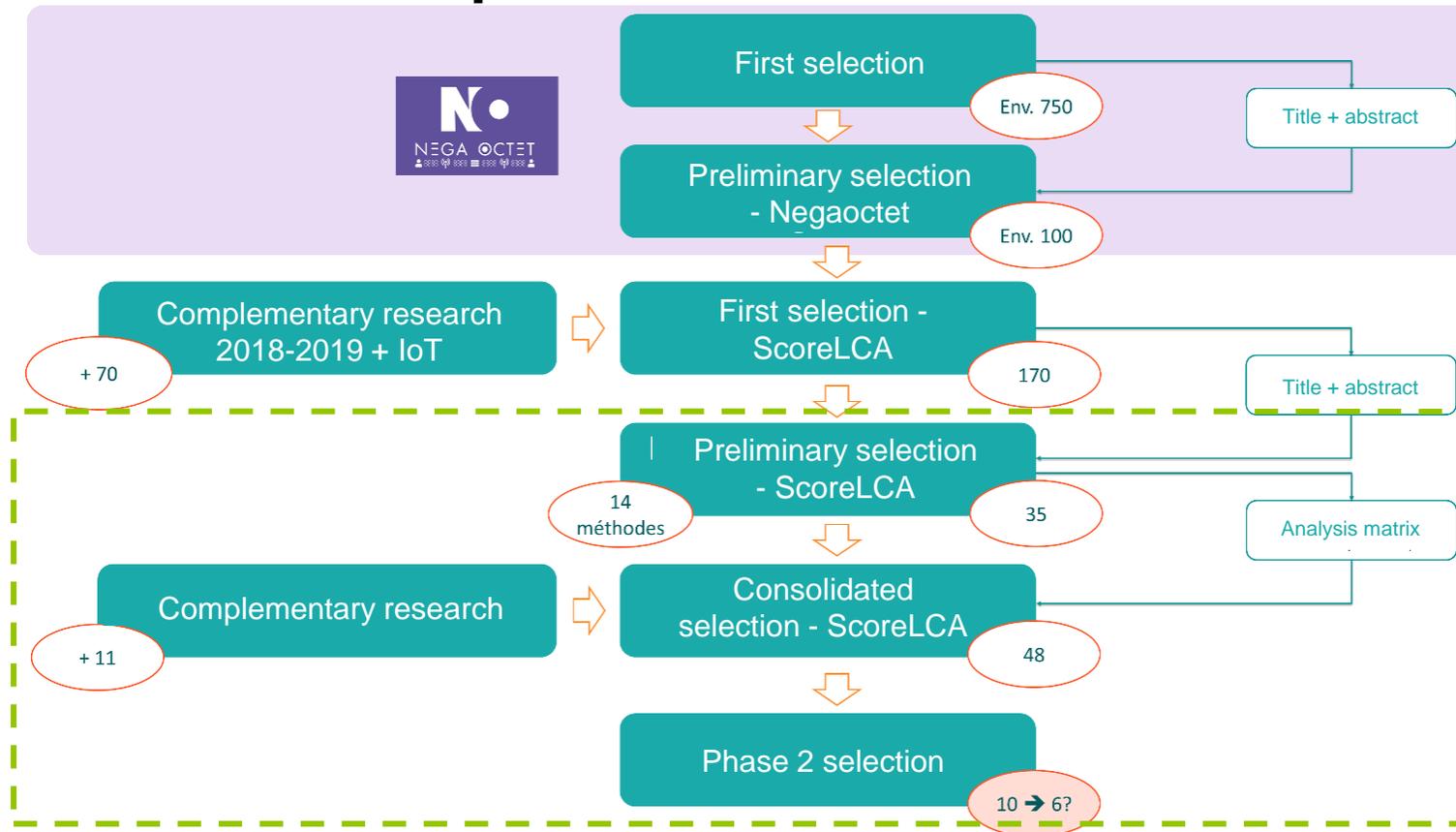


- ✓ Equipment is the most studied family
- ✓ Globally, studies are based on a specific family rather than on a whole digital service

Phase 2 – Detailed analyses

Phase 2 – Detailed analyses

Publication selection process



Phase 2 – Detailed analyses

4 series of documents:

- Digital services equipment LCA studies
 - How to deal with data heterogeneity in the context of digital services LCA?
- Digital services LCA studies
 - ISO 14040-44: do existing studies conform to the standards? If not, what is the explanation for the difference, and how to learn from that?
- Online video
 - How the fast technological evolution can modify results and interpretation, and how to take that into account?
- Indirect impacts
 - Consideration of digital services indirect impacts

Phase 3 – Recommendations



Phase 3 – Recommendations

Recommended data

- Data on digital services, globally (LCA of digital services)
- Data on equipment used for digital services (databases)
- Technical data on equipment used for digital services within organizations (collection data)

Characterization and details on the existing and in development sources

Phase 3 – Recommendations

Data on digital services, globally	Data on equipment used for digital services	Technical data on equipment used for digital services within organizations
GreenIT.fr studies	Manufacturers data	CMDB
The Shift Project – 1byte model	EIME	Datasheets
The Shift Project studies	Ecodiag	BOAVIZTA method
Négaocet studies	Environmental declaration programs – PEP ecopassport®	
ADEME-ARCEP studies	ADEME studies	
	Négaocet	
	PAIA	
	GaBi	
	Base Impacts	
	PEF/OEF database	

Phase 3 – Recommendations

Reference flow

- The reference flow concept is complex to adapt to digital service LCA. Additional information must be taken into account.

Recommendation

- Three steps to define goods related to the service:
 - Determination of the workflow: details all operations necessary to fulfill the functional unit
 - Determination of the functional diagram: detail all the digital service constitutive elements, following a user's perspective. It includes all tiers of a service and details the different use scenarios. Its granularity must be adapted to the objectives.
 - Determination of the flow diagram: the functional diagram is completed with the step by step progression of all actions occurring during the use

Phase 3 – Recommendations

Indirect impacts (1/2)

- Indirect impacts accounting is crucial. The order of magnitude is not well known today, but several studies consider it greater than direct effects (both positive and negative)
- Difficult to quantify with constrained resources and time for most LCA practitioners
- Require experts from various domains (economists, sociologists, etc.)
- Creates a strong uncertainty due to their estimated characteristic, particularly so in such a fast-evolving sector
- It is possible to identify and categorize them. The most extensive classification is the study *Nathaniel C Horner et al 2016 Environ. Res. Lett. 11 103001 ; Known unknowns: indirect energy effects of information and communication technology ; 2016*

Phase 3 – Recommendations

Indirect impacts (2/2)

Recommendation

- Indirect impacts should be identified and categorized. The classification can be as follow:
 - Efficiency: positive effect, reduction of resources used due to optimizations thanks to the service
 - Substitution: positive or negative effect, replacement of an existing service by another
 - Direct rebound effect: negative effect, increase of the service consumption due to its cost reduction or increased easiness
 - Indirect rebound effect: negative effect, increase of other services consumption due to saving caused by the reduction of the service cost
 - Structural economic changes: positive or negative effect, macroeconomic modifications related to the introduction of the new service, and the adjustment of existing services
 - Systemic transformation: positive or negative effect, changes in human behavior and economic and social institutions
- Moreover, it is recommended to identify which economic or business sectors are positively or negatively impacted by indirect impacts

Phase 3 – Recommendations

Possession and use environmental costs

- Compared to classic services, there often is a transfer of impact from the production, distribution, installation and end of life phases to the use phase
- It creates a modification of impact causes, from a possession cost to a use cost

Recommendation

- When identifying ecodesign measures, identify impacts due to possession and those due to use, including the life cycle of network and datacenter equipment

Phase 3 – Recommendations

Average and marginal environmental costs (1/2)

- Digital services generally share equipment with other services. Those equipment sometimes are produced even if the studied service is not provided
 - Example: an e-mail service use terminals, but is not the direct cause of their production. They would have been produced anyway.
- Two visions:
 - Average cost calculation: common LCA calculation: impacts related to the production are allocated to the service
 - Marginal cost calculation: cost linked to the increase of environmental impacts related to the service, compared to the previous situation. Excludes the production of equipment already in use
- In the case of marginal cost calculation, an equipment can have both impacts associated with the service (electricity consumption in active mode), and others not (fabrication, electricity consumption in stand-by)

Phase 3 – Recommendations

Average and marginal environmental costs (2/2)

- Responsibility for the impacts and ecodesign levers:
 - If the equipment is not installed previously to the service or if it is integrally dedicated to it, marginal and average cost conflate
 - Ecodesign lever: try to reduce the need for new equipment (reduction, mutualization, second-hand, etc.)
 - If the equipment is installed and not integrally dedicated to the service, the practitioner must decide if they calculate either the marginal or the average impacts. If possible, both view are interesting
 - Ecodesign lever: optimize the service to limit the use of bandwidth, calculation or stock resources in order to reduce the electricity consumption and limit the equipment's obsolescence

Recommendation

- Do both to identify additional levers when performing LCA for ecodesigning

Open issues

Open issues

- Some evolutions of digital services and the global context can be anticipated
- In order to allow the current works durability, those evolution must be known and controlled
- This part lists some focal points, and workarounds

Open issues

Digital services distribution level

- Digital services are more and more distributed
 - From a software installed on an isolated equipment (*on premise*), towards a global interconnection through networks
- This trend will increase in the coming years
 - Increase of cloud-based solutions: SaaS (*software as a service*), PaaS (*platform as a service*), and IaaS (*infrastructure as a service*)
- Increased interlocking of digital services
 - A digital service can use other digital services, often managed by third parties
- Global impacts are increasingly difficult to assess

Workaround: LCA on existing services must be performed and communicated in a transparent way → Creation of a digital services LCI or UPR database

Open issues

Electric and electronic equipment end of life

- Restrictive regulation BUT most WEEE are not treated in regulated sectors (~70%). It creates environmental, social and sanitary impacts and lose precious resources
- It is hard to assess unregulated sectors due to lack of data
- Focus on connected devices
 - →The proportion and volume of related WEEE will increase
 - →Many of which will end up mixed with other sectors wastes, in a weak proportion, and will be difficult to treat correctly. In addition, it could make recycling of other products more difficult

Workaround: Regulation reinforcement to have a better knowledge of WEEE flows, control and reduce them, in relation with the increase of connected devices. Improvement of dismantling to separate easily electronic parts from the rest. Increase the awareness of the public and institutions

Open issues

Technology leap

- Important functional and technological leaps (cathodic to LCD screens, classic phone to smartphone, etc.)
- An environmental evaluation can be precise only with hindsight, after the technology has been deployed, because of:
 - The modification of collection and LCI data necessary
 - Trade secrets surrounding new technologies
 - Latency of LCI database creation compared to new technologies developments

Workaround: increase transparency and communication around new technologies environmental impacts. At LCIA if necessary

Thank you for your attention

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