ICTFOOTPRINT.EU

European Framework Initiative for Energy & Environmental Efficiency in the ICT Sector

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List of Acronyms and Abbreviations

List of acronyms & abbreviations	
EAG	External Advisory Group
EC	European Commission
ETSI	European Telecommunications Standards Institute
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
ITU	International Telecommunication Union
LCA	Life Cycle Analysis
SAT	Self-Assessment Tool
SAT-O	Self-Assessment Tool for an ICT-intensive Organisation
SAT-S	Self-Assessment Tool for an ICT Service
SDO	Standard Development Organisation
SME	Small Medium Enterprise

List of organisations interviewed

Carbon3IT Ltd - https://www.carbon3it.com/

Circular Computing - http://www.circularcomputing.com/

ecoinvent - http://www.ecoinvent.org/

Escan - http://www.escansa.com

Green IT Amsterdam - http://www.greenitamsterdam.nl/

Greengage IT – https://www.greengageit.co.uk/

Operational Intelligence - http://dc-oi.com/

PRe sustainability - https://www.pre-sustainability.com/

A total of 30 organisations were contacted in the context of the deliverable. Phone interviews were conducted with 6 stakeholders; information was gathered by email exchange with 2 others during the month of August 2017. Questions related to the uptake of methodologies by the organisations and their potential clients; the main barriers and levers they identified to the implementation of ICT methodologies, based on their experience, their clients' experience or on their insight of the sector. All interviewees mentioned barriers related to the complexity of methodologies, the ICT sector or the type of structure. The material gathered from the interviews complemented the desk search previously undertaken for the development of section 3.

Executive Summary

Numerous methodologies, whether ICT specific or applicable to ICT systems, were developed in the past years and have been identified in the scope of the project (see map of methodologies available on ICTFOOTPRINT.eu platform). Each of them describes the given applications and potential benefits – some examples of tangible benefits may as well be found among the success stories showcased online.

However most local authorities and companies in the ICT sector are facing difficulties which may prevent them from adopting the methodologies, and more globally from taking into consideration environmental aspects. Literature review as well as feedback gathered from ICT stakeholders (through surveys, during events as well as phone interviews) allowed for the identification of the main barriers, gathered in this deliverable in distinct categories, depending on whether the barriers relate to the inherent complexity of life cycle approaches, to the ICT sector, or to the type of structure (e.g. SMEs, local authorities).

General findings gathered during the first year and half of ICTFOOTPRINT.eu indicate that the perceived benefits from “ICT for green” approaches (e.g. digitalisation of services in sectors others than the ICT sector) are widely recognised among stakeholders, whereas the advantages related to “green ICT” (i.e. ICT with optimised performance / reduced environmental footprint) would strongly benefit from larger awareness raising. Wider implementation of the methodologies among ICT stakeholders cannot be expected without a better understanding of the related benefits and advantages on “green ICT”.

Among the levers currently identified to encourage implementation of methodologies, several of them appear to be in scope of ICTFOOTPRINT.eu. Raising awareness among ICT stakeholders is a key aspect of the project, notably through webinars, factsheets on the methodologies, as well as simplified assessment tools (SAT-S was released recently, SAT-O will be released in the coming months). Another contribution from ICTFOOTPRINT.eu aims at improving relations and communication between stakeholders of the sector, e.g. through the marketplace as well as success stories showcased online.

The materials and services provided by ICTFOOTPRINT.eu evolve during the three years of the project, in order to adapt to the users’ identified needs. This is why it is important for ICTFOOTPRINT.eu to receive feedback from stakeholders on the relevance and applicability of existing services as well as on how they believe the ICT sector would benefit from such an initiative.

In this regard, the deliverable is a first iteration of an ongoing work, and will be updated during the second half of the project based on additional feedback. The report is divided into three main sections, the first outlines the introduction, purpose and scope. The second section details the uptake of the methodologies in the scope of the project. The third section details the main barriers for uptake and it concludes with some existing and potential levers. The content and material gathered during the three years of the project will contribute to deliver concrete recommendations to Member States to reduce/remove these barriers, to be included in the final deliverable D3.4, to be delivered on M36.

1 Introduction

1.1 Purpose and Scope

The ICT sector is estimated to contribute for 8-10% of the European electricity consumption and 4% of its greenhouse gases (GHG) emissions – with numbers expected to grow rapidly in the coming years. Although the above estimates are generally acknowledged, and although multiple methodologies specific to the ICT sector are now available to assess the environmental footprint of ICT products and organisations, few companies in the sector and local authorities currently implement environmental methodologies or best practices, e.g. when defining their strategy or developing a new product.

This deliverable aims at providing some insight on the perception and implementation of existing environmental footprint methodologies in the ICT sector, and identifying the main barriers to their implementation by ICT stakeholders, with a particular focus on SMEs and cities. The content will be introduced by a clear and synthetic view of the existing environmental footprint methodologies specific to the ICT sector.

The analysis provided in the deliverable is based on literature review and feedback gathered at the events organised in WP4, complemented with content from interviews with EAG members and additional ICT stakeholders (please refer to the table of content for the list of organisations interviewed).

1.2 Structure of the document

The document is structured as follow:

Section Errore. L'origine riferimento non è stata trovata., this section, introduces the deliverable and contextualises it in the framework of the ICTFOOTPRINT.eu project.

Section 2 provides a summary of the recent evolutions of footprint methodologies specific to the ICT sector and presents an insight on the uptake of these methodologies by the sector.

Section Main barriers to implementing environmental methodologies in the ICT sector**3** focuses on the main barriers to the implementation of environmental methodologies, whether they relate to the type of structure (e.g. large organisation, SME, local authority), the ICT sector or the methodologies themselves.

Section 4 draws some conclusions and sets the next steps.

1.3 Relationship to other project outcomes

The deliverable is part of WP3 which focuses on stakeholder engagement, from the identification of relevant stakeholders to the definition of a Policy Action Plan to the EU Member States to raise awareness on the needs, challenges and opportunities related to ICT sustainability and carbon footprint.

In this regard, the deliverable is a first iteration of an ongoing work on the identification of the main barriers and levers to the implementation of ICT footprint methodologies by the sector. During the second half of the project, further feedback will be gathered from users of the various tools and materials available on the ICTFOOTPRINT.eu platform among which: self-assessment tools (SAT-S and SAT-O), marketplace, webinars, and methodology factsheets. Based on that feedback, the content of the deliverable will be updated and the most relevant data will be disseminated through the ICTFOOTPRINT.eu online platform.

Although the present deliverable refers to ICT methodologies, no technical content is provided – references to deliverable D2.1 Description & characterisation of the methodologies selected within the scope of ICTFOOTPRINT.eu are provided in that respect.

The information gathered in the deliverable D3.2 will also support the definition of the Policy Action Plan and can therefore be considered as a preliminary version of deliverable D4.2 Policy Action Plan and ICTFOOTPRINT.eu sustainability roadmap, due at the end of the project.

2 Methodologies in the ICT sector

Various methodologies have been developed in the past years to assess the environmental impact or performance indicators of products and organisations in the ICT sector. ICTFOOTPRINT.eu has the objective to raise awareness on methodologies and best practices in measuring the energy and environmental efficiency of the ICT sector with a sufficient level of reliability. In the scope of the project, a methodology is understood as a framework of technical rules to be followed in order to define and assess a specified (group of) indicator(s). There is a clear distinction between methodologies used to assess environmental impacts (so called life cycle or “footprint" methodologies) or performance indicators (“KPI” methodologies). Further information on terminology, selection and description of the methodologies may be found in deliverable D2.1 Description & characterisation of the methodologies selected within the scope of ICTFOOTPRINT.eu.

In addition, selected methodologies are displayed on a map available on the project platform (see also Figure 1). The aim of the map is to provide a clear and up-to-date overview of existing methodologies specific to the ICT sector, based on feedback from EAG members and a continuous market watch. An insight on the main technical characteristics and main uses is provided on the platform as a factsheet for each of the displayed methodologies (by clicking on each box of the map online) with the aim of facilitating comprehension among practitioners.

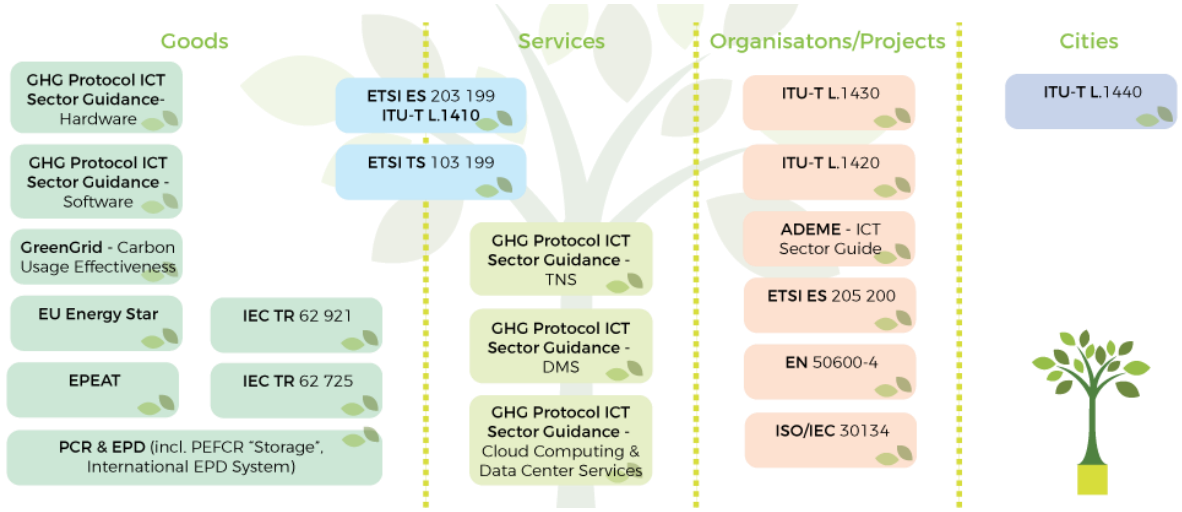

Figure 1: ICTFOOTPRINT.eu map of ICT methodologies

The section quickly presents the recent evolutions of ICT methodologies before providing a first analysis of the uptake of ICT methodologies in the sector.

2.1 Recent evolutions of ICT methodologies

Since the first selection of methodologies for the project in 2016, a new methodology specific to the ICT sector was developed by CENELEC. The EN 50600 relates to datacentre facilities and infrastructures. In particular, EN 50600-4 [1] provides requirements and recommendations for key performance indicators (KPIs) used to assess and improve the resource usage efficiency and effectiveness of a data centre: the Power Usage Effectiveness (PUE), commonly used in that respect; and a Renewable Energy Factor, providing a metric of electricity used in a datacentre from a renewable energy source.

The GHG Protocol released in July 2017 the final version of the ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard [2]. The consortium, through its liaison with the GHG Protocol interface in the US, together with Andie Stephens of Carbon Trust, as an EAG member of the project, managed to obtain this information in advance and carried out a dedicated webinar on the evolutions of these guidelines. The methodology provides support for the calculation of life cycle GHG emissions for ICT products with a focus on five ICT goods and services:

Telecommunications Network Services, Desktop Managed Services, Cloud and Data Center Services, Hardware, and Software.

A dedicated factsheet is being developed for the EN 50600-4 methodology, to be available on the ICTFOOTPRINT.eu platform. The five factsheets relative to each chapter of the GHG Protocol ICT Sector Guidance are being updated to integrate the latest specifications.

2.2 Uptake of methodologies by the ICT sector

There are various reasons to the implementation of footprint and KPI methodologies by stakeholders in the ICT sector, among which the identification of the main hotspots and improvement of the performance of a product; the reporting and other communication goals; or the comparison of similar products, e.g. as part of a green procurement scheme [3].

2.2.1 Improving and tracking the performance of ICT goods and services

Life cycle assessments (LCA) allow for the quantification and management of environmental aspects of products (including services) and activities, accounting for the different life cycle stages. This approach offers opportunities to improve the environmental aspects at various stages of the product life cycle by implementing eco-design practices to encourage increased efficiency, innovation and potentially cost savings. Hence, not only the energy consumption during the use stage but also the production and end-of-life stages can be optimised.

Among the methodologies identified in the scope of ICTFOOTPRINT.eu, several of them stipulate that they can be used to identify the main contributors to environmental impacts. The ETSI 203 199 and ETSI 103 199, as well as the GHG Protocol ICT Sectorial Guidance are among them.

Furthermore, integrating environmental criteria into core business decision-making and actions enables to gain competitive advantage and to comply with stricter environmental regulations but also to prepare environmental action plans and to manage risks and potential liabilities.

The following examples illustrate the benefits from implementing methodologies with the aim of tracking and improving the performance of ICT products:

- In order to improve the environmental and social performance of its digital offering, Solocal (a French company providing local services) carried out a multicriteria LCA of the entire digital device used to operate one of its websites, PagesJaunes.fr. The company identified the main sources of impacts and consequently implemented eco-design practices to tackle the issues. As a result, the amount of HTTP requests was reduced by 43% and the average weight of the pages by one-third, leading to a reduction of the potential impact on climate change by around 15% and of water consumption by 21% [4].
- The European Service Network (ESN – a project led by the European Commission to raise awareness on environmental projects carried out by the European Union) conducted an analysis of its website environmental performance, which revealed that reducing the amount of articles displayed on the homepage allowed to divide the full display time by 4 and thus reduce operating costs. The changes resulted in 1.1 to 3 gCO_2eq savings per loaded page [4].
- Apple uses LCA as criteria in internal decisions, in addition to supporting product eco-design or benchmarking the carbon footprint of similar products. Simplified results from LCA are also published for each product [5].

2.2.2 Environmental information as part of the communication strategy

Communication on environmental information is one of the potential uses of implementing life cycle methodologies. Providing with environmental information improves the image of the company among consumers and increases the brand value towards both market players and suppliers. The results communicated are considered more credible and robust when assessed based on a LCA approach, as it provides scientific (and often independently verified) information.

The reasons at stake may be numerous, and include: explain a strategic decisions taken by a company; arguments against external and internal criticism; display information on environmental product declarations to the customer; etc. Furthermore, companies are increasingly willing to label their products according to environmental criteria, to showcase the environmental efforts to customers. Such information may also be used to communicate internally, for instance to reassure shareholders, mobilise its teams around common project, or to ensure better communication with upstream suppliers.

Finally, a large number of organisations publish environmental information as part of reporting processes, whether mandatory or voluntary.

Among the footprint methodologies displayed in the scope of ICTFOOTPRINT.eu, the majority include communication purposes or reporting in their targeted uses. Some methodologies specify a list of mandatory requirements before communication with external parties.

The following example illustrates the benefits from implementing methodologies with the aim of communicating on ICT environmental information:

- In September 2013, FNAC (a retailer of consumer electronics) started the deployment of the environmental labelling on all proposed televisions, available in store and on the e-shop. The display of a simplified environmental grade aimed at improving the client experience by accessing accurate information on the environmental impacts of the products, and at fostering consumers in taking into account this criterion in their purchasing decision [6].

2.2.3 Comparing similar products and green procurements

One of the main uses of footprint methodologies is for comparison purposes, while accounting for impacts from the entire life cycle of products. However, the comparison is only possible for similar goods or services, for instance: comparing two technical options for a designer, two products (with the same intended application) for a buyer, or two policy directions for a decision maker.

By accounting for impacts from all life cycles, negative effects such as shifting impacts from one stage to another are avoided. A life cycle assessment reports potential pollution transfers in the comparison of two alternative scenarios. Thus, two similar products having the same function (for example a smartphone with no-tool battery access or not), two different products having the same function (a laptop and a desktop) or a physical and a "dematerialized" service (a postal mail and an e-mail) can be compared.

Among the footprint methodologies displayed in the scope of ICTFOOTPRINT.eu, only the ITU 1430 allow the comparison of impacts between two scenarios (baseline impacts vs. product activity results). KPI methodologies such as the GreenGrid Carbon Usage Effectiveness (CUE) also stipulate that when the CUE is used in combination with the Power Usage Effectiveness (PUE) metric, results from distinct datacentres may be compared (however it does not account for impacts from all life cycles). Most methodologies (GHG Protocol, ETSI) recommend to avoid comparisons between products as much as possible due to the large uncertainties.

Green procurements are another application of comparing similar products, by allowing for the selection of products depending on their environmental performance. Two methodologies among those displayed on the platform allow for green procurements: the EPEAT initiative and the EU Energy Star initiative. While the EPEAT includes various environmental criteria of electronic products throughout their life cycle, the EU Energy Star focuses on their energy efficiency.

In order to encourage the public authorities to use their purchasing power to increase the demand and thus the offer of more environmentally-friendly goods and services, the European Commission implemented the Green Public Procurement (GPP) strategy, in particular to reward environmental initiatives of public sector bodies. The GPP criteria developed within this strategy includes impacts from various life cycles [7].

The following examples illustrate the benefits from implementing methodologies with the aim of comparing the environmental performance of similar ICT products, e.g. in purchase decisions:

- Frugal-IT conducted a comparative environmental impact study dealing with the development of two websites with strictly identical functions, content and ergonomics. The aim was to measure the differences in environmental impacts and performances of a showcase site: the optimised website resulted in a 49% reduction of potential impact on climate change and water consumption [8].
- In a 2008 study, the French Energy and Environment Agency (ADEME) carried out a comparative LCA of cell phones, which included a comparison of environmental performances according to different parameters (size, type of telephone, functionality, etc.). The assessment also resulted in the identification of the main hotspots and provided key environmental practices for consumers to use their phone [9].
- The Finnish Association of Local Authorities developed an online decision support tool (Hymonet) for green procurements of cities such as Pori. The platform provides general environmental information on products (including life cycle based data, energy efficiency) and allows for selection of products based on specific environmental criteria [10].

As described in this section, there are various identified reasons for implementing methodologies. Further information may be found in each of the methodologies in the scope of the ICTFOOTPRINT.eu initiative. Although companies may apply methodologies, there are few publicly available case studies establishing a relationship between implementation of a methodologies and tangible benefits. The ICTFOOTPRINT.eu initiative aims at overcoming this lack of public information by showcasing examples of success stories in the ICT sector. However other reasons may explain the apparent low implementation of ICT methodologies: it is the focus of section 3.

3 Main barriers to implementing environmental methodologies in the ICT sector

Benefits from applying environmental methodologies are multiple, as previously described. However there are various barriers to implementing the methodologies, which may be due to the methodologies themselves (and therefore may be experienced by any stakeholders applying these methodologies), specific to the ICT sector, or experienced by certain structures only (e.g. SMEs, local authorities).

This section aims at providing an overview of these barriers, although not exhaustive. The content provided comes from Deloitte's experience applying environmental methodologies for its clients, complemented by a through literature review and interviews with EAG members and other ICT stakeholders (among which suppliers identified from the ICTFOOTPRINT.eu marketplace). Some existing and potential levers to implementing methodologies are indicated, and will be subject to more in-depth analysis later in the project.

3.1 Barriers due to the inherent complexity of life cycle approaches

The main identified barriers which prevent the adoption of life cycle methodologies and are directly related to the inherent complexity of this approach are the following:

- Complexity of implementing life cycle methodologies;
- Multiplicity of existing methodologies and initiatives;
- Difficulty to interpret and use the results.

Let us consider the **complexity of implementing life cycle methodologies**, particularly for non-initiated/non-expert profiles [11]. Their implementation requires preliminary comprehension of the technical aspects and potential compliance with defined requirements. In addition, most life cycle methodologies aim at providing a general framework for the assessment of generic products (e.g. covering all ICT services), thus leaving to the practitioner much of the interpretation on many aspects including the following questions [12]:

- What is the scope and boundary of the product or system under study (e.g. should third party datacentres be included in the scope of the assessment of an organisation)?
- Is primary data available (e.g. from an industrial plant)? When primary data is not used, which generic data should be used (e.g. third-party commercial databases such as ecoinvent)?
- Which environmental impact indicators should be assessed (e.g. climate change, resource depletion)? Which characterisation methods should be selected?

The generic and complex nature of most methodologies is considered to be of higher impact on SMEs for several reasons (see section 3.3), one of the main reasons being that SMEs do not have the same financial and human resources as larger companies.

Examples of existing levers:

Complementarily to the efforts currently being undertaken to reduce the complexity of the methodologies, initiatives such as ICTFOOTPRINT.eu aim at providing an overview of the technical characteristics and uses of ICT methodologies to facilitate their uptake by the sector.

In addition, the more specific to a certain sector or product category, the more applicable the methodology. Several initiatives have been undertaken at European or world level to develop methodologies that are specific to certain sectors or product categories. The PEF/OEF (Product/ Organization Environment Footprint) initiative is part of the "Single market for Green products" initiative led by the European Commission and aims to provide specific rules for a product or an organisation of a particular sector (e.g. PEF on IT storage equipment), to measure its life cycle environmental performance [13]. At world level, the EPD system defines category rules for specific products (e.g. home and SOHO gateway) and is compliant with life cycle ISO standards. Several ICT

stakeholders thought the initiatives listed above are easier to apply as they do not require as big an expertise as for more generic methodologies.

In addition, the **multiplicity of existing methodologies and initiatives** can generate confusion among organisations, since the practitioner may not be aware of all relevant methodologies, and may not know which methodology is best suited to the situation (with regards to the goal of the assessment, the product assessed, data availability, etc.). The lack of homogenisation between methodologies is also identified as a barrier, since distinct methodologies may apply to the same products or organisations, although recommending different approaches or technical choices.

The absence of a platform providing a global overview of existing initiatives and synergies between them is identified as a key barrier, in particular when talking about datacentres, due to the large number of existing tools, initiatives and methodologies to assess datacentres' environmental footprint or key energy factors at national, European or world level.

Discussions with ICT stakeholders show that some practitioners therefore choose the methodology they have most experience with, or the most frequently used methodology rather than the most appropriate methodology for the specific objectives of their study or the technical characteristics of a methodology.

Examples of existing levers:

Cooperation between SDOs increased in recent years notably to avoid unnecessary duplication of methodologies, e.g. with ETSI and ITU developing common standards such as the ETSI 203 199 / ITU 1410 on ICT goods, networks and services.

In addition, providing the practitioners with an overview of existing ICT methodologies, with a focus on their objective and scope would ease the decision making. This is the aim of the map of ICT methodologies available on ICTFOOTPRINT.eu platform (please note that methodologies not specific to the ICT sector are not displayed, although potentially applicable to ICT systems).

Another identified barrier related to the inherent complexity of life cycle approaches is the **difficulty to interpret and use the results** of a life cycle assessment. Various impact categories recommended in the methodologies such as ecotoxicity or eutrophication are not easy to apprehend and interpret by non-expert profiles. Although methodologies specify for which objectives they can be used, several interviewed ICT stakeholders said that the information is not clear enough and is difficult to apply to their given situation.

Finally, the use of results is not intuitive for all practitioners, due to the lack of guidance on how to develop recommendations specific to their situation, e.g. with best practices to reduce the contribution of the main hotspots. In addition, most methodologies recommend a multicriteria approach and thus complicate the practitioner decision since the results may be for or against a given best practice depending on the impact categories.

Example of potential levers:

Further guidance, e.g. provided on an online platform, could overcome the difficulty to interpret results, in particular for the most complex impact categories. Examples on how to conduct and interpret an assessment are already provided in most methodologies, as well as in published studies. Practitioners may also compare their results to generic equivalents (e.g. a number of km equivalents of an average car driving) to get a better understanding of the magnitude of impacts.

A better cooperation between practitioners and experts – providing help on difficult aspects - would also be an incentive as it would ease the interpretation of the results. The ICTFOOTPRINT.eu SAT-S tool has been orchestrated bearing in mind these aspects.

3.2 Barriers specific to the ICT sector

Besides the barriers identified before, specific barriers to the ICT sector were equally identified:

- Lack of knowledge on ICT environmental impacts;
- Lack of reliability and availability of data used, due to the complexity of ICT equipment and services as well as confidentiality issues relating to ICT data;
- Lack of reliability of results.

The **lack of knowledge on ICT environmental impacts** is among the identified barriers – specific to the ICT sector – to the implementation of methodologies by organisations and local authorities. This is first due to a common emphasis on how ICT can reduce environmental impacts from other sectors ("ICT for green") rather than on the impacts of the ICT sector itself ("green ICT").

In addition, the perception of impacts from the ICT sector is not always in accordance with the reality. The indirect (or "hidden") nature of most ICT environmental impacts makes it difficult to apprehend: while the energy required for the networks operations (e.g. data exchange and storage) of a smartphone is significant, the user may focus only on the energy consumed by its phone. Indeed, in the digital world, we deal with flows of information, which have less material or obvious impacts than the material flows of the standard economy. Similarly, people perceive the impacts from the use phase more easily than the impacts from other stages, for instance when the sustainable procurement policy of an organisation focuses on the energy efficiency of IT equipment without accounting for product longevity extension or end-of-life management.

Finally, there is a lack of awareness on impact categories other than energy consumption and climate change, since most assessments focus on these two environmental impacts.

Examples of potential levers:

The question of responsibility of organisations and local authorities towards the environment is particularly complex in the ICT sector, considering its dematerialised and diluted nature. Increasing general knowledge on environmental impacts – in particular indirect – from ICT goods and services, and providing users with best practices could be a first step before implementing a methodology to quantitatively assess the impacts of an ICT product or organisation. The success stories collected in the scope of ICTFOOTPRINT.eu aim at providing examples of environmental impacts and how they can be reduced thanks to the implementation of sustainable practices and relevant methodologies.

Another barrier is the **lack of reliability and availability of data used** in the assessment of ICT equipment and services. The first reason to this is the particular **complexity of ICT equipment and services**, resulting in increased difficulty to model the system and in data uncertainty that may affect the reliability of results. Indeed, ICT equipment are made of a considerable amount of components, with technologies which evolve faster than in other sectors. The environmental assessment of an ICT product does require a large amount of data, with many well-identified sources of data uncertainty [14]:

Table 1: Main uncertainty sources by life cycle stage

Life Cycle Stage	Main uncertainty sources	Reasons
Raw material acquisition	• Complex supply chain • Variations in geographical location • World market variations	Impacts in the supply chains are subject to world market variations and out of the ICT sector's direct control.
Production	• Large supplier base which changes continuously • Allocation of facility data to a specific product	Selection of upstream supplier is based on price, availability, etc., which makes it impossible to collect all data for the whole upstream supply chain.

Life Cycle Stage	Main uncertainty sources	Reasons
Use	• Lifetime, geographical location, traffic scenario model. • Network design and energy use variation • Variation in electricity and power production supply	The use stage of ICT equipment is highly dependent on user behaviour and the lifetime of the product. There is uncertainty on how and for how long an ICT product is used.
End of life treatment	• Future processes principally unknown • Variations between suppliers and regions • Allocation of facility data to a specific product	The end of life treatment depends on future processes and is highly variable between regions.

Similarly, ICT services are quite complex to model due to the complexity of the architecture of information systems (e.g. between the sender and receiver of information) and the diversity of potential configurations in terms of equipment and infrastructure. For example, when modelling an email being sent, the following steps are accounted for: sending the message from the computer, transmitting it to the datacentre, storing the message, processing the information, forwarding the message to the receiver. Each step involves a complex arsenal of transmission tools and some parameters can vary greatly depending on the assumptions made (amounts of routers, location of datacentres, etc.).

Another reason to the lack of data availability is the **confidentiality of data** on ICT products, because the sector is very dynamic, with technology constantly evolving; and because the market is very competitive. The lack of transparency of the biggest players of the sectors was identified by several stakeholders as a limitation specific to the ICT sector.

Practitioners may choose to use life cycle inventories (LCI) rather than raw data, for the above mentioned reasons. However commonly used LCA databases (such as Ecoinvent or GaBi) are often considered incomplete concerning ICT products and services, with inventories too generic or not up-to-date enough.

On the overall, most of interviewed stakeholders believed that **access to reliable data** [15] is one of the key barriers to implementing methodologies, even for data as simple as the number of desktop in an organisation. Various reasons were discussed, among which: data required for the assessment is not tracked, the person in charge of the data is not clearly identified, there is no access to data from suppliers, etc.

Examples of potential levers:

An identified lever is the provision of incentives for more transparency on data used in the assessments. According to several stakeholders, the effort should come from big players first, e.g. by sharing information through industry associations to make it anonymous.

In addition, connection and cooperation between departments of an organisation as well as along the supply chain could increase data availability and strengthen data reliability.

Finally, the **lack of reliability of results** from assessments of ICT products and organisations hampers the implementation of methodologies in the sector. The results are influenced by parameters already described such as databases, calculation tool, and quality of the activity data; as well as by interpretation of the methodological rules by the practitioner [16]. The methodologies provide very similar and comparable results (at least in terms of carbon footprint): a maximum deviation of 2-3% was found when one same practitioner tested the different methodologies with the same software tool, databases and primary data [15]. However, since the methodologies often leave freedom in terms of technical choices (see previous section), the choices and thus the final results may vary when applied by distinct practitioners; uncertainty in calculation outcomes was estimated around 20% [15].

The comparability of results is consequently reduced, since the differences due to distinct methodological choices observed between studies cannot be distinguished from uncertainty issues. In addition, practitioners are not always able to check the overall consistency of their results (e.g. contribution of stages to the carbon footprint) with publicly available results due to the low number of existing studies – this is particularly valid for cloud services.

Examples of potential levers:

As previously identified, an increased transparency in the sector is key to improve the reliability of the results, and should concern both dataset used and methodological choices.

The existence of simplified sectorial tools, to be used by any relevant practitioners, would guide the user through the best technical choices while increasing the robustness of the results.

3.3 Barriers related to SMEs and other private organisations

The present section focuses on barriers identified for private organisations and which are not inherent to methodologies or to ICT products. The findings are applicable to all private organisations, unless specified otherwise. A first survey was conducted in 2016 on the challenges that organisations face to conduct an environmental assessment. Results were confirmed during the phone interviews carried out for the present deliverable: the lack of resources, the lack of incentive and the lack of tangible benefits as the main barriers identified by private organisations, SMEs in particular.

The **lack of clearly identified benefits** for the companies is common to all private organisations, and the implementation of environmental methodologies is perceived as an **economic burden** rather than a source of opportunity and innovation. Many stakeholders providing or using ICT products express fear that sustainable IT practices will affect the economic performance of existing products and operations; the reaction is similar towards performance tracking software (which need to follow existing operations to identify environmental hotspots). On the other hand, economic savings are the main reason for SMEs to take actions e.g. to increase energy efficiency or better manage IT equipment (procurement, end of life) [17]. Similarly, profit margin from eco-designed products is usually 12% higher than for conventional products, in addition to extra-financial benefits [18]. It should also be stressed that economic savings are usually expected in the mid-term (not before 9 months to 2 years according to one stakeholder), thus making it more difficult to showcase.

The other tangible barrier relates to **marketing**: data on environmental performance of ICT products is showcased on few websites, since the display is not mandatory. Therefore, customers are not encouraged to select this information when buying a product. The potential lack of user-friendliness of EU Energy Star or EPEAT websites could also restrict the use of relevant databases. On the overall, a key aspect when discussing information displayed to the consumer is the level of complexity (e.g. with results on numerous impact categories) vs. transparency (e.g. with a unique and easy-to-understand score) of the data. Finally, the perception of environmental impacts by the consumer may differ from proven impacts.

Examples of potential levers:

Tangible benefits are clearly identified from implementing environmental methodologies, and are described in several studies [17],[18]. Other potential levers may focus on raising awareness among organisations about tangible benefits as well as about other mid- or long-term benefits (incl. improvement of image reputation, increased motivation and pride among employees, better relationship with clients, increased capacity to innovate) [18].

Best practices – within an organisation – should promote the inclusion of financial information (such as payback and return on investment) along with environmental and social information, in any potential environmental projects.

Incentive from consumers (through purchasing decisions) is a possible lever if information is displayed on labels or environmental performance of the products. Governments and local authorities

can also play a role in driving ICT suppliers to be more sustainable e.g. by choosing ICT products for which environmental assessments were conducted through green public procurement policies.

Various ICT stakeholders do not see the advantages of an approach based on existing methodologies compared to **a set of indicators already defined by the organisation** (e.g. for reporting purposes). The reason is that using a set of indicators specific to the organisation is both less complex to implement and more relevant with regards to the organisation's activities. In addition, organisations may prefer to apply indicators that only account for activities in their "direct scope" (on which they have direct control) rather than in their "enlarged scope" (i.e. including the rest of the value chain as well).

Finally, existing regulation are a good incentive towards inclusion of environmental issues in organisations' strategy. An example is the EU Energy Efficiency Directive, which stipulates that large companies must carry out energy audits to identify ways to reduce their consumption [19]. However most of them (e.g. sustainable reporting at national or European level) concern the publication of environmental information only, and companies are not required to use any specific methodologies or to report specifically on ICT activities.

Examples of potential levers:

One of the main identified levers is to raise awareness on benefits of applying calculation methodologies. In addition to those already described, it is important to stress out that the implementation of one methodology may be useful for various applications (reporting purposes, benchmarking, hotspots identification, etc.).

In addition, several voluntary incentives such as the EPEAT initiative or the EU Energy Star initiative require the implementation of specific methodologies.

On the overall, the **lack of resources (time, economic or expertise)** is one of the key barriers to companies, in particular SMEs, and the implementation of a complex methodology is seen as one additional constraint. The lack of specialists with the necessary skills to understand the methodology and carry out the assessment is particularly identified among SMEs, which therefore need to train employees on these aspects or to call on an external service provider. Life cycle assessments can quickly become very costly (with typical LCA budget ranging from around 8k€ to >100k€) [15],[16], in particular when the methodologies are not free of access. Training time for employees can also greatly extend the time required for the application of the methodology.

Examples of existing levers:

Complementary to potential economic incentives, an identified lever is to provide companies with an insight of potential benefits and simplified technical content for the implementation of relevant methodologies. The ICTFOOTPRINT.eu initiative was launched with this specific objective, though the provision of technical material available online (e.g. factsheets of the methodologies) as well as during webinars (with SDOs contributing to several of them).

Another barrier relates to **governance in companies, in particular regarding sustainability and green ICT** topics. Feedback from interviews with ICT stakeholders confirms that priorities differ depending on the department in an organisation, and sustainability is not on top of the agenda for most of them. While putting an environmental strategy in place requires a close collaboration between the sustainability and the IT departments, the latter is often considered as a service provider, with requirements on performance of IT services delivered to other departments, and limited resources for other aspects. In addition, the IT department may not be involved in future project formulation and development, while being asked to increase energy performance later during the project [20].

The lack of involvement on environmental issues from the top management is also a limitation to considering green ICT as a common goal for the entire company.

Examples of potential levers:

Several stakeholders believe that sustainability is a key issue which should be tackled by the top management, translated as priority for each department. This would also encourage internal communication on best practices e.g. between departments or factories.

Moreover, most of the environmental impacts are set by early choices e.g. on IT deployment, at the first step of a project development – relevant departments should be included to optimise energy use and resource efficiency while providing the required operational performance. The inclusion of relevant departments could also apply to green procurements, e.g. when renewing the IT equipment or managing IT equipment at end of life.

Legal incentives such as the EU Energy Efficiency Directive promote the inclusion of environmental issues in companies' strategy; for instance, with the Directive indicating that large companies must complete audits of their energy consumption to help identify ways to reduce it.

Finally, among the barriers identified is the **lack of public communication** of ICT environmental assessments. Mandatory or voluntary environmental reports from large listed companies (at European or Member States level) rarely include information on the footprint if IT products and activities. There are very few existing benchmarks on ICT products; the fewer the studies available, the less reliable and consistent market averages. The lack of publicly available data and transparency may be explained by a reluctance to share information with the sector, including third parties: organisations do not see the benefit of sharing their data since others do not.

Feedback from ICT stakeholders shows that there is a **lack of certified publicly available data**. Marketing information may be published without transparency on the scientific basis and particular methodological choices (see section 3.1); whereas third-party certification and transparency on technical choices is a key aspect of some methodologies. Some initiatives – for instance the Energy Star and EPEAT labels – provide a comparative database of ICT products. Potentials for improvement include an increase in the number of third-party certification body involved in the process, e.g. ensure the comparability of energy efficiency data between product suppliers. On the demand side, e.g. when sourcing ICT equipment, these initiatives are sometimes thought to be too generic, with EPEAT providing a large ratio of "gold rating" products (thus not distinguishing between top energy efficient products).

Examples of potential levers:

The question of public availability of ICT data as a key lever for organisations was identified earlier in the document, and should concern all stakeholders from the ICT sector. When data is publicly available, third party certification is perceived as insurance for increased reliability and comparability.

A potential legal way to improve communication on environmental impacts from ICT is the mandatory inclusion of environmental impact from IT activities in the sustainable reporting of companies, e.g. in the tertiary sector. This step would be the first one towards a CSR approach of ICT in companies.

3.4 Barriers concerning local authorities

Several of the identified barriers for local authorities to implementing methodologies are similar to those already described for SMEs and other private organisations. Aggregating the presentations by and discussions with city experts in many relevant occasions ([21], [22], [23], [24], [25]), barriers for local authorities are summarised in the following paragraphs.

Lack of resources (time, economic, skills), especially in a time of tightening public budgets, appears to be the most commonly cited barrier. In addition, difficulty to implement methodologies by non-expert profiles (as described in section 3.1) and low data availability (as described in section 3.2).

The **lack of clearly identified benefits** for a local authority is a common barrier. Application of ICT methodologies can prove to be expensive, therefore cities prefer to develop their own limited set of indicators. Especially for small cities, an LCA approach can be too complex and its results may not justify the necessary investment in resources.

Even more and going one step before that, for most local authorities the usefulness of such methodologies or action related to the mitigation of their ICT footprint are not clear enough. ICT is still perceived as an auxiliary activity, a tool that facilitates all other traditional activities. In this framework, ICT footprint is considered a small fraction of the total footprint that results from the municipal fleet, buildings, lighting or daily operations. Practically speaking, the case of why, in local authorities, ICT footprint might be important to look at, hasn't been made or proved yet in a convincing way.

Examples of potential levers:

Increase of general awareness on benefits from ICT methodologies, e.g. increased energy efficiency (as done in cities in Netherlands due to legal incentives). Communicate on best practices along with methodologies, so that cities start with best practices before any more technical assessment. Success stories collected from local authorities in the scope of ICTFOOTPRINT.eu aim at providing examples on how to gain cost and environmental savings thanks to sustainable practices and environmental methodologies.

Improvement of data publicly available, in particular when the data is not specific to a city but generic (e.g. national level), can help in identifying the benefits from ICT methodologies.

The **lack of legal or voluntary incentive schemes** can further hinder the adoption and implementation of ICT methodologies. Legal incentive schemes usually originate from the national level and are accompanied by requirements for setting reduction goals and reporting the progress, as in the case of the Netherlands. Especially LCA methodologies are not compatible with the usual business and procurement models of local authorities. Lack of clarity and of guidance can further prevent cities from adopting methodologies.

Voluntary incentive schemes build on the existence of initiatives and platforms that allow cities to promote and compare their efforts and achievements. However, until now major European initiatives (e.g. the Covenant of Mayors or the European Green Capital Award) haven't recognised or mentioned explicitly ICT as an activity whose footprint or environmental impact can be measured, monitored or reduced. Moreover, fear of or unwillingness to be involved in comparisons with other cities, which can be correlated to the lack of systematic use of reporting for communication purposes, can deflect local authorities from using ICT methodologies.

Examples of potential levers:

Regarding legal incentives, mandatory publication of data on energy efficiency for IT procurements could be adopted. Also, explicitly mentioning ICT in the monitoring methodologies of the current major European initiatives (e.g. Covenant of Mayors) can stimulate adoption of methodologies.

Encouraging cities to share their results publicly can help define best practices etc. later at a sector level. To do that, public contests at national or European level should be organised, with awards for cities with the best environmental performance.

Improving communication of success stories can increase recognition of the local authorities' efforts and thus voluntary incentive schemes. The creation of platforms (e.g. the ICTFOOTPRINT.eu platform), can help in the creation of the critical mass necessary for voluntary incentive schemes.

Examples of existing levers:

From September 2011 to May 2014, the FP7-funded NiCE project [26] served as a platform for action based on the Green Digital Charter. A "Reference Cities Group"[1] provided feedback during the development of the "*Green Digital Charter Toolkit*", which includes an ICT carbon footprint reporting tool designed to help cities monitor the carbon emissions generated by their ICT equipment. This tool was inspired by the *Green AddICT programme* developed by Bristol City Council.

Main drivers and barriers for "green and digital" were discussed during the NiCE Focus Group meeting in Linköping on 3 April 2012. A training visit on 'measuring green IT' in Belfast (19 June 2012) was the occasion for representatives of 11 European cities[2] to discuss challenges and opportunities ICT provides in cities. The discussion focused around infrastructure, regulation and procurement.

Finally, another barrier often mentioned is the **lack of agreement between different departments** in a city administration. A frequently mentioned example includes the different approach of the typical IT department whose indicators relate to IT cost, speed and integrity of digital services, total time of systems being down, etc. and the typical energy/environment department that looks at the energy bill or the environmental impact of equipment and operations. In addition, the lack of cooperation between different departments makes it difficult to raise the issue of ICT methodologies and secure the necessary political support for their implementation.

Examples of potential levers:

Increase of communication between departments and agreement of common goals that can be translated in procurement rules or operational practices can help all involved departments to meet their objectives.

[1] The NiCE "Reference Cities Group" is made up of five European cities (Bologna, Eindhoven, Linköping, Manchester and Warsaw) and one Chinese city (Yantai)

[2] The NiCE training event in Belfast (19/06/2012) gathered representatives from 11 European cities (Belfast, Birmingham, Bologna, Derry, Ghent, Manchester, Sunderland, Tallinn, Vienna and Venice) as well as coordinators from EUROCITIES and the International Telecommunications Union (ITU)

4 Conclusions

Numerous methodologies, whether ICT specific or applicable to ICT systems, were developed in the past years and have been identified in the scope of the project (see map of methodologies available on ICTFOOTPRINT.eu platform). Each of them describes the given applications and potential benefits – some examples of tangible benefits may as well be found among the success stories showcased online.

However, most local authorities and companies in the ICT sector face difficulties which may prevent them from adopting the methodologies, and more globally from taking into consideration environmental aspects. Literature review as well as feedback gathered from ICT stakeholders (through surveys, during events as well as phone interviews) allowed for the identification of the main barriers, gathered in this deliverable in distinct categories, depending on whether the barriers relate to the inherent complexity of life cycle approaches, to the ICT sector, or to the type of structure (e.g. SMEs, local authorities). These barriers are summarised in

, along with existing and potential levers.

Table 2: Main barriers and levers to the implementation of methodologies in the ICT sector

Identified barriers	Existing and potential levers
Barriers due to the inherent complexity of life cycle approaches	
Complexity of implementing life cycle methodologies	Development of initiatives specific to a sector or product category (PEF/OEF, EPD system). Provision of simplified and easy-to-use content to raise awareness of technical aspects and uses of methodologies (e.g. on ICTFOOTPRINT.eu platform).
Multiplicity of methodologies and initiatives	Cooperation between SDOs to avoid unnecessary duplication of methodologies. Provision of an overview of existing ICT methodologies (e.g. on ICTFOOTPRINT.eu platform).
Difficulty for practitioners to interpret and use the results	Increased cooperation between practitioners and experts. Provision of guidance on how to interpret results (generic equivalents, relationship between results and ensuing best practices).
Barriers specific to the ICT sector	
Lack of knowledge on ICT environmental impacts	Awareness raising on ICT environmental impacts (in particular indirect/“hidden” impacts). Provision of best practices to reduce ICT impacts.
Lack of reliability and availability of data (due to complexity of ICT products and high level of confidentiality of ICT data)	Incentives for more transparency on data used in the assessments by ICT stakeholders (e.g. publication of aggregated data through industry associations). Increased cooperation between departments of an organisation and along the supply chain.
Lack of reliability of results	Increased transparency in the sector (cf. before) Availability of simplified sectorial life cycle tools to any practitioners.

Identified barriers	Existing and potential levers
Barriers related to SMEs and other private organisations	
Lack of clearly identified benefits (financial burden, no marketing advantage)	Increased communication on tangible benefits (economic or not) from implementing environmental methodologies. Inclusion of financial data (along with social & environmental information) in any potential environmental projects. Incentive from consumers & public authorities through purchasing decisions or green procurement policies.
Lack of resources (time, economic, expertise)	Economic incentives from public authorities to overcome the lack of resources, in particular for SMEs. Provision of material on potential benefits and simplified technical content for the implementation of methodologies.
Low governance in companies on sustainability and green ICT	Incentives for companies to include sustainability as key issue at organisation level: • Encourage internal communication on best practices e.g. between departments or factories. • Include IT departments from the start of a project development or in green procurements (when relevant).
Lack of public communication & lack of certification of publicly available data	Increased transparency in the sector (cf. before). Legal incentives for the inclusion of data on IT activities in environmental reporting of companies (e.g. in tertiary sector).
Barriers concerning local authorities	
Lack of resources (time, economic, expertise)	Similar to levers for SMEs and other private organisations.
Lack of clearly identified benefits	Increased communication on tangible benefits (economic or not) from implementing environmental methodologies. Better access to publicly available data (e.g. generic data).
Lack of legal or voluntary incentive schemes	Legal incentives for the publication of environmental data on IT activities. Voluntary incentives for cities to publicly share IT environmental performance, e.g. by improved recognition of local authorities' efforts (awards, public contests, etc.). Voluntary incentives for cities to calculate the carbon footprint of ICT activities (e.g. NiCE project).
Lack of agreement between departments on IT issues	Similar to levers for SMEs and other private organisations.

General findings gathered during the first year and half of ICTFOOTPRINT.eu indicate that the perceived benefits from "ICT for green" approaches (e.g. digitalisation of services in sectors others than the ICT sector) are widely recognised among stakeholders, whereas the advantages related to "green ICT" (i.e. ICT with optimised performance / reduced environmental footprint) would strongly benefit from larger awareness raising. Wider implementation of the methodologies among ICT stakeholders cannot be expected without a better understanding of the related benefits and advantages on "green ICT".

Among the levers currently identified to encourage implementation of methodologies, several of them appear to be in scope of ICTFOOTPRINT.eu. Raising awareness among ICT stakeholders is a key aspect of the project, notably through webinars, factsheets on the methodologies, as well as simplified assessment tools (SAT-S was released recently, SAT-O will be released in the coming months). Another contribution from ICTFOOTPRINT.eu aims at improving relations and communication between stakeholders of the sector, e.g. through the marketplace as well as success stories showcased online.

The materials and services provided by ICTFOOTPRINT.eu will evolve during the three years of the project, in order to adapt to the users' identified needs. This is why it is important for ICTFOOTPRINT.eu to receive feedback from relevant stakeholders on the relevance and applicability of existing services as well as on how they believe the ICT sector would benefit from such an initiative.

In this regard, the deliverable is a first of a second iteration of this continued work, and will be updated during the second half of the project based on user-experience feedback. The content and material gathered during the three years of the project will contribute to deliver concrete recommendations to reduce/remove these barriers, which will be included in the final deliverable D3.4.

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