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D2.5 - THIRD MARKET WATCH, BEST PRACTICE REPORT, SDOS UPDATE & VOICE OF THE USERS

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List of Acronyms & Abbreviations

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BP	Best Practices
CoC	Code of Conduct
EAG	External Advisory Group
EC	European Commission
EN	European Standards / Norms
ERF	Energy Reuse Factor
ETSI	European Telecommunications Standards Institute
GeSi	Global e-Sustainability Initiative
GHG	Green House Gases
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
ISO	International Organisation for Standardisation
KPI	Key Performance Indicator
LCA	Life Cycle Analysis
PUE	Power Usage Effectiveness
REF	Renewable Energy Factor
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

Executive Summary

The present deliverable describes the global and emerging trends observed in the sustainable ICT sector during the three years of the ICTFOOTPRINT.eu project, with regards to: environmental indicators and methodologies; emerging best practices and subsectors; and more generally, the inclusion of sustainable ICT practices in a broader perspective, including economic, social and societal aspects.

The deliverable should be considered as a complete version of the market watch, a synthesis which notably includes information identified in the two first occurrences of the market watch (deliverables D2.2 and D2.3).

Results show that the contribution of the ICT sector to the European electricity consumption and carbon emissions is increasing over the years, although results may vary according to sources. The trend is explained, among others, by changes in consumer patterns and use of ICT to optimise the processes and impacts from other sectors ("IT for green"). It includes the significant improvements that have been made in the past decade towards "greener IT", e.g. regarding energy efficiency of hardware. It should be noted that "green ICT" is a common term, used in the context of the project and the deliverable to reflect on "environment-friendly ICT", "ICT with reduced environmental impact", etc.

Although ICTFOOTPRINT.eu focuses on the energy and carbon footprint of ICT, other environmental impacts from the sector should be considered, such as water pollution or mineral depletion. These aspects are gradually being addressed by the market and policies, moving from "green ICT" to "responsible ICT".

The vision is based on the insight acquired by the ICTFOOTPRINT.eu initiative during the three years of activities, and specifically describes the services developed as part of the project, with a particular focus on the map of methodologies and the calculation tools to raise awareness on the uptake of best practices and the implementation of methodologies to assess the environmental impact of ICT products and organisations. The deliverable also gives an insight on the data collected on other existing tools, labels and initiatives toward "greener" ICT, and outlines activities and results achieved with regards to community engagement at the completion of project.

Intermediate results may be found in the first market watch (D2.2) and the second market watch (D2.3), delivered respectively at the end of the first year and second year of activities.

1. Introduction

1.1. Purpose and scope

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 this context, the market watch presented in various deliverables (namely D2.2, D2.3, and D2.5) aim at providing a global picture of the "green ICT"[1] market and players in the European Union, and the uptake of environmental best practices and approaches.

A first insight of the "green ICT" market and involved players was provided in the deliverable D2.2 and introduced the concept of "sustainability in ICT". A second deliverable D2.3 focused on emerging trends in the "green ICT" sector, in a broader perspective including economic, social and societal aspects.

The present deliverable summarises three years of market watch of the European ICT sector in terms of sustainability trends: overall electricity consumption and carbon footprint, improvements undertaken by the sector, emerging trends for more responsible ICT, etc. The deliverable also gives an insight on the initiatives recorded in the European ICT sector towards a reduced environmental footprint (including best practices, tools and labels, etc.) and the development of specific services on the ICTFOOTPRINT.eu. Finally, the report outlines activities and results achieved with regards to community engagement at the completion of project.

1.2. Structure of the document

The document is structured as follow: **Section 1** introduces the deliverable and contextualises it in the framework of the ICTFOOTPRINT.eu project.

Section 2 provides with an insight on the global trends observed in the ICT sector towards more environment-friendly solutions and positions the project in a broader context of responsible ICT. A brief analysis of existing national initiatives in Member States within the European context is included.

Section 3 Errore. L'origine riferimento non è stata trovata. focuses on the various means identified by the consortium to support and enhance "greener ICT", from best practices and calculator tools to labels and success stories.

Section 4 Errore. L'origine riferimento non è stata trovata. describes the development of ICTFOOTPRINT.eu services on the project platform during the 3 years of project and presents the final achievements.

Section 5 provides the results on the community engagement after the 3 years of project.

Appendixes A to C gives an insight of several of ICTFOOTPRINT.eu services: list of success stories, of factsheets on ICT calculation methodologies, and the marketplace suppliers on the project platform

1.3. Relationship to other project outcomes

This deliverable is part of WP2, which provides the technical background and knowledge around the ICT-specific carbon and, more generally, environmental footprint methodologies. It is the last of three deliverables outlining the activities and results achieved in the course of the project. A first deliverable

[1] "Green ICT" is used here to reflect on ICT with reduced environmental impact

D2.2 was produced at the end of Year 1 and a second at the end of Year 2, both available on the project platform. The present deliverable D2.5 is the third and final market watch, and is based on the two previous deliverables, with updates after this Year 3 of ICTFOOTPRINT.eu project.

For the purpose of the deliverable, the consortium collected and analysed data from the use of the services provided on the project platform, as well as feedback received at Year 3 of the project, mainly from workshops organised for the project and events the consortium attended. In addition, the consortium updated and complemented the first insights provided in the deliverable D2.2 and D2.3 on the ICT sector in the European Union and the current trends of “green ICT”.

2. Market watch of the "green" ICT sector in the EU

A detailed market watch of the sector after Year 1 and Year 2 of the ICTFOOTPRINT.eu project may be found in the previous market watch reports D2.2 and D2.3 respectively. The present section of the deliverable gives an overview of the "green ICT" sector state at project completion, and its evolution over the duration of the three-year long project.

2.1. Overview of carbon footprint and energy efficiency in ICT in the EU

Results show that the contribution of the ICT sector to the electricity consumption and carbon emissions is increasing over the years at European and world levels. According to recent estimates from the Shift Project, the ICT sector amounts for 3.7% of worldwide carbon emissions in 2018 (compared to 2.5% in 2013) and 2.7% of worldwide energy consumption in 2018 (compared to 1.9% in 2013 – for the use stage only) [1]. Previous studies concluded that the ICT sector at the European level is expected to use from 124 TWh in 2011 to 259 TWh in 2020 (for the use stage only) [2]; and at worldwide level, about 1.9% of worldwide carbon emissions in 2011 (i.e. 1,037 TWh of the worldwide energy consumption, covering all lifecycle stages) [3].

There is an annual increase of energy consumption from the ICT sector (about 4% annually) despite a global GDP decrease (about -1.8% annually), which goes against the aim of decoupling the economic growth from its energy and carbon footprint thanks to dematerialisation. In other words, for each euro generated from the digital economy in 2018, 37% more direct energy consumption is needed compared to 2010 [1].

The results are based on an update of the work conducted by Andrae and Edler in 2015 [4]. In particular estimates for 2015 prove to be higher than predicted based on previous tendencies. Predictions from the Shift Project for 2025 show that the ICT sector should amount for more than 5% of the energy consumption worldwide (and 3.2% considering a sobriety scenario).

Another source found that the ICT sector accounts for 8-10% of the European electricity consumption and up to 4% of its carbon emissions in 2012 [5]. The results from the Shift Project on electricity consumption (and not energy consumption as detailed before, including but not limited to electricity) reflect on a trend for the digital sector from 11% in 2013 to 14% in 2017 worldwide, and would almost reach 16% in 2020 [1].

Overall, it remains complex to evaluate the impact from the ICT sector, and results may vary according to sources. Indeed, although multiple methodologies specific to the ICT sector are now available to assess the environmental footprint of ICT products and organisations, the implementation of those methodologies may differ between studies, therefore limiting any comparison of results. Among the potential differences identified, the definition of ICT perimeter may vary (covering data centres, ICT and enterprise networks, and ICT user devices in several sources; or including the entertainment and media sector as well, i.e. cable TV and broadcasting, and other user devices not previously listed). Moreover, data on the environmental impact of ICT equipment and services may differ, partly due to the indirect nature of most ICT impacts (e.g. generated from manufacturing or landfill). The hypothesis used in the assessment can also impact the results, in particular the hypothesis used for forecast. Finally, potential bouncing effects from ICT usage is difficult to assess (although it may be significant), and most studies do not include it.

As an example, estimates from Malmodin et al. (2018) for the ICT sector show a decrease in carbon footprint between 2015 and 2025 (from 1.3 to 1.1 Gt carbon emissions worldwide, including entertainment and media activities), based on a study from GeSi [6] and previous estimates by the authors [7] [8]. They differ from results based on the work conducted by the Shift Project and Andrea and Edler (from 1.5 to 3.6 Gt carbon emissions worldwide, including entertainment and media activities,

for the “expected scenario”) [1] [4]. Both approaches seem to use similar 2020 and 2025 forecast on data traffic and consumer goods (including smartphones). The differences may originate from calculation of embodied emissions (in particular, contribution of extraction of raw materials and manufacturing of consumer goods to its lifecycle carbon footprint), or from hypothesis on potential technological changes.

Although results may vary on the environmental impact of the ICT sector depending on sources, there is a relative consensus on data traffic, ICT devices, data centres, networks and web services. On the overall, the production and use of ICT consumer goods (smartphones, tablets, home products, Industrial Internet of Things - IIoT) and the demand for content streaming, bigger data storage, etc. are increasing. The number of smartphones used worldwide is expected to grow from 4 billion in 2017 to 5.5 billion in 2020, i.e. a 11% annual increase [9]. Data traffic is expected to increase by 25% annually on networks and by 35% annually in data centres, based on Cisco models [1]. Among the considered reasons is the increased number of users, number of terminals for each user and change in consumer patterns (streaming, cloud gaming, etc.); with most data from the use of services from the GAFAM[2].

Further elements on the evolution of each sub-sector and its environmental impact is provided in deliverable D2.2. In addition to this, recent studies were conducted on the environmental of new ICT services, and their potential significant contribution to the carbon footprint of the overall ICT sector. For instance, the Bitcoin (a cryptocurrency increasingly used as investment and payment system worldwide) may generate carbon emissions large enough to push global warming over 2°C alone, in less than three decades [10]. This example illustrates the **need to consider environmental aspects from the design stage of new ICT services**, and not only include the potential of ICT initiatives to mitigate climate change and reduce environmental impacts from other sectors.

In the European Union, various regulations – at the EU level as well as at national level – have contributed to improving the **energy efficiency of hardware** over the past years. Minimum energy efficiency requirements were put in place, by product groups, following the Ecodesign Directive 2009/125/EC [11] and its implementing Regulations. So far, Ecodesign Regulations exist for: computers, set-top boxes, (network) standby and off modes of appliances. A dedicated one on enterprise server is currently being drafted.

Voluntary initiatives complement the regulatory approach, such as the EU Energy Star label, the EU Ecolabel, Green Public Procurement, TCO Certified, etc. These initiatives are either specific to IT products or include other product categories, and they aim at evaluating environmental criteria such as energy efficiency. A description of these initiatives may be found in section 3.3.

While the energy efficiency of IT equipment in use remained an important focus for manufacturers in the past decade, it is now acknowledged that other stages in the life cycle, and other environmental impacts, of the equipment should be considered. Estimates conducted by the Shift Project conclude that direct energy consumption from the use stage amounts respectively to 6%, 11% or 33% of the consumption over the life cycle of a smartphone, a laptop or a connected TV [1]. Other sources consider that depending on the lifetime of a product and the type of product, the manufacturing of IT equipment may contribute from 26% to 80% of the impact over the life cycle [12].

Certifications approaches such as the EPEAT label include mandatory or optional criteria that cover stages other than the use of equipment. For the product category of servers for instance, the design for repair, reuse and recycling and minimum recyclability rates are required; while other criteria cover the manufacturing process, or the packaging of the IT equipment assessed.

[2] Google, Apple, Facebook, Amazon, as well as Chinese equivalents such as Baidu, Alibaba, Tencent, Xiaomi (BATX).

Another important aspect is that the implementation of best practices and assessment of environmental impacts is more complex when it comes to IT services rather than IT equipment. Indeed, IT services comprise numerous IT equipment and software; such complexity limits the identification of responsibilities and levers of action [13]. Among the identified levers towards an IT service optimisation, the **improvement of software development** and usage is a growing topic. While a significant share of software developers may not account or be aware of the related energy consumption when developing a software [14], it is considered that the implementation of green coding recommendations significantly contributes to the reduction of environmental footprint. For instance, the performance of the Environment for Europeans website was audited and the functional conception of the website consequently changed, in addition to reducing the number of article links displayed on the home page: as a result, the carbon and water footprints respectively decreased by 65% and 45%, through the reduction of server capacity and bandwidth usage [13]. For the website of the Banque cantonale de Fribourg, a Swiss cantonal bank, the use of green coding practices decreased the loading time by 88% and the bandwidth usage by 95% [13]. A growing number of initiatives and companies offer dedicated solutions to help website and software designers implement green coding practices, such as the GREENSOFT Model, from the Trier University of Applied Sciences; or the software developed by Greenspector (see deliverable D2.2 for further description). As another marker of the growing interest of the market on the “green software” topic, it is worth mentioning that the French Environment and Energy Management Agency published in January 2018 a call for interest for research projects for the improvement of the environmental performance of products and software ecodesign (PERFECTO).

When looking at IT service optimisation, other aspects than green coding may be considered, as telecommunication networks and data centres are estimated to contribute to 50% of the total energy consumption of the sector in 2017 [15]. When looking at the **environmental footprint of data centres**, various energy performance indicators are now broadly used by the sector, such as the Power Usage Effectiveness (PUE) or the Renewable Energy Factor (REF).

In the path of companies such as Facebook, Google and Apple committing back in 2012 to sourcing their data centres with 100% renewable energy, a growing number of organisations is working on reducing the energy consumption and carbon emissions of their data centres. In 2017, more than 20 IT companies who operated energy intensive data centres to power the internet committed to transition their own operations to 100% renewable energy, i.e. over 7 GW [16]. Various surveys were conducted in the past years on data centre energy efficiency: in 2011, the average PUE was estimated between 1.8 and 2.5, i.e. 0.8 to 1.5 additional kWh spent on other equipment than computing for each kWh used for computing equipment [17]; detailed numbers may be found in deliverable D2.2. On the overall, it remains complex to obtain average figures, thus to conclude on the environmental efficiency of the industry; in particular when using the PUE indicator alone [18] [19].

While a variety of initiatives seems to emerge, the inclusion of environmental aspects in the global strategy of enterprises remains limited. About a fifth of the companies responding to a French survey did so in 2016, however less than 10% implemented the strategy into action plans [20]. At the sector level, cooperation and data sharing between ICT players appear as key levers to better tackle the topic. Although sustainability is included in a growing number of ICT-related events, some aspects on the environmental impacts of ICT remain quite unknown, in particular when it comes to indirect effects of the technologies, or to the potential bouncing effects [12].

Considering these trends, raising awareness among the ICT sector and the ICT consumers is a key challenge. Hence communicating reliable and sincere information on the environmental impacts of the ICT sector and ICT use becomes a strong need.

As a conclusion, it is acknowledged that the environmental impacts from the ICT sector will continue to grow in the coming decade, mostly due to more end users and more data exchanges. Various levers, either regulatory or voluntary, aim at tackling these impacts at the manufacturer or the end user level. Among the existing voluntary initiatives, the ICTFOOTPRINT.eu project focused on awareness raising

among European ICT players, on best practices and calculation methodologies to increase the energy efficiency and reduce the carbon footprint of ICT products and services. The existing initiatives may be developed based on public or private funding; focusing on a specific IT product or not; promoting a calculator tool or providing guidance, etc. A description of these projects may be found on the ICTFOOTPRINT.eu platform.

Although ICTFOOTPRINT.eu focuses on the energy and carbon footprint of ICT, other environmental impacts from the sector should be considered, such as water pollution, use of hazardous substances or mineral depletion. The following section illustrates these impacts in several examples.

2.2. Global trends of in the EU: from “green ICT” to “responsible ICT”

The **energy consumption** and **carbon footprint** are two environmental impact indicators now largely used by the ICT sector. Significant improvements have been made in the past decade (e.g. to improve energy efficiency of ICT equipment), and the topic is now tackled by most hardware manufacturers. Therefore, despite the increased number of ICT equipment in use, the contribution of this sub-sector is not expected to grow at the same path in the coming years.

However, the assessment of **other aspects such as natural resource depletion** (e.g. water consumption, metal depletion) remains quite limited in the past years in the literature and among companies. The trend is likely to evolve towards a broader picture, in particular on mineral resource depletion and hazardous chemicals, from both regulatory incentives (in the context of EU regulations such as REACH, RoHS, etc.) and voluntary incentives (in the context of the general tendency toward a Circular Economy). They are also among the key indicators selected in the 2017 Greenpeace report, and used to score several of the leading consumer electronics companies worldwide [16].

Assessing the **various environmental impacts and resource consumption from a life cycle perspective**, as well as **promoting IT equipment with longer lifespan** are among the practices that are encouraged at both European and national levels. For instance in France, the energy and environment agency ADEME and the Ministry for an Ecological and Inclusive Transition have been collaborating on actions to enhance improved lifespan of IT products; while the national association Halte à l’Obsolescence Programmée (HOP) was created in 2015 to raise awareness and report on potential cases of planned obsolescence of IT equipment, from printers to smartphones [21].

Green procurement approaches, by including environmental aspects in the requirements for purchasing of IT goods or services, may reveal a strong incentive towards reduced environmental footprint. In particular, public entities are encouraged to set an example on the topic – a specific focus on green public procurements may be found in deliverable D2.2.

As part of their **Corporate Social Responsibility** (CSR), companies in the ICT sector are increasingly considering their involvement and potential impact with regards to environmental and social aspects, along with other considerations such as data confidentiality and web access. The ICTFOOTPRINT.eu project focuses on some “green ICT” aspects and can be set in a broader context of “responsible ICT”, to account as well for initiatives and actions towards improved social and economic performance. “Responsible ICT” can be defined as information and communication technologies with a reduced economic, ecological, social and societal impact, and / or contributing to the achievement of sustainable development objectives [22].

The current trend for companies that adopt a CSR strategy is to progressively extend corporate responsibility to the upstream supply chain, including suppliers and sub-contractors. Among the issues considered by ICT players, engaging suppliers in their social and environmental responsibility, among which **Human Rights**, is a key although complex aspect. Regulatory constraints are expected to reinforce the trend, e.g. with the European Conflict Mineral Regulation 2017/821 [23]. The Regulation will require EU companies to ensure by 2021 that their imports of tin, tungsten, tantalum and gold

originate from responsible and conflict-free sources. Worldwide, similar regulation is already implemented: in the United States as part of the Dodd-Frank act, manufacturers are required to disclose the source of the above four 'conflict minerals'; voluntary guidelines exist in China [16]. Voluntary commitments were taken to include cobalt to the supply chain due-diligence program by several ICT players such as Apple, Microsoft, Fairphone and Dell; while the Fairtrade certified gold supply chain is supported by Fairphone [16] [24].

When looking at responsibilities with regards to end user aspects, **data confidentiality** seems to be among the key aspects considered by companies. Because IT services deal with a tremendous amount of confidential data exchanged though communication networks, cyber security has evolved over the years and is now a key component to data exchanges. From a consumer perspective, data privacy is regulated in particular at the EU level, through the General Data Protection Regulation (GDPR) [25], replacing the Data Protection Directive 95/46/EC [26] as of May 2018.

The regulatory approach is also a strong incentive on **digital inclusion** and **web accessibility** aspects. The Directive 2016/2102 [27] on the accessibility of the websites and mobile applications of public sector bodies aims at harmonising the rules between Member States for enabling all users to have equal access to information and functionalities on the web, starting with the public sector – national regulations may be more constraining.

From a broader perspective, the ICT sector can play a significant role in several of the **UN Sustainability Goals** defined in the 2030 Agenda for Sustainable Development [28]. As such, a report ranked EU countries based on the maturity of their ICT sector and their achievements on six SDGs, and found a connection between ICT sector development and SDG achievement (with countries with advanced ICT sectors and information societies likely to perform well on measures of sustainable development) [29].

2.3. Towards a common agenda on "green ICT" in the EU?

National initiatives launched by governments or national public authorities reveal an increasing commitment at Member State level in the European Union, towards the inclusion of environmental aspects with regards to the ICT impacts. Some examples are provided hereafter, although this overview should not be considered exhaustive.

In Denmark, the national **Action Plan for Green IT** was established in 2008 by the Ministry of Science, Technology and Innovation. The initiative permitted, among others, to collect information about the experience of Danish companies using "green ICT", to make available for other companies interested in "greening" their ICTs. It also aimed at increasing environmental awareness among general public, targeting children and young people as the largest group of individual ICT consumers, e.g. using communication platforms such as online computer games or social networking sites [30].

In Germany, **Der Blaue Engel** (The Blue Angel) is one of the oldest and most recognised eco-labels, established on the initiative of the German Federal Minister of the Interior in 1978. More than 3 600 products categories are certified, including (but not limited to) ICT equipment. Pollution and energy consumption associated with the goods, and their recyclability, are among the criteria used for certification. Further information on the label may be found in section 3.3.

Several initiatives were recently launched in Germany regarding ICT and the environment, however the focus was rather on "ICT for green". For instance, the e-Energy project (part of the 2008 **Action Plan "Germany: Green IT Pioneer"** launched by the German Federal Ministry of Economics and Technology) aims at optimising energy supply system thanks to ICT [31]; the **GreenTech made in Germany 2018** promotes ICT innovation to mitigate climate change and protect the environment [32].

Finally, the web portal **www.ITK-beschaffung.de** ("ITK beschaffung" meaning "ICT procurement") was established in partnership between the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the German Federal Environment Agency and the German

Association for Information Technology, Telecommunications and New Media (BITKOM). The site provides detailed guidelines on how to write a product-neutral description of performance and on how to secure environmentally sound, sustainable procurement [31].

In the UK, the **UK Greening government ICT strategy** focuses, since 2011, on delivering more cost-effective digital public services, by changing the ICT landscape. On one hand, the strategy focuses on reducing the environmental impact of ICT over the lifecycle, from design and manufacturing to disposal. Various strategies and programmes of work are included, among others those led by the Government CIO Delivery Board, such as data centre consolidation and hosting services, the Public Services Network (PSN) and End User Device Strategy. On the other hand, the initiative focuses on the role of ICT to reduce the environmental impact of government operations ("IT for green") [31].

The strategy was refreshed since then, and a **2020 Greening Government Sustainable Technology Strategy** was published in 2018 by Defra, to set out how government ICT will contribute to green commitments and adopt efficient, sustainable practices, among others on ICT procurement [33].

Among the tools developed in this context, the **UK HM Government Green ICT Maturity Model** was launched in 2013 for public sector bodies, to support the Greening Government Commitments (GGC) programme. The tool is available as an Excel file, where organisations can assess their "green ICT" efforts and keep track of progress [34] [35]. The **Green ICT Scorecard** was developed in 2008 in conjunction with the CIO/CTO Council of the United Kingdom as an instrument used by organisations for benchmarking the environmental impact of their ICTs. The tool helps identify strengths and weaknesses in "green ICT" strategies and their implementation [31] [35].

In France, national initiatives were recently started by ICT stakeholders to encourage the government to commit and develop a "green ICT" strategy. In that respect, a white paper on digital technology and environment was developed by Iddri, Fing, WWF and GreenIT.fr in 2018 and publicly introduced to representatives of the French government. The aim of the document is to offer concrete actions for the government to ensure that the digital transition and the ecological transition lead towards the same goal, among other things by accounting for the environmental impacts from the ICT sector.

In conclusion, commitment of Member States to reducing the environmental impact of ICT started about a decade ago and seems to be increasing over the years. However, these initiatives remain limited to a number of Member States, and do not seem to be applicable to the entire ICT sector, nor integrated in a national ICT strategy. A common agenda at the EU level, applicable to all MS and integrated to an ICT strategy (rather than developed aside of it) would support such national initiatives and set an example for the ICT sector in the EU.

3. Main initiatives in the European ICT sector

A detailed description of the initiatives in the European ICT sector that where identified within the scope of the ICTFOOTPRINT.eu project may be found in the previous market watch reports D2.2 and D2.3. The present section of the deliverable gives an overview of the initiatives collected at project completion.

3.1. Best practices implemented in Europe

This section presents the work of the consortium that aimed at identifying existing reference documents and initiatives promoting “best practices” (BP) for the improvement of the energy efficiency and environmental footprint of ICT services, goods and organisations. The scope of this review includes:

- Best practices for the implementation of actions for the improvement of energy efficiency/environmental footprint of IT goods, services and organizations;
- Best practices for the implementation of ecodesign of ICT goods/services.

Among the key BP guides and initiatives applicable to the ICT sector, the “European Code of Conduct for ICT” [36] series remain one of the most widely recognized. The Code of Conduct (CoC) for ICT, developed by both the industry and the Joint Research Centre of the European Commission, describes energy-saving practices for the ICT sector. In 2000, the European Commission launched the initiative as a voluntary policy instrument, initially targeting the External Power Supplies, and Digital TV Services and later extended to additional categories (Uninterruptible power supplies - UPS, broadband equipment and data centres). They provide a platform bringing EU stakeholders together to discuss and agree on voluntary actions which will improve energy efficiency. The codes' key objective is to inform and stimulate the ICT sector to reduce energy consumption in a cost-effective manner without hindering the critical function of the facility or the equipment.

Table 1 displays the list of the initiatives establishing best practices guidance identified and published on the ICTFOOTPRINT.eu platform.

Table 1: Best practices guides identified in the ICTFOOTPRINT.eu project

Initiative	Author
EU Code of Conduct on Energy Efficiency and Quality of AC Uninterruptible Power Systems (UPS)	European Commission - JRC
EU Code of Conduct on Data Centre Energy Efficiency	European Commission - JRC
EU Code of Conduct on Energy Consumption of Broadband Equipment	European Commission - JRC
EU Code of Conduct on Energy Efficiency of Digital TV Service Systems	European Commission - JRC
EU Code of Conduct on Energy Efficiency of External Power Supplies	European Commission - JRC
Code of Best Practices for Green ICT	Council of European Professional Informatics Societies
Eco-conception web : les 115 bonnes pratiques	Frédéric Bordage (Alliance Green IT)
Toolkit on environmental sustainability for the ICT sector	ITU Telecommunication Standardization Sector
Saving Energy with Office Equipment - A Best Practices Resource Guide	The State Electronics Challenge
ECMA 341 "Environmental Design Considerations for ICT & CE Products "	ECMA
Green Computing: Latest Practices and Technologies for ICT Sustainability	Piotr Pazowski

3.2. Awareness and assessment tools for the ICT sector

The consortium worked on the identification of existing calculation tools, either used to assess the potential environmental impact / performance of an ICT product or organisation; or to raise awareness on environmental aspects of ICT products. In this context, all tools applicable to the ICT sector and that can be used by an end-user were considered, regardless of the complexity of calculations. In addition, as described in section 4.5, two generic tools were developed for the ICTFOOTPRINT.eu project to raise awareness on the calculation of environmental impact for ICT services and ICT organisations.

Table 2 displays the list of calculation tools identified and published on the ICTFOOTPRINT.eu platform.

Table 2: Calculation tools identified in the ICTFOOTPRINT.eu project

Initiative	Organisation
CLEER Model	Lawrence Berkeley National Lab and North-western University
GeSICloudImpact	GeSI - Global e-sustainability initiative
HP Carbon Footprint Calculators	HP
BT Carbon calculator for business	British Telecom
Save Energy on your PC	Carbon Footprint Management
Ecoindex	Green IT
Cost and Carbon Comparison Tool: Thick Vs Thin Clients	SusteIT & JISC
ICT Energy and Carbon Footprinting tool	SusteIT & JISC
Mobile Efficiency Index	GreenSpector
SASF	Gesi - Global e-sustainability initiative
EcoMeter	Consortium of French web agencies and digital services based in Burgundy (Atol-CD, Cadoles, Logomotion, Planet Bourgogne, Pulsar DS)
EURECA Tool	EURECA Consortium
LCA2Go	LCA2Go Consortium coordinated by Fraunhofer
RenewIT Project	RenewIT Consortium (IREC, BSC, Loccioni, AIGUASOL, TUC, 451 Research, Deerns)

The tools differ according to various criteria, among which:

- The **aim of the tool**, from raising awareness on a given aspect to enabling a detailed assessment of an ICT product or organisation;
- The **complexity of the interface** directly linked to the number of hypothesis and generic data used to develop the model. A tool requiring a large number of inputs will enable for a finer analysis but will be more complex to complete (e.g. user may not have access to all data inputs);
- The **complexity of the calculations developed** as part of the model – this may not be directly related to the complexity of the interface;
- The **level of compliance with existing ICT methodologies**: while some tools will strictly apply existing ICT standards such as those described in section 2, other may be built on a methodology specific to the initiative; or on limited calculations involved;
- The **display of results** as absolute values or as a scoring system;
- The **level of specificity to the ICT sector and/or to dedicated ICT products**. In particular, several tools cover a specific product, for a specific brand; while others may be applicable to various sectors, among which ICT products.

The diagram displayed on Figure 1 provides with a preliminary analysis of the various tools, based on two of the criteria described above: complexity of the interface vs. the level of specificity to the ICT sector. The criteria were selected for their relevance and due to the lack of public information on some other criteria, e.g. on the level of compliance with existing ICT calculation methodologies.

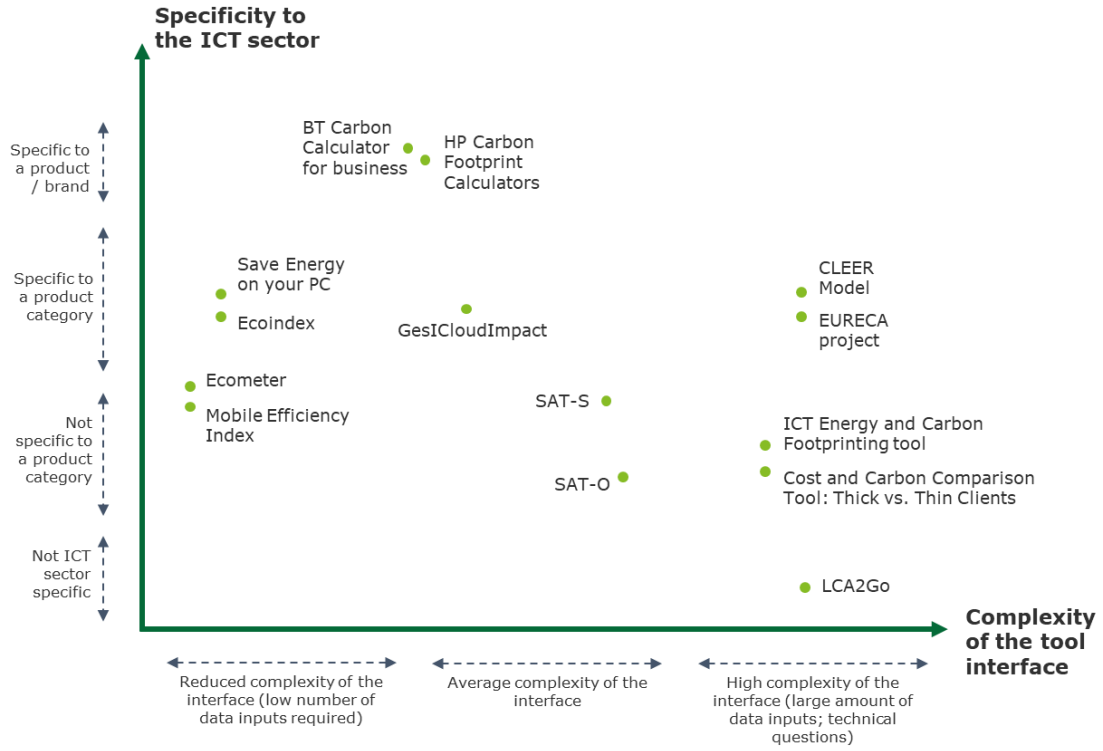


Figure 1: Comparative diagram of the tools identified

Calculation tools such as the CLEER Model or the EURECA project are specific to a given product category and predefined scenarios (servers and cloud servers) and require some preliminary knowledge on the topic to be used. Other tools such as the BT and the HP carbon footprint calculators are brand specific, although the assessment proposed does not require any technical background.

Please note that several tools (SASF, RenewIT) identified in Table 2 are not displayed on Figure 1 due to limited information accessed in the scope of the project.

The SAT-S and the SAT-O proposed as part of the ICTFOOTPRINT.eu initiative are not specific to a given product category and require from 10 to 20 data inputs. The aim of the tools is to raise awareness on environmental assessments, thus further insight is provided along with the questions to guide the end-user. These tools should be considered as complementary to other existing initiatives and should not be considered as assessment tools.

3.3. Certification schemes and labels for the ICT sector

In addition to the identification of calculation tools and best practices dissemination initiatives, the consortium listed a variety of labels and claims that may be used by "green ICT" players to display the environmental performance or approach of an ICT product or organisation (see list in Table 3 and on the ICTFOOTPRINT.eu platform).

Table 3: Identified labels and other communication claims within the scope of "green ICT"

Initiative	Organisation
Energy Star	U.S. Environmental Protection Agency
EU Code of Conduct on Data Centres' Energy Efficiency	European Commission
TCO Certified	TCO Development
Nordic Swan Ecolabel	Nordic Ecolabelling
Blue Angel	Der Blaue Engel
European Ecolabel	European Commission
EPEAT	Green Electronics Council
80 Plus	Ecova
Certified Energy Efficient Data Centre Award (CEEDA)	CEEDA
ECMA 360	ECMA

The labels and certifications schemes that do not apply to products sold on the EU market were not selected. All initiatives apply to at least one category of ICT products; however, several of them are not specific to the ICT sector (e.g. European Ecolabel, Blue Angel, etc.).

The initiatives may be distinguished based on various criteria, among which the inclusion of a rating system or not. For instance, the EPEAT or 80 Plus provide with various ratings, depending on the environmental performance of the products assessed. On the contrary, with Energy Star or the Nordic Swan Ecolabel, products are either under the scope or not of the initiative.

Finally, some initiatives may be compliant with the ISO 14020 [37] approach, a standard which sets the main principles of sustainable marketing. By providing accurate and avoiding misleading information on all relevant aspects of the life cycle of a product, the label or certification initiatives can be used to inform consumers and help them purchase more environmentally friendly products, or in Green Public Procurement policies. The ISO 14020 approach distinguishes between three categories of claims, depending on existence of verification by an eco-labelling body or third party for instance; or on the nature of the information (qualitative or quantitative).

4. Development of ICTFOOTPRINT.eu services

4.1. ICTFOOTPRINT.eu selection of success stories

By implementing best practices such as described in section 3, players from the ICT sector are improving the environmental and energy footprint of their activities and products. ICTFOOTPRINT.eu portfolio of success stories provides a good sign of relevant actions being deployed by the community that merit visibility. The ICT sector, despite becoming more aware of the importance and competitive advantages obtained from “green ICT”, still lacks information on the benefits and policy instruments to facilitate usage. This fact makes market engagement a difficult process.

ICTFOOTPRINT.eu recruited success stories from European and non-European countries, based on the consortium insight, as well as EAG members, synergies and communication efforts to collect relevant stories. Success stories answer a twofold purpose, by enabling relevant ICT providers and users to showcase their best practices, while providing examples to stakeholders on how they can achieve gains and competitive advantages thanks to sustainable ICT.

The selected success stories describe how players implemented changes towards improved environmental and energy footprint, through the use or the provision of:

- IT goods or services with reduced environmental impact;
- IT solutions aiming to reduce the environmental impact of the ICT sector.

All success story available online have the same page structure and type of content available, to make easier the information analysis:

1. **Organisation presentation**: Legal Name, City, Country, Contact, Website URL, Logo;
2. **Claim to fame** (max 500 characters): a short message explaining why the story is relevant for sustainable ICT landscape;
3. **Main benefits & achieved results** (max 1,000 characters): list all benefits and all results achieved;
4. **Presentation of the initiative** (max 700 characters):
    - Why the organisation/city/other started the initiative;
    - Short story describing the initiative;
    - Which standard or calculation methodology was used (if relevant);
5. **Commitments for the future & other relevant information** (max 600 characters): list all commitments and add links & figures for more information.

The list of success stories available on the ICTFOOTPRINT.eu platform is displayed in Appendix A – List of success stories.

4.2. Helpdesk

ICTFOOTPRINT.eu multilingual helpdesk, as one of the main services provided by the project, supports all those who are interested in improving the sustainability of their ICT. Since its launch in M6, available in 5 languages (English, French, German, Italian and Spanish), the helpdesk was an important tool to collect feedback from the online community. Supported was provided mainly through the Frequently Asked Questions (FAQ) page, which contains a knowledge base related to ICTFOOTPRINT.eu services and technical knowledge related to sustainable ICT. The FAQ management ensured that it is up to date, to avoid having outdated information (see

Figure 2).

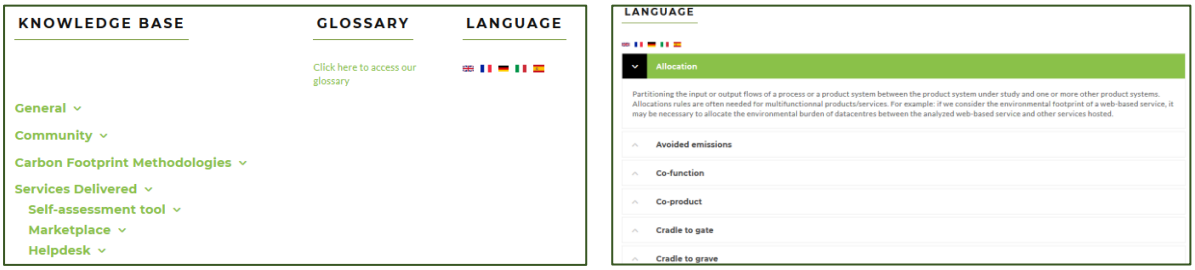
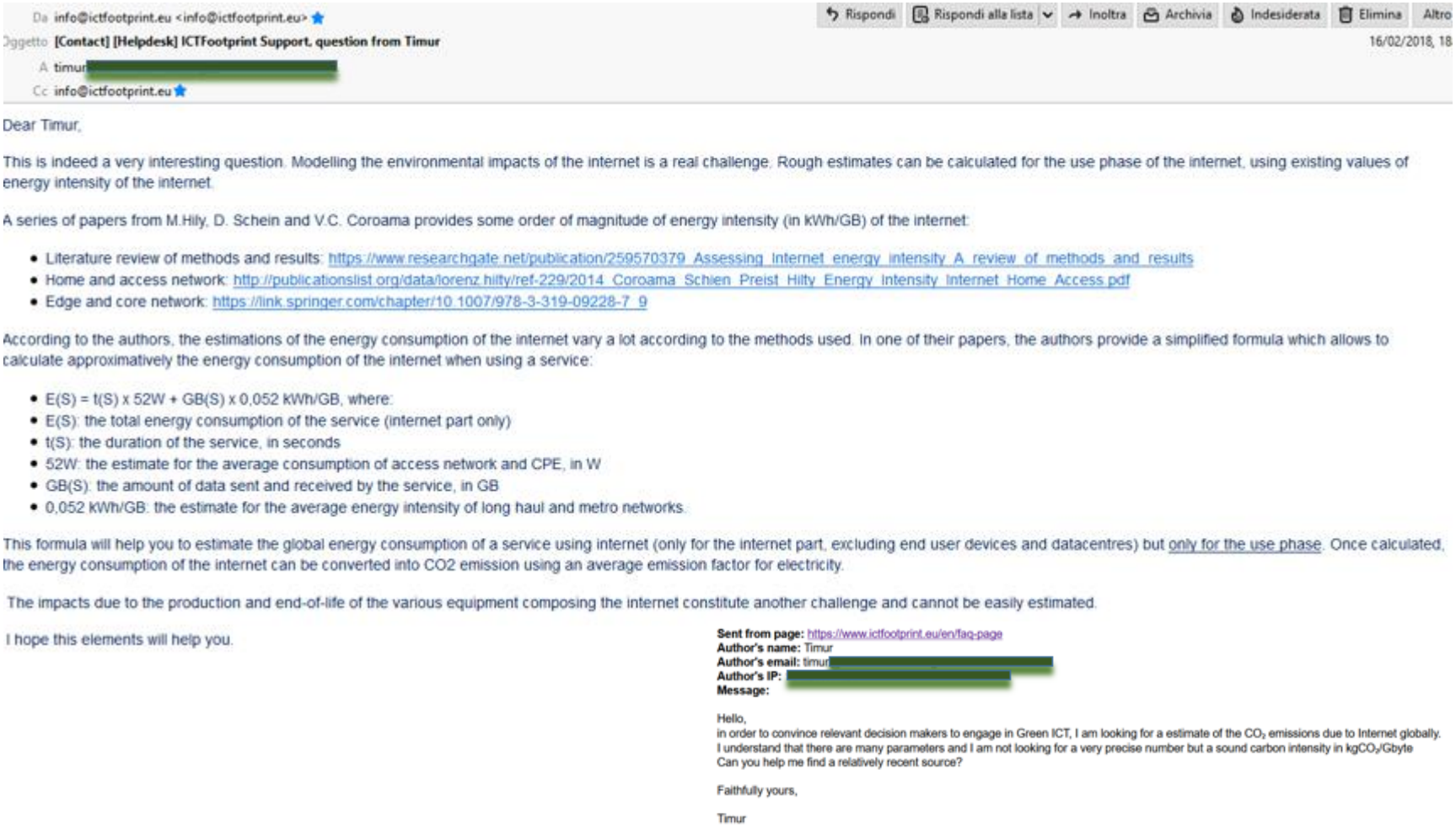


Figure 2: ICTFOOTPRINT.eu multilingual helpdesk with knowledge base's & glossary (detail)

Questions submitted by the users were either related to ICTFOOTPRINT.eu's services or to request more technical info regarding to ICT carbon footprint and the sustainable methodologies (see Figure 3).



Da info@ictfootprint.eu <info@ictfootprint.eu>

Oggetto **[Contact] [Helpdesk] ICTFootprint Support, question from Timur**

A timur[redacted]

Cc info@ictfootprint.eu

Rispondi | Rispondi alla lista | Inoltra | Archivia | Indesiderata | Elimina | Altro

16/02/2018, 18

Dear Timur,

This is indeed a very interesting question. Modelling the environmental impacts of the internet is a real challenge. Rough estimates can be calculated for the use phase of the internet, using existing values of energy intensity of the internet.

A series of papers from M.Hily, D. Schein and V.C. Coroama provides some order of magnitude of energy intensity (in kWh/GB) of the internet:

- Literature review of methods and results: https://www.researchgate.net/publication/259570379_Assessing_Internet_energy_intensity_A_review_of_methods_and_results
- Home and access network: http://publicationslist.org/data/lorenz.hilty/ref-229/2014_Coroama_Schien_Preist_Hilty_Energy_Intensity_Internet_Home_Access.pdf
- Edge and core network: https://link.springer.com/chapter/10.1007/978-3-319-09228-7_9

According to the authors, the estimations of the energy consumption of the internet vary a lot according to the methods used. In one of their papers, the authors provide a simplified formula which allows to calculate approximatively the energy consumption of the internet when using a service:

- E(S) = t(S) x 52W + GB(S) x 0,052 kWh/GB, where:
- E(S): the total energy consumption of the service (internet part only)
- t(S): the duration of the service, in seconds
- 52W: the estimate for the average consumption of access network and CPE, in W
- GB(S): the amount of data sent and received by the service, in GB
- 0,052 kWh/GB: the estimate for the average energy intensity of long haul and metro networks.

This formula will help you to estimate the global energy consumption of a service using internet (only for the internet part, excluding end user devices and datacentres) but only for the use phase. Once calculated, the energy consumption of the internet can be converted into CO2 emission using an average emission factor for electricity.

The impacts due to the production and end-of-life of the various equipment composing the internet constitute another challenge and cannot be easily estimated.

I hope this elements will help you.

Sent from page: https://www.ictfootprint.eu/en/faq-page
Author's name: Timur
Author's email: timur[redacted]
Author's IP: [redacted]
Message:

Hello,
in order to convince relevant decision makers to engage in Green ICT, I am looking for a estimate of the CO_2 emissions due to Internet globally.
I understand that there are many parameters and I am not looking for a very precise number but a sound carbon intensity in $kgCO_2/Gbyte$
Can you help me find a relatively recent source?

Faithfully yours,

Timur

Figure 3: Question submitted in the helpdesk & feedback from ICTFOOTPRINT.eu expert

After project completion, the helpdesk will be maintained by Trust-IT and Deloitte staff, as indicated with more detail in “Deliverable D3.3 Exploitation Plan & Sustainability Model”.

4.3. Map of the methodologies

For each ICT methodology selected and analysed, the consortium summarised the most relevant characteristics into a dedicated factsheet. The methodologies are displayed on a map available on the project platform (see also Figure 4), with the aim of providing 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.

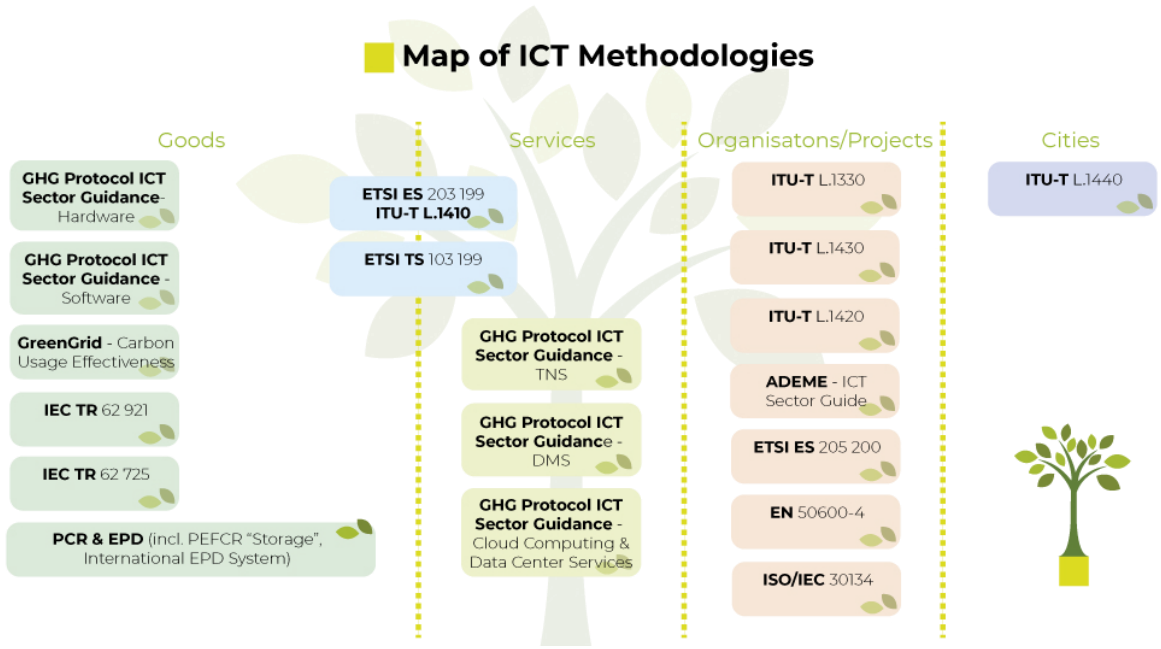


Figure 4: ICTFOOTPRINT.eu map of ICT methodologies

In particular, at the Review Meeting with the European Commission in September 2017 confirmed the relevance of the identified calculation methodologies; although two of them were considered out of scope of the project and removed from the map. In addition, the EAG helped identify the implementation of the Data Centre Maturity Model (DCMM) as a Technical Report into the EN 50600 standard, as well as the EN 50600 series elaborated as an ISO/IEC standard.

The feedback gathered as well as continuous market watch contributed to the addition and update of various associated factsheets, such as:

- ETSI ES 205 200, focused on global and specific KPIs for data centres and various types of access networks (update of factsheet after the publication of KPIs for global ICT sites and specific KPIs for mobile access networks);
- ISO/IEC 30134, which provides key performance indicators for data centre facilities and infrastructures, developed consistently with EN 50600-4 (update of factsheet for the addition of KPIs e.g. Energy Reuse Factor (ERF));
- ITU-T L.1330, on energy efficiency measurement and metrics for telecommunication networks (factsheets added at the end of the project).

A classification of the methodologies according to their nature (horizontal axis), the type of approach (vertical axis), and impact assessed (diagonal axis) may be found in deliverable D2.1. On the overall, the majority of the methodologies identified are based on the "footprint" approach either product-oriented or organisation-oriented. Most of them are dealing with a single environmental issue, mainly climate change: this reflects the fact that the ICT sector has historically focused on climate change issues. However, some methodologies are now considering other environmental impacts as required in the full life cycle assessment approach.

The final list of the methodologies displayed on the ICTFOOTPRINT.eu platform is available in Appendix B – Factsheets on ICT calculation methodologies.

4.4. Marketplace

Since its launch in Year 1, the Marketplace provided visibility to organisations, mostly from Europe, with services that increase ICT's sustainability levels. Organised in 6 categories (see Figure 5), the marketplace has today 30 companies showcasing their services to potential clients who are looking for ICT services with a reduced environmental footprint (see Figure 6).

Figure 5: ICTFOOTPRINT.eu marketplace home page

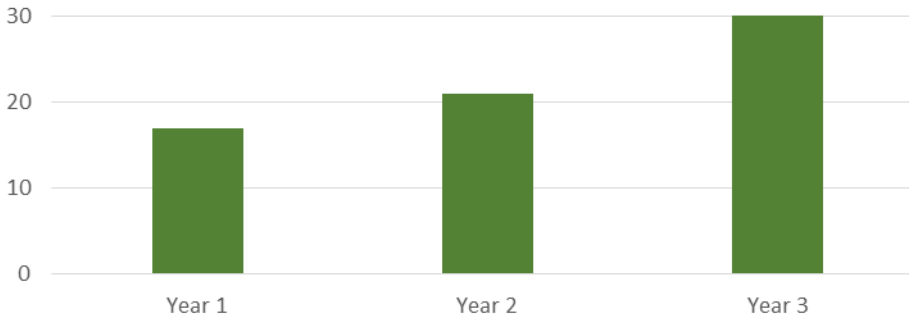


Figure 6: Number of sellers registered in the ICTFOOTPRINT.eu marketplace

As indicated in Figure 6, new sellers came on board to the marketplace during year 3 (Table 4), from different European countries (e.g. Sweden & Ireland). The list of all sustainable suppliers in the ICTFOOTPRINT.eu Marketplace is provided in Appendix C – Marketplace Suppliers.

Table 4: New ICTFOOTPRINT.eu marketplace suppliers during Year 3

Organisation	Country	Category
ASPERITAS	The Netherlands	Hardware
CAST	Italy	Advisory or Consultancy; Certifications & Other Services; Software
Club Green IT	France	Advisory or Consultancy; Certifications & Other Services
Consulting & Development Strategies	Switzerland	Advisory or Consultancy; Software
EasyVirt	France	Advisory or Consultancy; Software
EnergyElephant	Ireland	Advisory or Consultancy; Data Management; Hardware; Software
International Federation for Global and Green ICT	Switzerland	Advisory or Consultancy; Certifications & Other Services
TCO Development	Sweden	Certifications & Other Services

Since Year 2, the number of “Advisory or Consultancy” services increased (from 26% to 29%) likewise for “Software” category, which registered a small growth (from 20% to 21%). These two categories are the most popular ones, followed by “Certifications & Other Services” (18%), “Hardware” (14%) and Data Management (10%). The category with the least number of suppliers is “Connectivity” (8%) (see Figure 7). More statistical information related to the usage of the platform is available in deliverable “D2.4 Impact Assessment Report”.

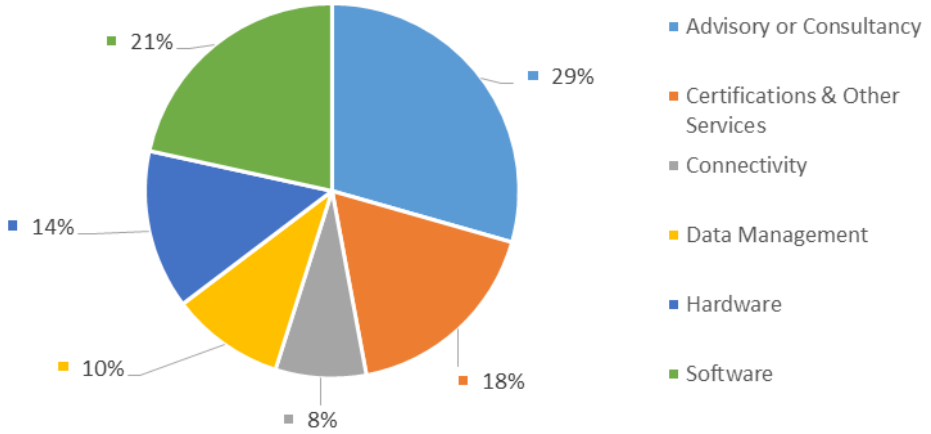


Figure 7: Type of services offered by ICTFOOTPRINT.eu marketplace sellers (Year 3)

All marketplace sellers were selected based on criteria selection.

4.5. Self-assessment tools

The self-assessment tools developed in the context of ICTFOOTPRINT.eu are simplified calculators that allow to estimate, by briefly answering a set of questions, the carbon and primary energy footprint of digital services and organisations. The aim of the tools is to raise awareness on the potential impacts

and main environmental hotspots of digital services and organisations, as well as on the use of ICT methodologies presented in section 3.

The SAT-S (Self-Assessment Tool for an ICT Service) is available on the ICTFOOTPRINT.eu platform since September 2017. Users can have a preliminary estimate of the carbon and energy footprint of web-based digital services (e.g. web-based services involving end user devices, transmission networks and datacentres).

The SAT-O (Self-Assessment Tool for an ICT-intensive Organisation) is available on the ICTFOOTPRINT.eu platform since February 2018. The tool allows users to estimate the carbon and primary energy footprint of ICT organisations, or ICT activities of non-ICT organisations. Similarly, the aim of the SAT-O is not to provide a full organisation footprint, but to give a first overview of the main contributors of the organisation to the carbon emissions and primary energy consumption using a simplified and easy to use methodological approach.

The scope of the SAT-O covers the ICT activities of an organisation, whether ICT user or ICT provider. Although ICT methodologies may recommend including all activities in the case of an ICT provider, this is not be the focus of the first version of the tool.

Feedback collected from users since the tools were implemented originate from online questionnaire, complemented during a dedicated workshop organised by the consortium, and at events during which the tools were showcased. Users concluded that the tools were helpful as awareness tools, and sufficiently user-friendly. In particular, the results come with a customised report explaining how to read the results, and potential actions to implement and reduce the environmental impact.

Further information on the tools may be found in dedicated deliverables as well as on the project platform.

5. Community engagement

During these 3 years, ICTFOOTPRINT.eu believes it managed to create a truly European community engaged on ICT and sustainability, from different organisations: "green ICT" suppliers, certification organisations, clusters of "green ICT" companies, policy members, large and small organisations, academia, cities, amongst others. The project brought to the table topics such as energy efficiency, life cycle assessments, ICT methodologies and standards, levers to increase "green ICT" procedures' adoption, etc. The continuous implementation of engagement activities with diverse stakeholders, through distinct but complementary channels, boosted the ICTFOOTPRINT.eu community growth.

During Year 3, ICTFOOTPRINT.eu organised a series of "Hands-on workshops" to obtain direct feedback from the users regarding the usage of ICTFOOTPRINT.eu tools (e.g. SAT-O & Light Certification Scheme), as well collected insight on potential recommendations to promote the adoption of "green ICT" by the European community. A final event was organised, co-located with the Connect Smart Cities Conference 2019 (CSCC), to showcase the project's final outputs, promote the marketplace sellers and collect feedback to be included in final deliverables (see Table 5).

Table 5: ICTFOOTPRINT.eu Spectrum of Public Participation during the whole project time-frame

	Information	Consultation	Cross-collaboration
	Keep the public informed.	Seek public's feedback by listening and acknowledge concerns and aspirations.	Work with the public to ensure concerns and aspirations are reflected in the services developed by the project.
Actions	• Newsletters • Pieces of News • Success Stories • Social Media (Twitter, LinkedIn, YouTube, SlideShare) • Messages • Presentations • Webinars • Communication Materials • Presence at Events • FAQ in 5 languages	• Questions on webinars • Helpdesk • Online Surveys on service satisfaction (SAT-S & SAT-O) • Engagement at Events • Interviews • Final Event	• Hands-on workshops (Amsterdam and Paris) • ICTFOOTPRINT.eu final event, Brussels • Service satisfaction Survey on SAT-O • Feedback collection regarding the Light Certification Scheme.

The community engagement through social media, webinars, EAG members, newsletters and the presence at third-party events, also brought on board new members, following the trend that was implemented in the previous 2 years (see Table 6)

Table 6: Overview of actively engaged organisations from Y1 to Y3

	Year 1	Year 2	Growth Y1 vs Y2	Year 3	Growth Y2 vs Y3
Webinars	121 participants	331 participants	+173%	493	48%
Marketplace	15 sellers	21 sellers	+40%	30 sellers	+43%
Success Stories	8 stories	37 stories	+362%	67	+81%
SAT-S Users	0 users (SAT-S made available on Year 2)	25 users	-	33	+32%

	Year 1	Year 2	Growth Y1 vs Y2	Year 3	Growth Y2 vs Y3
SAT-O Users	0 users (SAT-0 made available on Year 3)	0 users (SAT-0 made available on Year 3)	-	43	-
Light Certification Scheme	0 users (made available on late Year 3)	0 users (made available on late Year 3)	-	14 (being analysed)	-
Social Media	1.236 members	2.153 members	74%	2.950 members	+37%
SDOs	4 SDOs engaged	4 SDOs engaged	+0%	5 SDOs engaged	+25%

5.1. External Advisory Group (EAG) members

Year 3 on boarded additional new EAG members with additional know-how, to enrichen the esteemed group of experts and to ensure engagement (see Table 7).

Table 7: ICTFOOTPRINT.eu EAG new members (Year 3)

Name	Institution	Country	Recruitment	Info
Beat Koch	Green IT Plus	Switzerland	Introduced by EAG member Jaak Vlasveld	Beat is a software engineer and environmental consultant focusing on sustainable ICT procurement, operation and disposal. He attended the final event.
Rita Tedesco	ECOS	Belgium	Replaced former EAG Thomas Wilson, who left ECOS	Rita responsible for standardisation work on Smart Grids, Electro-Mobility, Smart Homes and Buildings. Rita also worked in the NGO Transport & Environment where she undertook policy and technical research on biofuels and renewable energy alternatives. She attended the ICTFOOTPRINT.eu workshop in Paris

Besides the support provided in Year 1 and Year 2, EAG members kept supporting ICTFOOTPRINT.eu activities in distinct levels. **Beat Koch** joined the final ICTFOOTPRINT.eu webinar to present generic web applications for assessments and catalogues, developed by Green IT Switzerland that increase your ICT sustainability. **Mark Acton**, co-chair of Code of Conduct, was a speaker on the 11th ICTFOOTPRINT.eu webinar presented standards and best practices related to ICT Sustainability, particularly in relation to data centres. Mark also joined the "Hands-on workshop" in Amsterdam, were he presented the Code of Conduct and made suggestions on how to improve the just-launched SAT-O. **Jaak Vlasveld**, from Green IT Amsterdam, also attended the workshop, where he made not only a presentation how sustainable policies support "green ICT" adoption in Amsterdam, but also introduced the Green IT Global, a global network motivated to promote green ICT. Jaak attended the "ICTFOOTPRINT.eu networking session" that took place at ICT2018 Vienna. The new member **Rita Tedesco**, along with **Thomas Corvaisier**, joined the "Hands-on workshop" in Paris, where they contributed to the identification of recommendations to promote "greener ICT" in Europe. At ICTFOOTPRINT.eu final event in Brussels, the EAG members **Beat Koch** and **Derek Webster** joined a panel session to discuss on how to increase "green ICT" adoption in Europe, along with other IT experts.

Through this third year, EAG members were contacted by ICTFOOTPRINT.eu consortium to contribute for project activities, namely:

- Invite to hands-on workshop in Amsterdam and Paris;
- Invite to ICTFOOTPRINT.eu networking session in Vienna and final event in Brussels;
- Provide feedback on:
    - "Green ICT" initiatives (calculation tools, guidelines, labels and best practices);
    - New additions to the Map of ICT Methodologies (ITU-T L.1330 & IEC TR 62726:2014);
    - ICTFOOTPRINT.eu Light Certification Scheme, developed together with ICIM.

5.2. Helpdesk users

As described in deliverable "D2.4 Impact Assessment Report", the helpdesk reached over 1.600 views and most of the users requested were from marketplace sellers, individuals looking for some reports related to "green ICT", suggestions for the Map of ICT Methodologies or other initiatives looking for new partnerships with ICTFOOTPRINT.eu.

5.3. Success stories subscribers

During Year 3, Success Stories catalogue increased the number of stories available. Twenty-nine new stories were made available, thanks to desktop research, stories from marketplace suppliers (e.g. Verne Global) and synergies with the Green Digital Charter and Green IT Global (where AGIT belongs to). These stories (see Appendix A), which come from different stakeholders, such as SMEs, large organisations, cities and academia / research centres, are organised by category of stakeholder. By using a filter, the website user easily can easily identify the stories that may interest him the most and understand how his peers became sustainable in their IT. So far, the online catalogue reached over 1.200-page views.

5.4. Industry engagement

5.4.1. Suppliers & buyers of the marketplace

ICTFOOTPRINT.eu marketplace increased its number of sellers up to 30 organisations, being the second most popular section of the website. New countries joined the seller community (e.g. Ireland & Italy), which enriched the offer available in the platform. The full list of sellers is shown in Appendix C – Marketplace Suppliers. Some suppliers joined actively certain ICTFOOTPRINT.eu activities.

Regarding webinars, **ASPERITAS & Start2Act** were speakers on ICTFOOTPRINT.eu 9th webinar, while **EasyVirt** and **GREENSPECTOR** (this one for the 2nd time) joined the 10th edition and **CircularComputing** joined the 11th edition. Each one had the possibility to introduce their organisations and their ICT services (with a focus on energy efficiency and environmental footprint, applied to both data centers and other IT equipment).

Focusing on ICTFOOTPRINT.eu events, **Carbon3IT** joined as speaker both "hands-on workshop Amsterdam" and "ICTFOOTPRINT.eu final event" in Brussels. The company had the opportunity to promote their brand, services and to demonstrate its expertise to potential partners and clients. **GREENSPECTOR, IFGICT, C&Ds** and **Club Green IT** both joined the "hands-on workshop Paris", where had the opportunity to join panel discussions. Club Green IT had the opportunity to do a presentation about company's services, in front of the entire audience. At ICTFOOTPRINT.eu final event, **Carbon3IT** and **Circular Computing** joined a panel to discuss how "green ICT" may bring innovation to the European economy.

5.4.2. Other players

During Year 3, ICTFOOTPRINT.eu had the opportunity to expand its network and engage actively with other players. For SDOs, the French body ADEME joined ICTFOOTPRINT.eu networking session to make a presentation about GreenConcept, (project which had already been presented in in ICTFOOTPRINT.eu 8th webinar, by AGIT). The project consolidated its partnership with AGIT. The 8th webinars speakers' panel was composed entirely by members of AGIT network and the "hands-on workshop Paris" was organised in partnership with AGIT. Plus, AGIT is also part of Green IT Global Network, which provided a list of success stories that are now available in ICTFOOTPRINT.eu online catalogue. ICTFOOTPRINT.eu promoted the AGIT's White Paper on Digital Services' eco-design in its channels (French Version) and the English version will be promoted as soon as it is available.

Likewise, in the previous 2 years, ICTFOOTPRINT.eu counted with Green Digital Charter project, which had dedicated presentations at ICTFOOTPRINT.eu events (Networking Session in Vienna and ICTFOOTPRINT.eu final event in Brussels) and shared some stories for the online catalogue.

Related to the Light Certification Scheme initiative, ICTFOOTPRINT.eu established partnerships ICIM, a certification body focused on energy efficiency and renewable energy, who joined the project. Plus, WeForest, a non-profit organisation who is fighting global warming by planting trees in tropical countries to decrease carbon levels in the planet, became the official carbon off-set of the certification scheme. ICTFOOTPRINT.eu brought to its community organisations who are not directly related to Green IT but share the same mind-set of decreasing carbon footprint levels, across different sectors. ICIM joined the official presentation of the Light Certification Scheme at ICTFOOTPRINT.eu networking session in Vienna, while WeForest joined as an attendee the ICFOOTPRINT.eu final event in Brussels.

As mentioned in "D2.4 Impact Assessment Report", during Year 3 ICTFOOTPRINT.eu also joined third-party events, by joining panels, preparing an exhibition booth or doing a dedicated presentation, which allowed to get further direct feedback from stakeholders about project's results, promote the brand and network with new individuals interested in "green ICT". Plus, ICTFOOTPRINT.eu's work is still being recognised by key initiatives, by receiving invitations to be a speaker at 3rd party events, even after the end of funding period. The project was invited to be a panellist at World Summit on the Information Society (WSIS), an international forum organised by ITU, UNESCO, UNDP and UNCTAD, which gathers together people interested in ICT for Sustainable Development Goals sharing and learning. Taking place in April 2019, at Geneva (Switzerland), ICTFOOTPRINT.eu is discussing its participation on the "the "ICT and Pollution Panel Discussion". The invitation is a recognition of ICTFOOTPRINT.eu efforts on helping ICT sector on increasing efficiency and reducing its carbon footprint

More info regarding community engagement is available in deliverable "D4.4. Third Annual Report on ICTFOOTPRINT.eu Communication & Outreach Activities".

6. Conclusions

During the three years of the project, the consortium had the opportunity to conduct an in-depth market watch, complemented by feedback gathered from the various ICTFOOTPRINT.eu services as well as during events organised or attended by the consortium.

Results show that the contribution of the ICT sector to the European electricity consumption and carbon emissions is increasing over the years, although results may vary according to sources. The trend is explained, among others, by changes in consumer patterns and use of ICT to optimise the processes and impacts from other sectors ("IT for green"). It includes the significant improvements that have been made in the past decade towards "greener IT", e.g. regarding energy efficiency of hardware.

Although ICTFOOTPRINT.eu focuses on the energy and carbon footprint of ICT, other environmental impacts from the sector should be considered, such as water pollution or mineral depletion. These aspects are gradually being addressed by the market and policies, moving from "green ICT" to "responsible ICT".

Along this period, the project was put in perspective with the overall ICT sector and compared against other existing initiatives. The market watch conducted to the identification of:

- Best practices guidance that can be implemented by ICT providers to reduce the environmental footprint of ICT products or activities;
- Awareness and assessment tools available to ICT users and providers, to better understand how to evaluate the environmental footprint of ICT products or activities;
- Certification schemes and labels available to ICT users, e.g. as keys in procurement choices.

The project was also the opportunity to develop several services, complementary to the existing initiatives identified. Please note that an illustrative assessment of the project is provided in deliverable D2.4, dedicated to the impact assessment of the ICTFOOTPRINT.eu initiative.

The community engagement continuously increased during the three years of the project, both in numbers and engagement in ICTFOOTPRINT.eu. It appears that there is a need for more knowledge sharing on the topic: in particular, success stories seem to be an important mean to communicate on the benefits from implementing one (or various) of the initiatives displayed in the deliverable, notably to inspire other ICT users or providers.

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Appendix A – List of success stories

Nº	Organisation	Organisation Type	Country
1	Linkoping	City / Public Administration	Sweden
2	Malmo	City / Public Administration	Sweden
3	China Southern Power Grid	Public Company	China
4	Lexmark	Large Enterprise	USA
5	Walhalla	SME	Spain
6	BMW Group	Large Enterprise	Germany
7	EARLHAM Institute	Academia/Research	United Kingdom
8	Verne Global	SME	Iceland
9	HM Land Registry	City / Public Administration	UK
10	Capgemini	Large Enterprise	UK
11	Deutsche Telekom	Large Enterprise	Germany
12	Equinix	Large Enterprise	UK
13	FCO Services	City / Public Administration	UK
14	Logicalis	Large Enterprise	UK
15	Politecnico di Milano	Academia/Research	Italy
16	PuzzlePhone	SME	Finland
17	Atman	Large Enterprise	Poland
18	Fairphone	SME	The Netherlands
19	Jerlaure	SME	France
20	Microsoft	Large Enterprise	Ireland
21	STMicroelectronics	Large Enterprise	Switzerland
22	Hoylake Holy Trinity CofE Primary School	Academia/Research	UK
23	Bedford Drive Primary School	Academia/Research	UK
24	Bexley Business Academy	Academia/Research	UK
25	St Jeroms School	Academia/Research	UK
26	Digital3rd	SME	UK
27	Beaulieu College	Academia/Research	South Africa
28	University of Coimbra	Academia/Research	Portugal
29	Postbank	Large Enterprise	Germany
30	Sun Microsystems (Oracle)	Large Enterprise	USA
31	Altron	SME	Czech Republic
32	Telia Sonera	Large Enterprise	Sweden
33	EDF	Large Enterprise	France
34	KPN	Large Enterprise	The Netherlands
35	Goethe University Frankfurt	Academia/Research	Germany
36	Federal Ministry of the Interior	City / Public Administration	Germany
37	Centre of Registers and Information Systems	City / Public Administration	Estonia
38	Queen Margaret University	Academia/Research	UK
39	FollowMe – Printing Joint Procurement	City / Public Administration	Finland
40	Joint Procurement of ICT Infrastructure and Devices	City / Public Administration	Finland
41	RVX	SME	Iceland

Nº	Organisation	Organisation Type	Country
42	Digiplex and Stockholm Exergi	City / Public Administration	Sweden
43	TELEHOUSE	SME	France
44	European Commission	Government/Public Services	Belgium
45	Aperam	Large Enterprise	Luxembourg
46	GreenConcept Project	Government/Public Services	France
47	COOP	Large Enterprise	Switzerland
48	Green Data Center Platform	Other	The Netherlands
49	EURECA project	Other	UK
50	Schuberg Philis	Small & Medium Enterprise	The Netherlands
51	Network Energy St.Gallen	Government/Public Services	Switzerland
52	EnergieSchweiz	Government/Public Services	Switzerland
53	Valérie Schneider Conseil	Small & Medium Enterprise	France
54	Point de M.I.R, Maison de l'Informatique Responsable	Small & Medium Enterprise	France
55	Green IT Week	Other	The Netherlands
56	Alliance Green IT	Other	France
57	Zurich Insurance Company	Large Enterprise	Switzerland
58	GreenServe	Government/Public Services	The Netherlands
59	Nederland ICT	Small & Medium Enterprise	The Netherlands
60	Cabinet Ricard & Ringuier	Small & Medium Enterprise	France
61	Toyota	Large Enterprise	Australia
62	Gerrard Street	Small & Medium Enterprise	The Netherlands
63	HP & Sinctronics	Large Enterprise	Brazil
64	Google	Large Enterprise	Worldwide
65	Mazuma Mobile	Small & Medium Enterprise	UK
66	Re-Tek	Small & Medium Enterprise	UK
67	Design4Green	Academia / Research	France

Appendix B – Factsheets on ICT calculation methodologies

Methodology / Associated factsheet	Development organisation (incl. SDOs)	Area of operability
ADEME – ICT Sectoral Guidance	ADEME (French Environment and Energy Management Agency) CIGREF (association of large French companies dealing with ICT thematics)	Organisations / projects
EN 50600-4: Information technology: Data centre facilities and infrastructures	European Standards	Organisations / projects
ETSI ES 203 199/ITU-T L.1410: Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services	The European Telecommunications Standards Institute (ETSI) The International Telecommunication Union (ITU)	Goods & Services
ETSI ES 205 200: Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures	The European Telecommunications Standards Institute (ETSI)	Organisations / projects
ETSI 103 199: Environmental Engineering (EE); Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements	The European Telecommunications Standards Institute (ETSI)	Goods & Services
IEC TR 62725:2013 Analysis of quantification methodologies of greenhouse gas emissions for electrical and electronic products and systems	International Electrotechnical Commissions (IEC)	Goods
IEC TR 62921:2016: Quantification methodology for greenhouse gas emissions for computers and monitors	International Electrotechnical Commissions (IEC)	Goods
ISO/IEC 30134: Information technology – Data centres – Key Performance indicators	The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC)	Organisations / projects
ITU-T L. 1330 - Recommendation ITU-T L.1330: Energy efficiency measurement and metrics for telecommunication networks	The International Telecommunication Union (ITU)	Organisations / projects
ITU-T L.1420 - Recommendation ITU-T L.1420: Methodology for energy consumption and greenhouse gas emissions impact assessment of information and communication technologies in organisations	The International Telecommunication Union (ITU)	Organisations / projects
ITU-T L.1430 - Recommendation ITU-T L.1430: Methodology for assessment of the environmental impact of information and communication technology greenhouse gas and energy projects	The International Telecommunication Union (ITU)	Organisations / projects

Methodology / Associated factsheet	Development organisation (incl. SDOs)	Area of operability
ITU-T L.1440 - Recommendation ITU-T L.1440: Methodology for environmental impact assessment of information and communication technologies at city level	The International Telecommunication Union (ITU)	Cities
GHG Protocol ICT Sector Guidance – Cloud Computing and Data Centre Services	The GHG Protocol	Services
GHG Protocol ICT Sector Guidance - Desktop Management Services (DMS)	The GHG Protocol	Services
GHG Protocol ICT Sector Guidance – ICT Hardware	The GHG Protocol	Goods
GHG Protocol ICT Sector Guidance – Software	The GHG Protocol	Goods
GHG Protocol ICT Sector Guidance - Telecommunications Network Services (TNS)	The GHG Protocol	Services
Carbon Usage Effectiveness (CUE): A Green Grid Data Centre Sustainability Metric	The GreenGrid	Goods
ISO/IEC 30134: Information technology – Data centres – Key Performance indicators	The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC)	Organisations / projects

Appendix C – Marketplace Suppliers

Organisation	Country	Category	Recruitment Year
ASPERITAS	The Netherlands	• Hardware	Y3
Caelus Sustainability Consulting	United States of America	• Advisory or Consultancy	Y1
Carbon3IT	United Kingdom	• Advisory or Consultancy • Certifications & Other Services	Y1
CAST	Italy	• Advisory or Consultancy • Certifications & Other Services • Software	Y3
CELESTE	France	• Connectivity • Data Management • Hardware	Y2
Certios	The Netherlands	• Advisory or Consultancy • Certifications & Other Services	Y2
Circular Computing	United Kingdom	• Hardware	Y1
Club Green IT	France	• Advisory or Consultancy • Certifications & Other Services	Y3
Consulting & Development Strategies	Switzerland	• Advisory or Consultancy; Software	Y3
Deloitte Sustainability	France	• Advisory or Consultancy • Software	Y1
EasyVirt	France	• Advisory or Consultancy • Software	Y3
ecoinvent	Switzerland	• Data Management	Y1
EnergyElephant	Ireland	• Advisory or Consultancy • Data Management • Hardware • Software	Y3
Enervalis	Belgium	• Software	Y1
Escan	Spain	• Advisory or Consultancy • Certifications & Other Services • Data Management • Software	Y2
Extreme Low Energy	United Kingdom	• Hardware	Y2
Green Digital Charter	Belgium	• Connectivity	Y1
GreenGageIT	United Kingdom	• Advisory or Consultancy	Y2
GreenGoWeb	Switzerland	• Software	Y1
GREENSPECTOR	France	• Software	Y1

Organisation	Country	Category	Recruitment Year
International Federation for Global and Green ICT	Switzerland	• Advisory or Consultancy • Certifications & Other Services	Y3
Maki Consulting	Germany	• Advisory or Consultancy	Y1
Network DNA	United Kingdom	• Connectivity • Hardware • Software	Y1
Planet First	United Kingdom	• Certification & Other Services	Y1
Start2Act	Hungary	• Advisory or Consultancy	Y2
TCO Development	Sweden	• Certifications & Other Services	Y3
The Green Grid	United States of America	• Advisory or Consultancy • Certifications & Other Services	Y1
Verne Global	United Kingdom	• Data Management	Y1
Wi6labs	France	• Connectivity • Hardware • Software	Y1