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D2.3 - SECOND 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
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
WEEE	Waste Electrical and Electronic Equipment

Executive Summary

The present deliverable describes the global and emerging trends in the green ICT sector, with regards to: environmental indicators; emerging best practices and subsectors; and more generally, the inclusion of green IT practices in a broader perspective, including economic, social and societal aspects. A specific focus is made on green public procurements. It should be considered as a complement to the deliverable D2.2, which introduced the concept of “sustainability in ICT”, by opposition to “sustainability by ICT” (i.e. contributing to other sectors) and gave a first insight of the green ICT market and involved players.

This vision is based on the insight acquired by the ICTFOOTPRINT.eu initiative during the first two 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.

Moreover, the report outlines activities and results achieved with regards to community engagement, and the 3rd year plan to manage and analyse information gathered from the users, e.g. through the helpdesk support tool. A plan for complete development of all ICTFOOTPRINT.eu services is also described.

The present deliverable is the second issue of the report. A first version was delivered at the end of the first year of activities (D2.2), and a third version will be issued at project completion (D2.5).

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 ICT 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", by opposition to "sustainability by ICT" (i.e. contributing to other sectors). The present deliverable focuses on the global and emerging trends in the green ICT sector, with regards to: environmental indicators; emerging best practices and subsectors; and more generally, the inclusion of green IT practices in a broader perspective, including economic, social and societal aspects.

1.2 Structure of the document

The document is structured as follow:

Section 1, this section, 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 specific focus is made on green public procurements.

Section 3 focuses on the various means identified by the consortium to support and enhance more responsible ICT, from best practices to calculator tools.

Section 4 describes the development of ICTFOOTPRINT.eu services on the project platform since the previous market watch report from January 2017. A particular focus is given to the update of the map of calculation methodologies specific to the ICT sector, as well as on the self-assessment tools.

Section 5 provides an update on the community engagement during the second year of the project.

Section 6 analyses the results and engagement observed during the two past years of the project and details a plan of action for the third and last year of the project. **Section 7** concludes this document and sets the next steps.

Appendixes A to D provide supportive information such as the identified calculation tools developed with the aim of enhancing the green IT in the sector; and updated content provided on the project platform (additional success stories, updated factsheets on ICT methodologies and marketplace).

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 second of three deliverables outlining the activities and results achieved in the course of the project. A first deliverable D2.2 was produced at the end of Year 1 and is available on the project platform. The last deliverable D2.5 will follow at the end of year 3.

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 during Year 2, mainly from the Review Meeting with the European Commission in September 2017 and from the External Advisory Group (EAG) members. In addition, the consortium conducted in-depth analysis in order to update and complement the first insight provided in the deliverable D2.2 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 overview of the green ICT sector and associated players in the EU may be found in deliverable D2.2. The aim of the present section is to complement this approach by focusing on growing trends in the ICT sector, in particular by approaching environmental-friendly topics as part of a broader strategic approach. A particular focus is given to public procurement approaches.

2.1 Global trends of "green IT" in the EU

The contribution of the ICT sector in the overall energy consumption and GHG emissions is increasing over the years, in the EU and worldwide. When looking at energy efficiency and carbon footprint of ICT equipment, significant improvements have been made in the past decade, 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. Further detail may be found in the first market watch provided in deliverable D2.2.

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 [1] 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, 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 3.2.

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. 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, according to the sources considered [2]. 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.

In addition, although the energy consumption and carbon footprint are two environmental impact indicators now largely used by the ICT sector, 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 [3].

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 [4].

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 [5]. 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 [6], 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 [5]. 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% [5]. 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 [7]. 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 in 2012 to sourcing their data centres with 100% renewable energy, a growing number of organisations is working on reducing the energy consumption and GHG 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 [3]. 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 [8]; 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 [9] [10].

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 [11]. 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 [2].

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 focuses 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 dedicated page of the ICTFOOTPRINT.eu platform.

2.2 Moving from "green IT" to "responsible ICT"

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 IT" aspects and can be set in a broader context of "responsible IT", to account as well for initiatives and actions towards improved social and economic performance. "Responsible IT" 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 [12].

The current trend for companies that adopt a CSR strategy is to progressively extending 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 [13]. 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 [3]. 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 [3] [14].

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) [15], replacing the Data Protection Directive 95/46/EC [16] from May 2018.

The regulatory approach is also a strong incentive on digital inclusion and web accessibility aspects. The Directive 2016/2102 [17] 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 [18].

2.3 Focus on "green" public procurement in the ICT sector

By using their purchasing power to choose environmentally-friendly goods and services, European public authorities have the potential power to support the development of a market of sustainable products and services and reduce negative environmental impacts.

2.3.1 Green policies in Europe

Green Public Procurement (GPP) is a voluntary instrument which aims at facilitating the purchase of products, services and works with reduced environmental impacts by public authorities. In 2016, the European Commission published the EU GPP criteria on computers and monitors [19], guiding public bodies in the purchase of energy efficient equipment, a specific obligation for national governments set out in the Energy Efficiency Directive 2012/27/EU [20]. However, these guidelines are limited in scope to stationary computers, display devices (monitors) and portable computers. The criteria focus on the most significant environmental impacts during the life-cycle of the products (energy consumption, hazardous substances, product lifetime extensions, end of life management).

The extraction and recovery of metals and Critical Raw Materials from computer and display products at the end of their life has the potential to increase the EU's resource efficiency and reduce the impact of making new IT products. The criteria therefore reflect the state of the art for encouraging the selective dismantling and disassembly of equipment.

Key Environmental Aspects	GPP Approach
• Energy consumption and resulting Greenhouse Gas emissions from production and use. • Air, soil and water pollution, bioaccumulation and effects on aquatic organisms due to raw material extraction and processing, and hazardous substances used in products. • Consumption of finite resources and critical raw materials to produce IT products. • Generation of potentially hazardous waste electronic equipment upon its final disposal	• Purchase energy efficient models • Purchase products with a restricted amount of hazardous constituents and with a reduced potential for hazardous emissions upon disposal • Design for durability, upgradeability and repairability • Product life extension upon the end of its service life • Design for dismantling and End-of-life management to maximise the recovery of resources

Please note that the order of environmental aspects does not necessarily translate to the order of their importance.

Figure 1: Key environmental impacts, EU GPP on computers and monitors [19]

In terms of management accounting, adopting a life-cycle perspective corresponds to measuring the **Total Cost of Ownership (TCO)** which helps determine the direct and indirect costs of a product or system. The objective is to buy high quality products and have an external vendor to manage the ICT-products at end of life [21]. This approach was adopted by the Swedish city of Malmö: a living dialogue forum was created by the city of Malmö with the chosen ICT-distributer and logistics partner ATEA, active in the Electronic Industry Citizenship Coalition (EICC) [22] to develop environmental-friendly ICT. On regular basis, ICT product portfolio is developed and changed so the municipality has access to the best assortment from a sustainable perspective. When looking at additional requirements to suppliers, the Helsinki City Council added a description of the required recycling process, following the EU WEEE Directive and the EU RoHS Directive.

GPP are most of the time part of a broader environmental policy or strategy. As an example, Stockholm's 'Green IT strategy' [23] includes 9 action areas to increase energy efficiency, including a eco-friendly and cost-efficient IT procurement, green data centres and telecommunications, and more efficient printouts. The strategy in particular states that "the environmental in the data communications sphere can be reduced by setting environmental criteria for the acquisition and operation of network equipment. In the IT infrastructure and operations sphere, Green IT is primarily about reducing energy consumption by making optimum use of networks and other infrastructural resources". Finally, Stockholm Data Parks [24] is an initiative aiming at making of Stockholm an attractive hub for large data centers which employ heat recovery for district heating (GleSys data centre company).

Another important topic is on datacentres. In 2011, the city of Malmö asked its vendor Schneider Electrics to conduct an energy audit of existing datacentres. Conclusions from an energy management perspective led the city administration to close down the existing datacentres and instead use collocation services from two external suppliers. The objectives was to reach a Power Usage Effectiveness (PUE) value lower than 1.4. The goal around virtualisation was 90% of the business systems, and the number of physical servers was reduced by about 50%.

From a general perspective, it appears that virtualisation is still an emerging topic; both end users (public bodies included) and services providers are learning. It requires professional management and experience to understand energy savings calculation and resists marketing arguments from vendors.

As previously argued, encouraging more aggregation of public sector contracting authorities to create superstructures may be a way for the public sector to pool knowledge together. Ten years ago, the Irish central government mandated an IT infrastructure for shared services, which had to be restructured in 2016. Rapid digitalisation creates a continuous need to evolve and improve services, requires building new datacentres and optimise the usage of existing ones. In the Irish case, the Shared Services' mandate was widened to all public-sector entities [25].

One of the objectives of the H2020-funded EURECA project is to increase the capacity of the European public sector through bespoke training and knowledge-sharing programmes. The EURECA training kit is dedicated to public procurement for innovation (PPI) of 'environmentally-sound' data centre products and services [26]. This online training module covers various aspects of innovation procurement (such as policies, timelines and business case development) as well as technical best practices, standards and frameworks related to datacentre energy efficiency. This training platform is accessible to any person registered to the EURECA platform.

2.3.2 The procurement process

Chapter 2 of the EU handbook on green public procurement [27] provides a series of advice to demonstrate cost savings through GPP, or to lower investment barriers, including life-cycle costing, joint procurement, framework agreement or energy performance contracting.

Joint procurement, defined as the combination of procurement activities of a group of public authorities, can enable the public sector to achieve savings through bulk buying but can also reduce administrative costs, and pool knowledge altogether on the environmental, technical and market perspectives. The city of Tampere opted for the joint procurement of ICT infrastructures and devices with the eight neighbouring municipalities of Tampere City Region. All parties agreed that the properties of the devices should fulfil at least the minimum requirements of environmental standards. The procurement of the web hosting required for ICT was centralised, and the energy needs of the datacentre optimised. For example, part of the heat energy produced by the devices is used for building heating [28]**.**

Another way of increasing the efficiency of tendering while implementing GPP is the adoption of a **framework agreement**. Established with one or more operators, this solution allows for multiple contracts to be awarded without repeating the whole procurement process. It may create incentives for suppliers to offer environmentally enhanced solutions.

The City of Helsinki's Procurement Centre acts as a central purchasing unit and manages purchasing framework agreements, with approximately 10,000 computers purchased every year by the City. In October 2014, an open procedure was launched, dividing the tender into five lots, including desktop computers and laptops/notebooks [29]. The framework contract was made with three operators / suppliers and consisted of a 24-month lease to purchase contract, with possible extensions. Energy savings were estimated about 27% and cost saving about €72,000 over the lifetime of the products.

2.3.3 Contract requirements for eco-friendly IT equipment

Technical standards, label as well as GPP criteria are valuable sources of information when defining the requirements of a public contract. Technical specifications and standards have two functions: describing the contract to the market so that companies can decide whether it is of interest to them; and providing measurable requirements to evaluate tenders. Technical specifications may be formulated by reference to European, international or national standards.

The omnipresence of the American 'Energy Star' standards for energy performance demonstrates that the market may not be considering the European market as a main target (including in the EU GPP guidelines and related good practices published by the European Commission. e.g. the French Communauté Urbaine de Dunkerque [30], Helsinki City Council, Stockholm County Council, etc.).

Third-party labels can be introduced as well to demonstrate the willingness of the public contractor, a position adopted by the city of Malmö that reached the impressive level of 98% of environmentally labelled IT products in 2013. Malmö indeed only purchased products that came with recognised third-party environmental certifications, such as Germany's Blue Angel or TCO Certified [31].

2.3.4 Challenges

Despite the publication of the 'Green Procurement Handbook' by the European Commission in 2006, cities still face legal uncertainty when including environmental criteria in public tenders. They face difficulties when evaluating the services of the products from the environmental point of view. And sometimes, the green products or services they want to purchase do not yet exist on the market. There

could also be a tension between the desire to procure green products and the desire to procure local SMEs but none of them can fulfil the environmental criteria [32].

Contracting authorities experience considerable problems with the procurement of ICT systems. The ICT environmental of a contracting authority consists of different interconnected systems. This means that additional works, such as extra licences and suitable new modules, cannot always be tendered for without serious inconvenience, both technical and financial [32].

In an age of cuts in administrations' operational costs, public tenders are often awarded on the basis of price. An important gap in prices between solutions definitely represents an obstacle. Here lies the importance for public bodies to measure and assess the energy savings in the long-run as well as the overall environmental impact of the ICT equipment from a life-cycle perspective.

3 Best practices, success stories and tools in the European ICT sector

Examples of best practices and success stories identified during Year 1 are provided in the deliverable D2.2. The aim of the present section is to complement the first overview with an update on identified success stories, and to present as well the main calculation tools and certification schemes applicable to the ICT sector. These initiatives may be used to support and enhance the uptake of calculation methodologies, and more generally green and responsible ICT. Please note that most of the content provided in the section will also be available on the platform.

3.1 Best practices implemented in Europe

This section presents the ongoing work of the Consortium that aims 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,

The scope may be extended to other relevant best practices during the next steps of this task.

Among the key BP guides and initiatives applicable to the ICT sector, the "European Code of Conduct for ICT" [33] series remain one of the most widely recognized. The CoC for ICT, developed by both the industry and the Joint Research Centre of the European Commission develops energy-saving codes of conduct for the ICT sector. In 2000, the European Commission launched the EU Code of Conduct for ICT 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 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.

Code of Conduct	Link
AC Uninterruptible Power Systems Code of Conduct	https://e3p.jrc.ec.europa.eu/publications/code-conduct-energy-efficiency-and-quality-ac-uninterruptible-power-systems-ups
Broadband Communication Equipment Codes of Conduct	https://e3p.jrc.ec.europa.eu/publications/eu-code-conduct-energy-consumption-broadband-equipment-version-6
Data Centres Code of Conduct	https://e3p.jrc.ec.europa.eu/publications/2017-best-practice-guidelines-eu-code-conduct-data-centre-energy-efficiency
Digital TV Services - Code of Conduct	https://e3p.jrc.ec.europa.eu/publications/code-conduct-energy-efficiency-digital-tv-service-systems-version-9
External Power Supplies Code of Conduct	https://e3p.jrc.ec.europa.eu/publications/code-conduct-energy-efficiency-external-power-supplies-version-5

In addition, several private initiatives supported by stakeholders of the ICT sector can be found:

- The "*White paper for the ecodesign of digital services*" [5] published in 2017 by the Alliance Green-IT (AGIT) (currently available only in French, an English version should be released later),
- The "*Code of Best Practices for Green ICT*" published in 2015 by the Council of European Professional Informatics Societies

This non-exhaustive list of initiatives for the dissemination of best practices for the ICT sector will be completed in coming weeks and published online on the ICTFOOTPRINT.eu platform with a short

description and a link to the corresponding documents or websites. As far as possible, the Consortium will try to link the services available on the ICTFOOTPRINT.eu platform (SAT-S, SAT-O, etc.) with the best practices identified.

3.1 Identification of awareness and assessment tools

During Year 2 of the project, the consortium also worked on the identification of existing calculation tools which can be used either 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, the consortium considered all tools applicable to the ICT sector and that can be used by an end-user, regardless of the complexity of the calculations. For each tool identified, a description and link to the initiative is available in Appendix A – Identified calculation tools developed in the scope of "green" ICT. In addition, as described in section 4.4, two generic tools were developed within the ICTFOOTPRINT.eu project to raise awareness on the calculation of environmental impact for ICT services and ICT organisations.

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, and the user may not have access to certain 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 0, 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 2 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 at this time of the project, e.g. on the level of compliance with existing ICT calculation methodologies.

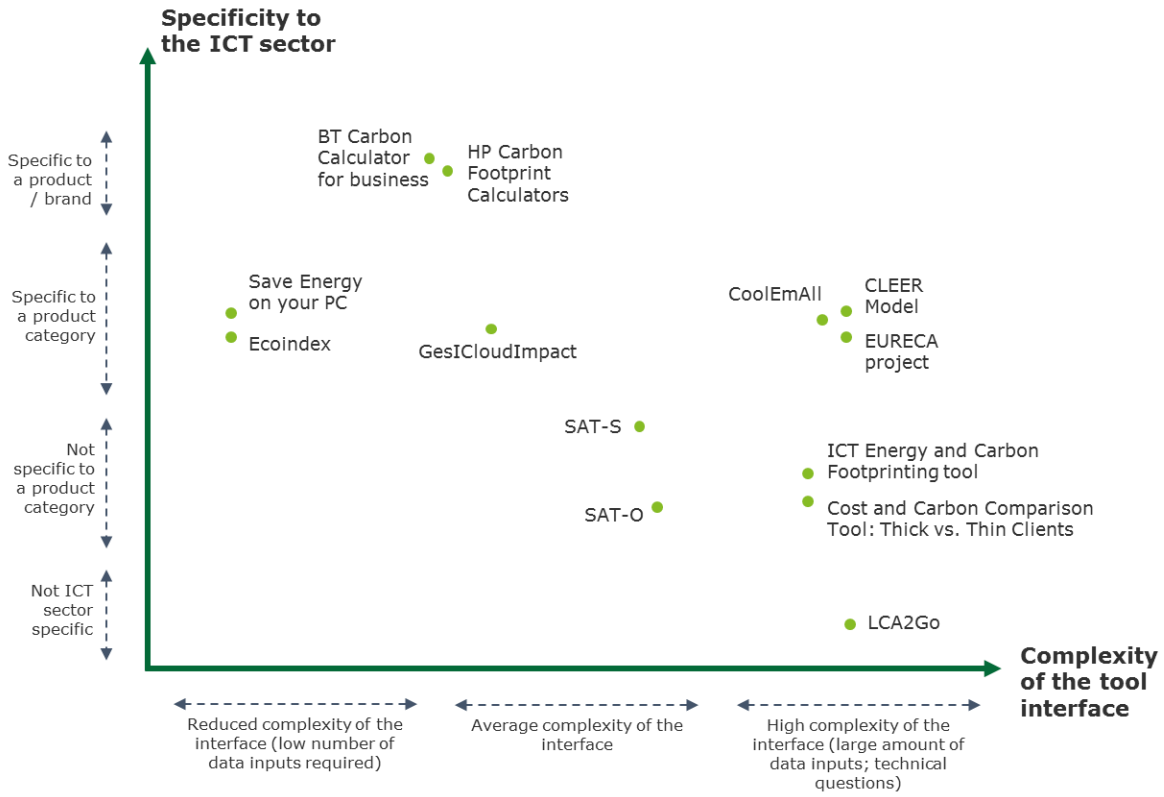

Figure 2: Comparative diagram of the tools identified

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 the SASF tool is not included in the above figure due to limited information publicly available; however, it is described in the dedicated annex.

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

3.2 Identification of certification schemes and labels

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. For each of the initiatives identified, a description and link is available in Table 1.

Table 1: Identified labels and other communication claims within the scope of “green” ICT

Label / claim	Organisation	Description
Energy Star	U.S. Environmental Protection Agency	Energy Star is an international standard for energy efficient consumer products originated in the United States. Since its creation in 1992, the European Union as well as Australia, Canada, Japan, New Zealand and Taiwan have adopted the program. Devices carrying the Energy Star service mark, such as computer products and peripherals, buildings and other products, generally use 20–30% less energy than required by federal standards. Requirements concern GHG emissions and energy efficiency of appliances. The EU Energy Star program covers certain office equipment.
EU Code of Conduct on Data Centres' Energy Efficiency	European Commission	The EU Code of Conduct on Data Centres' Energy Efficiency is a voluntary initiative developed by the DG JRC (Joint Research Centre) in 2008 in response to increasing energy consumption in data centres and the need to reduce the related environmental, economic and energy supply security impacts. Its objective is to inform and stimulate data centre operators and owners to reduce energy consumption in a cost-effective manner without jeopardising the reliability and operational continuity of the services provided by data centres. In particular, it proposes general principles and practical actions to be followed by all parties involved in data centres, operating in the EU, to result in more efficient and economic use of energy. Parties signing up are expected to follow the intent of this Code of Conduct and abide by a set of agreed commitments. Participants that significantly reduce their energy consumption are eligible for the annual EU Data Centres Code of Conduct Awards.
TCO Certified	TCO Development	TCO Certified is an independent sustainability certification for IT products. The approach includes life cycle criteria for social and environmental responsibility, in order to help organisations make more sustainable IT choices. The certification is a type 1 Ecolabel in accordance with ISO 14024, therefore the criteria development is based on scientific principles and involves multiple stakeholders and experts in an open development process.
Nordic Swan Ecolabel	Nordic Ecolabelling	The Nordic Swan is a voluntary ecolabel applicable in various European Nordic countries (Norway, Sweden, Denmark, Iceland). The label evaluates a product's impact on the environmental considering the entire life cycle, in order to guarantee, among others, that climate requirements are taken into account, and that carbon emissions are limited. The Nordic Swan Ecolabel follows the ISO 14024 standard and is a Type 1 ecolabel. The approach applies the RPS model (Relevance, Potential, Steerability). Relevance is evaluated based on the environmental

Label / claim	Organisation	Description
		impacts associated with the product; Potential considers the potential environmental gains or improvements; and Steerability considers if the ecolabel is the right label or tool to tackle the environmental impacts. The label covers 63 product groups and 23,718 products.
Blue Angel	Der Blaue Engel	The Blue Angel is an ecolabel developed by the German Ministry of Ecology since 1977, which guarantees that a good or service meets high standards in terms of health, climate, water and resources characteristics. The products are evaluated across their entire life cycle, and criteria are developed for each individual product group. In particular, the end of life of hardware is considered. Around 12,000 products are labelled, and the Blue Angel is used in more than 20 countries.
European Ecolabel	European Commission	The EU Ecolabel aims at promoting among European consumers products and services which have a reduced environmental impact. The approach considers the entire life cycle of the products and services covered. Although the European Ecolabel is not specific to IT products, a dedicated group of products is identified. The Ecolabel for IT products is based on criteria related to energy production consumption, the reduction of the number of hazardous substances used, the end of life management and the product design. The European Ecolabel is a third party certified Type I ISO 14024. Around 54,000 products and services are covered by the Ecolabel.
EPEAT	Green Electronics Council	EPEAT is an environmental product rating which aims at easing the selection of high performance electronics that support organisations' IT and sustainability goals. The tool is a method for purchasers (governments, institutions, consumers, etc.) to evaluate the effect of a product on the environment. It assesses various life cycle environmental aspects of a device and ranks products as Gold, Silver or Bronze based on a set of environmental performance criteria. EPEAT is based on 23 mandatory criteria and 28 optional criteria, categorized in 8 fields, from materials selection to end of life management. The label is obtained via the self-evaluation of manufacturers, but the GEC carries out tests to ensure that products are in compliance with EPEAT requirements. Around 4,400 products across 43 countries are covered by the EPEAT.
80 Plus	Ecova	80 Plus is a voluntary certification program intended to promote efficient energy use in computer power supply units (PSUs). It certifies products that have more than 80% energy efficiency at 20%, 50% and 100% of rated load, and a power factor of 0.9 or greater at 100% load.

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 [34] 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).

3.2.1 Certification schemes and labels in relation to ICTFOOTPRINT.eu

The consortium identified a set of motivational mechanisms to support the ICTFOOTPRINT.eu sustainability model in Year 3, including mechanisms that are reward driven, incentive driven, and insurance driven. In this regard, the following steps may take place to generate interest around the motivations listed:

- ➔ **Visibility of identified schemes on project platform**: The consortium will continue to identify and present additional labels and certification initiatives during Year 3. The results will be displayed on the project platform;
- ➔ **Potential referral agreements with certification authorities**: Once the labels available in Europe are analysed, related authorities are contacted to find the feasibility of obtaining labels for the products and/or organisations interested, and to increase visibility and incentives for organisations to support and use the services provided on the ICTFOOTPRINT.eu platform. The ultimate objective could be in potential referral agreements between certification authorities and ICTFOOTPRINT.eu;
- ➔ **Promotion of best-in-class**: Based on the SAT-O service, a document is generated for each organisation completing the awareness tool, providing preliminary results on the carbon and energy footprint related to their activities. The consortium will work during Year 3 on developing a dedicated mechanism to promote the organisations that rank among the top based on the SAT-O results. One of the options currently developed is to list on a dedicated page of ICTFOOTPRINT.eu the top organisations based on how good they rank in terms of carbon footprint per FTE, as an incentive for the implementation of practical efforts towards footprint reduction. Among the information listed: the name of the organisation, logo, type of organisation, number of FTE covered, etc. however the exact carbon footprint result will not be displayed. The page could be regularly updated, e.g. on a weekly basis to account for new assessments through the SAT-O. As done for the SAT-S and SAT-O, the consortium will provide some relevant and essential disclaimers to ensure transparency on the aim of the approach and the criteria applied for the top ranked list; for instance, to inform users that the list is generated from organisations completing the SAT-O evaluation only, and that ranking is based on data provided by the organisations (no check on the accuracy of the data is possible). Ultimately an “ICTFOOTPRINT.eu best-in-class acknowledgement” summarising the result of their assessment will be produced by ICTFOOTPRINT.eu. It will be accompanied by a series of disclaimers stating that this is based on an awareness tool and that ICTFOOTPRINT.eu nor its partners can certify directly the veracity of the information provided by the “ICTFOOTPRINT.eu best-in-class acknowledgement” holder. The holders will be invited to expose this on the homepages of their websites;
- ➔ **Setting an example**: The consortium will study the feasibility of engaging the project into a certification initiative, e.g. on green coding or web accessibility. The consortium is aware that

such action would reflect on the engagement of the ICTFOOTPRINT.eu project in green and responsible ICT.

3.3 ICTFOOTPRINT.eu selection of success stories

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.

One of the consortia's KPIs (KPI 2.1) was to reach 100 stories by end of Year 1 – considering that this KPI was not reached, it was decided during the first Review Meeting that what was important was to publish appropriate stories with content rich-insights, rather than publishing stories that may not meet the objectives of the selection. The new 29 stories from Year 2 were identified thanks to the consortium network, presence at events, webinars, further desktop research and a continued dissemination campaign, namely launch of newsletters requesting these success stories, finding them through the webinars and call-to-actions messages on social media.

As illustrated in Figure 3, most stories collected are from UK, followed by Germany and are from Large Enterprises and Academia/Research Centre. The focus during Year 3 will be to collect stories from other EU countries and from SMEs and Public Administrators, making for a larger geographical representation and variety. For instance, today there is a lack of stories related to public procurement and a high number of success stories on low carbon data centres.

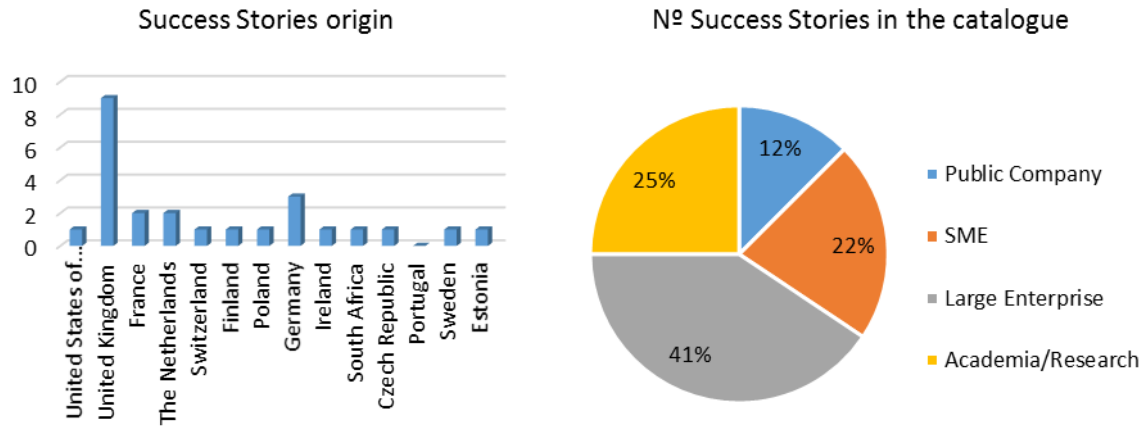

Figure 3: Success Stories country of origin (left) and categories (right)

To find more stories, the consortium will keep implementing communication efforts to promote not only the stories already available in the catalogue, but also to invite users to submit their own stories. A call to action has gone out to the EAG members – especially the newcomers for support there. At the end of Year 2, the project has identified 20 stories with the potential to be approved by the project partners.

Table 1 provides a list of all new stories collected during Year 2. In Appendix B – Additional success storiesare available the full description of each success story.

Table 2: New Success Stories collected during Year 2

	Institution	Country	Stakeholder	Claim to Fame
9	HM Land Registry	UK	City / Public Administration	Reduction of electricity use over the previous year by 16.4%. Discussing the energy used by monitors with staff resulted in a reduction from 14% of monitors left on when not in use to 5%, which contributed to a 40% reduction in the office's electricity consumption in December 2016 compared to December 2015.
10	Capgemini	UK	Large Enterprise	Capgemini created a model which will enable future data centres to be more

	Institution	Country	Stakeholder	Claim to Fame
				sustainable, operate with significantly more efficiency, be located more flexibly and make high-end data management services accessible to a wider range of organisations
11	Deustsche Telekom	Germany	Large Enterprise	Deutsche Telekom reduces their carbon footprint in mind when planning and operating their data centers. The organisation was able to reduce the average PUE factor img at the T-Systems data centers from 1.85 to 1.63 between 2008 and 2015.
12	Equinix	UK	Large Enterprise	Equinix is now the first data center provider in Europe to achieve ISO 50001 accreditation, emphasizing the company's firm commitment to continuous improvements in both energy efficiency and environmental management
13	FCO Services	UK	City / Public Administration	FCO Services' efficient data centre has won the prestigious European Code of Conduct Awards for Energy Efficiency in Data Centres from the European Commission's Joint Research Centre
14	Logicalis	UK	Large Enterprise	Logicalis is committed to data centers that are energy- and cost-efficient. Because cooling makes up almost 50% of your total energy spend in a data center, Logicalis' data centers use minimal water and electricity for cooling activities, meaning they cost less in the long run. Logicalis also utilizes solar power in our data center builds, further reducing the cost and doing their part to take advantages of renewable energy resources.
15	Politecnico di Milano	Italy	Academia / Research Centre	The institution sets itself the goal of reducing power consumption across its networked devices. The benefit is that the daily uptime of PCs managed by PoliSave is 9.7 hours, while the daily uptime for other PCs is 15.9 hours. The annual energy savings is 219 kW, which translates to over EUR 250 000
16	PuzzlePhone	Finland	SME	PuzzlePhone is the long-lasting smartphone with three easy-to-change modules. (Like a puzzle. Except this is a phone.) PuzzlePhone is reliable, upgradeable - even repairable! Need more power? Break your screen? Dead battery? All are easily replaced - by the user!
17	ATMAN	Poland	Large Enterprise	Atman, a data center provider, has developed its own environmental parameters and takes advantage of direct free cooling solutions in their DC facilities.
18	Fairphone	The Netherlands	SME	Fairphone is the world's first modular phone. Fairphone is using modular design as a means to create longer-lasting phones and directly combat the rapid phone replacement cycle that consumers and the industry have become accustomed to.
19	Jerlaure	France	SME	Reducing energy losses from the technical architectures, to use virtualisation to optimise the IT infrastructure and, where possible, to recover the calories to produce energy or heating. JERLAURE totally supports this approach.
20	Microsoft	Ireland	Large Enterprise	Microsoft opened a new data centre in Dublin, Ireland, that has a Power Use Effectiveness (PUE) of 1.25, on a scale where 1 is the optimal (the average in the industry is approximately 2.0 and Microsoft data centres globally have an average of 1.6). The new Microsoft data center in Ireland already consumes approximately 50 percent less energy than a traditional data center of similar size and level of activity
21	Life.augmented	Switzerland	Large Enterprise	ST is committed to reducing its energy consumption and associated carbon footprint through energy efficiency and conservation programs along with the purchase of CO2-free and renewable energies. ST carefully monitors and anticipates changes in the energy market to mitigate business exposure to climate change.
22	Holylake Holy Trinity Primary School	UK	Academia / Research Centre	Hoylake Holy Trinity's new computing technology is now delivering all the performance of a standard PC with half the energy and carbon consumption.
23	Bedford Drive Primary School	UK	Academia / Research Centre	Working in partnership with Hi-Impact, the school's technical support provider and computing consultants ELe® introduced a tailored ultra-low energy computing solution to support the school's ambition to improve its sustainability profile. The Hi-Impact installation has enabled the school to achieve 70% energy savings
24	The Business Academy	UK	Academia / Research Centre	Bexley academy 4Over the first year, the Academy has been able to dramatically reduce its ICT suite energy consumption. With each PC now running at 40 Watts* instead of 100 Watts, initial energy running costs for the ICT suite were reduced from £749 to £262 per year, a saving of 65%
25	St Jerome's Catholic	UK	Academia / Research Centre	Compared to the running of their previous PCs, energy consumption has significantly reduced. The new low energy screens run at just 20-25W

	Institution	Country	Stakeholder	Claim to Fame
	Primary School			compared to 170-190W of their previous ones. The school's complete desktop ICT solution now runs on less than 500 Watts – the equivalent of 3 or 4 of their old PCs
26	Digital3RD	UK	SME	Digital3rd is expected to make a saving of 75% on energy consumption of their computing equipment, which over 5 years will amount to around £1,324. Additional savings were also made as no electrical sockets were required for the ELe® equipment. This saved the company an extra £1,000 and many hours of potential downtime.
27	Beaulieu College	South Africa	Academia / Research Centre	When looking to expand their ICT facilities, they were concerned about the impact more PCs and subsequent air-conditioning requirements would have on their energy usage. The Kyalami School was able to run their whole ICT suite for less than 700 Watts. This was equivalent to 3 or 4 of the school's previous PCs and a reduction of around 87% in energy consumption.
28	University of Coimbra	Portugal	Academia / Research Centre	The Laboratory of Advanced Computer of the Coimbra University installed a free-cooling system. When outdoor temperature is below the indoor temperature, cold ambient air is drawn inside the data centre to accomplish cooling while the conventional mechanical chilling system is off (or in standby). The free cooling system allowed for energy savings of about 90 MWh/year, while providing similar environmental conditions as in the old system (same temperatures).
29	Postbank	Germany	Large Enterprise	The implementation of the MPLS technology, beside a quick return on investment, resulted in reduced energy costs due to energy savings. Energy savings of over 59% were realised in the data centre following the replacement of network components. The introduction of logically separated networks made decentralised firewall-transitions redundant, thus with energy savings of over 61% for firewall servers. The energy savings associated with the distribution infrastructure were estimated around 52%.
30	Sun Microsystems Oracle	USA	Large Enterprise	Sun Microsystems estimated that by adopting a sustainable approach, the space required for the data centres was reduced by 80%. Similarly, the ecodesign of the centres allowed for the cutting of electrical and cooling costs by 50% compared to average data centres. The energy savings corresponded to 4,100 t of CO2e savings per year, i.e. about 1% from Sun's total carbon footprint.
31	Altron	Czech Republic	SME	The optimization of the whole system provided an increased efficiency of the cooling system and reduced its power consumption. The new installation produced energy savings of 5.04 GWh per year. The total operational expenditure savings amounted to 15 million CZK per year (equivalent to € 0.6 million).
32	Telia Sonera	Sweden	Large Enterprise	Telia Sonera Sweden ran several modernization programs focused on reducing energy consumption and costs related to facility rent. The company invested SEK 20 million in green cooling solutions in 2014 and 2015 and planned to invest an additional SEK 50 million when expanding the scope to additional sites. Total savings were estimated around SEK 40 million for 2014 and 2015. The programs were also expected to lower annual costs by SEK 20 to 25 million until 2018
33	EDF	France	Large Enterprise	Through the sophistication of its equipment, EDF managed to reach a 25% reduction of its electric consumption for the NOE data centre in Val de Rueil. This corresponds to an economy of 17,400 MWh (equivalent to 1,500 tonnes of CO2). Energy savings in 2018 are expected to double.
34	KPN	The Netherlands	Large Enterprise	The new data centre at the High-Tech Campus in Eindhoven is powered by a 100% sustainably generated energy. In 2015, KPN won the ICT Environment Award for this new data centre, because of their sustainable technology reducing energy consumption despite the strong increase in data traffic in the Netherlands
35	Goethe University Frankfurt	Germany	Academia / Research Centre	The energy efficiency of the LOEWE CSC computer is reflected in its PUE value of 1.076. Compared to a traditional similarly sized data centre (with a PUE value of 2.00), the computer saves 3,37 GWh/year, i.e. approximately €462,000/year. In addition to reducing power consumption, the large utilization of passive cooling elements and the reduction of electrical components in the cooling circuit led to improved reliability and lower maintenance costs.
36	Federal Ministry of the Interior	Germany	City / Public Administration	Contract tender for thin clients tendered by the Procurement Agency of the Federal Ministry of the Interior, Germany (Beschaffungsamt) published in August 2013. Framework contract about 50.000 thin client computer systems (30.00 smart-thin-clients and 20.000 full-thin-clients) and

	Institution	Country	Stakeholder	Claim to Fame
				connected services to replace old and inefficient desktop PCs in several government agencies.
37	Centre of Registers Information Systems	Estonia	City / Public Administration	This particular procurement process was for a joint framework agreement for the purchase of personal computers (PCs) and computer monitors by several Estonian entities. PCs bought under this contract are estimated to generate energy savings of 20-30% compared to non-green product alternatives

4 Development of ICTFOOTPRINT.eu services

A detailed description of the services developed within the ICTFOOTPRINT.eu project may be found in the previous market watch report D2.2. The present section of the deliverable focuses on the update in the development of the project services since the deliverable D2.2.

4.1 Helpdesk

ICTFOOTPRINT.eu helpdesk was considered, in proposal phase and in the GA, as a multilingual tool that aids end-users on different aspects of ICTFOOTPRINT.eu initiatives/services. The online support is always “offline” and the software transforms automatically the received question in an email which is sent immediately to an assistant. The assistant will come back to the user in 16 working hours. An online support can be activated when necessary.

Following the trend from the previous year, the low number of questions received through helpdesk may be an indication that the website already provides adequate information understood by all stakeholders. Requests of assistance collected during the 2nd year of the project were related to the status of the evaluation of marketplace sellers’ applications or updating information available on marketplace sellers’ pages. It is curious that, despite ICTFOOTPRINT.eu being focused on sustainability in ICT, the helpdesk requests were from users wishing to learn about carbon footprint of business sectors not necessary related to ICT.

The consortium will boost the feedback from users of the platform, by providing new helpdesk services, such as online surveys related to the usage of ICTFOOTPRINT.eu services, namely the SAT-O delivery in February 2018. It is important to mention that the FAQ available on the helpdesk, will be maintained to ensure it is up to date, via regular updates, when relevant, to avoid having outdated information.

4.2 Update on the map of the methodologies

The detailed description and characterisation of the methodologies selected within the scope of the project may be found in deliverable D2.1. For each ICT methodology 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.

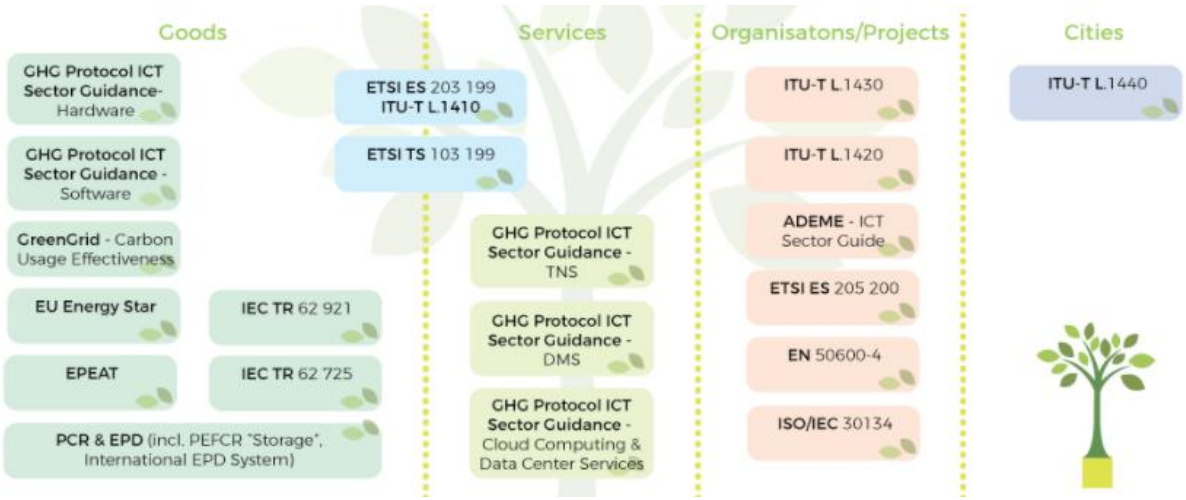

Figure 4: ICTFOOTPRINT.eu map of ICT methodologies

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, since the last market watch report in January 2017, five methodologies were published and/or updated:

- The EN 50600 (developed by CENELEC) relates to datacentre facilities and infrastructures. In particular, EN 50600-4 [35] 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 (REF), providing a metric of electricity used in a datacentre from a renewable energy source.
- The ISO/IEC 30134 [36] provides key performance indicators for data centre facilities and infrastructures, developed consistently with EN 50600-4. In addition to defining common indicators such as PUE and REF, ISO/IEC 30134 specifies an energy efficiency indicator (ITEEsv) and an utilisation indicator (ITEUsv) for servers. Additional parts dedicated to other KPIs e.g. Energy Reuse Factor (ERF) will be developed further.
- The final version of the ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard [37] was released in July 2017. 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.
- The ETSI ES 205 200 [38] details global and specific KPIs for data centres and various types of access networks. The methodology was updated in 2017 with the publication of KPIs for global ICT sites. Additional parts will be developed later, in particular on specific KPIs for mobile access networks.
- The IEC TR 62921 [39] relates to computers and monitors. An updated version of the methodology was released at the end of 2016, in particular to include further informative recommendations on sources for energy consumption.

Dedicated factsheets were developed and/or updated for each of the methodologies listed above, in order to integrate the latest specifications. The factsheets are available on the ICTFOOTPRINT.eu platform as well as in Appendix B – Additional success stories. Please note that five factsheets are available for the GHG Protocol ICT Sector Guidance, relative to each chapter of the document.

The market watch on existing calculation methodologies will continue during the rest of the project. Additional feedback from EAG members and other SDOs will complement the work of the consortium. In particular, the EAG helped identify the ongoing work on the Data Centre Maturity Model (DCMM) [40] to implement it as a Technical Report into the EN 50600 standard, as well as the EN 50600 series currently being elaborated as an ISO/IEC standard.

4.3 Marketplace

After Year 2, the marketplace has 21 registered sellers (see Figure 5), of which 6 were recruited during Year 2 (see Table 3), as indicated in deliverable D4.3 on the second annual report on ICTFOOTPRINT communication & outreach activities. All services categories increased the number of suppliers which are available to support organisations willing to improve their sustainability in ICT. The list of all sustainable suppliers in the ICTFOOTPRINT.eu marketplace is provided in Appendix D – Marketplace Suppliers.

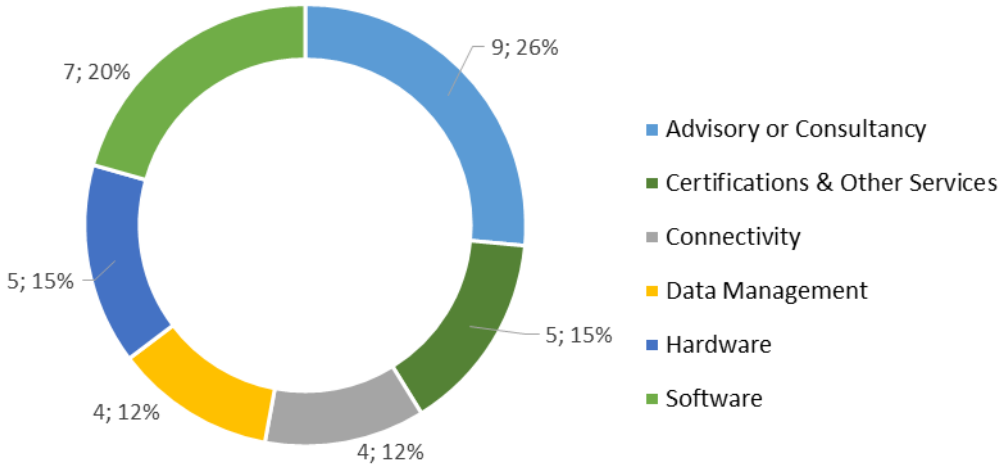

Figure 5: Type of Services offered by ICTFOOTPRINT.eu marketplace sellers

The category with the highest number of suppliers is “Advisory or Consultancy” (26%), followed by “Software” (20%) and “Hardware” and “Certifications & Other Services (both with 15% each). The most popular page, besides the marketplace home page, was the one with the list of all suppliers.

Table 3: Additional ICTFOOTPRINT.eu marketplace suppliers

Organisation	Country	Category
CELESTE	France	• Connectivity • Data Management • Hardware
Certios	The Netherlands	• Advisory or Consultancy • Certifications & Other Services
Escan	Spain	• Advisory or Consultancy • Certifications & Other Services • Data Management • Software
Extreme Low Energy	United Kingdom	• Hardware
GreenGageIT	United Kingdom	• Advisory or Consultancy
Start2Act	Hungary	• Advisory or Consultancy

Regarding the country of origin, most of the suppliers are from UK (30%), followed by France (20%). Switzerland, Belgium and USA have 10% each (see Figure 6). During the 3rd year of the project, the consortium will implement communication campaigns to recruit more sellers, preferably from other European countries which are not yet part of the marketplace.

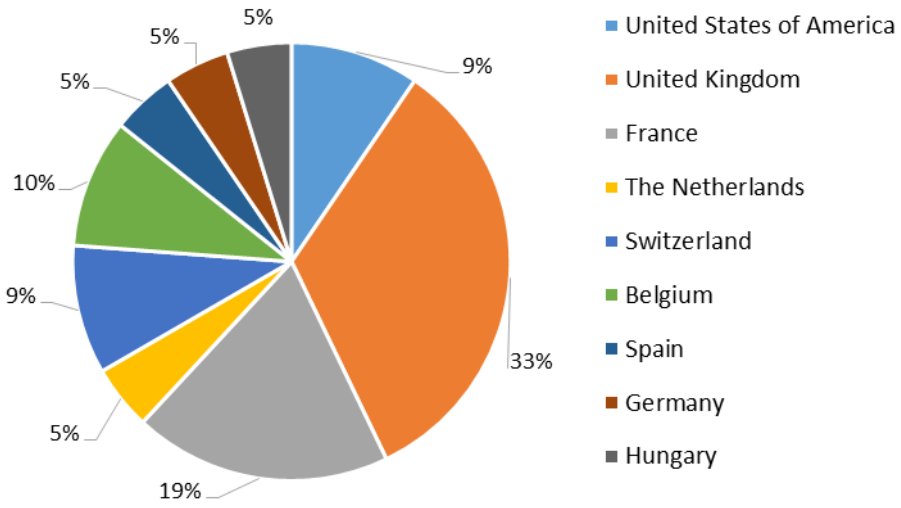

Figure 6: Marketplace Suppliers Country of Origin

Since the launch of the marketplace, this ICTFOOTPRINT.eu service has had over 4.600-page views from over 2.600 users, mostly from Europe. As described in deliverable D4.3, the marketplace will become a central element of the ICTFOOTPRINT.eu Sustainable Business Model and a central pillar of the sustainability path.

.Plus, it will be launched award-like initiatives for those organisations who improved their sustainability in ICT thanks to the implementation of low carbon footprint services from suppliers listed in the marketplace.

4.4 Self-assessment tools

As described in section 3.1, two awareness tools are amongst the services developed and available on the ICTFOOTPRINT.eu platform. These simplified calculators allow to estimate, by briefly answering a set of questions (10 min maximum), the carbon and primary energy footprint of digital services and organisations in order to raise awareness on the potential impacts and main environmental hotspots of digital services and organisations. The detailed goals and plan of development may be found in deliverable D2.2.

The first calculator, the **SAT-S** (Self-Assessment Tool for an ICT Service) is freely available on the platform since September 2017 to estimate the carbon and energy footprint of web-based digital services. As raised during the Review Meeting with the European Commission in September 2017, the tool provides a preliminary evaluation of single digital scenarios, based on a single device and is therefore limited to awareness raising. The provision of a robust environmental assessment would require further work and development, e.g. to include more sophisticated usage patterns.

Feedback collected from users through an online questionnaire, which is made available after users compiled SAT-S, found that the tool was helpful and sufficiently user-friendly. Some comments received to improve it related to providing more explanation on the parameters in graphs within the report, in order to better interpret the results. Feedback also showed that having an evaluation scale (e.g. excellent, good, bad) would help users to better understand not only the state of the user's service in regards to its ICT carbon footprint, but also the benefits they may gain should they implement modifications.

Another area of improvement for the SAT-S would be to reflect better what the consequences from using a specific ICT service or device (e.g. data centres, servers, telecom equipment) are, and what the methodologies and data is behind the SAT-S engine. These recommendations have been considered in the fine-tuning of SAT-O, to ensure the final report provides users with useful information.

The consortium is currently finishing the development of the second tool, the **SAT-O** (Self-Assessment Tool for an ICT-intensive Organisation), which allows to estimate the carbon and primary energy footprint of ICT organisations and 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 GHG emissions and primary energy consumption using a simplified and easy to use methodological approach. Emphasis was given by the consortium on the presentation of the results, with the aim of providing the target audience with various levels of information, from key results and recommendations to detailed information on the methodology applied. The SAT-O is expected to be launched in February 2018; dedicated workshops are scheduled, starting in March 2018, to present the tool to ICT stakeholders and receive their feedback.

5 Community engagement

An engaged community consists of a group of individuals working together towards a common set of goals and values. ICTFOOTPRINT.eu engages has made it its mandate to make a continued effort of weekly engagement with its different stakeholders through information, consultation and cross-collaboration.

During Year 3, the consortium will focus on involving the community members, by introducing a novel approach that has worked successfully on past efforts the coordinating partner has carried out, with a type of "on the road roadshows" – i.e. physically going to a well-connected community interested in the topic with an already rich, local community. These **SAT-O hands-on workshops** aim at ensuring that concerns and aspirations are accounted for by ICTFOOTPRINT.eu (see Table 4). The focus would be to have the users try out the SAT-O and provide immediate feedback and they are given immediate results at the same time. The idea is to have a half day event to not take up small companies' time and to offer something as well as obtaining feedback at the same time.

Table 4: ICTFOOTPRINT.eu Spectrum of Public Participation (Source: adapted from International Association of Public Participation - IAP2)

	Information	Consultation	Cross-collaboration
Promise to the Public	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 • Messages • Presentations • Webinars • Communication Materials • Presence at Events • FAQ in 5 languages	• Questions on webinars • Helpdesk • Online Surveys on service satisfaction (SAT-S) • Engagement at Events • Interviews	• SAT-O hands-on workshops • Service satisfaction Survey on SAT-O

During Year 2, by leveraging ICTFOOTPRINT.eu services, the consortium consolidated their community engagement, by recruiting new members, mostly from social media and webinars (see Table 5). ICTFOOTPRINT.eu experts are expected to increase their engagement level after the SAT-O is available (e.g. more organisations, hands-on workshops in other European countries).

Table 5: Actively engaged organisations

	Year 1	Year 2	Growth Y1 vs Y2
Webinars	121 participants	331 participants	+173%
Marketplace	15 sellers	21 sellers	+40%
Success Stories	8 stories	37 stories	+362%
SAT-S Users	0 users (SAT-S made available on Year 2)	25 users	-
Social Media	1.236 members	2.153 members	74%
SDOs	4 SDOs engaged	4 SDOs engaged	+0%

5.1 External Advisory Group (EAG) members

As described in deliverable D4.3, during Year 2 the EAG added five new members, with distinct backgrounds and know how. These new members were identified thanks to active engagement at key-events and from synergies that ICTFOOTPRINT.eu established with relevant initiatives. Such recruitment effort was also recommended during the last ICTFOOTPRINT.eu project Review Meeting held in Brussels in September 2017, with the aim to bring new ideas and perspectives to EAG.

Table 6: ICTFOOTPRINT.eu EAG new members

Name	Institution	Country	Recruitment	Info
Mark Acton	CBRE Data Centre Solutions	UK	Introduced by the coordinator of Eureca project	Mark has over 25 years' experience in the IT industry and has specialised in the field of Data Centre Operations for over 20 years, concentrating on the delivery of business-critical services from highly reliable, world class Data Centres.
Roel Castelein	The Green Grid	Belgium	Introduced by a former EAG member	Roel worked as Corporate Strategist at Microsoft, Autodesk & EMC² on GoToMarket transformations & global Sales & Marketing operations. Roel volunteers as The Green Grid's EMEA Marketing Chair for the last 5 years.
Thomas Corvaisier	GREENSPECTOR	France	Seller in the Marketplace	Thomas has been a Green IT and carbon accounting consultant for years. He's now leading the first editor specialized in software eco-design.
Steve Horn	Data Centre Alliance	UK	Introduced by the coordinator of Eureca project	Despite have an engineering back ground, Steve has spent the last 20 years in the IT Industry. Steve co-founded Colofinder; a consultancy practice which provides independent data centre search and selection guidance to end user looking for the right providers and services to meet their business needs. Steve also co-found the Data Centre Alliance.
Derek Webster	Andget Limited	UK	Presence at event	Experience providing strategic road mapping for new Data Centre portfolio builds, pre-investment advisory or restructuring for investments and end users. Represented Foreign Direct Investors (FDI) in the Data Centre Country search and site select process

Some EAG members joined ICTFOOTPRINT.eu webinars as speakers, providing key insights on how to be more energy efficient and how to lower the ICT carbon footprint. **Thomas Corvaisier** (GREENSPECTOR) introduced the concept of software eco-design and its benefits, i.e. to help reduce IT consumption without affecting performance and user experience. **Andie Stephens** shared insights from ICT Sector Guidance for the GHG Protocol Product Standard by providing detailed guidance for the ICT products and services footprint. **Derek Webster** demonstrated how formula one (F1 DC) Designs can reach the Enterprise Site with Macro Green to improve ROI. Derek illustrated how building for efficiency is not a low-cost strategy but a win-win solution for all stakeholders, e.g. environmental concerns, socio-economic impact, architecture, history of the location, natural resources issues.

Throughout the year, feedback was collected from EAG members by leveraging EAG's mailing list and conference calls. The last call took place in December 2017, dedicated to:

- Update ICTFOOTPRINT.eu yearly developments;
- Brainstorm how EAG members' skills can contribute during the following year;
- Provide insights on topics that ICTFOOTPRINT.eu should address, specially certification, and area in which there is a lack of clarity regarding what can be certified;
- Share that for SAT-O hands-on workshops, the CIFAL training centers from the United Nations could be relevant partners.

EAG members were also challenged to:

- Include other carbon footprint calculation tools, in the assessment between the SAT-S/SAT-O different targets/approaches and other tools available in the market;
- Share ideas for business models and insights to be included in the roadmap;
- Provide relevant updates to be included in the Map of ICT Methodologies;
- Share success Stories to be included in our online catalogue;
- Suggest potential buyers/sellers for the Marketplace;
- Give feedback on SAT-O as soon as it gets published;
- Join ICTFOOTPRINT.eu webinars as speakers.

5.2 Helpdesk users

Since Year 1, the helpdesk webpages page views increased by ~60% (over 1.300) and all users´ requests were replied. As mentioned in section 4.1, users were either marketplace sellers requesting feedback or users looking for insights on how to lower the carbon footprint.

The availability of FAQ in various languages seems to have proven useful, as the users selected the language according to their country of origin.

5.3 Success stories subscribers

Success stories in energy efficiency and low carbon footprint in ICT come from different stakeholders, such as SMEs, Large Organisations, Cities and Academia/Research Centres. As already mentioned, the consortium collected 29 new stories, with a total of 34 stories published with ~1.000 views.

Besides the extensive desktop research, ICTFOOTPRINT.eu collected new stories from marketplace suppliers and synergies stablished with key associations. Extreme Low Energy, a marketplace supplier, shared client stories which lowered their ICT carbon footprint due to their services. HM Land Registry's Telford Office story was provided by Save@Work, an H2020 funded project which focuses on overcoming the barriers to energy savings in public office buildings and changing the behaviour of public sector employees at their work place. Other stories were shared by The Green Digital Charter initiative.

Thanks to synergies with AGIT (Alliance Green IT), the association will also share new success stories that can be included in the catalogue. The consortium will focus also on finding stories related with municipalities, namely sustainable and green procurement.

5.4 Industry engagement

5.4.1 Suppliers & buyers of the marketplace

As mentioned, the marketplace received six new members during Year 2, reaching twenty-one seller organisations. The marketplace is one of the most visited sections of ICTFOOTPRINT.eu website. The following months focus will be on recruiting new sellers, preferably from different European countries, buyers who can submit their requests and getting support from all registered sellers. The full list of the submitted requests is shown in Appendix D – Marketplace Suppliers.

5.4.2 Other players

During Year 2, ICTFOOTPRINT.eu engaged with major industry players and SDOs who actively joined the project and shared with the community sustainable ICT best practices to be followed. Jean Marc-Alberola (Airbus and ETSI) joined the 4th ICTFOOTPRINT.eu webinar, while Adina Braha-Honciuc (Microsoft) and Jakub Bartnicki (Bureau Veritas, Trust-EPC South) joined the 7th one.

As mentioned in deliverable D4.3, the project also stablished other synergies with NPO, public sector and other H2020 funded projects, which had positive impact on the project visibility and brand awareness. Experts from these organisations contributed to ICTFOOTPRINT.eu not only as webinars speakers, but also by providing pieces of news and disseminating webinars and events where ICTFOOTPRINT.eu organised cafés. Thanks to the ICTFOOTPRINT.eu network, the project was invited to join several relevant events (e.g. “Digitalisation and Energy” by IEA Workshop, “Greening through ICT Summit”, by IEEE) related to lowering carbon footprint. This is a clear sign that ICTFOOTPRINT.eu has reinforced his place in the sustainability community.

Thanks to an integrated communication, dissemination and engagement efforts, ICTFOOTPRINT.eu has reached a community of over 3.000 members, where 53% are SMEs, followed by NPO (24%) and Large Enterprises (12%). By end of the project, the goal is to reach 5.000 members.

6 Third year plan for managing & analysing feedback form the users

6.1 Analysis of the second-year progress on ICTFOOTPRINT.eu services

During Year 2, the consortium released additional services and content on the platform, in addition to updating the information already available from Year 1. As presented in the previous sections of the deliverable, a particular effort was made on the development of the awareness tools as well as the identification of additional success stories. As a result, the second version of the SAT-S was released in September 2017; the first version of the SAT-O will be available in February 2018. A total of 29 new success stories were identified and published during year 2.

On the overall, the consortium better engaged with the community on the overall, in particular during the various webinars proposed in the scope of the project, and during the events the consortium attended. A particular focus was made on the EAG members' engagement, to get their feedback on the technical content provided online, as well as on the project in general.

At the end of Year 1, a plan of actions was proposed for Year 2 – further information may be found in the deliverable D2.2. An update of the plan is provided in Table 7.

Table 7: Update on the proposed plan of actions for Year 2

Topic	Proposed action for Year 2	Update at end of Year 2
Services	Success stories, complemented by additional interviews of identified key stakeholders of the "green" ICT market in Europe;	**Status: under progress** - 29 new success stories published - 6 interviews conducted within the scope of deliverable D3.2
Platform	Revise content of the project platform, e.g. by providing references (when relevant) and ensuring a global consistent and robust message	**Status: under progress** - Content of some pages of the project platform being revised - Link between existing pages (e.g. in the SAT-O result page)
Communication	Webinars involving organisations presenting their ICT-related best practices	**Status: under progress** - 3 webinars (out of 4) during year 2 involved stories on ICT best practices (webinars available for replay on the project platform) - Additional webinars during year 3
Communication	Webinars aiming at explaining how to implement ICT calculation methodologies. In addition, these webinars could be the base of a tool box, available to any potential user of the methodologies	**Status: under progress** - 3 webinars (out of 4) during year 2 provided information on ICT calculation methodologies (webinars available for replay on the project platform) - Additional webinars planned for year 3
Survey	Surveys launched among the marketplace sellers, to gain their insight on what their clients expect, and why they got involved in "green" ICT	**Status: under progress** - Questions to relevant marketplace sellers in August – feedback gathered by phone or email (10 in total)
All	Better integrate the consortium's knowledge of the SME market in the ICT sector in Europe, to the points raised above.	**Status: done** - Contacts through SME Alliance - Survey in April 2016 shared with network

The barriers observed during Year 2 were already identified at end of Year 1:

- Difficult uptake of ICT calculation methodologies and best practices by the sector, partly due to the complexity of the LCA frameworks, the prioritisation by competing business with other subjects e.g. data security, or the lack of identified benefits. Dedicated work was conducted on the topic during Year 2, and may be found in deliverable D3.2;
- Delay between the release of the project services and the uptake by the targeted community.

The above analysis was highlighted as well during the Review Meeting with the European Commission and the two external reviewers in September 2017. While the project was considered to be in line with most of the objectives and technical goals for the period under study, it was acknowledged that the uptake of the project services could be strengthened during the rest of the project.

6.2 Proposed plan of actions for the third year

As for Year 2, dedicated plans of actions are developed for each of the services provided by ICTFOOTPRINT.eu. In addition to these, the consortium identified actions to tackle each of the following four aspects:

- Increase the platform visibility;
- Use the Hands-on workshops in the consortium partner countries (i.e. NL, FR, BE, IT & UK) as potential to monitor and record user experience;
- Improve the relevance and consistency of the information provided on the platform;
- Speed up the uptake of ICTFOOTPRINT.eu services;
- Focus the services and content on pre-identified target audience.

Table 8 proposes the plan of actions for Year 3, for each of these four aspects. The content includes the actions identified for Year 2 and under progress (see Table 7).

Table 8: Proposed plan of actions for Year 3

Topic	Proposed action for Year 3
Platform visibility	Success stories, complemented by additional interviews of identified key stakeholders of the “green” ICT market in Europe
	Better engage with the network of identified key contacts
Reliability and relevance of content online	Revise content of the project platform, e.g. by always providing references (when relevant) and ensuring a global consistent and robust message
	Involve EAG members to ensure the reliability and relevance of the technical content
	Continue the release of ICTFOOTPRINT.eu services (factsheets on methodologies, awareness tools, etc.)
	Better link the various services. For instance, the result page of the SAT-O will provide the users with some recommendations and include links to relevant pages, e.g. marketplace or ICT methodologies
Uptake of project services	Additional webinars, involving organisations presenting their ICT-related best practices or how to implement ICT calculation methodologies
	Organisation of dedicated workshops to promote the use of the SAT-O and receive feedback from ICT stakeholders

Topic	Proposed action for Year 3
	Communication planned in WP4
Focus on target audience	Engage with EAG members to better define what is considered as part of the “ICT sector” in the scope of the project
	Specify the target audience on the platform and in all the deliverables
	Review the categories displayed on the marketplace, e.g. to better reflect on some players such as telecommunication networks. Use the hands-on workshops to attract smaller ICT-intensive local SMEs of the local community and capitalise on a host partner to help bring the network together.

7 Conclusions

During Year 2, the team continued to work on the development of the platform services, as well as on gaining a better understanding of the leverages to enhance the uptake of best practices and calculation methodologies among ICT players.

Along this period, the project was put in perspective with the overall ICT sector and compared against other existing initiatives. The present deliverable provides with an insight of the global trends in green ICT, and more globally sustainable and responsible ICT. Such insight is complemented with research on other calculation tools, labels and any initiatives developed to support and enhance the uptake of more sustainable practices. The SAT-S and the SAT-O proposed as part of the ICTFOOTPRINT.eu initiative is among the existing tools that aim at raising awareness on environmental assessments, by providing the user with further insight on the calculations and the methodological principles to follow. In this perspective, the SAT tools are complementary to other existing initiatives which may enable for a detailed and more robust analysis of the environmental impacts of an ICT product or ICT organisation.

Additional services will be provided during the third and last year of the project, in particular with the launch of the SAT-O tool planned for February 2018. In addition, the consortium will continue to regularly update the technical content provided online and complement it with additional best practices in ICT activities, as well as identified success stories.

During Year 2, the consortium continued to work on better engaging with the community, by communicating about the services on the platform, receiving feedback from the use of the services, and sharing experience during webinars and events. In addition, regular contact was kept with EAG members, and the consortium received feedback on various aspects of the project.

Additional events and webinars are planned for Year 3; it will be the opportunity for the consortium to refine the strategy on how to engage with the project target audience. The consortium will pay a particular attention to the areas for improvement highlighted during the Review Meeting held in September 2017, among which the importance of clarifying to end users what tangible benefits the project would bring them, depending on the type of business or the level of LCA requirements they target.

Deliverable D2.5 will provide an updated analysis for Year 3 and will include conclusions on the overall project. The insight gained through the project will be useful in the elaboration of other deliverables such as the Policy Action Plan, due at the end of the project (D3.4).

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Appendix A – Identified calculation tools developed in the scope of "green" ICT

The list compiled in the table below are listed on our "Other Tools" section on the ICTFOOTPRINT.eu web platform. We also envisage to invite the most pertinent to the workshops organised to provide a mutual synergy and viability to consortia with companies who create or have created like-minded products. This will also incentivise participants to attend the workshops organised.

Table 9: Identified calculation tools developed in the scope of "green" ICT

Tool / initiative	Organisation	Description
EURECA Project	EURECA Consortium	The EURECA project is part of the H2020 Program from the European Commission. It tackles the lack of knowledge and awareness on how to identify and procure environmentally sound and sustainable data centres. The work will encompass solutions for pre-commercial procurement (PCP) and procurement of innovative solutions (PPI). The initiative is based on different services: - Procurement support in building business cases for data centre projects; - Technical support, though audits and energy consumption measurements and a range of guidance based on best practices & standards for the transformation of data centre; - Knowledge sharing encouraged through events and a platform dedicated to the project.
CLEER Model	Lawrence Berkeley National Lab and Northwestern University	The CLEER (Cloud Energy and Emissions Research) Model is a comprehensive and open-access model for assessing the net energy and emissions implications of cloud computing systems compared to the existing digital and physical systems that they might replace - in different regions and at different levels of market adoption. The model aims to provide full transparency on calculations and input value assumptions so that the results can be replicated, and the data and methods can be easily refined and improved by the research community.
LCA2Go	LCA2Go Consortium coordinated by Fraunhofer	The LCA2Go project is supported by the FP7 Program of the European Commission and aims at boosting Life Cycle Assessment (LCA) use in European small and medium-sized enterprises. The project develops sectoral methods and tools for a variety of sectors, among which electronics. For each sector, the objectives are to develop simplified operative methods and tools; sector-specific eco-design and LCA approaches; a web-based, open source toolbox.

Tool / initiative	Organisation	Description
GeSi Cloud Impact	GeSi – Global e-Sustainability initiative	The environmental impact modelling tool allows for the evaluation of energy savings, cost savings and carbon emissions abatement potential of 3 types of cloud computing in 11 different countries. The software was created by Qingtech, a UK based team focused upon providing organisations with both the scientific and business orientated knowledge and tools to quantify and manage the environmental impact of their ICT. The tool provides with results at country level.
SASF	GeSi – Global e-Sustainability initiative	The Sustainability Assessment Framework (SASF) enables ICT companies to evaluate the sustainability performance of their products and services. The SASF is a comprehensive assessment framework for the evaluation of ICT products and services in terms of environmental, human rights and utility aspects as well as benefits. The result is a product score, ranging from 0 points (lowest performance) to 100 points (highest performance). The results allow insights into the value chain of products and services. SASF may be used as an internal management tool, as it allows users to manage their portfolios of sustainable products and services. Furthermore, SASF provides a solid foundation for policy/decision-making.
CoolEmAll	CoolEmAll Consortium	CoolEmAll is a project financed by the European Commission. Its goal is to develop a tool for determining and visualizing heat loads depending on workload condition, and allocating workload in order to operate the data centre's cooling system more efficiently, by avoiding over-cooling server rooms.
HP Carbon Footprint Calculators	HP	The web based HP Carbon Footprint Calculators helps estimate how applying power-saving technologies, upgrading to more efficient features, and consolidating devices can lower the energy use and carbon footprint. The ICT goods in the scope of the calculator are printers, desktops, notebooks, workstations, monitors, tablets developed by the company.
BT Carbon calculator for business	British Telecom	The calculator proposed by British Telecom helps estimate the carbon emission savings associated with the products and services developed by the company. Various services are assessed, from reducing unnecessary travel through video conferencing to decreasing power consumption through virtual datacentres.
Save Energy on your PC	Carbon Footprint Management	Carbonfootprintmanagement.com aims to accelerate the reduction of greenhouse gas emissions. This acceleration is realized by informing, inspiring and activating small and medium enterprises in how to save energy and generate renewable energy. The tool is a simplified calculator that provides an estimate of the potential carbon and economic savings, based on the number of laptops and desktops under scope.
Ecoindex	Green IT	The Ecoindex is an online tool which aims at testing the environmental and technical performance of a website. It provides an absolute environmental performance score (from 1 to 100), the relative environmental performance through a A to G

Tool / initiative	Organisation	Description
		ranking, the technical footprint and the environmental footprint of a website. The evaluation gives a general idea of the website performance.
Cost and Carbon Comparison Tool: Thick Vs Thin Clients	SusteIT & JISC	The Cost and Carbon Comparison Tool is an Excel tool designed to help Further and Higher Education (FHE) Institutions estimate the costs and carbon emissions of thin versus thick client PCs over a given evaluation period. The tool calculates the savings (positive values) or costs (negative values) of thin clients compared to thick clients over the evaluation period.
ICT Energy and Carbon Footprinting tool	SusteIT & JISC	The ICT Energy and Carbon Footprinting tool is an Excel tool designed to help Further and Higher Education (FHE) Institutions estimate the in-use energy consumption, costs and carbon footprint of their non-residential ICT usage. This in turn is used to estimate energy costs and carbon emissions associated with ICT usage. The final results are designed to provide a reasonable estimate of the overall magnitude of electricity/carbon used.

Appendix B – Additional success stories

New stories from city / public administrators

Table 10: Her Majesty's Land Registry Success Story

Her Majesty's Land Registry - UK	
Organisation presentation	Organisation: Her Majesty's Land Registry Organisation Type: Government/Public Services City: Telford Country: United Kingdom Contact: David Michael Bailey Link website: http://www.gov.uk/land-registry
Claim to fame	Thanks to a strategy to work with staff and make adjustments to working practices, HM Land Registry's Telford Office is leading the way in the UK branch of the Horizon 2020 funded Save@Work competition, aiming to reduce the amount of energy wasted by offices in the public sector. Part of this undertaking involved making savings with our ICT equipment's energy use and talking to staff about their monitors and how much of an impact seemingly small changes can have if we all make them.
Main benefits & achieved results	By drawing up and implementing an action plan as well as engaging positively with staff, Telford has reduced its electricity use over the previous year by 16.4%. Discussing the energy used by monitors with staff resulted in a reduction from 14% of monitors left on when not in use to 5%, which contributed to a 40% reduction in the office's electricity consumption in December 2016 compared to December 2015. Writing an article for staff about the positive impacts of each of us making small changes caught the attention of a wider audience and may be adopted as 'Best Practice' throughout all HM Land Registry offices. Running a monthly competition with prizes for the team that have the fewest monitors left on standby has increased engagement, participation and goodwill amongst our colleagues in the office. Average CO2 emissions during the competition have reduced by 270 KG per employee, which equates to an average energy saving of 800 kWh per employee so far and the savings are still increasing.
Presentation of the initiative	We saw monitors around the office were being left on standby. We highlighted this to staff and requested that they start to switch off monitors when not in use. We got a question about how much energy it would really save – 'is it worth it?' This was a good question that deserved an answer, so we decided to work it out. As we suspected, the energy saved when turning off a monitor was minimal. Instead of thinking 'why bother?', we considered the matter on a larger scale, and this was the perspective from which we wrote the article – turning off monitors won't win the competition, but it illustrated the point the competition was making – small changes made by many people do make a difference.
Commitments for the future & other relevant information	The Save@Work competition draws to a close at the end of February and we are looking to continue the positive habits we have implemented during the year beyond this and into the future. We will continue to communicate and engage with our colleagues to help make all our offices more sustainable for the future, as well as looking for more changes, small or large, to cut carbon and save energy. We will work with sustainability champions across HMLR, as well as other government departments such as Natural England (DEFRA) to push sustainable working and climate change to the top of the agenda.

Table 11: FCO Services Success Story

FCO Services - UK	
Organisation presentation	Organisation: FCO Services Organisation Type: Government/Public Services City: Milton Keynes Country: United Kingdom Contact: Paolo Bertoldi Link website: http://www.fcoscareers.co.uk/
Claim to fame	Recognised for reducing its environmental footprint, FCO Services' efficient data centre has won the prestigious European Code of Conduct Awards for Energy Efficiency in Data Centres from the European Commission's Joint Research Centre (2016). From using rainwater recycling systems for hybrid cooling towers to implementing cold aisle containment and designing the underground structure of the data centre as a natural heat drain – FCO Services have adopted recognised energy efficient best practice to reduce the impact of related environmental, economic and energy demands.
Main benefits & achieved results	FCO Services Chief Executive, Danny Payne said: "We are very proud to receive this award. It is a welcome recognition of our commitment to reduce energy consumption in this recognised high demand area. We currently operate at a world class efficiency power usage effectiveness of 1.1, well below the average value of 2.0 seen in most data centres. This cost-effective energy saving measure helps both our business and our customers".
Presentation of the initiative	FCO Services signed up to the EU Code of Conduct in 2014 to put the organisation firmly in line with the government 's ICT greening strategy – reinforcing its commitment to make energy and cost savings. The system was designed to support an average 1.1 PUE performance. During winter mode the solution should perform to incredible PUE figures of Modular, scalable power and cooling architecture that allows deployment as needed. This is the crucial element for improving data centre efficiency. The implementation of modern energy efficient cooling technologies reduces organisation's operational energy overhead and will have a surprising contribution to data centre energy savings. The bespoke dual 12mL x 3.5mW x 3.5mH modular pods combined with a link corridor is designed supported 22 equipment racks with 1.2m front and 875mm rear rack clearance. Once inside the solutions looks and feels like a conventional bricks and mortar design. The solution was designed to support pay as you grow capability. This was fulfilled through the deployment of modular and scalable UPS and cooling technology delivering incremental growth. FCO Services has maximised the use of space to reduce the modular data centre footprint. Use of free air evaporative cooling for the data centre reduces power consumption.
Commitments for the future & other relevant information	FCO Services has committed to adopt best practice energy and cost-efficient initiatives for their data centres and to migrate ICT services to the cloud. FCO Services received the Carbon Trust Standard as well and the Carbon Trust Waste Standard – further demonstrating the organisation's commitment to energy and cost savings.

Table 12: Federal Ministry of the Interior Success Story

<table>
<tr><th colspan="2">Federal Ministry of the Interior - Germany</th></tr>
<tr><td>Organisation presentation</td><td>Organisation: Federal Ministry of the Interior
Organisation Type: Cities or Public Administration
City: Bonn
Country: Germany
Contact: +49 22899 601-0
Link website: Website
Bundesministerium der Finanzen</td></tr>
<tr><td>Claim to fame</td><td>Contract tender for thin clients tendered by the Procurement Agency of the Federal Ministry of the Interior, Germany (Beschaffungsamt) published in August 2013. Framework contract about 50.000 thin client computer systems (30.00 smart-thin-clients and 20.000 full-thin-clients) and connected services to replace old and inefficient desktop PCs in several government agencies. A 24 months purchase contract (framework contract) with the possibility to extend twice for 12 months. Contract Clauses: Repair and maintenance: warrantee of compliance for the following environmental aspects:
- Energy consumption: 61 kWh/a/unit
- Emissions: 31 Kg CO2/a/unit
- All components must be labelled with the CE-mark.
- Noise. all components guarantee an acoustic power level established by EN ISO 7779:2001 in association with ISO 9296:1988.
- Hazardous waste: separated collection and delivering to authorised waste managers.
- No Hazardous waste: good management according to general law and local regulations.</td></tr>
<tr><td>Main benefits & achieved results</td><td>Energy savings and CO2 emission reductions were calculated based on GPP 2020 methodology for a lifecycle of 5 years. The results are as follows.
<table><tr><th></th><th>Smart-thin-client systems</th><th>Full-thin-client systems</th></tr><tr><td>Idle mode max.</td><td>9,06 Watts
25% below technical specifications in the tender</td><td>12,42 Watts
17% below technical specifications in the tender</td></tr><tr><td>Electricity savings (kWh)</td><td colspan="2">58,750,000 kWh energy savings</td></tr><tr><td>Reduction of CO2-Emissions (kg)</td><td colspan="2">29,500,000 kg CO2 savings</td></tr></table>
The market for thin-client computer systems offers more energy-efficient products than demanded in the technical specifications (see table above).</td></tr>
<tr><td>Commitments for the future & other relevant information</td><td>In the future more ambitious criteria on the energy efficiency could be considered as an award criterion.</td></tr>
</table>

Table 13: CENTRE OF REGISTERS AND INFORMATION SYSTEMS Success Story

CENTRE OF REGISTERS AND INFORMATION SYSTEMS - Estonia	
Organisation presentation	Organisation: CENTRE OF REGISTERS AND INFORMATION SYSTEMS Organisation Type: Cities or Public Administration City: Tallinn Country: Estonia Contact: Mariliis Kannukene, Link website: Website eRIK Centre of Registers and Information Systems
Claim to fame	The Centre of Registers and Information Systems (RIK) is an agency in the jurisdiction of Estonia's Ministry of Justice. RIK serves to provide an innovative environment by supplying integrated e-services for a more efficient implementation of the national administration, legal and criminal policies. This particular procurement process was for a joint framework agreement for the purchase of personal computers (PCs) and computer monitors by several Estonian entities and was carried out by RIK in March/April 2012. A market consultation exercise was established to facilitate dialogue between manufacturers' representatives and joint procurers. Technical specifications were prepared based on the results of the market research.
Main benefits & achieved results	**Results** Five offers were received following publication of the call for tender. The framework agreement was signed in June 2012, will operate for two years and its value is estimated at €500,000. PCs bought under this contract are estimated to generate energy savings of 20-30% compared to non-green product alternatives. RIK's experiences with using these sustainability criteria have been positive. No major problems have been experienced, because most of the larger producers' products seem to comply with the criteria and carry the above-mentioned labels. Furthermore, the technical market dialogue in the pre-procurement phase has proved to be a good approach for avoiding any future problems in the tendering and award phases. **Environmental Impacts** For many office IT products, the most significant environmental impact relates to the energy consumption during their lifetime. This is particularly the case for office PCs, notebook computers and monitors. According to the Energy Star website, most studies report that for an office PC primary energy consumption during use is more than three to four times higher than the primary energy needed for manufacturing and materials production, whilst the energy costs/credits of waste disposal and recycling are comparatively small (<15% of production energy). This is the result for a typical office PC, used eight hours per day (including standby) over 260 years. Whilst substantial improvements have been made in the energy saving modes of IT equipment, the same cannot be said for 'active middle' mode requirements, that is, when the machine is in active use. Large variations in active energy use exist between different models on the market (some devices consume twice as much energy as others), and the active mode is in most cases responsible for the majority of total energy consumption. Whilst energy consumption in the 'active' mode is principally determined by the functionality of the machine (powerful, high-specification models will consume more energy), differences exist between models offering the same level of functionality)
Presentation of the initiative	**Subject matter of the contract** Purchase or lease at least 1,000 PCs (with software licences) and 1,000 monitors, additional equipment and components, together with transportation and take-back of the leased products. **Technical specifications** • All PCs are required to meet the Energy Star 5.0 requirements, or equivalent; • All monitors are required to meet the TCO' 5.0requirements, or equivalent; • Power supply efficiency must be at least 85% (regardless of load) and power cord must be included in the set; • Sound power level (sound pressure level) at operating mode (CPU load of 90%) should not exceed 33.3 dB (measured in accordance with ISO 9296); • Monitors must be LED-backlit LCD (liquid crystal display); • PCs must have the possibility to extend RAM size. **Award Criteria** The award criteria were based on the most economically advantageous tender. The various criteria were weighted as follows: • 80% for price; • 10% for energy consumption in operating mode. Bids with PCs and monitors with the lowest energy consumption receive the most points. • 4% if the device included an integrated smart card reader in the keyboard; • 6% of the points for other criteria related to monitors only.

New stories from large enterprises

Table 14: Capgemini Success Story

Capgemini - UK	
Organisation presentation	Organisation: Capgemini Organisation Type: IT Consultancy/Development City: Swindon Country: United Kingdom Contact: kevin.read@capgemini.com Link website: https://www.capgemini.com
Claim to fame	Capgemini's newest data center: Located in Swindon, UK, it is a state-of-the-art facility that breaks new ground in terms of data center design and construction principles. Capgemini created a model which will enable future data centres to be more sustainable, operate with significantly more efficiency, be located more flexibly, and make high-end data management services accessible to a wider range of organisations and enterprises. It is a model which is more cost effective to implement than traditional data centres, minimises CapEx and reduces running costs, generating savings for the end client.
Main benefits & achieved results	Among Merlin's key sustainability achievements are: -An expected PUE (Power Usage Effectiveness) of 1.10 -Built to LEED standard – an independent and internationally recognized green building accreditation. -A fresh air cooling system that delivers 80% savings in run costs and produces up to 50% less carbon emissions -Power savings of 91% compared to an 'industry average' data center (with a PUE of 2.5) -The elimination of batteries in the Uninterruptible Power Supply (UPS) thanks to the application of innovative flywheel technology. With a factory tested PUE rating of 1.08 across all loads and ambient operating temperatures and humidity, Merlin will deliver the best PUE rating gained industry-wide and is testimony to its achievement in energy efficiency. All energy-efficiency targets were met without compromising N+1 resilience, in a facility designed to last for a minimum of 30 years. The benefit to clients is clear: the massive cost savings, business efficiency and environmental benefits without any diminishing of space or technical services.
Presentation of the initiative	The Merlin project is a success on all fronts. In September 2010, Capgemini's new data centre, Merlin, came online. This state-of-the-art, 3,000m2, Tier 3 facility will set a new global standard for energy efficiency, with an industry-leading Power Usage Effectiveness (PUE) rating. With significantly lower running costs than comparably sized data centres, Merlin still meets all of its original criteria: - Sustainable - Recyclable - Energy Efficient - Resilient - Modular Sustainability has been at the heart of the Merlin project – all the way from location selection, design and construction, through to the day-to-day operation of the site.
Commitments for the future & other relevant information	Capgemini's strategy is to continue to roll out its solution globally, linking strategically paired sites with high bandwidth synchronous fibre, providing client business continuity failover. Merlin is already twinned with its Bristol Flagship List X data centre.

Table 15: Deutsche Telekom Success Story

Deutsche Telekom - Germany	
Organisation presentation	Organisation: Deutsche Telekom AG Organisation Type: Large Enterprise City: Bonn Country: Germany Contact: impressum@telekom.de Link website: https://www.telekom.com/en
Claim to fame	Deutsche Telekom reduces their carbon footprint in mind when planning and operating their data centers. To achieve this goal, T-Systems takes a two-step approach: It starts with optimizing energy consumption at each data center site and then continues with improving processes throughout the global data center landscape.
Main benefits & achieved results	The PUE img factor serves as an indicator for improvements in energy efficiency. We were able to reduce the average PUE factor img at the T-Systems data centers from 1.85 to 1.63 between 2008 and 2015. Current program plans estimate a cumulated CO2 reduction of up to 51 percent by 2020 based on the 2012 figures.
Presentation of the initiative	Between 2008 and 2013 the focus was on optimizing existing data center space. Some examples include updating the cooling systems and installing cold aisle containment to control the flow of cooling air as needed and minimize cold air waste in the IT areas. Advancements in IT technology also made it possible to considerably reduce energy consumption. In addition to these fundamental technical optimization measures, Deutsche Telekom is always fine-tuning its climate control technology; this in combination with optimum data center capacity utilization enables the company to continue to improve efficiency. The second phase has been ongoing since 2013. This phase combines physical data center consolidation (i.e., reducing data center space and sites) with logical consolidation (i.e., virtualizing img data center infrastructure). The DC11@2018 program is working to globally consolidate data center sites with the latest IT technology to a few FMO (future mode of operation) data centers. The target average PUE factor at the FMO data centers will be 1.4 once the program has been completed. This requires a homogeneous IT landscape combined with optimum capacity utilization of data center infrastructure, IT hardware and the software running on the systems.
Commitments for the future & other relevant information	Deutsche Telekom expects these measures to bring about another massive reduction in CO2 emissions by year 2020

Table 16: Equinix Success Story

Equinix - UK	
Organisation presentation	Organisation: Equinix Organisation Type: Large Enterprise City: London, Amsterdam, Enschede and Zwolle Country: UK and The Netherlands Contact: info@eu.equinix.com Link website: http://www.equinix.com/
Claim to fame	All nine Equinix's data centers in the UK and the Netherlands have achieved both ISO 14001(environmental management) and ISO 50001 (energy management) certifications from leading assurance provider, LRQA. Leading the way in environmental standards, Equinix is now the first data center provider in Europe to achieve ISO 50001 accreditation, emphasizing the company's firm commitment to continuous improvements in both energy efficiency and environmental management.
Main benefits & achieved results	All Equinix $56 million of energy efficiency investments since 2011 have help the company to avoid 36,000 kilowatts of demand annually or approximately 370,000 metric tons in CO2 emissions avoided now every year. Plus, 20% improvement in energy efficiency for the all data centers was achieved.
Presentation of the initiative	The ISO 50001:2011 standard is intended to provide organizations with a recognized framework for integrating energy performance into their management practices. The ISO 14001:2004 is intended to provide organizations with the elements of an effective environmental management system that can help them achieve environmental and economic goals. Certification to these standards demonstrates that Equinix has put in place systematic energy and environmental management processes to continually improve its environmental performance. The new certifications are a key element in Equinix's ongoing international standards program which is designed to ensure that the company's data centers meet the most demanding customer requirements in the industry. Ken Roberts, LRQA Account Manager says, "Equinix is leading the way in the data center sector in meeting the most rigorous standards for energy and environmental management. Facilities like data centers usually require a lot of energy to run and so it is really beneficial for the sector to see companies like Equinix working hard to ensure they are playing a part in improving energy efficiency." "At Equinix we understand that the health of our business is closely linked to the health of the environment it operates in. That's one reason why the company is committed to building and maintaining the most sustainable data centers it can," says Dick Theunissen, chief marketing officer for Equinix in EMEA. "It's also important to our customers that their data center provider is implementing best practices to reduce its environmental footprint and to meet stringent European regulations in this area. By working with a data center provider which provides energy and environmental best practices in a framework of continuous improvement, customers will be able to achieve their energy efficiency and environmental objectives in the data center now and in the future."
Commitments for the future & other relevant information	Equinix wants to become the first global data center company 100% renewable and is still expanding their energy efficiency program (EEP), while maximizing opportunities for continuous improvement within their data centers.

Table 17: Logicalis Success Story

Logicalis - UK	
Organisation presentation	Organisation: Logicalis Organisation Type: Large Enterprise City: Berkshire Country: UK Contact: info@uk.logicalis.com Link website: http://www.uk.logicalis.com/
Claim to fame	Logicalis manages the performance of its data centres worldwide by looking at the Power Usage Effectiveness (PUE) and other performance metrics such as the number of W per active server or the server utilisation rate. The performance is monitored through the use of a relevant software, which captures the data of interest across the data centre. Logicalis is committed to data centers that are energy- and cost-efficient. Because cooling makes up almost 50% of your total energy spend in a data center, Logicalis' data centers use minimal water and electricity for cooling activities, meaning they cost less in the long run. Logicalis also utilizes solar power in our data center builds, further reducing the cost and doing their part to take advantages of renewable energy resources.
Main benefits & achieved results	"Capture power and cooling information in real time" With this data center management software, you can create standard and custom metrics such as Power Usage Efficiency (PUE) to benchmark your data centers, facilities equipment and IT assets. It also helps you decide where to place new racks by identifying where excess cooling and power are available so that you can efficiently manage energy and service costs. In addition, CA DCIM can measure and analyze power load and consumption across multiple devices, systems, buildings and data centers. "Main Benefits" - Enables data collection from multiple systems and protocols, reducing manual efforts - Provides data center monitoring and alarming for facilities with visualization of power, space and cooling data for insight, analysis and control - Enables capacity data center management software for more effective use of data center infrastructure and planning - Provides visibility into space and power utilization, allowing for smart, real-time decision making Using CA DCIM, Logicalis has achieved an impressive 159 percent return on investment and an 11-month payback.
Presentation of the initiative	Logicalis UK deployed CA ecoSoftware to help measure, manage and reduce the consumption of power in the data center. CA ecoSoftware enables Logicalis UK to collect and analyze data from points throughout the data center to provide detailed real-time insight into energy use and efficiency. It supplies status, alerting and management information to increase the reliability of operations. In addition, CA ecoSoftware helps enable Logicalis UK to provide customers with more accurate data center efficiency metrics and energy billings, both of which have become increasingly important when providing cloud computing services. CA ecoSoftware also helps Logicalis UK identify inefficient power use, which can significantly reduce unnecessary electricity costs, make better use of available power capacity, and mitigate the carbon footprint associated with data center operations. For more information, please see: http://www3.ca.com/us/opscenter/ca-dcim.aspx
Commitments for the future & other relevant information	Logicalis is constantly seeking new ways of measuring and improving its sustainability performance.

Table 18: Atman Success Story

Atman - Poland	
Organisation presentation	Organisation: Atman Organisation Type: Large Enterprise City: Warsaw Country: Poland Contact: Paolo Bertoldi Link website: https://www.atman.pl
Claim to fame	Atma, a data center provider, has developed its own environmental parameters and takes advantage of direct free cooling solutions in their DC facilities.
Main benefits & achieved results	"Online efficiency monitoring using SCADA" Atman has developed its own environmental parameter s monitoring using SCADA. Instant information and alerts from SCADA enable Atman's personnel to react immediately and fine-tune electrical and mechanical devices in order to maximize energy efficiency. "Free cooling (direct and indirect)" - Atman is taking advantage of direct free cooling solutions in their DC facilities where flexible approach to environmental conditions Is allowed. - In data-rooms which require strict humidity and temperature control Atman uses precision free cooling systems - Set points recommended by ASHRAE classes A1-A4: 18- 27 ºC "Sealed racks and isles" Atman's staff regularly monitors data-rooms against proper and optimal use of cooling. Hot-spots, empty rack-slots, reverse fans, etc. are subject to immediate corrections. This activity is backed by appropriate provisions in contracts "Vendors – endorsers" When possible, Atman selects their vendors from registered Code of Conduct Data Centre endorsers (Schneider Electric, Emerson Network Power, Stulz, Socomec, and others) "Power Usage Effectiveness (PUE)" Atman uses industry-standard efficiency metrics, such as PUE, to benchmark our operations and precisely assess the efficiency gained from infrastructure upgrades
Presentation of the initiative	As one of the leading data centers operators in Central and Eastern Europe, Atman endeavors to set the benchmark in our quality standards and do our part for the environment. We apprehend that our main environmental impact as a data center operator comes from the power we use to run our facilities. In order to downsize our energy consumption, we use technologies that considerably improve the efficiency of data center power usage and cooling.
Commitments for the future & other relevant information	Commitments for the future & other relevant information: As a data center operator and the Polish market leadeR, the company encourages clients and partners to endorse the European Code of Conduct for Energy Efficiency in Data Centre, especially. This relates to the consumption efficiency of the IT equipment in the data centre and can be described as the IT work capacity available for a given IT power consumption. Atman supports and advise our business partners on optimization of IT infrastructure because the utilisation of its capacity is an important part of efficiency in a data center.

Table 19: Microsoft Success Story

Microsoft - Ireland	
Organisation presentation	Organisation: Microsoft Organisation Type: Large Enterprise City: Dublin Country: Ireland Link website: https://www.microsoft.com
Claim to fame	Microsoft opened a new data centre in Dublin, Ireland, that has a Power Use Effectiveness (PUE) of 1.25, on a scale where 1 is the optimal (the average in the industry is approximately 2.0 and Microsoft data centres globally have an average of 1.6).
Main benefits & achieved results	Benefits: - Reduced energy consumption - Reduced CO2 emissions - Increased capacity and performance The new Microsoft data center in Ireland already consumes approximately 50 percent less energy than a traditional data center of similar size and level of activity. Besides the EU Code of Conduct for Green Data Centers, this is possible due to a range of innovations, one being the use of outside air to cool the data center at almost zero cost. This provides dramatic environmental savings as artificial cooling normally consumes approximately 38 percent of the facility's electricity consumption and 18 million liters of water per month. In addition, the latest generation of servers and 24/7 monitoring will help to create further energy savings.
Presentation of the initiative	To tackle the data centres' energy consumption, Microsoft has adopted a strategy to dramatically improve its data centres' energy efficiency. The company signed the EU Code of Conduct for Green Data Centres, which includes a commitment to comply with European standards and best practices. Plus, an important function for the Irish data centre will be to host web conferencing tools to reduce business travel, and thereby reduce costs and emissions.
Commitments for the future & other relevant information	Beyond the Dublin data centre, Microsoft has already implemented, or is planning to implement, the majority of the EU Code's best practices in its data centres in Europe and across the globe. The company is also exploring the innovative use of shipping containers as flexible and portable housing for servers which provide 10 times the density for data centres and drive dramatic savings in power usage. Finally, Microsoft Research, the company's in-house research branch, is supporting these efforts by constantly looking for innovative ways to improve energy efficiency.

Table 20: STMicroelectronics Success Story

STMicroelectronics - Switzerland	
Organisation presentation	Organisation: STMicroelectronics Organisation Type: Large Enterprise City: Geneva Country: Switzerland Link website: http://www.st.com/content/st_com/en.html
Claim to fame	ST is committed to reducing its energy consumption and associated carbon footprint through energy efficiency and conservation programs along with the purchase of CO2-free and renewable energies. ST carefully monitors and anticipates changes in the energy market to mitigate business exposure to climate change.
Main benefits & achieved results	"Saving Energy at our sites" Optimizing processes and replacing or upgrading equipment are important means of improving energy efficiency. Our energy teams are constantly analysing options to implement energy-related upgrades or optimization to drive down usage. A good example is the energy management efforts undertaken at ST Rousset (France), where the energy-saving activities implemented over the last five years have had an impressive result. While production has increased by 32%, absolute electricity consumption at the site has decreased by 2.3% and gas consumption by 15%. In 2016, ST Crolles (France) carried out a range of different actions. The 20 programs identified included an equipment retrofit, optimization of air conditioning, and the replacement of a preheat exchanger supplying ultra-pure water. This achieved a total electricity saving of 4.7GWh during the year. "Monitoring usage" We have put a rigorous and detailed monitoring in place to keep our energy consumption under control. Close analysis of energy usage in our processes and facilities highlights possible areas for improvement. It enables us to fine-tune settings and maximize energy efficiency by eradicating waste and delivering only what is needed precisely when it is needed. As an example, ST Crolles (France) signed a contract with its plant facilities services supplier with a commitment to saving energy. Through smart monitoring done remotely by the supplier, who provided real-time data analysis and decision-making, the site has been able to identify opportunities to maximize equipment efficiency and to save 2.3GWh in 2016. "Introducing new equipment" When optimizing processes or upgrading equipment is not sufficient to reduce energy consumption, replacing old equipment is an alternative. For example, in our Muar site (Malaysia), the installation of a new, more efficient, and reliable consolidated cooling water system resulted in an annual energy reduction of 2.9MWh.
Presentation of the initiative	At ST, we minimize our energy consumption and associated carbon footprint by implementing energy-efficiency and conservation programs. We also maximize our purchase of CO2-free and renewable energies. In addition, we work with external stakeholders to carefully monitor and anticipate developments in the energy market and to mitigate business exposure to climate change. For nearly 20 years, ST has been decreasing its energy usage, reducing its costs and gaining efficiency through continuous upgrades of its existing equipment and manufacturing processes. ST is committed to reducing its office-related energy consumption through improvements and installation of more efficient lighting, system controls, cleanroom heating, ventilation and air conditioning. All ST Front-end sites are certified ISO 500011 since 2013.ST sites also raise employee awareness and engagement through regular energy conservation campaigns and site events.
Commitments for the future & other relevant information	- Continually improve energy efficiency at equivalent production level (kWh per production unit) through process and facilities optimization, conservation and building design. - Yearly increase by 10% the quantity of green energy used by the Company. - By 2016, ensure that 90% of calls for tenders from US$200k include criteria on energy efficiency and use of CO2 emission-free and/or renewable energy regarding facilities and site services.

Table 21: Postbank Success Story

Postbank - Germany	
Organisation presentation	Organisation: Postbank Organisation Type: Large Enterprise Country: Germany Contact: direkt@postbank.epost.de Link website: https://www.postbank.de
Claim to fame	In 2009, the Postbank initialised a new backbone project based on the MPLS (Multi-Protocol-Label-Switching) technology, and which aimed to evaluate and then implement new technologies. It replaced the ATM (Asynchronous-Transfer-Mode) technology, started in 1996. The network based on MPLS technology met with the requirements of Postbank IT and improved the energy balance, which is an important criterion for Postbank, as an ISO 14 001 certified enterprise.
Main benefits & achieved results	The implementation of the MPLS technology, beside a quick return on investment, resulted in reduced energy costs due to energy savings. Energy savings of over 59% were realised in the data centre following the replacement of network components. The introduction of logically separated networks made decentralised firewall-transitions redundant, thus with energy savings of over 61% for firewall servers. The energy savings associated with the distribution infrastructure were estimated around 52%. On the overall, in respect to the improved security and increased availability, the project resulted in a significant marketing potential for the provided services. The main aspects were: • New network equipment with a 10-year lifespan; • Return on investment about 18 months; • Switch replacement linked to server life cycle due to soft migration.
Presentation of the initiative	With the MPLS technology the physical network was divided into logical and independent subdivisions or clients. This virtualization satisfied increasing demands in terms of scalability and easy network management capability, as well as the need of protection for data connections from unauthorized access. After the introduction of the MPLS backbone, network components in the data centre were removed and replaced gradually with new components. The subdivision of the new system allowed for a strong reduction of necessary hardware, thus energy consumption, at all sites: the virtualised network needed 188 network components, compared to about 400 routers and switches previously.
Commitments for the future & other relevant information	Postbank was able to pre-test the new network configuration at Cisco laboratory in San Jose. Postbank voluntarily implemented an environmental management system certified to ISO 14001. Ecological standards in procurement are part of Postbank's environmental management system.

Table 22: Sun Microsystems (Oracle) Success Story

Sun Microsystems (Oracle) - USA	
Organisation presentation	Organisation: Sun Microsystems (Oracle) Organisation Type: Large Enterprise City: Santa Clara Country: USA Contact: Véronique Blin Link website: https://www.oracle.com/index.html
Claim to fame	As part of the company's ongoing commitment to greening its global operations, Sun Microsystems (acquired by Oracle) unveiled three active, new data centres. Put into operation in 2007, three data centres (located in California, the UK and India) were built using energy saving oriented designs and next-generation energy efficient systems. The largest of the three is located in Santa Clara, California.
Main benefits & achieved results	Sun Microsystems estimated that by adopting a sustainable approach, the space required for the data centres was reduced by 80%. Similarly, the ecodesign of the centres allowed for the cutting of electrical and cooling costs by 50% compared to average data centres. The energy savings corresponded to 4,100 t of CO2e savings per year, i.e. about 1% from Sun's total carbon footprint.
Presentation of the initiative	Efforts were focused on data centres in California, the UK and India. In particular, the conception of the data centre in Santa Clara has been divided into two phases. Phase one: hardware consolidation. This phase aimed to increase compute power by 450% and save $1.1 million in energy costs a year. Phase two: designing of the Santa Clara space and installation of the new hardware. This phase aimed to create an additional 30% reduction in energy costs.
Commitments for the future & other relevant information	Following the construction of the Santa Clara data centre, Sun held an event for customers in the facility to share best practices from the company's global data centre efforts. Building on Sun's heritage of sharing and open source, the company posted key learnings from the project free of charge to help other companies green their own data centres.

Table 23: Telia Sonera Success Story

Telia Sonera - Sweden	
Organisation presentation	Organisation: Telia Sonera Organisation Type: Large Enterprise City: Solna Country: Sweden Contact: Deloitte Link website: https://www.teliacompany.com/en
Claim to fame	In order to meet customers' expectations in terms of reduced environmental impacts, Telia Sonera Sweden ran several modernization programs focused on reducing energy consumption and costs related to facility rent.
Main benefits & achieved results	The company invested SEK 20 million in green cooling solutions in 2014 and 2015, and planed to invest an additional SEK 50 million when expanding the scope to additional sites. Total savings were estimated around SEK 40 million for 2014 and 2015. The programs were also expected to lower annual costs by SEK 20 to 25 million until 2018. In addition, old technology and systems, used by few people, were replaced by more energy efficient platforms. Finally, core technical sites were or are being energy optimised; and numerous rural technical sites expected to be closed.
Presentation of the initiative	The cooling investment programs include: • The replacement of compressor-based cooling with free air and geo-cooling solutions, along with the redesign of data centers • The dismantle of legacy equipment: in 2015, such cleanouts generated over 200 tons of mainly electronic waste • The utilization of contractors in the programs, by taking advantage of the potential available time of contractors working at a site and having completed the ordered work. The contractors are asked to identify and switch off equipment no longer in use, thus saving time and money for both TeliaSonera and the contractor
Commitments for the future & other relevant information	Telia Sonera aims at improving the environmental impact throughout the value chain, by minimizing negative while maximizing positive impacts. Specific goals were defined for 2018: • Certification ISO 14001 for all major operations in region Europe • Establishment of buy-back programs for mobile devices in region Europe • 10% lower energy consumption and 33% lower CO2 emissions per subscription equivalent

Table 24: EDF Success Story

EDF - France	
Organisation presentation	Organisation: EDF Organisation Type: Large Enterprise City: Val de Reuil Country: France Contact: Deloitte Link website: https://www.edf.fr/en/
Claim to fame	EDF owns several data centres, among which NOE data centre, located in Val de Reuil, and one its biggest data centres. In 2016, the NOE data centre was certified ISO 50001, along with all data centres of EDF. In addition, EDF committed to dividing by 2 by 2018 the energy consumption of its data centres located in the Eure department (among which NOE), in comparison to the 2011 period.
Main benefits & achieved results	Through the sophistication of its equipment, EDF managed to reach a 25% reduction of its electric consumption for the NOE data centre in Val de Rueil. This corresponds to an economy of 17,400 MWh (equivalent to 1,500 tonnes of CO2). Energy savings in 2018 are expected to double.
Presentation of the initiative	EDF data centres use innovative technology, and are state of the art in terms of energy performances. All major energy consumers are being reviewed, in order to reduce as much as possible, the Power Usage Effectiveness (PUE), currently at 1.74 for NOE data centre. In particular, the installations are based on: • Use of the latest technologies jointly developed with start-ups: wireless sensors, LED lighting etc. • Cloud computing solution to mutualize the server capacities • Outdoor air caption to supply the cooling system • The utilities management was outsourced to Dalkia, now in charge of the system for cooling and power, among others.
Commitments for the future & other relevant information	The next step currently under study for the NOE data centre is the reuse of hot water outgoing from the cooling system, e.g. by piping it to nearby greenhouses owned by a cosmetic manufacturer.

Table 25: KPN Success Story

KPN - The Netherlands	
Organisation presentation	Organisation: KPN Organisation Type: Large Enterprise City: Eindhoven Country: The Netherlands Contact: Deloitte Link website: https://www.kpn.com/
Claim to fame	KPN owns ten data centres throughout the Netherlands, where they store their customer's data and run their software. The new data centre at the High Tech Campus in Eindhoven is powered by a 100% sustainably generated energy. In 2015, KPN won the ICT Environment Award for this new data centre, as a result of their sustainable technology reducing energy consumption despite the strong increase in data traffic in the Netherlands.
Main benefits & achieved results	The data centre at the High-Tech Campus in Eindhoven is powered by a 100% sustainably generated energy. The data centre was also the first in the Netherlands to receive the Tier IV certification, thus proving that a sustainable energy sourcing policy is compatible with a high reliable service. In particular, the data centre provides with continuous power supply and cooling.
Presentation of the initiative	The energy needed to run the data centre is generated by biomass and the Princess Amalia wind farm, an offshore wind farm in the Netherlands. In addition, the surplus heat from the data centre is diverted to nearby buildings in the High-Tech Campus, which consequently require less energy and generate lower carbon emissions. Finally, the design and construction of the data centre followed a cradle-to-cradle principle: the components are reusable, and the materials can have a second life and be used for other purposes when the data centre reaches its end of lifespan. ong others.
Commitments for the future & other relevant information	KPN is committed to integrating sustainability into business operations. The company is 100% climate neutral since 2015 and aims to make all new equipment and products 100% circular by 2025. Meanwhile, KPN makes improving online security a top priority and has identified key security objectives such as the development of threat intelligence capabilities. In 2017 KPN was named sustainability leader of the telecommunication services industry by the Dow Jones Sustainability Index.

New stories from small and medium enterprises

Table 26: PuzzlePhone Success Story

PuzzlePhone - Finland	
Organisation presentation	Organisation: Circular Devices Organisation Type: Small and Medium Enterprise City: Espoo Country: Finland Contact: Alejandro Santacreu Link website: http://www.puzzlephone.com
Claim to fame	PuzzlePhone it's the long--lasting smartphone with three easy-to-change modules. (Like a puzzle. Except this is a phone.) Buying a new phone every time you drop it is now history. PuzzlePhone is reliable, upgradeable - -even repairable! Need more power? Break your screen? Dead battery? All are easily replaced - by the user!
Main benefits & achieved results	Sustainability in the mobile phone business: it's no longer a cliché. Talk is cheap. "Green" and "sustainable" may go down in history as the great clichés of the 21st century, the era of greenwashing and carbon export to foreign shores. If we truly believe in sustainability, then just why do we replace our phones so often? PuzzlePhone aspires to make modern communication and sustainability no longer a contradiction in terms. Manufactured in Finland, PuzzlePhone's sustainable business ecosystem may be cut and pasted anywhere in the rest of the world. bring your phone back to life by changing a single module. It's fast and cost-efficient. MODULES Create an entire device or a module for a specific need. Optimize the use of smartphone as an essential tool for getting the job done. Or perhaps your module is an upgrade for everyday use. With us you can create functionalities like action camera, walkie-talkie, chemical sensors and bulletproof body. ACCESSORIES The ultimate in customizable smartphones welcomes accessory makers. Both internally and externally, PuzzlePhone can be customized and personalized. Why stop with a bullet-proof cover? The ways of personalizing a PuzzlePhone are virtually limitless. To attach the protection covers, arm straps, etc. AVERAGE LIFESPAM Electronics - Lasts up to ten years (or until obsolescence); Battery - Lasts up to three years (or until malfunction) Screen - Lasts ten years (unless you break it)
Presentation of the initiative	PuzzlePhone's Design philosophy is rooted in a blend of usability and sustainability. Nordic Design focussed on subtle and functional forms, optimal use of available resources and materials. Longer-lasting products with carefully selected eco-friendly materials, combined with practicality. PuzzlePhone is the winner of the Green Electronics Council 2016 Catalysing Disruptive Innovation Award! More info here: https://www.youtube.com/watch?v=-TzEFxAlLhc
Commitments for the future & other relevant information	PuzzlePhone's team keeps dedication to move our common dream for sustainable, safe and modular smartphone forward.

Table 27: Fairphone Success Story

Fairphone - The Netherlands	
Organisation presentation	Organisation: Fairphone Organisation Type: Small and Medium Enterprise City: Amsterdam Country: The Netherlands Contact: Fabian Hühne Link website: https://www.fairphone.com/
Claim to fame	When it comes to making our phone, we're doing things a little differently. We aim to create positive social and environmental impact from the beginning to the end of a phone's life cycle, thanks to long lasting design, fair materials, good working conditions, reuse and recycling.
Main benefits & achieved results	Fairphone is the world's first modular phone. Fairphone is using modular design as a means to create longer-lasting phones and directly combat the rapid phone replacement cycle that consumers and the industry have become accustomed to. As a result, the Fairphone is easy to open, and the most commonly damaged component -- the screen -- can be replaced in under a minute without any tools. The other modules can be repaired with only a screw driver. The free repair guide - iFixit - gave the Fairphone 2 its first ever perfect score (10 out of 10) for repairability. Besides supporting longevity, do-it-yourself repair also gives buyers a greater sense of ownership and responsibility for their devices. Fairphone's modular design approach aims to increase product longevity and decrease the overall environmental footprint of producing smartphones. The environmental benefit of extending the lifetime of Fairphone can be quantified with a Life Cycle Assessment. The reduction of 30% of the emissions becomes apparent when comparing the total emissions per year of the baseline scenario of an average of 3 years of use (average for smartphones in Europe is often around 2 years) and the repair scenario, enabled by the modularity of Fairphone 2 of five years (including the replacement of modules).
Presentation of the initiative	In 2013, Fairphone launched a movement for fairer electronics. By making a phone, we're opening the supply chain and creating new relationships between people and their products. We're making a positive impact across the value chain in mining, design, manufacturing and life cycle, while expanding the market for products that put ethical values first. Together with our community, we're changing the way products are made. Fairphone's efforts in creating fairer and more sustainable electronics have been recognized with a number of prestigious awards
Commitments for the future & other relevant information	We'll keep doing everything we can to reduce our environmental impact on the production, design and end-of-life phase, including studies like the LCA that will help us make more informed decisions going forward.

Table 28: Jerlaure Success Story

Jerlaure - France	
Organisation presentation	Organisation: Jerlaure Organisation Type: Small and Medium Enterprise City: Abignon Country: France Contact: Nathalie Dulcamara Link website: http://www.jerlaure.fr/en/en
Claim to fame	The aim of the “Green Data Centre” is globally to reduce energy losses from the technical architectures, to use virtualisation to optimise the IT infrastructure and, where possible, to recover the calories to produce energy or heating. JERLAURE totally supports this approach.
Main benefits & achieved results	"Measures for system optimization" - Chillers in free cooling, subservient to the cooling units (regulation of the temperature depending on the thermal load to cool) - Variable-flow cooling units - High efficient UPS and COS phi 0,9 - Cold aisles containment - Containment of the return air flow "Measurement concept" There are five measurement stations: - Three stations are installed in the three electric distribution closets (UPS, cooling systems, other applications in the data centre such as lighting) - Two stations are installed in electric distribution closets after the UPS (IT equipment supply) A software acquires all the data from the measurement stations and provides an interface for the PUE calculation, given the recorded data. Calculations can be made upon different periods (day, week, month, year). "Key aspects and success factors" The cooling systems implemented should enable substantial energy savings. The technology use is homogeneous in terms of cold production and diffusion (chillers and cooling units). Thus, the different elements of the chain communicate with each other, in order to adapt the cooling supply to the actual needs The temperature set points being in the range 7-12°C, depending on the needs the set point automatically increases and just the necessary and sufficient water flow and temperature are provided to respect the set point.
Presentation of the initiative	Services, products, solutions or principles improving the data centre efficiency include: intelligent PDU, modular UPS, side mount cooling units, air flow containment and management, scalable blanking panels and air flow baffle systems, energy efficient cooling systems utilizing variable extractor fan, energy efficient cooling systems utilizing variable compressors, urbanization in accordance with principle of cold aisle - hot aisle, data centre management tools, increase of air supply temperature (18 °C, instead of 16 °C), analysis of climatic chain components efficiency, considering the data centre load.

Table 29: Digital3rd Success Story

Digital3rd - UK	
Organisation presentation	Organisation: Digital3rd Organisation Type: Small and Medium Enterprise City: Birmingham Country: United Kingdom Link website: http://www.dn-uk.com
Claim to fame	Digital3rd is a UK based IT training provider specialising in the delivery of highly capable software, data and infrastructure apprentices to its local business community in the West Midlands. Following a successful bid to provide an approved Pearson Examination Centre for Birmingham, the company was looking for a new technology provider to support the installation of a new IT training and testing suite. As a business dedicated to developing the next generation of technical talent, one of Digital Native's primary objectives was to ensure that they had the very latest technology. The team were equally passionate about running their business in an energy efficient, sustainable way.
Main benefits & achieved results	Digital3rd is expected to make a saving of 75% on energy consumption of their computing equipment, which over 5 years will amount to around £1,324. Additional savings were also made as no electrical sockets were required for the ELe® equipment. This saved the company an extra £1,000 and many hours of potential downtime. Once installed, the team at Digital3rd found that the flexibility to easily move and re-position the ELe® computers presented a real benefit in how they could use the suite to meet their changing requirements. As part of the installation, ELe® engineers were able to train the apprentices in how to install, set up and support the new PC's providing them with a valuable learning experience. As ELe®'s DC based equipment has no moving parts, the quiet running of the machines was a welcome additional benefit. The noise levels at the examination centre are now near silent, with no fans to disturb the candidates sitting their exams.
Presentation of the initiative	As a business keen to promote its environmental and sustainability practices, ELe®'s low carbon computer technology has enabled the company to make a positive contribution to Birmingham's vision as a leading green city. Digital3rd is now using this project to launch a wider campaign to promote this innovative solution to other locations for Pearson Examination Centres and wider projects

Table 30: Altron Success Story

Altron - Czech Republic	
Organisation presentation	Organisation: Altron Organisation Type: Small & Medium Enterprise City: Prague Country: Czech Republic Contact: Petr Chmel Link website: http://www.altron.net/en/
Claim to fame	Altron a.s. is a European data centre and computer consulting services firm. The company decided the renovation, upgrade and improvement of one of its existing hosting data centres, where the indoor air conditioning units were approaching end of life.
Main benefits & achieved results	The optimization of the whole system provided an increased efficiency of the cooling system and reduced its power consumption. In addition, increased performance and level of serviceability during operation were observed. The new installation produced energy savings of 5.04 GWh per year. The total operational expenditure savings amounted to 15 million CZK per year (equivalent to 0.6 million euros).
Presentation of the initiative	In order to increase the availability and overall effectiveness of the cooling equipment, a high qualified technical group worked along with technical designers to design and implement the associated measures. The case involved detailed data centre audits, as well as detailed evaluation of existing energy and economics data (e.g. OPEX data). As a result, the original indoor air conditioning units were replaced with new units involving compressors, with the possibility of free cooling (DualFluid).
Commitments for the future & other relevant information	As a complement to the issue of ICT environmental impacts, Altron is also developing cloud management solutions.

New stories from academia & research centre

Table 31: Politecnico di Milano Success Story

Politecnico di Milano - Italy	
Organisation presentation	Organisation: Politecnico di Milano Organisation Type: Academia/Research City: Milan Country: Italy Contact: Luca Chiaraviglio Link website: http://www.polimi.it/en/home/
Claim to fame	The monthly electricity bill at Politecnico di Torino now exceeds EUR 150 000, an increase of 218% since 1993, largely due to the proliferation of electronic systems across the campus. As a result, the institution set itself the goal of reducing power consumption across its networked devices.
Main benefits & achieved results	To reduce the number of PCs powered on, the institution implemented PoliSave, a centralized web-based architecture which allows users to automatically schedule the power state of their PCs. The server component remotely triggers power-up and power-down events by controlling local software that handles features such as wake-on-LAN (WoL) on network cards and hibernation. The benefit is that the daily uptime of PCs managed by PoliSave is 9.7 hours, while the daily uptime for other PCs is 15.9 hours. The annual energy savings is 219 kW, which translates to over EUR 250 000.
Presentation of the initiative	The institution started monitoring a number of Transmission Control Protocol (TCP) ports 39 in order to scan which devices were left on and idle. Analysis showed that, of a total of 9 000 registered devices, over 3 500 computing devices are on during the day, with as many as 1 840 of them were running during the night. While most Unix devices are left on, possibly due to the operation as a server, the largest category of devices, desktop PCs running either Windows or Linux, accounted for 30% of all active devices during the day, and 40% of active devices during the night. In effect, the devices turned on at night were consuming around 35-40% of the institution's total power consumption.
Commitments for the future & other relevant information	As future work, we want to customize the monitor capability of PoliSave, so that individual users can track the power consumption of their PCs. Another future topic is to introduce active learning techniques in order to track the user activity and then automatically compute the best power scheme to apply for each user. PoliSave is being extended to the whole set of Campus PCs, and other Italian Universities are studying how to deploy it

Table 32: Hoylake Holy Trinity CofE Primary School Success Story

Hoylake Holy Trinity CofE Primary School - UK	
Organisation presentation	Organisation: Hoylake Holy Trinity CofE Primary School Organisation Type: Academia/Research City: Wirral Country: United Kingdom Link website: http://www.hoylakeholytrinity.wirral.sch.uk/ Hoylake Holy Trinity C of E Primary School
Claim to fame	Hoylake Holy Trinity School were looking to enhance their existing ICT suite to create more desk space for its students. From the outset, the children's comfort, happiness and academic achievement were a priority for the school. In replacing their existing technology, a key consideration for the teaching staff was the productivity of the teaching environment. This included addressing the excessive noise and heat their computers were generating as well improving the layout and use of space in the classroom.
Main benefits & achieved results	Hoylake Holy Trinity 's new computing technology is now delivering all the performance of a standard PC with half the energy and carbon consumption. The main driver for the school however was always to create the best possible teaching environment so the children could receive an optimal learning experience. The ICT suite is now silent and no longer overheated by the computers. The desks are clear with only the monitors on them and the cables and wiring are neat and tidy. Without the limitations on computers needing to be located near plug points, the teachers now have the flexibility to re- configure the room as requirements change. Furthermore all of the children have commented on the speed and responsiveness of the new PC's.
Presentation of the initiative	Having successfully addressed similar concerns at a number of other schools, the recommended computing solution was one that ELe®'s re-seller partner Hi-Impact and ELe®'s own team were confident would address the challenges the school was facing. - A Power over Ethernet (PoE) system utilising ELe®'s Power Injector was recommended and installed to power the school's desktop computing via its existing Ethernet cabling. This allowed them to remove all the old power cabling and streamline the desk spaces. - Sixteen brand new low energy, high performing ELe® NUC Intel® PC's and ELe® lightweight monitors were then installed. With no moving parts, these advanced computers would run silently and without generating heat. - Hi-Impact was once again delighted with the ease of deployment and speed of the PC's as they were able to image and fully install all the PC's on site in one school day. - The ELe®Energy Monitoring Package was also installed so that the school could see at any time the amount of energy required to run the ICT suite. As well as allowing the school to manage their energy bills more effectively, this also presented a fantastic teaching opportunity for the children.

Table 33: Bedford Drive Primary School Success Story

Bedford Drive Primary School - UK	
Organisation presentation	Organisation: Bedford Drive Primary School Organisation Type: Academia/Research City: Wirral Country: United Kingdom Link website: http://www.bedforddrive.wirral.sch.uk/website/home/1565
Claim to fame	Aligned with their motto 'Inspire, Believe, Succeed', Bedford Drive Primary School wanted to take full advantage of their multi-million pound rebuild by ensuring the very latest technology was adopted. Working in partnership with Hi-Impact, the school's technical support provider and computing consultants ELe® introduced a tailored ultra-low energy computing solution to support the school's ambition to improve its sustainability profile
Main benefits & achieved results	The Hi-Impact installation, powered with ELe® technologies has enabled the school to achieve 70% energy savings. Beyond the energy savings however, the whole team at the school is now benefiting from the new computing solutions. *"As we were about to move into a brand-new build, we were looking for new, innovative ways to ensure that school was as eco-friendly as possible from the start. We were excited when we first saw the ELe® technology and could not quite believe that the computer was so small. We love the way that the device fits neatly behind the monitors saving space in the classrooms and it is so quiet without having fans in it, so you don't even know it is there! We chose it to potentially reduce our electricity costs after being shown how much energy is used by the fans inside a traditional PC tower compared to an ELe® device. Our Eco Club will be monitoring this for us with support from ELe® and we look forward to positive results. We were concerned initially about the speed of performance due to the size, but we have been amazed at how much quicker the computer loads up when it is switched on and how much faster programs load; it is saving valuable teaching and learning time."* - Rebecca Stewart, Computing Co-ordinator
Presentation of the initiative	The computing solution recommended for Bedford Drive school included a number of innovative technologies: - A Power over Ethernet (PoE) solution utilising ELe®'s Power Injector was recommended and installed to power the schools desktop computing via its existing Ethernet cabling. - Hi-Impact installed 24 ELe® NUC Intel PC's and Monitors for use by students, teachers and support staff. An additional 21 ELe® NUC Intel PC's were then installed to operate the 65 inch teaching screens in each of the new classroom spaces. - ELe®'s very latest product – a DC powered server was then installed at the school. The Intel Xeon E5 Server is now supporting the whole school and is consistently running at below 100 watts per hour, giving an energy saving of more than 50% versus

Table 34: Bexley Business Academy Success Story

Bexley Business Academy - UK	
Organisation presentation	Organisation: Bexley Business Academy Organisation Type: Academia/Research City: Kent Country: United Kingdom Link website: http://www.thebusinessacademy.org/
Claim to fame	As an early adopter of low-carbon initiatives, the Bexley Business Academy had already trailed low-energy thin client solutions. But Bexley's IT team found that this technology was not achieving the performance they needed to run the complex software their curriculum required. In February 2015 an ICT suite at the Academy was installed with ELe® NUC Intel PCs and low-energy monitors. The school immediately started to experience the energy savings and environmental benefits they were aiming to achieve.
Main benefits & achieved results	Bexley academy 4Over the first year, the Academy has been able to dramatically reduce its ICT suite energy consumption. With each PC now running at 40 Watts* instead of 100 Watts, initial energy running costs for the ICT suite were reduced from £749 to £262 per year, a saving of 65%. As an environmentally progressive school, Bexley had already experienced the benefits of solar energy with a large ground mounted Solar installation. By adding some additional roof mounted panels to run ten of the new PCs, the school has been able to achieve even greater savings. The annual energy costs for running the ICT suite are now at £166, giving an ultimate energy cost saving of 77%. Over coming years, the savings with ELe® technologies will increase year on year. Projecting out over ten years, from this single ICT suite, it is expected that Bexley will achieve an overall saving of £7,314 compared to running their old PCs. As the Academy's focus was as much about the environmental gains as the commercial gains, the savings in carbon emissions was equally important. Over the year, running the ICT suite with 20 PCs on the grid and 10 powered by solar, the school had managed to save 2.09 tonnes of carbon and a further £25.06 in CRC tax charges. Since installing Bexley's ICT suite in 2015, its latest ultra-low energy PCs have evolved even further to the extent that they are now able to run on 25-30 Watts giving and additional saving of at least 25%.
Presentation of the initiative	Bexley academy 4Over the first year, the Academy has been able to dramatically reduce its ICT suite energy consumption. With each PC now running at 40 Watts* instead of 100 Watts, initial energy running costs for the ICT suite were reduced from £749 to £262 per year, a saving of 65%. As an environmentally progressive school, Bexley had already experienced the benefits of solar energy with a large ground mounted Solar installation. By adding some additional roof mounted panels to run ten of the new PCs, the school has been able to achieve even greater savings. The annual energy costs for running the ICT suite are now at £166, giving an ultimate energy cost saving of 77%. Over coming years, the savings with ELe® technologies will increase year on year. Projecting out over ten years, from this single ICT suite, it is expected that Bexley will achieve an overall saving of £7,314 compared to running their old PCs. As the Academy's focus was as much about the environmental gains as the commercial gains, the savings in carbon emissions was equally important. Over the year, running the ICT suite with 20 PCs on the grid and 10 powered by solar, the school had managed to save 2.09 tonnes of carbon and a further £25.06 in CRC tax charges.

Table 35: St Jeroms School Success Story

St Jeroms School - UK	
Organisation presentation	Organisation: St Jeroms School Organisation Type: Academia/Research City: Liverpool Country: United Kingdom Link website: http://www.st-jeromes.co.uk/
Claim to fame	St Jerome's is a school with a very strong focus on sustainability. It has a wind turbine and solar panels that contribute to its power supply, a rainwater harvesting system and is even constructed from renewable materials. When faced with needing to replace their dated, slow computer systems, the school was keen to find a solution that would improve their classroom performance. With escalating energy bills, they continued to look for ways to gain further energy efficiencies and were conscious of the increasing energy demand that new computing technologies would introduce.
Main benefits & achieved results	St Jerome's new ELe® ICT system now runs 10 times faster than their old PCs. With login times of less than 30 seconds and the quieter more ambient environment, productive classroom time has noticeably improved. Compared to the running of their previous PCs, energy consumption has significantly reduced. The new low energy screens run at just 20-25W compared to 170-190W of their previous ones. The school's complete desktop ICT solution now runs on less than 500 Watts – the equivalent of 3 or 4 of their old PCs. Because of the ELe® installation, St Jerome's has been able to make considerable improvements in their computing capability while combating the impact of rising energy costs. "Our new computers are so much more powerful, faster and quieter to use. They run on 10% of the energy of the old systems and require no costly PAT testing – which is amazing!" - Kathy Monaghan, Head Teacher, St Jerome's School
Presentation of the initiative	The ELe® solution team installed 24 high performance Intel® Celeron® dual-core PCs at St Jerome's, all with 19" low energy widescreen displays, operating on Windows 7. As the computers have no fans or moving parts, they require less energy for cooling and create minimal heat. This, along with the elimination of the AC/DC power conversion process, significantly reduces any system failures and future maintenance requirements. The PCs also run completely silent removing any distracting background noise.

Table 36: Beaulieu College Success Story

Beaulieu College - South Africa	
Organisation presentation	Organisation: Beaulieu College Organisation Type: Academia/Research City: Gauteng Country: South Africa Link website: http://www.kyalamischools.org/beaulieu-college/home
Claim to fame	Having tried thin-client processors to save energy, the school found them unsuitable for their demanding curriculum. When looking to expand their ICT facilities, they were concerned about the impact more PCs and subsequent air-conditioning requirements would have on their energy usage. Addressing the additional issue of load shedding and power outages, which regularly disrupted teaching and caused frustrating loss of work, was also an important priority. The room identified for the new ICT suite had few AC plug sockets and would require either cumbersome multi-plug cabling or costly electrical work.
Main benefits & achieved results	The ELe® solution In collaboration with local technology partner Ambit, ELe's ultra-low energy computing powered by a lithium energy pod was installed at the school, including: - 28 Intel® i3 quad-core fat-client PCs, operating on Windows 10 - All with 19" widescreen low-energy monitors - Direct battery power – no need for AC/DC converters or external power supplies - Power distribution deployed via the school's existing CAT5e ethernet network – no additional re-wiring or electrical work was required
Presentation of the initiative	The Kyalami School was able to run their whole ICT suite for less than 700 Watts. This was equivalent to 3 or 4 of the schools' previous PCs and a reduction of around 87% in energy consumption. With no AC/DC power conversion required and PCs without fans or moving parts, system failures and subsequent maintenance requirements have been virtually eliminated. For Kyalami's teachers and students, the reduced noise and heat of their ELe® technologies has created a more peaceful, ambient and productive learning environment. "ELe® has delivered a computing solution for our students that was simple to install and has delivered enhanced, reliable computing capability at a fraction of the energy consumption. We are looking forward to installing more next year". David Rogers – Head of Innovation & Technology, Kayalami Group of Schools

Table 37: University of Coimbra Success Story

University of Coimbra - Portugal	
Organisation presentation	Organisation: University of Coimbra Organisation Type: Academia/Research City: Coimbra Country: Portugal Contact: gabadmin@uc.pt Link website: http://www.uc.pt/en
Claim to fame	The Laboratory of Advanced Computer of the Coimbra University installed a free-cooling system. When outdoor temperature is below the indoor temperature, cold ambient air is drawn inside the data centre to accomplish cooling while the conventional mechanical chilling system is off (or in standby). The free cooling system allowed for energy savings of about 90 MWh/year, while providing similar environmental conditions as in the old system (same temperatures).
Main benefits & achieved results	The free cooling system allowed for energy savings of about 90 MWh/year, corresponding to a PUE decreased by 0.2 points. The temperature conditions remained the same; however, the relative humidity was increased from 50%-70% to 80% with the new system. The equipment was 100% financed by a program of the Portuguese utility within the scope of the DSM Portuguese program. The installation costs of the system were about €6,040 (50 % financed by the program). Considering the financial incentive, the payback period was estimated to be around one year.
Presentation of the initiative	The free-cooling system was about 170,000 BTU/hour. It was implemented between 2008 and 2010 and concerned 132 servers. The measurement concept was based on an energy consumption monitoring (every 15 minutes for one week). The measurement points for energy consumption were the data centre panel board and HVAC (Heating, Ventilation and Air Conditioning) panel board. As fans, humidifiers or dehumidifiers and controls were the only power consuming components, airside economisers offered a great opportunity for energy savings.
Commitments for the future & other relevant information	The mission of the Laboratory of Advanced Computer is to support the research efforts of scientists who use high-performance computing in their work. In addition, the laboratory provides support for advanced computing learning programs within the University. The Laboratory is involved in: • Evaluation and deployment of performance computing resources, including both computing systems and software • Provision of expert consulting and documentation to assist researchers in using these resources effectively • Collaboration with other computing centres and other Universities to enhance the capabilities of the Laboratory resources

Table 38: Goethe University Frankfurt Success Story

Goethe University Frankfurt - Germany	
Organisation presentation	Organisation: Goethe University Frankfurt Organisation Type: Academia/Research City: Frankfurt Country: Germany Contact: Deloitte Link website: http://www.goethe-university-frankfurt.de
Claim to fame	The Centre for Scientific Computing (CSC) of the Goethe University Frankfurt created the LOEWE-CSC, a hybrid cluster used for research purposes. The energy consumption, inherent to the use of super computers, was tackled by implementing passing cooling elements and using power generated in local biogas station and local waste incineration powerplant.
Main benefits & achieved results	The energy efficiency of the LOEWE CSC computer is reflected in its PUE value of 1.076. Compared to a traditional similarly sized data centre (with a PUE value of 2.00), the computer saves 3,37 GWh/year, i.e. approximately €462,000/year. In addition to reducing power consumption, the large utilization of passive cooling elements and the reduction of electrical components in the cooling circuit led to improved reliability and lower maintenance costs.
Presentation of the initiative	The cooling system implemented contained four electrically powered components: primary pump (6 kW), secondary pump (28 kW) and two fans located in the towers (4.5 kW each). The cooling towers used the principle of evaporation cooling. In addition, each rack contained an autonomous Linux based microcontroller, which monitored air and water temperature and adjusted cooling performance accordingly for the cooling performance to match heat load.

Appendix C – Updated factsheets on ICT calculation methodologies

EN 50600-4: Information technology: Data centre facilities and infrastructures

EUROPEAN STANDARDS	**EN 50600-4: Information technology: Data centre facilities and infrastructures**	
Name of Initiative/ Methodology	Information technology: Data centre facilities and infrastructure Part 4-1: Overview of and general requirements for key performance indicators Part 4-2: Power Usage Effectiveness Part 4-3: Renewable Energy Factor	
Link to the latest published version	EN 50600-4-1 (12/2016) https://www.cenelec.eu/dyn/www/f?p=104:110:491117009914501:::FSP_ORG_ID,FSP_PROJECT,FSP_LANG_ID:1258297,60776,25 EN 50600-4-2 (12/2016) https://www.cenelec.eu/dyn/www/f?p=104:110:491117009914501:::FSP_ORG_ID,FSP_PROJECT,FSP_LANG_ID:1258297,60777,25 EN 50600-4-3 (12/2016) https://www.cenelec.eu/dyn/www/f?p=104:110:491117009914501:::FSP_ORG_ID,FSP_PROJECT,FSP_LANG_ID:1258297,60778,25	
Developed by	The CLC/TC 215 "Electrotechnical aspects of telecommunication equipment"	
History and Status	○ Work started in 2015 ○ Published in December 2016	
Involved companies / parties	None identified – to be filled later	
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3	☐ **Product env. assessment** ☐ Life cycle approach ☐ Use phase only
	☐ GWP ☒ Energy ☐ Other environmental impacts	☒ KPIs ○ Power Usage Effectiveness (PUE) ○ Renewable Energy Factor (REF)
System(s) covered by the methodology	○ Data centres, covering: ▪ IT and network telecommunications / infrastructure: ▪ Servers and computing systems ▪ Networking and communication equipment ▪ Data storage equipment ▪ Supporting electronic equipment ▪ Power distribution infrastructure ▪ Environmental control / infrastructure ▪ Security and safety infrastructure	
Goals	○ Providing indicators to measure the effective or efficient use of resources through: The minimization of energy and other resource consumption Task effectiveness of the IT load within the data centre, maximizing the IT output with the minimum energy consumption Energy reuse in the form of waste heat, if possible The use of renewable energy, both generated on site and off site ○ Promoting the reduction of the environmental impacts of a data centre, through an efficient or effective use of resources (e.g. minimised energy consumption, reuse of unconsumed resources, etc.)	

EUROPEAN STANDARDS	**EN 50600-4: Information technology: Data centre facilities and infrastructures**
	○ Improving the data centre's resource usage effectiveness or efficiency by comparing and assessing improvement options ○ PUE provides effective guidance and useful insight into the design of efficient power and cooling architectures, the deployment of equipment within those architectures, and the operation of that equipment
Generic features	○ In order to allow an individual facility to measure and monitor progress in each individual area, the KPIs are designed to be: applicable to all types of data centres technology neutral geographically neutral In the same way, in order to be based upon parameters that are measurable in an unambiguous manner, the following procedure shall be respected for the implementation of the KPIs: The KPIs shall be assessed over a defined period of time All parameters relevant to the assessment of the KPI shall be measured over a period not exceeding a specified time The maximum time between measurements defines the time interval between which KPIs shall re-assessed ○ Typical boundaries shall include the perimeter of the data centre property, using spatial and logical considerations. It may be in terms of aggregate space and electrical load. Changes to the boundaries require updates to the KPI. ○ Conditions to applying the energy re-use indicator: ○ What about derivatives? ○ PUE objectives depend on the service levels
ICT-specific features	In order to measure the energy consumed with the same metric, conversion factors for energy generated by gaseous and liquid fuels are indicated as follows: Diesel: 9,9 kWh/l Gas: 10,5 kWh/m^3 Hydrogen: 38,9 kWh/kg Bioethanol: 6 kWh/l The energy contribution of fluids for cooling shall be measured using heat meters and multiplied by the relevant conversion factor of the system used to provide the fluid used. ***Part 4-2: Power Usage Effectiveness (PUE)*** ▪ As defined, PUE is associated with the data centre infrastructure within its boundaries only, it describes the energy efficiency relative to facilities with given environmental conditions and illustrates the energy allocation of a data centre PUE provides means to determine : ▪ Opportunities for the improvement of the operational efficiency of the data centre ▪ The improvement of the designs and processes of a data centre over time ▪ A design target or goal for new data centres across the anticipated IT load range PUE does not take into account: energy efficiency of the IT load, its utilisation or productivity; efficiency of onsite electricity generation; efficiency of

EUROPEAN STANDARDS	**EN 50600-4: Information technology: Data centre facilities and infrastructures**

other resources such as human resources, space or water; use of renewable energy resources or accounts for reuse of waste by products.

- Total data centre energy consumption shall include electricity, gaseous fuel, fluid fuel, and fluids for cooling. Measurements of air for cooling and water from natural sources are not required.

PUE = E_{DC}/E_{IT} ; where:

- E_{IT} is the IT equipment energy consumption (annual) in kWh and includes : IT equipment and supplemental equipment
- E_{DC} is the total data centre energy consumption (annual) in kWh and includes : E_{IT}, power delivery, cooling system and others

Measurements of E_{DC} and E_{IT} shall be undertaken using either:

- Watt meters with the capability to report energy usage, or
- Kilowatt-hour (kWh) meters that report the actual energy usage through simultaneous measurement of the voltage, current and power factor over time

Derivatives of PUE may be useful in certain circumstances

PUE should not be used to compare different data centres

Three categories of PUE are defined, depending on the accuracy of energy usage measurements:

- PUE_1 : based on uninterruptible power supply output, it provides a basic level of resolution of energy performance data
- PUE_2 : based on power distribution unit output, it provides an intermediate level of resolution of energy performance data
- PUE_3 : based on IT equipment input, it provides an advanced level of resolution of energy performance data

The use of PUE category is based on the following distribution:

- PUE > 1.5: Category 1 to 3
- 1.5 >= PUE > 1.2: Category 2 to 3
- PUE =< 1.2: Category 3

The correct reporting of power usage effectiveness relies on multiple elements such as :

- Use standard construct for communicating PUE data
- Provide required information and supporting evidence for public reporting of PUE

Part 4-3: Renewable energy factor (REF)

REF metric describes the percentage of a renewable energy (RE) over total data centre energy. It provides an assessment of the mitigation of carbon emission that originated from energy consumption in a data centre.

REF is an effective KPI to monitor the use of RE and to increase the diversity of energy dependence and improve the sustainability of a data centre by enhancing the use of RE.

The use of this KPI allows data centre managers to improve a data centre's energy procurement process and increase the diversity of energy dependence of a data centre. In addition, customers can also use this KPI as a guide to select a data centre.

REF = Eren/ E_{DC} ; where:

- E_{DC} is the total data centre energy consumption (annual) in kWh
- Eren is the RE in kWh owned and controlled by a data centre

REF shall have a maximum value of 1.00 indicating 100% of the total data centre energy is RE. Thus, in the case of on-site generation of RE beyond

EUROPEAN STANDARDS	**EN 50600-4: Information technology: Data centre facilities and infrastructures**
	the need of the data centre, the excess power generated shall not be accounted for REF. Measurements of E_{DC} and E_{IT} shall be undertaken using either: ▪ Watt meters with the capability to report energy usage, or Kilowatt-hour (kWh) meters that report the actual energy usage through simultaneous measurement of the voltage, current and power factor over time
Examples of implementation / experience feedback	○ E-shelter in Vienna: first data center in Europe to receive the EN 50600 certification within the DIN standards ○ United Biscuits data centre
Interaction with other methodologies	○ [EN 50600] Information technology – Data centre facilities and infrastructures ○ [EN 62040-3] Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements ○ [EN 62052] Electricity metering equipment (AC) – General requirements, tests and test conditions ○ [EN 62053] Electricity metering equipment (AC) – Particular requirements [ISO 8601] Data elements and interchange formats — Information interchange — Representation of dates and times

ISO/IEC 30134

	ISO/IEC 30134 : Information technology – Data centres – Key Performance indicators
Name of the standard	ISO/IEC 30134 series: information technology – Data centres – Key Performance indicators. • ISO/IEC 30134-1: Part 1 - Overview and general requirements • ISO/IEC 30134-2: Part 2 - Power usage effectiveness (PUE) • ISO/IEC 30134-3: Part 3 - Renewable energy factor (RES) • ISO/IEC 30134-4: Part 4 - IT equipment energy efficiency for servers (ITEE) • ISO/IEC 30134-5: Part 5 - IT equipment utilization for servers (ITEU_SV) Additional parts under preparation : • Part 6: Energy Reuse Factor (ERF) • Additional parts dedicated to other KPIs will be developed further
Link to the latest payable version	ISO/IEC 30134-1 (2016); Part 1: https://www.iso.org/standard/63450.html ISO/IEC 30134-2 (2016); Part 2: https://www.iso.org/standard/63451.html ISO/IEC 30134-3 (2016); Part 3: https://www.iso.org/standard/66127.html ISO/IEC 30134-4 (2017); Part 4: https://www.iso.org/standard/66191.html ISO/IEC 30134-5 (2017); Part 5: https://www.iso.org/standard/66934.html
Developed by	The International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) : ISO/IEC JTC 1/SC 39
History and Status	○ Parts 1-3: Developed and finished in 2016, actual enquiry for update versions ○ Parts 4&5: Developed and finished in 2017 ○ Part 6: under preparation
Involved companies / parties	○ No companies or other parties involved
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3 ☐ **Product env. assessment** ☐ Life cycle approach ☐ Use phase only
	☐ GWP ☒ Energy ☐ Other environmental impacts ☒ KPIs ○ Energy consumption ○ Renewable energy ○ Energy efficiency ○ Task efficiency ○ Energy reuse
System(s) covered by the methodology	○ Data centres and its boundaries, thus are including the following elements : IT and network telecommunications/infrastructure Power generation and distribution infrastructure Environmental control/infrastructure Security and safety infrastructure ○ Renewable energy generation plants owned and controlled by the data centre, whether the energy is generated on site or obtained (i.e. any energy for which the data centre owns the legal rights to the environmental attributes of renewable generation).

ISO IEC	***ISO/IEC 30134 : Information technology – Data centres – Key Performance indicators***
Goals	○ Enabling the optimum resource effectiveness of data centres through: the minimization of energy and other resource consumption the maximization of IT load's task effectiveness within the data centre the energy reuse in the form of waste heat the use of renewable energy ○ Providing a suite of effective Key Performance Indicators (KPI) in relation to the objectives described above in order to define an improvement roadmap.
Generic features	○ The term "resource usage effectiveness" is preferred to "resource usage efficiency", which is restricted to situations where the input and output parameters used to define the KPIs have the same units. ○ In order to allow an individual facility to measure and monitor progress in each individual area, the KPIs are designed to be : applicable to all types of data centres technology neutral geographically neutral In the same way, in order to be based upon parameters that are measurable in an unambiguous manner, the following procedure shall be respected for the implementation of the KPIs: The KPIs shall be assessed over a defined period of time All parameters relevant to the assessment of the KPI shall be measured over a period not exceeding a specified time The maximum time between measurements defines the time interval between which KPIs shall re-assessed
ICT-specific features	**Part 2: Power Usage Effectiveness (PUE)** PUE illustrates the energy allocation of a data centre. PUE provides means to determine : ▪ Opportunities for the improvement of the operational efficiency of the data centre ▪ The improvement of the designs and processes of a data centre over time ▪ A design target or goal for new data centres across the anticipated IT load range PUE = E_{DC}/E_{IT} ; where: ▪ E_{IT} is the IT equipment energy consumption (annual) in kWh and includes : IT equipment and supplemental equipment ▪ E_{DC} is the total data centre energy consumption (annual) in kWh and includes : E_{IT}, power delivery, cooling system and others Measurements of E_{DC} and E_{IT} shall be undertaken using either: ▪ Watt meters with the capability to report energy usage, or ▪ Kilowatt-hour (kWh) meters that report the actual energy usage through simultaneous measurement of the voltage, current and power factor over time Derivatives of PUE may be useful in certain circumstances PUE should not be used to compare different data centres Thus, PUE does not take into account: energy efficiency of the IT load, its utilisation or productivity; efficiency of onsite electricity generation; efficiency of other resources such as human resources, space or water; use of renewable energy resources or accounts for reuse of waste by products.

	ISO/IEC 30134 : Information technology – Data centres – Key Performance indicators
	Then 3 PUE's categories are defined according to the energy consumption measurement process used for the PUE calculation: ▪ PUE_1 : based on uninterruptible power supply output, it provides a basic level of resolution of energy performance data ▪ PUE_2 : based on power distribution unit output, it provides an intermediate level of resolution of energy performance data ▪ PUE_3 : based on IT equipment input, it provides an advanced level of resolution of energy performance data The use of PUE category is based on the following distribution: ▪ PUE > 1.5: Category 1 to 3 ▪ 1.5 >= PUE > 1.2: Category 2 to 3 ▪ PUE =< 1.2: Category 3 The correct reporting of power usage effectiveness relies on multiple elements such as : ▪ Use standard construct for communicating PUE data ▪ Provide required information and supporting evidence for public reporting of PUE **Part 3: Renewable energy factor (REF)** REF metric describes the percentage of a renewable energy (RE) over total data centre energy. It provides an assessment of the mitigation of carbon emission that originated from energy consumption in a data centre. REF is an effective KPI to monitor the use of RE and to increase the diversity of energy dependence and improve the sustainability of a data centre by enhancing the use of RE. The use of this KPI allows data centre managers to improve a data centre's energy procurement process and increase the diversity of energy dependence of a data centre. In addition, customers can also use this KPI as a guide to select a data centre. REF = Eren/ E_{DC} ; where: ▪ E_{DC} is the total data centre energy consumption (annual) in kWh ▪ Eren is the RE in kWh owned and controlled by a data centre REF shall have a maximum value of 1.00 indicating 100% of the total data centre energy is RE. Thus, in the case of on-site generation of RE beyond the need of the data centre, the excess power generated shall not be accounted for REF. Measurements of E_{DC} and E_{IT} shall be undertaken using either: ▪ Watt meters with the capability to report energy usage, or ▪ Kilowatt-hour (kWh) meters that report the actual energy usage through simultaneous measurement of the voltage, current and power factor over time
Examples of implementation / experience feedback	○ None identified
Interaction with other methodologies	○ [ISO/IEC 30134] has no interaction with other methodologies

ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 2: Guide for assessing GHG emissions of Telecommunications Network Services

Please note that the factsheet below is part of the GHG Protocol ICT Sector Guidance, which contains six chapters. The first chapter is an introduction to the general principles of life cycle accounting and reporting in the ICT sector; the following five chapters are divided into five separate factsheets, for better readability – and are available on the map of methodologies of the project. Although no specific factsheet was developed for the introduction chapter, relevant content is included in the factsheet below on Telecommunications Network Services (TNS).

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance - Telecommunications Network Services (TNS)**	
Name of Initiative/ Methodology	ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 2: Guide for assessing GHG emissions of Telecommunications Network Services	
Link to the latest published version	GHG Protocol ICT Sector Guidance (07/2017): Final version www.ghgprotocol.org/sites/default/files/ghgp/GHGP-ICTSG%20-%20ALL%20Chapters.pdf	
Developed by	Carbon Trust, Global e-Sustainability Initiative (GeSI)	
History and Status	○ Work started in 2011, issued as drafts in two rounds of public consultation ○ Published in July 2017	
Involved companies / parties	**Steering Committee**: Alcatel Lucent, BT, Carbon Trust, CDP, Cisco, Deutsche Telekom, European Commission, Ericsson, Fujitsu, Gartner, GeSI, HP, ITU, Massachusetts Institute of Technology, World Business Council for Sustainable Development, World Resources Institute, WSP	
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3	☒ **Product env. assessment** ☒ Life cycle approach ☐ Use phase only ○ Cradle to grave for final products ○ Cradle to gate for intermediate products
	☒ GWP ☐ Energy	☐ Other environmental impacts ☐ KPIs
System(s) covered by the methodology	Telecommunications Network Services. The services comprise ICT goods, including: ○ Service provider equipment (e.g. routers, mobile transmitters, servers) ○ Support equipment such as cabling and racking ○ Customer premise equipment (CPE) such as telephones, computers and videoconferencing systems as well as equipment deployed on the customer's premises ○ Operational (people-related) activities associated with telecoms network services such as installation, maintenance and customer service	
Goals	○ Providing supporting data for identification of a life cycle stage, subassembly or process that have significant GHG emissions (hotspot) ○ Assessing the GHG emissions of a TNS, e.g. in order to reduce the associated emissions (for an existing network) or to estimate potential future emissions (for a planned network) ○ Prioritising GHG emissions reduction efforts across the product life cycle (from a service provider or user perspective)	

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance - Telecommunications Network Services (TNS)**
Generic features (from the GHG Protocol Product Standard)	○ All stages other than the use stage may be grouped together (embodied emissions) ○ Critical review by a first or third party is required ○ Offsets, avoided and delayed emissions are not to be included in the inventory results ○ Functional unit: For all final products, the unit of analysis is defined as a functional unit For intermediate products where the eventual function is unknown, the unit of analysis is defined as the reference flow ○ Cradle-to-gate and gate-to-gate inventory results should be reported separately (if not limited by confidentiality) ○ Companies shall disclose and justify any exclusions of attributable processes in the inventory report ○ Companies shall collect primary data for all processes under their ownership / control ○ Companies shall assess the data quality of activity data, emission factors, and/or direct emissions data
ICT-specific features	○ The scope and the function of the service being assessed shall be clearly described, focusing on the quantitative and qualitative aspects of the function ○ Examples of functional units are provided: One minute of use (e.g. phone call) One megabyte of data transferred Service contract life (e.g. three years) Annual usage (i.e. one year) ○ TNS are subdivided into 3 elements, that can be individually assessed: Customer Domain: all ICT equipment and support equipment (e.g. cabling) that is part of the TNS; associated cooling and uninterruptable power supply equipment; end-user equipment involved in the service provided Service Platform: all ICT equipment and support equipment used by the TNS provider in delivering the service; ancillary support equipment (e.g. heating, air conditioning); uninterruptable power supply equipment Operational Activities: any people (labour) activities and non-ICT support equipment that are directly engaged and dedicated to the assessed TNS. Embodied emissions may be excluded if the impact is of low significance ○ Provision of calculation methods for the use stage (e.g. definition of required energy data), as well as typical values ○ Allocation is important in the assessment of TNS since many equipment is shared among multiple services (e.g. various end-users using the same routers). Refer to [ETSI 103 199] for allocation guidance specific to ICT
Examples of implementation / experience feedback	None identified – to be filled later

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance - Telecommunications Network Services (TNS)**
Interaction with other methodologies	○ [IEC TR 62725] Analysis of quantification methodologies of greenhouse gas emissions for electrical and electronic products and systems ○ [ISO/TS 14067] Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication ○ [ISO 14040] Environmental management - Life cycle assessment - Principles and framework ○ [ISO 14044] Environmental management - Life cycle assessment – Requirements and guidelines ○ [GHG Protocol Product Standard] Product Life Cycle Accounting and Reporting Standard ○ [ETSI TS 103 199] Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements ○ [ETSI ES 203 199/ITU-T L.1410] Methodology for environmental life cycle assessments of information and communication technology goods, networks and services ○ [PAS 2050] Specification for the assessment of the life cycle greenhouse gas emissions of goods and services

ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 3 – Guide for assessing GHG emissions of Desktop Managed Services

Please note that the factsheet below is part of the GHG Protocol ICT Sector Guidance, which contains six chapters. The first chapter is an introduction to the general principles of life cycle accounting and reporting in the ICT sector; the following five chapters are divided into five separate factsheets, for better readability – and are available on the map of methodologies of the project. Although no specific factsheet was developed for the introduction chapter, relevant content is included in the factsheet below on Desktop Management Services (DMS).

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance - Desktop Management Services (DMS)**
Name of Initiative/ Methodology	ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 3 – Guide for assessing GHG emissions of Desktop Managed Services
Link to the latest published version	GHG Protocol ICT Sector Guidance (07/2017): Final version www.ghgprotocol.org/sites/default/files/ghgp/GHGP-ICTSG%20-%20ALL%20Chapters.pdf
Developed by	Carbon Trust, Global e-Sustainability Initiative (GeSI)
History and Status	○ Work started in 2011, issued as drafts in two rounds of public consultation ○ Published in July 2017
Involved companies / parties	**Steering Committee**: Alcatel Lucent, BT, Carbon Trust, CDP, Cisco, Deutsche Telekom, European Commission, Ericsson, Fujitsu, Gartner, GeSI, HP, ITU, Massachusetts Institute of Technology, World Business Council for Sustainable Development, World Resources Institute, WSP

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance - Desktop Management Services (DMS)**	
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3	☒ **Product env. assessment** ☒ Life cycle approach ☐ Use phase only ○ Cradle to grave for final products ○ Cradle to gate for intermediate products
	☒ GWP ☐ Energy	☐ Other environmental impacts ☐ KPIs
System(s) covered by the methodology	Desktop Managed Services, which comprise: ○ Service desk (incident and change management; may also include remote assistance) ○ End-user device service (provision and management of services related to the device) ○ Deskside services (to ensure the right level of support to the users) ○ End-user infrastructure service (management of the infrastructure supporting the end-user device service, e.g. services on email, fine and print, or internet proxy) ○ Service delivery management (ensuring quality of service)	
Goals	○ Providing supporting data for identification of a life cycle stage, subassembly or process that have significant GHG emissions (hot spot) ○ Assessing GHG emissions of a DMS (either external or in-house DMS) ○ Prioritising reduction efforts across the DMS life cycle (from a service provider or user perspective)	
Generic features (from the GHG Protocol Product Standard)	○ All stages other than the use stage may be grouped together (embodied emissions) ○ Critical review by a first or third party is required ○ Offsets, avoided and delayed emissions are not to be included in the inventory results ○ Functional unit: ▪ For all final products, the unit of analysis is defined as a functional unit ▪ For intermediate products where the eventual function is unknown, the unit of analysis is defined as the reference flow ○ Cradle-to-gate and gate-to-gate inventory results should be reported separately (if not limited by confidentiality) ○ Companies shall disclose and justify any exclusions of attributable processes in the inventory report ○ Companies shall collect primary data for all processes under their ownership / control ○ Companies shall assess the data quality of activity data, emission factors, and/or direct emissions data	
ICT-specific features	○ The functional unit needs to define the magnitude (e.g. number of users supported), the duration (e.g. length of service, or per year) and the quality (e.g. type of support, response times) of the service. Several examples are provided. ○ The use stage is almost always where the biggest emissions occur (energy use from the equipment, service desk, engineering and infrastructure) ○ Some processes may be excluded from the GHG emissions calculation, such as: upstream emissions of capital goods (e.g. vehicles used for support staff transportation, construction of buildings), lighting and heating for users of the DMS, travel of support staff which is not directly related to the provision of DMS ○ The decommissioning / standing down of support teams at service end may not necessarily be considered a major factor to generation of emissions but screening should be employed to ascertain materiality ○ Technical refresh (of parts of the estate, at different times) should be accounted for by assuming a level of refresh for the duration of the service (e.g. contract duration)	

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance - Desktop Management Services (DMS)**
	○ for different categories of equipment. If the refresh is different in practice (from what planned) and significant, it should be treated as a new service and recalculated ○ The most appropriate allocation methods of DMS between independent products should involve pro-rating of usage of the shared component. Recommended allocation methods are provided for several examples of shared components ○ Provision of example of GHG emissions calculations for each stage. Refer to guidance defined in other chapters of the GHG Protocol ICT sector guidance e.g. for calculation of impacts from hardware or cloud and data centre services
Examples of implementation / experience feedback	None identified – to be filled later
Interaction with other methodologies	○ [IEC TR 62725] Analysis of quantification methodologies of greenhouse gas emissions for electrical and electronic products and systems ○ [ISO/TS 14067] Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication ○ [ISO 14040] Environmental management - Life cycle assessment - Principles and framework ○ [ISO 14044] Environmental management - Life cycle assessment – Requirements and guidelines ○ [GHG Protocol Product Standard] Product Life Cycle Accounting and Reporting Standard ○ [ETSI TS 103 199] Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements ○ [ETSI ES 203 199/ITU-T L.1410] Methodology for environmental life cycle assessments of information and communication technology goods, networks and services ○ [PAS 2050] Specification for the assessment of the life cycle greenhouse gas emissions of goods and services

ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 4 – Guide for assessing GHG emissions of Cloud Computing and Data Center Services

Please note that the factsheet below is part of the GHG Protocol ICT Sector Guidance, which contains six chapters. The first chapter is an introduction to the general principles of life cycle accounting and reporting in the ICT sector; the following five chapters are divided into five separate factsheets, for better readability – and are available on the map of methodologies of the project. Although no specific factsheet was developed for the introduction chapter, relevant content is included in the factsheet below on Cloud Computing and Data Centre Services.

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – Cloud Computing and Data Centre Services**	
Name of Initiative/ Methodology	ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 4 – Guide for assessing GHG emissions of Cloud Computing and Data Center Services	
Link to the latest published version	GHG Protocol ICT Sector Guidance (07/2017): Final version www.ghgprotocol.org/sites/default/files/ghgp/GHGP-ICTSG%20-%20ALL%20Chapters.pdf	
Developed by	Carbon Trust, Global e-Sustainability Initiative (GeSI)	
History and Status	○ Work started in 2011, issued as drafts in two rounds of public consultation ○ Published in July 2017	
Involved companies / parties	**Steering Committee**: Alcatel Lucent, BT, Carbon Trust, CDP, Cisco, Deutsche Telekom, European Commission, Ericsson, Fujitsu, Gartner, GeSI, HP, ITU, Massachusetts Institute of Technology, World Business Council for Sustainable Development, World Resources Institute, WSP	
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3	☒ **Product env. assessment** ☒ Life cycle approach ☐ Use phase only
	☒ GWP ☐ Energy	☐ Other environmental impacts ☐ KPIs
System(s) covered by the methodology	Cloud Computing Services and Data Centre Services, which comprise: ○ E-mail, calendar, document and other business applications ○ Consumer photo, video and music and other data storage applications ○ Search, social networking and database applications ○ Application hosting	
Goals	○ Quantifying the energy and GHG emissions associated with the delivery of cloud and data centre services, with a focus on the "user" perspective ○ Providing with standard and repeatable methods for a better understanding of the GHG emissions of alternative ICT service delivery solutions ○ Assessing GHG emissions of a cloud service provided by or associated with the use of data centres ○ Comparing GHG emissions of a cloud service with those from an equivalent non-cloud service	

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – Cloud Computing and Data Centre Services**
Generic features (from the GHG Protocol Product Standard)	○ All stages other than the use stage may be grouped together (embodied emissions) ○ Primary data should be collected for processes under the ownership or control of the cloud service provider ○ Critical review by a first or third party is required ○ Offsets, avoided and delayed emissions are not to be included in the inventory results ○ Functional unit: For all final products, the unit of analysis is defined as a functional unit For intermediate products where the eventual function is unknown, the unit of analysis is defined as the reference flow ○ Cradle-to-gate and gate-to-gate inventory results should be reported separately (if not limited by confidentiality) ○ Companies shall disclose and justify any exclusions of attributable processes in the inventory report ○ Companies shall collect primary data for all processes under their ownership / control ○ Companies shall assess the data quality of activity data, emission factors, and/or direct emissions data
ICT-specific features	○ Cloud services create emissions through data centres, network, and end-user devices. For specific cloud applications, certain aspects may not be included. ○ The functional unit should clearly describe: The quantity of the service (e.g. number of users, size of storage capacity) The duration of the service (e.g. per year, for the contract duration) The quality of the service (e.g. in terms of recovery/availability) ○ Optional processes in the GHG impact assessment of cloud and data centre services: Energy consumed during software development Material and energy flows not directly related to equipment for hosting and fulfilment of the service Maintenance of capital equipment ○ Processes to include in the assessment of cloud and data centre services: Hosting and fulfilment of cloud applications (e.g. servers, storage devices) Internet transfer and user access Energy, water and other materials consumed by the above processes ○ Guidance is provided on allocation methods of emissions and ICT devices of the data centre; the method should seek to separate fixed vs. variable emissions of the site. ○ The document specifies the data required for the assessment and allocation choices. ○ Refer to [GHG Protocol ICT Sector Guidance – Hardware] and [GHG Protocol ICT Sector Guidance – TNS] for the calculation of GHG impacts of the component parts of the infrastructure that support a cloud or a data centre service
Examples of implementation / experience feedback	The document presents a case study based on Microsoft cloud services (the updated study will be published in 2017)
Interaction with other methodologies	○ [IEC TR 62725] Analysis of quantification methodologies of greenhouse gas emissions for electrical and electronic products and systems ○ [ISO/TS 14067] Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication ○ [ISO 14040] Environmental management - Life cycle assessment - Principles and framework ○ [ISO 14044] Environmental management - Life cycle assessment – Requirements and guidelines

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – Cloud Computing and Data Centre Services**
	○ [GHG Protocol Product Standard] Product Life Cycle Accounting and Reporting Standard ○ [ETSI TS 103 199] Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements ○ [ETSI ES 203 199/ITU-T L.1410] Methodology for environmental life cycle assessments of information and communication technology goods, networks and services ○ [PAS 2050] Specification for the assessment of the life cycle greenhouse gas emissions of goods and services

ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 6 – Guide for assessing GHG emissions of Software

Please note that the factsheet below is part of the GHG Protocol ICT Sector Guidance, which contains six chapters. The first chapter is an introduction to the general principles of life cycle accounting and reporting in the ICT sector; the following five chapters are divided into five separate factsheets, for better readability – and are available on the map of methodologies of the project. Although no specific factsheet was developed for the introduction chapter, relevant content is included in the factsheet below on Software.

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – Software**	
Name of Initiative/ Methodology	ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 6 – Guide for assessing GHG emissions of Software	
Link to the latest published version	GHG Protocol ICT Sector Guidance (07/2017): Final version www.ghgprotocol.org/sites/default/files/ghgp/GHGP-ICTSG%20-%20ALL%20Chapters.pdf	
Developed by	Carbon Trust, Global e-Sustainability Initiative (GeSI)	
History and Status	○ Work started in 2011, issued as drafts in two rounds of public consultation ○ Published in July 2017	
Involved companies / parties	**Steering Committee**: Alcatel Lucent, BT, Carbon Trust, CDP, Cisco, Deutsche Telekom, European Commission, Ericsson, Fujitsu, Gartner, GeSI, HP, ITU, Massachusetts Institute of Technology, World Business Council for Sustainable Development, World Resources Institute, WSP	
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3	☒ **Product env. assessment** ☒ Life cycle approach ☒ Use phase only
	☒ GWP ☐ Energy	☐ Other environmental impacts ☐ KPIs
System(s) covered by the methodology	Any software, with a particular focus on the use stage for the following software: ○ Operating system (OS) (at consumer level devices) ○ Applications (at consumer level devices) ○ Virtual machines (focus on devices within a data centre environment)	
Goals	○ Assessing the life cycle GHG impact of a software as a product (e.g. where the software forms part of a larger ICT service or system, or comparing electronic software distribution with distribution using physical media) ○ Measuring in detail the energy consumption and corresponding GHG impact of a software at the use stage (e.g. to understand changes in the design or operations of the software or hardware)	

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – Software**
Generic features (from the GHG Protocol Product Standard)	○ All stages other than the use stage may be grouped together (embodied emissions) ○ Critical review by a first or third party is required ○ Offsets, avoided and delayed emissions are not to be included in the inventory results ○ Functional unit: For all final products, the unit of analysis is defined as a functional unit For intermediate products where the eventual function is unknown, the unit of analysis is defined as the reference flow ○ Cradle-to-gate and gate-to-gate inventory results should be reported separately (if not limited by confidentiality) ○ Companies shall disclose and justify any exclusions of attributable processes in the inventory report ○ Companies shall collect primary data for all processes under their ownership / control ○ Companies shall assess the data quality of activity data, emission factors, and/or direct emissions data
ICT-specific features	○ The functional unit should define the software's magnitude or quantity, its duration or life, and its quality ○ A screening assessment is recommended in order to determine if a detailed assessment of the embodied emissions (all stages but 'Use') is necessary: 'Material acquisition and pre-processing': considers the use of existing software libraries or modules as 'raw materials' 'Production': includes the energy required for the buildings and equipment, office supplies, and potential business travel related to the development and testing procedures of the software 'Distribution and storage': service delivery (electronic or by physical media) 'End of life': for software distributed by physical media, the emissions associated with the end of life of the media should be considered ○ Assessment of energy consumption in order to calculate the related GHG emissions during the use stage of a software is detailed ○ Power consumption value should reflect software utilisation and design features through power measurement (i.e. integrate power management of the device). A 'typical' device should be defined ○ Measured data is preferred over secondary data. Methodologies on how to set up and perform benchmark tests (or assess the power consumption) are provided for OS and application software (or virtual machines). ○ The results reported should include a description of the chosen methodology
Examples of implementation / experience feedback	Williams and Tang (2012) Methodology To Model the Energy and Greenhouse Gas Emissions of Electronic Software Distributions
Interaction with other methodologies	○ [IEC TR 62725] Analysis of quantification methodologies of greenhouse gas emissions for electrical and electronic products and systems ○ [ISO/TS 14067] Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication ○ [ISO 14040] Environmental management - Life cycle assessment - Principles and framework ○ [ISO 14044] Environmental management - Life cycle assessment – Requirements and guidelines ○ [GHG Protocol] Product Life Cycle Accounting and Reporting Standard

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – Software**
	○ [ETSI TS 103 199] Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements ○ [ETSI ES 203 199/ITU-T L.1410] Methodology for environmental life cycle assessments of information and communication technology goods, networks and services ○ [PAS 2050] Specification for the assessment of the life cycle greenhouse gas emissions of goods and services ○ [EU Energy Star] ○ [IEC 62301] Household electrical appliances - Measurement of standby power ○ [IEC 62087] Methods of measurement for the power consumption of audio, video and related equipment

ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 5 – Guide for assessing GHG emissions of ICT Hardware

Please note that the factsheet below is part of the GHG Protocol ICT Sector Guidance, which contains six chapters. The first chapter is an introduction to the general principles of life cycle accounting and reporting in the ICT sector; the following five chapters are divided into five separate factsheets, for better readability – and are available on the map of methodologies of the project. Although no specific factsheet was developed for the introduction chapter, relevant content is included in the factsheet below on ICT Hardware.

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – ICT Hardware**	
Name of Initiative/ Methodology	ICT Sector Guidance built on the GHG Protocol Product Life Cycle Accounting and Reporting Standard – Chapter 5 – Guide for assessing GHG emissions of ICT Hardware	
Link to the latest published version	GHG Protocol ICT Sector Guidance (07/2017): Final version www.ghgprotocol.org/sites/default/files/ghgp/GHGP-ICTSG%20-%20ALL%20Chapters.pdf	
Developed by	Carbon Trust, Global e-Sustainability Initiative (GeSI)	
History and Status	○ Work started in 2011, issued as drafts in two rounds of public consultation ○ Published in July 2017	
Involved companies / parties	**Steering Committee**: Alcatel Lucent, BT, Carbon Trust, CDP, Cisco, Deutsche Telekom, European Commission, Ericsson, Fujitsu, Gartner, GeSI, HP, ITU, Massachusetts Institute of Technology, World Business Council for Sustainable Development, World Resources Institute, WSP	
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3	☒ **Product env. assessment** ☒ Life cycle approach ☐ Use phase only
	☒ GWP ☐ Energy	☐ Other environmental impacts ☐ KPIs
System(s) covered by the methodology	ICT hardware (IH) including computers and peripheral equipment; communication equipment (e.g. network equipment); consumer electronic equipment; and various ICT components and goods	
Goals	○ Providing information on several calculation methods and guiding the practitioner in choosing the appropriate method, depending on the intended assessment ○ Assessing GHG emissions of an ICT hardware (or a product family), which may then focus attention to reduce the emissions from main sources ○ Assessing GHG emissions due to the hardware in a complex ICT system (e.g. as part of a TNS or DMS, see [GHG Protocol ICT Sector Guidance – TNS] and [GHG Protocol ICT Sector Guidance – DMS])	

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – ICT Hardware**
Generic features (from the GHG Protocol Product Standard)	○ All stages other than the use stage may be grouped together (embodied emissions) ○ Critical review by a first or third party is required ○ Offsets, avoided and delayed emissions are not to be included in the inventory results ○ Functional unit: For all final products, the unit of analysis is defined as a functional unit For intermediate products where the eventual function is unknown, the unit of analysis is defined as the reference flow ○ Cradle-to-gate and gate-to-gate inventory results should be reported separately (if not limited by confidentiality) ○ Companies shall disclose and justify any exclusions of attributable processes in the inventory report ○ Companies shall collect primary data for all processes under their ownership / control ○ Companies shall assess the data quality of activity data, emission factors, and/or direct emissions data
ICT-specific features	○ The functional unit description includes magnitude, duration and quality of the IH's service ○ A screening assessment is recommended to focus data collection efforts; in particular for ICT hardware that is kept operating for long periods of time ○ Refer to [ETSI TS 103 199] and [ETSI ES 203 199 / ITU-T .1410] for boundary settings and allocation specific to ICT ○ Some processes are excluded from the IH assessment, such as: facility operations, corporate activities, and capital goods (e.g. machine used in assembling IH product) ○ Four calculation methods may be used to assess cradle-to-gate GHG emissions of IH; capabilities and drawbacks are detailed for each of them. Component characterization Hardware parameterisation Life cycle stage ratio profiling Environmentally extended input-output (EEIO) ○ The product lifespan is a very important factor as it can have very significant impact on the total life cycle GHG emissions from an IH product. In all cases, documentation of the modelled product life and the rationale for the modelling is imperative. ○ The use profile needs to reflect the time spent in the different power states ○ The software and firmware installed on the equipment can make a significant difference in the product's power consumption over its operating life
Examples of implementation / experience feedback	The Appendix 1 of the document presents the calculation of GHG emissions by the component characterisation method, for a SOHO wireless router
Interaction with other methodologies	○ [IEC TR 62725] Analysis of quantification methodologies of greenhouse gas emissions for electrical and electronic products and systems ○ [ISO/TS 14067] Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication ○ [ISO 14040] Environmental management - Life cycle assessment - Principles and framework ○ [ISO 14044] Environmental management - Life cycle assessment – Requirements and guidelines ○ [GHG Protocol] Product Life Cycle Accounting and Reporting Standard ○ [ETSI TS 103 199] Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements

GREENHOUSE GAS PROTOCOL	**GHG Protocol ICT Sector Guidance – ICT Hardware**
	○ [ETSI ES 203 199/ITU-T L.1410] Methodology for environmental life cycle assessments of information and communication technology goods, networks and services ○ [PAS 2050] Specification for the assessment of the life cycle greenhouse gas emissions of goods and services ○ [EU Energy Star]

ETSI ES 205 200: Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures

ETSI	***ETSI ES 205 200: Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures***
Name of Initiative/ Methodology	Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures Part 1: General requirements Part 2: Specific requirements Sub-part 1: Data centres Sub-part 2: Fixed broadband access networks Sub-part 4: Cable Access Networks Part 3: Global KPIs for ICT sites
Link to the latest published version	ETSI ES 205 200-1 (03/2014): Version 1.2.1 http://www.etsi.org/deliver/etsi_es/205200_205299/20520001/01.02.01_60/es_20520001v010201p.pdf ETSI ES 205 200-2-1 (03/2014): Version 1.2.1 http://www.etsi.org/deliver/etsi_es/205200_205299/2052000201/01.02.01_60/es_20520000201v010201p.pdf ETSI ES 205 200-2-2 (01/2016): Version 1.0.0 (On Approval) http://www.etsi.org/deliver/etsi_es/205200_205299/2052000202/01.00.00_50/es_20520000202v010000m.pdf ETSI ES 205 200-2-4 (06/2015): Version 1.1.1 http://www.etsi.org/deliver/etsi_es/205200_205299/2052000204/01.01.01_60/es_20520000204v010101p.pdf ETSI ES 205 200-3 (01/2017): Version 1.0.0 (On Approval) http://www.etsi.org/deliver/etsi_es/205200_205299/20520003/01.00.00_50/es_20520003v010000m.pdf
Developed by	The European Telecommunications Standards Institute (ETSI)
History and Status	○ Work started in 2013 and finished in 2016 ○ Published from March 2014 (general requirements) until January 2016 (specific requirements)
Involved companies / parties	○ Orange ○ EADS ○ Thales ○ PSA Peugeot Citroen ○ SFR (Sub-part 2 only) ○ e-Ready Building Limited (Sub-part 2 only) ○ Cable Europe (Sub-part 4 only) ○ CableLabs (Sub-part 4 only) ○ RATEL (Sub-part 4 only) ○ Liberty Global B.V. (Sub-part 4 only)
Scope	☒ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3 ☐ GWP ☒ Energy ☐ Other environmental impacts	☐ **Product env. assessment** ☐ Life cycle approach ☐ Use phase only ☒ KPIs ○ Energy consumption ○ Task efficiency ○ Energy reuse

ETSI	***ETSI ES 205 200: Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures***
	○ Renewable energy
System(s) covered by the methodology	○ Infrastructures of broadband deployment, including: Data centres Fixed broadband access networks ○ Integrated broadband cable telecommunication networks, including cable access networks
Goals	○ Improving energy management of the operational infrastructures through a reduction in energy consumption, improvements in task efficiency, the re-use of energy and the contribution of renewable energy ○ Providing methodological framework for the definition and calculation of Global Key Performance Indicators (KPI) in relation to the objectives described above (one global indicator + 4 objective indicators)
Generic features	○ The reduction in energy consumption and task efficiency are primary objectives ○ Conditions to applying the energy re-use indicator: "Non-use" is better than "re-use" and therefore the preference is for energy consumption reduction rather than energy re-use; Re-use of energy should give the preference to heat generated from by ITE/NTE rather than from poorly designed facilities and infrastructures. ○ Conditions to applying the renewable energy indicator: If all energy is renewable, the indicator shall encourage the application of other indicators ○ All indicators are based on measurements of energy consumption and shall be assessed over a defined period of time (typically 1 year). ○ All indicators shall clearly define strict criteria for inclusion/exclusion with the formula ○ Comparative costs and environmental impacts of different energy sources are outside the scope of the document. ○ Recommendations and best practices are not in the scope of the document (a list of references is provided in the documents related to specific requirements).
ICT-specific features	○ All systems covered by the methodology are not intended to/able to operate within a common limits for the KPIs (e.g.: infrastructures required to deliver high reliability) ***Sub-part 1: Data centres*** The KPIs may be applied to a single data centre or a group of data centres under common governance All energy input to a data centre is converted into heat The energy provided to data centres comes from utility (grid) or local sources (non-renewable or renewable). A data centre is unlikely to meet all of its energy needs from local renewable sources on a continuous basis. The maximum time difference in the periods of assessment shall be 7 days Detailed formula, measurement points and procedures, and criteria are provided for each of the considered indicators. ***Sub-part 2: Fixed broadband access networks*** The OS may contain a single fixed broadband access node or a group of FAN in a same site, and can be indoor or outdoor In general, fixed access network sites are geographically scattered (limited possibility for merging any heat generated at each site); however local

ETSI	***ETSI ES 205 200: Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures***

renewable energy sources may produce more energy than that required by a fixed access network site, allowing its reuse for other purposes.

The energy provided to FAN comes from utility (grid) or local sources (non-renewable or renewable). FAN may meet their energy needs from local, renewable sources on a continuous basis. The scope of the KPI for renewable energy only takes local renewable energy into account.

The maximum time difference in the periods of assessment shall be 7 days

Detailed formula, measurement points and procedures, and criteria are provided for each of the considered indicators.

Sub-part 3: Global KPIs for ICT sites

Energy consumption: $KPI_{EC} = EC_{REN} + EC_{FEN}$; where:

- EC_{REN} : Yearly energy consumption by ICT site from local renewable energy sources minus the energy required to extract such energy (if applicable)
- EC_{FEN} : Yearly energy consumption by ICT site from other power sources

Task efficiency: is the ratio of energy consumption by equipment that manage data for calculation, storage or transport purposes inside the ICT site. Thus, $KPI_{TE} = KPI_{EC} / EC_{HE}$; where:

- EC_{HE} : is the yearly energy consumption by equipment that manage data for calculation, storage and transport purposes, expressed in MWh
- Thus, $KPI_{TE} >= 1$ and $KPI_{TE} = 1$ is an ideal value

Energy reuse: is the ratio of reused energy for external uses to total ICT site energy. Thus, $KPI_{REUSE} = EC_{REUSE} / KPI_{EC}$; where :

- EC_{REUSE} : Yearly energy reused outside the ICT site

Use of renewable energy: is the ratio of energy consumption from renewable sources over the total ICT site energy consumption. Thus, $KPI_{REN} = EC_{REN} / KPI_{EC}$

Energy use management: determines the performance of energy use management by a single ICT site or a group of ICT sites. It is composed of two values :

- DC_{EC} : is the energy consumption by a single or a group of ICT sites, expressed in MWh over a year and equals KPI_{EC}
- DC_{CLASS}: corresponds to the energy use management performance DC_P of a single ICT site or a group of ICT sites, expressed as a letter within the range A to G (see the default classes table below)

  FOR A SINGLE ICT SITE:

  $DC_P = KPI_{TE} \times (1-W_{REUSE} \times KPI_{REUSE}) \times (1-W_{REN} \times KPI_{REN})$; where:
  - W_{REUSE}: Mitigation factor for KPI_{REUSE} (the value may vary depending on the gauge (ffs) within the range 0 to 1, the default value is 0,8), the value used is at the hand of the EC depending on the policy it choose to promote.
  - W_{REN}: Mitigation factor for KPI_{REN} (the value may vary depending on the gauge (ffs) within the range 0 to 1, the default value is 0,8), the value used is at the hand of the EC depending on the policy it choose to promote.

ETSI	***ETSI ES 205 200: Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures***
	FOR A GROUP OF ICT SITES: $DC_P = \frac{\sum_{i=1}^{n} DCclass\ (i) * KPIec\ (i)}{\sum_{i=1}^{n} KPIec\ (i)}$; class letters are translated to their rank, i.e. A=1, B=2… and DC_{CLASS} is expressed as a letter; and $DC_{EC} = \sum_{i=1}^{n} KPIec\ (i)$ DEFAULT CLASSES TABLE :

	DC_P	
DC_{CLASS}	>=	<
A		1,00
B	1,00	1,40
C	1,40	1,70
D	1,70	1,90
E	1,90	2,10
F	2,10	2,30
G	2,30	

Sub-part 4: Cable Access Networks

The data volume transferred across the network is registered between the cable modem (in-home) and the headend equipment.

The KPI for energy consumption involves all the main energy consuming equipment of the broadband access network concerned in the transmission of data between the cable modem and the headend equipment

Energy re-use is considered to be the recovery of portions of the total energy consumption, that would be dissipated into the environment otherwise (e.g. heat)

The scope of the KPI for renewable energy use only takes locally generated renewable energy into account. This does not take into consideration any proportion of utility supplies certified as "green" by nationally recognised schemes nor the carbon footprint of the energy source

Examples of implementation / experience feedback	○ None identified – to be filled later
Interaction with other methodologies	○ [EC Mandate M/462] Standardisation mandate addressed to CEN, CENELEC and ETSI to enable efficient energy use of ICT networks ○ EC DG JRC Code of Conduct for Data Centre Energy Efficiency ○ EC DG JRC Code of Conduct on Energy Consumption of Broadband Equipment ○ [ISO Guide 82] Guide for addressing sustainability in standards ○ [ETSI TS 105 174] Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators ○ [ETSI TR 102 881] Access, Terminals, Transmission and Multiplexing (ATTM); Cable Network Handbook ○ And many others for Sub-part 4 ○ [EN 50600] Series: "Information technology – Data centre facilities and infrastructures" ○ [EN 1434] Series: "Heat meters"

IEC	**IEC TR 62921:2016 : Quantification methodology for greenhouse gas emissions for computers and monitors**
Name of Initiative/ Methodology	Quantification methodology for greenhouse gas emissions for computers and monitors
Link to the latest published version	IEC TR 62921 (10/2016): Version 2.0 https://webstore.iec.ch/publication/25994
Developed by	International Electrotechnical Commissions (IEC), Technical Committee 111: Environmental Standardisation for Electrical and Electronic Products and Systems
History and Status	○ Work started in 2011 and first publication in 2015 ○ Updated version published in October 2016
Involved companies / parties	○ Not known
Scope	☐ **Organisation env. accounting** ☐ Scope 1 ☐ Scope 2 ☐ Scope 3 ☒ **Product env. assessment** ☒ Life cycle approach ☐ Use phase only
	☒ GWP ☐ Energy ☐ Other environmental impacts ☐ KPIs
System(s) covered by the methodology	○ Computers and monitors (incl. notebook, desktop, LCD monitor, etc.)
Goals	○ Providing supporting data for identification of a life cycle stage, subassembly or process that have significant GHG emissions (hot spot) ○ Assessing carbon footprint of computers and monitors ○ Prioritising reduction efforts across the product life cycle ○ Creating a basis for quantifying and reporting CFP performance over time.
Generic features	○ Targeted data collection is performed based on an analysis of the biggest contributors to impacts and to results' uncertainty. This analysis may also be used to determine the appropriate cut-off criteria. ○ Allocation should be avoided; if proven necessary, several methods can be used and are detailed in the document. ○ Uncertainty analysis and sensitivity analysis are to be performed ○ First party verification is recommended for communication ○ An informative list of life cycle database (public database) is provided in Annex C.
ICT-specific features	○ Primary data or aggregated primary data should be used for LCDs, PWBs and ICs. Secondary data should be used for all other data needs. ○ When assessing GHG emissions of EE products, the following should be considered: ▪ The organisation should use primary data from its suppliers ▪ All packaging materials should be considered. ▪ Distribution stage should include transportation processes ▪ The use phase should be estimated under realistic conditions of use (i.e. use profile based on actual usage patterns, power consumption of the different modes, etc.) ▪ End of life should cover impacts generated from transport to the recycling facility, recycling or landfilling of the materials ▪ Maintenance, refurbishment and second use are excluded. ○ Communication may not necessarily detail results for each life cycle stage. ○ Recommended sources for product energy consumption are provided in Annex.

	IEC TR 62921:2016 : Quantification methodology for greenhouse gas emissions for computers and monitors
Examples of implementation / experience feedback	○ None identified.
Interaction with other methodologies	○ [IEC TR 62725] Analysis of quantification methodologies of greenhouse gas emissions for electrical and electronic products and systems ○ [IEC 62430] Environmentally conscious design for electrical and electronic products ○ [IEC 62474] Material declaration for products of and for the electrotechnical industry ○ [IEC 62623] Desktop and notebook computers - Measurement of energy consumption ○ [IEC TR 62635] Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment ○ [ISO 14040] Environmental management - Life cycle assessment - Principles and framework ○ [ISO 14044] Environmental management - Life cycle assessment – Requirements and guidelines ○ [ISO 14064-1] Greenhouse gases - Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals ○ [ISO/TS 14067] Greenhouse gases -- Carbon footprint of products -- Requirements and guidelines for quantification and communication ○ [GHG Protocol] Product Life Cycle Accounting and Reporting Standard ○ [ETSI TS 103 199] Environmental Engineering (EE); Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements ○ [ITU-T L.1410] Methodology for environmental life cycle assessments of information and communication technology goods, networks and services

Appendix D – Marketplace Suppliers

Organisation	Country	Category	Recruited in Y2
Caelus Sustainability Consulting	United States of America	• Advisory or Consultancy	No
Carbon3IT	United Kingdom	• Advisory or Consultancy • Certifications & Other Services	No
CELESTE	France	• Connectivity • Data Management • Hardware	Yes
Certios	The Netherlands	• Advisory or Consultancy • Certifications & Other Services	Yes
Circular Computing	United Kingdom	• Hardware	No
Deloitte Sustainability	France	• Advisory or Consultancy • Software	No
ecoinvent	Switzerland	• Data Management	No
Enervalis	Belgium	• Software	No
Escan	Spain	• Advisory or Consultancy • Certifications & Other Services • Data Management • Software	Yes
Extreme Low Energy	United Kingdom	• Hardware	Yes
Green Digital Charter	Belgium	• Connectivity	
GreenGageIT	United Kingdom	• Advisory or Consultancy	Yes
GreenGoWeb	Switzerland	• Software	No
GREENSPECTOR	France	• Software	No
Maki Consulting	Germany	• Advisory or Consultancy	No
Network DNA	United Kingdom	• Connectivity • Hardware • Software	No
Planet First	United Kingdom	• Certification & Other Services	No
Start2Act	Hungary	• Advisory or Consultancy	Yes
The Green Grid	United States of America	• Advisory or Consultancy • Certifications & Other Services	No
Verne Global	United Kingdom	• Data Management	No
Wi6labs	France	• Connectivity • Hardware • Software	No