ICT footprint
Pilot testing on methodologies for energy consumption and carbon footprint of the ICT-sector

FINAL REPORT
A study prepared for the European Commission
DG Communications Networks, Content & Technology

Digital Agenda for Europe
This study was carried out for the European Commission by

ECOFYS
sustainable energy for everyone

Quantis
Sustainability counts

bio Intelligence
Service

Internal identification
SMART-Nr 2011/0078

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- Shailendra Mudgal (BIO Intelligence Service)
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Executive summary

Background
ICT has the potential to play a useful role in addressing the climate and energy challenges we face today. The European Commission highlighted this opportunity in its Recommendation of October 2009 on mobilising ICT to facilitate the transition to an energy-efficient, low-carbon economy. At the same time, the Commission called on the ICT industry to: "Develop a framework to measure its energy and carbon performance and adopt common methodologies to this end by 2011". This has been identified as a priority by the Commission, as the current landscape in Europe and internationally has been fragmented when it comes to measurement of energy and carbon footprints.

In accordance with Key Action 12 of the Digital Agenda for Europe [DAE], the Commission will assess whether the ICT-sector has complied with the timeline to adopt common measurement methodologies for the sector’s own energy performance and carbon emissions.

Several international standardisation organisations and industry bodies have established a variety of methodologies to measure and quantify the footprint of ICT products, services and organisations. In the context of the implementation of the DAE, the Commission has initiated and supported this project "Pilot testing on methodologies for energy consumption and carbon footprint of the ICT-sector", which compares the most relevant methodologies.

Objectives
The basic aim of this project is to pilot test the compatibility and workability of the different methodologies on the energy and carbon footprints of ICT products, services and organisations, when applied by actual footprint practitioners to specific products, services and organisations.

The Commission has specifically envisioned the following outcomes of the pilot tests:

1. Compatibility: Enable feedback to the standards development organisations and industry bodies on what should be done next, to ensure compatibility amongst the methodologies.
2. Workability: Provide assurance to ICT companies that the methodologies are workable.

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1 For further details, see EC Recommendation C(2009)7604 Mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy (http://ec.europa.eu/digital-agenda/)
4 In this report the term "methodology" is used to describe each of the documents published by different organisation. The publications are however technically different: standards, technical reports, recommendations, and guidelines. It should be noted that they were developed to serve somewhat different purposes but were tested as being LCA methods/methodologies.
5 Compatibility is defined in this project as "generation of the same calculation results when applying different methodologies to the same set of data from the same organisation/product/service by the same LCA practitioner".
3. **Policy input:** Inform policy at national and EU level for example to prepare new initiatives in the field.

The Commission has asked, within the scope of this project, to test six methodologies from ITU\(^7\), ETSI\(^8\), IEC\(^9\), and from the Greenhouse Gas Protocol (GHG Protocol)\(^10\), see Table 1 below. Additionally to these six methodologies, volunteering companies could test other methodologies as well (like the JRC methodology\(^11\), Bilan Carbone\(^12\), and an ISO methodology\(^13\)).

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\(^6\) Workability is defined as a methodology is robust, reliable, cost efficient and can be implemented in a practical way both within the company itself and across its upstream and downstream supply chain.

\(^7\) ITU (International Telecommunication Union) is the United Nations specialized agency for information and communication technologies – ICTs. ITU standards are called recommendations.

\(^8\) The European Telecommunications Standards Institute (ETSI) produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies. ETSI is officially recognized by the European Union as a European Standards Organization.


\(^10\) The GHG Protocol, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) is an international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. The GHG Protocol has developed several methodologies that are relevant for this study (see Table 1).

\(^11\) The Joint Research Centre (JRC) is a Directorate-General of the European Commission and forms its scientific and technical research laboratory. It has developed two relevant methodologies for this study (see Table 1).

\(^12\) Bilan Carbone is an accounting method for greenhouse gas emissions for any organization, industrial or tertiary companies, public administration, communities or territory that was developed by ADEME. ADEME is a French Environment and Energy Management Agency, a public agency under the joint authority of the Ministry for Ecology, Sustainable Development and Energy and the Ministry for Higher Education and Research.

\(^13\) The International Organisation for Standardization (ISO) develops international voluntary standards. The standard that was tested in this study is listed in Table 1.
Table 1: Methodologies included in the pilots

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU-T L.1410</td>
<td>Methodology for environmental impacts assessment of ICT goods, networks and services</td>
</tr>
<tr>
<td>ITU-T L.1420</td>
<td>Methodology for environmental impacts assessment of ICT in organisations</td>
</tr>
<tr>
<td>ETSI TS 103 199</td>
<td>Life Cycle Assessment (LCA) of ICT equipment, networks and services: General methodology and common requirements</td>
</tr>
<tr>
<td>GHG Protocol Corporate (Value Chain) Standard</td>
<td>Corporate Accounting and Reporting Standard - including the Corporate Value Chain (Scope 3) Standard (not ICT specific)</td>
</tr>
<tr>
<td>IEC/TR 62725</td>
<td>Analysis of quantification methodologies for greenhouse gas emissions for electrical and electronic products and systems</td>
</tr>
<tr>
<td>ISO 14064*</td>
<td>International standard to measure, quantify and reduce greenhouse gas emissions of organisations (not ICT specific)</td>
</tr>
<tr>
<td>Bilan Carbone *</td>
<td>French accounting methodologies for greenhouse gas emissions of organisations (not ICT specific)</td>
</tr>
<tr>
<td>JRC Product Environmental Footprint Guide *</td>
<td>A technical guide for the calculation of the environmental footprint of products (not ICT specific)</td>
</tr>
<tr>
<td>JRC Organisational Environmental Footprint Guide *</td>
<td>A technical guide for the calculation of the environmental footprint of organisations (not ICT specific)</td>
</tr>
</tbody>
</table>

* Methodologies with a grey background are outside of the original scope of the project but were additionally tested by certain pilots and compared with the methodologies that were part of the original scope.

**Participating companies and organisations**

In total 27 volunteering ICT companies and organisations participated in this project, see list below (3 organisations prefer to stay anonymous). A wide range of corporate activities from within the ICT-sector was represented in the pilots, varying from telecom, software & services, equipment manufacturing and supply to chips and components manufacturing.

- Alcatel-Lucent
- AMD
- AUO
- BT
- Cisco
- Dassault Systèmes
- Dell
- EECA-ESIA
- Ericsson
- GSMA
- Hitachi
- HP
- Huawei
- Intel
- Lenovo
- NEC
- Nokia
- Nokia Siemens Networks
- Orange
- Sagemcom
- SAP
- Telecom Italia
- Telefónica
- TeliaSonera

Execution of pilots
In two rounds, with an overall time span of 10 months, the 27 ICT companies have executed a total of 18 pilot tests of the various methodologies. In each pilot test at least two methodologies were tested by the volunteering companies. Table 2 shows an overview of the methodologies tested within this project per type of pilot (organisation, product and services).

Table 2: Methodologies tested for organisation, product and service carbon footprinting

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Organisation</th>
<th>Product</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU-T L.1410</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ITU-T L.1420</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETSI TS 103 199</td>
<td>4</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>GHG Protocol Product Standard – ICT-sector Guidance</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>GHG Protocol Corporate (Value Chain) Standard</td>
<td>6</td>
<td></td>
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</tr>
<tr>
<td>IEC/TR 62725</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 14064</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilan Carbone</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JRC Product Environmental Footprint Guide</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JRC Organisational Environmental Footprint Guide</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The outcomes of the pilots were independently validated by third party consultants BIO Intelligence Service, Quantis and Ecofys.

Results on compatibility and workability of methodologies
The overall results of the pilots on compatibility and workability of the various methodologies for organisations, products and services are presented in the subparagraphs below, and by using concise tables\(^\text{18}\). These results provide useful information on all methodologies for standards development organisations (SDOs), EC and industry bodies.

\(^\text{18}\) Different shades of blue are used for indicating the differences and similarities between methodologies on the criteria of compatibility and workability. The same colour shading indicates similarity between methodologies, whereas a different colour indicates differences.
Results of pilots on Organisation footprinting

The main pilot results are presented in Table 3 and explained further in the paragraphs below.

Table 3: Compatibility and workability of Organisation footprint methodologies

<table>
<thead>
<tr>
<th>Aspect</th>
<th>GHG Protocol (original list)</th>
<th>ITU-T L.1420 (original list)</th>
<th>ISO 14064 (additional)</th>
<th>Bilan Carbone (additional)</th>
<th>JRC (additional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pilot tests</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Compatibility</td>
<td>• Focus on Kyoto GHGs</td>
<td>• Focus on Kyoto GHGs and</td>
<td>• Focus on Kyoto GHGs</td>
<td>• Covers more types of</td>
<td>• Covers more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>energy consumption</td>
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<td>GHGs</td>
<td>environmental</td>
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<td></td>
<td></td>
<td>• Viewed as an ICT specific</td>
<td></td>
<td></td>
<td>impacts</td>
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<td></td>
<td></td>
<td>extension of the GHG</td>
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<td></td>
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<td>Protocol</td>
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<tr>
<td></td>
<td></td>
<td>• GHG Emissions of capital</td>
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<tr>
<td></td>
<td></td>
<td>goods, and purchased</td>
<td></td>
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<td></td>
<td></td>
<td>goods/services included in</td>
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<td></td>
<td>the year of purchase</td>
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<tr>
<td></td>
<td>Workable</td>
<td>Workable</td>
<td>Workable</td>
<td>Workable</td>
<td>Views of 2 pilots</td>
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<tr>
<td></td>
<td>• Extended</td>
<td>• Limited</td>
<td>• Limited</td>
<td>• Choice for emission</td>
<td>on workability</td>
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<td></td>
<td>calculation guidance</td>
<td>calculation guidance</td>
<td>calculation guidance</td>
<td>factors supported</td>
<td>differ</td>
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<td></td>
<td>• High demands for</td>
<td>• Flexible</td>
<td>• Limited</td>
<td>through own database</td>
<td>Higher level of</td>
</tr>
<tr>
<td></td>
<td>completeness</td>
<td>demands for completeness</td>
<td>calculation guidance</td>
<td></td>
<td>detail and</td>
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<tr>
<td></td>
<td>Workability</td>
<td>Workability</td>
<td></td>
<td></td>
<td>complexity</td>
</tr>
<tr>
<td></td>
<td>• All of the methodologies</td>
<td>• All of the methodologies</td>
<td>• All methodologies</td>
<td></td>
<td>Good quality</td>
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<td>tested provided comparable</td>
<td>tested provided comparable</td>
<td>require considerable</td>
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<td>rating scheme</td>
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<td>footprint results for the</td>
<td>footprint results for the</td>
<td>investments in</td>
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<td>total emissions, except</td>
<td>total emissions, except</td>
<td>knowledge, time,</td>
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<td>for the emissions of</td>
<td>staff and money (see</td>
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<td>capital goods and purchased</td>
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<td>also also</td>
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<td>goods and services</td>
<td>goods and services</td>
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<td>high quality activity</td>
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<td>data, and emission</td>
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<td>factors is the most</td>
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<td>time consuming part of</td>
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<td>the footprinting</td>
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<td>process (independent of</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>the methodology)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compatibility of Organisation footprint methodologies

According to the main results quoted in Table 3, the two methodologies that were part of the original scope of this project (GHG Protocol and ITU-T L.1420) are considered compatible with each other by the pilot participants. The ITU-T L.1420 methodology was viewed (by the pilots) as an ICT specific

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19 Note: The results for Bilan Carbone and ISO 14064 are based on one pilot test and therefore might be related to these specific pilot circumstances.
extension of the GHG Protocol. Three pilots additionally mentioned that ITU-T L.1420 would benefit from being applied together with the more detailed calculation guidance provided by the GHG protocol. The most significant difference between the methodologies noted is the proposed way of accounting for purchased capital goods, purchased goods and services. While the ITU-T L.1420 requires these emissions to be divided by the operational lifetime (depreciation), the GHG Protocol requires accounting for the full life cycle emissions in the year of purchase.

Regarding the additional methodologies tested we found the following results:

• The ISO 14064 standard is considered to have less (strict) calculation rules, and does not require the reporting of non-energy related (other) indirect emissions;

• Bilan Carbone differs from the GHG Protocol Corporate (Value Chain) Standard and ITU-T L.1420 because it has different emission source categories, uses a specific database with different emission factors and focuses on all greenhouse gases (GHGs) rather than only the Kyoto gases. The pilot testing Bilan Carbon reported a significant 7% difference for the total footprint, which was mainly caused by the additional GHGs included in this methodology and the use of different emission factors;

• The JRC methodology differs from the other mentioned methodologies because it includes more environmental impact categories, categorises emissions in a different way, provides an own set of characterisation factors to be used, and provides a specific hierarchy for LCI databases to be used for selecting generic emission data. Finally the JRC, like ITU-T L.1420 chooses a depreciation method for accounting for the emissions of capital goods. The different way of accounting for the emissions of capital goods and purchased goods and services leads to a difference in the final organisation footprint results varying from 2% to even 17.5% of the total footprint for one pilot participant

Overall the tested methodologies provided very comparable final organisation footprint results for most of the emissions categories calculated. Most pilots noticed that the emission factors and the activity data (and not the methodology that is used) are eventually the greatest source for variation in the outcomes of the calculation.

Workability of Organisation footprint methodologies

The methodologies tested within this project are considered workable by all the pilots. Only the views of the two pilots testing the JRC methodology differed. One pilot deemed it complex to apply, and prefers a different emission categorisation (the three scopes). The other pilot deemed it very complete because of the inclusion of all environmental impacts, and valued the fact that JRC addresses the topic of uncertainty directly with the inclusion of a data quality rating.

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It should however be noted that this difference is expected to decline over time. As this was the first time the pilots calculated the emissions with the “depreciation” method, the depreciated emissions of goods and services purchased in earlier years were not reported yet. If these are taken into account in future years the difference between the methodologies will become smaller.
The presence of detailed calculation guidance, or guidance on the use of emission factors is mentioned by the pilots to be very important for the workability of a methodology. In this context the detailed calculation guidance of the GHG Protocol was valued positive by the pilots testing it, while the guidance of ITU-T I.1420 and ISO 14064 was considered more limited.

For all methodologies the workability was judged lower for scope 3 emissions (than for scope 1 and 2). The lack of good quality activity data and emission factors was often a problem. The inclusion of a good “data quality policy” in a methodology (like JRC has), enabling the footprint practitioner to assess the quality of and uncertainty behind the numbers reported, would therefore be appreciated by the pilots.

Finally, all methodologies require a considerable amount of investment in time and staff. The data collection stage in particular is most time consuming (rather than the calculation stage). However, the amounts reported vary widely between the pilots in this project. Table 4 below summarizes the approximate numbers that were reported by the different pilots. Due to the wide variation of the answers of the different pilots a range is included in the table below. The final column gives some more information about the drivers behind the differences between the pilots.

Table 4: Workability of Organisation footprint methodologies based on pilot audit reports

<table>
<thead>
<tr>
<th>Items</th>
<th>Pilot’s answers (range)</th>
<th>Interpretation of results</th>
</tr>
</thead>
</table>
| Number of staff involved to carry out the methodology | Out of 7 companies:  
  - 4 companies report 1-5 FTE;  
  - 1 company reports 7.5 FTE;  
  - 2 companies report 10-30 staff members (not full time);  
  - In addition, from the total of 7 companies, 4 companies report to have 10-30 non-full timers working on data collection throughout the company on average. | The dispersion of results can be explained by:  
  - The scope of the footprint (full supply chain, or only a part)  
  - The budget available  
  - The availability of specialized staff, or the need to hire external consultants  
  - The internal knowledge/background in LCA  
  - The size and complexity of the organisation |
| Additional out of pocket costs involved to carry out the methodology (when starting from scratch) | Out of 7 companies:  
  - 4 companies report 200-500 k Euros per year;  
  - 1 company report 0 k out of pocket costs;  
  - 2 companies consider the information confidential and/or did not provide information. |                                                                                          |
| Amount of time involved to carry out the methodology in case you would start from scratch | 1 month-3 years                                                               |                                                                                          |
**Results of pilots on Product footprinting**

Regarding product footprinting the main results are included in Table 5.

Table 5: Compatibility and workability of product footprint methodologies

<table>
<thead>
<tr>
<th>Aspect</th>
<th>GHG Product Standard / ICT-sector Guidance (original list)</th>
<th>ETSI TS 103 199 (original list)</th>
<th>ITU-T L.1410 (original list)</th>
<th>IEC TR 62725 (original list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pilots tested</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Compatibility

- No inherent differences between GHG Product Standard / ICT-sector Guidance, ETSI, ITU-T and IEC, allowing same conditions, assumptions, boundaries, etc.
- All methodologies provided comparable final footprint results for total emissions when the same practitioner tested methodologies with the same software tool, same databases and same primary data.
- All the methodologies are rather general framework standards and mostly in line with each other as well as with the ISO 14040/44 standard.
- ITU-T focuses on GHG emissions and energy consumption, whereas ETSI covers more environmental impact categories. The GHG Product Standard is limited to GHG emissions only.
- ETSI puts stricter methodological requirements, which leads to less deviation in calculation outcomes between studies, when compared with other methodologies.
- ITU-T and IEC leave a certain degree of freedom regarding application of the requirements on several accounts.

Workability

- GHG Product Standard / ICT-sector Guidance, ETSI, ITU-T and IEC were considered not to differ significantly regarding workability.

Overall

- No inherent differences between methodologies regarding compatibility or workability when applied under identical conditions (database, assumptions, boundaries, etc.)

**Compatibility of Product footprint methodologies**

As Table 5 shows, the four tested methodologies were considered to be compatible with each other by the pilots. According to most pilots, Product Category Rules (PCR) and/or Product Environmental Footprint Category Rules (PEFCR) would be required in order to improve the repeatability and comparability of results for product LCAs (from one LCA practitioner to another).

The methodologies always provided very similar and comparable final footprint results (with a maximum deviation of 2-3% between methodologies in the “worst” case) for total emissions when the same practitioner tested the methodologies with the same software tool, same databases and same primary data. Uncertainty in calculation outcomes was quantified in only one pilot and in that case it was estimated to be of the order of ±20%. Uncertainty within LCA calculation outcomes is a general issue that is not feasible to eliminate entirely; therefore, it is important that methodologies provide a structural mechanism to account for and minimize uncertainty in the outcomes of the footprint calculations.

In spite of the similar footprint outcomes in the pilots, the four methodologies which are intended to set a framework for LCAs, inherently all (ETSI TS 103 199 to a lesser degree) allow a lot of freedom regarding LCA modelling decisions that influence the calculation outcomes (e.g. end of life
approaches, allocation rules, uncertainty analysis, data gathering, etc.). This freedom can potentially lead to large variations in results between studies if performed by different practitioners, using different tools and/or databases, even if they employ the same methodology.

Of the different methodologies, ETSI TS 103 199 contains relatively stricter requirements than the other methodologies, thus reducing the potential variation in outcomes between studies (higher repeatability) compared with other methodologies (e.g. more mandatory parts (“shall”) instead of optional parts (“should”) in the other methodologies).

Content wise, ETSI 103 199 and ITU T L.1410 have very similar requirements and cover the same aspects. IEC/TR 62725 provides guidelines for Product Carbon Footprints (PCF) of Electrical and Electronic Equipment (EEE), including (but not limited to) ICT and thus has a broader scope. The GHG Protocol Product Standard is aligned with the other 3 tested methodologies but is limited to GHG emissions only.

**Workability of Product footprint methodologies**

The four tested methodologies were considered by the pilots not to differ significantly in terms of workability.

Table 6: Workability of Product footprinting methodologies based on pilot audit reports

<table>
<thead>
<tr>
<th>Items</th>
<th>Pilot’s answers (range)</th>
<th>Interpretation of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of staff involved to carry out the methodology</td>
<td>Staff: Out of 9 companies: 8 companies report 1-5 FTE; 1 company reports 10 people (not full time). In addition, from the total of 8 companies, 4 companies report to have 10-30 non-full timers working on data collection throughout the company on average.</td>
<td>The dispersion and variability of the numbers can be explained by: budget available for LCA projects / involvement of the company (internal policy) knowledge/background in LCA complexity of the studied product interpretation to the question by pilots: difficulty to determine if these costs include the purchases of datasets, software, personnel or only the man day the scope: difficulty to determine if these durations include the data collection externally (e.g. on the suppliers’ side)</td>
</tr>
<tr>
<td>Additional out of pocket costs involved to carry out the methodology (when starting from scratch)</td>
<td>Out of 9 companies: 4 companies report 20-120 k€; 1 company reports 300-600 k€ (investment to secure the required skilled resources); 2 companies report 1-10 k€ for one study; 2 companies could not make an estimation.</td>
<td></td>
</tr>
<tr>
<td>Amount of time involved to carry out the methodology in case you would start from scratch</td>
<td>1 - 6 months</td>
<td></td>
</tr>
</tbody>
</table>

The bulk of the effort in applying the four methodologies is in the data collection including soliciting, analysing and clarifying data while the rest is spent on disassembly, modelling and writing the reports. The respective shares in terms of time spent, however, were not quoted by the pilots. The methodology choice doesn't appear to significantly affect the effort related to those activities. Pilot companies emphasized the fact that doing LCAs in general requires specialist competence and can be
very time consuming and costly for companies. Table 6 summarizes the main pilot’s results regarding workability.

Overall, pilot companies considered that methodologies are quite exhaustive and provide a good baseline to understand the most significant challenges of a given product, but cannot be used as a tool to differentiate products with the same function based on their footprint performance.

Results of pilots on Service footprinting
Three methodologies from the original list in Table 1 were tested for ICT services carbon footprinting. The overall results are presented in Table 7.

Table 7: Compatibility and workability of Service footprinting methodologies

<table>
<thead>
<tr>
<th>Aspect</th>
<th>GHG Protocol Product Standard – ICT-sector Guidance (original list)</th>
<th>ITU-T L.1410 (original list)</th>
<th>ETSI TS 103 199 (original list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pilots tested</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Compatibility</td>
<td>• The GHG Protocol ICT-sector Guidance - Telecom Network Services (TNS) chapter, ITU-T L.1410 and ETSI TS 103 199 share a compatible basis: there is an overlap area between the methodologies. If calculations are made according to this overlap area, they are compliant with all three methodologies at the same time</td>
<td>• ETSI TS 103 199 provides a more rigorous set of requirements for performing an LCA (e.g. life cycle elements mapped onto unit processes for an ICT service)</td>
<td></td>
</tr>
</tbody>
</table>
| Workability     | • The GHG Protocol TNS chapter was deemed useful for the telecommunications service tested  
                  • Data gathering was deemed more straightforward than by following the two other methodologies | • Needs more details regarding ICT network and service assessment | • Needs more details regarding ICT network and service assessment |
| Overall         | • Fundamental basis of all methodologies is the same.  
                  • Workability of GHG Protocol ICT-sector guidance is perceived as higher than workability of ITU-T L.1410 and ETSI TS 103 199, for the type of service tested (only one pilot). | | |

Compatibility of Service footprint methodologies
All three methodologies have a compatible basis. In the case of one pilot testing all three methodologies, the outcomes of the calculations for the carbon footprint were the same in the end, irrespective of the methodology applied. For the remaining two pilots testing ETSI TS 103 199 and ITU-T L.1410, full compliance with ETSI TS 103 199 was not achieved due to lack of time and input data. Indeed, this methodology sets more stringent mandatory requirements for some elements of the assessment (e.g. life cycle elements mapped onto unit processes) that may or may not be met while following another methodology. In theory, an LCA fully compliant with ETSI TS 103 199 is thus compliant with ITU-T L.1410, but the contrary is not necessarily true. The strict rules defined in ETSI TS 103 199 are expected to reduce the spread in the results of LCA performed by different practitioners but this study did not investigate this aspect.
Workability of Service footprint methodologies

In terms of workability, all three pilots commented that the guidance specifically provided for the assessment of ICT networks and services in ITU-T L.1410 and ETSI TS 103 199 does not seem sufficient on some points to properly support the practitioner because of the high complexity of the ICT systems.

For the only pilot who used it, the ICT-sector Guidance of the GHG Protocol Product standard provides a higher level of detail and useful guidance in the specific case of the telecommunications service tested. Furthermore, regarding the workability of ITU-T L.1410, this pilot found that the suggested data breakdown into 8 different categories was not always feasible. Regarding the workability of ITU-T L.1410 and ETSI TS 103 199, one pilot found that more time was needed to follow these standards compared to the GHG Protocol Product Standard – ICT-sector Guidance for the service tested.

Table 8 summarizes the main pilot’s results regarding workability.

Table 8: Workability of Service footprinting methodologies based on pilot audit reports

<table>
<thead>
<tr>
<th>Items</th>
<th>Pilot’s answers (range)</th>
<th>Interpretation of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of staff involved to carry out the LCA</td>
<td>Out of 3 companies:</td>
<td>People of different backgrounds and expertise were directly involved in the pilot tests with additional occasional support from businesses outside the pilot consortia. Additional people were required to supplement the expertise, guidance and data collection required or recommended.</td>
</tr>
<tr>
<td></td>
<td>• 1 company reports 9-12 FTE of varying backgrounds and expertise + additional staff required to supplement the expertise, guidance and data collection required or recommended;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 1 company reports 5 FTE;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 1 company reports 7 staff members (not full time).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional out of pocket costs involved to carry out the LCA (when starting from scratch)</td>
<td>Out of 3 companies:</td>
<td>The time reported by pilots is variable because it depends on:</td>
</tr>
<tr>
<td></td>
<td>• 1 company reported 85 k Euros;</td>
<td>- The knowledge/background in methodologies and LCA; the time required decreases based on familiarity with methodologies and LCA processes, existence of internal tools for data treatment and interpretations, and existence of previous LCA outcomes;</td>
</tr>
<tr>
<td></td>
<td>• 1 company did not assess the amount of out of pocket costs and did not provide data;</td>
<td>- The complexity of the studied service;</td>
</tr>
<tr>
<td></td>
<td>• 1 company did not provide data for confidential reasons.</td>
<td>- The availability and accessibility of internal company data sources.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount of time involved to carry out the LCA in case you would start from scratch</td>
<td>2 - 3.5 months</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions and recommendations

Compatibility
The overall conclusion regarding compatibility of footprint methodologies and standards for organisations, products and services that were piloted is that on the one hand they are in principle compatible and can deliver the same results (as has been shown by the various pilots), but on the other hand that the methodologies leave considerable freedom to make different methodological choices, potentially leading to different outcomes. Thus two footprint practitioners using different methodologies or even the same methodology, may arrive at different results as a result of the methodological changes they made. It was also noticed during this study that the emission factors used, the databases, the calculation tool, the quality of the activity data and the person who is conducting the footprint have a larger impact on the outcome of the calculations than the choice of the methodology. There are several ways in which the footprint methodologies could be made more compatible or applied in a way that ensures more compatibility between them (see below).

Workability
The overall conclusion regarding workability is that in principle all methodologies are workable, but it needs to be kept in mind that footprinting in general requires a considerable amount of resources in terms of (out of pocket) costs and/or staff. The most resource intensive part in any footprinting study is the collection of data. The needed resources for footprinting analyses depend on:

- The complexity of the organisation, product or service that is footprinted;
- The availability of existing tools (e.g. semi-automatic treatment of LCA data) and outcomes of previous footprint studies that were developed and used in the past;
- The level of knowledge and experience from previous work available internally.

Ways to improve the compatibility and workability of organisation footprint methodologies
The following measures are believed most important to be considered in order to improve the compatibility and workability of organisation footprint methodologies:

- Focus only on activities for which relatively easy high quality activity data and emission factors can be obtained (with a relatively low inherent uncertainty). For carbon footprinting these are for example the so called scope 1 and scope 2 greenhouse gas emissions (direct emissions and energy related indirect emissions) as opposed to scope 3 emissions (other indirect emissions). This will reduce the workload and also decrease the variation in footprinting results. The downside of this approach would be that for those industries for which scope 3 emissions are relatively very important in relation to their total footprint, important emission sources are disregarded;
- Define, alternatively to the measure mentioned above, clear “scope 3” footprint categories, which need to be taken into account and reported separately, regardless of the methodology being applied;
- Apply a good “data quality policy” (like the JRC contains for example), enabling the footprint practitioner to assess the quality of and uncertainty behind all the numbers reported;
- Agree on common secondary data sources with emission factors to be used (for example regarding emission factors of electricity production per country);
• An alternative to the aforementioned measure is to exclude the impact of having different sources of emission factors in calculations in the first place, for example by focusing on primary energy use rather than GHGs, so no conversion from energy to greenhouse gases is necessary;
• Agree on detailed calculation approaches for certain emission sources with a potentially high impact on the overall organisation footprint, for example regarding annual accounting for the lifecycle impact of procured capital goods, products and services or regarding scenario-based use phase emissions and provide detailed calculation guidance.
These measures could be included an overarching framework, containing specific organisation footprint guidance for companies in the ICT sector.

Ways to improve the compatibility and workability of product and service footprint methodologies
The following elements are considered to be most important to this end:
• For different categories of products and services so called product category rules (PCRs) and Product Environmental Footprint Category Rule(s) (PEFCRs) could be created. PCRs and PEFCRs prescribe the methodological choices that footprint practitioners need to make, for example regarding the functional unit, the scope, allocation and impact assessment method, thereby making the outcomes of LCA analyses more compatible;
• The measures mentioned above to improve the compatibility and workability of organisation footprinting methodologies regarding the selection of secondary data sources, selection of environmental impacts and detailed calculation approaches, are equally relevant to improve the compatibility and workability of methodologies for footprinting of products and services;
• Generic emission factors could sometimes be proposed in methodologies to avoid use of publically available emission factors that can sometimes lead to a large variation in outcomes;
• LCA practitioners could benefit from LCA studies evolving in three different directions:
  • Screening LCAs (relatively less resource intensive, high aggregation level, providing first insights in environmental hotspots);
  • High level LCAs (mid level);
  • Detailed LCAs (most resource intensive, in cases very detailed results are needed and high accuracy is very important).
In addition it is recommended to have a roadmap available as to why and how companies should select a certain assessment level of analysis.

Recommendations for public authorities regarding organisation, product and service footprinting
The most important conclusions that can be drawn from the study, with relevance for policy makers, are listed below:
• The established collaboration and interaction between EC and ICT companies has been valued by the ICT companies. The ICT companies and the third parties who supported them in this study recommend finding ways to continue and sustain this collaboration;
• Since the opinion of the pilots about future policy measures based on the tested methodologies strongly depends on what the policy and/or requirements would look like, the third parties recommend following up this dialogue based on more concrete policy options;
• Several ICT companies have recommended aligning the activities concerning the ICT-sector, and implemented by the various DGs within the Commission (especially between DG Environment and DG CONNECT).

Recommendations for SDOs
For SDOs, it is recommended to provide more guidance (e.g. examples) for applying the methodologies. More guidance on choosing emission factors, collecting data, assessing and ranking data quality, assessing uncertainties, allocating emissions, and reporting is requested by most pilot companies. Also more detailed PCRs/PEFCRs are required. Since the need for a global LCI/LCA database on ICT-specific emission sources/factors and PCRs/PEFCRs is diverse, we recommend to further investigate this need among the participating ICT companies and/or broader in the sector.

Recommendations to the ICT industry
It is recommended to the ICT industry:
• To build upon the pilot results and jointly establish a common framework to align footprinting of ICT-organisations, products and services, based on existing methodologies. This framework could be developed by the ICT-sector, but in close cooperation with the SDOs. The ICT-sector is recommended to make sector specific agreements on how to deal with the most important drivers behind the accounting for the energy use and GHG emissions of products, services and organisations;
• Since the inaccuracy (or uncertainty level) of the results widely comes from the choice and quality of available inventory/activity data, the ICT industry could investigate ways to share data and increase data quality.

Limitations of pilot test results
The following limitations of this project should be kept in mind:
• Although the third parties expect that the conclusions are applicable in general, it is important to keep in mind that the results are based on a limited number of pilots, and that they are derived from exercises under specific pilot circumstances;
• In this parallel testing process of at least two methodologies per organisation, product or service, it was challenging to judge whether the application of each of the methodologies would really be the same if they were implemented as stand-alone assessments.
## Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADEME</td>
<td>Agence de l’Environnement et de la Maîtrise de l’Energie (French Environment and Energy Management Agency)</td>
</tr>
<tr>
<td>BoM</td>
<td>Bill of Materials</td>
</tr>
<tr>
<td>CML methodology</td>
<td>Impact assessment methodology that is commonly used in the LCIA steps of an LCA, which include classification and characterization, and optionally normalization and/or weighting</td>
</tr>
<tr>
<td>DG CONNECT</td>
<td>Directorate General Information Society and Media</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EE</td>
<td>Energy Efficiency</td>
</tr>
<tr>
<td>EEE</td>
<td>Electrical and Electronic Equipment</td>
</tr>
<tr>
<td>EF(s)</td>
<td>Environmental Factor(s)</td>
</tr>
<tr>
<td>EoL</td>
<td>End-of-life</td>
</tr>
<tr>
<td>EoLT</td>
<td>End-of-life treatment</td>
</tr>
<tr>
<td>ETSI</td>
<td>European Telecommunications Standards Institute</td>
</tr>
<tr>
<td>GHG(s)</td>
<td>Greenhouse Gas(es)</td>
</tr>
<tr>
<td>GHG Protocol</td>
<td>Used in this report to refer to the &quot;GHG Protocol Corporate Standard&quot; and the &quot;Corporate Value Chain (Scope 3) Accounting and Reporting Standard&quot;</td>
</tr>
<tr>
<td>GNS</td>
<td>Goods, Networks and Service</td>
</tr>
<tr>
<td>IEA</td>
<td>International Energy Agency</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>ITU</td>
<td>International Telecommunication Union</td>
</tr>
<tr>
<td>ITU-T</td>
<td>Telecommunication Standardization Sector of ITU</td>
</tr>
<tr>
<td>JRC</td>
<td>Joint Research Centre (European Commission Joint Research Centre</td>
</tr>
<tr>
<td>LCA(s)</td>
<td>Life Cycle Assessment(s)</td>
</tr>
<tr>
<td>PAIA</td>
<td>Product Attribute to Impact Algorithm</td>
</tr>
<tr>
<td>PCF(s)</td>
<td>Product Carbon Footprint(s)</td>
</tr>
<tr>
<td>PCR(s)</td>
<td>Product Category Rule(s)</td>
</tr>
<tr>
<td>PEFCR(s)</td>
<td>Product Environmental Footprint Category Rule(s)</td>
</tr>
<tr>
<td>SDO(s)</td>
<td>Standards Development Organisation(s)</td>
</tr>
<tr>
<td>Third Party</td>
<td>Independent third party consultancy coordinating and supporting the pilots</td>
</tr>
<tr>
<td>TNS</td>
<td>Telecommunication Network Services</td>
</tr>
<tr>
<td>TR</td>
<td>Technical report</td>
</tr>
<tr>
<td>VC(s)</td>
<td>Volunteering Company(-ies)</td>
</tr>
<tr>
<td>WBC</td>
<td>Wholesale Broadband Connectivity</td>
</tr>
</tbody>
</table>
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1 Introduction

1.1 Background
ICT has the potential to play a central role in addressing the climate and energy challenges we face today\textsuperscript{21}. The European Commission highlighted this opportunity in its Recommendation\textsuperscript{22} of October 2009 on mobilising ICT to facilitate the transition to an energy-efficient, low-carbon economy. At the same time, the Commission called on the ICT industry to: "Develop a framework to measure its energy and carbon performance and adopt common methodologies to this end by 2011". This has been identified as a priority by the Commission, as the current landscape in Europe and internationally has been altogether fragmented when it comes to measurement of energy and carbon footprints.

In accordance with Key Action 12 of the Digital Agenda for Europe [DAE]\textsuperscript{23}, the Commission will assess whether the ICT-sector has complied with the timeline to adopt common measurement methodologies for the sector's own energy performance and carbon emissions.

Currently several standard development organisations (SDOs) and industry bodies have established a variety of methodologies to quantify the energy, Greenhouse Gas (GHG) and environmental footprint of ICT products, services and organisations.

In the context of the implementation of the DAE, the European Commission, DG CONNECT has initiated and supported this project, which compares the most relevant methodologies.

1.2 Objectives
The basic aim of this project is to pilot test the compatibility and workability of the different methodologies\textsuperscript{24} on the energy and carbon footprints of ICT products, services and organisations, when applied by actual practitioners. It should be noted that the goal of this project is not to qualify, judge or rank footprinting methodologies.

\textsuperscript{21} For further details, see EC Recommendation COM(2009)7604 Mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy
\textsuperscript{22} http://ec.europa.eu/information_society/activities/sustainable_growth/docs/recommendation_d_vista.pdf
\textsuperscript{24} In this report the term "methodology" is used to describe each of the documents published by different organisation. The publications are however technically different: standards, technical reports, recommendations, and guidelines. It should be noted that they were developed to serve somewhat different purposes but were tested as being LCA methods/methodologies.
The European Commission specifically envisions the following outcomes of the pilot tests:

1. **Compatibility**: Enable feedback to the standards development organisations & industry bodies on what should be done next, to ensure compatibility amongst the standards\(^{25}\).
2. **Workability**: Provide assurance to ICT companies that the methodologies are workable\(^{26}\).
3. **Policy input**: Inform policy at national and EU level for example to prepare new initiatives in the field.

To test the compatibility of methodologies, the EC has formulated the following key objectives for the pilots:

1. To assess the compatibility of the methodologies which are currently under development by SDOs and industry bodies (ITU, ETSI, GHG Protocol and IEC). An example of testing can be the use of two methodologies on the same ICT product or service and the same (activity) data set to check if they deliver results within the same margin of error or uncertainty;
2. Check along the value chain that the metrics, data, scope, boundaries are coherent (this can be done using different chapters of the same methodology or different methodologies) and gain practical experience and learning how to use these methodologies across the upstream and downstream value chain.

### 1.3 Structure of this report

In this report the final outcome of the project “Pilot testing on methodologies for energy consumption and carbon footprint of ICT-sector” is presented. The outcome is derived from the evaluation reports delivered by the third parties, drawing from the audit reports and calculations delivered by the volunteering companies. In chapter 2 the project plan is described and in chapter 3 an overview of all pilots undertaken is given. Chapter 4, 5, and 6 present the results of the pilots on compatibility and workability of the footprint methodologies of organisation, product and services. Results regarding policy input are provided in chapter 7. In chapter 8 specific feedback and recommendations for SDOs is given. Overall recommendations are presented in chapter 9.

\(^{25}\) Compatibility is defined in this project as “generation of the same calculation results when applying different methodologies to the same set of data from the same organisation/product/service by the same LCA practitioner”.

\(^{26}\) Workability is defined as a methodology is robust, reliable, cost efficient and can be implemented in a practical way both within the company itself and across its upstream and downstream supply chain.
2 Project plan

2.1 Variety of methodologies tested

Several international standardisation organisations and industry bodies have established a variety of methodologies to measure and quantify the energy and carbon footprint of ICT products, services and organisations. The Commission has asked, within the scope of this project, to test six methodologies from ITU\textsuperscript{27}, ETSI\textsuperscript{28}, IEC\textsuperscript{29}, and from the Greenhouse Gas Protocol (GHG Protocol)\textsuperscript{30}, see Table 9 below. Additionally to these six methodologies, volunteering companies could test other methodologies as well (like the JRC methodology\textsuperscript{31}, Bilan Carbone\textsuperscript{32}, and an ISO methodology\textsuperscript{33}).

For organisation footprinting any methodology can be chosen to compare with ITU-T L.1420, since only the ITU L.1420 methodology is specifically created for ICT companies.

\textsuperscript{27} ITU (International Telecommunication Union) is the United Nations specialized agency for information and communication technologies – ICTs. ITU standards are called recommendations.

\textsuperscript{28} The European Telecommunications Standards Institute (ETSI) produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies. ETSI is officially recognized by the European Union as a European Standards Organization.

\textsuperscript{29} The International Electrotechnical Commission (IEC) prepares and publishes International Standards for all electrical, electronic and related technologies.

\textsuperscript{30} The GHG Protocol, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) is an international accounting tool for government and business leaders to understand, quantify, and manage greenhouse gas emissions. The GHG Protocol has developed several methodologies that are relevant for this study (see Table 1).

\textsuperscript{31} The Joint Research Centre (JRC) is a Directorate-General of the European Commission and forms its scientific and technical research laboratory. It has developed two relevant methodologies for this study (see Table 1).

\textsuperscript{32} Bilan Carbone is an accounting method for greenhouse gas emissions for any organization, industrial or tertiary companies, public administration, communities or territory that was developed by ADEME. ADEME is a French Environment and Energy Management Agency, a public agency under the joint authority of the Ministry for Ecology, Sustainable Development and Energy and the Ministry for Higher Education and Research.

\textsuperscript{33} The International Organisation for Standardization (ISO) develops international voluntary standards. The standard that was tested in this study is listed in Table 1.
Table 9: Methodologies included in the pilots

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU-T L.1410 Methodology for environmental impacts assessment of ICT goods, networks and services</td>
<td></td>
</tr>
<tr>
<td>ITU-T L.1420 Methodology for environmental impacts assessment of ICT in organisations</td>
<td></td>
</tr>
<tr>
<td>ETSI TS 103 199 Life Cycle Assessment (LCA) of ICT equipment, networks and services: General methodology and common requirements</td>
<td></td>
</tr>
<tr>
<td>GHG Protocol Corporate (Value Chain) Standard Corporate Accounting and Reporting Standard - including the Corporate Value Chain (Scope 3) Standard (not ICT specific)</td>
<td></td>
</tr>
<tr>
<td>IEC/TR 62725 Analysis of quantification methodologies for greenhouse gas emissions for electrical and electronic products and systems</td>
<td></td>
</tr>
<tr>
<td>ISO 14064* International standard to measure, quantify and reduce greenhouse gas emissions of organisations (not ICT specific)</td>
<td></td>
</tr>
<tr>
<td>Bilan Carbone * French accounting methodologies for greenhouse gas emissions of organisations (not ICT specific)</td>
<td></td>
</tr>
<tr>
<td>JRC Product Environmental Footprint Guide * A technical guide for the calculation of the environmental footprint of products (not ICT specific)</td>
<td></td>
</tr>
<tr>
<td>JRC Organisational Environmental Footprint Guide * A technical guide for the calculation of the environmental footprint of organisations (not ICT specific)</td>
<td></td>
</tr>
</tbody>
</table>

* Methodologies with a grey background are outside of the scope of the project but were additionally tested by certain pilots and compared with the methodologies that were part of the original scope.

2.2 Participating companies and organisations
Volunteering ICT companies and organisations have been invited by DG CONNECT to run pilots with a selection of methodologies for footprinting of organisations, products and services. In total, 27 volunteering ICT companies and organisations participated in this project, see list below (3 organisations prefer to stay anonymous). A wide range of corporate activities from within the ICT-sector was represented in the pilots, varying from telecom, software & services, equipment manufacturing and supply to chips and components manufacturing.

- Alcatel-Lucent
- AMD
- AUO
- BT
- Cisco
- Dassault Systèmes
- Dassault Systèmes
- Dell
- EECA-ESIA
- Ericsson
- GSMA
- Hitachi
- HP
- Huawei
- Intel
- Lenovo
- NEC
- Nokia
- Nokia Siemens Networks
- Orange
- Sagemcom
- SAP
- Telecom Italia
- Telefónica
- TeliaSonera

2.3 Project organisation
To ensure that the results in the pilots are based on verified quantitative evidence, the outcomes of all pilots have been validated by third party consultants: BIO Intelligence Service (for ICT Services), Quantis (for ICT Products) and Ecofys (for ICT Organisations) (see figure 1). The third party consultants verified all footprint calculations based on the calculation models and the calculation descriptions, proposed changes and provided verification statements.

![Organisational structure third party verification](image)

Next to regular communication through physical meetings, telephone meetings and e-mail, the horizontal support and coordination has provided a website with a helpdesk facility, frequently asked questions and answers, links to relevant versions of the standards and methodologies, a progress reporting facility, and upload facilities for deliverables: [www.ict-footprint.com](http://www.ict-footprint.com).

2.4 Reporting structure
This final report has been created based on the evaluation reports received from the third parties. These reports are based on the input from the volunteering ICT companies.

The volunteering companies have been asked to provide the following information to the third parties:
- An audit report (based on a template provided by horizontal support and coordination);
- Pilot calculations (in the form of an Microsoft Excel tool or other);
- Calculations description (in the form of a Microsoft Word file or other).

The audit report consists of the following information:
- Information about the compatibility of the methodologies being tested:
  - Check if they deliver results within a reasonable margin of error or uncertainty;
  - Check coherency of metrics, data, scope, and boundaries;
- Information about the workability of the methodologies being tested:
Check on items like robustness, reliability, cost efficiency and practical implementation;

- Other conclusions;
- Useful information and feedback for the Standards Development Organisations (SDOs);
- Input for EC policy.

The third party consultants have created evaluation reports for ICT footprinting of organisations, products and services, based on the information provided in the audit reports and other observations during the coordination of the pilots. In addition, the third party consultancies have validated the calculations made by the volunteering companies based on the information provided by the volunteering companies. In this report the third parties have included only information from pilots that could be validated, based on the submitted calculation models and calculation descriptions. The validation statements can be found in annex 1.

The described reporting structure is summarised in Figure 2.

Figure 2: Reporting structure

2.5 Execution of pilots

In two rounds, with an overall time span of 10 months (December 2011 – September 2012), the 27 ICT companies have executed a total of 18 pilot tests of the various methodologies. In each pilot at least two methodologies were tested by the volunteering companies. Table 10 shows an overview of the methodologies tested within this project per type of pilot (organisations, products and services).
Table 10: Methodologies tested for organisation, product and service carbon footprinting

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Organisation</th>
<th>Product</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITU-T L.1410</td>
<td></td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>ITU-T L.1420</td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>ETSI TS 103 199</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>GHG Protocol Corporate (Value Chain) Standard</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>IEC/TR 62725</td>
<td></td>
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<tr>
<td>ISO 14064</td>
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<td></td>
<td></td>
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<tr>
<td>Bilan Carbone</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JRC Product Environmental Footprint Guide</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>JRC Organisational Environmental Footprint Guide</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.6 Limitations of the pilot process

- It should be noted that the results are based on a limited number of pilots. Although the third parties expect that the conclusions are applicable in general, it is important to keep in mind that they are derived from exercises with specific pilot circumstances.
- In this parallel testing process, it is challenging to judge whether the application of each of the methodologies would really be the same if they were implemented as stand-alone assessments. In other words, pilot practitioners obviously have to start the testing with one of the methodologies. They may tend to build the basis and modelling of the analysis from the more stringent methodology or from the one they are the most familiar with. The guidance contained in this particular methodology may favour one particular approach or calculation model, which may afterwards be adapted or re-used for the other methodologies (understandably for the sake of resource efficiency). Because of this unavoidable limitation, the comparisons of time estimations required to complete the LCA should also be considered with caution.
3 Overview of pilots undertaken

The following pilots have been undertaken in Round 1 and 2 (see Table 11).

Table 11: Overview of the pilots

<table>
<thead>
<tr>
<th>Round</th>
<th>Pilots Applicant</th>
<th>Pilot Methodologies</th>
<th>Pilot Scope</th>
<th>Object tested</th>
<th>Objective</th>
<th>Type</th>
<th>Third party consultant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hitachi</td>
<td>- IEC/TR 62725</td>
<td>Product</td>
<td>IT Storage equipment</td>
<td>2</td>
<td>Single Company</td>
<td>Quantis</td>
</tr>
<tr>
<td>1</td>
<td>Anonymous</td>
<td>- IEC/TR 62725</td>
<td>Product</td>
<td>Smartphone, Notebook</td>
<td>1</td>
<td>Single Company</td>
<td>Quantis</td>
</tr>
<tr>
<td>1</td>
<td>NEC</td>
<td>- ETSI TS 103 199</td>
<td>Product</td>
<td>Server</td>
<td>2</td>
<td>Single Company</td>
<td>Quantis</td>
</tr>
<tr>
<td>1</td>
<td>Anonymous</td>
<td>- IEC/TR 62725</td>
<td>Product</td>
<td>Network security camera</td>
<td>1</td>
<td>Single Company</td>
<td>Quantis</td>
</tr>
<tr>
<td>1</td>
<td>Consortium leader</td>
<td>- IEC/TR 62725</td>
<td>Product</td>
<td>Notebook</td>
<td></td>
<td>Consortium</td>
<td>Quantis</td>
</tr>
<tr>
<td></td>
<td>HP</td>
<td>- ITU-T L.1410</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Dell</td>
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<tr>
<td></td>
<td>Lenovo</td>
<td></td>
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<tr>
<td></td>
<td>AMD</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>AU Optronics (Taiwan)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>ESIA</td>
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<tr>
<td></td>
<td>Intel</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Orange</td>
<td>- ITU-T L.1420</td>
<td>Organisation</td>
<td>Telecom activities in metropolitan France, with an operational approach</td>
<td>1</td>
<td>Single Company</td>
<td>Ecofys</td>
</tr>
<tr>
<td>1</td>
<td>Nokia Siemens Networks</td>
<td>- ITU-T L.1420</td>
<td>Organisation</td>
<td>Global operations of all NSN units with an operational approach</td>
<td>1</td>
<td>Single Company</td>
<td>Ecofys</td>
</tr>
<tr>
<td></td>
<td>Alcatel-Lucent</td>
<td>- ETSI TS 103 199</td>
<td>Service</td>
<td>End-to-end broadband</td>
<td>1</td>
<td>ABC Consortium</td>
<td>Bio Intelligence Service</td>
</tr>
<tr>
<td></td>
<td>Cisco</td>
<td>- ITU-T L.1410</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- GHG Protocol (incl. Scope 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- JRC</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>- ITU-T L.1410</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>- GHG P (ICT-sector Guidance on Telecommunications and Network Services)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Ericsson</td>
<td>- ETSI TS 103 199</td>
<td>Product, Organisation, Service</td>
<td>Mobile phone, a telecom network and a telecom service</td>
<td>1</td>
<td>TENNG Consortium</td>
<td>Ecofys / Quantis</td>
</tr>
<tr>
<td></td>
<td>Nokia Siemens Networks</td>
<td>- ITU-T L.1410</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nokia</td>
<td>- IEC/TR 62725</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Telia Sonera</td>
<td>- GHG P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Round</td>
<td>Pilote Applicant</td>
<td>Pilot Methodologies</td>
<td>Pilot Scope</td>
<td>Object tested</td>
<td>Objective</td>
<td>Type</td>
<td>Third party consultant</td>
</tr>
<tr>
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<td>------------------------</td>
</tr>
<tr>
<td>2 Huawei Orange Telecom Italia</td>
<td>- ITU-T L.1410  - GHG P  - IEC/TR 62725</td>
<td>Product</td>
<td>Smartphone</td>
<td>1</td>
<td>ORAHU Consortium</td>
<td>Quantis</td>
<td></td>
</tr>
<tr>
<td>2 Telefonica</td>
<td>- ITU-T L.1420  - GHG Protocol (excl. Scope 3)  - ISO 14064</td>
<td>Organisation</td>
<td>All operations in countries with operational control</td>
<td>Single Company</td>
<td>Ecofys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Dassault Systèmes</td>
<td>- ITU-T L.1420  - GHG Protocol (incl. Scope 3)</td>
<td>Organisation</td>
<td>All countries &amp; business units with financial control</td>
<td>Single Company</td>
<td>Ecofys</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 France Télécom Orange</td>
<td>- ETSI TS 103 199  - ITU-T L.1410</td>
<td>Service</td>
<td>Cloud hosting service</td>
<td>Single Company</td>
<td>Bio Intelligence Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 SAGEMCOM SAS Orange</td>
<td>- ETSI TS 103 199  - ITU-T L.1410</td>
<td>Service</td>
<td>Video on demand</td>
<td>Orange/Sagemcom Consortium</td>
<td>Bio Intelligence Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 BT</td>
<td>- ITU-T L.1420  - GHG Protocol (incl. Scope 3)</td>
<td>Organisation</td>
<td>All countries with significant business presence and with a “hybrid” control approach (based on operational control)</td>
<td>Single Company</td>
<td>Ecofys</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4 Compatibility and workability of Organisation footprint methodologies

4.1 Main results of pilots on Organisation footprint methodologies

Within the pilots on organisation footprinting the following methodologies were tested. The main results are presented in Table 12 and elaborated further in the subsequent paragraphs.

| Table 12: Compatibility and workability of Organisation footprint methodologies |
|---------------------------|---------------------------|---------------------------|-----------------------------|---------------------------|
| Aspect                    | GHG Protocol (original list) | ITU-T L.1420 (original list) | ISO 14064 (additional) | Bilan Carbone (additional) | JRC (additional) |
|---------------------------|---------------------------|---------------------------|-----------------------------|---------------------------|
| Number of pilot tests     | 7                         | 6                         | 1                           | 1                         | 2               |
| Compatibility             | Focus on Kyoto GHGs       | Focus on Kyoto GHGs and energy consumption | Focus on Kyoto GHGs | Covers more types of GHGs | Covers more environmental impacts |
|                           | Defines three scopes for GHG accounting | Viewed as an ICT specific extension of the GHG Protocol | Generic framework with less (strict) calculation rules | Defines 9 main emission categories (no scopes) |
|                           | GHG Emissions of capital goods, and purchased goods/services included in the year of purchase | GHG Emissions of capital goods, and purchased goods/services depreciated over the lifetime | “Other indirect emissions” (scope 3) are optional | Includes a specific emission factor database |
| Workability               | Workable                  | Workable                  | Workable                    | Workable                  | Views of 2 pilots on workability differ |
|                           | Extended calculation guidance | Limited calculation guidance | Limited calculation guidance | Choice for emission factors supported through own database | Higher level of detail and complexity |
|                           | High demands for completeness | Flexible demands for completeness |                      |                           | Good quality rating scheme |
| Overall                   | All of the methodologies tested provided comparable footprint results for the total emissions, except for the emissions of capital goods and purchased goods and services | All methodologies require considerable investments in knowledge, time, staff and money (see also Table 13 below) | The collection of high quality activity data, and emission factors is the most time consuming part of the footprinting process (independent of the methodology) |

38 Note: The results for Bilan Carbone and ISO 14064 are based on one pilot test and therefore might be related to these specific pilot circumstances.
4.2 Compatibility of Organisation footprint methodologies

Under the specific conditions that were applicable within pilots performed in this project the main pilot outcomes on the compatibility of the organisation footprint methodologies are:

• Overall it can be stated that the tested methodologies provided comparable final organisation footprint results for most of the emissions categories calculated. There is one important exception however. This exception is caused by the different way of accounting for the emissions of capital goods and purchased goods and services. The differences in the final organisation footprint results due to this difference vary from 2% to even 17.5% of the total footprint for one pilot participant;\(^\text{39}\)

• Besides the exception above, the variation within the other emission categories (and thus the total footprint) is much smaller and often even zero. Only the pilot testing Bilan Carbon reported a 7% difference for the total footprint, which was mainly caused by the additional GHGs included in this methodology and the use of different emission factors;

• Most pilots noticed that the emission factors and the activity data (and not the methodology that is used) are eventually the greatest source for variation in the outcomes of the calculation.

As the GHG Protocol Corporate (Value Chain) Standard and the ITU-T L.1420 were the two methodologies selected by the Commission to be part of this pilot project, these two methodologies were therefore tested by most pilots (7 and 6 respectively). The conclusions on the compatibility of these methodologies are:

• Under the conditions of the pilots performed, the GHG Protocol Corporate Standard (including Scope 3) and the ITU-T L.1420 were found to be well aligned and therefore considered to be compatible within these pilots;

• The methodologies use the same emission categories (Scope 1, 2 and 3, and scope 3 with the same 15 categories);

• Furthermore the ITU-T L.1420 methodology was viewed as an extension of the GHG Protocol specifically tailored to the ICT-sector by the pilots. Three pilots additionally judged that the ITU-T L.1420 would benefit from being applied together with the more detailed calculation guidance provided by the GHG protocol. They judge the guidance of ITU-T L.1420 to be too limited to perform the calculations. However, one pilot judged that ITU-T L.1420 can be applied independently from the GHG Protocol;

• The biggest differences between the GHG-Protocol and the ITU-T L.1420 noted within the pilots are:
  o The difference in accounting for ‘capital goods’ and ‘purchased goods and services’. This was actually the main reason behind any differences in the absolute amount of CO\(_2\) emissions between the methodologies:

\(^{39}\) It should however be noted that this difference is expected to decline over time. The main difference was caused by a different way of accounting for purchased (capital) goods and services (depreciation or not: see explanation on next pages). As this was the first time the pilots calculated the emissions with the “depreciation” method, the depreciated emissions of goods and services purchased in earlier years were not reported yet. If these are taken into account in future years the difference between the methodologies will become smaller. The final difference will then be determined by the fluctuation of purchased (capital) goods and services over the years. If these are stable the difference will be small. If the amount of purchases differs a lot over the years, the difference between the two accounting methods will be large.
ITU-T L.1420 requires these emissions to be divided by the operational lifetime (depreciation);
The GHG Protocol requires to account for the full life cycle emissions in the year of purchase;
This difference is particularly large when capital goods or purchases account for a large part of the total footprint and when investments fluctuate over time.

- The fact that the impact from all buildings used (owned or rented) by the organisation have to be included in the ITU-T L.1420 independent of the consolidation approach (equity or control approach). In the GHG protocol the inclusion differs depending on the consolidation approach;
- The fact that the reporting categories 'waste' and 'investments' are optional in the ITU-T L.1420 methodology, but not in the GHG Protocol;
- The larger flexibility of ITU-T L.1420 to exclude categories for reporting (only the most relevant have to be included);
- The larger emphasis/focus within ITU-T L.1420 on calculating the energy consumption for an ICT organisation.

The one pilot testing the Bilan Carbone standard concluded that this methodology differs from the ITU-T L.1420 and GHG Protocol standard mainly with regards to how emissions are categorised (instead of the division into three scopes, Bilan Carbon uses the following main categories: Energy, Process, Purchasing, Freight, Travel, Waste, Capital asset, Use, End of Life), the inclusion of all (also non Kyoto) GHGs in office buildings, and its use of a specific (ADEME) database for (different) emission factors. Besides these differences, the final results were judged to be quite compatible under the conditions that were applicable within this pilot.

The one pilot testing the ISO 14064 standard concluded that the main difference of this methodology versus the others is the fact that the category “other indirect emissions” (scope 3) is optional. Furthermore ISO gives a generic framework but the guidance of this protocol is very limited, leaving the practitioner a lot of room for determining the calculation methods. It therefore allows a practitioner to make the methodology compatible with most others. Because of that fact, this methodology is fundamentally compatible with the other ones, which often also use ISO 14064 as a basis.

Under the conditions that were applicable within the two pilots testing the JRC methodology it can be concluded that:
- The JRC differs from the ITU-T L.1420 and the GHG Protocol for the following reasons:
  - It is aimed at broader environmental impacts than energy and carbon alone, including 14 environmental impact categories;
  - The categorisation of carbon emissions is different from the other methodologies. The JRC has chosen to subdivide the emissions into emissions related to direct activities and indirectly attributable activities instead of the three scopes (as the GHG protocol, ITU-T L.1420, and ISO 14046 do);
Instead of separating scopes and general reporting categories on a company level, the JRC also requires an allocation of all life cycle emissions to products. This allocation approach was judged by the pilots testing the methodology as rather complex. A separation in three scopes was preferred;

- There are differences in the way emission data and characterization/emission factors (like energy profiles) need to be selected. The JRC provides an own set of characterisation factors to be used, and provides a specific hierarchy for LCI databases to be used for generic emission data. This hierarchy puts commonly used commercial/property databases such as EcoInvent or the databases from EIME/Gabi at a relatively low level (after public databases);

- Emissions for purchased capital goods need to be depreciated (same as with ITU-T L.1420, but different as with the GHG Protocol).

- Despite these differences the overall (total) calculation results for CO\textsubscript{2} emissions were in line with each other.

- The opinion of the two pilots about the compatibility was rather different:
  - One pilot judged the JRC methodology as too complex, and advised harmonisation with the GHG protocol;
  - The other pilot however had a preference for the JRC methodology because it goes beyond the scope of the others with regard to completeness and data quality rating. This is, in their opinion, the right approach to build on already existing methodologies and leverage their experience. They do however also propose a “scope based” reporting opposed to allocating the emissions to the products.

Furthermore several specific conclusions and suggestions were drawn from the separate pilots, which are worthwhile to mention here as well:

- Energy consumption during the use phase of sold products can be calculated based on either:
  1. Energy consumption of the entire lifetime of all products sold in the reporting year or;
  2. Annual consumption of products in use in the market during a specific year.

It was noted by two pilots that option 2 would be unfeasibly complex. Therefore option 1 is preferred, even though this means reporting emissions that will occur in the future (and hence a discrepancy in the timeline between the emission categories), and significant uncertainties for infrastructure products which often have a typical lifetime of greater than 10 years;

- Similar issues were encountered by another pilot for the end of life emissions calculation for sold products, with an added challenge that the actual recycling rate depends on the available technologies and recycling facilities\textsuperscript{40}:
  - According to ITU-T L.1420 the end of life (EoL) treatment of waste generated during operation and EoL of sold products shall be reported without further detail;
  - The GHG Protocol Corporate Value Chain Standard requires EoL reporting during the year the product is sold. In the view of this pilot this conflicts with the reporting timeframe (as this means reporting of emissions occurring in the future), and is based on estimates. The basic principle of the GHG Protocol is to account for all activities of the company during

\textsuperscript{40} It should be noted here that emissions from EoL are often a minor fraction of the total emissions.
the reporting year. However, EoL activities occurring during the year of reporting are not included. This avoids double accounting of EoL activities but increases the uncertainty of the results significantly.

• It was suggested by one pilot that a common methodology must be developed with regard to the use and purchase of sold products by customers. I.e. can or should a telecom operator with no stores report zero emissions for the retail and/or use phase of their mobile phones?

4.3 Workability of Organisation footprint methodologies
Under the specific conditions that were applicable within pilots performed in this project, the main pilot outcomes regarding workability of the organisation footprint methodologies are:

• The methodologies tested within this project are considered workable by all the pilots. Only the views of the two pilots testing the JRC methodology differed (see more details below).

• The presence of detailed calculation guidance, or guidance on the use of emission factors is mentioned by the ICT companies to be very important for the workability of a methodology.

• For all methodologies the workability was judged to be lower for scope 3 emissions (then for scope 1 and 2). The availability of good quality activity data and emission factors was often a problem. In many cases this led to the fact that calculations had to be based on secondary data and very general emission factors (like emissions per € spent). Therefore most pilots noted that the uncertainty of the outcome of the scope 3 calculations is generally higher and therefore the data quality and reliability lower. The inclusion of a good “data quality policy” in a methodology, which enables the reader to assess the quality of and uncertainty behind the numbers reported, was therefore also appreciated by the pilots;

• This lack of good quality data often leads to the choice for financial activity data combined with environmentally extended input-output emission factors. The unwanted side effect of this choice is however that companies can use these type of data only for determining the estimated impact of their activities, but not to actively steer and reduce their emissions and these actions will not reflect in the activity data nor the emission factors;

• The category “Use of sold products” was noted by multiple pilots as being the most difficult one to calculate. It was recommended to set up more specific calculation guidance for this subject (e.g. including examples).

Considering the allocated time and resources to carry out the different methodologies the following conclusions can be drawn:

• All methodologies require a considerable amount of investment in time and staff. The data collection stage, in particular, is most time consuming (rather than the calculation stage). This includes the collection of activity data and the search for good emission factors, especially for scope 3. The amounts reported however vary widely between the pilots in this project. Table 13 below summarizes the approximate numbers that were reported by the different pilots.

• The level of knowledge available in the pilot companies to carry out the different methodologies differs from one to another. Most companies within these pilots have already built up extensive knowledge on this subject in the past years, but others are still in a learning process.
Furthermore several companies need to hire external expertise, and all need to invest a lot of time in knowledge development.

Table 13: Workability of Organisation footprint methodologies based on pilot audit reports

<table>
<thead>
<tr>
<th>Items</th>
<th>Pilot’s answers (range)</th>
<th>Interpretation of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of staff involved to carry out the</td>
<td>Out of 7 companies:</td>
<td>The dispersion of results can be explained by:</td>
</tr>
<tr>
<td>methodology</td>
<td>• 4 companies mention 1-5 FTE;</td>
<td>- The scope of the footprint (full supply chain, or only a part)</td>
</tr>
<tr>
<td></td>
<td>• 1 company mentions 7.5 FTE;</td>
<td>- The budget available</td>
</tr>
<tr>
<td></td>
<td>• 2 companies mention 10-30 staff members (not full time);</td>
<td>- The availability of specialized staff, or the need to hire external consultants</td>
</tr>
<tr>
<td></td>
<td>In addition, from the total of 7 companies,</td>
<td>- The internal knowledge/background in LCA</td>
</tr>
<tr>
<td></td>
<td>4 companies mention to have 10-30 non-full timers working on data collection</td>
<td>- The size and complexity of the organisation</td>
</tr>
<tr>
<td></td>
<td>throughout the company on average.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional out of pocket costs involved to</td>
<td>Out of 7 companies:</td>
<td></td>
</tr>
<tr>
<td>carry out the methodology (when starting</td>
<td>• 4 companies mention 200-500 k Euros per year;</td>
<td>- The scope of the footprint (full supply chain, or only a part)</td>
</tr>
<tr>
<td>from scratch)</td>
<td>• 1 company mentions 0 k out of pocket costs;</td>
<td>- The budget available</td>
</tr>
<tr>
<td></td>
<td>• 2 companies are confidential/did not provide data</td>
<td>- The availability of specialized staff, or the need to hire external consultants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The internal knowledge/background in LCA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The size and complexity of the organisation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amount of time involved to carry out the</td>
<td>1 month-3 years</td>
<td></td>
</tr>
<tr>
<td>methodology if you were to start from</td>
<td></td>
<td></td>
</tr>
<tr>
<td>scratch</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The two most investigated methodologies, ITU-T L.1420 and the GHG Protocol, are both perceived as relevant and workable methodologies by the different pilots, although there are differences between the pilots performed. Below the main workability differences between the methodologies are highlighted:

- The more detailed calculation guidance of the GHG Protocol was valued positive by the pilots testing it. The guidance and background information presented in ITU-T L.1420 is generally seen as more limited. Furthermore it is noticed by three pilots that for this reason the ITU-T L.1420 methodology should (only) be used in combination with the GHG Protocol (guidance) and should be seen as an ICT specific extension of this protocol. Other pilots, however, judged that the ITU-T L.1420 methodology is usable by itself;

- The GHG Protocol is a general methodology dedicated to all sectors. The ITU-T L.1420 however provides specific rules for the ICT-sector and the use of ICT in all other sectors, and is therefore more tailor-made for this sector;

- The difference in accounting for capital goods and purchased goods and services was highlighted before (depreciation versus all emissions in the year of purchase). Most (3) pilots argued that the choice for the depreciation method was not positive for the workability of a methodology, as it makes the calculations more complex. One pilot however judged it as more workable as it had a better fit with their financial accounting system;
• ITU-T L.1420 leaves the most freedom for "cut off" and the choice for practical methodological and calculation approaches. Some scope 3 categories are even "optional". For the GHG Protocol the demands for completeness are higher;
• Because of its long existence the GHG protocol is already commonly used and widely accepted across the world.

The Bilan Carbone methodology developed by ADEME and the ISO 14064 standard were both tested in only one pilot (each). Both methodologies were perceived as relevant, workable methodologies by the pilots testing them. An advantage of Bilan Carbone is the associated (ADEME) emission factor database, as it can save companies a lot of time in finding good quality emission factors (especially for France). An advantage of the use of the ISO 14064 standard is its (international) importance for verification processes and a disadvantage is that it does not contain a categorisation or instruction about scope 3 emissions.

The JRC methodology was tested within 2 pilots and the opinions about workability showed a mixed result. Both pilots noted that the additional insight in the other environmental impact categories provided an interesting additional insight for stakeholders. But furthermore:
• One pilot perceived it as reasonably workable, but less than the other methodologies. This is largely because of its different approach towards the categorisation of emissions, the level of detail requested, and the increased complexity introduced with its life cycle and product allocation approach. The pilot would prefer if the JRC used the same three scopes categorisation approach as used by the GHG Protocol, ITU-T L.1420, and ISO 14064;
• The other pilot however concluded that they deemed the JRC Methodology as the most workable methodology. With a slightly clearer focus and definition the methodology would be the optimum in terms of workability and completeness. The inclusion of other environmental impacts was seen as an advantage. A great benefit is also attributed to the data quality rating that allows you to better interpret the data and hence better manage the different KPIs. Also two points of improvement for the workability of the JRC methodology were mentioned:
  o The depreciation method for emissions of capital goods is not practical from a traceability perspective, due to the number of different assets or asset categories;
  o The recommendation to allocate the emissions to the different products will not be possible due to confidentiality, and other practical issues.

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41 It was noted by the pilot that three scope separation was preferred because:
1. In the JRC definition of "Directly attributable emissions", a company is asked to add up very accurate data (scope 1 and scope 2 emissions) and inaccurate data (for some scope 3 activities like employee commuting). The addition of this inaccurate information causes damage to the quality (uncertainty) of the ‘directly attributable emissions’.
2. Due to the somehow unclear definition of the JRC with regards to what belongs under direct and indirectly attributable activities a risk of double counting of emissions between companies exists. It is possible that different companies report the same emissions, which would lead to double counting when the emissions would be aggregated to sector level.
5 Compatibility and workability of Product footprint methodologies

5.1 Main results of pilots on Product footprint methodologies

Regarding product footprinting, the main results are included in Table 14.

Table 14: Compatibility and workability of product footprint methodologies

<table>
<thead>
<tr>
<th>Aspect</th>
<th>GHG Product Standard / ICT-sector Guidance (original list)</th>
<th>ETSI TS 103 199 (original list)</th>
<th>ITU-T L.1410 (original list)</th>
<th>IEC TR 62725 (original list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pilots tested</td>
<td>5</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>
| Compatibility     | • No inherent differences between GHG Product Standard / ICT-sector Guidance, ETSI, ITU-T and IEC, allowing same conditions, assumptions, boundaries, etc.  
                       • All methodologies provided comparable final footprint results for total emissions when the same practitioner tested methodologies with the same software tool, same databases and same primary data  
                       • All the methodologies are rather general framework standards and mostly in line with each other as well as with the ISO 14040/44 standard  
                       • ITU-T focuses on GHG emissions and energy consumption, whereas ETSI covers more environmental impact categories. The GHG Product Standard is limited to GHG emissions only  
                       • ETSI puts stricter methodological requirements, which leads to less deviation in calculation outcomes between studies, when compared with other methodologies  
                       • ITU-T and IEC leave a certain degree of freedom regarding application of the requirements on several accounts |
| Workability       | • GHG Product Standard / ICT-sector Guidance, ETSI, ITU-T and IEC were considered not to differ significantly regarding workability |
| Overall           | • No inherent differences between methodologies regarding compatibility or workability when applied under identical conditions (database, assumptions, boundaries, etc.) |

5.2 Compatibility of Product footprint methodologies

These are the main pilot outcomes on compatibility of methodologies for product footprinting:

• All the methodologies tested provided comparable final footprint results for the total emissions when it was the same practitioner who tested methodologies with the same software tool, same databases (same emission factors) and same primary data (distance and means of transportation, electric mix, metrics and hypotheses). The impacts of assumptions, different Life Cycle Assessment (LCA) software tools, Life Cycle Impact Assessment (LCIA) methods, Life Cycle Inventory (LCI) databases and scenarios when assessing GHG impacts on the product level all cause variations in results. The methodologies which are intended to set a framework for LCAs, allowing for many different kinds of studies, inherently allow a lot of freedom for the footprint
practitioner regarding methodological choices. This allows large variations in results between studies performed by different practitioners independent of the used methodology;

- In fact, there are no fundamental differences between the methodologies. All methodologies are based on the methodology of life cycle assessment (LCA) as specified in ISO 14040 and ISO 14044. Some methodologies, however, leave a certain degree of freedom on several counts (e.g. approaches regarding end-of-life, allocation rules, uncertainty analysis, data gathering, etc.) such that it would be possible to generate quite different results (nominally about the same product) between the two methods while still being "compliant" with the methodologies. More precisely, if two persons perform an LCA on the same product using two different methodologies, their methodological choices will be conditioned by the working habits of the person, his beliefs and his subjectivity, thereby leading to possibly different results while still being compliant with the respective methodologies. Not only this, freedom may result in possible differences between the methodologies for a given product, but also two distinct practitioners may end up with different results for the same product even when using the same methodology. In other words, the methodologies are consistent with each other but offer a range of options to the practitioners (in particular, the choice of environmental factors for example);

- The methodologies always provided very similar and comparable final footprint results (with a maximum deviation of 2-3% between methodologies in the "worst" case) for total emissions when the same practitioner tested the methodologies with the same piece of software, same approach, same databases and same primary data. In that case, the differences in the results are small compared to the total footprint and are caused by:
  - the guidance and optional approaches offered to assist the LCA practitioner;
  - the possibilities for modelling the system (life cycle approach);
  - the data quality requirements.

The uncertainty, calculated in one pilot, was estimated to be of the order of ±20%. Uncertainty within LCA is a widespread issue that is not feasible to eliminate entirely; therefore, it is important that methodologies provide a structural mechanism to account for and minimize uncertainty in the areas with the highest impact (i.e., emissions source "hotspots");

- The GHG Protocol Product Standard is aligned with methodologies developed by SDOs. One chapter is dedicated to software, thereby providing a very useful way for software carbon footprinting based on a full life cycle assessment approach (note that this chapter covers only the use stage of software, and does not cover the full life cycle of software). The GHG Protocol Product Standard does not provide deep guidance so far for detailed LCA studies of ICT equipment compared to ETSI TS 103 199 or ITU-T L.1410 (e.g. for the data collection of ICT equipment). Moreover, distribution and storage are defined as one separate life cycle stage, whereas other methodologies make a distinction between the two. The effect is that the same information will be structured differently between the methodologies, although the activities/stages are included in all of them. Elements of the guideline are oriented towards target setting and similar issues, i.e. the guideline does not only address how to assess GHG emissions but is also oriented towards GHG management;

- The ETSI TS 103 199 methodology is applicable to various environmental indicators (not only global warming potential). This methodology puts stricter requirements in place (e.g. "shall")
instead of “should”) which leads to less deviation between outcomes of studies using this methodology compared with studies using other methodologies. The ETSI TS 103 199 methodology gives more details of LCA for ICT Equipment than LCA for Networks and Services. The ETSI TS 103 199 covers all type of ICTs but does not have separate requirements of different ICT Equipment, i.e. ETSI requirements are the same on an LCA for an end-user product and an LCA for a Network Equipment or a Data Centre equipment. For some aspects (classification and description of life cycle stages), the requirements or recommendations for the assessment of ICT equipment are not completely suitable for end-user products, but could be suitable for analyses of ICT equipment, which are then used as part of further assessments (networks and services). The main difficulty lies with the study boundaries prescribed by the ETSI TS 103 199 methodology, namely the mandatory inclusion of the upstream raw material extraction & processing and equipment parts production & processing life cycle stages;

• The IEC/TR 62725 is not a methodology which describes requirements as such but it’s rather a technical report (TR) which evaluates existing methodologies, especially ISO 14067; it also provides some additional observations and guidance for the electro-technical sector. It provides the LCA practitioners with the minimum requirements for performing an LCA on ICT products. The generic information and guidance which cover the whole electrical and electronic equipment (EEE) product are provided. As the document is a TR and is still in a draft form, more precise conclusions cannot be drawn with respect to compatibility with respect to ITU-T L.1410 and ETSI TS 103 199, but at a high level IEC/TR 62725, seems quite well aligned with other methodologies at this stage;

• The ITU-T L.1410 methodology is detailed regarding software development and system description. ITU-T L.1410 offers a great deal of useful guidance on what to include in and exclude from the study. More guidance, however, is recommended on allocation rules, uncertainty analysis, and use phase assumptions. ITU-T also provides a dedicated Part (part II) for comparative analysis between a reference system and the corresponding ICT system. This was however not tested during the pilots;

• With respect to providing a framework for assessment of ICT product systems in terms of system boundary setting, definition of unit processes and data quality, the ETSI TS 103 199, ITU-T L.1410 and GHG Protocol Product Standard methodologies contain the most detailed requirements. By doing so, they provide a number of necessary conditions for comparison, but in spite of that, implementation of these methodologies does not provide sufficient restrictions to grant comparability between product LCAs. Such comparability was not the intention of these methodologies, but instead the intention was to ensure a high-quality, transparent assessment. A difference in perspective between the two is that ETSI TS 103 199, to a larger extent, seems to address the practitioners, while ITU-T L.1410 rather addresses both the organisations and the practitioners, i.e. it gives a bit more background information;

• All the methodologies are rather general framework standards and mostly in line with each other as well as with the ISO 14040/44. As such and without Product Category Rules (PCR), none of them is detailed enough to ensure repeatable and comparable results for product LCAs (if using the same database, hypotheses, approach, pieces of software, etc.). The methodologies don’t give reference to PCRs. The use of PCRs which could be developed in the future is not reflected enough in the methodologies;
• The general requirements for allocation do not differ between the methodologies. Overall, the guidelines on allocation are not sufficient to ensure equivalent treatment of data. Allocation rules remain unclear in the methodologies, which can lead to any number of unexpected outcomes;

• For all methodologies, any discussion of primary data needs much more specificity regarding data collection processes, allocation rules, etc. Two LCA practitioners collecting primary data at the same facility can end up with two drastically different data-sets, depending on the approach and allocation rules applied. If more primary data are to be gathered within the supply chain, methodologies should develop more detailed and specific rules on which allocation rules should preferably apply to particular kinds of facilities/production portfolios/product characteristics. If volunteering companies are expected to report on supply chain PCF in a consistent way, methodologies need to outline the characteristics of a facility(ies) that determine when it is appropriate to allocate by area, cost, piece, number of contact points, performance metrics, etc. Pilots believe it is not a correct approach to gather primary data from upstream because very few suppliers can reply. In addition to that, the EEE industry features world-wide markets, long and complicated supply chains, huge number of components for each product, etc., so it should be taken into account that a rational data gathering rule must be made. Concerning the use stage, actual usage patterns for some products are not known at product launch and are never precisely known due to lack of good customer use data. Also, the distribution of products geographically, which can have a big impact in the use stage of a product, would also not be known at product launch. So, pilots need to have more specifications or guidance for use stage scenarios. Some pilots refer to Energy Star methodologies and/or public use patterns, in order to be transparent regarding the use stage.

5.3 Workability of Product footprint methodologies

These are the main outcomes:

• The IEC/TR 62725, ITU-T L.1410, ETSI TS 103 199 and GHG Protocol Product Standard methodologies do not differ too much in terms of workability;

• The bulk of the effort in applying these methodologies is in the data collection including soliciting, analysing and clarifying data while the rest is spent on disassembly, modelling and writing the reports. The methodologies don’t appear to significantly affect the effort related to those activities. Some software pilots think that the requirements of the GHG Protocol Product Standard to include upstream emissions for hardware manufacture and raw materials processing are not relevant to their sustainability priorities and influences;

• It should be remembered that doing LCAs in general requires specialist competence. To perform a PCF study from scratch, a lot of preparatory work and time would be needed to become familiar with the methodologies. Additionally, the person conducting the analysis would need support from other departments (product design, in-house manufacturing, purchasing, etc.) to obtain data on manufacturing and the supply chain. A major limitation would be the data gathering. To get specific data from suppliers and in-house measurements is difficult and time consuming, while professional databases with applicable and relevant secondary data are costly. A generic regularly updated database with reliable data should be available for free for use by the ICT industry;
One-off product carbon footprints (PCFs) are extremely time consuming and costly and for companies that have large amounts of products, it is unrealistic to perform PCFs for all their products. The number of staff involved to perform the LCAs varies from 1 to 10 regarding the products being tested. In addition, these numbers presumably exclude the staff involved in data collection externally (e.g. on the suppliers’ side). Moreover, this number of staff depends on the complexity of the product tested, the budget available dedicated to this approach, the company policy, etc.;

The costs of conducting the methodology depend heavily on the complexity of the object studied and the processes within the company. Starting from scratch requires the hiring of an LCA expert, purchase of tools, hardware and databases, training and establishing internal links, and a collection process of product specific data. For ICT products which are typically very complex, the costs are in the order of €25 000 - €500 000. These costs are variable because it depends on if it is an effort to set up the activity or if it is a yearly effort;

The amount of time involved to carry out the methodology in case pilots were starting from scratch is provided by most of pilots questioned. The time reported, however, is highly variable (from 20 days to 120 days) because it depends on the complexity of the product and varies in terms of scope (e.g. including data collection performed externally, on the suppliers’ side, or not, internal training, implementation of carbon footprint model);

Most pilots would be uncomfortable using the tested LCAs for eco-design. In fact, data may not be detailed and realistic enough to reflect changes in the product design and PCF analyses only reflect the effect on climate change. So, other environmental impacts are not analysed and positive design changes regarding the PCF may result in negative changes regarding other impact categories. PCF could be used more efficiently in terms of eco-design if methodologies were more detailed about the amount and quality of data which can be obtained from suppliers and in house processes;

LCA, however, can be used as an indicator to develop products and production processes and improve their environmental performance and can be very useful to understand system environmental challenges;

Most pilot participants would be uncomfortable using the tested methodologies for public procurement, agreeing that the methodologies are not appropriate for comparing and/or differentiating products (e.g. given the degree of freedom that is allowed for the LCA practitioner, possibly resulting in significant deviations in the results). Moreover, in methodologies, there are no specifications for use stage scenarios which would allow comparable assumptions. For procurement decisions, it is essential that the use stage is represented in the same way for different products. To summarise, methodologies are quite exhaustive and provide a good baseline to understand the most significant challenges of a given system, but they cannot be used as a tool to differentiate products with the same function based on their environmental performance;

Most pilot participants would be uncomfortable using the tested methodologies for energy, one of the reasons being the lack (in all methodologies) of precise use stage scenarios per type of products (such as those defined for the Energy Star label for instance). Since products relating to reduction of energy consumption during use are already being addresses in the ErP directive, the
scope of using CFP could exclude the scope which is subject to the ErP to avoid consumer confusion;

- Software tools (used by the LCA practitioner) could be a limit for the application of the tested methodologies as they are not fully compatible with the proposed methodologies that promote the use of a particular software tool. In some cases, LCA software cannot distinguish raw material acquisition from production stages impact because of software architecture, which may be incompatible with the structure (in terms of life cycle stages) imposed by some methodologies. The same is valid for end-of-life allocation rules which can be imposed by software tools. For example, some pieces of software only support the 0/100 end-of-life allocation method, whereas some methodologies recommend using the 50/50 method or 100/0 method.

In summary, LCA is not a straight-forward approach (a lot of data to collect), sometimes not very transparent (manufacturers and suppliers are not too keen on providing information, a lot of average values), not easy to verify (calculations and modelling), it is an expensive approach and it is a method with a high level of uncertainty which relies on a countless number of assumptions and subjective choices. Results can differ widely depending on the chosen scenarios for life cycle stages like use, transport and waste management, and on the databases and emission factors (EFs). LCA may however be a very useful tool for providing an orientation in the initial phase of a comprehensive assessment of environmental performance, in particular for identifying hot spots, relevant life cycle stages and improvement options at any stage of product lifetime. Methodologies are generally written from the perspective of companies wishing to do very thorough assessments and following a high level of internal housekeeping and documentation. Companies are recommended to do a very high level “screening study”, then to progress into a more detailed study in accordance with the methodologies. No guidance or process is provided within the methodologies for such a screening study. Actually, there is no opportunity for a lighter-touch, less burdensome approach to footprinting activities.

Instead of the above, companies would benefit if the methodologies and guidance could evolve to meet the needs of 3 assessment levels:

- Screening study – highlights fundamental learnings, allows efficacy and directs focus of work for more revealing and meaningful studies; businesses use this as a stepping stone to the next level and would not typically stop here. There are a few initiatives attempting to tackle this issue currently, namely the PAIA methodology and the iNEMI Eco-impact Estimator\(^{42}\);
- High level study – suitable for company internal decision making and internal communications; enables target setting for internal management activities, informs sustainability strategy and business planning;
- Detailed study - suitable for more exact application of product footprinting including communication to public, significant investment decisions, detailed target setting

\(^{42}\) The International Electronics Manufacturing Initiative (iNEMI) Eco-Impact Evaluator for ICT Equipment provide iNEMI members with a simplified means of evaluating such impacts, summarizing the results, communicating the information within the industry, and requests toward the supplier industry (http://www.inemi.org/projectpage/eco-impact-evaluator-ict-equipment-phase-2-lca-estimator-tool-development)
Above would work well if all guidance/methods could provide a roadmap indicating why and how companies should select a certain assessment level. This type of guidance is only provided in the GHG protocol ICT-sector guidance TNS document.

Part of the solution could also include making existing methodologies simpler, providing further details on open issues, providing reference data for new “positions”.

The four tested methodologies, based on the pilots, were considered not to differ significantly in terms of workability.

The bulk of the effort in applying the four methodologies is in the data collection including soliciting, analysing and clarifying data while the rest is spent on disassembly, modelling and writing the reports. The respective shares in terms of time spent, however, were not quoted by the pilots. The methodology choice doesn't appear to significantly affect the effort related to those activities. Pilot companies emphasized the fact that doing LCAs in general requires specialist competence and can be extremely time consuming and costly for companies. The table below summarizes the main pilot’s results regarding workability.

Table 15: Workability of Product footprint methodologies based on pilot audit reports

<table>
<thead>
<tr>
<th>Items</th>
<th>Pilot’s answers (range)</th>
<th>Interpretation of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of staff involved to carry out the methodology</td>
<td>Staff: Out of 9 companies: • 8 companies mention 1-5 FTE; • 1 company mentions 10 people (not full time). In addition, from the total of 8 companies, 4 companies mention to have 10-30 non-full timers working on data collection throughout the company on average.</td>
<td>The dispersion and variability of the numbers can be explained by: - budget available for LCA projects / involvement of the company (internal policy) - knowledge/background in LCA - complexity of the studied product - interpretation to the question by pilots: difficulty to determine if these costs include the purchases of datasets, software, personnel or only the man day - the scope : difficulty to determine if these durations include the data collection externally (e.g. on the suppliers’ side)</td>
</tr>
<tr>
<td>Additional out of pocket costs involved to carry out the methodology (when starting from scratch)</td>
<td>Out of 9 companies: • 4 companies mention 20-120 k€; • 1 company mentions 300-600 k€ (investment to secure the required skilled resources); • 2 companies mention 1-10 k€ for one study; 2 companies could not make an estimation.</td>
<td></td>
</tr>
<tr>
<td>Amount of time involved to carry out the methodology in case you would start from scratch</td>
<td>1 - 6 months</td>
<td></td>
</tr>
</tbody>
</table>

Overall, pilot companies considered that methodologies are quite exhaustive and provide a good baseline to understand the most significant challenges of a given product, but cannot be used as a tool to differentiate products with the same function based on their carbon performance.
6 Compatibility and workability of Service footprint methodologies

6.1 Main results of pilots on Service footprint methodologies

Three methodologies from the original list in Table 9 were tested for ICT services carbon footprinting. The overall results are presented in Table 16.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>GHG Protocol Product Standard – ICT-sector Guidance (original list)</th>
<th>ITU-T L.1410 (original list)</th>
<th>ETSI TS 103 199 (original list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pilots tested</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**Compatibility**

- The GHG Protocol ICT-sector Guidance - Telecom Network Services (TNS) chapter, ITU-T L.1410 and ETSI TS 103 199 share a compatible basis: there is an overlap area between the methodologies. If calculations are made according to this overlap area, they are compliant with all three methodologies at the same time.

- ETSI TS 103 199 provides a more rigorous set of requirements for performing an LCA (e.g. life cycle elements mapped onto unit processes for an ICT service).

**Workability**

- The GHG Protocol TNS chapter was deemed useful for the telecommunications service tested.
- Data gathering was deemed more straightforward than by following the two other methodologies.

- Needs more details regarding ICT network and service assessment

- Needs more details regarding ICT network and service assessment

**Overall**

- The fundamental basis of all methodologies is the same.
- The workability of GHG Protocol ICT-sector guidance is perceived as higher than the workability of ITU-T L.1410 and ETSI TS 103 199, for the type of service tested (only one pilot).

6.2 Compatibility of Service footprint methodologies

In total, four services were tested over the two rounds of pilots. All pilot teams already had some knowledge and experience from previous work on GHG emissions methodologies. As a result, it is possible that the conclusions of the implementation of these methodologies may not be fully valid for less experienced teams.

The three tested methodologies appear compatible based on the pilots testing. The main outcomes concerning their compatibility are listed below:

- Fundamentals of all methodologies are the same, which results in a validity overlap, i.e. the same calculations can be compliant with all three methodologies:
  - The three tested methodologies are based on ISO 14040/44 and are generally aligned with each other;
o Types of GHGs emissions included are the same;

o Approaches to setting life cycle boundaries and requirements for data collection are essentially the same;

o The three methodologies provide organisations and LCA practitioners with sufficient requirements, approaches and options for implementing LCA;

o They provide similar guidance that allows the practitioner:
  - to use essentially the same energy and carbon emission factors;
  - to develop the same allocation rules;
  - to consider uncertainty;
  - to assess the use stage with the same assumptions (lifetime, duty cycle);

o For the only pilot testing them all, the three methodologies provided the same final footprint results.

• Three main differences between the tested methodologies can be highlighted, which may lead to a situation where given calculations are compliant with one standard, but not with the two others. These are:
  o The way the inventory gathering and calculation approaches are broken down into their component parts, which in particular results in different reporting tables and figures. The proposed reporting breakdown is nonetheless not mandatory in all methodologies;
  o The level of detail of the guidance provided by the methodologies and the optional approaches/methods offered to support the practitioner, especially regarding the network and service considerations, and
  o The level of demand on specific aspects: in particular, ETSI TS 103 199 is the most demanding methodology in terms of mandatory boundaries (e.g. unit processes to be included and allocation rules for recycling). In ITU-T L.1410, a non mandatory appendix is also available.

These differences in the methodological approach could lead to differences in the assessments and quantitative outcomes (e.g. absolute figures and shares of the different life cycle stages). Finally, pilots indicate that the emission factors and databases, the LCA tool used, the activity data and the practitioner are more significant elements responsible for variations in the quantitative outcomes of the calculation for a given service, than the choice of the methodology.

6.3 Workability of Service footprint methodologies

In general, the GHG Protocol Product standard with the ICT-sector Guidance, ETSI TS 103 199 and ITU-T L.1410 methodologies are perceived as relevant and workable methodologies.

The GHG Protocol Product standard with the ICT-sector Guidance is perceived as highly workable, more than the other two methodologies for the tested telecommunications service (only one pilot), because of its higher level of guidance. The assessment has been mainly based on the Telecommunication Network Services (TNS) chapter of the guidance: in particular, it provides the
most supportive information for carbon footprinting network services based on a full life cycle assessment approach.

According to the three pilots, ETSI TS 103 199 and ITU-T L.1410 methodologies are not sufficiently detailed and do not provide enough guidance for the assessment of ICT networks and services, which is associated to a higher level of requirements in ETSI TS 103 199. Under the existing level of guidance and due to the inherent complexity of undertaking an LCA of an ICT network or service, not all requirements/recommendations could be met in the way suggested by the ETSI TS 103 199 and ITU-T L.1410 methodologies, by two pilots within the timeframe of the testing process.

Main outcomes on specific aspects of workability are detailed below:

- **Data collection activities**: In general, the pilot who tested the three methodologies considered that the data gathering for the GHG Protocol ICT-sector Guidance was straightforward. The way a methodological approach is aligned with availability and type of internal company data sources often determines the level of difficulty of gathering inventory. For instance, for non product manufacturers, primary data collection may not be possible as it requires contact with components manufacturers and access to datasheets. In general, data collection cannot be done with the same level of precision for ICT equipment LCA and network or services ones because of the global system complexity;

- **Allocated time and resources to carry out the methodologies**: For one of the pilots, more time was needed to carry out the ITU-T L.1410 approach compared to the two other tested methodologies. It is explained by the fact that more resources were needed to gather inventory data to support the detailed life cycle requirements for each of the eight proposed checklist items, and assess their relevance/appropriateness to the service being assessed. Also, this could be partly due to the fact that the GHG Protocol ICT-sector Guidance was used as the “starting point” methodology for the tested service (see paragraph 2.6). Concerning the allocated resources, the more detailed requirements for minor impact areas of the service mandated or recommended in the ETSI TS 103 199 and ITU-T L.1410 methodologies require more inputs from additional staff. Two pilots were not able to compare the time required by the methodologies being tested as only one calculation approach was carried out, which was used for all methodologies tested (in particular, full compliance was not achieved with ETSI TS 103 199 within the timeframe of the pilot process). Several other factors impact the time and resources needed, regardless of the methodology chosen:
  - The use of existing tools (e.g. semi automatic treatment of LCA data) and outcomes (e.g. outcomes of previous ICT equipment LCA) which were developed and used in the past: the application of a methodology “from scratch” requires more resources;
  - The level of knowledge and experience from previous work on methodologies, which is available internally;
  - The complexity of the service.

One recommendation made by one pilot for a better workability of the methodologies is that it should be possible to fulfil at least mandatory requirements (if not the recommended and optional requirements) when using any LCA tool. One could argue that tool developers are also concerned by this issue.
Table 17: Workability of Service footprint methodologies based on pilot audit reports

<table>
<thead>
<tr>
<th>Items</th>
<th>Pilot’s answers (range)</th>
<th>Interpretation of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of staff involved to carry out the LCA</td>
<td>Out of 3 companies:</td>
<td>People of different backgrounds and expertise were directly involved in the pilot tests with occasional additional support from businesses outside the pilot consortia. Additional people were required to supplement the expertise, guidance and data collection required or recommended.</td>
</tr>
<tr>
<td></td>
<td>• 1 company reports 9-12 FTE of varying backgrounds and expertise + additional staff required to supplement the expertise, guidance and data collection required or recommended;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 1 company reports 5 FTE;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 1 company reports 7 staff members (not full time).</td>
<td></td>
</tr>
<tr>
<td>Additional out of pocket costs involved to carry out the LCA (when starting from scratch)</td>
<td>Out of 3 companies:</td>
<td>The time reported by pilots is variable because it depends on:</td>
</tr>
<tr>
<td></td>
<td>• 1 company reported 85 k Euros;</td>
<td>- The knowledge/background in methodologies and LCA: the time required decreases based on familiarity with methodologies and LCA processes, existence of internal tools for data treatment and interpretations, and existence of previous LCA outcomes.</td>
</tr>
<tr>
<td></td>
<td>• 1 company did not assess the amount of out of pocket costs and did not provide data;</td>
<td>- The complexity of the studied service</td>
</tr>
<tr>
<td></td>
<td>• 1 company did not provide data for confidentiality reasons.</td>
<td>- The availability and accessibility of internal company data sources.</td>
</tr>
<tr>
<td>Amount of time involved to carry out the LCA in case you would start from scratch</td>
<td>2- 3.5 months</td>
<td></td>
</tr>
</tbody>
</table>
7 Feedback on public policy

7.1 Introduction
An important policy action on European level that is directly linked to the pilots is on mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy (key action 12 of the European Digital Agenda based on a European Commission Recommendation of October 2009). Further policy actions may be launched in the field, also drawing on the pilot results.

All pilots have been requested to provide feedback or their opinion on using carbon footprint methodologies as an input for public policy. The answers of the different pilots were diverse, but in the following paragraphs the results are given.

7.2 Policy input based on pilots on organisation footprint methodologies
First it has to be said that the opinion of the pilots about policy measures based on the tested methodologies strongly depends on what the policy and/or requirements would look like. Overall it can be concluded that there are mixed responses:

• Most pilots report that, only under certain specific conditions and for specific purposes, they would feel comfortable with public policy measures based on most of the methodologies tested;
• One pilot however argued that the use of the different energy and carbon methodologies are and should be driven by voluntary commitments of companies only, and be used to improve their internal performance. This is reflected in the transparency that companies have in terms of reporting emissions. Therefore in their opinion reporting emissions could be used as a policy incentive, but not as an obligation;
• It is also noted by several pilots that they would be comfortable by policy measures (like for public procurement) based on scope 1 and 2 reporting. But they would be less comfortable with public procurement based on full scope 3 accounting and reporting. This is due to the level of resources, time, and cost required, and the high level of estimation, and/or uncertainty around the upstream and downstream calculation techniques, and the data currently available. Scope 1 and 2 can be based on measurable figures, but scope 3 often has to rely on LCA data and estimates. This type of data is therefore often very general, inconclusive and not appropriate to base comparisons (between companies) on;
• One pilot remarked that the tested methodologies should not be used for regulatory purposes that require a high level of accuracy, and only be used for policy measures that do not directly impact fair competition between companies or market access. But the tested methodologies are inappropriate for use in measures having a direct impact on competition between companies or

An example of this is the "C(2009)7604, Commission Recommendation of 9.10.2009 on mobilizing Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy" where some of the expectations expressed by the Commission, e.g. developing a common methodology framework, do not require such high accuracy as those policy measures impacting market access or competition.
market access, because the achievable accuracy is not high enough. Examples of such measures are those related to regulatory market entry requirements and those impacting purchase decisions, e.g. regulatory eco-design requirements and green public procurement respectively. The methods are appropriated to use for high level aggregation of sector environmental data;

- However, to be able to use energy or GHG emission reporting as a basis for public policy, the general methodological framework for the ICT-sector (or sub sectors) has to be determined to ensure that the results are compatible. It must for example be ensured that companies report on the same scope and categories (for scope 3), use similar emission factors, etc.

Furthermore the following remarks have been made by the different pilots:

- Implementing policy on this subject would require a substantial preparation and education of most companies in the sector. This would require a lot of time. Furthermore, companies need to have access to appropriate calculation tools, databases, and average data to perform this work. It should be noted that many of the pilot companies in this project are already frontrunners on knowledge and investments in this topic but a lot of others aren’t;

- It was also mentioned that the ICT-sector consists of different type of players. For example hardware companies, telecommunication companies, software editors, data centre operating companies. And these activities don’t have the same issues, and challenges regarding their carbon impact. Any policy measure should respect and account for these differences;

- One pilot argued that they support the mandatory reporting of all scope 1 and 2 energy and GHG emissions, and that they consider that this may be a better way forward than requiring full scope 3 reporting. This is considered to be a more effective public policy measure to reduce GHG emissions and carbon in the atmosphere as it is a more straightforward requirement and the methodologies are established and proven. Scope 3 reporting should continue to be voluntary rather than mandatory as it is a far more complex and resource intensive requirement and the methodologies are not yet established and proven;

- For public procurement one pilot mentioned that policy instruments could be established to foster innovation or provide incentives for companies participating in public procurement processes to demonstrate optimal internal energy efficiency and GHG reduction performance. This topic should be seen as an optional selection criteria on which a company could distinguish itself, instead of a regulated or mandatory part;

- A pilot noted that it would be good to use public policy to encourage companies that establish business models for energy efficiency and GHG reductions;

- Regarding policy on the maximum use of data centres the following comments were made;
  - A pilot mentioned that this is a sensitive issue, as data centres are core for delivering services to final users and its reliability is crucial. The pilot argues that instead of establishing thresholds, it is important to work on the definition of KPIs for energy efficiency in these facilities. It is also important to know that energy efficiency requires initial investments. Policy instruments should be focused on incentives to find funding for energy efficiency or incentivize the use of new financing models for energy efficiency;
  - Another pilot mentioned that it is important to also cover the external (outsourced) server space within this KPI;
Another pilot mentioned that there are several existing industry groups/efforts like the Green Grid, Uptime Institute, and DOE E* for DC that are working on KPIs for energy efficiency. As a result, there is no lack of attention to the challenges by the ICT industry and any new policy instruments are not necessary.

7.3 Policy input based on pilots on Product footprint methodologies

The pilot companies feel that the applicability of the tested methodologies to possible future policy applications strongly depends on what the requirements could look like. One pilot would be in favour of legally binding rules for companies to perform carbon footprints of products and to make them publically available. If product footprinting was to be somehow included in policy and/or legal frameworks, then a process-based approach (as opposed to a product-based approach) is considered essential, because companies are in general a lot more process-oriented. In addition, the application of LCA in this specific situation is not considered to be relevant without the use of PCR and/or PEFCR.

It is important to match precision with the aim of the policy measure to ensure that the result is the desired one without causing unfair competition or disproportionate burdens to stakeholders. Hence, when agreeing on the policy tool, the expected level of accuracy also needs to be agreed upon. The tested methodologies are not appropriate as bases for policy measures having an impact on competition or market access. As with any other policy measure, it is also essential to ensure that it is possible to verify the results which in some situations may not be possible. As a result, this will be a serious problem for the enforcement by authorities.

To achieve the necessary accuracy, methodologies specifying real measurement would be needed (in contrast to LCA, which is model based), e.g. methodologies which define how to measure energy efficiency of products. In a laboratory environment there would still be a challenge to correctly reflect the real use phase during measurement, thus such methodologies may still not qualify as bases for policy measures having an impact on competition or market access. Methodologies for field measurements may reflect the real usage situation more correctly. These, however, would by their nature apply to measurements of the installed product, and would not be relevant as bases for policy measures targeting the placing on the market and sale of products.

To sum up, the tested methodologies can be used as a basis for certain policy measures that do not require a high degree of accuracy e.g.:

- Identification of the key stages in a product’s life cycle;
- High level aggregation of sector environmental data.

The achievable accuracy when using the tested methodologies is not high enough to justify their use as a basis for policy measures influencing market access or competition.

46 A process-based approach would mean that the companies are obliged to report LCA results on a regular basis according to any of the methodologies tested in the product pilots.
The pilots estimate that methodologies should offer some minimum requirements to be implemented through public policies. Some aspects of these methodologies, however, are not sufficiently precise (e.g. approaches regarding end-of-life, allocations rules, uncertainties, data quality, etc.) such that it would be possible to generate quite different results (nominally about the same product) between the two methods while still being "compliant" with the methodologies. The tested methodologies are therefore not appropriate for comparing and/or differentiating products (e.g. given the degree of freedom that is allowed for the LCA practitioner, possibly resulting in significant deviations in the results).

Some pilots considered that methodologies require a lot of primary data whereas primary data does not fit with legal applications.

It would be necessary to structure a methodological framework which would guide the practitioner (especially about the choice of environmental factors and the databases). Methodologies must give less degree of freedom on certain points (allocation rules, data collection, functional unit) while giving a degree of freedom in modelling to allow product differentiation.

7.4 Policy input based on pilots on Service footprint methodologies

In general, the three pilots suggest that they would not be comfortable if public policies were based on any of the methodologies tested. Regarding policies such as public procurement or eco-labelling, the structure of any of the methodologies applicable to services, and in particular, the liberty of choice of the LCA tool, the use of scenario and emission factors, does not allow the comparison between carbon footprints of services from different companies. For ecodesign-related measures, the application of these methodologies is a useful approach to work and communicate internally, but not externally because of the same difficulty of service assessment comparison between companies. Two pilots express that they would be comfortable in the case of ecodesign measures and general requirements on sustainability regarding the ICT-sector being based on the existing methodologies, but only if these public policy measures were applied at a high level of aggregation (i.e. for product groups/categories), and do not require or lead to a direct comparison between products or services of a same category. Methodologies can indeed be useful to understand system environmental challenges.

Even if all pilots indicated not being comfortable with public policies based on any of the existing methodologies, if one methodology had to be chosen, the pilot who tested the three methodologies estimate that they would be more comfortable if the policies were based on the GHG Protocol - ICT-sector Guidance. Nonetheless, this pilot supports the coexistence of various calculation methodologies. In line with what is stated in ISO 14040\[47\], their opinion is that the ICT industry has not yet reached at a point where one particular carbon footprinting methodology can be chosen or

\[47\] "There is no single method for conducting LCA. Organisations have the flexibility to implement LCA as established in this International Standard, in accordance with the intended application and the requirement of the organisation."
disregarded. Recommendations are that future policy developments should not restrict the choice of calculation methodologies and organisations should be able to choose the most suitable one depending on their specific requirements. It should also be noted that LCA is fit for purpose and is a useful and successful technique for addressing GHG emissions.
8 Feedback and recommendations to SDOs

8.1 Introduction
In this chapter feedback and recommendations for Standards Development Organisations (SDOs) are provided based on the outcomes of the pilots carried out by the volunteering ICT companies.

8.2 Feedback on Organisation footprint methodologies

8.2.1 General feedback on five tested methodologies
Below the general feedback and recommendations which are applicable for the five methodologies tested for organisation footprinting is summarized. More detailed feedback per methodology tested can be found in the following paragraphs.

- Most (five) pilots argued that both the compatibility and workability would benefit from more guidance on the emission factors that should be used. This counts for energy emission factors (Scope 1 and 2), but also for more ICT specific emission factors (in Scope 3 e.g. for purchased materials). A possible solution to this topic which was mentioned/supported by at least two pilots would be a global database with available (non confidential) emission factor. Such a database is deemed to be very beneficial by these pilots. At the same time it should be noted that ICT products, networks and services evolve very fast, which would make the update of such a database a substantial challenge;

- As noted in the chapter for compatibility an important difference between the methodologies is the way of accounting for the emissions of capital equipment and purchased goods and services with a longer life time. This is due to a difference in the approaches between (linear) depreciation, and full life cycle emissions during the year of purchase. All (four) companies mentioning this difference suggest alignment between, and more guidance of the methodologies in question. The opinions of the pilots about this choice differed however. While most (three) pilots deemed the depreciation method more complex and suggest to change this approach, one pilot actually preferred the yearly depreciation as it was more in line with their regular financial reporting.

- Three pilots recommended the inclusion of a good “data quality policy” in the methodologies, which enables the reader to assess the quality of and uncertainty behind the numbers reported. Such a measure could furthermore reduce uncertainty levels and guarantee the quality of the reported energy & GHG values.

- Furthermore two pilots recommend that scope 3 should be divided into two scopes, by moving product use into a new scope (for example scope 4). This would allow showing direct and indirect emission from energy usage (scope 1 & 2), emissions from purchased goods and contracted activities (scope 3) and finally emissions from product usage (additional scope 4). The product use phase knows a very high uncertainty as both the type/way and the length of the product usage is not exactly known upfront. A division will create a more transparent separation between the emissions with more accuracy (scope 1 and 2) and values with a growing uncertainty (scope 3).
Additionally the use phase emissions have a very big impact within scope 3 for a large part of the ICT-sector.

8.2.2 ITU-T L.1420 Methodology for environmental impacts assessment of ICT in organisations

The aggregated feedback by the pilots is listed below:

- A general comment by most pilots is that the guidance for calculations of the different categories is too limited. It details ‘What’ is required at a high level but provides minimal guidance to the practitioner on “How” to apply it in practice. It provides few practical examples about how to build the inventory, and carry out the calculations. Some examples or case studies would however be very helpful. This should be improved, or a referral should be made to the GHG Protocol guidance. More detailed recommendations on the guidance can be found below;

- The different pilots have requested further guidance by L.1420 for the following areas:
  - Emission factors, in particular for electricity in scopes 1 and 2, and scope 3, to improve the consistency or possibility of results comparison (ITU-T 1420 chapter 8.3.4.2) (for instance per country);
  - To subdivide scope 1 and 2 energy consumption, and GHG emissions according to: technical (network) activities, sales activities, and offices;
  - To propose sub-categories for scope 3 emissions, in each category (A to P). For example for Category S3A the following sub-categories are recommended:
    - Production-related procurement cradle to gate, with for instance fabrication of customer devices (box, mobile), purchases of network maintenance and interconnection;
    - Non-production related procurement, with for instance other purchases (services, marketing, etc.).
  - For the Category S3B (Capital Goods), the following sub-categories are recommended:
    - Cradle-to-gate emissions from vehicles, facilities and infrastructure, with for instance network infrastructure, buildings and office equipment, vehicles;
    - Computer-ware cradle-to-gate, with, for instance, computer, printer, IT infrastructure (servers).
  - Category S3E: more guidance is requested on perimeters and emission factors as these are fundamentals;
  - Category S3J: more guidance is requested in order to be able to compare different assessments;
  - Category S3L & S3M: The time perspective should be clarified: should (like in the GHG Protocol) for the use and end of life treatment stage all lifetime emissions for a certain product be considered in the year the product is sold? The ITU-T L.1420 leaves this question open at this moment.
  - More guidance is requested for the consolidation approach, sub-categories and emission factors. Bilan Carbone provides some guidance relative to these items but is a national initiative only;
  - Separating the “related fuel supply chain” (S3C) is not viewed as fundamental by one of the pilots;
• Several comments were made about the depreciation of capital equipment and purchased goods and services:
  o According to several pilots this method is considered as (too) complex. The requirement is viewed as burdensome in terms of data management and resources to track all such emissions. In addition the calculation leads to an additional source of uncertainty, and it is expected that lifespan calculation for different types of goods may need to be revised regularly with changing customer/consumer behaviour trends and with availability of better usage data. Therefore these pilots recommend to make an alignment with the GHG Protocol and to account all life cycle emissions in the year of purchase;
  o If alignment on the topic above with the GHG Protocol would not be possible it is recommended to at least include more guidance on the depreciation method to be applied and to standardise the lifetime of various typical asset categories to improve compatibility;
  o Furthermore it was argued that it is not clear whether these depreciated emissions need to be reported only in the year of purchase or each year thereafter as well, based on the lifespan of each item. If the second is the intention then this places additional complex data management and administrative burdens on the reporting company trying to keep track of the yearly reporting of these assets going forward. Secondly the increased uncertainty and complexity around estimating the lifespan for (numerous – possible many hundreds) of different types of goods/equipment would also be burdensome. Especially if using a EIO rather than process sum approach to calculate emissions;
  o It is important to mention however that one pilot actually preferred the yearly depreciation approach for the categories described above as it is more in line with their regular financial reporting.
• One pilot recommended including specific guidelines about how to report the uncertainty rates of the inventory. It’s hard to manage the uncertainty of a GHG inventory when it is based on a lot of data from different data sources with different quality;
• One pilot suggested to define minimal requirements for primary data and emissions verification, to reduce uncertainty levels and guarantee the quality of reported energy & GHG values;
• Also see the comments made under section 8.2.3 which in most cases also apply for this methodology.

8.2.3 GHG Protocol Corporate (Value Chain) Standard for organisations
The aggregated feedback by the pilots is listed below:
• It was advised by a pilot to introduce a “data quality measure” to support continuous improvement. The JRC methodology provides a strong example of this;
• The basic principle of the GHG Protocol standard is to account for all activities of the company during the reporting year. However, end of life (EoL) activities occurring during the year of reporting are not included. Instead EoL emissions shall be reported when the product is sold. A pilot testing this protocol would advise the GHG Protocol to change this (back) to the actual EoL emissions in the current year, as the current practice of disposing, processing and recycling of waste are known, and reports are received for this handling. But it is impossible to predict these for the future;
• One pilot would prefer to yearly depreciate the emissions of their capital equipment as this is more in line with their financial accounting. The other pilots however preferred the GHG Protocol approach;

• It was suggested by a pilot that comparability should be enhanced by improving (enlarging) the items “scope definition”, and “emission factor definition”, and by providing more regional factors (often DEFRA) and for a specific time period;
  o Example: Business flights emissions: uplift factor (9%). Businesses have freedom to further multiply these factors (2.5 or 2.7). Standardization of this reporting will help comparability.

• A pilot noted that the scope 3 protocol could be more robust in how to address primary and secondary data. The Scope 3 protocol is currently sufficient from a reporting perspective, but not from a management or a reduction perspective;
  o Example: When reporting the Scope 3 emissions for the category “Purchased Goods & Services”, this pilot company can only report the emissions based on secondary data (euro’s spent). Due to this the pilot company cannot initiate reduction management initiatives.

• **Chapter 9:** One pilot believes that companies who purchase low or zero carbon electricity should be able to report emissions reductions associated with this, and that renewable energy should be reported as ‘zero carbon’ not the ‘grid average’;

• A pilot mentioned that the overall approach tends to be (to report) all or nothing and lacks flexibility in its adoption. It may benefit from giving practitioners and organisations a suggested pathway from moving from Scope 1 and 2 accounting towards full Scope 3 accounting.

• A pilot noted that the GHG protocol being the methodology applicable for all sectors, sometimes has guidelines that are too generic. It would be appreciated to have another specific methodology for the ICT-sector.

### 8.2.4 European Commission Joint Research Centre (JRC) Organisational Environmental Footprint Guide (1st draft)

The aggregated feedback by the pilots is listed below:

• It is recommended by one pilot that the methodology in general should be aligned with the GHG Protocol because of the current reporting praxis and requirements. Furthermore including scope definitions (scope 1/2/3) in the methodology would improve its usability for companies where product use phase emissions are dominating and hiding all other emissions. The three scope separation is furthermore preferred because:
  o In the JRC definition of “Directly attributable emissions”, a company is asked to add up very accurate data (scope 1 and scope 2 emissions) and inaccurate data (for some scope 3 activities like employee commuting). The addition of this inaccurate information causes damage to the quality (uncertainty) of the ‘directly attributable emissions’;
  o Due to the somehow unclear definition of the JRC with regards to what belongs under direct and indirectly attributable activities a risk of double counting of emissions between companies exists. It is possible that different companies report the same emissions, which would lead to double counting when the emissions would be aggregated to sector level. The three scope separation is designed to protect against double counting;
• One pilot suggests that the JRC initiative can enhance the comparability by improving the following parameters within GHG emissions reporting:
  o Better "scope definition" for the environmental reporting categories;
  o Better "emission factor definition" (the pilot company had no access yet to any emission factor databases which might be provided when the methodology is final);
  o Better regional factors choice.
• According to one pilot the Data Quality Measure of JRC adds value to the organisation’s reporting. However, this measure needs to be adjusted or modified for the case of organisational environmental footprint calculation (it is currently based on an LCA approach). It also needs to be adjusted for qualitative KPIs (which are currently only based on expert judgement);
• The linear depreciation of capital equipment is valued as relatively complex by the two pilots testing this methodology. It is recommended to make an alignment with GHG Protocol;
• It is recommended by one pilot that mandatory parts need to be reduced and instead sector specific options could be included;
• One pilot participant testing the methodology is part of a stock exchange listed organisation and is obliged to report certain key environmental figures, for example energy and water usage and the resulting impact according to form 20-F. The JRC methodology is recommended to harmonise its reporting section accordingly;
• A pilot noted that in this methodology some emission factors are different from the units used in the GHG protocol and the International Energy Agency (IEA). In order to be able to compare results, it is deemed important by this pilot to have units which are widely used in this context, or preferably standardized figures;
• Related with the topic above: One pilot participant noticed that the CO\textsubscript{2} emission impact was categorically bigger in the JRC methodology calculation than e.g. with the CML methodology. This was caused because in energy profiles, burning wood had a 100 times bigger impact than in the CML methodology. In particular, this has a big impact on the energy emissions in Finland, because in Finland energy comes for 10% from burning wood. In other countries, this portion is lower. An industry agreed and harmonised calculation method for this would be appreciated by the pilot;
• JRC advises using a Characterization Factor, including one for individual GHGs, to reach a single number across 14 environmental reporting categories. Both pilots testing this methodology did not see a real practical benefit (internal or external) in reporting this single number. In the view of one pilot this blurs the scientific results and does not do justice to all the efforts made for the detailed calculations. This pilot also argues that it would be simpler to focus on energy usage to see the footprint of sold ICT products instead of the different environmental impact categories with country specific emission factors. Energy use during product use phase has the most significant impact for several parts of the ICT-sector (like network equipment);
• It was recommended by one of the pilots to:
  o Reduce overlaps in reporting KPIs;
  o Prioritise the reporting topics in order to optimize an organisation’s reporting efforts (the overall effort could be very high for an organisation that is starting from scratch);
• It was suggested by a pilot that comparability should be enhanced by improving (enlarging) the items “scope definition”, and “emission factor definition”, and by providing more regional factors (often DEFRA) and for a specific time period;
  o Example: Business flights emissions: uplift factor (9%). Businesses have freedom to further multiply these factors (2.5 or 2.7). Standardization of this reporting will help comparability.
• A pilot noted that the methodology for indirectly attributable activities could be more robust in how to address primary and secondary data. The methodology is currently sufficient from a reporting perspective, but not from a management or a reduction perspective.

8.3 Feedback on Product footprint methodologies

8.3.1 General feedback on four tested methodologies
Below the general feedback and recommendations which are applicable for the four methodologies tested for product footprinting is summarized. More detailed feedback per methodology tested can be found in the following paragraphs:
• Regarding the functional units required by all tested methodologies “Total ICT good use per lifetime of ICT good” it is necessary and essential to find a precise time base equivalent between products or product categories to allow for comparison. The lifetime must be clearly defined in each methodology for each type of product or for all ICT products;
• It would be useful to have one or many generic emission factors (EFs list for grid mix, major transportation, transformation processes for example) in the methodologies to avoid quite important differences in impacts assessment.

8.3.2 IEC TR 62725 Quantification methodology of GHG emissions for EE products (electrical and electronic products and systems)
The aggregated pilot feedback is listed below:
• Paragraph 6-4-1 [Life cycle stage and process map]. In general BoM information is not always easy to obtain, particularly at a very detailed level. This has been a limitation for scaling these analyses as products of interest need to be disassembled often within the analysis. This is a significant issue within ICT, many of the components with multiple tiers of suppliers and OEMs generally have limited ability to know exactly what is in the product. Finally, another point on BoM dependence is that there is the tendency to think of BoMs as a list of materials, when in fact for these products they are typically a list of components made of many materials. Some companies have done a screening assessment to identify hot spots of their product and to guide data collection → this data collection approach used is compatible with the methodologies investigated here;
• Paragraph 6.10 [End-of-life stage scenario]. IEC/TR 62725 recommends using allocation rules for recycling (0/100 method, 100/0 method, 50/50 method) but the document doesn’t indicate which to select to avoid double counting;
• For the choice of emission factor, when supply chains and use of product are dynamic (different countries of production and use), what is the most accurate way to represent that? (detailed approach to adopt);
• The IEC/TR 62725 methodology should be more specific when simplified assumptions are suitable:
  o Line 648: define "high yield ratio" (%);
  o Line 807: name products for which a more detailed approach would be needed.
• This methodology provides no guidance with regards to attributable and non-attributable processes. The difference is merely acknowledged (line 920), but no real guidance is given;
• The IEC/TR 62725 methodology should be clearer about "product unit" and "product system". One underlying assumption behind a "product unit" or "product system" approach is that products serve the same function for the same period of time but it’s not really clear in the report;
• Two and three examples (e.g. in Appendix) showing the application of this technical report would help.

8.3.3 ITU-T L.1410 Methodology for environmental impacts assessment of ICT goods, networks and services
Feedbacks of pilots concerning ITU-T L.1410 methodology are listed below:
• Annex C provides details on the generic processes and could go a step further to outline which factors should be used for which regions, etc., or the main preferred source(s) for the information;
• Section 8 p.20, Annex F (table F1). Difficulty to match the terminology between the various checklists, mostly between the table in Section 8 on page 20 and the Annex F, Table F.1. The mapping between consumables and other supportive products and supporting goods manufacture for example is a bit confusing. Where working environment fits into Table F.1 could be a bit clearer;
• For the choice of a carbon conversion factor, when supply chains and use of product are dynamic (different countries of production and use), what is the most accurate way to represent that? (detailed approach to adopt);
• Examples in Appendix VII could include the same notations as defined in the sections before (e.g. Fig. 8: O&M?, Figure H1: Resources is probably not an output);
• More comprehensive examples for medium ICT would help;
• Application of Annex F for networks/services needs further clarification;
• ITU-T L.1410 should consider adding recommendations for allocations.

8.3.4 ETSI TS 103 199 Life Cycle Assessment (LCA) of ICT equipment, networks and services: General methodology and common requirements
Feedbacks of pilots concerning ETSI TS 103 199 methodology are listed below:
• Annex K. The approach to assess the uncertainty is vague;
• Paragraph 5.3.3.1.5 [Allocation rules for recycling]. ETSI recommends using allocation rules for recycling (0/100 method, 100/0 method, 50/50 method) but the document doesn’t indicate which to select;
• For the choice of carbon conversion factor, when supply chains and use of product are dynamic (different countries of production and use), what is the most accurate way to represent that? (detailed approach to adopt);
• The ETSI TS 103 199 methodology should incorporate the requirement that available PCRs should be used (or otherwise state why an existing PCR is not suitable). This would allow harmonization for certain product groups without having too many details in the methodology;
• Network examples in Section O.4 could be updated to give more guidance and explanations;
• The validity of the methodology for cradle-to-gate calculations is obvious but nevertheless not clearly communicated;
• Unclear data quality requirements regarding black box modules (for example: fan unit, charger device, camera module) compared to the “main” ICT Equipment;
• The examples in Annex O could be improved for clarity in relation to the normative text;
• Section N.1 needs checking and some revision, especially Fig. N.2;
• ETSI TS 103 199 should clarify the relation between the SHALL for software and the RECOMMEND for support activities as software mainly relates to support activities;
• ETSI TS 103 199 should clarify to what extent applicable annexes apply if focusing on GHG only;
• ETSI TS 103 199 should consider clarification regarding temporary networks;
• ETSI TS 103 199 should distinguish more clearly between record keeping and external reporting.

In future versions, ETSI TS 103 199, ITU-T L.1410 and IEC/TR 62725 methodologies could further clarify how to consider the fact that both software and hardware are often gradually developed and reused between products and ask for additional descriptions in reporting, regarding how support activities were included.
Methodologies should also clarify that software as such can be the object of an assessment (which is often not explicitly stated) and may therefore also need to review the text from this perspective, especially ETSI TS 103 199.

8.3.5 GHG Protocol Product Life Cycle Accounting and Reporting Standard – ICT-sector guidance
Feedbacks of pilots concerning GHG Protocol Product Life Cycle Accounting and Reporting Standard – ICT-sector guidance are listed below:
• Chapter 2: More ICT and Support Equipment Use/Manufacturing proxies must be given in Table 5 (p16);
• The GHG Protocol Product Standard is good enough for execution of rapid Network basic results with enough precision. But if e.g. phones and computers are parts of the Network scope more details may be needed than Use/Embedded proxies. Should easier-to-understand examples be included, showing the applications on Networks of the ETSI TS 103 199/ITU-T L.1410/IEC/TR 62725 methodologies and GHG ICT Guide, small/medium sized ICT companies will be able to understand how to be compliant;
• Chapter 6 scope:
  o Comment for future ICT-sector guidance: software has an ultimate utility beyond ‘annual use’. VCs need help from the methodologies or sector guidance to evolve the functional unit definition from annual use into a tangible and measurable delivered service, so that
the balance of benefits/disadvantages with new generations of software can be seen. New software may be more capable and bring more value to businesses but may also consume more energy over the year: the definition must move beyond annual use to an intensity metric e.g. $ revenue managed by software / emissions;

- **6.3.1 Choosing the studied product**
  - "A review or screening exercise of all the products a company produces, distributes, buys, or sells is the first step to identifying an individual product to study. Companies should pick a product that is GHG intensive as well as strategically important and aligned with their business goals”;
  - The GHG Protocol Product Standard assumes that companies will only wish to start with one product or a limited set of products. Language dissuades widespread application of product footprinting.

- **Chapter 7: Boundaries**
  - Footprint practitioners would welcome clear guidance on boundaries for ICT-sector guidance:
    - Upstream hardware manufacture may be non-material and can be excluded from boundary - with justification. Assumption in ICT guidance is that it is relevant and should be included;
    - Processes controlled by software are typically excluded from the boundary;
  - Guidance on assessing positive benefits of software would be very helpful to allow software to be considered as a mitigation tool. Software typically used to improve operational processes, substitute materials and suppliers, and improve product performance; all of which may have highly beneficial impact. This must be built into ICT-sector guidance.

- **Chapter 9: Allocation**
  - It would be helpful to see richer guidance on allocation for typical software scenarios in the ICT-sector guidance. For example, the following emission sources will commonly need allocating to software:
    1. Application server emissions;
    2. Data server/centre emissions;
    3. Network systems emissions;
    4. End user devices emissions (laptops, notebooks, desktops);
    5. IT support activities;
    6. IT consultancy activities.

- **Chapter 13: Reporting**
  - The GHG Protocol contains many requirements relevant for communication of a given product footprint to external parties. The requirements are written in the context of communicating a single product footprint in text-document form and do not adapt readily to our needs which are:
    1. Cover a large portfolio of products in one reporting platform;
    2. Provision of information in business analytics tools in a graphical and rich analytics format;
    3. Typical web media.
8.4 Feedback on Service footprint methodologies

8.4.1 General feedback on three tested methodologies
The following general observations for all three tested methodologies were made. More detailed feedback per methodology tested can be found in the following paragraphs.

- It should be highlighted in methodologies (besides the reference to ISO 14040/14044 requirements) that the exact electricity mix (source, year, and reference carbon factor) and other important data sources must be disclosed in reports particularly for comparison with existing LCAs;
- Furthermore, generally the data collection cannot be done with the same level of precision for ICT equipment LCAs and networks or services LCAs because of overall systems complexity. Also, for similar reasons, data collection with the same level of detail for all ICT equipment included in the hardware architecture is not possible;
- “Generic” emission factors could be proposed in the methodologies in order to avoid use of public factors (which are very heterogeneous and may lead to very high differences across LCAs). For instance, for operator and service provider activities, it could be useful to define a set of generic emission factors (one global or many for specific activities/profiles, e.g. technical staff, sales staff, and other) in order to harmonise LCA results in case no private and specific data are available;
- For the software handling, there is a need for a common database and common guidance for more accurate results. If not available, software inclusion should only be optional and not mandatory.

8.4.2 ITU-T L.1410 Methodology for environmental impacts assessment of ICT goods, networks and services
Feedbacks of pilots concerning ITU-T L.1410 Methodology for environmental impacts assessment of ICT goods, networks and services are listed below:

- Level of guidance. In general, the ITU L.1410 methodology provides the LCA practitioner with the minimum requirements for performing an LCA on ICT products, networks and services. There is therefore a general lack of guidance for the tested services. The level of requirements is high but minimal guidance is provided to the practitioner on practical implementation (e.g. few practical examples of how to build the inventory and carry out the calculations).
  More guidance would be needed, in particular for networks and services. For instance, difficulties were faced by the pilots to apply the methodology concerning end-of-life modelling, uncertainty calculations and support activities (for service provider and operator) assessment. Providing guidance on the use of LCA estimation techniques, such as common component characterisation and life cycle stage ratios, under certain conditions could save considerable resources and time. The pilots suggest that providing examples of when the reporting categories apply to different goods, networks and services, by supplementing the Annexes or providing additional references. Alternatively, cross referencing to other methodologies where appropriate may be another option (e.g. sections regarding network analysis, and LCA estimation techniques);
- Data collection activities. The (proposed but not mandatory) data breakdown requirements into the 8 categories (e.g. software and storage and working environment) were not all possible in the
manner proposed for the tested services, in particular for the network equipment. Obtaining data for certain life cycle stages according to the checklist categories was not possible;

- **Approaches to estimate LCA.** For the tested services, the pilots reported that the advised hierarchical allocation from Goods to Networks to Services for the ITU L.1410 standard seems a little too restrictive and might lead to extra work addressing parts of networks not related to the service considered and/or preclude a more detailed allocation of ICT Goods to Services. They recommend that further advice and recommendations be provided to help address this (or alternatively, references to other methodologies);

- Furthermore, the methodology could provide additional advice on how to best address transport and/or alternative options for this;

- **Ease of application.** The ITU-T L.1410 standard may be difficult to apply by a service provider without the full support of all its equipment vendors in relation to the GHG emissions of the hardware supporting the service (this issue also exists for manufacturers carrying out an LCA of their products, when modelling the use phase of the equipment);

- **Practicality.** The standard provides some practicality for the tested services. However, certain sections propose obtaining information in a manner which is either not possible or not practical. This may be attributed to the standard having to cover such a broad scope of ICT goods, networks and services;

- **Robustness.** By looking at the details within the ICT hardware use stage emissions, sensitivity against assumptions for the key contributing CPE goods can be properly addressed;

- It is recommended that more guidance be provided to the practitioner for carrying out sensitivity analysis with regard to networks and services;

- **Reporting requirements.** For the tested services, the pilots suggest data/reporting requirements are not possible sometimes (e.g. across all eight checklist categories split into 4 life cycle stages) and obtaining information to fit the 8 categories was not always feasible;

- More guidance and flexibility could be provided on allocation techniques suitable to ICT services: they could avoid unnecessarily addressing services or parts of a network which are not the subject of the assessment;

- **Allocated time and resources to carry out the methodology.** One of the pilots highlighted that additional resources (compared to the other methodologies) were needed to gather inventory data to support the detailed life cycle requirements/recommendations for each of the eight checklist items, and assess their relevance/appropriateness to the service being studied.

### 8.4.3 ETSI TS 103 199 Life Cycle Assessment (LCA) of ICT equipment, networks and services

Feedbacks of pilots concerning ETSI TS 103 199 Life Cycle Assessment (LCA) of ICT equipment, networks and services are listed below:

- **Level of guidance.** For the tested services, the ETSI TS 103 199 standard provides the LCA practitioner with sufficient requirements for performing an LCA. The detail of information/recommendations decreases as the standard moves from product to network and then onto service. For products, the level of information, requirements and guidance is well defined, while for services it tends to be less detailed;
Due to the inherent complexity of undertaking an LCA of a network service, not all mandatory requirements could be met for the tested services and the full compliance to the standard was not possible for all pilots, at least during the timeframe of this project;

Moreover, choices and mandatory requirements seem sometimes not fully relevant (e.g. annual use is mandatory in the functional unit) and may be more suitable if only recommended: other types of functional unit (per Gbit/per hour, on a specific use case and operating year, etc.) can be more accurate and relevant in the perspective of LCAs results aggregation for a service;

More guidance would be needed, in particular for networks and services. The pilots suggest providing examples to supplement the Annexes or provide additional references. Alternatively, cross referencing to other methodologies where appropriate may be another option (e.g. sections regarding network analysis and LCA estimation techniques). Providing guidance on the use of LCA estimation techniques, such as common component characterisation and life cycle stage ratios, under certain situations could save considerable resources and time;

**Data collection activities.** According to the pilots, the level of data specificity for a service (e.g. Section 5.2.4 - Table 2 - Tag B) may not always be possible – e.g. within core network portions where capacity / functionality are shared with multiple services/users. The requirements for specific end-of-life data may also not be possible in all situations, and considering the very small impact (typically, unless studied alone), they could seem unwarranted;

**Approaches to estimate LCA.** For the tested objects, ETSI TS 103 199 requirements in Section 5.2.4 - Table 2 for specific data for ICT Equipment Production (Tag B) were not possible for some portions of the network (where the network total capacity and functionality were shared with a vast number of service users). For this equipment, it was estimated that other LCA estimation techniques (e.g. life cycle stage ratios) could be suitable (this was supported by a comparative analysis with other existing detailed LCAs of the network equipment);

**Miscellaneous comments.** A small inconsistency has been identified. The methodology states on page 27 that "For assessment of Networks, operator activities shall always be included." This statement does not seem consistent with Table 1 of the methodology (p19), where operator support activities (C3) are only recommended for services;

Besides, the methodology states on page 32 (section 5.4) that "For other impact categories there is no methodological consensus in the LCA community". This statement could be nuanced, as DG JRC has been developing recommendations in the ILCD Handbook;

**Ease of application.** The ETSI TS 103 199 methodology may be difficult to apply by a service provider without the full support of all of its equipment vendors in relation to the GHG emissions of the hardware supporting the service (this issue also exists for manufacturers carrying out an LCA of their products, when modelling the use phase of the equipment);

The boundaries requirements (i.e. unit processes to include in the analysis) are more stringent than for the other two methodologies (e.g. Support Equipment manufacturing is mandatory);

Furthermore, the difference between operator and service provider is not clear enough and raises concerns. There is not always just one single operator (technical operator) or service provider: a single service can be based on multiple operators (one main operator and many technical sub-component suppliers, e.g. a third party hosting a specific platform subcomponent of the global platform). Regarding these support activities, there is also a need for a more detailed list of activities to be taken into account;
• Regarding the end-of-life assessment, it is very much dependent on the LCA tool used and none of the pilots were able to implement a 50/50 approach for this reason;
• Robustness. It is recommended that more guidance be provided for the practitioner to carry out sensitivity analysis, in particular with regard to networks and services;
• Reporting requirements. For the tested services, the pilots found data/reporting requirements to be excessive sometimes. Due to time constraints, full reporting according to Annex F was not carried out by the pilots, within the timeframe of the pilot testing process.

8.4.4 GHG Protocol Product Life Cycle Accounting and Reporting Standard - ICT-sector Guidance

Feedbacks of pilots concerning GHG Protocol Product Life Cycle Accounting and Reporting Standard - ICT-sector Guidance are listed below:
• Level of guidance. For the tested service (only one pilot), the TNS chapter of the ICT-sector Guidance, coupled with the GHG Protocol Standard thoroughly provides various techniques and guidance for conducting the GHG emissions assessment;
• Data collection activities. The pilots confirmed that the standard offers guidance on the approach to be followed in those cases when primary/secondary data may not be fully available (or at all), for the tested service. Estimation techniques are covered in detail;
• Approaches to estimate LCA. The pilots reported some uncertainty in the approach to conduct LCA by life cycle stage ratios, due to the comparison with equipment having very similar functional characteristics and operating profiles. In case of values concerning the total GHG emissions from all life cycle phases, the approach can be used to provide a good approximation of the share of emissions from each life cycle phase. However, for estimating a tangible value for the embodied phase emissions, a mismatch in the equipment type and also the uniqueness of the equipment under analysis (compared to the equipment representing the life cycle stage ratio information) can have a significant impact on the outcome of the results;
• The methodology was valuable in identifying those parts of the LCA (e.g. operational activities embodied phase) which were not of primary importance for a service assessment, under certain conditions;
• Ease of application. The pilot suggests that a service provider would find it reasonably straightforward to apply this methodology, counting on some support from its equipment vendors;
• Robustness. For the tested service, the methodology showed good robustness, particularly in critical areas such as sensitivity on drivers for variation in outcomes. For example, the greatest impact was in the use phase of the CPE equipment, and as such, a different operating profile for the CPE equipment has a significant impact on the outcomes of the LCA;
• Allocated time and resources to carry out the methodology. The pilot suggests that using LCA estimation techniques such as common component characterisation and life cycle stage ratios save considerable resources and time.
9 Overall recommendations

Besides the specific feedback and recommendations given towards policy makers and SDO’s in chapter 7 and 8, this chapter includes the overall recommendations.

9.1 Recommendations to public bodies
Based on the feedback of the volunteering ICT companies and described in chapter 7 Policy input the following overall recommendations are given to public bodies, like European Commission and national authorities:

- The established collaboration and interaction between EC and ICT companies has been valued by the ICT companies. The ICT companies and the third parties recommend finding ways to continue and sustain this collaboration;
- Since the opinion of the pilots about future policy measures based on the tested methodologies strongly depends on what the policy and/or requirements would look like, the third parties recommend following up this dialogue based on more concrete policy options;
- Several ICT companies have recommended aligning the activities concerning the ICT-sector, and implemented by the various DGs within the Commission (especially between DG Environment and DG CONNECT).

9.2 Recommendations to SDOs
Next to all detailed feedback on the methodologies as described in chapter 8 the volunteering companies and/or third parties have the following recommendations for SDOs:

- Some pilots suggest that ETSI and ITU work on a unique standard (or harmonisation), as they already have similar approach and requirements in ETSI TS 103 199 and ITU-T L.1410. More generally, SDOs should sustain communication and collaboration between them as much as possible to avoid redundant efforts;
- Most volunteering companies suggest providing more guidance (e.g. examples) for applying the methodology. More guidance on choosing emission factors, collecting data, assessing and ranking data quality, assessing uncertainties, allocating emissions, and reporting is requested by most pilot companies. Also more detailed PCRs/PEFCRs are required;
- Since the need for a global LCI/LCA database on ICT-specific emission sources/factors and PCRs/PEFCRs is diverse, the third parties recommend to further investigate this need among the participating ICT companies and/or broader in the sector.

9.3 Recommendations to ICT industry
Based on the feedback of the volunteering ICT companies the third parties recommend the ICT industry the following:

- The third party consultants recommend building upon the pilot results and jointly establishing a common framework to align footprinting of ICT-organisations, products and services, based on existing methodologies. This framework should be developed by the ICT-sector, but in close
cooperation with the SDOs. The ICT-sector is recommended to make sector specific agreements on how to deal with the most important drivers behind the accounting for the energy use and GHG emissions of products, services and organisations.

- Since the inaccuracy (or uncertainty level) of the results widely comes from the choice and quality of available inventory/activity data, the third parties recommend the ICT industry to investigate ways to share data and increase data quality.
- Finally it’s recommended, especially towards ICT companies with limited experience, to develop a supporting structure to help them with calculating their energy and carbon footprint (like seminars, workshops, online FAQ, or helpdesk).
Annex 1: Verification Statements Pilot results

Verification results organisation footprint pilots
Ecofys has performed a validation of the calculations and outcomes of all pilots and their compliance with the methodologies chosen. During this process, the pilot tests were validated on the 17 validation topics as prescribed in the road testing guidelines of this project. The validation has been done by:

- Auditing the calculation tool (or information available about this tool);
- Auditing the audit reports;
- Questions and answers through e-mail;
- A detailed interview through WebEx telephone with the responsible persons at the pilot companies.

Due to confidentiality reasons, Ecofys has not always been able to receive and validate the actual calculations. Also, some pilots have included conclusions and recommendations based on a detailed study and/or analyses of the methodologies but without performing actual calculations. In these instances, Ecofys has included the conclusions or recommendations that could be verified during the validation process.

Based on this validation, Ecofys concludes that the calculations are of appropriate quality and that all methodologies have been implemented correctly. All conclusions drawn in this report can be justified.

Verification results product footprint pilots
The following verification procedure was applied to all pilots:

- Quantis followed the checklist specified in the “Road testing guidelines” document (section 4.4.3) in order to check the footprint calculations and results of product pilots;
- Whenever available, Quantis checked if the calculation methodology documents were clear and followed the methodology structure.
- Whenever possible/applicable, the compliance with the methodologies was checked step by step. When these documents were not made available easily by companies (mostly due to confidentiality reasons), Quantis checked the calculation methodology by going to the company site or by organizing call conferences with companies concerned or by sending (by email) a checklist summarizing each point of methodology to validate their calculation approach and their compliance with the tested methodologies.

Based on the approach described above, Quantis made feedbacks to pilots by developing a list of questions/comments from documents (calculation and checklist documents, including spreadsheets) provided by pilots or from exchanges during interviews with companies. Quantis checked that all important choices made during the footprint calculation by pilots were explained in their documents.

If Quantis was not always in a position to provide a full validation of the calculations (for various reasons), Quantis can however validate, based on the verification procedure above, that the conclusions drawn by pilots as a result of the testing exercise are valid.

Verification results service footprint pilots
BIO Intelligence Service followed a validation process in order to verify both the compliance of the methodologies and the results provided by all the pilots:

- As a first step, the descriptions of the calculation methods were checked step by step by the team, in regards with their compliance with the methodologies requirements and recommendations;
- As a second step, questions and suggestions were submitted to the pilots in order to point out missing information, potential mistakes and clarify specific concerns. These were discussed between BIO Intelligence Service and the volunteering companies, either by e-mail exchanges, or by face-to-face meetings during which confidential calculation sheets were presented to the project team;
- Finally, the volunteering companies delivered a revised version of their deliverables (results were very slightly impacted by the revision).

The validation process that was undertaken allows BIO Intelligence Service to certify the quality and accuracy (when compliance has been achieved) of the results and feedback provided by the pilots on the three methodologies tested.
European Commission

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