Guide to ICT Carbon Footprint measurement tool

Contents

Introduction

The aim of this ICT Footprint measurement tool is to develop a method and technique which is flexible and complementary to existing methods that cities already use. It draws on existing international standards and methodologies (such as the ITU's L.1400 recommendations[1], GHG protocol, the Carbon Disclosure Project, as well as standards from International Bodies such as ISO14064) to enable cities to measure, compare and report on ICT's direct carbon footprint at a city level.

This tool is complimented by an online visualization tool to allow comparison of metrics across a specified time period, thereby supporting cities to evaluate their status in meeting the Green Digital Charter target of 30% reduction of CO2 emissions on ICT equipment over 10 years.

This ICT carbon measurement process provided in this document can be used by anyone. The visualization tool described can only be used by signatories of the Green Digital Charter (www.greendigitalcharter.eu) who have login access to the Green Digital Toolkit.

Approach

By following the 7-steps guide below, a City / Municipality can measure aspects of their ICT Footprint and analyse the results. The ICT Carbon Footprint measurement tool should be viewed as an iterative process, added to, or refined as local ICT records, relating to both equipment owned, or used (eg. outsourced services; 3rd parties who may attach their own ICT devices) by a City are identified, and/or authoritative data on energy usage for all ICT devices are published.

It is therefore recommended that a City's first attempt at measuring their ICT Footprint should be based on a self-contained Department which has a good record of their ICT assets. Once they have an ICT Footprint 'score', this should also identify where there are gaps and how they might refine the process. Especially in relation to equipment where there is no published energy rating, or possibly where on the first pass an estimated figure was used and subsequently an Agency (such as the ITU or Energy Star) has updated/expanded their energy / CO^2 database for ICT equipment.

[1] The L.1400 series of recommendations published by the International Telecommunications Union (ITU) presents general principles on assessing the environmental impact of information and communication technologies (ICT) and outlines the different methodologies that are being developed, namely:
L.1410 Environmental impact of ICT goods, networks and services
L.1420 Environmental impact of ICT in organisations
L.1440 Environmental impact of ICT in cities (expected in 2012-2013)

In Summary

7-step guide to measuring carbon footprint of ICT

This guide describes a process for cities to capture their energy data. This data can be collected in table format for city analysis. An example table is provided below.

ICT Carbon Footprint measurement tool v.1

Organisational Scope	Operational Scope	Time in Use	Time on Standby	Switched off	Power usage (watts)			Annual unit consumption	Number of units	Total power consumption pa.	Total Cost	CO_2 emissions (%)
Detail City Depts.	Categorise ICT Assets	(hours per year)	(hours per year)	(hours per year)	in-use	standby	switched off	(kWh)		(kWh)	Pence per kWh	(kgCO2e)
	Device Type										12.5	0.5246
Example - Finance	HP LaserJet printer	350	8410	0	550	7	0.4	251.37	6	1508.22	£ 188.53	131.87
Example - Finance	Laptop - type 1	1840	460	6460	65	18	0	127.88	24	3069.12	£ 383.64	67.09
Example - Finance	Desktop - type a	1840	1380	5540	60	5	0.5	120.07	10	1200.70	£ 150.09	62.99
Example - HR	HP LaserJet printer	320	160	8280	550	7	0.4	180.43	3	541.30	£ 67.66	94.65
Your city details here											£ -	-
											£ -	-
											£ -	-
											£ -	-
											£ -	-
											£ -	-
											£ -	-
											£ -	-
											£ -	-
											£ -	-
											£ -	-
										Totals	£ -	£ -

Figure 1: An example table for gathering ICT carbon footprint data

Key outputs from this data can be uploaded into a visualization tool on the Green Digital Toolkit using the spreadsheet provided (http://www.greendigitalcharter.eu/nice_toolkit/documents/Template.csv).

This spreadsheet captures the essential data for tracking the ICT carbon usage over time namely:

- *Asset*
- *Number of unit*
- *Uptime (hours)*
- *Standby (hours)*
- *Downtime (hours)*
- *Consumption (kWh)*
- *CO2 emissions (kgCO2e)*
- *Total Cost (your preferred currency or Euros)*

The data is plotted into a graph and provided in summary as a snapshot for analysis.

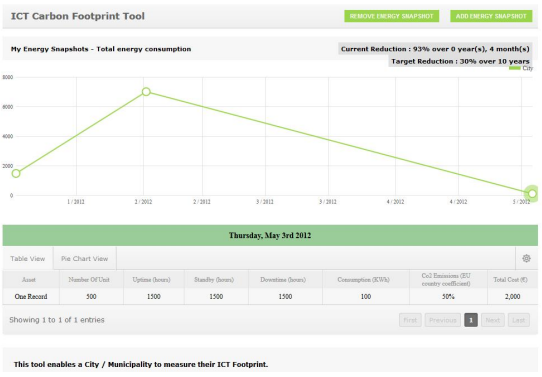


Figure 2: App for Visualizing ICT carbon footprint data over time

Gathering the ICT carbon footprint data

Step 1 – **Organisational Scope** – as stated in Recommendation ITU-T L.1420, "the organizational boundaries define which parts of the organisation to include in the energy consumption or emissions assessment (eg. main units, subsidiaries, joint ventures etc)", adding that irrespective of the approach chosen, ICT organisations should take into account all facilities used for the operation of the organisation, whether owned or rented.

Therefore at the outset of any ICT Footprint Reporting task, a City must firstly **define / agree** the boundaries of the departments[2] that are to be included (and excluded) from the City/Municipality's ICT Footprint.

Note: the data is best captured at a departmental level; thereby encouraging greater accountability for departmental footprints as well as ownership and accountability for a reduction plan manageable within a defined area of responsibility.

Step 2 – **Define the Assets** - gather data on the type[3] and number[4] of ICT devices to be included (NB. initial estimates can be refined with further ICT devices, improved analysis of device types, or other factors such as a cooling for high end devices).

Step 3 – **Estimate** – how much time in hours, on average, an asset is in use and is on standby, on an annual basis.

Step 4 – **Count / Calculate** – how much energy, in terms of kilowatt hours (kWh) each asset type uses, both when in use and on standby.

Energy use as duration
Calculating energy usage of ICT equipment can be either estimated as a rough guess or carefully measured based on the resources available to the city. At the very least, a city can use its energy bills and an estimation of working hours to calculate the period of time used by ICT equipment, categorized by when in use, on standby and off. Tools are also available to monitor equipment on an IP network to establish their on/off/standby status. One such tool (EasyArp) has been developed for the Green Digital Charter and is available from the Linkoping administration in Sweden in the Green Digital Toolkit.

Energy use by asset type
Currently there is no single source of trusted data on actual usage of energy by the wide range of ICT equipment used in cities. Cities are therefore developing their own methods for calculating energy usage (see Linkoping case study in this document). Products are available which will calculate the energy of equipment using 'plug in' monitors. Cities are encouraged to share the data they are capturing on energy use of ICT equipment with each other.

There is a European version of the Energy Star database (www.eu-energystar.org/en/database.shtml) where energy consumption data for office and related ICT equipment can be used. This is mainly restricted to office ICT equipment e.g. desktop and notebook computers; workstations; small-scale servers; monitors and imaging equipment. There are two ways in which the Energy Star database can be deployed. The more time consuming, but accurate way is to extract the number of devices of

[2] In the context of ICT Footprint Reporting, a "department" can be any function from a unit within the City council, to a mainstream function, such as education (eg. schools) or health (eg. hospitals).
[3] A list of equipment categories together with their energy use, energy cost and CO_2 Emissions complement the list contained in the Annex of L.1420, and are reproduced in this document as Annex A.
[4] The number of each type of device can be derived from an inventory list / asset register or an equipment audit provided by a City / Department.

a specific make, type and configuration (eg. Compaq laptop with Windows 7), and 'Search Database' – see examples in Figures 3 and 4, below:

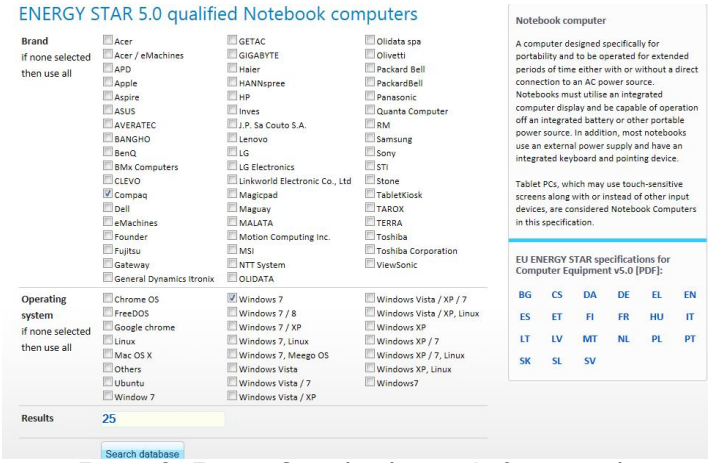


Figure 3: Energy Star database – Refine search

Figure 4: Energy Star database – Search results

Alternatively an approximation method can be deployed using the 'Energy Calculator' interface on the EU energy-star website (see Figure 5, below). This enables a user (eg. a City) to assess the energy

usage of a device by denoting equipment type (eg. Workstation, Multi-media PC, Imaging Equipment) and its Usage profile (eg. “Average office”, “Never switched off” etc),

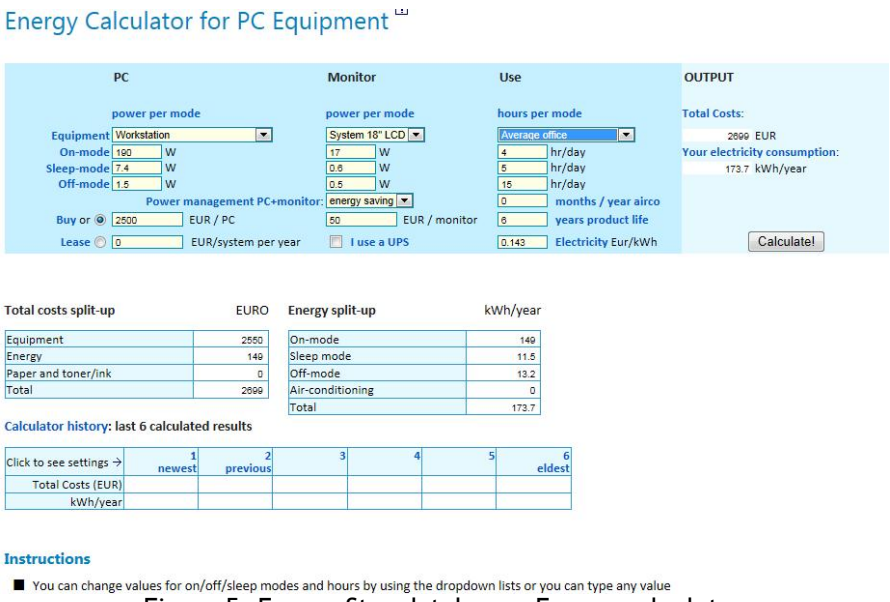


Figure 5: Energy Star database – Energy calculator

Step 5 – **Convert** the kWh units into a CO_2 rating (ie. kgCO2e) based on the energy conversion factor for grid electricity published at a regional or country level (in the UK this conversion factor is 0.5246[5]). NB. this figure could also influenced by the energy source (eg. this can be ‘top-down’ average for a City, or alternatively a ‘bottom-up’ approach based on knowledge of energy sources).

Note : to convert watts (ie. electrical power) into kilowatt-hour (kWh), the formula is “Energy (E) in kilowatt-hour (kWh) is equal to the power (p) in watts, multiplied by the time period (t) in hours divided by 1000”[6] (for example: what is the energy consumption in watt-hour when the power consumption is 5000 watts for time duration of 3 hours?). Answer : E = 5000W × 3h / 1000 = 15 kWh.

Step 6 – **Summarise** – the findings by Department and City, as appropriate.

Step 7 – **Action Plan** – detail the actions planned, or need to be undertaken and what effect these will have, and by when, on the City’s ICT Footprint.

Next steps

Cities are advised to repeat the 7-step plan across departments until an overall assessment of the city administration’s ICT carbon footprint can be made. It is recommended that the 7-step plan is refined, developed and repeated as the action plans are rolled out.

[5] Based on UK government (ie. Department of Energy and Climate Change) GHG conversion factors.

[6] http://www.rapidtables.com/calc/electric/watt-to-kwh-calculator.htm

Visualising ICT Carbon Footprint data

Cities are advised to repeat the 7-step plan across departments until an overall assessment of the city administration's ICT carbon footprint can be made. When the data has been captured to a satisfactory level, it can be uploaded into the Green Digital ICT Carbon Footprint Visualisation tool available on the NiCE toolkit.

The data is shared via a simple spreadsheet.

Asset	Number Of Unit	Uptime	Standby	Downtime	Consumption	Co2 Emissions	Total Cost
Example: Standard PC	2921	1670.14	-	7089.86	123.55742	144364.4895	204636.6639

This spreadsheet should be saved in CSV format and uploaded via the online tool (NB: if not saved in as a .csv file, the spreadsheet will not upload correctly).

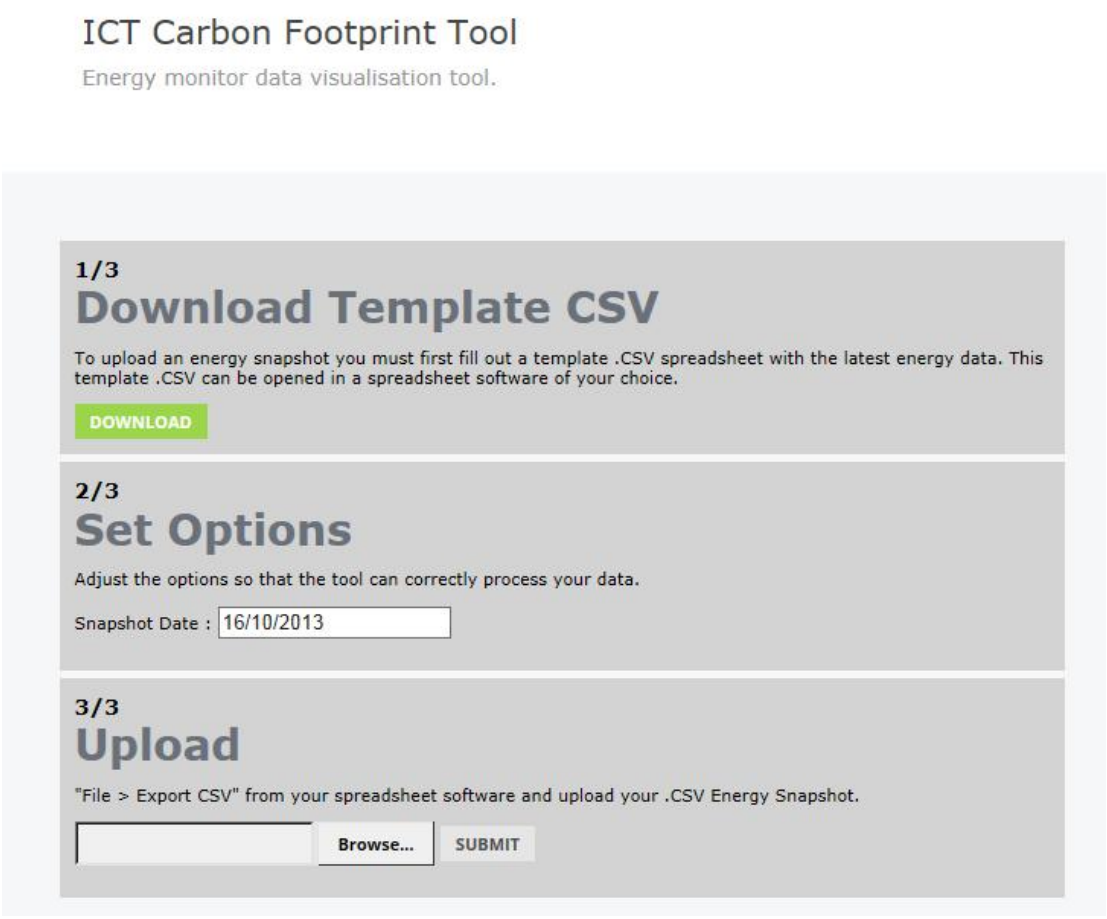
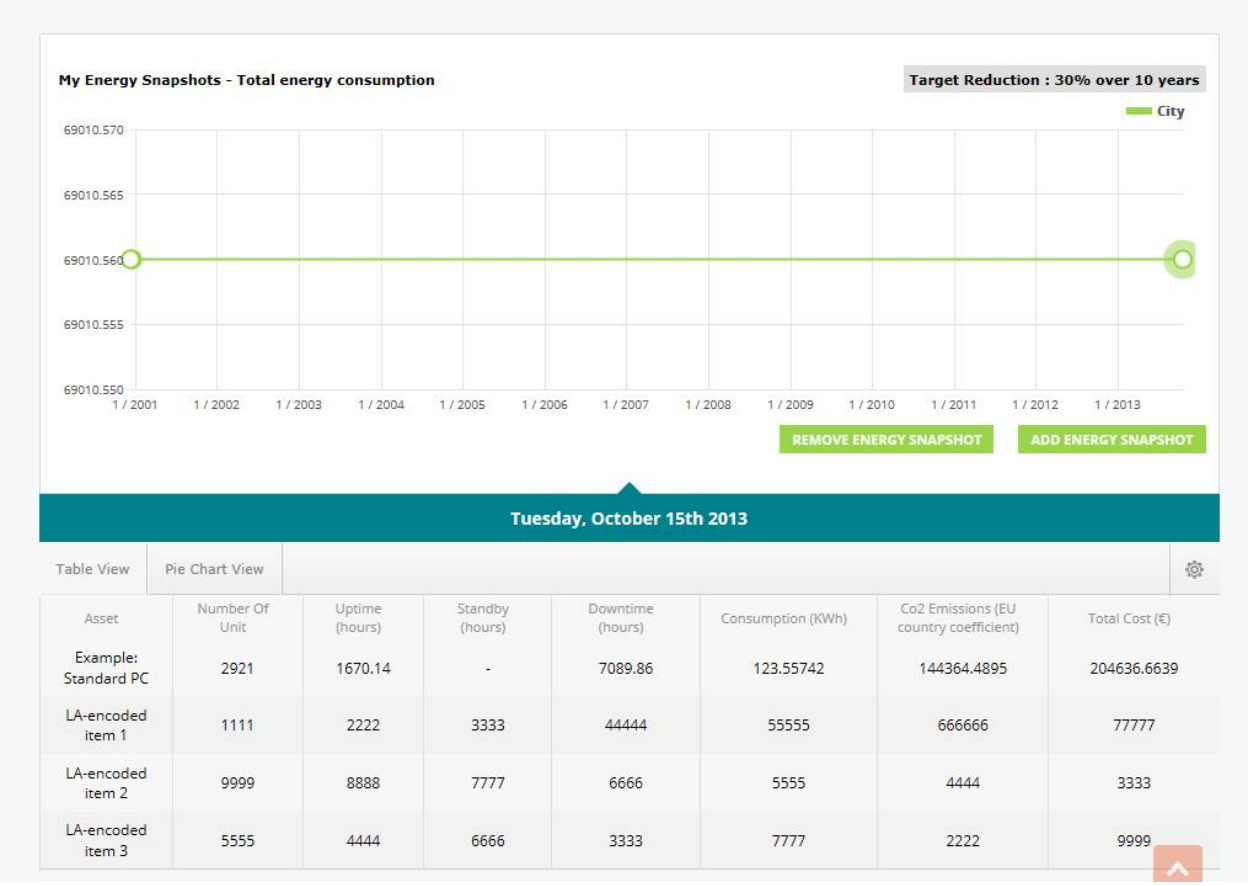


Figure 6: Green Digital ICT Carbon Footprint visualisation tool – data upload

Once uploaded, the CSV spreadsheet data will be presented in graphical format.



Asset	Number Of Unit	Uptime (hours)	Standby (hours)	Downtime (hours)	Consumption (KWh)	Co2 Emissions (EU country coefficient)	Total Cost (€)
Example: Standard PC	2921	1670.14	-	7089.86	123.55742	144364.4895	204636.6639
LA-encoded item 1	1111	2222	3333	44444	55555	666666	77777
LA-encoded item 2	9999	8888	7777	6666	5555	4444	3333
LA-encoded item 3	5555	4444	6666	3333	7777	2222	9999

Figure 7: Green Digital ICT Carbon Footprint visualisation tool – data visualisation

The tool works best with 2 or more data uploads across time, to show the changing trajectory of ICT carbon footprint data over time. The tool calculates the % reduction over a 10 year period so cities can see how well they are progressing towards their target 30% reduction.

This visualisation tool should be returned to again and again by cities. It can be used both for analysis and as a visual guide for presentations and political engagement.

Case Study: Linkoping public administration, Sweden

The Green Digital Charter team worked with the ICT Strategy team within Linkoping public administration in Sweden to develop this ICT Carbon Measurement tool.

Linkoping used the 7 step guide and the spreadsheet provided to capture ICT asset data. This is an account of their process.

Step 1 – **Organisational Scope:**
Linkoping already have an asset register in their city so they were able to cover all departments and organisations that are served by their ICT department in the city and which use the city-wide IP network.

Step 2 – **Define the Assets**:
Linkoping were able identify ICT equipment across the different departments including the data centre itself. Since Linkoping manage ICT for all their schools, this included all PCs, laptops and tablets used by students and teachers.

Step 3 – **Estimate**:
Linkoping tried to identify the energy usage of ICT equipment using Symantec utilities but there was a bug in the software so they needed to try another method. They then looked at open source software available on the internet, but no tools suited their purposes. They could identify what ICT equipment was on via their IP network, but they could not work out *how long* the equipment was on for nor when it was on standby and when it was off. Eventually they wrote a quick software tool themselves, called EasyArp (now available as open source software), which uses ARP tables to identify what equipment is on the IP network. ARP table is read every 30 min and the information stored in a database, on which they could run queries. Since Linkoping use a strict naming convention for host names, they were able to identify the *type* of equipment being used from the ARP tables and cross-reference it with their asset register. The equipment was grouped into categories rather than by brand/make to make the counting process faster and easier.

Step 4 – **Count / Calculate:**
Linkoping used the spreadsheet provided to capture the details of the ICT equipment and their time on and off. They added rows and columns to improve their calculations as required. While there is no standardized measure of the actual energy use of ICT equipment, Linkoping identified supplier estimations of energy use and cross-checked this with their own measurements using physical 'off the shelf' plug in monitors. They identified energy use factors for each category of ICT equipment.

Step 5 – **Convert:**
Linkoping have energy provision from renewable sources so they identified an energy conversion factor in discussion with their national energy metrics team. This metric was included in the spreadsheet to calculate CO2 emissions of the different categories of ICT equipment. The energy use of the data centre was added in as a final item on the spreadsheet based on its energy usage per quarter, found in its energy bills.

Step 6 – **Summarise**
Linkoping came to some interesting conclusions from looking at their data. Compared to a similar measurement 2008 (Fig 5), they found that their CO2 emissions by 2013 (Fig 6) had dropped even though the number of ICT assets they owned increased in the same period. They attributed this to the more efficient ICT equipment, but also questioned the industry estimates on which they had based their calculations.

Step 7 – **Action Plan**

Linkoping continue to refine their energy measurement data and are developing action strategies based on their findings.

ICT Carbon Footprint measurement tool v.1

Results from Linköping 2008

In 2008 Linköping made measurements of how many computers was used daily, for how many hours and what their energy consumption was
The measurement only covered PC's, Thin clients and the Datacentre. It focused on detecting machines that wasn't turned off during night-time. Average numbers for power usage were u
Here we have put the numbers from 2008 into the same reporting format as we use today
Cost and Co2 emmision value from 2008 has been used

Organisational Scope	Operational Scope	Time in Use	Time on Standby	Switched off	Power usage (watts)			Annual unit consumption	Nur of u
Detail City Depts.	Categorise ICT Assets	(hours per year)	(hours per year)	(hours per year)	in-use	standby	switched off	(kWh)	
	Device Type								
	PC & screen 9 hours a day	2034		6726	170	0	0	346	4
	PC & screen 24 hours a day	8760		0	170	0	0	1,489	6
	Thin client 9 hours a day	2034		6726	66	0	0	134	1
	Thin client 24 hours a day	8760		0	66	0	0	578	8
	Datacenter	8760		0	97,000	0	0	849,720	

This spreadsheet is accompanied by a 7 step guide on measuring carbon footprint of ICT in city administrations - accessible here: http://www.green

Workdays per year	226	
	hours per day	Switched off
PC & screens	9	15
Thin client & screens	9	15
Datacenter	24	0

Figure 7: Linköping calculation of 2008 ICT carbon footprint measurements

.

ICT Carbon Footprint measurement tool v.1

ganisational Sco	Operational Scope	Time in Use	ime on Standb	Switched off	Power usage (watts)			Annual unit consumption	Number of units	Total power consumption pa.	Total Cost	CO_2 emissions (%)
Detail City Depts.	Categorise ICT Assets	(hours per year)	(hours per year)	(hours per year)	in-use	standby	switched off	(kWh)		(kWh)	SEK per kWh	(kgCO2e)
	Device Type										0.338	0.09
Example - Finance	*HP LaserJet printer*	*350*	*8410*	*0*	*550*	*7*	*0.4*	*251.37*	*6*	*1508.22*	*£ 5.10*	*22.62*
Example - Finance	*Laptop - type 1*	*1840*	*460*	*6460*	*65*	*10*	*0*	*127.88*	*24*	*3068.12*	*£ 10.37*	*11.51*
Example - Finance	*Desktop - type a*	*1840*	*1380*	*5520*	*60*	*5*	*0.5*	*120.07*	*10*	*1200.70*	*£ 4.06*	*10.81*
Example - HR	*HP LaserJet printer*	*320*	*160*	*8280*	*550*	*7*	*0.4*	*180.43*	*3*	*541.30*	*£ 1.83*	*16.24*
HP2570p	**Ultraportable PC**	**1670.14**		**7089.86**	**47**	**1.47**	**1.17**	86.7917162		0.00	- kr	-
	Portable PC & screen	**1670.14**		**7089.86**	**57**	**3.6**	**4**	123.55742	**2921**	360911.22	**121,987.99 kr**	**32,482.01**
HP8470p	**Portable Advanced PC**	**1670.14**		**7089.86**	**43**	**1.45**	**1.43**	81.9545198		0.00	- kr	-
	Portable Workstation PC	**1670.14**		**7089.86**	**49**	**2.38**	**1.74**	94.1732164		0.00	- kr	-
	iMac	**1670.14**		**7089.86**	**114**	**0.75**	**0.75**	195.713355		0.00	- kr	-
HP6300	**PC Standard & screen**	**1670.14**		**7089.86**	**86**	**4.2**	**2.5**	161.35669	**3429**	553292.09	**187,012.73 kr**	**49,796.29**
	PC Workstation	**1670.14**		**7089.86**	**65**	**3.12**	**1.81**	121.3917466		0.00	- kr	-
Igel UD2	**Thin client**	**4520**		**4240**	**43**	**2.75**	**0.75**	197.54	**495**	97782.30	**33,050.42 kr**	**8,800.41**
	iPad	**904**		**7856**	**3**	**0**	**0**	2.712		1342.44	**453.74 kr**	**120.82**
	Laser printer colour	**113**		**8647**	**445**	**18**	**0.48**	54.43556		0.00	- kr	-
	Laser printer b/w	**226**		**8534**	**610**	**28**	**0.1**	138.7134	**1014**	140655.39	**47,541.52 kr**	**12,658.98**
	Printer Simple	**113**		**8647**	**550**	**7**	**0.4**	65.6088		0.00	- kr	-
	Multifunction Printer	**226**		**8534**				0	**78**	0.00	- kr	-
	Video projector	**226**		**8308**				0		0.00	- kr	-
HP L2245wg	**Extra screen 22"**	**1670.14**		**7089.86**	**34**	**0.75**	**0.71**	61.8185606		0.00	- kr	-
	IP phone	**8760**		**0**				0	**305**	0.00	- kr	-
	Extra screen 24"	**1670.14**		**7089.86**	**47**	**1.22**	**0.82**	84.3102652		0.00	- kr	-
	Datacenter									960,000	**324,480.00 kr**	**86,400.00**
										Totals	**714,526.40 kr**	190,258.51

This spreadsheet is accompanied by a 7 step guide on measuring carbon footprint of ICT in city administrations - accessible here: http://www.greendigitalcharter.eu/toolkit/toolkit_ICTcarbonFootprintTool.php

Workdays per year	226	
	hours per day	Switched off
PC & screens	7.39	16.61
Thin client & screens	20	4
Ipad	4	20
Laser colour	0.5	23.5
Laser b/w	1	23
Printer Simple	0.5	23.5
Multifunction printer	1	23
Video projector	2	22
IP phone	24	0

Green = measured real energy consumption
Yellow = exact number based on measurements

Figure 8: Linköping calculation of 2013 ICT carbon footprint measurements

Annex A

List of goods to be considered when assessing the impact of ICT activities in organisations

(This annex forms an integral part of ITU-T L.1420 Recommendation, and has been reproduced from the ITU-T document)

When emissions due to goods used by the organisation are concerned, the emissions from the following types of goods may be considered. The following list is not exhaustive and shows typical examples:

- Desktops;
- Laptops;
- Cathode Ray Tube (CRT) screens;
- Flat screens;
- Individual printers;
- Cables;
- Network printers and copies;
- Servers, switches and routers;
- Fax machines;
- Scanners;
- Fixed phones;
- Mobile phones;
- Personal Digital Assistants (PDA) and tablets;
- Projectors;
- Videoconference installations;
- Televisions;
- Cooling systems for ICT goods;
- Other small ICT goods;
- Outsourced ICT goods, in particular outsourced datacentres;
- Power supply back-up generators.

It should be noted that these generators systems have to be dedicated to the ICT goods in this list. Otherwise an allocation approach would need to be used if the generators system is used for more than the ICT goods. The same remark applied for the cooling systems for ICT good mentioned above.

Annex B

EU ENERGY STAR qualified office equipment

EU database description

This EU Energy Star database (www.eu-energystar.org) contains only products that are available in the EU. It is based on the US EPA database (for products available in the EU) plus products that are directly registered with the EU, managed by the European Commission. For (legal) disputes the lists of qualified products downloadable from the above website (for the EC) and from www.energystar.gov (for the US) are applicable. The database is intended to make the registered products more accessible.

The database shows energy consumption and main performance data as supplied by the manufacturers. Pictures (100 x 100 pixels) and brand-specific websites (if available) for the most recent models of ENERGY STAR qualified equipment are added.

How to Use

- Click on one of the main categories in the right menu or in the dropdown-menu above.
- A selection form for the category will appear, allowing you to select various product features.
- You can also limit your query by choosing product-specific **ATTRIBUTES** and specific **BRANDS**. If none are selected, then all models will be shown. The total number of models in your selection is indicated in the **Results** line.
- After pressing the **Search Database** button a table containing the models in your selection will appear. The data-rows in this table can be ***sorted*** in ascending or descending order on a maximum parameters in the headers by clicking red (first sort order) and blue (second sort order) triangular buttons.
- To view **Pictures** and website-URLs of selected models (only recent EU), use the checkboxes at the beginning of each row and then click the **View** button at the top of the first table-column. You will then see the new table with just the selection and the pictures.
- To return to previous tables use the **Back** button at the top of the page.

End