

**EPEAT Standards Development Roadmap  
(EPEAT SDR)**

**Background and Discussion Document**

**April 10, 2007**



*Zero Waste  
Alliance*

**Prepared by Zero Waste Alliance  
with support from  
The Center for Clean Products and Materials Policy  
and the  
US EPA**

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## **Purpose**

The purpose of this report and comment page is to receive and capture comments from all stakeholders so that we can understand their perspective and synthesize the consensus or at least general agreements.

The material presented in this document was developed by Zero Waste Alliance and the Center for Clean Products and Materials Policy at the University of Tennessee. It is preliminary, based on material that is publicly available, and only partial at this point in time. While we believe it to be useful, it has not been verified nor is it endorsed by this project. It is presented as reported findings for stakeholder awareness, not as a presentation of facts.

## **1.0 Project Overview**

### ***1.1 Purpose of SDR Project***

The purpose of the EPEAT Standard Development Roadmap (SDR) project is to gather input from interested stakeholders on:

- 1) Which electronics products are the highest priority for the development of new leadership environmental standards
- 2) Order in which to develop standards
- 3) Possible groupings of products into appropriate standards
- 4) Issues that need to be considered both in the prioritization and the actual standards development.

This project is being organized and facilitated by a Project Team consisting of representatives of EPA, Green Electronics Council and Zero Waste Alliance. This Team is soliciting and receiving the stakeholder input, and obtaining other sources of data and research to help make the project decisions.

The Team will synthesize the stakeholder input into a “Standards Development Roadmap” document with recommendations for the process and sequence for developing environmental leadership standards for electronic products over the next few years. These recommendations will be presented to the stakeholders to make sure that they have accurately captured the input.

The Standards Development Roadmap recommendations will then be implemented through product standard development processes by other groups, through involvement of stakeholders. These groups that will organize the development of the product standards have not been identified, though they will likely include representation from the Green Electronics Council, EPA, state and local governments, manufacturers, retailers, not-for-profit organizations and others.

A stakeholder review draft of the Standards Development Roadmap (see Section 1.2) will be posted on this website ([www.zerowaste.org/epeat\\_collab](http://www.zerowaste.org/epeat_collab)) on or before May 21<sup>st</sup>. Two teleconferences will be held June 14<sup>th</sup> and 19<sup>th</sup> to solicit stakeholder feedback. Final recommendations will be presented to stakeholders in mid June.

Initial information to aid in framing the project was collected through a convening assessment ([http://zerowaste.org/epeat\\_collab/files/Convening\\_Assessment\\_Findings\\_070408.pdf](http://zerowaste.org/epeat_collab/files/Convening_Assessment_Findings_070408.pdf) and attached below (on webpage). In addition, The Center for Clean Products and Materials Policy at

the University of Tennessee gathered existing research and reports on environmental and energy profiles for the priority products. The information from this existing research and reports is presented below and will be incorporated into the recommendations along with stakeholder input. It has not been verified nor is it endorsed by this project. It is presented as reported findings for stakeholder awareness, not as a presentation of facts.

The EPEAT SDR Project is being managed by Zero Waste Alliance ([www.zerowaste.org](http://www.zerowaste.org)) with support from US EPA.

Thank you and we appreciate your input.

More information on the project can be found at [www.zerowaste.org/epeat/roadmap.htm](http://www.zerowaste.org/epeat/roadmap.htm).

## ***1.2 Development of Roadmap Recommendations***

Following the public comment period for this Background and Discussion Document, the SDR project team will develop a Draft Standards Development Roadmap for stakeholder review. The Roadmap will include recommendations on:

- Priority products for standards development
- Grouping of products for standards development
- Sequencing and/or timing recommendations and prioritization of products/categories
- Synthesis of considerations used to develop recommendations (market share, environmental impacts, interest, other standards, etc)
- Potential areas of concern that were identified via this process
- How the current standard for computers and monitors, IEEE1680, fits into the Roadmap
- Possible implementation issues (e.g. identification of a Standard Development Organization such as IEEE served for 1680)

The Roadmap is intended to present stakeholder input. Future activities for the development of electronic standards for EPEAT are expected to follow the recommendations of this Roadmap and to honor the intentions of the stakeholders. The Roadmap, however, will not imply a commitment by any of the stakeholders.

## ***1.3 Preliminary Observations***

This section presents some preliminary observations of proposed priority products (see Section 2.1 for more discussion on proposed priority products) based on the information collected to date. Understanding that the following report is lengthy, this section is offered as a way for stakeholders to quickly provide comment on some of the key factors that will be used in designing the Standards Development Roadmap. The information is presented in two sets of tables:

- The first matrix is a preliminary summary of identified considerations, with the exception of environmental and energy profile information
- The second set of tables is a preliminary summary of opportunity for environmental benefits

The following observations and supporting tables below are offered for consideration by stakeholders:

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- Since a core principle of EPEAT is to build on existing standards or requirements, if such a starting point is not available for a product type, the timing of a new standard should be either postponed or coordinated with other standard development. This is the case for servers, for which an ENERGY STAR standard does not exist, but is under development. This may delay the timing of development of a server standard.
- The IEEE 1680 standard is specifically targeted for institutional purchasers with their involvement and input. Some product types, most especially TVs, are not major in the institutional market, but are in the consumer market. It would be important to hear real interest from representatives of that market as to their interest in an environmental standard before departing from the original intent of EPEAT.
- Some product types, such as TVs, are very closely related to computers and monitors in the environmental criteria that would be included. It may be easiest to expand or modify the existing IEEE 1680 to accommodate those products.
- For some product types, such as cell phones and PDAs, the environmental criteria may be quite different, though possibly parallel to the existing standard for computers and monitors. Though there is a substantial body of environmental literature, there are not a lot of existing standards. This may make standard development more difficult and time consuming.
- For some product types, especially printers and imaging devices, there are quite a few existing standards that could make standard development easier if those standards include environmental criteria that are acceptable to stakeholders.

Provided in the table below is a brief summary of the observations collected to date. Each cell corresponds to a section in the following report with more information, questions to stakeholders and an opportunity to comment.

Preliminary Summary of Considerations for Proposed Priority Products						
	Proposed Product Definition	Existing Standards	Ease of Standard Development	Market Characteristics	Stakeholder Interest	Other Factors To Be Considered in Product Selection and/or Standard Development
<p><b>Cell phones, Smartphones and PDAs (Section 3.1)</b></p>	<p><b>Proposed cell phone definition from Blue Angel:</b> Mobile phones operating according to the GSM, GPRS or UMTS standard. The products shall be primarily designed for the transmission of telephone calls and messages. They may, however, offer additional functions, such as, for example, organizers, as well as wireless internet access and data transmission via infrared interfaces or Bluetooth.</p> <p><b>Proposed smartphone definition:</b> Smartphones are generally considered any handheld device that integrates personal information management and mobile phone capabilities in the same device. Often, this includes adding phone functions to already capable PDAs or putting "smart" capabilities, such as PDA functions, into a mobile phone. Examples include the Palm Treo, the Blackberry, and the Motorola Q. Smartphones functions can include games, mobile video, e-mail, music mp3 files, news and information, or video and picture taking.</p> <p><b>Proposed PDA definition:</b> Handheld devices that offer multiple functions including (but not limited to) personal contact storage and</p>	<p>Cell phones: TCO and Blue Angel PDAs: None identified (See Section 3.1.1)</p>	<ul style="list-style-type: none"> <li>• The environmental criteria for these products would be expected to be substantially different from those for computers/monitors in IEEE 1680.</li> <li>• There exists a very strong basis of scientific literature, including LCAs, about the environmental impacts of these products.</li> <li>• (See Section 3.1.4)</li> </ul>	<ul style="list-style-type: none"> <li>• US consumer sales of cell phones and PDAs doubled every 5 years from 2002 to present and will be 130 million units in 2007 (CEA, 2007)</li> <li>• Converged mobile device market grew 42% in 2006 totaling over 80 million units sold world wide (IDC, 2007a)</li> <li>• (See Section 3.1.5)</li> </ul>	<p>Please provide input in Section 3.1.6.</p>	<p>Please provide input in Section 3.1.7.</p>

	retrieval, calendar functions, music player, web browsing, as well as wireless internet access and data transmission via infrared interfaces, Bluetooth, or Wi-Fi. They should have a user interface that allows entering text via touch screen or keyboard. (See Section 3.1.1)					
<b>Printers (Section 3.2)</b>	<b>Proposed product definition from ENERGY STAR:</b> A commercially-available imaging product that serves as a hard copy output device, and is capable of receiving information from single-user or networked computers, or other input devices (e.g., digital cameras). The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as printers, including printers that can be upgraded into multi-function devices in the field. (See Section 3.2.1)	ENERGY STAR, TCO, Nordic Swan, Japanese Eco-Mark, Environmental Choice EcoLogo and Blue Angel (See Section 3.2.1)	<ul style="list-style-type: none"> <li>• These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as printers.</li> <li>• The possible desire of some stakeholders to address consumables, and the uniqueness and possible difficulty of addressing that issue, could complicate standard development.</li> <li>• There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.</li> <li>• (See Section 3.2.4)</li> </ul>	US <b>consumer</b> sales of printers (product as defined by CEA, 2007) are relatively flat at 20 million units/year (CEA, 2007). (See Section 3.2.5)	Please provide input in Section 3.2.6.	Please provide input in Section 3.2.7.
<b>Facsimile Machines (Section 3.3)</b>	<b>Proposed product definition from ENERGY STAR:</b> A commercially-available imaging product whose primary functions are scanning hard copy originals for electronic transmission to remote units and receiving similar electronic transmissions to produce hard copy output. Electronic transmission is primarily over a public telephone system, but also may be via computer network or the	ENERGY STAR, Blue Angel, Environmental Choice EcoLogo and Nordic Swan. The TCO printer standard also applies. (See Section 3.3.1)	<ul style="list-style-type: none"> <li>• These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as fax machines.</li> </ul>	There is convergence with other imaging devices in the consumer fax machine market, and a notable decline in single function consumer fax machines. Overall, US consumer sales of fax machines (product as defined by CEA) have declined from	Please provide input in Section 3.3.6.	Please provide input in Section 3.3.7.

	Internet. The product also may be capable of producing hard copy duplicates. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as fax machines. (See Section 3.3.1)		<ul style="list-style-type: none"> <li>• The possible desire of some stakeholders to address consumables, and the difficulty of addressing that issue, could complicate standard development</li> <li>• There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.</li> <li>• (See Section 3.3.4)</li> </ul>	2.3 million in 2002 to 1.2 million in from 1.2 million units in 2007 (CEA, 2007). (See Section 3.3.5)		
<b>Copiers (Section 3.4)</b>	<b>Proposed product definition from ENERGY STAR:</b> A commercially-available imaging product whose sole function is the production of hard copy duplicates from graphic hard copy originals. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as copiers or upgradeable digital copiers. (See Section 3.4.1)	ENERGY STAR, Blue Angel, Nordic Swan, Environmental Choice EcoLogo and Japan Eco-Mark (TCO printer standard may apply) (See Section 3.4.1)	<ul style="list-style-type: none"> <li>• These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as copiers.</li> <li>• The possible desire of some stakeholders to address consumables, and the difficulty of addressing that issue, could complicate standard development</li> <li>• There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.</li> <li>• (See Section 3.4.4)</li> </ul>	Market data was not located for copiers. Please provide any input on data sources in Section 3.4.5.	Please provide input in Section 3.4.6.	Please provide input in Section 3.4.7.
<b>Scanners (Section 3.5)</b>	<b>Proposed product definition from ENERGY STAR:</b> A commercially-available	ENERGY STAR and Blue Angel (See	<ul style="list-style-type: none"> <li>• These products are likely to have many of the</li> </ul>	Market data was not located for scanners. Please provide	Please provide input in Section 3.5.6.	Please provide input in Section 3.5.7.

	imaging product that functions as an electro-optical device for converting information into electronic images that can be stored, edited, converted, or transmitted, primarily in a personal computing environment. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as scanners. (See Section 3.5.1)	Section 3.5.1)	<p>environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as scanners.</p> <ul style="list-style-type: none"> <li>• There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.</li> <li>• (See Section 3.5.4)</li> </ul>	any input on data sources in Section 3.5.5.		
<b>Multi-Function Devices (Section 3.6)</b>	<b>Proposed product definition from ENERGY STAR:</b> A commercially-available imaging product, which is a physically-integrated device or a combination of functionally-integrated components, that performs two or more of the core functions of copying, printing, scanning, or faxing. The copy functionality as addressed in this definition is considered to be distinct from single sheet convenience copying offered by fax machines. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as MFDs or multifunction products (MFPs). (See Section 3.6.1)	ENERGY STAR, Blue Angel, Nordic Swan, TCO, Environmental Choice EcoLogo and Japan Eco-Mark (See Section 3.6.1)	<ul style="list-style-type: none"> <li>• These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as MDFs.</li> <li>• The possible desire of some stakeholders to address consumables, and the difficulty of addressing that issue, could complicate standard development</li> <li>• There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.</li> <li>• (See Section 3.6.4)</li> </ul>	Market data was not located for MFDs. Please provide any input on data sources in Section 3.6.5.	Please provide input in Section 3.6.6.	Please provide input in Section 3.6.7.
<b>Servers (Section 3.7)</b>	<b>Proposed product definitions from ENERGY STAR:</b> <b>Mid-range and larger servers:</b>	An ENERGY STAR standard is under development for mid-	<ul style="list-style-type: none"> <li>• Servers are likely to have similar environmental criteria</li> </ul>	Research firm IDC estimated that there were 1.8 million new servers installed in 2002,	Please provide input in Section 3.7.6.	Please provide input in Section 3.7.7.

	<ul style="list-style-type: none"> <li>• Designed and placed on the market as a Class A product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a single or dual processor capability (1 or greater sockets on board);</li> <li>• Placed on the market as a Class B product, but hardware upgraded from a Class A product, per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed capable of having a single or dual processor capability (1 or greater sockets on board); and</li> <li>• Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a <i>minimum</i> dual processor capability (2 sockets on board).</li> </ul> <p><b><u>Desktop-Derived Servers (in ENERGY STAR's computer standard):</u></b> A desktop-derived server is a computer that typically uses desktop components in a tower form factor, but is designed explicitly to be a host for other computers or applications. For the purposes of this specification, a computer must be marketed as a server and have the following characteristics to be considered a desktop-derived server:</p> <ul style="list-style-type: none"> <li>▪ Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and has no more than single</li> </ul>	<p>range and larger servers. Desktop derived servers fall under ENERGY STAR's new computer standard. (See Section 3.7.1)</p>	<p>to computers with the exception of energy conservation.</p> <ul style="list-style-type: none"> <li>• There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.</li> <li>• An ENERGY STAR standard is presently under development for mid-range and larger servers. This could impact the timing of the finalization of an EPEAT standard.</li> <li>• (See Section 3.7.4)</li> </ul>	<p>and estimates that by 2009, that number will increase to 4.9 million per year (<a href="http://www.publiccio.com">www.publiccio.com</a>, 12/19/2006) (See Section 3.7.5)</p>		
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	<p>processor capability (1 socket on board);</p> <ul style="list-style-type: none"> <li>▪ Designed in a pedestal, tower, or other form factor similar to those of desktop computers such that all data processing, storage, and network interfacing is contained within one box/product;</li> <li>▪ Designed to operate in a high-reliability, high-availability application environment where the computer must be operational 24 hours/day and 7 days/week, and unscheduled downtime is extremely low (on the order of hours/year);</li> <li>▪ Capable of operating in a simultaneous multi-user environment serving several users through networked client units; and</li> <li>▪ Shipped with an industry accepted operating system for standard server applications (e.g., Windows NT, Windows 2003 Server, Mac OS X Server, OS/400, OS/390, Linux, Unix and Solaris).</li> </ul> <p>(See Section 3.7.1)</p>					
<p><b>Televisions (Section 3.8)</b></p>	<p><b>Proposed product definitions from ENERGY STAR:</b>  <b>Television (TV):</b> A commercially available electronic product consisting of a tuner/receiver and a monitor encased in a single housing. The monitor usually relies upon a cathode-ray tube (CRT), liquid crystal display (LCD), plasma display, or other display device. The TV is designed to receive and display a television signal broadcast by antenna, satellite, or cable. To qualify, the TV must be capable of being powered from either a wall outlet or a battery unit that is sold with an AC adapter. This definition includes analog and digital televisions in addition to</p>	<p>ENERGY STAR, TCO and Nordic Swan (See Section 3.8.1)</p>	<ul style="list-style-type: none"> <li>• TVs could be expected to have very similar environmental criteria to monitors, as included in IEEE 1680. It may even be possible, with some modification, to include TVs within IEEE 1680 through a revision process.</li> <li>• Since TVs are primarily a consumer-marketed product, this would require modification of the intent of IEEE 1680, and possibly some of the text.</li> <li>• The purchaser stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• There has been a dramatic rise in flat panel sales. By 2008, FPDs are projected to account for 85% of the US market (King County, 2007)</li> <li>• The upcoming switch from analog to digital TV in February 2009 will drive sales</li> <li>• Current US sales of TVs overall around 31-34 million units/year</li> <li>• (See Section 3.8.5)</li> </ul>	<p>Please provide input in Section 3.8.6.</p>	<p>Please provide input in Section 3.8.7.</p>

	<p>televisions that require additional power to receive and process signals that contain information and/or data for electronic programming guides. Television products with a tuner/receiver and computer capability (e.g., computer input port) may qualify as long as they are marketed and sold to consumers as televisions (i.e., focusing on television as the primary function). However, products with a tuner/receiver and computer capability that are marketed and sold as 1) computer monitors or 2) dual function televisions and computer monitors are not included in this specification.</p> <p><b>Television Monitor:</b> An electronic product intended to display a video signal from an external tuner or other video source such as a VCR or DVD Player on a CRT, LCD, plasma display, or other display device. To qualify, the television monitor must be capable of being powered from either a wall outlet or a battery unit that is sold with an AC adapter. This definition includes analog and digital television monitors. Television monitors with computer capability (e.g., computer input port) may qualify as long as they are marketed and sold to consumers as television monitors (i.e., focusing on television/video as the primary function). <i>However, products with computer capability that are marketed and sold as 1) computer monitors or 2) dual function television and computer monitors are not included in this specification.</i> (See Section 3.8.1)</p>		<p>would be different from EPEAT for computers/monitors due to their consumer market presence.</p> <ul style="list-style-type: none"> <li>• There is considerable literature regarding the environmental impacts of CRTs, but much less regarding flat panel displays which would be the focus of the standard.</li> <li>• (See Section 3.8.4)</li> </ul>			
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**Preliminary Summary of Opportunity for Environmental Benefits**

The calculations provided below are simple estimates using the data reported in the body of this report and are meant as simple bounding estimates of the potential of future standards development. Key data points or assumptions used in the calculations are listed. Please note that:

- The variation in units of the data may not allow direct comparisons (e.g. US versus world wide)
- Calculations are not provided for the products where environmental and/or energy data was not located
- Data supporting these calculations and citations are provided in the body of the report in the sections referenced for each table
- The first table is a summary of the calculations and the remaining tables are by product and include the key data used in the calculations

<b>Preliminary Summary of Opportunity for Environmental Benefits</b>					
	<b>Solid Waste</b>	<b>GHG</b>	<b>PM10</b>	<b>BFRs</b>	<b>Other</b>
<b>Cell phones</b>	<b>23.7 metric tons</b> of waste (U.S.) disposed in <b>2005</b> <b>132 metric tons</b> of waste (U.S.) projected by <b>2010</b>	<b>2.2 million metric tons</b> of CO2 emitted (U.S.) from phone <b>mfg in 2005</b> <b>12.2 million metric tons</b> of CO2 (WW) from <b>mfg projected in 2010</b>	<i>Need kWh of energy consumption during mfg to calculate</i>	<b>163.8 metric tons</b> of BFRs used in phone <b>mfg (U.S.) in 2005</b>	
<b>Printers</b>	<i>Need average mass of printer to calculate</i>	<b>6.9 - 10.3 million metric tons</b> of CO2 emitted (U.S.) from printer <b>use</b> depending on lifespan of printers <b>9.2 million metric tons</b> of CO2 emitted from printer <b>use in EU (2007)</b>	<b>728 - 1,092 metric tons</b> of PM10 emitted (US) from printer <b>usage in 2007</b> depending on lifespan of printers	<i>Need average mass of printer to calculate</i>	
<b>Copiers</b>	<i>Need average mass of copier to calculate</i>	<b>1.6 million metric tons</b> of CO2 emitted (EU) from copier <b>usage in 2007</b>	<b>154 metric tons</b> of PM10 emitted from copier <b>usage in 2007</b>	<i>Need average mass of copier to calculate</i>	<b>Energy</b> - 2.7 times more than printers
<b>Servers</b>	<i>Need average mass of server to calculate</i>	<b>11.1 million metric tons</b> of CO2 emitted (US) from <b>usage</b> of servers, minis, and mainframes in <b>2006</b>	<b>2,028 metric tons</b> of PM10 emitted (US) for the <b>usage</b> of servers, minis, and mainframes in <b>2006</b>	<i>Need average mass of server to calculate</i>	
<b>TVs and Display</b>	<i>Need average mass of TVs and displays to calculate</i>	<b>25.1 million metric tons</b> of CO2 emissions (US) projected from <b>usage of FPDs in 2008</b>	<b>2,507 metric tons</b> of PM10 emissions (US) projected from <b>usage of FPDs in 2008</b>	<i>Need average mass of TVs by category to calculate</i>	<b>Mercury</b> - 5,280 kg Hg use in the projected mfg of LCDs (US) in 2008

**Cell Phones (see Sections 3.1.2 and 3.1.3 for data sources)**

Key Data	Opportunities for Environmental Benefits?
180M phones in US (2005)	Solid Waste - 23.7 metric tons of waste (U.S.) disposed in 2005
779M phones WW (2005)	Solid Waste - 132 metric tons of waste (U.S.) projected by 2010
1B phone sales projected WW in 2010	GHG - 2.2 million metric tons of CO <sub>2</sub> emitted (U.S.) from phone mfg in 2005
91g average cell phone mass	GHG - 12.2 million metric tons of CO <sub>2</sub> (WW) from mfg projected in 2010
1% BFR content in phone	BFRs - 163.8 metric tons of BFRs used in phone mfg (U.S.) in 2005
133.28 kg CO <sub>2</sub> Eq/kg phone	PM <sub>10</sub> - need kWh of energy consumption during mfg to calculate

**Printers (see Sections 3.2.2 and 3.2.3 for data sources)**

Key Data	Opportunities for Environmental Benefits?
20M units/yr sales in US (2007)	GHG - 6.9-10.3 million metric tons of CO <sub>2</sub> emitted (U.S.) from printer use depending on lifespan of printers
106.8M units in use in EU (2007)	GHG - 9.2 million metric tons of CO <sub>2</sub> emitted from printer use in EU (2007)
100 kWh/yr energy use per unit	PM <sub>10</sub> - 728-1,092 metric tons of PM <sub>10</sub> emitted (US) from printer usage in 2007 depending on lifespan of printers
4 yr IJ printer lifespan 6 yr EP printer lifespan	BFRs - Need average mass of printer to calculate
0.23989 kg CO <sub>2</sub> /MJ energy	Solid Waste- Need average mass of printer to calculate

**Copiers (see Sections 3.4.2 and 3.4.3 for data sources)**

Key Data	Opportunities for Environmental Benefits?
6.3M units in use in EU (2007)	GHG - 1.6 million metric tons of CO <sub>2</sub> emitted (EU) from copier usage in 2007
1M unit sales/year (assumed, based on inventory and 6 yr life)	PM <sub>10</sub> - 154 metric tons of PM <sub>10</sub> emitted from copier usage in 2007
270 kWh/yr energy use per unit	BFRs - need average mass of copier to calculate
6 yr EP Copier lifespan	Solid Waste - Need average mass of copier to calculate
0.23989 kg CO <sub>2</sub> /MJ energy	Energy - 2.7 times more than printers

**Servers (see Sections 3.7.2 and 3.7.3 for data sources)**

Key Data used in Calcs	Opportunities for Environmental Benefits?
560 kWh/yr servers (61%) 5,840 kWh/yr minicomputer (37%) 58,400 kWh/yr mainframe (2%)	GHG - 11.1 million metric tons of CO <sub>2</sub> emitted (US) from operation of servers, minis, and mainframes in 2006
8.2 M units sold WW (2006)	PM <sub>10</sub> - 2,028 metric tons of PM <sub>10</sub> emitted (US) for the operation of servers, minis, and mainframes in 2006
3.3 M units sold in US (2006)	BFRs - need average mass of server to calculate
0.23989 kg CO <sub>2</sub> /MJ energy	Solid Waste - Need average mass of server to calculate
0.091g of PM <sub>10</sub> /kWh electricity	

**Televisions/Displays (see Sections 3.8.2 and 3.8.3 for data sources)**

<b>Key Data</b>	<b>Opportunities for Environmental Benefits?</b>
Projected sales in 2008 (US): 55 M LCDs 9.7 M Plasma (calc)	GHG - 25.1 million metric tons of CO2 emissions (US) projected from usage of FPDs in 2008
240W for LCDs 375W for PDs	PM10 - 2,507 metric tons of PM10 emissions (US) projected from usage of FPDs in 2008
8.8 W standby for both LCDs and PDs (Rosen & Meier, 2001)	<i>BFRs - need average mass of TVs by category to calculate</i>
TV's - 16% active, 84% standby	Mercury - 5,280 kg Hg use in the projected mfg of LCDs (US) in 2008
0.091g of PM10/kWh electricity	<i>Solid Waste - Need average mass of TVs and displays to calculate</i>

## **2.0 Possible Products and Product Categories**

### **2.1 Electronic Products for Possible Standard Development**

An initial list of products for consideration was developed through (conversations with purchasers.) The list is:

- Audio/Video equipment (receivers, VCR, DVR, speakers, etc.)
- Boomboxes
- Cameras
- Cell phone network infrastructure equipment
- Cell phones
- Computer peripherals (external hard drives, etc...)
- Copiers
- Data center equipment (large disc & tape drives, routers, switches, UPS, etc.)
- Fax machines
- Hand-held portable game players
- Home computer networking equipment (home WiFi, routers, cable/DSL modems, etc.)
- Internet routers, etc.
- Mainframe computers
- Portable digital audio players
- Multi-function devices
- PDAs
- Printers
- Scanners
- Servers
- Telephone switches
- Televisions

This list was discussed during the convening assessment. Participants of the convening assessment indicated that the following products were their priorities (in alphabetical order):

<b><u>First Priority</u></b>	<b><u>Second Priority</u></b>
Cell phones	Communications and cabling
Copiers	Digital converters
Facsimile machines	Gaming devices
Multi-functional devices	Home entertainment electronics (VCRs, stereos, DVD players, etc..)
PDAs	Set top boxes
Printers	Software
Scanners	Telecom
Servers	Telephones
Televisions and other display devices	

This document focuses on the first priority products. However, if stakeholders indicate that there are additional priority products to be considered, they will be added. Also, in the process of determining which standards will cover which products, it may happen that second priority products are covered in a standard developed for one or more first priority products.

In order to reach a common definition of the priority products, definitions of these or similar product categories in five other major eco-labels or environmental standards were reviewed. These included:

- ENERGY STAR
- Blue Angel
- TCO
- Japan's Eco-mark
- Nordic Swan

Not all these labels covered all products. There was a fair amount of overlap, though there were notable differences in some products. Our recommended definitions are listed within each product category below. These definitions were selected because they seemed to best capture the general consensus of the majority of the standards.

More general product declaration schemes, such as IT-ECO or ECMA/TED, were not reviewed for product definitions as they are not product-specific. However, these will likely be useful resources in developing any future standards.

**Questions:**

- In priority order, what are your top 5 products for standards development?
- What, if any, products would you recommend NOT developing standards for?

**Comments:**

## ***2.2 Possible Product Categories***

In several other standard programs, individual products are grouped together into categories of products based on similar characteristics. During the convening assessment, participants recommended grouping several products together into categories for this process including:

- Cell phones, smartphones and PDAs
- Imaging devices (copiers, faxes, printers, scanners, and multi-functional devices)
- Servers

- Televisions and television monitors

Imaging devices are addressed as individual products (e.g. printers, scanners, etc.) in this evaluation. However, the information obtained for the other products was available primarily by product category, not individual product. For example, environmental and sales data was available for cell phones, smartphones and PDAs as a group.

**Questions:**

- Do you agree that the products should be grouped into categories for standards development?
- Are these categories the correct ones?
- Would you suggest adding other categories?
- Would you suggest deleting categories?
- Do you have a recommended priority or sequence for standards development process? Please include the basis for your recommendation.

**Comments:**

## **3.0 Considerations for Prioritizing Product Categories for Standard Development**

### ***3.1 Cell Phones, Smartphones and PDAs***

Although the original intent was to present information on cell phones, smartphones and PDAs separately, the information obtained for these products was available primarily as a product group. Consequently, the information is presented for these products grouped together.

#### **3.1.1 Existing Standards and Proposed Product Definition**

Two existing standards were identified for cell phones; TCO and Blue Angel. Blue Angel's definition was more complete in terms of the various protocols and functions currently in use in cell phones.

None of the ecolabels reviewed included PDAs. The definition presented below is a modification of the Blue Angel Mobile Phone definition. The definition focuses on the multi-functionality, to distinguish PDAs from single-purpose devices such as MP3 player or calculators.

**Proposed cell phone definition from Blue Angel:** Mobile phones operating according to the GSM, GPRS or UMTS standard. The products shall be primarily designed for the transmission of telephone calls and messages. They may, however, offer additional functions, such as, for example, organizers, as well as wireless internet access and data transmission via infrared interfaces or Bluetooth.

**Proposed smartphone definition:** Smartphones are generally considered any handheld device that integrates personal information management and mobile phone capabilities in the same device. Often, this includes adding phone functions to already capable PDAs or putting "smart" capabilities, such as PDA functions, into a mobile phone. Examples include the Palm Treo, the

Blackberry, and the Motorola Q. Smartphones functions can include games, mobile video, e-mail, music mp3 files, news and information, or video and picture taking.

**Proposed PDA definition:** Handheld devices that offer multiple functions including (but not limited to) personal contact storage and retrieval, calendar functions, music player, web browsing, as well as wireless internet access and data transmission via infrared interfaces, Bluetooth, or Wi-Fi. They should have a user interface that allows entering text via touch screen or keyboard.

**Questions:**

- Should cell phones, smartphones and PDAs be grouped together for this evaluation?
- Are there other existing standards that include cell phones?
- Are there existing standards that include PDAs and/or smartphones?
- Any comments on the proposed definitions?

**Comments:**

### **3.1.2 Environmental Profile**

#### **Product Profile**

Cell phone specifications:

- Average mass per cell phone without battery was estimated to be 91 grams- based on 2002- 2004 models (Socolof et al., 2007).
  - Nokia cell phone 3595 – 113 grams (Nokia, 2005).
  - Average mass of cell phone and battery – 136 grams (Socolof et al, 2007).
  - Average mass of small sampling of batteries- 28 grams (Geibig, 2007).
- (Many other sources available for typical cell phone mass)

Cell phones typically consist of the following components (IPMI, 2003):

- Electronic circuitry – primarily containing metal circuitry (see below for details), a fiberglass or epoxy resin circuitboard, solder containing tin, lead, silver or other metals, and components of various types and compositions.
- Antenna- metal coil antenna (internal) or an external solid or telescopic antenna.
- LCD screen- contains a liquid crystal compound typically a polycyclic aromatic hydrocarbon (PAH) between 2 thin layers of glass. Typically less than 5 mg liquid crystal (<http://www.umweltbundesamt.de/uba-info-daten-e/daten-e/lcd.htm> ).
- Battery – Nickel cadmium (rare), nickel metal hydride, or lithium ion.
- Plastic case or shell- typically made from poly carbonate (PC), acrylonitrile butadiene styrene (ABS), or a mixture thereof. Also likely to contain brominated flame retardants that may be hazardous to human health.
- Charging base or connector – transformer, wires, and sometimes a plastic base typically made from PC, all used to recharge the battery.
- Accessories- ear phone, blue tooth, etc.

Cell phones are comprised of the following, exclusive of battery and charger (USGS Fact Sheet, 2006):

- 58% Plastics
- 25% Metals- incl. copper, iron, nickel, silver, zinc, with small amts of aluminum, gold, lead, manganese, tin, platinum, and palladium.

- 16% Ceramics
- 1% Flame retardants
- Less than 5 mg liquid crystal (<http://www.umweltbundesamt.de/uba-info-daten-e/daten-e/lcd.htm> )

Note: Additional detailed breakdown information is also presented in the following references: (Basel, 2006) ([http://www.nokia.com/link?cid=EDITORIAL\\_65032](http://www.nokia.com/link?cid=EDITORIAL_65032) )

**Content Specific Environmental or Human Health Concerns**

Toxic materials likely found in cell phones sold today include (Socolof, 2007):

- Metals- lead and hexavalent chromium
- BFRs- tetrabromobisphenol-A (TBBPA) and decabrominated biphenyl ether (DBBE)
- Mercury has been effectively phased out of use in modern cell phones (Basel, 2006)
- Liquid crystal compounds are not acutely toxic, mutagenic, or otherwise known to be harmful to humans or the environment. Potential for chronic affects remains unknown. (King County, 2007)

In addition, older phones in storage that may enter the recycle stream are likely to include (Socolof et al, 2007):

- Metals - mercury, cadmium, lead, hexavalent chromium
- BFRs - polybrominated biphenyls (PBBs), and polybrominated diphenyl ethers (PBDEs)

**Table: Potentially hazardous metal content in cell phones (IPMI, 2003)**

Lead	< 0.5 g	Solder content in older phones. Lead has been banned by ROHS for future phone mfg. – Lead is a PBT
Cadmium	7 g (est.)	contained in some batteries, typically less than 25% of the battery mass. Mass reported was estimated using 28 g average mass of small selection of batteries (Geibig, 2007)
Beryllium	0.1 grams	Used at electronic circuitry connection points. Beryllium is an inhalation threat to workers.
Silver	1-3 g +	Contained in pad contact as well as in lead free solders (Geibig and Socolof, 2005). Silver is an extreme aquatic toxin.
Copper	common	Most commonly used metal used mostly in electronic circuitry of phone- Copper is an aquatic toxin

Note: More information on other metal content in IPMI report (IPMI, 2003)

Environmental data on cell phone batteries include:

- Nickel-cadmium batteries have been phased out in cell phones today, though older phones in storage may still contain them (Basel, 2006)
- Modern phone batteries are based on lithium ion or Nickel metal hydride technology
- Potassium hydroxide and/or lithium cobalite compounds used in battery technologies are corrosive to skin and can cause potentially serious chemical burns upon contact (IPMI, 2003)

Plastics used in most cell phones include PC, ABS, or some combination of PC/ABS. The plastics themselves do not pose a threat to human health during the use stage. However, the plastics do have the following life-cycle issues:

- ABS is comprised of compounds that are all suspected or known carcinogens and could likely pose an occupational threat during manufacture.
- Both the printed wiring board as well as the case of the phone are likely to have brominated flame retardants (BFRs) most of which have been banned or are under consideration for banning.
- Deca-PBDE has been recently banned by the State of Washington for use in new products.
- PBBs, penta-PBDE and octa-PBDE have all been phased out of new products but may still appear in products using recycled content.

### **Manufacturing and Use Impacts**

Mobile phones do not appear to pose a threat to human health during their normal use, but could result in the release of potentially harmful compounds if not handled and disposed of properly at end-of-life (Mueller, et al, 2003).

No information was obtained regarding occupational and environmental health affects during the manufacturing process that are specific to cell phones. Occupational and human health affects are presented for various aspects of electronics manufacturing in the following publications, but would likely apply to all electronics based devices:

- Printed Wiring Board Surface Finishes CTSA (Geibig and Swanson, 2001)
- Printed Wiring Board CTSA: Making Holes Conductive (Kincaid et al, 1998)

Air Emissions for cell phone production include:

- Life-cycle green house gas emissions 133.28 kg CO<sub>2</sub> Equiv/kg phone
- Projected 180 million cell phones in use in 2005 resulted in an estimated **2.2 million** metric tons of CO<sub>2</sub> equivalents released to air (calc from referenced data in this report, based primarily on embodied energy per phone excl. battery- UT Clean Products)

### **End of Life**

The following information regarding end-of-life disposition and recycling of cell phones was reported:

- 130 million cell phones were retired annually in the United States in 2005 (US EPA, 2005), equivalent to:
  - 14,000 metric tons
  - 2,100 metric tons of copper
  - 46 metric tons of silver
  - 3.9 metric tons of gold
  - 2 metric tons of palladium
- 500 million obsolete cell phones by 2005 would be stored by consumers awaiting disposal (INFORM, 2003).
- Less than 1 % of cell phones retired and discarded annually are recycled. (INFORM, 2003).
- Typically, cell phones are used for only 1½ years before being replaced (IPMI, 2003).
- If all 180 million cell phones sold in the U.S. in 2005 were replaced in mid 2007 as suggested above, and accounting for the 1% recycling rate, they would represent nearly **23.7 metric tons** of solid waste discarded in 2007 into landfills or incinerated. If projections prove accurate, that number will climb to **132 metric tons** disposed world wide by 2010.

Cell phones at end of life can be effectively refurbished and reused without harm to human health or the environment. (IPMI, 2003)

- Many cell phones are refurbished and sold to developing countries.
- All three battery types can be readily recycled using currently recycled technologies.
- NiCd batteries are considered hazardous waste in many countries at end of life.
- Liquid crystal compounds cannot currently be reclaimed at end of life economically (King County, 2007).

Leachability results from cell phones indicate that the following metals all leached in amounts that exceeded the Total Threshold Limit Concentrations (TTL): Copper, Lead, Chromium, Nickel, and Antimony (California DTSC, 2004).

**Questions:**

- Are there are other data sources that should be reviewed for this evaluation?

**Comments:**

### **3.1.3 Energy Profile**

#### **Energy consumption- Use Phase**

- Cell phones are typically powered by batteries, so energy usage is dependent on battery technology, capacity, phone use, and phone feature set.
- Energy use profiles were identified for individual specific phones:
  - Casio W51CA with digital TV tuner – 250 minute duration of cell phone communication requires 140 minutes of charging time (<http://www.mobilewhack.com/casio-w51ca-digital-tv-phone> )
- Energy consumption and use profiles for cell phone chargers were measured to be (Rosen and Meier, 2001):
  - 1.0 W while machine is in standby, 75% of the time
  - 5 W while in charging, 5% of the time

#### **Life-cycle Energy/Embodied energy**

- Life cycle embodied energy estimated to be 463 kWh/kg of phone– excludes batteries, LCD, and camera (Socolof et al, 2007)
- No life-cycle manufacturing data specific to cell phone batteries was readily identified

**Questions:**

**Comments:**

### **3.1.4 Ease of Standard Development**

- The environmental criteria for these products would be expected to be substantially different from those for computers/monitors in IEEE 1680.
- There exists a very strong basis of scientific literature, including LCAs, about the environmental impacts of these products.
- Existing eco-label standards: TCO and Blue Angel standards.

**Questions:**

**Comments:**

**3.1.5 Market Characteristics**

Overall, mobile phone sales and smartphone sales show strong increases, while PDA sales have fallen over the past year. PDAs are being replaced by smartphones with multiple services and features.

The following **usage data** for the US and world wide were reported:

- 1 billion cell phones in use worldwide in 2002 (USGS Fact Sheet, 2006)
- 180 million in use the US in 2004 (USGS Fact Sheet, 2006)
- An estimated 2.6 billion cell phones are projected to be in use world wide by the end of 2009 (Gartner, 2005)

Market **sales data** reported include:

- Worldwide, cell phone sales of 779 million units per year were reported for 2005 (USGS Fact Sheet, 2006)
- Cell phone sales are projected to exceed 1 billion units per year world wide in 2009 (Gartner, 2005)
- US consumer sales of cell phones and PDAs doubled every 5 years from 2002 to present and will be 130 million units in 2007 (CEA, 2007)
- PDA handheld sales worldwide dropped 28.5% in 2006, primarily due to converged mobile devices and smartphones (IDC, 2007b)
- PDA sales worldwide for 2006 totaled 5.5 million units (IDC,2007b)
- Converged mobile device market grew 42% in 2006 totaling over 80 million units sold world wide (IDC, 2007a)
- Smartphone sales grew by 63% in 2006 to 64.1 million units **worldwide (Palm Infocenter, 2007)**
- Projected sales to exceed 200 million smartphone sales in 2008 (Gartner, 2005)
- Smartphone penetration of US market is 2.0% ranging up to 6.6% in other countries (M:Metrics, 2006)

**Questions:**

- Are there data or estimates available on the percentage of institutional versus consumer sales of cell phones, smartphones and PDAs?
- What share of the cell phone and smartphone sales market goes through a wireless service provider?

**Comments:**

**3.1.6 Level of Stakeholder Interest**

**Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?

- Do you have any suggestions regarding availability of funds to support the development of a standard?

**Comments:**

### **3.1.7 Other Considerations**

**Questions:**

What other factors should be considered in product selection and/or standard development?

**Comments:**

## **3.2 Printers**

### **3.2.1 Existing Standards and Proposed Product Definition**

Six existing standards were identified for printers; ENERGY STAR, TCO, Nordic Swan, Japanese Eco-Mark, Environmental Choice EcoLogo and Blue Angel. Printers capture a broad range of devices and technologies that put images on paper. A definition was sought that encompassed both the various technologies (e.g. laser vs. ink jet), and modes of use (e.g. stand alone, networked, etc.) typical of office printers. The ENERGY STAR and Nordic Swan definitions, which are the same, appear to be the most easily understandable and complete.

**Proposed product definition from ENERGY STAR:** A commercially-available imaging product that serves as a hard copy output device, and is capable of receiving information from single-user or networked computers, or other input devices (e.g., digital cameras). The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as printers, including printers that can be upgraded into multi-function devices in the field.

**Questions:**

- Should printers be grouped with other imaging devices?
- Are there other existing standards that include printers?
- Any comments on the proposed definition?

**Comments:**

### **3.2.2 Environmental Profile**

#### **Product Profile**

No information was located.

#### **Content Specific Environmental or Human Health Concerns**

Toner used in printing devices may pose a threat to human health (Nicholson, 1989):

- Toner powder consists of 70-95 % synthetic resin, 15-20 iron oxide, and 0-5 % carbon black (Ahmadi et al, 2003).
- Carbon black can contain traces of nitropyrenes and polyaromatic hydrocarbons discovered to be a potential cause of mutagenic effects (Nicholson, 1989).
- Entrained dust from toner cartridges can pose a respiratory threat for the worker changing or refilling the toner cartridge (Ambruster et al., 1996).

BFRs in office electronic housings and other plastic parts pose the following human health and environmental threats:

- Octa-PBDE, which was phased out in the US in 2005, was typically used with ABS plastics in some older office equipment that might likely remain in storage.
- Deca-PBDE is manufactured in large quantities and is commonly used in the housings and other plastic parts of copiers, printers and other electronic devices.
- Deca-PBDE, which is considered slightly less toxic, is a concern due to its tendency to break down to other more toxic congeners (Rossi and Heine, 2007).
- Deca-PBDE is considered a possible human carcinogen (King County, 2007).
- BFRs which have been found to be ubiquitous in the environment are neurotoxins in children, immune system suppressors, and have other chronic human health effects (Rossi and Heine, 2007).

### **Manufacturing and Use Impacts**

Operation of printers contributes to poor indoor air quality through the generation and release of ozone, TVOCs, and particulate matter:

- When in use, electrophotographic (laser) printers create a strong corona effect responsible for generating ozone through the reaction of charged ions and electrons with atmospheric gases (Lee et al, 2001).
- Tests indicate generation of ozone to be 10 ppm and did not exceed the World Health Organization guideline for ozone of 150 micrograms/m<sup>3</sup> (Lee et al., 2001).
- Charcoal filters capable of reducing ozone levels from 430 micrograms/min to 100 micrograms/min are available on some models (Aeris, 2000).
- Ozone can cause asthma, throat irritation, and other respiratory ailments.
- At least one study reported maximum particulate levels from laser printers in excess of the national ambient air quality standard of 75 micrograms/m<sup>3</sup> (Lee et al., 2001).
- Entrainment of toner into the indoor air has been reported at least in one case to lead to acute or chronic distress (Ambruster, et al., 1996).
- The four greatest measured VOC emissions were toluene, ethylbenzene, m-p-xylene, and styrene, all used as solvent in toner (Lee, et al., 2001).
- Styrene, benzene, toluene, and xylene are all suspected or known human carcinogens.
- TVOCs released by laser printers were 6 times that of Ink Jet printers due to the higher fusing temperatures volatilizing VOCs in the toner (Lee et al, 2001).

### **End of Life**

- Ink jet printers average lifetime is approximately 4 years, triggered by repair or obsolescence (EUP, 2007).
- Second hand markets for Ink Jet printers are virtually non-existent (EUP, 2007).
- Electrophotographic printers average lifetime is approximately 6 years, triggered by repair or obsolescence (EUP, 2007).
- 22,000 metric tones per year of office equipment waste were generated in the EU for 2006 (EUP, 2007).
- HP claimed a 10.3% reclamation rate for all products (including printers) sold in 2005 (HP, 2005).
- Canon claims remanufacturing allows for 89% of product parts and materials to be recycled into other imaging products of equal or greater value (Canon, 2006).
- 97% of the content of toner cartridges can be reused or recycled (NAGPI, 2007)
- At least one study indicated that printers leached copper, lead, and antimony at levels that exceeded regulations (Cal DTSC, 2004).

**Questions:**

- Is there any information available on the material composition of printers?
- Are there other data sources that should be reviewed?

**Comments:**

### **3.2.3 Energy Profile**

#### **Energy consumption- Use Phase**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Energy estimates and usage patterns for **printers** identified in the research include the following:

- Energy consumption measured for printers during operational mode include (Rosen and Meier, 2002):
  - Standby mode- 3.6W (49% time)
  - Idle mode- 12.1W (50% time)
  - Active mode- 361W (1% time)
- Total estimated average annual energy consumption for printers – 100 kWh/yr (Rosen and Meier, 2002)

**Questions:**

- Is there any information available on the life-cycle energy/embodied energy of printers?
- Are there other data sources that should be reviewed?

**Comments:**

### **3.2.4 Ease of Standard Development**

- These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as printers.
- The possible desire of some stakeholders to address consumables, and the uniqueness and possible difficulty of addressing that issue, could complicate standard development.
- There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.
- Several existing eco-label standards ENERGY STAR, TCO, Blue Angel, Environmental Choice EcoLogo, Nordic Swan and Japan Eco-Mark standards cover printers.

**Questions:**

**Comments:**

### **3.2.5 Market Characteristics**

There is convergence with other imaging devices in the consumer printer market, and likely a decline in single function consumer printers. However, there has been growth in the consumer single function photo printer.

- US **consumer** sales of printers (product as defined by CEA, 2007) are relatively flat at 20 million units/year (CEA, 2007).
- In 2005, a total of 106.8 million printers were estimated to be in use in the European Union- 90.2 million Ink Jet and 16.6 million EP printers (EuP, 2007)
- Toner sales in the EU are reported as 220,000 tonnes/yr, and are expanding 3-5% per year (Wacker, 2006)

**Questions:**

- Is there data available for institutional sales of printers?
- What is the split between consumer and institutional sales of printers?

**Comments:**

### **3.2.6 Level of Stakeholder Interest**

**Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?
- Do you have any suggestions regarding availability of funds to support the development of a standard?

**Comments:**

### **3.2.7 Other Considerations**

**Questions:**

- What other factors should be considered in product selection and/or standard development?

**Comments:**

## **3.3 Facsimile Machines (Fax Machines)**

### **3.3.1 Existing Standards and Proposed Product Definition**

All of the eco-labels reviewed include fax machines, though some (such as TCO) and include fax machines in their standards for copiers or printers. Most definitions were very similar – the definition used by Nordic Swan and ENERGY STAR was selected because it was the most clear and complete.

**Proposed product definition from ENERGY STAR:** A commercially-available imaging product whose primary functions are scanning hard copy originals for electronic transmission to remote units and receiving similar electronic transmissions to produce hard copy output. Electronic transmission is primarily over a public telephone system, but also may be via computer network or the Internet. The product also may be capable of producing hard copy duplicates. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as fax machines.

**Questions:**

- Should fax machines be grouped with other imaging devices?
- Are there other existing standards that include fax machines?
- Any comments on the proposed definition?

### **3.3.2 Environmental Profile**

Data specific to fax machines was not located, with the exception of the life span information below. The environmental profile of fax machines is likely similar to that of copiers.

#### **End of Life**

- Fax machines average lifetime is approximately 8+ years, triggered by obsolescence (EUP, 2007).

#### **Questions:**

- Is there any information available specific to the environmental profile of fax machines?
- Are there other data sources that should be reviewed?

#### **Comments:**

### **3.3.3 Energy Profile**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Specific energy estimates and usage patterns for fax machines was not identified in this research. However, the energy profile of fax machines is likely similar to printers with the following exception: fax machines are likely to be on idle rather than the power saving standby mode much more frequently than printers (EuP, 2007).

#### **Questions:**

- Is there any information available on the energy profile of fax machines?

#### **Comments:**

### **3.3.4 Ease of Standard Development**

- These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as fax machines.
- The possible desire of some stakeholders to address consumables, and the difficulty of addressing that issue, could complicate standard development
- There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.
- Existing eco-label standards: ENERGY STAR, Blue Angel, Environmental Choice EcoLogo and Nordic Swan. The TCO printer standard also applies.

#### **Questions:**

#### **Comments:**

### **3.3.5 Market Characteristics**

There is convergence with other imaging devices in the consumer fax machine market, and a notable decline in single function consumer fax machines.

- Overall, US consumer sales of fax machines (product as defined by CEA) have declined from 2.3 million in 2002 to 1.2 million units in 2007 (CEA, 2007).
- 20.1 million ink jet fax machines were estimated to be in use in the European Union during 2005 (EuP, 2007).

#### **Questions:**

- Is there data available for sales of non-consumer fax machines?
- What is the split between consumer and institutional sales of fax machines?

#### **Comments:**

### **3.3.6 Level of Stakeholder Interest**

#### **Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?
- Do you have any suggestions regarding availability of funds to support the development of a standard?

#### **Comments:**

### **3.3.7 Other Considerations**

#### **Questions:**

What other factors should be considered in product selection and/or standard development?

#### **Comments:**

## **3.4 Copiers**

### **3.4.1 Existing Standards and Proposed Product Definition**

All five of the eco-labels reviewed, as well as Environmental Choice EcoLogo, include copiers in their standards. Copiers include a broad range of technologies that create multiple copies from hard copy or electronic originals. Most definitions in existing eco-labels focus on the “sole function” of making copies from paper originals, to distinguish them from standard desktop printers. However, most include equipment that can be upgraded to operate on a computer network. Several of the labels distinguish copiers from “digital duplicators”, which use a stencil input with digital reproduction. The definition used by ENERGY STAR and Nordic Swan was selected; however there were not great differences between these and the others.

**Proposed product definition from ENERGY STAR:** A commercially-available imaging product whose sole function is the production of hard copy duplicates from graphic hard copy originals. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as copiers or upgradeable digital copiers (UDCs).

**Questions:**

- Should copiers be grouped with other imaging devices?
- Are there other existing standards that include copiers?
- Any comments on the proposed definition?

**Comments:**

**3.4.2 Environmental Profile**

**Product Profile**

**Content Specific Environmental or Human Health Concerns**

Toner used in printing devices may pose a threat to human health (Nicholson, 1989) (Ambruster et al, 2003):

- Toner powder consists of 70-95% synthetic resin, 15-20% iron oxide, and 0-5% carbon black (Ahmadi et al, 2003).
- Carbon black can contain traces of nitropyrenes and polyaromatic hydrocarbons discovered to be a potential cause of mutagenic effects (Ambruster, et al., 1996).
- Entrained dust from toner cartridges can pose a respiratory threat for the worker changing or refilling the toner cartridge (Ambruster, et al., 1996).

BFRs in office electronic housings and other plastic parts pose the following human health and environmental threats:

- Octa-PBDE, which was phased out in the US in 2005, was typically used with ABS plastics in some older office equipment that might likely remain in storage.
- Deca-PBDE is manufactured in large quantities and is commonly used in the housings and other plastic parts of copiers, printers and other electronic devices.
- Deca-PBDE, which is considered slightly less toxic, is a concern due to its tendency to break down to other more toxic congeners (Rossi and Heine, 2007).
- Deca-PBDE is considered a possible human carcinogen (King County, 2007).
- BFRs which have been found to be ubiquitous in the environment are neurotoxins in children, immune system suppressors, and have other chronic human health affects (Rossi and Heine, 2007).

**Manufacturing and Use Impacts**

Operation of copiers contributes to poor indoor air quality through the generation and release of ozone, VOCs, and particulate matter:

- When in use, copiers create a strong corona effect responsible for generating ozone through the reaction of charged ions and electrons with atmospheric gases (Lee et al, 2001).
- Tests for 5 copiers found ozone ranging from 16-131 micrograms/copy prior to routine maintenance, which reduced ozone emissions to 1-4 micrograms/copy afterwards (EPA, 1995).
- U.S. manufacturer for six different copiers gave time weighted average concentrations for ozone ranging from 0.010 ppm (10 ppb) to 0.066 ppm (66 ppb) (Nicholson, 1989).
- Charcoal filters are available on some models that are effective at decomposing 94% of the ozone into oxygen (Nicholson, 1989).
- Ozone can cause asthma, throat irritation, and other respiratory ailments.

- The four greatest measured VOC emissions were toluene, ethylbenzene, m-p-xylene, and styrene, all used as solvent in toner (Lee, et al., 2001).
- Styrene, benzene, toluene, and xylene are all suspected or known human carcinogens.
- Entrainment of toner into the indoor air has been reported at least in one case to lead to acute or chronic distress (Ambruster, et al., 1996).

#### **End of Life**

- EP copiers average lifetime is approximately 6 years, triggered by repair or obsolescence (EUP, 2007).
- Frequent leasing of copiers likely to lead to more frequent upgrading to improve product energy performance (EUP, 2007).
- 97% of the content of toner cartridges can be reused or recycled (NAGPI, 2007).

#### **Questions:**

- Is there any information available on the material composition of printers?
- Are there other data sources that should be reviewed?

#### **Comments:**

### **3.4.3 Energy Profile**

#### **Energy consumption- Use Phase**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Energy estimates varied drastically in identified sources likely resulting from differences in personal and professional machines. Energy estimates and usage patterns for **copiers** identified in the research include the following:

- Energy consumption measured for copiers during operational mode include (Rosen and Meier, 2002) (Ahmadi et al., 2003):
  - Standby mode- 4 -360 W (0% time)
  - Idle mode- 30 W- 1920 W (99% time)
  - Active mode 100 W- 7440 W (1% time)
- Total estimated average annual energy consumption for copiers – 270 kWh/yr (Rosen and Meier, 2002):

#### **Questions:**

- Is there any information available on the life-cycle energy/embodied energy of copiers?
- Are there other data sources that should be reviewed?

#### **Comments:**

### **3.4.4 Ease of Standard Development**

- These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as copiers.
- The possible desire of some stakeholders to address consumables, and the difficulty of addressing that issue, could complicate standard development

- There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.
- Existing eco-label standards: ENERGY STAR, Blue Angel, Nordic Swan, Environmental Choice EcoLogo and Japan Eco-Mark standards exist. The TCO printer standard may apply.

**Questions:**

**Comments:**

**3.4.5 Market Characteristics**

Sales data for copiers was not located. However, there were a reported 6.3 million electrophotographic copiers in use in the European Union in 2005 (EuP, 2007).

**Questions:**

- Is sales data available for copiers?
- What is the consumer versus institutional market split?

**Comments:**

**3.4.6 Level of Stakeholder Interest**

**Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?
- Do you have any suggestions regarding availability of funds to support the development of a standard?

**Comments:**

**3.4.7 Other Considerations**

**Questions:**

What other factors should be considered in product selection and/or standard development?

**Comments:**

**3.5 Scanners**

**3.5.1 Existing Standards and Proposed Product Definition**

ENERGY STAR and Nordic Swan define scanners, incorporating the definition under their “imaging devices” standards. Most copiers and fax machines use scanning technology, so the definitions for scanners focus on their ability to save and retrieve the information. The ENERGY STAR definition was selected because it clearly delineated the product from others that may include scanners.

**Proposed product definition from ENERGY STAR:** A commercially-available imaging product that functions as an electro-optical device for converting information into electronic images that can be stored, edited, converted, or transmitted, primarily in a personal computing environment. The unit must be capable of being powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as scanners.

**Questions:**

- Should scanners be grouped with other imaging devices?
- Are there other existing standards that include scanners?
- Any comments on the proposed definition?

**Comments:**

### **3.5.2 Environmental Profile**

Specific data on scanners was not located, with the exception of the life span information below. The environmental profile of scanners is likely similar to copiers or fax machines, excluding the toner and indoor air concerns.

**End of Life**

- Scanners average lifetime is approximately 6 years, triggered by obsolescence (EUP, 2007).

**Questions:**

- Is there any information available specific to the environmental profile of scanners?
- Are there other data sources that should be reviewed?

**Comments:**

### **3.5.3 Energy Profile**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Specific energy estimates and usage patterns for scanners was not identified in this research. However, the energy profile of scanners is likely similar to printers.

**Questions:**

- Is there any information available on the energy profile of scanners?

**Comments:**

### **3.5.4 Ease of Standard Development**

- These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as scanners.
- There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.
- Existing eco-label standards: ENERGY STAR and Blue Angel standards.

**Questions:**

**Comments:**

### **3.5.5 Market Characteristics**

Sales data for scanners was not located.

**Questions:**

- Is sales data available for scanners?
- What is the consumer versus institutional market split?

**Comments:**

### **3.5.6 Level of Stakeholder Interest**

**Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?
- Do you have any suggestions regarding availability of funds to support the development of a standard?

**Comments:**

### **3.5.7 Other Considerations**

**Questions:**

- What other factors should be considered in product selection and/or standard development?

**Comments:**

## ***3.6 Multi-Function Devices (MFDs)***

### **3.6.1 Existing Standards and Proposed Product Definition**

Multifunction devices typically combine the functions of a copier, scanner, printer, and sometimes a fax machine. ENERGY STAR, Nordic Swan and Eco-mark specifically define MFDs, though the latter two cover them in their copier standards. TCO and Blue Angel simply include MFDs in their definition of a “printer” and include MFDs in their printer standards. The selected definition was common to those that specifically addressed the product. Environmental Choice EcoLogo also includes MFDs in their standards.

**Proposed product definition from ENERGY STAR:** A commercially-available imaging product, which is a physically-integrated device or a combination of functionally-integrated components, that performs two or more of the core functions of copying, printing, scanning, or faxing. The copy functionality as addressed in this definition is considered to be distinct from single sheet convenience copying offered by fax machines. The unit must be capable of being

powered from a wall outlet or from a data or network connection. This definition is intended to cover products that are marketed as MFDs or multifunction products (MFPs).

**Questions:**

- Should MFDs be grouped with other imaging devices?
- Are there other existing standards that include MFDs?
- Any comments on the proposed definition?

**Comments:**

### **3.6.2 Environmental Profile**

Specific data on MFDs was not located, with the exception of the life span information below. The environmental profile of MFDs is likely similar to the combined profiles of printers, copiers, and fax machines.

**End of Life**

- Ink jet MFDs average lifetime is approximately 4+ years, triggered by repair or obsolescence (EUP, 2007).

**Questions:**

- Is there any information available specific to the environmental profile of MFDs?
- Are there other data sources that should be reviewed?

**Comments:**

### **3.6.3 Energy Profile**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Specific energy estimates and usage patterns for MFDs was not identified in this research. However, the environmental profile of MFDs is likely similar to the combined profiles of printers, copiers, and fax machines.

**Questions:**

- Is there any information available on the energy profile of MFDs?

**Comments:**

### **3.6.4 Ease of Standard Development**

- These products are likely to have many of the environmental criteria similar to computers. IEEE 1680 should provide a good starting point for a standard for imaging devices such as MFDs.
- The possible desire of some stakeholders to address consumables, and the difficulty of addressing that issue, could complicate standard development
- There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.

- Existing eco-label standards: ENERGY STAR, Blue Angel, Nordic Swan, TCO, Environmental Choice EcoLogo and Japan Eco-Mark standards (for some as part of another standard).

**Questions:**

**Comments:**

### **3.6.5 Market Characteristics**

Sales data for MFDs was not located.

**Questions:**

- Is sales data available for MFDs?
- What is the consumer versus institutional market split?

**Comments:**

### **3.6.6 Level of Stakeholder Interest**

**Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?
- Do you have any suggestions regarding availability of funds to support the development of a standard?

**Comments:**

### **3.6.7 Other Considerations**

**Questions:**

What other factors should be considered in product selection and/or standard development?

**Comments:**

## **3.7 Servers**

### **3.7.1 Existing Standards and Proposed Product Definition**

One existing standard was identified for servers; ENERGY STAR. ENERGY STAR divides servers into two categories – desktop derived servers, which fall under their new computer standard, and mid-range and larger servers, which will have their own standard. Both ENERGY STAR server definitions are provided below.

**Proposed product definitions from ENERGY STAR:**

**Mid-range and larger servers:**

- Designed and placed on the market as a Class A product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a single or dual processor capability (1 or greater sockets on board);
- Placed on the market as a Class B product, but hardware upgraded from a Class A product, per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed capable of having a single or dual processor capability (1 or greater sockets on board); and
- Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and designed and capable of having a *minimum* dual processor capability (2 sockets on board).

**Desktop-Derived Servers (in ENERGY STAR's computer standard):**

A desktop-derived server is a computer that typically uses desktop components in a tower form factor, but is designed explicitly to be a host for other computers or applications. For the purposes of this specification, a computer must be marketed as a server and have the following characteristics to be considered a desktop-derived server:

- Designed and placed on the market as a Class B product per EuroNorm EN55022:1998 under the EMC Directive 89/336/EEC and has no more than single processor capability (1 socket on board);
- Designed in a pedestal, tower, or other form factor similar to those of desktop computers such that all data processing, storage, and network interfacing is contained within one box/product;
- Designed to operate in a high-reliability, high-availability application environment where the computer must be operational 24 hours/day and 7 days/week, and unscheduled downtime is extremely low (on the order of hours/year);
- Capable of operating in a simultaneous multi-user environment serving several users through networked client units; and
- Shipped with an industry accepted operating system for standard server applications (e.g., Windows NT, Windows 2003 Server, Mac OS X Server, OS/400, OS/390, Linux, Unix and Solaris).

**Questions:**

- Should this category only include mid-range and larger servers, or should desktop derived servers be included?
- Should we consider amending IEEE 1680 to include desktop derived servers or should they stand alone as separate standard?
- Do you know of any other existing standards that include servers?
- Any comments on the proposed definition?

**Comments:**

**3.7.2 Environmental Profile**

**Product Profile**

Servers can be grouped into at least three categories:

- Blade servers- Blade enclosure contains all non-computing functions such as power supply, cooling, and network connections; while multiple blade computers containing memory, HDs, and processors perform the computing functions of the server
  - Components in blade enclosure serve all blades limiting the need for multiple devices such as power supplies, fans, and i/o devices.

- Multiple motherboards, processors, hard drive units, and memory modules to match the number of blades in the system.
- Rack Servers- A rack system with individual stand alone server units networked together often with redundant feature sets to meet a higher operational load.
  - Rack frame of aluminum or steel to provide structure, connections, and security
  - Server units (essentially stand alone) containing most components central to computing including circuitry, power supplies, i/o connections, cooling, processors, memory, etc.
- Off the shelf servers- Servers resembling personal computers commonly available on the consumer market are networked together to perform server functions.
  - Composition resembles a multiple of a personal computer case without display devices, floppy drives and multimedia components.
  - Will likely be handled well by existing EPEAT standard for computers

Server specifications: due to the wide variation in data server size, type and configuration, it is difficult to provide basic average across the product category. Data provided below relates to specific models. Mass of individual servers range from 14.1- 22.7 kg:

- Apple XServe RAID, 31.7 pounds (14.4 kg) for base configuration ([www.apple.com/xserve/specs.html](http://www.apple.com/xserve/specs.html))
- HP 24xx series rp2430/rp2470, 22.7 kg
- Dell PowerEdge SC1435, maximum weight of 31 pounds (14.1 kg)

Typical server components include:

- Printed wiring board – primarily containing metal circuitry (see below for details), a fiberglass or epoxy resin circuit board, solder containing tin, lead, silver or other metals, and components of various types and compositions
- Power Supply- transformer, metal cage, wiring, metal heatsink, fans, and circuitry with components
- Hard drives
- Microprocessors
- Cooling fans
- Network or input/output connections
- Plastic case or shell- typically made from poly carbonate (PC), acrylonitrile butadiene styrene (ABS), or a mixture thereof. Also likely to contain brominated flame retardants that may be hazardous to human health

### **Content Specific Environmental or Human Health Concerns**

Toxic materials likely found in servers sold today include

- Metals - lead, cadmium, silver, copper in electronic circuitry (Socolof et al, 2001)
- BFRs - tetrabromobisphenol-A (TBBPA) and decabrominated biphenyl ether (DBBE) contained in plastic cases of electronic devices (Rossi and Heine, 2007)

Plastics used in most servers include PC, ABS, or some combination of PC/ABS. The plastics themselves do not pose a threat to human health during the use stage. However, the plastics do have the following life-cycle issues:

- Both the printed wiring board as well as the case of the servers are likely to have brominated flame retardants (BFRs) most of which have been banned or are under consideration for banning (King County, 2007)
- Deca-PBDE has been recently banned by the State of Washington for use in new products

- PBBs, penta-PBDE and octa-PBDE have all been phased out of new products but may still appear in products using recycled content

Servers are much more processor and memory modules intensive than other electronic devices:

- Dram memory module required 3.5 pounds of fossil fuels, 0.16 pounds of chemicals, 70.5 pounds of water and 1.5 pounds of elemental gases-mainly nitrogen to manufacture ([http://www.eurekalert.org/pub\\_releases/2002-11/acs-ttp110502.php](http://www.eurekalert.org/pub_releases/2002-11/acs-ttp110502.php) )

### **End of Life**

Very little information specific to the end-of-life disposition and recycling of servers was found. Many anecdotal sources were found, which suggest that servers are somewhat unique in being used as long as serviceable, as well as often being stored on site for long periods of time. “The biggest issue in server disposal is getting around to it. In the rush to handle new technologies, many companies send aging boxes somewhere to be handled “later.” Yet, there they sit, sometimes for as long as half a decade.” (“Hardware Today: Strategic Server Disposal,” [www.serverwatch.com](http://www.serverwatch.com), 9/18/2006).

Electronic circuitry, processors, and other typically computer-based server components can be reclaimed, reused, or recycled at EOL using traditional electronic recycling processes.

### **Questions:**

- Are there other data sources that should be reviewed?

### **Comments:**

## **3.7.3 Energy Profile**

### **Energy consumption- Use Phase**

- Energy consumption is the prominent environmental concern currently being documented in the literature. Data centers in the US now consume an estimated 20 to 30 billion kilowatt hours of electricity annually (ACEEE calculations, based on a value of roughly 300 W per each of 10 million servers suggest US data center electricity consumption being around 30TWh/year, depending on the assumed operating hours/year-ACEEE, 2007).
- Data centers typically consume 15 times more energy per square foot than a typical office building, and may be 100 times more energy intensive (ACEEE, 2007; LBNL, 2005).
- Daily uptime for servers is commonly assumed to be 24 hours/day (IDC, 2006; ACEEE, 2007).
- Energy use profiles were identified for individual specific servers:
  - Apple XServe RAID: 300 W
  - HP 24xx series rp2430/rp2470: *maximum theoretical, 600 W, maximum actual, 275 W*
- Cooling of the server farm can account for between 50-100 % of power consumption (IDC, 2006).
- Energy efficiency has improved dramatically in the last few product generations, with manufacturer-reported improvements of 35% to 150% per watt. Major areas of processor efficiency improvements include multi-core processors, low voltage processors, and smaller chips made with advanced materials (ACEEE, 2007).
- Server energy use was estimated at 560 kWh/yr (Servers), 5,840 (Minicomputer), and 58,400 (mainframe) in the US (Kawamoto et al, 2002)

**Energy Consumption Protocols:**

- Small, desktop-type servers fit within the ENERGY STAR defined-parameters for computer devices.
- The Standard Performance Evaluation Corporation (SPEC) expects to complete its first energy performance protocol for small- and medium-sized servers in early 2007 (ACEEE, 2007).

**Questions:**

- Are there other data sources that should be reviewed?

**Comments:**

**3.7.4 Ease of Standard Development**

- Servers are likely to have similar environmental criteria to computers with the exception of energy conservation.
- There does not appear to exist a good basis of scientific literature, including LCAs, about the environmental impacts of the products.
- One existing standard was identified for servers; ENERGY STAR. Desktop derived servers fall under their new computer standard. An ENERGY STAR standard is presently under development for mid-range and larger servers. This could impact the timing of the finalization of an EPEAT standard which included mid-range and larger servers.

**Questions:**

**Comments:**

**3.7.5 Market Characteristics**

Estimates of active server usage in the United States are murky, but following usage and sales data for the US were reported:

- Research firm IDC estimated that there were 1.8 million new servers installed in 2002, and estimates that by 2009, that number will increase to 4.9 million per year ([www.publiccio.com](http://www.publiccio.com), 12/19/2006).
- In a February 2007 EPA technical workshop on energy efficient servers and datacenters, workshop participants identified the identification of growth trends in IT data and data centers (both historical and projected) as a key data need (EPA, 2007).
- By year, IDC estimated the following **US sales** (derived from IDC presentation, V. Turner, Spring 2006):
  - 2.8M units in 2005
  - 3.3M units in 2006
  - 3.9M units in 2007
  - 4.4M units in 2008
  - 4.9M units in 2009
  - Total unit sales 2005-2009 = 19.3M
- As reported by Gartner, **worldwide** server shipments totaled 8.2 million units in 2006, representing an 8.9 % increase from 2005 ([www.internetnews.com](http://www.internetnews.com), 2/22/07)
- Manufacturer market share for 2006 shipments, again reported by Gartner, included
  - Hewlett Packard: 27.5 %
  - Dell: 21.7 %

- IBM: 15.7 %
- Sun Microsystems: 4.5 % ([www.internetnews.com](http://www.internetnews.com), 2/22/07)
- 90% of sales are smaller servers (sales price < \$6,000) (from IDC presentation, above)
- Percentage of market in US by server type includes: 61% servers, 37% minicomputers, and 2% mainframes (Kawamoto et al., 2001)

**Questions:**

- Can we assume that institutional purchasing makes up nearly 100% of the market?

**Comments:**

### **3.7.6 Level of Stakeholder Interest**

**Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?
- Do you have any suggestions regarding availability of funds to support the development of a standard?

**Comments:**

### **3.7.7 Other Considerations**

**Questions:**

What other factors should be considered in product selection and/or standard development?

**Comments:**

## **3.8 Televisions**

### **3.8.1 Existing Standards and Proposed Product Definition**

Three existing standards were identified for televisions; ENERGY STAR, TCO and Nordic Swan. All the definitions were closely related. The standards differentiate TVs from computer monitors mainly on their primary function as viewing devices as opposed to being an output device for computing. ENERGY STAR's definition was the most complete and clear in terms of the distinction between a TV and computer monitor.

**Proposed product definitions from ENERGY STAR:**

**Television (TV):** A commercially available electronic product consisting of a tuner/receiver and a monitor encased in a single housing. The monitor usually relies upon a cathode-ray tube (CRT), liquid crystal display (LCD), plasma display, or other display device. The TV is designed to receive and display a television signal broadcast by antenna, satellite, or cable. To qualify, the TV must be capable of being powered from either a wall outlet or a battery unit that is sold with an AC adapter. This definition includes analog and digital televisions in addition to televisions that require additional power to receive and process signals that contain information and/or data for

electronic programming guides. Television products with a tuner/receiver and computer capability (e.g., computer input port) may qualify as long as they are marketed and sold to consumers as televisions (i.e., focusing on television as the primary function). However, products with a tuner/receiver and computer capability that are marketed and sold as 1) computer monitors or 2) dual function televisions and computer monitors are not included in this specification.

**Television Monitor:** An electronic product intended to display a video signal from an external tuner or other video source such as a VCR or DVD Player on a CRT, LCD, plasma display, or other display device. To qualify, the television monitor must be capable of being powered from either a wall outlet or a battery unit that is sold with an AC adapter. This definition includes analog and digital television monitors. Television monitors with computer capability (e.g., computer input port) may qualify as long as they are marketed and sold to consumers as television monitors (i.e., focusing on television/video as the primary function). ***However, products with computer capability that are marketed and sold as 1) computer monitors or 2) dual function television and computer monitors are not included in this specification.***

**Questions:**

- Should this category include both televisions and television monitors?
- Should we consider amending IEEE 1680 to include televisions and/or television monitors?
- Are there other existing standards that include televisions and/or television monitors?
- Any comments on the proposed definitions?

**Comments:**

**3.8.2 Environmental Profile**

**Product Profile**

TVs and display devices include traditional cathode ray tube (CRT) technology as well as new and maturing technologies such as plasma displays (PDs), and liquid crystal displays (LCDs).

**LCDs** are characterized by the following:

- LCDs use small electric current applied to a thin layer of LC dispersed between two plates of glass to transmit light provided from an array of backlights.
- LCDs used in TVs rely on a set of up to 8 backlights which can sometimes contain mercury to illuminate the screen (King County, 2007)
- TVs are primarily active matrix displays, using a thin film of transistors to activate the pixels, making them brighter and sharper than passive matrix displays.
- Recent technology improvements have led to larger possible screen sizes (65 inches +) making them more applicable as display devices.
- Typical LCD contains 20-25 LC compounds (Socolof et al, 2001 & King County, 2007)
- There is approx 0.6g of LC per sq. cm of display area (Socolof et al., 2001)

**Plasma** displays are characterized by the following:

- Plasma tech uses mixtures of inert noble gasses- primarily neon and xenon- to excite phosphors (same as CRTs) between two pieces of glass.
- Large screen sizes up to 80 inches have been produced using plasma, not suitable for computer displays due to flickering (King County, 2007)
- Mass of 42 inch plasma TV is 65 lbs  
(<http://www.plasmatvbuyingguide.com/plasmatv/nec-42xm2.html>)

- Susceptible to screen burn making them less than ideal for display applications.
- Plasma technology does not utilize mercury lamps (King county, 2007)

**CRTs** are characterized by the following:

- High voltage electron guns accelerate electrons through a shadow mask toward phosphors deposited on a faceplate that convert the kinetic energy to an image
- Average mass of TV is 65 lbs (<http://www.epa.gov/epaoswer/non-hw/reduce/wstewise/pubs/g2gfinal.pdf>)
- CRTs have 15-90 lbs of glass (depends on size), containing high lead content required to shield users from x-rays and other emissions from the electron gun and electromagnetic fields generated
- Some states have banned the disposal of these devices, requiring instead that they be recycled

Flat panel displays (Includes both PDs and LCDs) consist of the following materials (Socolof et al, 2001 & Townsend et al, 2004):

- Ferrous Metal (25-44%)- structural pieces
- Plastic (28-31%)- Mainly PVC, ABS, PC, and HIPS used in the FPD housing and wire jackets. Typically contains BFRs
- Glass (10-23%)- Display unit, does not typically contain lead
- Printed wiring board (6-10%) – comprised of fiberglass resin, components, and TV tuner elements
- Nonferrous metal (3-9%)- includes mercury in CCFLs, lead in PVC and solder, beryllium and cadmium
- Wires (4%)- typically PVC jackets surrounding copper wires, cord connectors and plug
- Other materials (<1%) – Includes cold cathode fluorescent lamps (CCFLs) and LCs

Note: A comprehensive list of materials in LCDs and other flat panels can be found in the following reports (King County, 2007) (Socolof et al, 2001)

### **Content Specific Environmental or Human Health Concerns**

Toxic materials notably found in TVs (CRTs, LCDs, PDs) sold today include:

- Liquid Crystals- LCDs
- Mercury in CCFLs – LCDs
- Lead- CRTs
- PWB metals including lead and hexavalent chromium cadmium - All
- BFRs- tetrabromobisphenol-A (TBBPA) and decabrominated biphenyl ether (DBBE)- All
- Other materials- All

Liquid crystals used in **LCDs** had the following human health and environmental impacts (<http://www.umweltbundesamt.de/uba-info-daten-e/daten-e/lcd.htm>):

- Liquid crystals were determined to not be mutagens or pose an acute threat to human health (Socolof et al, 2001).
- A test of five common LCs observed no known toxic affect to aquatic organisms (Socolof et al, 2001).
- Limited information suggests no carcinogenicity, however testing only on a small percentage of LCs (Socolof et al, 2001).
- Biodegradability of liquid crystals ranged between 0-30 % (King County, 2007).

- Primary exposures of potential concern over the LCD life-cycle include occupational exposures during the manufacture of the LCs, and exposure to dust during recycling or reclamation.

Mercury, present in CCFLs used to backlight **LCD** displays, poses the following threats.

- Mercury in CCFLs ranges from 4-12 mg depending on the length of the backlights (Note: value scaled up from 4 mg Hg reported in Socolof et al for 15 inch light). TVs can have up to 8 lights per set.
- Mercury is a possible human carcinogen, a persistent bioaccumulative toxin, and poses many other acute and chronic human health threats (ATSDR, 2000).
- Exposure to mercury vapor from broken CCFLs during reclamation and recycling is expected to be a primary route of exposure (Socolof et al, 2001).

Lead in **CRTs** pose the following human health and environmental threats:

- Sources of lead in CRTs include the funnel (22-28% by wt.), front panel (0-4%), CRT neck (26-32%), and the frit (70-80%) (Socolof et al, 2001).
- A 17 inch CRT monitor contains approx. 2.6 lbs of lead, bigger TVs would contain much more (Socolof et al, 2001).
- Lead is rated a probable human carcinogen, is a PBT, and is a neurotoxin to human health among other chronic and acute threats to human health.
- CRTs have demonstrated leaching that exceeded allowable thresholds for at least one or more compounds including lead.

BFRs in TV housings and other plastic parts pose the following human health and environmental threats:

- Octa-PBDE, which was phased out in the US in 2005, was typically used with ABS plastics in some older TVs that may yet hit the recycle or disposal streams.
- Deca-PBDE is manufactured in large quantities and is commonly used in the housings and other plastic parts of TVs and other electronic devices.
- Deca-PBDE, which is considered slightly less toxic, is a concern due to its tendency to break down to other more toxic congeners (Rossi and Heine, 2007).
- Deca-PBDE is considered a possible human carcinogen (King County, 2007).
- BFRs which have been found to be ubiquitous in the environment are neurotoxins in children, immune system suppressors, and have other chronic human health affects (Rossi and Heine, 2007).

### **End of Life**

The following end-of-life data was identified regarding reclamation, recycling, or disposal of TVs and display units:

- Disposal of CRTs has been banned in a number of states in the US due to concerns over lead and other toxic materials.
- Several studies have indicated large numbers of TVs are in storage in homes in the US: 2.9 million in CA in 2001, (CIWMB, 2002); 170,000 in WA (Cascadia, 2002), 1.9 million in SE U.S. (UT, 2004).
- An estimated 500 million lamps (all lamps, not just CCFLs) are disposed rather than recycled (King county, 2007).
- Assuming 40% of lamps disposed result from TVs or displays, and using an average mercury content of 8 mg per lamp from previous page, un reclaimed lamps potentially account for over 3,500 lbs of mercury released into the environment annually.

- TVs in the waste stream are typically an average of 15-17 years old (US Dept of Commerce, 2006).
- 70 tons of liquid crystals were manufactured in 2001, while liquid crystals cannot yet be economically reclaimed at end of life (King County, 2007).
- LCDs last as long as the lamps, which is approx 60,000 hours of use. Only one mfr to-date offers a TV that allows lamp changeouts.  
(<http://www.lcdtvbuyingguide.com/lcdtv/lcdtv-lifetime.shtml> )

Electronic circuitry, processors, and other typically computer-based TV components can be reclaimed, reused, or recycled at EOL using traditional electronic recycling processes.

**Questions:**

- Are there other data sources that should be reviewed?

**Comments:**

### **3.8.3 Energy Profile**

#### **Energy profile**

- CRT digital TVs use roughly 8.8W in standby, while consuming an average of 177W when active (Rosen and Meier, 2002).
- CRT consumption averaged 114 W for 30-36 inch TVs (Rosen and Meier, 2001).
- CRT average phantom power load when power off is 5.3W (Rosen and Meier, 2001).
- A check of current TV specs on 10 plasma and 10 LCD 40-42 inch TVs resulted in an average power consumption of 240W for **LCDs** versus 375W for **PDs**, a full 43% more energy consumption.
- Energy use profile was reported to be 16% active and 84% standby (Rosen and Meier, 2001) **Note-** this appears low compared to other non-citable research that is ongoing.

**Questions:**

- Are there other data sources that should be reviewed?

**Comments:**

### **3.8.4 Ease of Standard Development**

- TVs could be expected to have very similar environmental criteria to monitors, as included in IEEE 1680. It may even be possible, with some modification, to include TVs within IEEE 1680 through a revision process.
- Since TVs are primarily a consumer-marketed product, this would require modification of the intent of IEEE 1680, and possibly some of the text.
- The purchaser stakeholders would be different from EPEAT for computers/monitors due to their consumer market presence.
- There is considerable literature regarding the environmental impacts of CRTs, but much less regarding flat panel displays which would be the focus of the standard.
- Existing eco-label standards: ENERGY STAR, TCO, Nordic Swan and EU Eco-Flower standards.

**Questions:**

**Comments:**

**3.8.5 Market Characteristics**

Television technology has changed rapidly over recent years. There has been a dramatic rise in flat panel sales as price points decline. In addition, the upcoming switch from analog to digital TV in February 2009 has had a significant impact on the market and will continue to do so. The January 2007 CEA report on US consumer electronics sales indicated that (CEA, 2007):

- Sales of analog tuner TVs are declining rapidly
- Sales of digital tuner TVs are increasing rapidly
- From 2002 to 2007 digital TVs went from 0% of the market to 93% of the market
- US sales of TVs overall are relatively flat around 31-34 million units/year from 2002 – 2007

Market sales and trend data reported for **FPDs** include the following:

- By 2008 devices containing FPDs are projected to account for 85% of the US market (King County, 2007)
- FPDs are expected to replace **CRTs** in every application, particularly in TVs (King County, 2007)
- Of FPDs sold in 2003, 85% were **LCDs**, 13% were **plasma** displays (<http://www.lcdtvbuyingguide.com/lcdtv/lcdtv-misconceptions.shtml>)
- In May 2004, for 30-39 inch sets, **plasma** accounted for 47% and **LCDs** accounted for 53% of FPDs. In the same time period, for 40-49 inch sets, FPDs account for a full 43% of all TV sales. (<http://www.lcdtvbuyingguide.com/lcdtv/lcdtv-misconceptions.shtml>)
- Average U.S. home in 1997 had 2.1 TVs per home, 30% of which had 3 or more TVs. All are expected to be higher today ([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))
- World wide sales of **LCD** TVs were 9 million pieces with an average display diagonal of 21.3 inches in 2004- average display area of 218 square inches (King County, 2007)
- Projected LCD TV sales to exceed 55 million sets with a display diagonal of 30.4 inches- 480 square inches display areas (King County, 2007)

**Questions:**

- Are future projections of sales data available for televisions and television monitors?
- Is the consumer versus institutional market split estimated to be approximately 90% consumer and 10% institutional?

**Comments:**

**3.8.6 Level of Stakeholder Interest**

**Questions:**

- How important is it to have a standard for this product?
- Are you interested and available to assist with the development of a standard for this product?
- Can you recommend others who should be involved?

- Do you have any suggestions regarding availability of funds to support the development of a standard?

**Comments:**

### **3.8.7 Other Considerations**

**Questions:**

What other factors should be considered in product selection and/or standard development?

**Comments:**

## ***3.9 Environmental and Energy Profile Information on 2<sup>nd</sup> Priority Products***

### **3.9.1 Cable Boxes**

#### **Energy Consumption- Use Phase**

Energy estimates and usage patterns for **Cable Boxes (analog and digital)** identified in the research include the following:

- Energy consumption measured for **analog cable boxes** during operational mode include (Rosen and Meier, 2002):
  - Standby mode- 11W (78% time)
  - Active mode 12W (22% time)
- Total estimated average annual energy consumption for analog cable boxes – 95 kWh/yr
- Energy consumption measured for **digital cable boxes** during operational mode include (Rosen and Meier, 2002):
  - Standby mode- 23W (78% time)
  - Active mode 23W (22% time)
- Total estimated average annual energy consumption for digital cable boxes – 200 kWh/yr
- 74% of homes get TV via cable or satellite  
([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))
- 40% have set top boxes in 1997  
([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))
- 5-20W when in use, with virtually no change when in standby or off mode.  
([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))
- Annual energy consumption for cable boxes ranges from 40-175 kWh per year – average of 120 kWh/year  
([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))
- Satellite decoders consume more than cable boxes, ranging from 11-21 watts when in use or 130 kWh/year  
([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))

### **3.9.2 Video Boxes/Games (i.e. playstation)**

#### **Energy Consumption- Use Phase**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Energy estimates and usage patterns for **Video Boxes/Games** identified in the research include the following:

- Energy consumption measured for video boxes/games during operational mode include (Rosen and Meier, 2002):
  - Standby mode- 1.1 W (78% time)
  - Active mode 7.9 W (22% time)
- Total estimated average annual energy consumption for video boxes/games – 23 kWh/yr
- Approx 33% of US homes have video game systems  
([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))
- 10w energy consumption when on  
([www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html](http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/99/990510.html))

### **3.9.3 VCRS**

#### **Environmental Impacts**

At least one study indicated that printers leached copper, lead, and antimony at levels that exceeded regulations (Cal DTSC, 2004).

#### **Energy Consumption- Use Phase**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Energy estimates and usage patterns for **VCRs** identified in the research include the following:

- Energy consumption measured for VCRs during operational mode include (Rosen and Meier, 2002):
  - Standby mode- 5.9W (77% time)
  - Idle mode- 13W (24% time)
  - Active mode 17W (4% time)
- Total estimated average annual energy consumption for VCRs – 74 kWh/yr

### **3.9.4 DVDs**

#### **Energy consumption- Use Phase**

Measurement of the energy consumption of office equipment is made difficult by the many operational modes and varying usage patterns of the individual devices. Energy estimates and usage patterns for **DVDs** identified in the research include the following:

- Energy consumption measured for DVDs during operational mode include (Rosen and Meier, 2002):
  - Standby mode- 4.1 W (72% time)
  - Idle mode- 15W (24% time)
  - Active mode 17W (4% time)
- Total estimated average annual energy consumption for DVDs – 64 kWh/yr

## **4.0 References**

A complete listing of references will be provided on the webpage.