# ATIS REPORT ON ENVIRONMENTAL SUSTAINABILITY

March 2009

**A Report by the**
**ATIS Exploratory Group on Green**

ATIS is the leading technical planning and standards development organization committed to the rapid development of global, market-driven standards for the information, entertainment and communications industry. More than 300 companies actively formulate standards in ATIS' 20 Committees, covering issues including: IPTV, Service Oriented Networks, Home Networking, Energy Efficiency, IP-Based and Wireless Technologies, Quality of Service, Billing and Operational Support. In addition, numerous Incubators, Focus and Exploratory Groups address emerging industry priorities including "Green", IP Downloadable Security, Next Generation Carrier Interconnect, IPv6 and Convergence. < http://www.atis.org/ >

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*ATIS Exploratory Group on Green*

This is an ***ATIS Report*** developed by the **Exploratory Group on Green** for the ATIS Board.

**This document is a *work in progress* and subject to change.**

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## PREFACE/NOTICE

This document was developed by the Alliance for Telecommunications Industry Solutions (ATIS) Exploratory Group on Green (EGG) – an ad hoc group commissioned by the ATIS Board of Directors and is intended for use by ATIS Members. This document is not an ATIS standard and is not intended to be and should not be interpreted as a specific requirement, industry standard or policy directive. This report is intended to provide the results of an initial study into the topic of environmental sustainability for ICT that, by definition, must balance social, environmental and economic considerations. The information contained in this document reflects current efforts, market trends and projections with respect to environmental sustainability. The considerations, recommendations and best practices presented are intended to assist companies in identifying potential areas to achieve greater energy efficiency, as well as offering aspects of environmental sustainability to evaluate when implementing, maintaining or expanding an internal program.

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# 1 EXECUTIVE SUMMARY

Climate change, global warming, environmental sustainability, greenhouse gas (GHG) emissions, and "Green" issues are dominating the global agenda. Simultaneously, companies are confronting increasing energy costs, governmental mandates, pressures to establish targets toward reducing carbon dioxide ($CO_2$) emissions, consumer and investor demands and the proliferation of numerous initiatives and programs on the subject while ensuring economic growth. In an effort to better understand these issues and how they pertain to the Information and Communications Technology (ICT) industry in particular, the ATIS Board of Directors formed the Exploratory Group on Green (EGG) in late 2008 to provide considerations forward.

This report contains the results of the EGG review. It defines "sustainability" in relation to the ICT industry as the "ability to meet current needs without hindering the ability to meet the needs of future generations in terms of economic, environmental and social challenges[1]," reviews key initiatives and programs germane to the topic, and highlights initiatives and programs aimed at increasing energy efficiencies. Furthermore, this report sets the foundation for developing an industry roadmap to prioritize and advance issues associated with ICT sustainability (such as energy efficiency and management) and substantiates the ICT industry as an enabler of applications and services that can improve energy efficiency in other sectors in conjunction with reducing their $CO_2$ emissions.

From its assessment the EGG has determined that the ICT industry's focus is on achieving sustainable solutions and ATIS and its member companies are well-positioned to improve sustainability in the ICT sector and beyond. Namely, while the ICT sector has not been traditionally thought of as an enabler of GHG reduction, studies show that the ICT sector can play a key – potentially unique – role. A few findings show that:

- ICT-enabled solutions could cut annual $CO_2$ emissions in the United States (U.S.) by up to 22 percent in 2020. This translates to gross energy and fuel savings of as much as $240 billion. (*SMART 2020*[2])
- A seven percent increase in broadband adoption could result in $6.4 billion per year in mileage savings from unnecessary driving and 3.2 billion fewer pounds of carbon emissions in the U.S. The equivalent to taking 273,858 cars off the road for a year. (Connected Nation[3])
- If companies were to substitute video conferencing for 10 percent of business air travel, it would reduce carbon emissions in the U.S. by some 35 million tons annually. That's like saving the amount of energy it takes to provide electricity to more than 4.2 million homes each year. (American Consumer Institute[4])
- Widespread use of broadband has the potential to reduce carbon emissions by more than 1 billion metric tons. And that's equivalent to the annual $CO_2$ emissions of 215 coal fired power plants. (American Consumer Institute)

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[1] "ISM Principals of Sustainability and Social Responsibility." Ethics and Social Responsibility. Institute for Supply Management. 26 February 2009 <http://www.ism.ws/SR/content.cfm?ItemNumber=18497&navItemNumber=18499>.
[2] The Climate Group. Smart 2020: Enabling the Low Carbon Economy in the Information Age: The Climate Group on Behalf of the Global eSustainability Initiative, 2008.
[3] "Home." Connected Nation. 2008. Connected Nation. 3 March 2009 <http://www.connectednation.org/>.
[4] "Home." ACI. 2009. The American Consumer Institute Center for Citizen Research. 3 March 2009 <http://www.theamericanconsumer.org/>.

To maximize the ICT sector's ability to deliver advanced solutions for reducing GHG, the industry must be afforded the opportunity to invest and innovate. Future governmental mandate or self-imposed industry metrics must sustain -- not repress -- collaborative innovation and continued investments in the ICT sector. There is also an opportunity for the ICT sector to receive government and non-government organization grants and investments to sustainably and responsibly stimulate the global economy.

As recognized in the *SMART 2020 Report* and other initiatives presented in this report, the ICT sector has the opportunity to step into a global leadership position to help other industries reduce emissions and increase efficiency. It is estimated that while GHG emissions by the ICT sector may increase mainly from the increased use of electricity required to power ICT devices, networks and systems, the ICT sector could reduce global emissions by as much as 15 percent by 2020, through adjacent industries increased use of ICT products and services.

In order to fully realize these opportunities, while also setting in place measures for the ICT sector to increase its own energy efficiencies, the EGG presents considerations and recommendations which should be taken by ATIS, its members and the ICT industry as a whole, in the context of the aforementioned "Notice" (p. ii). To this end, the EGG recommends ATIS' support in further exploring and developing the area of sustainability as it relates to ICT (e.g., energy efficiency). The following are a few key items from Section 13: Considerations and Recommendations:

- ATIS and its member companies should establish a means to stay engaged in the work programs in the ICT industry with respect to sustainability in order to (1) report and share relevant data and information, and (2) better prepare to assist and support ATIS members to respond to technical, operations or policy and/or legislation proposals regarding climate change and ICT at all levels of government (e.g., in Congress, Federal Communications Commission (FCC), Environmental Protection Agency (EPA) etc.).
- ATIS and its members should continue an ATIS Board-level study on the subject of sustainability as it relates to technology solutions. Additional work is needed to include a more detail analysis across all the portfolios but especially in the area of wireless energy efficiency and lifecycle assessment (LCA) from an "end-to-end" perspective. In addition, this work should address the specific ICT needs of the adjacent industries highlighted in the *SMART 2020* report (power, transport, manufacturing, buildings), and any requirements this sets on technical standards and best practice.
- ATIS and its members should support the development of energy efficiency and management standards for network, enterprise and home equipment taking into account economic factors. Encourage standards developers to work closely together to harmonize technical criteria, as well as to work collaboratively with governmental agencies specifying targets and energy requirements; e.g., European Union (EU) Code of Conduct (CoC), U.S. Department of Energy (DOE)/ EPA. Existing standards work in the ATIS Network Infrastructure Power and Protection (NIPP) and other groups must also continue to be supported.
- ATIS members should educate policy makers and legislators on the ICT industry's considerations to help develop and advance solutions for reducing greenhouse gases by harnessing the power of ICT. Refer to *Appendix H: Informational Resource to Facilitate*

*Interactions with Legislators, Administrators, and Policy Makers,* as a potential source of information.

## 2 BACKGROUND

In 2008, the ATIS Board of Directors concluded that it was timely for ATIS to actively engage in the topic of Green in an effort to better understand various Green initiatives as they related to the communications, information and entertainment industry. After conducting preliminary research on the topic which included assessing the work in the Network Interfaces, Protection and Power (NIPP) committee on energy efficiency, ATIS concluded that while Green (i.e., sustainability-related programs) within many of ATIS' member companies were well advanced and robust or evolving to be more comprehensive, areas were identified where industry could further advance their sustainability initiatives to gain additional value.

Areas and actions where industry could further advance their sustainability initiatives included: (1) companies sharing lessons learned and other information about their initiatives with other companies; (2) companies collectively working toward industry-wide operational policies, technical standards or performance benchmarks to consistently "quantify" conformity to, or levels of, being Green; and (3) applying consensus industry-based parameters, criteria and guidelines when possible, versus government-driven mandates or programs.

In order to provide additional clarity around these areas and to further focus ATIS' work on Green, in July 2008 an "ATIS Green Workshop" was held to bring together ATIS Board members companies in order to assemble, assess and discuss existing internal and external Green initiatives/programs from a practical and business-oriented industry-wide perspective.

Based on the information presented during the Workshop and its subsequent recommendation to advance industry's Green programs, the ATIS Executive Committee of its Board of Directors commissioned the formation of the ATIS Exploratory Group on Green (EGG) to investigate how ATIS and its members could address Green. Its initial objective would be to investigate and prioritize the items identified as important to ATIS member companies during the ATIS Green Initiative Workshop. These items included: (1) development of a basic sustainability taxonomy; (2) categorization and assessment of existing vs. needed standards, best practices and matrices from a technical, regulatory/policy and business perspective; and (3) development of an Industry Roadmap to prioritize and advance issues associated with energy management, applications and services. The group is comprised of members from the telecommunication manufacturing industry and telecommunication service providers based internationally.

This report represents the findings of the ATIS EGG. It should be noted that based on subsequent discussions, it was deemed more appropriate to put specific focus on environmental sustainability in regard to the industry, rather than the broad reaching, all encompassing term "Green".

## 2.1 *The Current State of Environmental Sustainability*

The equipment vendors and operators have been concerned with reducing energy consumption, heat generation, and the equipment footprint for years in an effort to increase operational efficiencies and reduce cost. Most of these initiatives by equipment vendors and service providers appear to fall into three broad categories:

- Reducing energy consumption, heat generation and equipment footprint, which can lower energy costs in networks and user devices including measurement metrics used to report on these efforts.
- Using renewable materials to manufacture products and recycled materials for packaging.
- Conforming to government regulations and recommendations by renewable energy advocacy groups.

Industry is also taking steps in the areas listed and defined below; which are "bundled" into areas of importance or interest. Areas considered outside the mission of ATIS where member companies are involved (e.g. water management and manufacturing processes) are not included.

**Areas Considered of Importance**

- Network Efficiencies
    - Size, Wattage and Performance (SWAP) metrics
    - Heat generation (e.g., fresh air cooling vs. air conditioning)
    - Energy efficiencies and power consumption
- Data Centers
    - Power consumption of data centers, and measures to better manage energy use to achieve measurable results following the implementation of sustainability initiatives
- Applications and Services
    - The role of applications to enable energy conscious behavior and practices
    - Applications for the virtualization of server resources to reduce physical resource needs and power needs without sacrificing service
    - Applications for energy management to provide real time usage data for homes and businesses

**Areas Considered of Interest**

- Lifecycle Assessment
    - Biodegradable materials (e.g., packaging and design)
    - Recycling
    - Disposal of Hazardous Material (best practices)
- Corporate Operations
    - Reducing carbon-footprint
    - Employee incentives and programs (e.g., telecommuting, virtual meetings/conferences, telepresence)
    - Telepresence applications allow for reduced carbon emissions from travel to face-to-face meetings or worksites.
    - Fleet management (e.g., hybrid vehicles)
    - Facilities management (e.g., climate monitoring and control)

- Equipment Supply-Chain (Network/Consumer)
  - Compliance requirements and associated programs (e.g., EPA Energy Star and Research Conservation Challenge (RCC) programs)
  - Equipment power-down and sleep modes
  - Power consumption
- Alternative Energy (Renewable and Sustainable)
  - Alternative energy sources for power to reduce dependency on power grids and on carbon generating energy sources such as generators
  - Renewable energy such as wind and solar is now mature and will be increasingly deployed as solutions for remote sites

## 3 WHAT IS SUSTAINABILITY?

The *Our Common Future Report (The Brudtland Report*[5]*)* by the United Nations World Commission on Environment and Development defines sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". This definition is recognized by the EPA and World Business Council for Sustainable Development, among others. When considering sustainability the general business and government community further recognize what is known as the "Triple Bottom Line[6]" which is to consider balancing a growing economy, protection for the environment and social responsibility simultaneously.

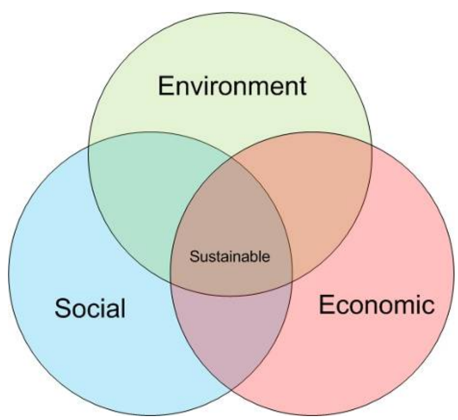


**Figure 1: Sustainable Development**

In applying the Triple Bottom Line concept (i.e., the economic, social, and environment), as seen above, sustainable development is achieved when balancing all three dimensions. Accordingly, environmental sustainability, as adopted by EGG, means "the ability to meet current needs without hindering the ability to meet the needs of future generations in terms of economic, environmental and social challenges."

The basic premise of ICT sustainability High Level Relationships figure below is to provide a high level look at how the three dimensions discussed above interact based on the

[5] "Report of the World Commission on Environment and Development: Our Common Future." UN Documents Cooperation Circles. United Nations. 24 February 2009 <http://www.un-documents.net/wced-ocf.htm.>
[6] Elkington, John. Cannibals with Forks: The Triple Bottom Line of 21st Century Business. Oxford: Capstone Publishing, 1997.

business drivers behind the ICT sector's actions toward sustainability and resultant outcomes to meet current needs.

As illustrated in the figure, working from left to right, the work being done as an industry is based on a number of input factors, including laws (from government entities or quasi government entities), social pressure from consumers, and also keeping up the market edge with competitors new products and services. From these drivers, ICT actions are both direct and indirect. The direct actions are for improving efficiencies, waste, and any practices for managing equipment/networks etc. These are those things that the industry can directly and immediately affect. The indirect actions are those where changes in practice can affect others. The business outcomes and effects are the opportunities and results of these actions, including the potential for self regulation, the potential consumer loyalty through meeting expectations, and meeting internal business goals such as shareholder expectations.

In short, industry's consideration of and actions toward sustainability are balanced against its environmental responsibility, social acceptance, and economical viability.

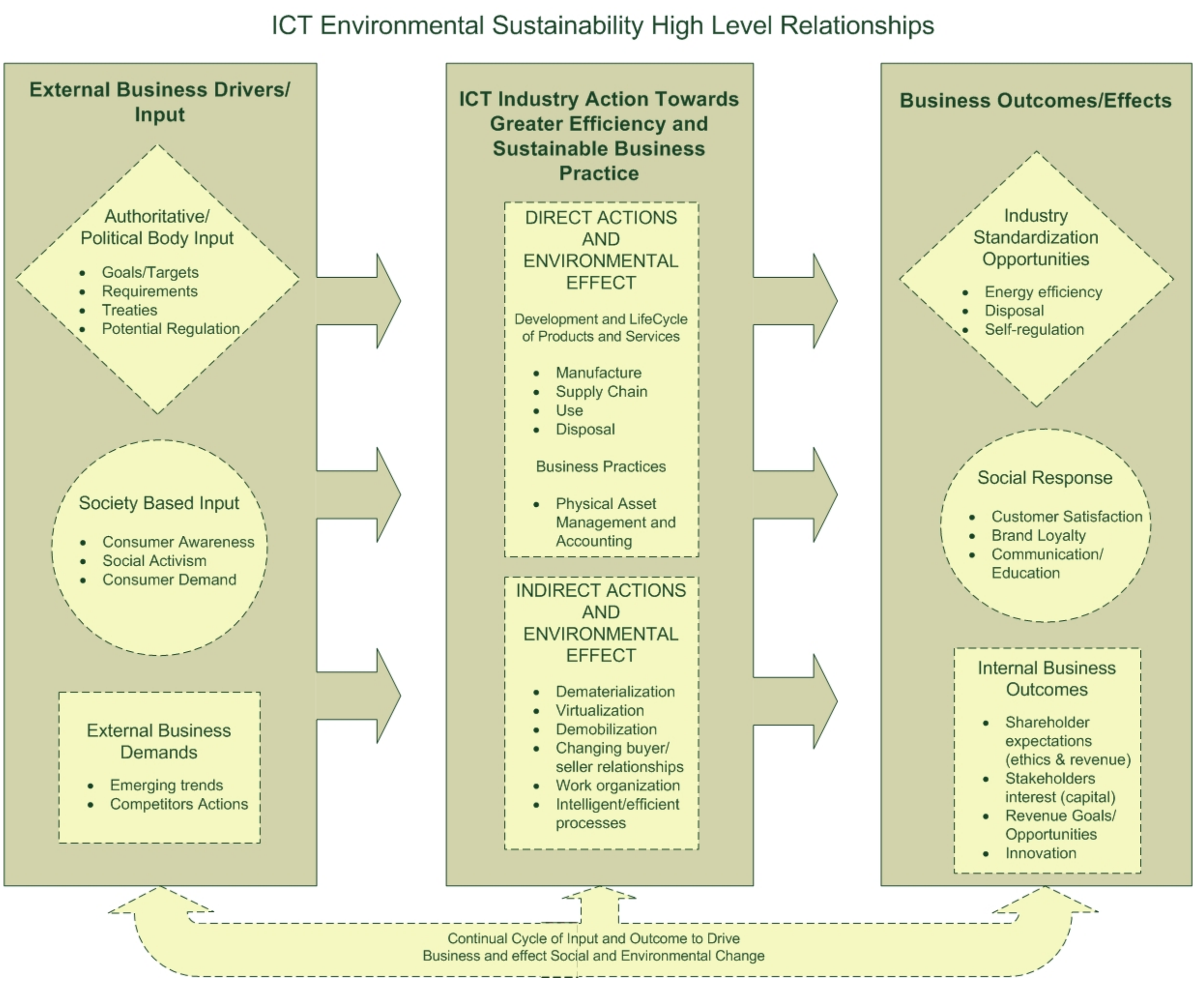


**Figure 2: ICT Environmental Sustainability High Level Relationships**

### *3.1 Taxonomy*

This section provides the Taxonomy of Sustainability Considerations for ICT Products, Services, and Operations. The purpose is to provide for common language and hierarchical relationships in the area of sustainability considerations for ICT products, services, and operations. This taxonomy is intended to be complementary with other sustainability models in this document and is not intended to be the exclusive hierarchical model used to help describe sustainability. For example, this taxonomy is not intended to define a sustainability work project, program or portfolio breakdown structure (which is a hierarchy) that could be the basis for a sustainability roadmap.

The hierarchical decomposition starts with the definition of sustainability itself, i.e.: *The ability to meet current needs without hindering the ability to meet the needs of future generations in terms of economic, environment and social challenges.* From this definition the major perspectives of sustainability can be derived, i.e.: economic, environment and social perspectives. This provides the basis for the top two layers of the taxonomy. All other detailed aspects, considerations and solutions fit under this top of the taxonomy. It should be noted that the placement of items in the taxonomy are determined as a "best fit" even though in some cases a given taxonomy item can be seen as containing some part of all three major sustainability perspectives (i.e., economic, environment and social perspectives). The taxonomy is not intended to be static as growth of the taxonomy is expected.

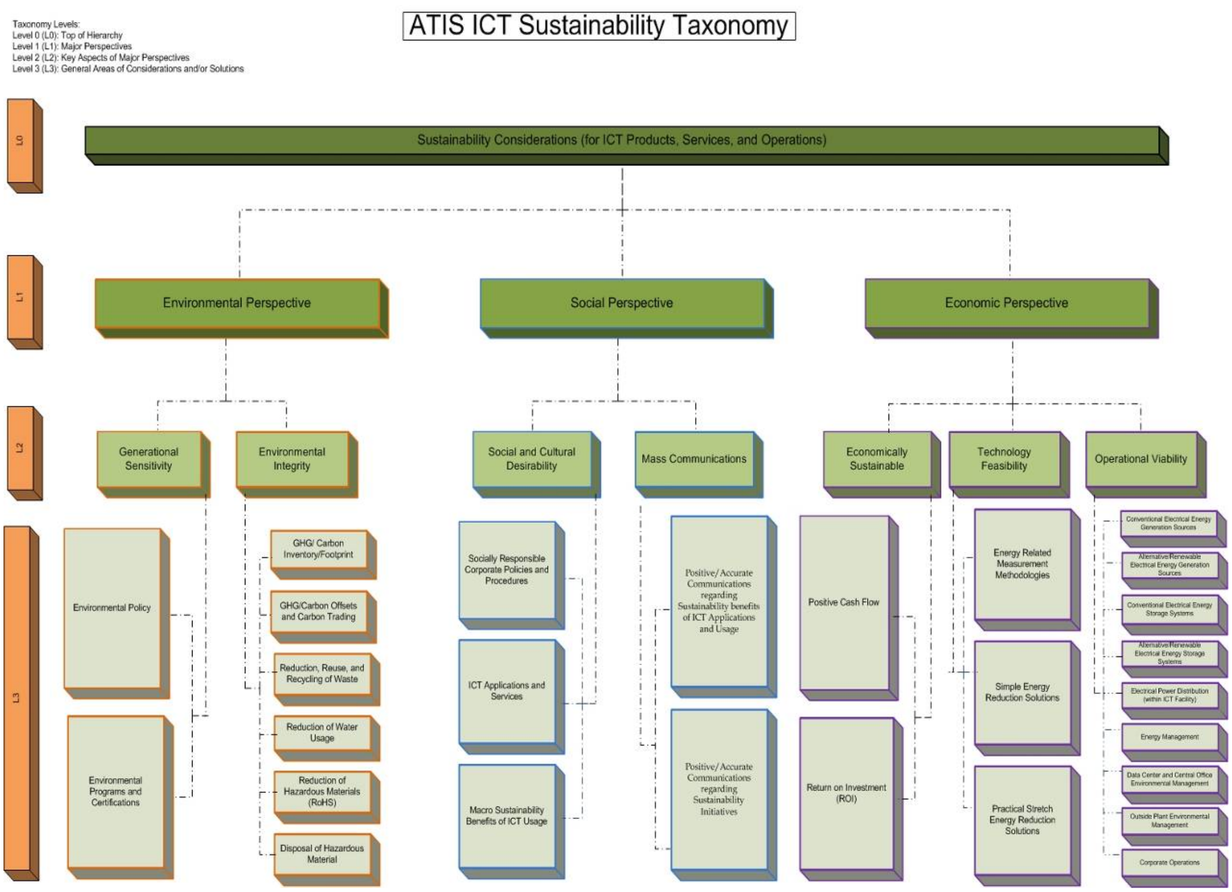


**Figure 3: ATIS ICT Sustainability Taxonomy**

The complete levels of the taxonomy and an enlarged diagram are available in *Appendix A: Detailed Taxonomy*.

# 4 DEFINITIONS

In order to establish a baseline of understanding when discussing environmental sustainability in the context of the communications industry's efforts toward achieving greater energy efficiencies, the following section defines commonly referenced terms, functions and elements relevant to sustainability.

## *4.1 Definition of Terms*

### 4.1.1 Abatement

The act of eliminating or reducing greenhouse gases from being emitted into the atmosphere.

### 4.1.2 $CO_2$ Equivalent

A metric used to equate the impact of various greenhouse gas emissions upon the environment's global warming potential based on $CO_2$.

The benefits of the "green agenda" are frequently discussed in terms of reduction in power consumption (energy efficiency) or decrease in GHG emissions. Quantifying the relationship between parameters in these two domains can be helpful in planning and in assessing performance.

For comparing efficiencies and analyzing scenarios with ATIS efforts, it is recommended that metrics related to power be used. Power consumption metrics are more readily and reproducibly measured at standardized interfaces. In addition, power-related measures also have fewer situational variances that are associated with GHG metrics; e.g. what was the actual instantaneous power source (fossil fuel, nuclear, hydroelectric, wind, solar, etc.), were any carbon off-sets applicable, etc.?

While power metrics are recommended for general use, once a power consumption-based measure is known, estimates of the equivalent GHG emission is possible using tools such as the EPA Carbon-equivalence calculator.[7]

This tool provides the estimated GHG equivalents based on a U.S. "national average" (uses the statistics on energy generation technologies across the country).

An equivalency calculator for specific regions, considering the current power generation sources in various regions of the U.S. is also available from the EPA. [8]

[7] "Greenhouse Gas Equivalencies Calculator." Clean Energy. 17 February 2009. U.S. Environmental Protection Agency. 26 February 2009 < http://www.epa.gov/cleanenergy/energy-resources/calculator.html>.

[8] "Green Power Equivalency Calculator." Green Power Partnership. 17 February 2009. U.S. Environmental Protection Agency. 26 February 2009 < http://www.epa.gov/greenpower/pubs/calculator.htm>.

### 4.1.3 Energy Efficiency

Any measure of the ratio of useful energy output to energy input. In the context of metrics for ICT equipment, energy efficiency should be associated with suitable metrics.

### 4.1.4 Energy Management

A systematic way of planning, organizing, controlling or monitoring energy use with the aim of energy efficiency.

### 4.1.5 Green Awareness

*Green awareness* can become *green action*. Using green technologies to extend capabilities while reducing costs and risks is more than smart business. Planning for energy efficiency and corporate responsibility with positive results go together. The global economy has made the world more competitive and cooperative. As organizations strive to thrive in a constantly changing world, adapting for sustainability is a business imperative.

### 4.1.6 Greenhouse Gas Offset and Trading

GHG offset and trading is a compensating equivalent for reducing, avoiding, or sequestering greenhouse gas emissions made at a specific source, which mitigates other greenhouse gas emissions that would have been emitted into the atmosphere. This is often associated with carbon trading on the open market.

### 4.1.7 Greenhouse Gases

Specific gases that absorb terrestrial radiation and contribute to the global warming or greenhouse effect. Six greenhouse gases are covered by the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

### 4.1.8 Lifecycle Assessment

Assessment of the sum of a product's effects (e.g., GHG emissions) at each step in its lifecycle, including resource extraction, production, operation and recycling/waste disposal.

### 4.1.9 Measurement Methodology

A system of principals, practices and procedures applied to metrics.

Efficiency measurements can be referenced from various points and from multiple perspectives. Within the ICT sector, for example, energy efficiency can be measured at the discrete equipment or device level to a more broadly measured system or network level. Consequently, when referencing energy efficiency it becomes importance to understand the context in which measurements are being made and efficiencies are being reported.

Today, several organizations have or are currently working on standards in the field of energy efficiencies at the device or equipment level, as well as the system level to some extent. The ATIS NIPP is publishing standards for telecom and Information Technology (IT) network equipment; both the Consumer Electronic Association (CEA) and EPA have specifications for consumer equipment (namely "ENERGY STAR"); and the EPA and Green Grid are looking at system level efficiencies relative to data centers. A uniform approach to network level measurements, however, is missing.

### 4.1.10 Metric

A general term used to describe a measurable value available from a particular system or service. A metric must be based on high level parameters applied to its measurement.

### 4.1.11 "Reduce, Reuse and Recycle" EPA program

According to the EPA, refers to any change in the design, manufacture, purchase or use of materials or products to reduce the amount or toxicity before they become municipal solid waste.

### 4.1.12 Renewable Energy

Energy taken from sources that are essentially inexhaustible, e.g., wind, water, solar, geo-thermal energy and biofuels.

### 4.1.13 Services and Applications

The words "services" and "applications" have many meanings in the telecommunications environment. Effort will be made in this document through the surrounding context and/or accompanying words what is meant in any particular instance of their use.

For our purposes, the basic uses of the terms are as follows:

*Service:*

a) Something of value being provided to and consumed by end-users. It may be a specific service, such as Internet Protocol Television (IPTV) Premier or Restaurant Finder, or it may be general, such as VoIP telephony service or emergency services.
b) A function that is performed by software whose output is used by some other entity. It may be, for example, a presence engine, or a routing function, or a number translation capability, or protocol interworking. 'Service' may also refer to the software itself.

*Application:*

a) Software that embodies the primary logic characterizing and supporting an end-user service and its features. Such an application may reside on an application server (AS) within a service provider's network or may be a 3rd Party application outside of a service provider network.
b) Software on user devices providing something of value consumed by the end user (e.g., word processing programs and search engines).
c) Applications interact with other applications or enablers or other service-type software, and that interaction typically would occur over a network (or networks).

### 4.1.14 Sustainability

Considering the United Nations (UN) definition of sustainability and the Triple Bottom Line, the EGG supports defining sustainability as referring to the ability to meet current needs without hindering the ability to meet the needs of future generations in terms of economic, environmental and social challenges.

### 4.1.15 Triple Bottom Line (TBL)

The consideration of simultaneously balancing a growing economy with protection for the environment and social responsibility.

#### 4.1.16 Taxonomy
The division of terms into ordered groups or categories.

# 5 INITIATIVES AND PROGRAMS
In an effort to frame the focus of this initiative, a need surfaces to identify and briefly assess initiatives and programs that are directly, or in some cases indirectly, working in the areas of sustainability. In this section, initiatives and programs deemed to be relevant to this report are identified. The information contained in this section by no means represents a comprehensive accounting of every potentially applicable program; rather, the following represents those initiatives more closely coupled to ATIS' Green Initiative to-date. Additional information is available in *Appendix C: Overview of Studies* in this report.

## *5.1 Standards Development*

### 5.1.1 Alliance for Telecommunications Industry Solutions (ATIS)
ATIS has been working with equipment vendors and operators concerned with reducing energy consumption, heat generation, and the equipment footprint for years in an effort to increase operational efficiencies and reduce cost. To-date, work on these topics have been done primarily in the ATIS NIPP Committee where standards related to power consumption reduction through energy efficiency improvements, reducing power consumption for Digital Subscriber Line (DSL) modems, and the Restriction of the use of certain Hazardous Substances in electronic equipment (RoHS) have been developed.

To create a uniform method for measuring telecommunication equipment energy consumption (power), as well as establishing reporting methods, the ATIS NIPP has completed the following series of documents which have been accepted by the American National Standards Institute (ANSI).

- ATIS-0600015.2009: *Energy Efficiency For Telecommunication Equipment: Methodology For Measurement and Reporting General Requirements* (Baseline Document)
- ATIS-0600015.01.2009: *Energy Efficiency For Telecommunication Equipment: Methodology For Measurement and Reporting Server Requirements*
- ATIS-0600015.02.2009: *Energy Efficiency For Telecommunication Equipment: Methodology for Measurement and Reporting Transport Requirements*

The following items work items are in progress.

- NIPP-TEE-2009-013: *Energy Efficiency For Telecommunication Equipment: Methodology for Measurement and Reporting Router and Ethernet Switch Requirements*
- NIPP-TEE-2009-015R1: *Energy Efficiency For Telecommunication Equipment: Methodology for Measurement and Reporting Direct Current (DC) Power System-Rectifier Requirements*

Subsequent documents in the NIPP's series of documents, planned for release over time, will cover other network and consumer equipment and devices including, but not limited to, core network routers and switches, outside plant equipment, gateways, set-top-boxes and other consumer electronic (CE) devices and power systems.

The ATIS NIPP also has work underway addressing the potential use of environmentally friendly materials in describing materials used for connectors; airborne contamination (mixed flowing gas and hygroscopic dust) requirements for network equipment in the central office and outside plant environments; and heat dissipation and power consumption requirements for network equipment in central office and outside plant environments including methods to reduce power consumption for DSL modems at both ends of the line.

Refer to *Appendix B: Relevant Standards* for a more detailed list of relative ATIS standards.

### 5.1.2 Consumer Electronics Association (CEA)

CEA is approaching sustainability through two initiatives on electronic product recycling and energy efficiency of consumer products.

The CEA program on electronic recycling seeks to promote a national solution, which is the most appropriate means to address this public policy challenge to avoid an undesirable patchwork of state legislative mandates. Moreover, CEA supports market-driven environmental design initiatives, such as federal and state government programs on purchasing of environmentally-preferable devices.

In 2008 CEA launched the website "myGreenElectronics.org" to inform consumers about electronics recycling and provide information on local electronics recycling centers. The website also allows product manufacturers to register "green" products in a database.

The CEA Energy Efficiency Working Group (EEWG) leads the organization's policy on energy efficiencies. Like its stance on waste disposal, CEA supports voluntary, market-oriented programs and initiatives, including industry-led standards, which highlight and sustain energy efficiency in the consumer electronics industry and opposes government mandates. CEA standards on energy efficiency include:

- CEA-2013-A: *Digital Set-Top-Box (STB) Background Power Consumption*
- CEA-2022: *Digital STB Active Power Consumption Measurement*

CEA research on energy efficiency has been published in the following reports:

- *The Energy and Greenhouse Gas Emissions Impact of Telecommuting and e-Commerce.* Final Report by TIAX LLC for the Consumer Electronics Association (CEA), July 2007.
- *Energy Consumption by Consumer Electronics in U.S. Residences.* Final Report by TIAX LLC for the Consumer Electronics Association (CEA), January 2007.

CEA is also a signatory to the *Second EU-Japan-U.S. Trilateral ICT-Electronics Associations Meeting Joint Statement (2006)* and the *International Industry Position and Support for Energy Efficiency (2007).*

### 5.1.3 European Telecommunications Standards Institute (ETSI)

The European Telecommunications Standards Institute (ETSI) is based in Europe, but is now a global not-for-profit organization with 700 member organizations in sixty countries. It produces ICT standards including fixed, mobile, radio, converged, broadcast and internet technologies.

ETSI is officially recognized by the European Commission as a European Standards Organization. Some work mandated to it may then become binding under EU legislation. For example:

- Harmonized standards covering protection from electromagnetic fields (M/305)
- ICTs applied to the domain of eHealth (M/403)

ETSI's *Green Agenda* was a strategic item in 2008. As part of its *Green Agenda*, ETSI will adopt the International Organization for Standardization (ISO) 14001 and 14004 standards, together with a green checklist for all work on standards.

The technical committee on Environmental Engineering (ETSI EE) is concerned with the reduction of energy consumption in telecommunications equipment and related infrastructure. Its present work includes:

- The use of alternative energy sources in telecommunication installations
- Reverse powering of small access network node by end-user equipment
- Energy efficiency of wireless access network equipment
- ICT energy consumption and global energy impact assessment methods

Refer to *Appendix B: Relevant Standards* for a more detailed list of relative ETSI standards.

### 5.1.4 International Telecommunication Union – Telecommunications (ITU-T)

The International Telecommunication Union (ITU) – Telecommunications (ITU-T) is an agency of the United Nations for ICT. The ITU recently launched a Focus Group (FG) on ICT and Climate Change (FG ICT & CC) to analyze and identify gaps in the areas of definitions, general principles, methodology and appropriate tools to characterize the impact of ICTs on Climate Change and support the development of appropriate international standards.

The FG[9] will be identifying (1) the impact of ICTs on climate change over their entire lifecycle; (2) mitigation measures to be recommended when using ICTs in relevant sectors; and (3) possible enhancements to monitoring of relevant climate parameters. Toward this goal, the FG ICT & CC will attempt to produce four deliverables by April 2009:

- *Definitions* – identify terms and definitions related to ICT and Climate Change.
- *Gap Analysis* – evaluate current ICT related measures; identify those that need to be standardized; assess existing standards work; and develop and propose a Roadmap for work.

[9] "Focus Group on ICTs and Climate Change." International Telecommunications Union. 30 March 2009. International Telecommunications Union. 30 March 2009 < http://www.itu.int/ITU-T/focusgroups/climate/index.html>.

- *Methodology* – develop a methodology to describe and estimate present and future user energy consumption of ICT's over their entire life-cycle.
- *Direct & Indirect Impacts on ITU* – internal assessment.

### 5.1.5 International Telecommunication Union – Radio (ITU-R)

The ITU-Radio (ITU-R) is the ITU's radio communications sector. Its mission is to "ensure the rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including those using satellite orbits, and to carry out studies and approve Recommendations on radiocommunication matters[10]."

ITU-R has an initiative on radio communications and climate change which focuses on "the use of ICT (different radio and telecommunication technologies and equipment) for weather and climate change monitoring, prediction, detection and mitigation of hurricanes, typhoons, thunderstorms, earthquakes, tsunamis, man-made disasters, etc."

This includes the use of space-based sensors that:

- Track tornadoes, hurricanes, typhoons, forest fires, etc.
- Monitor atmospheric composition of greenhouse gases
- Monitor ocean topography, sea temperature, ice distribution, etc.

ITU-R recommendations are used in most of today's radio-based systems for monitoring climate change, including those that provide the data for the global climate observing system (GCOS).

ITU-R Study Group 7 (SG7), in cooperation with the World Meteorological Organization, has produced a handbook entitled "Use of Radio Spectrum for Meteorology[11]" providing information on development and a proper use radiocommunication systems and radio-based technologies for environment observation, climate control, weather forecasting and natural and man-made disaster prediction, detection and mitigation.

ITU-R uses the world radiocommunications conferences (WRCs) and radiocommunications assemblies (RAs) as the focal points for its work. Conferences held in 2007 highlighted the following:

- WRC-07 extended spectrum allocations and adopted protection criteria for services involved in environmental monitoring in general, some of which are directly relevant to climate monitoring.
- WRC-07 and RA-07 adopted Resolutions on studies and actions by Radiocommunication Sector (ITU-R) relating to the services involved with Earth observation and with disaster prediction, detection and relief.
- Draft agenda of WRC-11 contains several items concerning the use and further development of radiocommunication systems involved with environmental monitoring.

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[10] "Mission Statement." Radiocommunication Sector (ITU-R). 15 March 2008. International Telecommunication Union. 27 February 2009 < http://www.itu.int/ITU-R/index.asp?category=information&rlink=mission-statement&lang=en>.

[11] "Handbooks." Publications by Sector. 27 February 2009. International Telecommunication Union. 27 February 2009 < http://www.itu.int/publ/R-HDB-45/en>.

- Increasing the awareness of Member States to the beneficial use of ICTs in monitoring and reducing the impact of climate change.
- General move from analogue to digital broadcasting will result in a reduction in number of transmitters and their power.

### 5.1.6 International Electrotechnical Commission (IEC)

The International Electrotechnical Commission (IEC) is the leading international organization preparing standards for electrical, electronic and related technologies (collectively known as "electrotechnology"). The IEC also manages conformance assessment systems that certify that equipment, systems and components conform to its standards. It undertakes work on electrical energy efficiency and on renewable energy.

IEC Technical Committee 82 works on photovoltaic energy systems. The IEC also provides conformance testing for photovoltaic products.

IEC Technical Committee 100 works on audio, video and multimedia systems and equipment. "WattWatt" is a Web 2.0 site created by the IEC for those concerned with energy efficiency.[12]

### 5.1.7 Institute of Electrical and Electronics Engineers (IEEE)

The IEEE, via its Standards Association (IEEE-SA), has issued a call for participation in a standards study group on climate change and GHG management to help examine the potential need and interest in standards related to climate change and greenhouse gas management.

The IEEE-SA, on its review of current standards activities, identified four areas for possible standards development:

- Terms and Semantics to foster a common lexicon concerning greenhouse gas management
- Framework for valuation of carbon impacts and measurements addressing life-cycle issues
- Process and framework for master global table of carbon sources (including actual carbon content values)
- Energy efficiency - sector specific e.g. for Energy/Electric Power, ICT sectors and cross sector impacts (e.g. for carbon trading).

The study group is expected to discuss the possibility of developing standards in these four areas, with the goal of developing one or more Project Approval Request (PAR) to initiate new standards development at the IEEE.

### 5.1.8 International Organization for Standardization (ISO)

The ISO is the world's largest developer and publisher of international standards. It is a network of the national standards institutes of 157 countries, one member per country, with a secretariat in Geneva. ISO is a non-governmental organization bridging the public and private sectors. It has produced a guide on tools to address climate change in terms of:

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[12] "Home." WattWatt Generated by Bright Sparks. 2007. WattWatt. 30 March 2009 <http://wattwatt.com/>.

- Monitoring climate change (e.g., ISO/Technical Committee (TC) 211 on geomatics, ISO/TC 146/SC5 on meteorology).
- Quantifying GHG emissions and communicating environmental effects (e.g., ISO/TC207 on environmental management).
- Promoting good practice in environmental management and design (e.g., ISO 14001).
- Opening markets for energy efficient technologies and renewable sources, including established programs for hydrogen, nuclear and wind technologies as well as new standardization work on solid and liquid biofuels, and proposals for standards on improving energy management in organizations.

ISO Technical Committee 207 works on environmental management (see table below).

| *Sub-committee* | *Subject* |
|---|---|
| TC 207/SC 1 | Environmental management systems |
| TC 207/SC 2 | Environmental auditing and related environmental investigations |
| TC 207/SC 3 | Environmental labeling |
| TC 207/SC 4 | Environmental performance evaluation |
| TC 207/SC 5 | Life cycle assessment |
| TC 207/SC 7 | Greenhouse gas management and related activities |

**Table 1:Sub-committees of ISO TC 207**

The ISO 14000 series is entitled "Environmental Management[13]" and includes standards on both systems and tools. ISO 14064 and ISO 14065 address greenhouse gas accounting, verification and emissions trading. ISO 14020 covers environmental labels and declarations while ISO 14063 describes environmental communications.

In December 2007, ISO, the World Resource Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) signed a Memorandum of Understanding agreeing jointly to promote the ISO 14064 and the GHG Protocol standards.

The ISO/IEC Software and Systems engineering Sub-Committee (JTC1/SC7) has worked on life cycle assessments. It has also developed a standard on the corporate governance of information technology ISO/IEC 38500:2008.

## *5.2 Industry Programs & Initiatives*

### 5.2.1 Global e-Sustainability Initiative (GeSI)

The Global e-Sustainability Initiative (GeSI) was created in 2001 to further sustainable development in the ICT sector. GeSI fosters global and open cooperation, informs the public of its members' voluntary actions to improve their sustainability performance and promotes technologies that foster sustainable development. GeSI is currently centering their activities in supply chain, climate change, accountability, e-waste and materiality. GeSI partners with the United Nations Environment Program (UNEP) and the ITU.

[13] "ISO 1400 Essentials." Products. 2009. International Organization for Standardization. 27 February 2009 < http://www.iso.org/iso/iso_14000_essentials>.

GeSI's Climate Change Group is working to identify the overall impact of ICT as well as initiate solutions through the development of measurement systems. Currently, this group is developing a tool to quantify carbon credits for using Video Teleconferencing as an alternative to business travel. GeSI partnered with the Climate Group to produce the report *SMART 2020: Enabling the Low Carbon Economy in the Information Age,* describing how through enabling other sectors to reduce their emissions, the ICT industry could reduce global emissions by as much as 15 per cent by 2020.

### 5.2.2 Green Grid

The Green Grid works to advance energy efficiency in data center and business computing ecosystems, focusing on defining:

- user-centric models and metrics,
- measurement methods,
- processes and new technologies to improve data center performance, and promoting energy efficient standards, measurement and technologies.

It has 10 Board Member Companies, 43 Contributor Member Companies, and 76 General Member Companies from around the world.

Green Grid white papers include:

- Addressing Organizational Behavior Issues to optimize IT and Facilities Energy Efficiency
- The Green Grid Metrics: Data Center Infrastructure Efficiency (DCiE) Detailed Analysis
- Green Grid Productivity Indicator
- Data center Baseline Study Report
- A Framework for Data Center Energy Productivity
- The Green Grid Peer Review of "DC Power for Improved Data Center Efficiency" by Lawrence Berkeley National Laboratory
- Five Ways to Reduce Data Center Server Power Consumption
- The Green Grid Data Center Power Efficiency Metrics: Power Usage Effectiveness (PUE) and DCiE
- Existing Metrics, Guidelines and Programs Affecting Data Center and IT Energy Efficiency
- Qualitative Analysis of Power Distribution Configurations for Data Centers
- The Green Grid Opportunity
- Guidelines for Energy Efficient Data Centers
- The Green Grid Metrics: Describing Data Center Power Efficiency

### 5.2.3 Greenhouse Gas Protocol (World Research Institute)

The goal of the Greenhouse Gas Protocol Initiative is to establish an international GHG emissions calculating and reporting standards for all areas of industry. This Protocol is meant to provide standards and guidance for companies and organizations preparing a GHG emissions inventory. Many industries have used the Protocol Initiative to develop industry-specific calculation tools; which account for both direct and indirect emissions.

- DIRECT EMISSIONS: Emissions from sources that are owned or controlled by the company.
- INDIRECT EMISSIONS: Emissions that are a consequence of the activities of the company, but occur at sources owned or controlled by another company.

It is important to recognize the difference between GHG emissions accounting and reporting. Accounting concerns the recognition and consolidation of the GHG emissions from operations in which a parent company holds an interest and linking data to specific operations. Reporting concerns the presentation of GHG data in formats tailored to the needs of various reporting uses and users.

Three scopes have been defined for GHG accounting and reporting purposes to help delineate direct and indirect emissions sources, improve transparency and provide utility for different types of organizations, climate policies and business goals. Scope 1 and 2 are mandatory to report on to ensure that two or more companies will not account for emissions in the same scope. Scope 3 is optional to report on. Accurately following the scopes protects against double counting of emissions:

- SCOPE 1: DIRECT GHG EMISSIONS
  - Accounts for direct GHG emissions from sources that are owned or controlled by the company.
- SCOPE 2: ELECTRICITY INDIRECT GHG EMISSIONS
  - Accounts for GHG emissions from the generation of purchased electricity consumed by the company. These emissions physically occur at the facility where electricity is generated.
- SCOPE 3: OTHER INDIRECT GHG EMISSIONS
  - Accounts for GHG emissions that are consequences of the activities of the company but occur from sources not owned or controlled by the company.

It is possible to compare GHG emissions over time even if the company structure has changed or changes occur. This is done by choosing a "base year" (i.e. a year for which verifiable emissions data are available or, an average of annual emissions over several consecutive years). Once the base year is calculated a base year emissions recalculation policy will be developed to reflect the changes in the company.

Calculation tools are available on the GHG Protocol Initiative website. To apply calculation tools, a business can control for cross-sector or sector-specific calculators. Additionally, ratio indicators are not required in reporting, but can be used to provide information on performance relative to a business type and can facilitate comparisons between similar products and processes over time.

The GHG Protocol Corporate Standard calculates GHG emissions using a "bottom-up" approach. This involves calculating emissions at the level of an individual source or facility and then rolling this up to the corporate level. Focusing on overall corporate or organizational level emissions has the advantage of helping companies manage their aggregate GHG risks and opportunities more effectively. It also helps focus resources on activities that result in the most cost effective GHG reductions. It is important for companies to report their physical inventory emissions for their chosen inventory boundaries separately and independently of any GHG trades they undertake.

After an inventory and reporting is complete, a company's results can become independently verified. Verification involves an assessment of the risks of material discrepancies in reported data. Reasons for verification include credibility within a company and with stakeholders and preparation for mandatory reporting. A verifier will speak to the completeness or discrepancies of the report and provide future recommendations. If independent verification is not reasonable or necessary, an alternate option is to appoint an internal verification oversight team.

### 5.2.4 Global Information Infrastructure Commission (GIIC)

The Global Information Infrastructure Commission (GIIC) is a confederation of chief executives and other officers of business firms engaged in the development, manufacture, deployment, operation, modernization, financing, and use of services and products based upon ICTs. These executives head enterprises are headquartered throughout the world and, as GIIC commissioners, are convinced that ICT-based capabilities have given rise to a rapidly evolving new era, denoted most frequently as an "information society," and widely regarded as one that transcends borders and is an increasingly powerful force in all societies. Commissioners include representatives from ICT companies, (inter)governmental organizations, and financial institutions.

The GIIC brings private sector expertise to promote access to ICT for the greater benefit of society, by working to influence government policies and corporate actions in a manner which ensures that corporate social responsibility (CSR) and sustainability objectives are not in conflict with commercial success.

#### 5.2.4.1 GIIC Green Agenda

The GIIC has through its forums and other engagements been raising awareness of the impact of climate changes on our lives. While the GIIC identified the impact of ICT on the environment and its contribution to GHG and emphasized the need to reduce these emissions, it also recognizes that ICT services provided to other industries and consumers can significantly reduce their GHG emissions.

The GIIC re-iterated its green agenda in the Tokyo Declaration[14] made following the annual GIIC conference in April 2008. The GIIC believes that climate change needs to be tackled through collaboration within the ICT industry as well as with other industries to leverage the full benefit of ICT on a truly global scale. This can be achieved through raising awareness and education, collaboration and lobbying to influence public policy. As standards organizations are one of the most effective ways to establishing a sound collaborative approach to delivering ICT solutions, the GIIC is keen to work in partnership with such organization.

### 5.2.5 The Climate Group

The Climate Group is an independent, not-for-profit organization that works internationally with government and business leaders to advance climate change solutions

[14] Global Information Infrastructure Commission, "The GIIC Tokyo Declaration." 25 April 2008. Global Information Infrastructure Commission. 30 March 2009 < http://www.giic.org/pdf/GIIC_Tokyo_Declaration.pdf>.

and accelerate a low carbon economy. Its coalition of proactive leaders – from government, business and civil society – has demonstrated that emissions reductions, can be achieved while boosting profitability and competitiveness.

The Climate Group in partnership with GeSI issued the *SMART 2020* Report that quantifies the direct emissions from ICT products and services based on expected growth in the sector. It also looked at where ICT could enable significant reductions of emissions in other sectors of the economy and has quantified these in terms of $CO_2$ emissions savings and cost savings.

### 5.2.6 Green Electronics Council

The Green Electronics Council partners with environmental organizations, government agencies, manufacturers and other interested stakeholders to improve the environmental and social performance of electronic products. In January 2006, it received a grant from the U.S. Environmental Protection Agency to promote and implement the Electronic Products Environmental Assessment Tool (EPEAT)[15] green computer standard.

The EPEAT standard is an easy-to-use tool to rank computer desktops, laptops and monitors based on their environmental attributes. The standard is applied to both energy and environmental factors. The three-tiered EPEAT rating system includes 23 required criteria and 28 optional criteria. The optional criteria are used to determine if the equipment receives EPEAT Bronze, Silver, or Gold recognition.

On January 24, 2007, President Bush issued Executive Order 13423[16], ''Strengthening Federal Environmental, Energy, and Transportation Management,'' Section 2(h) which states that the head of each Agency shall ''ensure that the agency when acquiring an electronic product to meet its requirements, meets at least 95 percent of those requirements with an EPEAT-registered electronic product, unless there is no EPEAT standard for such product."

EPEAT evaluates electronic products in relation to 51 total environmental criteria contained in IEEE 1680 -– 23 required criteria and 28 optional criteria. To qualify for registration as an EPEAT product, the product must conform to all the required criteria.

### 5.2.7 World Wildlife Fund (WWF)

The World Wildlife Fund (WWF) is a global nature conservation organization. To this end, human impact on global warming is on the forefront of WWF research. WWF has developed a partnership program with corporations and other businesses as well as U.S. Government agencies to share scientific research and help develop best practices toward becoming environmentally friendly.

### 5.2.8 European Telecommunications Network Operators (ETNO)

The European Telecommunications Network Operators Association (ETNO) is a founding member of the GeSI, supports the EU sustainable development strategy of environmental

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[15] "Welcome to EPEAT." Electronic Products Environmental Assessment Tool Green Electronics Made Easy. 2006. Electronic Products Environmental Assessment Tool. 30 March 2009 < http://www.epeat.net/>.
[16] "Executive Order 13423." U.S. General Services Administration. 03 November 2008. U.S. General Services Administration. 27 February 2009 < http://www.gsa.gov/Portal/gsa/ep/contentView.do?contentType=GSA_BASIC&contentId=22395>.

protection, social progress and economic growth, and is a member of the United Nations Global Compact.

ETNO developed an "Environmental Charter" for its signatory member companies in 1996 which evolved into a "Sustainability Charter" in 2004 emphasizing corporate social responsibility in sustainable development. They have joined with the WWF to publish a roadmap called *Saving the Climate @ the Speed of Light*[17] to promote the positive impact of ICT on the environment.

### 5.2.9 Carbon Disclosure Project

The Carbon Disclosure Project (CDP) is an independent not-for-profit organization which acts as an intermediary between shareholders and corporations on all climate change related issues; providing primary climate change data from the world's largest corporations to the global market place. The data is obtained from responses to CDP's annual Information Request, sent on behalf of institutional investors and purchasing organizations.

### 5.2.10 GSMA Development Fund Green Power Program

The Global System for Mobile (GSM) Association (GSMA) is a global trade association representing more than 750 GSM mobile phone operators across 218 territories and countries of the world. In addition, more than 180 manufacturers and suppliers support the Association's initiatives as associate members.

The primary goals of the GSMA are to ensure that mobile phones and wireless services work globally and are easily accessible, enhancing their value to individual customers and national economies, while creating new business opportunities for operators and their suppliers. The Association's members represent more than 3 billion GSM and 3$^{rd}$ Generation GSM (3GSM) connections - over 86 percent of the world's mobile phone connections.

The GSMA Development Fund exists to accelerate economic, social and environmental development through the use of mobile technology.

The Green Power for Mobile (GPM) program has been established to promote the use of green power to achieve two commercial objectives:

1. The expansion of mobile networks into regions currently lacking coverage – to bring coverage to the unconnected.
2. The systematic reduction of reliance on diesel consumption by operators.

GPM brings together a community of operators, vendors and financers to collaboratively catalyze the uptake of green power technology to accomplish these goals. The GPM program aims to help member mobile operators select and roll out green power solutions within their network infrastructures. The GPM webpage[18] has been created to guide operators through the process; from understanding the business opportunities, to deciding

[17] Dennis Pamlin, and Katalin Szomolanyi. Saving Climate @ the Speed of Light: First Roadmap for Reduced Co2 Emissions in the EU and Beyond: World Wildlife Fund and European Telecommunication Network Operators, 2006.
[18] "Green Power for Mobile." GSM World. 2009. Global System for Mobile Association. 30 March 2009 < http://www.gsmworld.com/our-work/development-fund/energy/index.htm>.

if green power is technically feasible in a specific geography, to highlighting how green power solutions can form part of corporate social responsibility.

### 5.2.11 Internal Corporate Programs and Best Practices

From the information gathered by ATIS with respect to the internal programs of its member companies, data shows that a number of ATIS' members have robust and evolving programs and processes in place and some companies have included corporate goals that reduce their carbon-footprint. These programs include:

- Internal Corporate Programs establishing "Green Teams" with oversight and management of internal eco-conscious programs; e.g., energy use, product materials, supply-chains, etc.
- Recycling Programs to include eco-conscious Product Development Programs (recyclable, reused and/or modular for scalability).
- Technical and Operations initiatives wherein internal parameters and guidelines are being established and implemented to enable greater energy/power efficiencies.
- Development and deployment of Applications and Services to enable greater use of ICT services by other industries to manage energy usage and reduce $CO_2$.

### 5.2.12 Energy Efficiency Inter Operator Collaboration Group (EE IOCG)

The Energy Efficiency Inter Operator Collaboration Group in a non-incorporated body formed from communications operators out of the EU Fireworks group. Members include most of the Tier-1 operators. The IOCG was established recognizing:

- Energy costs are continuously growing, and this trend will continue in the future
- Broadband penetration is bringing new active equipment in the network architecture
- Fragmented actions on energy efficiency among different Standardization Bodies/Fora

Leading to the following objectives for the group to:

- Share energy critical issues and agree on common goals
- Define high level strategic actions and coordinated guidance towards standardization for equipment suppliers (both network and user side) in order to speed up the availability of energy efficient equipment and networks, helping vendors towards investments optimization
- Finalize high level analysis to support operator's strategy
- Evaluate energy consumption trends for different fiber-to-the-x (FTTx) scenarios
- Define a set of key performance indicators (KPIs) to monitor the action implemented

The route to standardization will be via established Standards Development Organizations (SDOs). Critical areas identified for further work include access network, data centers, energy-optimized IP networks, STB and end-user equipment.

Discussions are currently underway regarding the group's official status and its relationships with SDOs and other industry bodies.

#### 5.2.13 Electronic Industry Citizenship Coalition (EICC)

The Electronic Industry Citizenship Coalition (EICC) is a coalition of companies who work together to establish and implement a Code of Conduct. The Code of Conduct is meant to be applied through out the global Electronics and ICT supply chain and aims to increase standardization in compliance, auditing and reporting using a socially responsible and environmentally friendly approach. The EICC Code of Conduct has been adopted by some of the world's major electronics companies and their suppliers.

#### 5.2.14 Storage Networking Industry Association (SNIA)

The SNIA Green Storage Initiative (GSI) is dedicated to advancing energy efficiency and conservation in all networked storage technologies and minimizing the environmental impact of data storage operations.

The GSI's mission is:

- To conduct research on power and cooling issues confronting storage administrators.
- Educate the vendor and user community about the importance of power conservation in shared storage environments.
- Leverage SNW and other SNIA and partner conferences to focus attention on energy efficiency for networked storage infrastructures.
- Provide input to the SNIA Green Storage Technical Working Group (TWG) on requirements for green storage metrics and standards.
- Provide external advocacy and support of the technical work of the SNIA Green Storage Technical Working Group.

Key vendor participants are Brocade Communications, CA, Cisco, Dell, EMC, HP, Hitachi, IBM, Intel, LSI, Microsoft, Network Appliance, Oracle, QLogic, Seagate Technology, Sun and Symantec.

### *5.3 Governmental*

#### 5.3.1 United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is a treaty entered into by 194 countries world wide with the goal of exploring options to reduce global warming and coping mechanisms for inevitable climate changes.

Since the UNFCCC entered into force in 1994, annual meetings have been held. These are referred to as "Conference of the Parties" and numbered sequentially.

No negotiating texts have been developed for an updated UNFCCC and the authors for such texts have not been identified as yet, so the nature of an updated global climate agreement is uncertain. However, topics discussed in UNFCCC brainstorming sessions have raised many issues significant to businesses:

- limits on greenhouse gas emissions
- need for private sector capital to address the climate change challenges

- developing country proposals to relax intellectual property rights for environmentally-sound technologies so that technology transfer from developed countries to developing countries is facilitated.

A future Conference of the Parties-15 (COP-15) is scheduled at the end of 2009 in Copenhagen. The goal of COP-15 is to establish an agreement for the post-2012 period when the Kyoto Protocol commitments expire.

### 5.3.2 U.S. Government

The Energy Improvement and Extension Act of 2008, a legislative package of renewable energy and energy efficiency Production Tax Credit (PTC) and Investment Tax Credit (ITC) extensions was signed into law in October 2008[19]. The Emergency Economic Stabilization Act, a financial recovery measure, incorporated H.R. 1424 the *Energy Improvement and Extension Act of 2008*[20].

As signed into law, the legislative package includes, but is not limited to, the following:

- Extends the wind energy production tax credit for one year, through December 31, 2009.
- Extends the production tax credits for other renewable sources – solar power, geothermal energy and hydropower through December 31, 2010. The bill also expands the definition of facilities to include new biomass facilities.
- Authorizes $2 billion of new Clean Renewable Energy Bonds (CREBs) for facilities producing electricity from all types of biomass, wind, geothermal, hydropower, landfill gas, trash combustion, marine and other small water-to-electricity projects.
- Continues credits for energy efficiency improvements in homes, new homes, and appliances.
- Extends green building bonds, and institutes new smart meter cost-recovery mechanisms.
- Provides $2.5 billion in new tax credits for carbon capture and sequestration demonstration projects.
- Extends the federal tax credit for alternative energy through 2016.

A comprehensive source of information is available from the Database of State Incentives for Renewables and Efficiencies[21] (DSIRE) on a state, local, utility, and federal level.

#### 5.3.2.1 U.S. National Science Foundation (NSF)

The National Science Foundation (NSF) supports basic research on topics from solar and oceanic observations to molecular biology to social and behavioral sciences using mechanisms from funding individual investigators to major research and engineering facility centers to partnerships with industry and academia. Issues associated with U.S. competitiveness in light of national issues such as climate change and energy independence

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[19] Emergency Economic Stabilization Act of 2008 (H.R.1424) is the vehicle for the economic rescue legislation. Division A is the Emergency Economic Stabilization Act of 2008; Division B is the Energy Improvement and Extension Act of 2008; and Division C is the Tax Extenders and Alternative Minimum Tax Relief Act of 2008.

[20] Emergency Economic Stabilization Act of 2008. Pub. L. 110-343. 3 October 2008. Stat. 3765.122

[21] "Home." DSIRE: Database of State Incentives for Renewables and Efficiency. 27 February 2009. Database of State Incentives for Renewables and Efficiency. 28 February 2009 < http://www.eia.doe.gov/>.

are promoting additional interdisciplinary work on the interrelationship between the environment, energy and economics.

NSF-funded work includes the use of ICT (cyber infrastructure; computer, and information science and engineering) to combat climate change, energy storage technology, nanotechnology, carbon sequestration, and factors influencing human decision-making. Working with the U.S. National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA) as well as international partners, they are also supporting studies to better understand the climate system.

The National Science Foundation is overseen by the National Science Board which advises the President and Congress on science matters.

#### 5.3.2.2 U.S. Environment Protection Agency (EPA)

The mission of the EPA is to protect human health and the environment, with numerous programs spanning from air quality to water management. In the context of this report, focus is centered on EPA's Energy and Efficiencies programs; in particular its ENERGY STAR[22] programs -- a joint program with the DOE.

One of the main goals of the ENERGY STAR program is to develop performance-based specifications that determine the most efficient products in a particular category. Products that meet these specifications earn the ENERGY STAR label. ENERGY STAR is mandated by several states and/or local governments for consumer products.

Existing programs covered under ENERGY STAR include, among others, external power supplies, set-top-boxes and computers related to industry's review of energy efficiencies.

The EPA is also working to identify ways in which energy efficiency can be measured, documented and implemented in data centers and the equipment they house, especially servers. Current initiatives in this area are:

- National Data Center Energy Efficiency Information Program
- EPA Report to Congress on Server and Data Center Energy Efficiency
- ENERGY STAR Enterprise Server Specification Development Process
- Data Collection Initiative to Develop an ENERGY STAR Rating for Data Centers

The EPA also sponsors the Leadership in Energy and Environmental Development (LEED) program. The LEED Green Building Rating System™[23] encourages and accelerates global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria. The LEED rating system has different certification levels; certified, silver, gold and platinum. These certification levels are based upon the number of sustainable practices that are implemented in a facility. The LEED program is run by the U.S. Green Building Council (USGBC). The USGBC is a non-profit organization committed to expanding sustainable

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[22] "Energy Star Home." Energy Star. Environmental Protection Agency and U.S. Department of Energy. 27 February 2009 < http://citationmachine.net/index2.php>.

[23] "What is LEED®?." LEED Rating Systems. 2008. U.S. Green Building Council. 26 February 2009. < http://citationmachine.net/index2.php>.

building practices. USGBC is composed of more than 15,000 organizations from across the building industry that are working to advance structures that are environmentally responsible, profitable, and healthy places to live and work.

#### 5.3.2.2.1 EPA Climate Leaders

Climate Leaders is an EPA industry-government partnership that works with companies to develop comprehensive climate change strategies. Partner companies commit to reducing their impact on the global environment by completing a corporate-wide inventory of their greenhouse gas emissions based on a quality management system, setting aggressive reduction goals, and annually reporting their progress to EPA. Through program participation, companies create a credible record of their accomplishments and receive EPA recognition as corporate environmental leaders.

### 5.3.2.3 U.S. Department of Energy (DOE)

#### 5.3.2.3.1 Office of Energy Efficiency and Renewable Energy (EERE)

The EERE works to strengthen the United States' energy security, environmental quality and economic vitality in public-private partnerships. It supports this goal through:

- Enhancing energy efficiency and productivity;
- Bringing clean, reliable and affordable energy technologies to the marketplace; and
- Making a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life.

The EERE sponsors various initiatives to build awareness about energy efficiency and renewable energy topics and to coordinate efforts toward specific goals.

##### 5.3.2.3.1.1 Federal Energy Management Program (FEMP)

As the largest energy consumer in the United States, the DOE established the Federal Energy Management Program to help government agencies save energy and demonstrate leadership with responsible, cleaner energy choices.

FEMP has released guidelines to help federal agencies meet energy management and renewable energy requirements for complying with the Energy Policy Act (EPAct) of 2005 and Executive Order 13423. For an overview of these requirements, read the *Renewable Energy Requirement Guidance for EPACT* 2005 *and Executive Order 13423*[24].

##### 5.3.2.3.1.2 Industrial Technologies Programs (ITP)

**BestPractices** is a program area within the Industrial Technologies Program (ITP) that supports ITP's mission to improve the energy intensity of the U.S. industrial sector through a coordinated program of research and development, validation, and dissemination of energy-efficient technologies and practices.

[24] U.S. Department of Energy, and Office of Energy Efficiency and Renewable Energy, and Federal Energy Management Program. Renewable Energy Requirement Guidance for EPACT 2005 and Executive Order 13423: U.S. Department of Energy, 2008.

BestPractices develops implements and disseminates best practices in energy management and helps identify opportunities to save substantial amounts of energy in industrial manufacturing plants. Targeted information is for:

- Corporate Executives
- Plant Management
- Technical Staff (e.g., Engineers, researchers, consultants, technicians, etc.)
- General Public (e.g., Academia, community, associations, state & local government)

**Save Energy Now** is a national initiative of the ITP to drive a 25 percent reduction in industrial energy intensity in 10 years. Industrial companies can participate in no-cost energy assessments and utilize ITP resources to reduce energy use while increasing profits. Through its Partnering Computer Data Centers program, Save Energy Now is working with U.S. computer data centers to reduce their energy consumption[25].

### 5.3.3 State Level Programs - Climate Registry

The Climate Registry is a nonprofit organization that provides meaningful information to reduce greenhouse gas emissions. The Climate Registry establishes consistent, transparent standards throughout North America for businesses and governments to calculate, verify and publicly report their carbon footprints in a single, unified registry. Thirty nine U.S. states, the District of Columbia, 12 Canadian provinces and territories, six Mexican states and three Native Sovereign Nations are the founders of the organization.

### 5.3.4 European Union (EU)

In March 2007, the European Council adopted energy targets for 2020:

- 20 percent increase in energy efficiency
- 20 percent reduction in $CO_2$ emissions
- 20 percent share of renewables in overall EU energy consumption

In May 2008, the European Commission (EC) adopted a communication entitled "Addressing the Challenge of Energy Efficiency through Information and Communication Technologies[26]." This was followed by a public consultation (the results of which have yet to be published). The manufacturers, via a response from European Information & Communications Technology Industry Association (EICTA), made clear their willingness to achieve the targets.

The EC has invited tenders for a study on state-of-the-art models and tools for the assessment of ICT impacts on growth and competitiveness in a low-carbon economy. This will provide a macro-model or enhanced quantitative tool allowing better understanding and analysis of the information society developments and policy simulations.

The *Renewable Energy Unit* of the Institute for Energy, part of the Joint Research Center (JRC), provides technical and scientific advice to the Transport and Energy Directorate-

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[25] "Partnering with Computer data centers." Energy Efficiency and Renewable Energy. 24 February 2009. U.S. Department of Energy. 26 February 2009 <http://www1.eere.energy.gov/industry/saveenergynow/partnering_data_centers.html>.

[26] Commission of the European Communities. Addressing the Challenge of Energy Efficiency through Information and Communication Technologies: Commission of the European Communities, 2008.

General (DG TREN) and the Environment Directorate-General (DG ENV) of the EC. It has undertaken work on the design, implementation and monitoring of energy efficiency policies and programs, including:

- Stand-by initiative
- Energy Star
- Green buildings
- Efficiency of energy use in buildings

In 1999 the EC adopted a "Communication on Policy Instruments to Reduce Stand-by Losses of Consumer Electronic Equipment (COM (99) 120)[27]." Following agreement by the Council of Ministers in 2000, the first two codes of conduct were agreed to. There are now five codes adopted with the support of DG Energy covering:

- digital television service systems (10 signatories)
- external power supplies (25 signatories)
- Uninterruptable Power Supplies (2 signatories)
- broadband equipment (3 signatories)
- data centers (still in draft)

The EU also adopted "Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC."

As stated in the Directive, "The purpose of this Directive is to enhance the cost-effective improvement of energy end-use efficiency in the Member States by:

> (a) providing the necessary indicative targets as well as mechanisms, incentives and institutional, financial and legal frameworks to remove existing market barriers and imperfections that impede the efficient end use of energy;
> (b) creating the conditions for the development and promotion of a market for energy services and for the delivery of other energy efficiency improvement measures to final consumers."[28]

The EC, under Framework Program 7 (FP7) funds research on a very wide range of initiatives including some related to ICTs and energy:

- Energy consumption of domestic appliances (AIM)
- Digital environment home energy management system (Dehems)
- Scalable multi-tasking baseband for mobile communications (Multi-base)

The *Efficient Servers* project, part of *Intelligent Energy Europe* (part of Competitiveness and Innovation Framework Program, an EU program), aims at demonstrating the high potential

[27] "Communication from the Commission to the Council and the European Parliament on Policy Instruments to Reduce Stand-by Losses of Consumer Electronic Equipment. COM (99) 120 final, 15.03.1999." Archive of European Integration. 2008. University of Pittsburgh. 3 March 3, 2009 <http://aei.pitt.edu/4966/>.
[28] "Directive 2006/32/EC of the European Parliament and of the Council." Official Journal of the European Union (2006): 22.

for energy savings and cost reductions for servers in practice and at supporting the market development for energy efficient servers.

EU Directives 2002/95/EC on the RoHS in electrical and electronic equipment and 2002/96/EC on Waste Electrical and Electronic Equipment (WEEE) were designed to tackle the growing waste stream of electrical and electronic equipment and complements measures on landfill and the incineration of waste.

Impact assessments are an aid to political decisions, rather than a substitute for them. They inform decision-makers of the likely effects of proposals and alternatives, leaving them to make the decisions. Best practice in the EU is to improve and to simplify the regulatory environment while giving full consideration to the effects of policies on the (1) economy; (2) society; and (3) environment.

The EC Communication COM(2002)276 sets out a general approach to impact assessments. This is within the frameworks of *Better Regulation and the European Sustainable Development Strategy.*

#### 5.3.4.1 EU Code of Conduct

##### 5.3.4.1.1 Data Center (EU) Code of Conduct

The European Commission created a code of conduct for data centers as a means for operators to understand energy demand within a data center. The CoC provides a resource to understanding energy demand by raising awareness and providing recommendations for best practices.

The primary target of the Code of Conduct is the data center operator who is committed to implement energy efficient solutions in existing or new data centers.

The aim of the Code of Conduct is to:

- Develop and promote a set of easily understood metrics to measure the current efficiencies and improvement going forward in conjunction with other industry though leadership forum.
- Provide an open process and forum for discussion representing European stakeholder requirements.
- Produce a common set of principles to refer to and work in coordination with other international initiatives.
- Raise awareness among managers, owners, investors, with targeted information and material on the opportunity to improve efficiency[29]. Suppliers of efficient services and equipment, as well as other organizations (e.g., Green Grid) can become allied (and endorser) in these targeted campaigns.
- Create and provide an enabling tool for industry to implement cost-effective energy saving opportunities.

[29] This information could be disseminated through messages and information campaigns sponsored by governmental bodies at EU and national level, which are seen as independent and unbiased organizations.

- Develop practical voluntary commitments which when implemented improve the energy efficiency of data centers and in so doing minimize the total cost of ownership (TCO).
- Determine and accelerate the application of energy efficient technologies.
- Foster the development of tools that promote energy efficient procurement practices.
- Support procurement, by providing criteria for equipment (based on the Energy Star Program specifications, when available, and other CoC's (e.g., CoC for Universal Power Supply (UPS)), and best practice recommendations.
- Monitor and assess actions to properly determine both the progress and areas for improvement.
- Set energy efficiency targets, for public and corporate data centre owners and operators (targets are differentiated according to the size and status of existing data centers, the geographical location, the return on investments, etc).
- Provides reference for other participants. The values of the Code of Conduct goes beyond the number of companies that sign and commit themselves, as the principles can be implemented also by other companies, which may not decide to make a public commitment. The existence of the European Code of Conduct introduces targets and guidelines, which are open to every data center.

#### 5.3.4.1.2 Energy Consumption of Broadband Equipment (EU) Code of Conduct

The European Commission has issued a code of conduct for broadband equipment which sets out the basic principles to be followed by all parties involved in broadband equipment (BBE), operating in the European Community, in respect of energy efficient equipment.

The CoC estimates that within the EU, BBE may be responsible for up to 50 TWhr per annum by 2015. By following the principles set out in the CoC, it is estimated that this could reduce to 25 TWhr per annum.

The CoC covers equipment both on the consumer side (end user equipment) and the network side (network equipment), for services providing a two way data rate of 144 kb/s or above. Signatories of the CoC agree to make all reasonable efforts to:

- Abide by the General Principles designed to achieve reduced power consumption targets.
- Achieve the power consumption targets set out in the document, for at least 90 percent of the number of the new broadband equipment that are introduced on the market or installed in the network after the indicated date.
- Provide end-users with information about power consumption of end-use equipment and about switching off end-use equipment.
- Co-operate with the European Commission and Member State authorities in an annual review of the scope of the Code of Conduct and the power consumption targets for two years ahead.
- Co-operate with the European Commission and Member States in monitoring the effectiveness of the Code of Conduct.
- Ensure that procurement specifications for broadband equipment are compliant with the Code of Conduct.

In addition, the CoC outlines measures that signatories must follow to provide information on power consumption to the European Commission. This enables the Commission to:

- Evaluate the level of compliance and the effectiveness of the Code of Conduct in achieving its aims.
- Evaluate current and future developments that influence energy consumption, (e.g. integrated circuit development, etc.) with a view to agreeing actions and/or amendments to the Code of Conduct.
- Set targets for future time periods.

The document also defines test methods to be followed in order to provide information on power consumption levels.

#### 5.3.4.2 Waste Electrical and Electronic Equipment Directive

The Waste Electrical and Electronic Equipment Directive (WEEE) is an EU directive (2002/96/EC of 27 January 2003) which is currently being implemented in the EU member states. The directive is closely related to the EU directives on RoHS. The WEEE directive is intended to prevent waste from electrical equipment via the reuse, recycling and other forms of recovery of such wastes. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, e.g. producers, distributors and consumers and in particular those operators directly involved in the treatment of waste electrical and electronic equipment.

The WEEE directive affects the following products and their suppliers:

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers

Since August 2005, each product in these categories must bear a WEEE symbol to inform the end consumer of its status. The manufacturer of WEEE products must provide for the products disposal at no cost to the end consumer at the end of the products useful lifecycle.

In 2006, the EU launched an information gathering to assess the WEEE implementation in its member states. From member state reporting it was determined that only 33 percent of e-waste was being properly treated, and that 54 percent of e-waste produced across the Union is shipped to sub-standard treatment facilities inside or outside the EU, while the remaining 13 percent went to landfills. The illegal shipping of e-waste for handling in non-EU countries was also found to be widespread.

In December 2008 the EU announced proposed revisions to the WEEE treaty (see MEMO/08/764) which will strengthen member state oversight, investigatory powers, and enforcement of the WEEE and institutes higher benchmarks for the overall treatment of electrical waste under the directive.

### 5.3.5 Intergovernmental Panel on Climate Change (IPCC)

The IPCC is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the UNEP to provide the decision-makers and others interested in climate change with an objective source of information about climate change. Its constituency is made of:

- The governments: the IPCC is open to all member countries of WMO and UNEP. Governments participate in plenary Sessions of the IPCC where main decisions about the IPCC work program are taken and reports are accepted, adopted and approved. They also participate in the review of IPCC Reports.
- The scientists: hundreds of scientists from all over the world contribute to the work of the IPCC as authors, contributors and reviewers.
- The people: as a UN body, the IPCC work aims at the promotion of the UN human development goals.

# 6 APPROACH AND CONSIDERATIONS FOR THE DEVELOPMENT OF ICT SUSTAINABILITY ROADMAP

Based on the information gathered with respect to sustainability, and in appreciation of the broad and complex nature of the topic, it is idealistic to suppose that an in-depth analysis can be conducted on each issue associated with sustainability. The time and resources that would be consumed to complete such an onerous task would surpass the returned value. Consequently, efforts must be focused on issues and programs of the utmost priority (e.g., energy efficiency) and a plan set in place to address those issues identified.

In order to organize the wide-range of topics, programs and issues being implemented or contemplated within the ICT industry with respect to sustainability, the diagram below bundles and categorizes like issues and programs (“programs”) under a particular topical area (or “portfolio”). It should be noted however that not every known program associated with sustainability is shown on the diagram nor are the underlying issues within each program. It should also be noted that while a particular program may be assigned to a single portfolio, many if not all the programs will traverse many if not all the shown portfolios. With like programs bundled together however, the ICT industry via ATIS members are able establish a layer of organization in order to better define its approach to ICT sustainability and develop a path forward – commonly referred to as an Industry Roadmap.

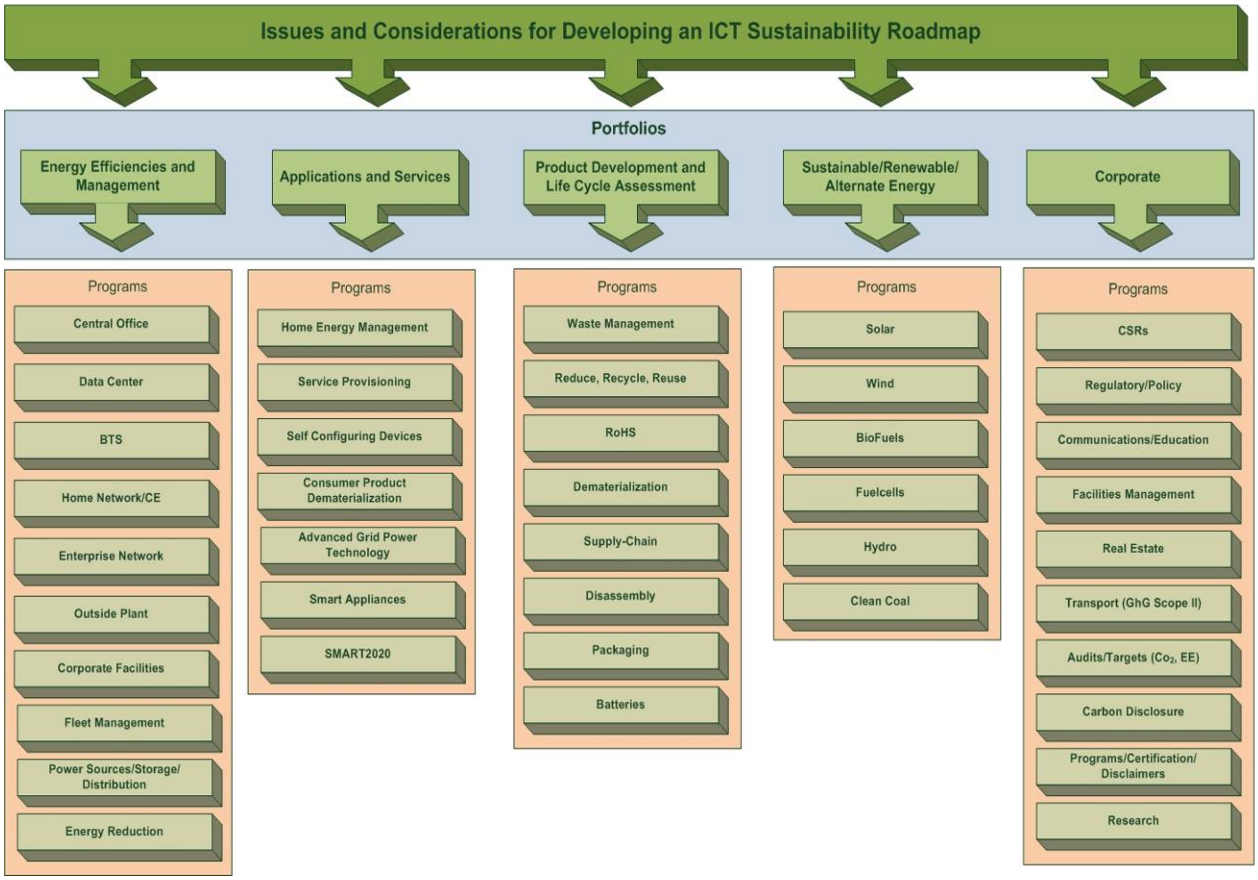


**Figure 4: Issues and Considerations for Developing an ICT Sustainability Roadmap**

The primary push of the ICT industry in addressing sustainability is on reducing energy consumption, heat generation and equipment footprint; which not only lowers its energy costs in networks and user devices, but also its emissions. Focus of late has also been placed on the ICT industry's ability to enable and advance services and applications that, when implemented, would benefit the larger social community, as they strive to find ways to reduce their carbon footprint through the increased use of ICT services and applications.

Other areas where the ICT industry and thus ATIS members are involved include (1) conducting lifecycle assessments and planning for dematerialization and environmentally conscious product development; and (2) evaluating sustainable energy sources for use as primary and/or supplemental power sources. In all, these activities plus numerous others exemplify a sweeping shift in corporate behavior both internally and externally, as programs are established and actions are taken to be even more eco-friendly than before.

The information contained in this report sets the foundation for developing this Industry Roadmap and at a high level begins to cover programs considered a priority across the portfolios. Subsequent work in these areas will be defined by the ATIS membership.

# 7 ENERGY EFFICIENCY AND MANAGEMENT

Facility center power and cooling are two of the biggest issues facing organizations today, and growing companies need a way to control these costs while enabling future expansion. With more efficient facilities, organizations can better manage increased computing, network and storage demands. Additionally, they will experience lower energy costs, and reduce TCO—all while remaining competitive and able to meet future business needs.

## *7.1 Energy Usage, Conservation and Efficiencies*

With respect to energy sustainability there are three primary components: (1) Energy Conservation (2) Energy Efficiency, and (3) Clean Energy.

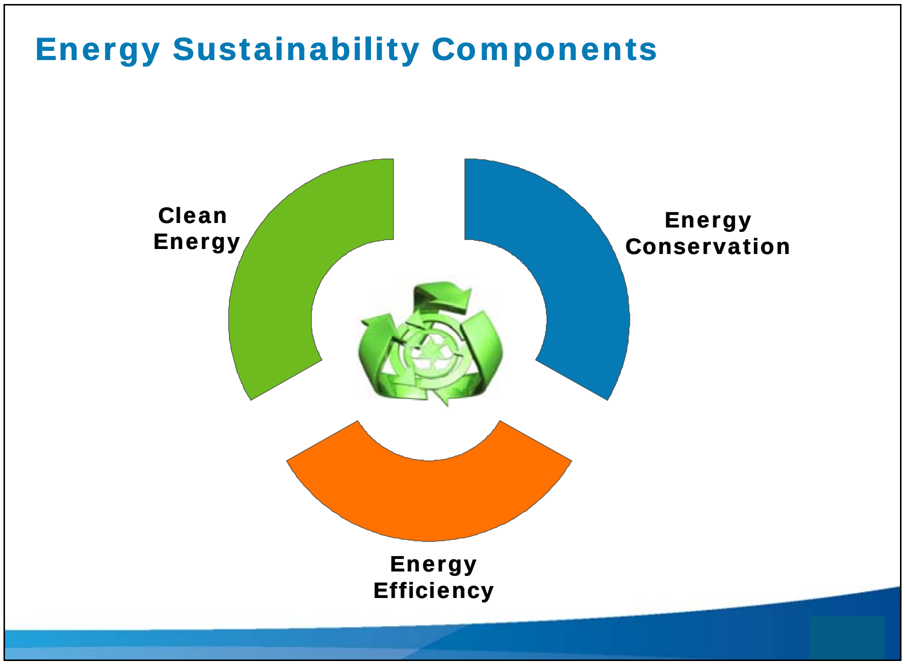


**Figure 5: Energy Sustainability Components**

**Energy Conservation** can be summarized via the long standing environmental pillars of "reduce, reuse, and recycle." In an ICT environment, energy conservation strategies include Operational Best Practices; Conduct Energy Audits; and Remove Obsolescent Equipment.

Improving the **energy efficiency** of individual ICT elements offers the largest opportunity to reduce energy consumption and energy cost. Strategies include:

- ICT Hardware Choices
- Improved Utilization
- Improved Equipment Efficiency
- High Efficiency Power Supplies
- High Efficiency Fans
- Sleep Mode

Improving facility energy efficiency strategy includes:

- Facility Operational Best Practices

- Telcordia Wide Band and Extended Wide Band Temperature
- Power Distribution Architecture
- Cooling Efficiencies
- Variable Capacity Cooling
- Monitoring and Optimization

**Clean Energy** holds a great deal of promise, but is not yet economically attractive. Clean energy includes, but may not be limited to:

- Photovoltaics
- Wind
- Fuel cells
- Biodiesel

### 7.1.1 Cascade Effect

The cascade effect refers to the fact that for every Watt of reduced ICT equipment energy consumption, there is a reduction of 0.3 to 2 Watts of facility support equipment energy consumption. Thus, there is an overall reduction of anywhere from 1.3 to 3 Watts of overall energy consumption. The actual number will vary depending on the energy efficiency of the facility, type of heating ventilation and air condition (HVAC) system, power distribution system, and climate, among other factors. The following example describes an alternate current (AC) powered ICT server in a data center environment, but is indicative of any ICT environment.

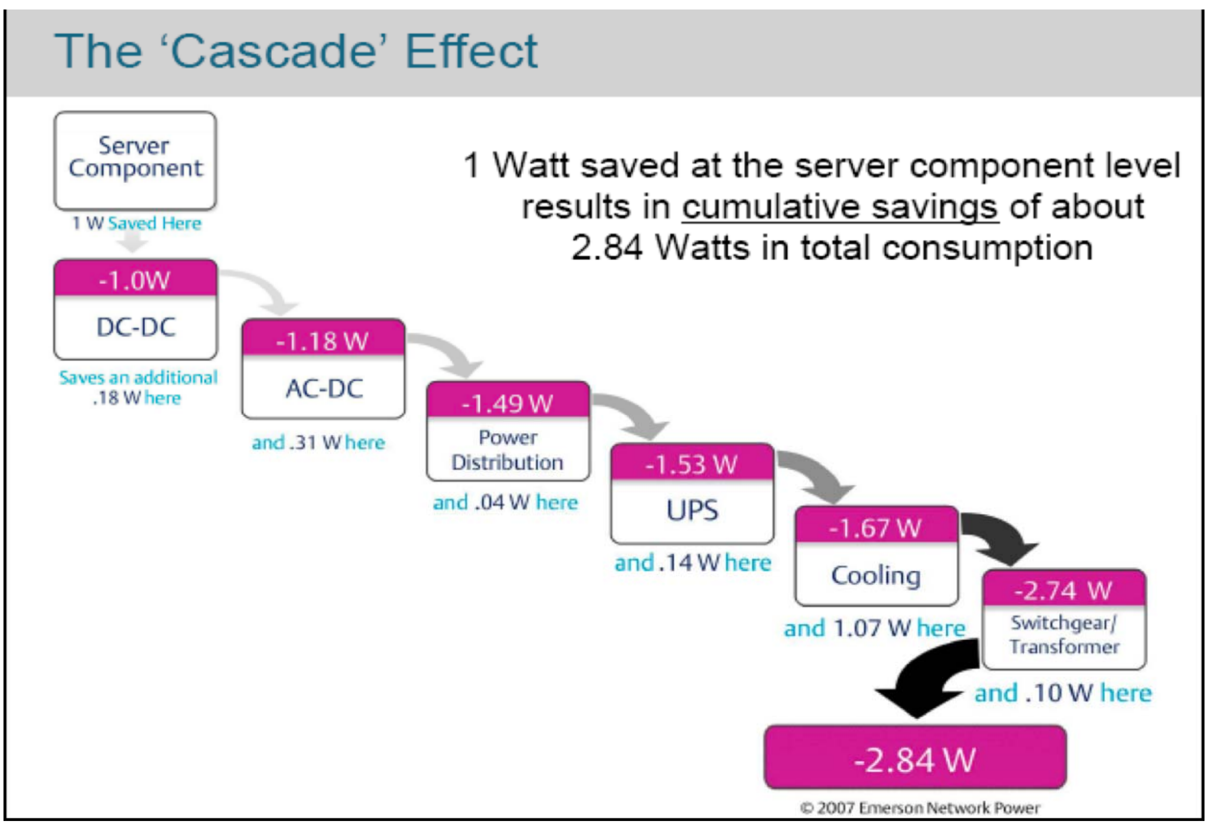


**Figure 6: Cascade Effect**
(Source: Emerson Network Power)

### 7.1.2 Energy Metrics

Energy metrics are a necessary tool to aid in implementing an energy roadmap. They can be divided into two broad categories: (1) Equipment level and (2) Facility level.

#### 7.1.2.1 Equipment Level Metrics

ICT equipment level metrics include the ATIS Telecommunications Energy Efficiency Rating (TEER) which is a ratio of work performed divided by power dissipated or energy consumed over time.

#### 7.1.2.2 Facility Level Metrics

Several metrics can help organizations better understand and improve the energy efficiency of their existing facilities, as well as help them make smarter decisions on new deployments. In addition, these metrics provide a dependable way to measure their results against comparable organizations.

##### 7.1.2.2.1 Power Usage Effectiveness (PUE) & Data Center Infrastructure Efficiency (DCiE)

Power usage effectiveness (PUE) was created by members of the Green Grid and is a metric used to determine the energy efficiency of data centers. PUE is determined by dividing the amount of power entering a data center by the power used to run the computer infrastructure within it. PUE is therefore expressed as a ratio, with overall efficiency improving as the quotient decreases toward DCiE.

DCiE is a metric used to determine the energy efficiency of a data center. The metric, which is expressed as a percentage, is calculated by dividing IT equipment power by total facility power. DCiE was developed by members of the Green Grid, an industry group focused on data center energy efficiency.

**PUE** is defined as:

$$\text{PUE} = \frac{\text{Total Facility Power or Energy}}{\text{ICT Equipment Power or Energy}}$$

**DCiE** is the inverse of PUE and is defined as:

$$\text{DCiE} = \frac{\text{ICT Equipment Power or Energy}}{\text{Total Facility Power or Energy}}$$

The PUE and DCiE provide a way to determine:

- Opportunities to improve a data center's operational efficiency
- If the data center operators are improving the designs and processes over time
- Opportunities to repurpose energy for additional IT equipment
- Identify facilities that are energy inefficient for corrective action
- Compare energy efficiency of facilities, normalized for load

While both of these metrics are essentially similar, they can be used to illustrate the energy allocation in the data center differently. For example, if a PUE is determined to be 3.0, this indicates that the data center demand is three times greater than the energy necessary to power the IT equipment. In addition, the ratio can be used as a multiplier for calculating the real impact of the system's power demands. For example, if a server demands 500 watts and the PUE for the data center is 3.0, then the power from the utility grid needed to deliver 500 watts to the server is 1500 watts. DCiE is quite useful as well. A DCiE value of 33 percent (equivalent to a PUE of 3.0) suggests that the IT equipment consumes 33 percent of the power in the data center.

In short, PUE is inversely related to energy efficiency – the higher the PUE, the poorer the facility energy efficiency. DCiE is directly related to energy efficiency – the higher the DCiE, the higher the energy efficiency.

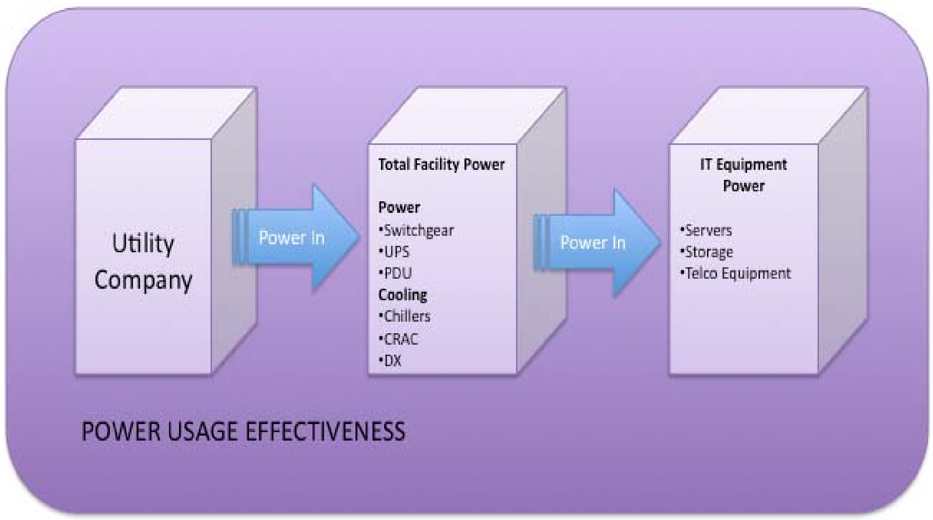


**Figure 7: Power Usage Effectiveness (PUE)**

*Total Facility Power* is defined as the power measured at the utility meter – the power dedicated to support the telecommunications network elements. This includes the Network Element (NE) equipment load and everything that supports the NE equipment load, including building electrical and mechanical systems, standby AC plant, DC power plant, lights, printers, freight elevators, etc. In a mixed use facility, such as a central office (CO) that also houses significant administrative space or a work center, the power dedicated to the administrative space or work center should not be included.

ICT is a generic term that includes both IT equipment and telecommunications NE equipment. For data centers, the term IT is commonly used, as found in *Green Grid Metrics: Describing Data Center Power Efficiency*[30]. At COs, Mobile Telephone Switching Office (MTSOs), and Out Side Plant (OSP) facilities, the term NE is commonly used.

*IT Equipment Power* includes the load associated with all of the IT equipment, such as compute, storage, and network equipment, along with supplemental equipment such as keyboard, video, mouse (KVM) switches, monitors, and workstations/laptops used to monitor or otherwise control the data center.

[30] "The Green Grid Metrics: Describing data center Power Efficiency." Metrics and Measurements White Paper. 20 February 2007. The Green Grid. 28 February 2009 <http://www.thegreengrid.org/sitecore/content/Global/Content/white-papers/Green-Grid-Metrics.aspx>.

#### 7.1.2.2.2 Data Center Productivity (DCeP)

The DCeP metric provides a unique analytical tool that may be used to track the overall work product of a data center per unit of energy expended to produce this work. While DCeP in its current form is only applicable to improvements in a single data center, it is hoped that this work will provide a framework to develop similar metrics for comparing across different data centers.

While efficiency, productivity, and business growth are closely related, efficiency tends to focus on reducing costs by eliminating unnecessary expenditures of various resources required to produce a work output. Productivity, while not ignoring this aspect, focuses on increasing the amount of useful work produced for a given expenditure of resources. When applied to the data center, productivity is the quantity of useful information processing done relative to the amount of some resource consumed in producing the work.

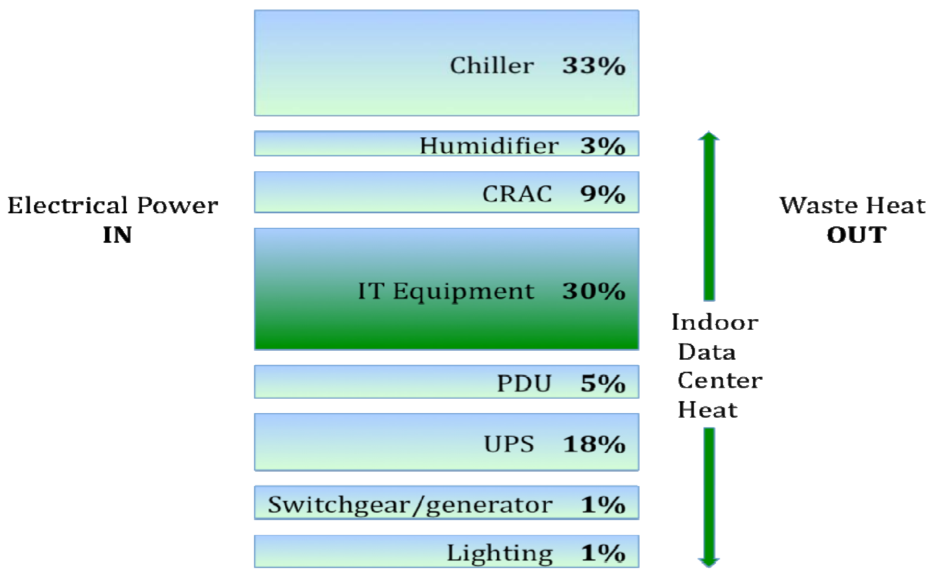


**Figure 8: Where Does Energy Go?**
**(Source: The Green Grid)**

### 7.1.3 System Efficiency

What can be measured, can be improved. Once energy consumption figures are available, it becomes easier to evaluate approaches to enhancing system efficiency. While this is an area that typically falls under the remit of the customers' IT teams (typically responsibility lies with the data center department), it's important that companies assess the efficiency of their infrastructures. New approaches to rack and server operations can reduce energy efficiency. A great example of this is virtualization, which uses software to partition server and rack assets so that numerous applications can be run off the same machine thereby optimizing infrastructure usage.

## *7.2 Energy Efficiency and Management for Networks and Facilities*

### 7.2.1 Data Centers/ Video Head End Office

Driven primarily by business needs to manage energy cost as well as environmental concerns, initiatives focusing on greening the data centers have taken hold in government agencies, consortiums and industry over the past couple of years.

The EPA estimates that data centers[31] today consume between one and a half percent and three percent of the U.S. energy/electricity supply growing by 12 percent a year. This growth is due to the increase demand for new services as well as Sarbanes-Oxley requirements. Companies like Microsoft and Google have been expanding their data center servers and storage at an incredible pace in recent years leading to a data center "Moore's Law" effect of doubling every 18-24 months. In 2007 data centers in the U.S. used 180 billion kilowatt hours including for cooling, costing more than $29 billion. And that's expected to double the next four years. The EPA has estimated that data centers consume more electricity than U.S. auto makers.

With the growth of data centers estimated to continue, it's extremely important that architecture and design of data centers improve and evolve. Energy efficiency is an important aspect of the next generation architecture.

Data centers supporting different organizations look as different as night and day on the surface - one looks like a computer hardware laboratory and another looks like a lights-out server farm. One has employees entering and leaving constantly, and another is accessed remotely and could be globally located. One may be housed in a building, and another may be housed within a controlled environment vault; but beneath the surface, our datacenters have similar underlying infrastructure including physical design, power, cooling, and connectivity.

When looking at the opportunity to save energy, most of the opportunity is in bad system design, not in the parts. The key to energy efficiency in the data center is right-sizing. The number one driver of waste in the data center whether it be servers, power systems, or cooling systems, is over-sizing whatever is being looked at.

There are two kinds of energy consumption reductions:

- Those that avoid energy consumption, but do not reduce power capacity requirements are referred to as "temporary consumption avoidances".
- Those that also allow the reduction of installed power capacity are referred to as "structural consumption avoidance".

In data centers, a general rule is that structural consumption avoidance is worth approximately twice as much as temporary consumption avoidance.

In the "information age" there is a vast amount of data that is stored and instantly made available upon request. Users of these data range from companies complying with the recent Sarbanes–Oxley accounting data legislation to consumers watching YouTube videos, to the processing and storage capabilities required for climate change modeling. This has led to a vast increase in the number of data centers – buildings that house a collection of servers, storage devices, network equipment, power supplies, fans and other cooling equipment – which provide information at our fingertips, supplying business, government, academia and consumers around the world.

[31] "EPA Report on Server and Data Center Energy Efficiency." Energy Efficiency and Renewable Energy. Environmental Protection Agency. 27 March 2009 <http://www.energystar.gov/index.cfm?c=prod_development.server_efficiency_study>.

In 2002, the global data center footprint, including equipment use and embodied carbon, was 76 $MtCO_2$ emissions and this is expected to more than triple by 2020 to 259 $MtCO_2$ emissions – making it the fastest-growing contributor to the ICT sector's carbon footprint, at seven percent in relative terms.

#### 7.2.1.1 Data Center Energy Efficiency

Data center energy efficiency needs to be characterized, metered and measured. The work being done in the "greening the data center" initiatives is initially focused on developing a set of standards and metrics that can be used to calibrate the energy efficiency of data centers. With standards and metrics in place, data center energy efficiency assessments can be made. Areas of focus are:

- Developing data center models
- Meter and measure energy usage
- Assess data center efficiency
- Developing best practices

#### 7.2.1.2 Data Center Utilization

An extremely important aspect of "greening the data center" is improving the utilization of servers, storage systems[32], appliances[33], blade servers, switches and routers. The traditional data center architecture of "one application per machine" approach to server provisioning leads to an over-provisioned underutilized data center. In this type of architecture servers typically operate at only 10-20 percent of their capability. Clustering and Virtualization are techniques specifically developed to improve server utilization and should be employed when building a data center.

##### 7.2.1.2.1 Data Center Power Management System

Servers, storage systems, appliances, blade servers, switches and routers (henceforth referred to as data center Infrastructure) are strategic accesses of an enterprise and must be managed carefully. In many cases, data centers are designed for peak usage and are thus underutilized as application load fluctuates during the course of a day or a week. Load balancing clusters and virtualization go a long way towards effectively balancing utilization across the data center Infrastructure but the total load on the data center will most likely fluctuate over a period of time.

To better manage power during low utilization periods, product architecture and design of data center infrastructure equipment must evolve to support the control of power consumption of individual components. Specifically products must have the ability to power down subsystems during low utilization periods. Management systems must be put in place that monitor utilization and dynamically bring on and off line components of the data center Infrastructure based on load. Attributes of a power management system:

- Monitoring data center utilization fluctuations

[32] Storage systems are: Network Attached Storage (NAS), Storage Area Network (SAN), Direct Attached Storage (DAS), etc.
[33] A data center appliance is an application specific system, examples of which are Load Balancers and Video on Demand Streamers.

- Architecture and design of data center infrastructure equipment to enable power management of individual components
  - Servers
  - Storage system
  - Appliances
  - Blade Servers
  - Switches
  - Routers
- Dynamic power management of data center infrastructure equipment
  - Servers
  - Storage system
  - Appliances
  - Blade Servers
  - Switches
  - Routers

A long term objective for The Green Grid is to develop a data center architecture that will include automatic control of data center components via policy-based management geared toward IT objectives for power efficiency.

**7.2.1.2.1.1 Case Studies**

The following examples summarize the case studies of two companies whose data centers load fluctuates over the course of a day and week. [34]

7.2.1.2.1.1.1 Company A

Company A is a leading media and entertainment company, whose businesses include interactive services, cable systems, filmed entertainment, television networks and publishing. Company A did a real word analysis of the launch of a new service offering; Start Over TV[35]. Among other things, they analyzed the demands that this new service put on their Video on Demand (VoD) infrastructure.

Looking at one deployment site, with Start Over service enabled the peak load varied over the course of the week from a low of ~1300 streams on Monday (Figure 9) to a maximum of ~3500 streams on Saturday night (Figure 10). To support the maximum load the VoD servers (an appliance) and network infrastructure were left largely underutilized for most of the week. Looking at each individual day, there is an extremely wide variance in the number of streams with a low of ~200 and a peak of ~3500. Taking into account load fluctuation over the course of the day and week a dynamic power management system together with a product design that could be incrementally power downed would yield a significant power savings for their VoD data center.

[34] Would You Like to Start Over? What It Is, What It Means
Conrad Clemson, Broadbus, and Glen Hardin, Time Warner Cable
http://www.cable360.net/print/ct/deployment/casestudies/18582.html

[35] The Start Over system instantaneously captures live television programming for immediate, on demand viewing.

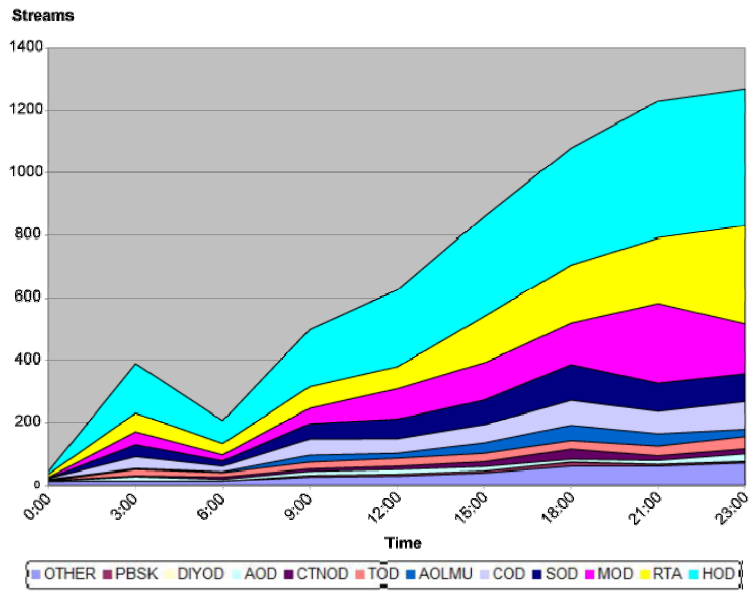


**Figure 9: Monday VoD Streams**

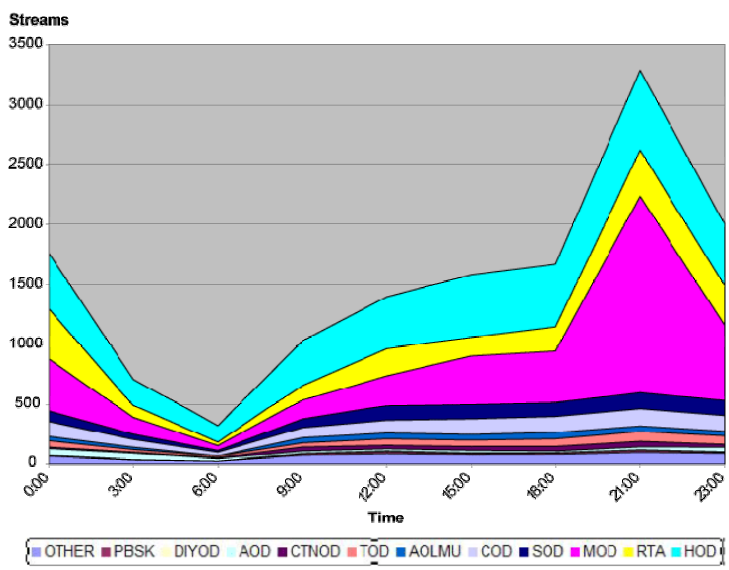


**Figure 10: Saturday VoD Streams**

7.2.1.2.1.1.2 Company B

Company B has built one of the worlds largest Content Delivery Network (CDN) handling 20 percent of the total Internet traffic. They have over 40,000 servers distributed worldwide across 70 countries and ~1,200 Point of Presences (POPs). In their Network Operation Command Center they monitor in real time internet traffic patterns and sort the data into net usage indices; Online News, Retail and Digital Music. Company B uses this information to optimize network routes and to replicate content for faster and more reliable delivery. The data shows that traffic fluctuates over the course of the day (see Figure 11 North American Retail Internet Traffic and Figure 12 Europe Retail Internet Traffic). Dynamic power management of the servers where utilization varies over the course of the day or week would improve power efficiency. Note: Time references are based on Eastern Standard Time.

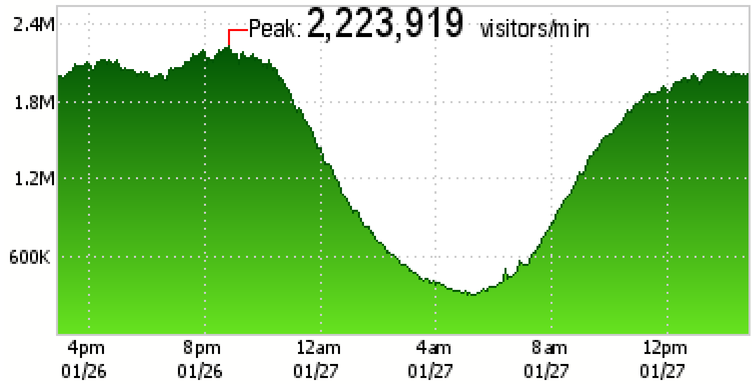


**Figure 11: North America Retail Internet Traffic**

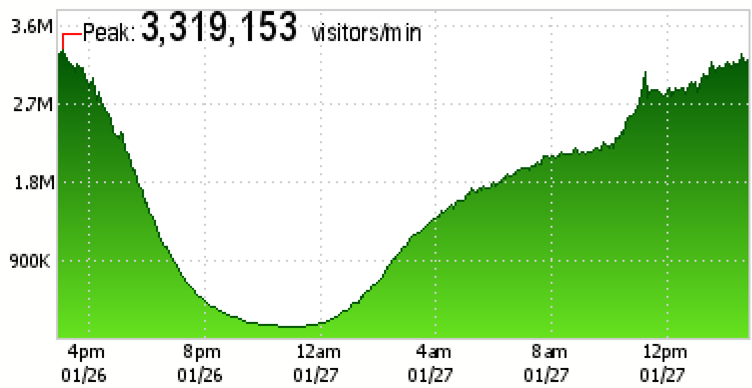


**Figure 12: Europe Retail Internet Traffic**

#### 7.2.1.2.2 Clustering

Server clustering is a technique of combining of "n" number of servers together so that they appear and work as a single server. Load balancing is typically used within the cluster to distribute the workload efficiently between servers improving performance and utilization. High availability and reliability are inherent attributes of a cluster and are achieved by implementing an n+1 architecture where a single server acts as a backup system in the event of failure.

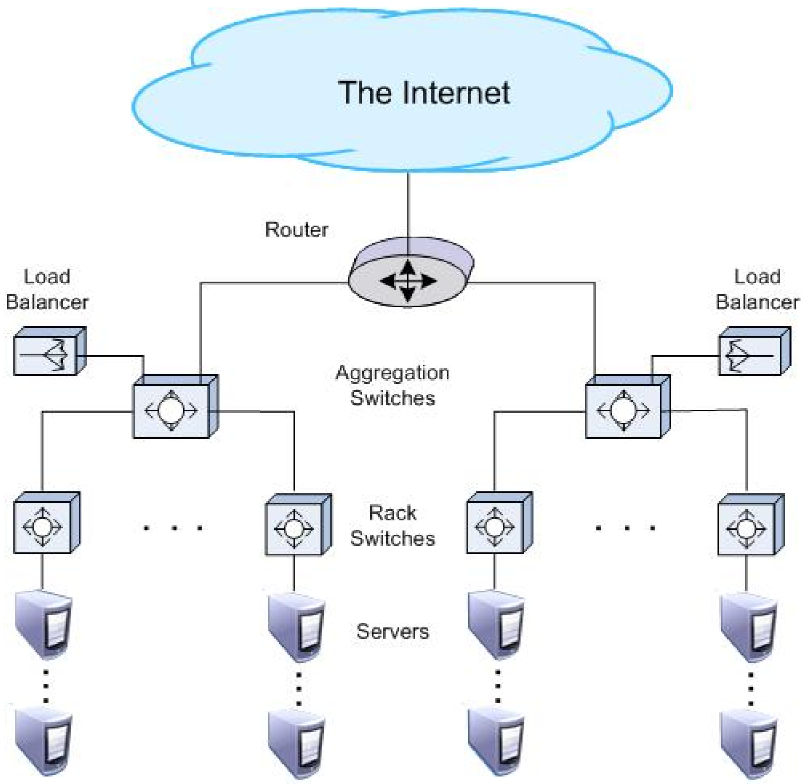


**Figure 13: Load Balancing Cluster**

#### 7.2.1.2.3 Virtualization

Virtualization of a data center provides an abstraction layer between physical servers and storage elements and virtual machines and storage. It enables a single server to look like many machines and allows for pooling of shared resources. Virtualization will enable data centers to dynamically shift available processing and/or storage to applications as required thus driving up efficiency and utilization. Virtualization is an emerging technology that can be a very effective as reducing energy consumption.

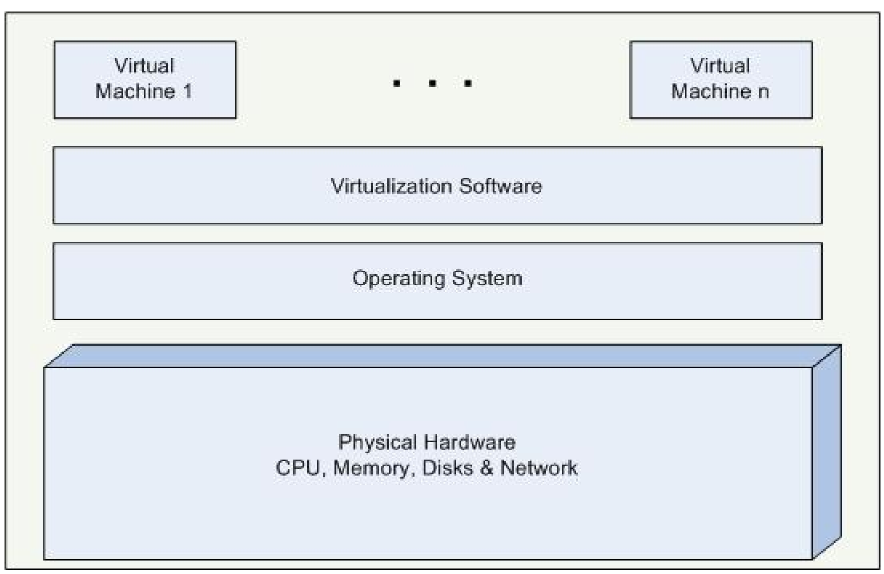


**Figure 14: Server Virtualization**

The Green Grid has developed a white paper called Using Virtualization to Improve Data Center Efficiency. The Green Grid suggests that "Virtualization has long held the promise of energy savings due to its server consolidation capabilities. This paper provides those responsible for reducing energy consumption with a description of the advantages and processes that should be considered when virtualizing servers in the data center. This paper outlines some of the advantages, considerations, processes, and implementation strategies needed to reduce server power consumption in a data center using virtualization techniques[36]."

#### 7.2.1.2.4 "Spring Back"

Currently, data center management is compensated based on ICT system throughput and not Energy Efficiency. When server power savings options are engaged, the throughput of the server and thus the overall system is reduced. Therefore, when the reduction in throughput occurs, data center Management is motivated to "Spring Back" and order the energy savings options disengaged to return to previous performance levels. Alternatively, additional servers may be designed into the system to maintain the throughput performance of the energy saving groups of servers, at the expense of energy efficiency.

##### 7.2.1.2.4.1 Considerations Related to Data Centers

A) Application, performance, and energy-efficiency needs for each data center should be used to develop a dynamic data center plan.

B) Member companies should consider establish energy training/awareness programs for data center management and staff. Training/awareness programs for data center management and staff could include awareness of how their decisions and actions can potentially negatively impact energy efficiency, e.g. "spring back".

C) Member companies could also consider including energy efficiency as a factor in the compensation of data center management and staff.

#### 7.2.1.3 Calculating the Data Center Footprint in 2020

If growth continues in line with demand, the world will be using 122 million servers in 2020, up from 18 million today. In addition to this nine percent increase in server numbers, there will be a shift from high-end servers (mainframes) to volume servers; the least expensive kind of server that can handle much of the computational needs of businesses. Without the use of application of virtualization technologies in data centers, simply scaling up today's data center technology would increase its footprint.

With energy cost and user demand for increased performance skyrocketing, organizations are attempting to find a balance between power, space and cost. According to some reports in fact, for every $1.00 spent on new data center hardware an additional $0.50 is spent on power and cooling; making power and/or cooling issues the single largest problem in the data center; 48 percent of the data center budget is being spent on energy, up from eight percent a few years ago[37].

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[36] "Using Virtualization to Improve data center Efficiency." Metrics and Measurements White Paper. 14 January 2009. The Green Grid. 28 February 2009 < http://www.thegreengrid.org/sitecore/content/Global/Content/white-papers/Using-Virtualization-to-Improve-Data-Center-Efficiency.aspx>.

[37] "Data Center Power." Power Management. 42U. 31 March 2009 <http://www.42u.com/power/data-center-power.htm>.

A major trend driving down the overall growth in the footprint of data centers is virtualization. Pooling assets such as computing and storage where utilization is low, so they can be used across the enterprise and beyond. Another approach is the use of blade servers. Their intent is to pack more horsepower into smaller chassis and enable a greater concentration of compute power in the data center. With multiple, highly compact blade servers, a single blade server chassis can deliver more compute resources than racks of individual server towers or rows of server racks. This has become a new way of rethinking how to best use the existing resources available and has been reported that it could reduce emissions as much as 27 percent. The hurdle faced by data centers is that software may not always be capable of running on a virtual server and could cause unintended downtime. Another area is open for improvement is software vendors. This subject will be covered further in this document as a separate study.

#### 7.2.1.4 Collocated Facilities for Data Centers

Collocation is defined as a type of data center where multiple customers locate network, server and storage gear and interconnect to a variety of telecommunications and other network service provider(s) with a minimum of cost and complexity.

Increasingly organizations are recognizing the benefits of collocating their mission-critical equipment within a data center. Collocation is becoming popular because of the time and cost savings a company can realize as result of using shared data center infrastructure. Significant benefits of scale (large power and mechanical systems) result in large collocation facilities, roughly 50,000 to 100,000 square feet. With IT and communications facilities in safe and secure hands, telecommunications, internet, applications and content providers as well as enterprises enjoy less latency and the freedom to focus on their core business. Additionally, customers reduce their traffic back-haul costs and free up their internal networks for other uses. Moreover, by outsourcing network traffic to a collocation service provider with greater bandwidth capacity, web site access speeds should improve considerably.

Major types of collocation customers are:

- Web commerce companies, who use the facilities for a safe environment and cost-effective, redundant connections to the Internet.
- Major enterprises, which use the facility for disaster avoidance, offsite data backup and business continuity.
- Telecommunication companies, who use the facilities to interexchange traffic with other telecommunications companies and access to potential clients.

Traditionally in collocation facilities, power costs are shared across customers depending on their infrastructure and space requirements. Moving away from this model has resulted in the availability of individual rack metering for customers. This fulfils two key objectives: first, it's a much more equitable way of charging as only used power is paid for; secondly, it's possible to monitor and measure power usage and advise when and how much power a company's systems consume and their overall and actual demands. This intelligence is often highly illuminating with many companies actually using less energy resources than they initially expected to.

The IT industry is a large user of resources as well as an enabler of efficiencies that reduce $CO_2$ emissions. However, as companies continue to grow to meet the demands of their customers and as environmental concerns continue to be an issue, organizations are looking for ways to reduce corporate energy consumption and to become more environmentally responsible to become green.

According to IBMs red-paper entitled *The Green Data Center: Steps for the Journey*[38], in order to optimize infrastructure, secure physical assets and reduce costs of operation, CIOs have been charged with consolidating their IT infrastructure as much as possible. This reveals a strong trend towards consolidating computing assets into raised floor, secured, centralized data center facilities. Many organizations are utilizing remote back-up data center facilities for the purpose of back-up, disaster recovery and business continuity.

In September 2007, IBM and the Economist Intelligence Unit issued a report entitled *IT and the Environment: A New Item on the CIO's Agenda?*[39] which found that although most organizations say they are green organizations, many of them are not actually doing as much as they could. Two-thirds of the two hundred or more executives polled said that their organizations have a board-level executive responsible for energy and the environment; however, only 45 percent of firms had a program in place to reduce their carbon footprint. In addition, of those that did have a carbon reduction strategy, the majority (52 percent) had no specific targets for it, although a small core (nine percent) aimed to be carbon-neutral by 2012.

### 7.2.2 Central Offices/Mobile Switching Offices

ICT Equipment Power in a CO or MTSO is defined as the power consumed by the network elements, including the primary and secondary distribution.

PUE is thus a ratio ≥ 1.0, since the total facility power must be ≥ ICT equipment power. For data centers, actual reported PUE measurements range from 1.3 to 3.0, according to a Lawrence Berkley National Lab study.

PUE and DCiE can be represented using either power or energy. Energy is power integrated over time. When it is calculated using power, the ratio represents an instantaneous PUE or DCiE. When it is calculated using energy, the ratio represents an average PUE or DCiE over the time period of the measurement. The standard unit of power is the Watt. The standard unit of energy is kiloWatt-hours (kWh).

The Figure 15 below illustrates a typical CO/MTSO power system block diagram with the recommended measurement points to calculate PUE and DCiE.

[38] Mike Ebbers, Alvin Galea, Michael Schaefer, and Marc Tu Duy Khiem. The Green data center: Steps for the Journey: IBM: International Technical Support Organization, 2008.
[39] Economist Intelligence Unit. IT and the Environment: A New Item on the CIO's Agenda?: Economist Intelligence Unit, 2007.

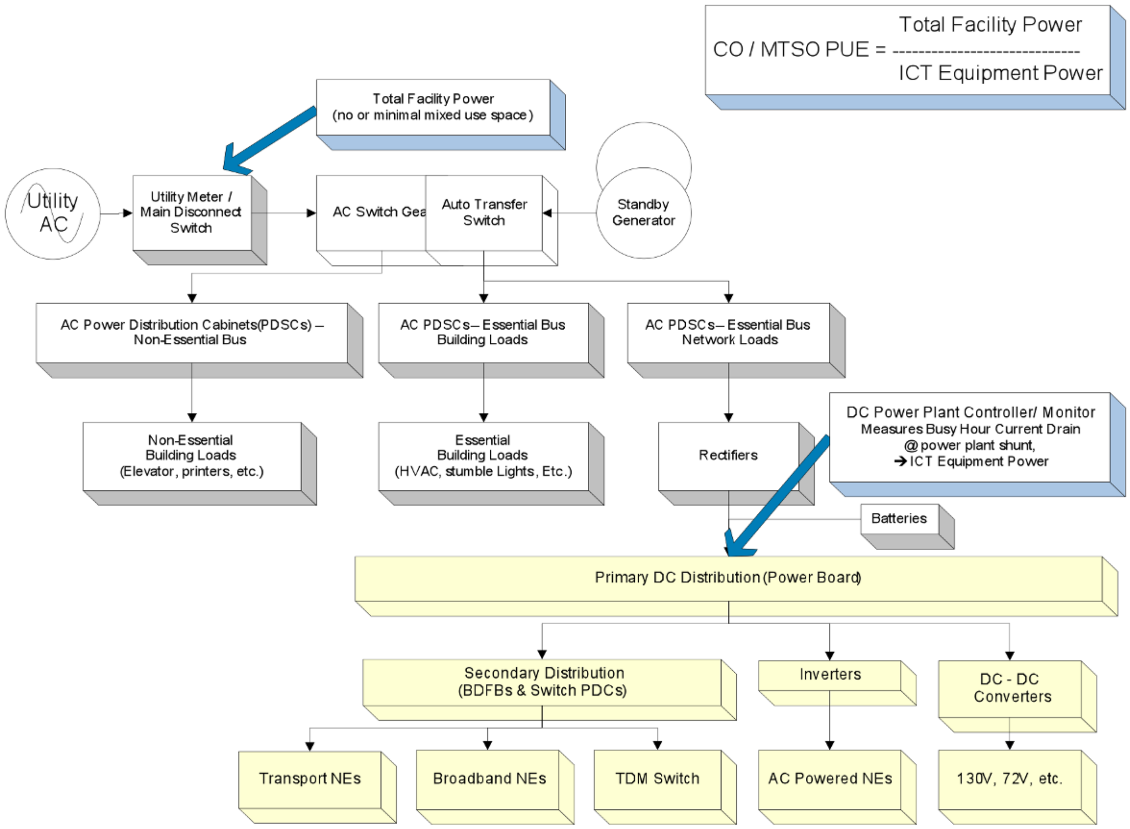


**Figure 15: Typical CO/MTSO Power System Block Diagram with recommended measurement points to calculate PUE and DCiE**

The recommended method of calculating PUE and DCiE is to calculate the ratio using energy with a time period of one year. Total Facility Power shall include a rolling 12 month cumulative kWh, generally collected from the commercial AC utility bills. It is important to include a 12 month cumulative total to capture energy usage fluctuations due to seasons, weather, etc. ICT Equipment Power shall be calculated utilizing the Busy Hour Drain captured by the DC power plant controller/monitor, multiplied by the DC power plant float voltage, multiplied by the number of hours in the given time period. If monthly Busy Hour Drain data is available, then sum for each month (using appropriate hours per month). If the Busy Hour Drain is not available (such as at an OSP facility that is not equipped with a monitor), then an instantaneous drain reading can be used.

Note: PUE and DCiE comparisons are more meaningful when comparing facilities with similar geographic weather patterns. Two identical facilities under identical load conditions, one in Michigan, the other in Florida, will have different ratios.

**Busy Hour Drain** is defined as the actual average current drawn by a circuit or group of circuits during the busy hour of the season (excluding power fail/battery discharge events). Busy hour drains for DC power plants are measured by power monitor devices. It is important to use a busy hour drain captured during the past 6 months – power monitors should be periodically reset to eliminate the possibility of using an outdated busy hour drain.

**Example PUE / DCiE calculation:**

Table below reflects the PUE / DCiE calculation for a small CO:

| Days of Service | Month | Year | Total Facility Energy (kWh) | NE Busy Hour Drain (A) | Float Voltage (V) | NE Eqpt Energy (kWh) | PUE | DCiE |
|---|---|---|---|---|---|---|---|---|
| 29 | Nov | 2007 | 8,958 | 167 | 52.08 | 6,053 | 1.48 | 67.6% |
| 35 | Dec | 2007 | 10,519 | 167 | 52.08 | 7,306 | 1.44 | 69.5% |
| 30 | Jan | 2008 | 8,750 | 167 | 52.08 | 6,262 | 1.40 | 71.6% |
| 31 | Feb | 2008 | 9,035 | 167 | 52.08 | 6,471 | 1.40 | 71.6% |
| 30 | Mar | 2008 | 8,994 | 167 | 52.08 | 6,262 | 1.44 | 69.6% |
| 29 | Apr | 2008 | 9,450 | 173 | 52.08 | 6,271 | 1.51 | 66.4% |
| 29 | May | 2008 | 11,288 | 173 | 52.08 | 6,271 | 1.80 | 55.6% |
| 31 | Jun | 2008 | 11,453 | 173 | 52.08 | 6,703 | 1.71 | 58.5% |
| 31 | Jul | 2008 | 11,178 | 173 | 52.08 | 6,703 | 1.67 | 60.0% |
| 32 | Aug | 2008 | 12,508 | 168 | 52.08 | 6,720 | 1.86 | 53.7% |
| 28 | Sep | 2008 | 10,228 | 168 | 52.08 | 5,880 | 1.74 | 57.5% |
| 30 | Oct | 2008 | 10,375 | 168 | 52.08 | 6,300 | 1.65 | 60.7% |
| | | | 122,736 | | | 77,201 | 1.59 | 62.9% |

**Table 2: PUE/DCiE for Small CO**

The PUE is 1.59 and DCiE is 62.9 percent for this facility. Graphing the monthly PUE for this CO reflects the impact of seasons on PUE.

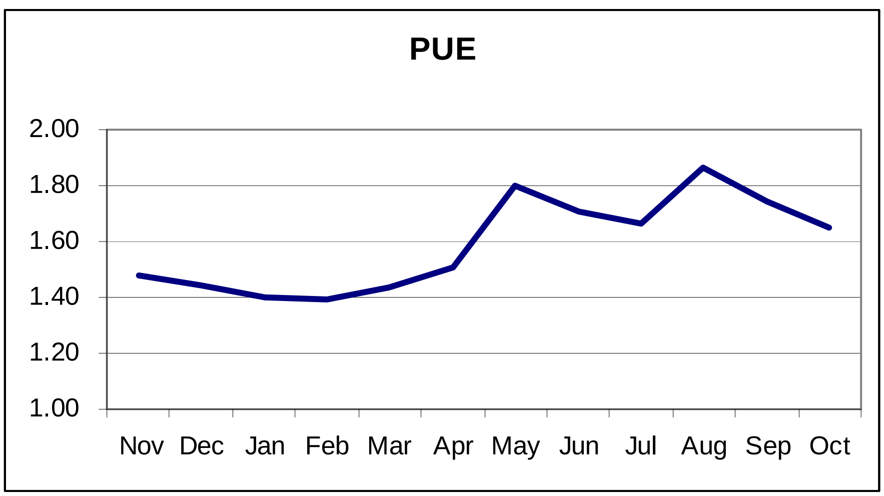


**Figure 16: Variation of Monthly PUE**

#### 7.2.2.1 Energy Audit

Periodic energy audits are an excellent tool to identify energy conservation opportunities. Facility level metrics combined with overall energy usage can be used to prioritize sites that may have the greatest opportunity. One possible use is to prioritize the frequency of energy audits:

- Highest frequency for facilities with high PUE and / or high usage

- Lowest frequency for facilities with low PUE and minimal usage
- Average frequency for majority of facilities with average PUE or average usage

A facility with the combination of high PUE and high overall energy usage is a prime target to achieve significant energy conservation. Low PUE and low usage indicates that few additional energy conservation improvements are available. Utilizing the filters of PUE and overall energy usage allows an ICT provider to target where to conduct energy audits and direct funding for energy conservation corrective action.

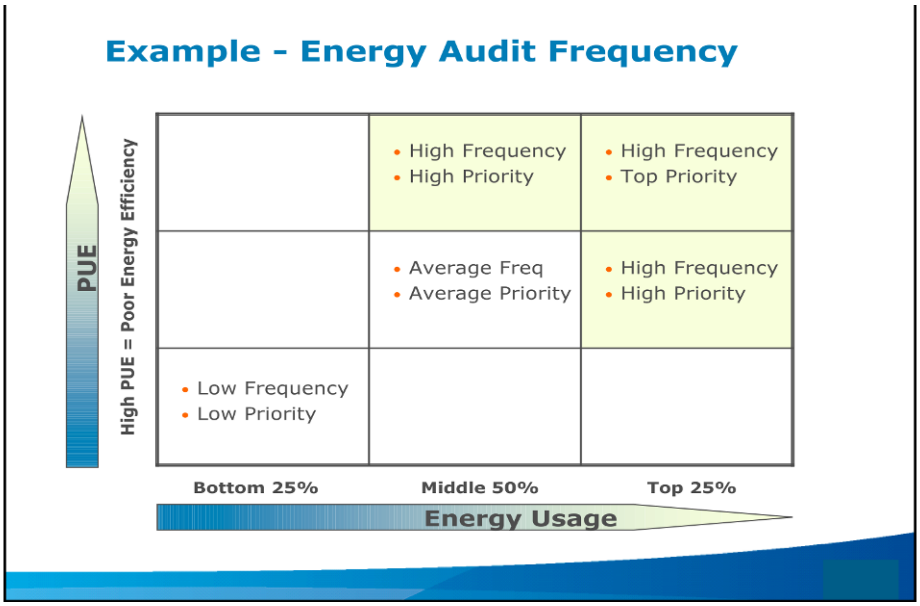


**Figure 17: Energy Audit Frequency**

To minimize cost, the energy audit should be structured so that local personnel can conduct the audit in 2 hours or less. Audit findings should be tracked, preferably on an intranet web based application, with reports that can then be sent to the appropriate responsible departments for investigation and corrective action, if warranted.

See *Appendix E: Operations Checklist* and *Appendix F: Property Manager Checklist* for samples.

#### 7.2.2.2 Retire, Remove, Replace Obsolescent Equipment

Normal business and accounting practices require the retirement and removal of obsolescent equipment no longer in service. However, there are pockets of obsolescent equipment that are providing minimal service that can be served with newer or different technologies.

For example, 130V power plants used to be common in COs, to serve T1 and T1C CXR technology. These copper based technologies have all but disappeared in the interoffice environment, replaced by fiber based transport technologies. However, copper based T1 CXR is still common in the OSP environment, serving individual business customers. Most of these loops are short, and do not require 130V power. For those that do require 130V power, most are equipped with plug-ins with on board DC-DC conversion. However, in some locations, there still exist a handful of circuits equipped with older plug-ins that are not equipped with an on board DC-DC converter, and are still being served from the 130V power plant. The typical drains on these plants are 5 Amps or less, resulting in poor utilization and poor energy efficiency.

By changing out the T1 repeater, which many providers have an ample reuse stock, the 130V power plant can be removed from service.

Unfortunately, these pockets of opportunity are generally small, and thus have a small incremental energy savings. They generally go unnoticed for years. The Energy Audit is an excellent vehicle to identify these opportunities and take corrective action.

**Proposed Action:** Retire and de-power obsolescent or underutilized equipment identified in the Energy Audits.

- Systematic review of obsolescent technologies
- Coin
- T1, T1-C CXR
- 130V power plants, -24v power plants
- MFT, D4, Asynchronous Fiber Optic Terminals (FOTs)
- TR008 Integrated DLC

#### 7.2.2.3 Percent Utilization Energy Savings

CO and MTSO power architecture utilizes DC power plants in either centralized (most common) or distributed architectures. The rectifiers utilized in telecommunications DC power plants are generally much more energy efficient than AC to DC power supplies commonly utilized in IT equipment in a data center. However, poor utilization of the rectifiers can result in excess energy waste.

The following figure reflects the typical energy efficiency of ferro-resonant (ferro) and Switch Mode rectifiers (SMRs) as a function of utilization. The knee of the curve is at 50 percent utilization for ferros and 30 percent utilization for SMRs.

Many legacy ferro rectifiers are reaching their end of service life. Newer ferro rectifiers are experiencing component failures. Spare parts are increasingly becoming more expensive and difficult to obtain, as the major manufacturers have discontinued product availability. Due to the increased frequency of failures, ICT providers are supporting provisioning of ferro rectifier capacity in excess of the historical recharge capacity requirement. The net result is that some ferro rectifier power plants are poorly utilized.

**Proposed Action:** Improve the utilization of older ferro-resonant rectifier power plants to at least 50 percent. There are four strategies to improve utilization of ferro rectifier power plants:

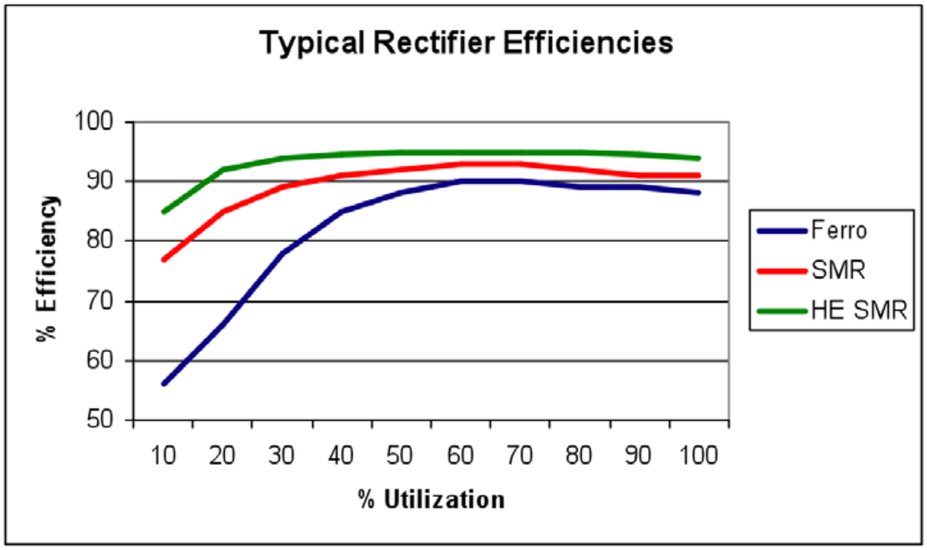


**Figure 18: Typical Rectifier Efficiencies**

- Turn off superfluous capacity rectifiers until the utilization is ≥ 50 percent
- Turn on manufacturer ferro rectifier energy management algorithms for plants with < 50 percent utilization
- Replace the ferro rectifiers with SMRs
- Implement a hybrid power plant (mixture of ferros and SMRs)

### 7.2.2.4 Hybrid Power Plants

Hybrid power plants are defined as DC power plants that contain both ferro-resonant (ferro) and SMRs. Hybrid plants will also generally include both legacy and modern primary distribution bays.

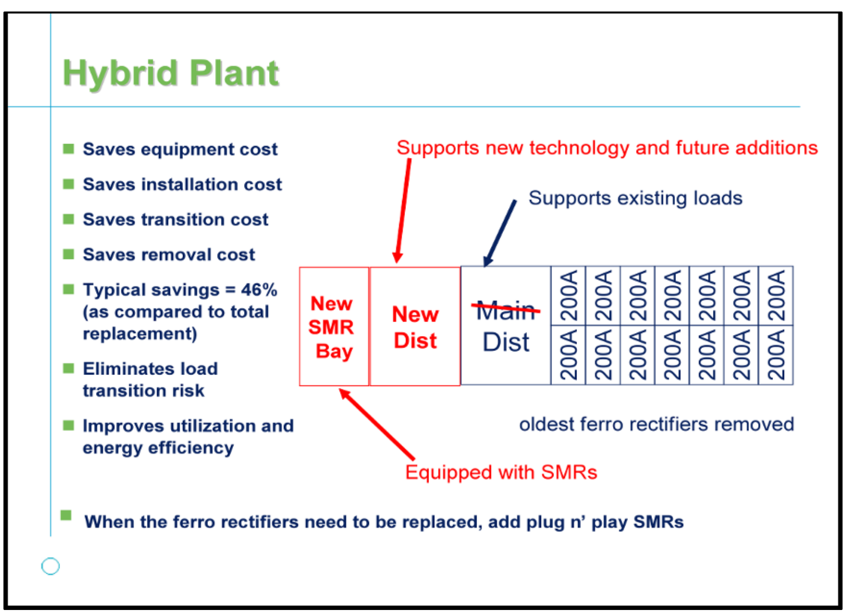


**Figure 19: Hybrid Power Plant**

By implementing a hybrid power plant, both reliability and energy efficiency can be improved, at the most economical price.

- Reliability is improved via the plug and play nature of SMRs. If a ferro rectifier fails in an all ferro plant, the net capacity is reduced until that rectifier can be repaired, usually at a high cost. If a ferro rectifier fails in a hybrid plant, the net capacity can be easily increased back to the original level via the addition of SMRs. Spare SMR slots should be available for this contingency.
- Energy efficiency is improved via improved utilization and the inherent improved efficiency of SMRs.

If planned and implemented properly, a hybrid plant does offer a tangible energy saving opportunity. Consider a power plant equipped with:

- (15) 400 A Ferro Rectifiers = 6,000 A capacity
- 2,500 A Busy Hour Load

This plant would be 42 percent utilized and will operate at ~85 percent efficiency. Now, assume we implement a hybrid power plant architecture as follows:

- (7) 400 A Ferro Rectifiers = 2,800 A capacity
- (3) 200 A SMRs = 600 A capacity
- Total Amps = 3,400 A
- 2,500 A Busy Hour Load

The hybrid plant can be configured so that the ferro rectifiers are 75 percent utilized and 90 percent efficient, while the SMRs are 70 percent utilized and 93 percent efficient, for an overall efficiency of ~ 91 percent. Figure #4 reflects the associated annual energy savings of $13,500 (assumes cost of energy is $0.10 / kWh).

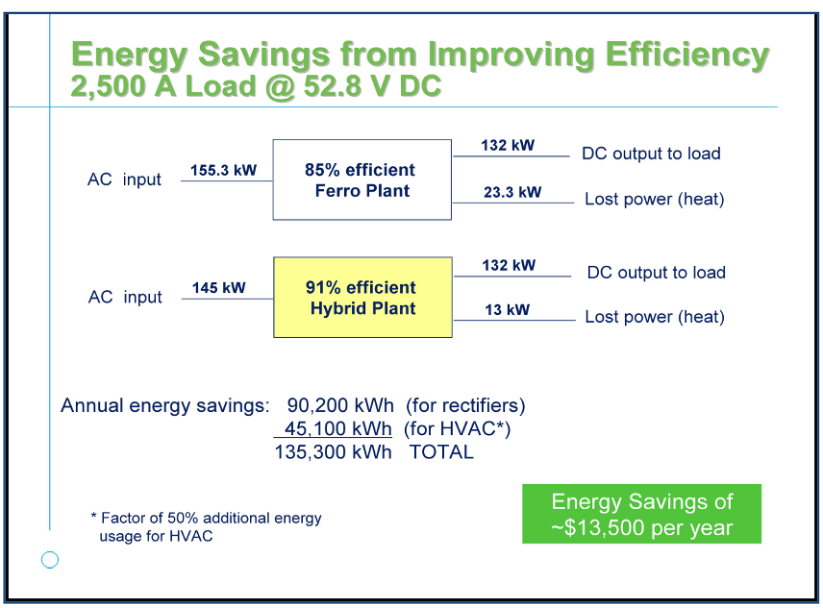


**Figure 20: Energy Savings by Improving Rectifier Efficiency**

#### 7.2.2.5 Reliability and Redundancy Standards

Many times, reliability and redundancy standards drive poor utilization and thus, poor energy efficiency. "2N" reliability architecture, by definition, drives < 50 percent utilization. Other reliability architectures, such as "N + 1," may provide adequate reliability, result in better utilization, improved energy efficiency, and less capital expenditures.

For example, a 2N architecture for HVAC chillers is common in ICT facilities. The result is the provisioning of two large chillers, either of which can serve the facility if the other is out of service. If a N + 1 architecture is employed, however, then the initial chillers can be sized to serve the current load, instead of the anticipated ultimate load of the facility 10 or 20 years in the future. As growth occurs, additional chillers are added. The facility is still protected if a single chiller fails. N + 1 architectures also support a modular approach to infrastructure growth.

Minimizing the use of 2N reliability architectures is included in the "*Code of Conduct on Data Centres Energy Efficiency*.[40]."

#### 7.2.2.6 Class 5 Switch Consolidation

Wireline access line loss is accelerating, due to factors such as wireless substitution and adoption of IP based telephony. Therefore, many class 5 Time-Division Multiplexing (TDM) switches are poorly utilized. Consolidating switch modules will lower energy costs, lower cooling and DC power plant capacity requirements, and recover floor space.

**Proposed Action:** Reduce switch size by grooming circuits from remaining line & trunk cabinets, and power down de-loaded cabinets.

- Priority 1 – Single Switch locations
  - Target > 40K spare lines/trunks and < 50 percent utilization
- Priority 2 – Multi-Entity Switch locations.
  - COs with more than one switch where one switch can absorb the demand from another co-located switch.

#### 7.2.2.7 OSP Energy Efficiency

Similar to COs, many older OSP huts, Controlled Environmental Vaults (CEVs), and cabinets utilize older ferro-resonant rectifiers with the same energy efficiency characteristics described above.

**Proposed Action:** Replace energy inefficient DC power supplies throughout the OSP Network, targeting sites with:

- Ferro-resonant power supplies that are:
  - poorly utilized
  - at their end of service life
  - manufacturer discontinued
  - potential to recover 'real estate' for revenue generating equipment

[40] Joint Research Centre Renewable Energies Unit. Code of Conduct on Data Centres Energy Efficiency: European Commission, 2008.

### 7.2.3 BTS Wireless Access Network Energy Efficiency rating Reference Model

This section addresses high-level wireless access network energy efficiency rating model that can be used for estimating product energy consumption.

#### 7.2.3.1 Access Network Reference Model

The figure below depicts the wireless access networks, which includes GSM, Wide Band Code Division Multiple Access (WCDMA), cdma2000, WiMAX and Long Term Evolution (LTE) systems. LTE is the 4th Generation wireless network developed by the Third Generation Partnership Project (3GPP) to improve the Universal Mobile Telecommunications System (UMTS) mobile phone standard to cope with future technology evolutions. This model can be broken-down further to individual components to estimate the energy efficiency rating of the component.

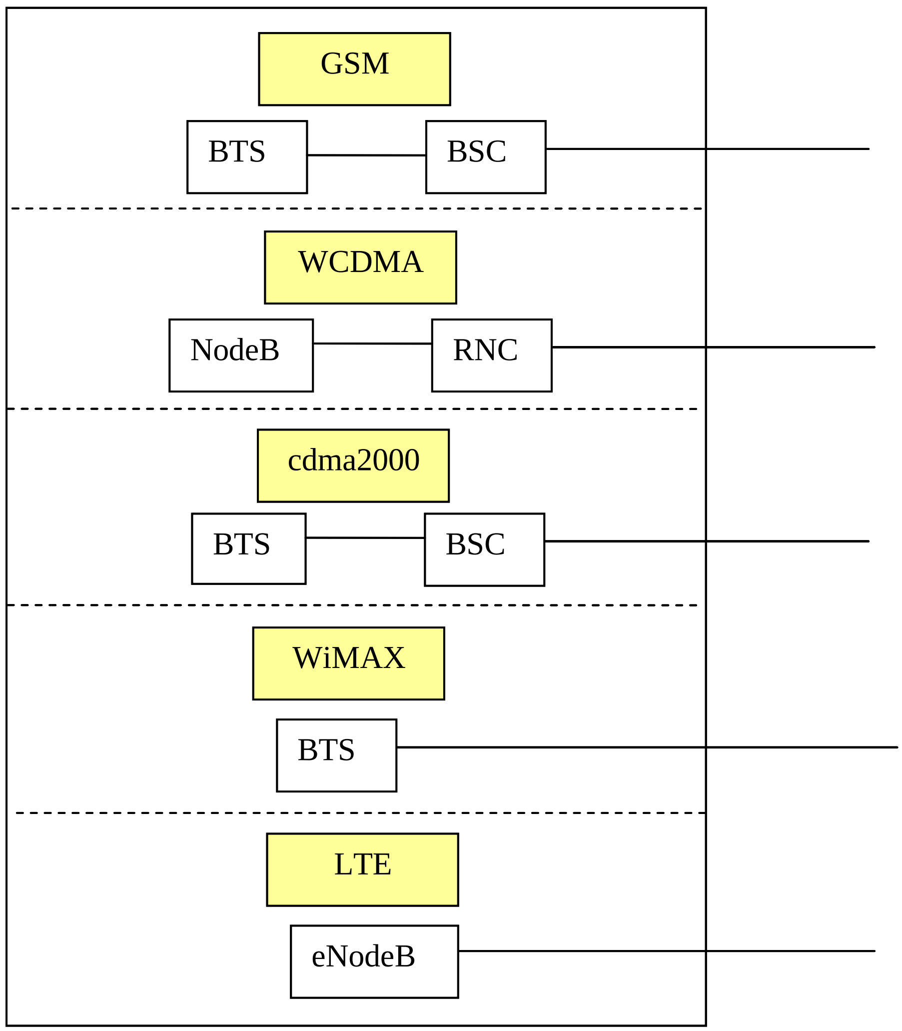


**Figure 21: Access Network Reference Model**

#### 7.2.3.2 Energy Efficiency Calculation Model

The figure below depicts specific steps for estimating wireless access network (specified in the figure above) energy consumption. The first step is to develop a traffic model that represents the average daily traffic behavior towards a given network. In addition, the performance parameter of the product must be gathered and ready to be used in mathematical equations to compute the energy efficiency rating of the product.

Performance parameters of an existing product in operation can be estimated based on data from the field. For a new solution however, or if significant changes have been made to a design, it is important to estimate the energy efficiency rating before any field data is available.

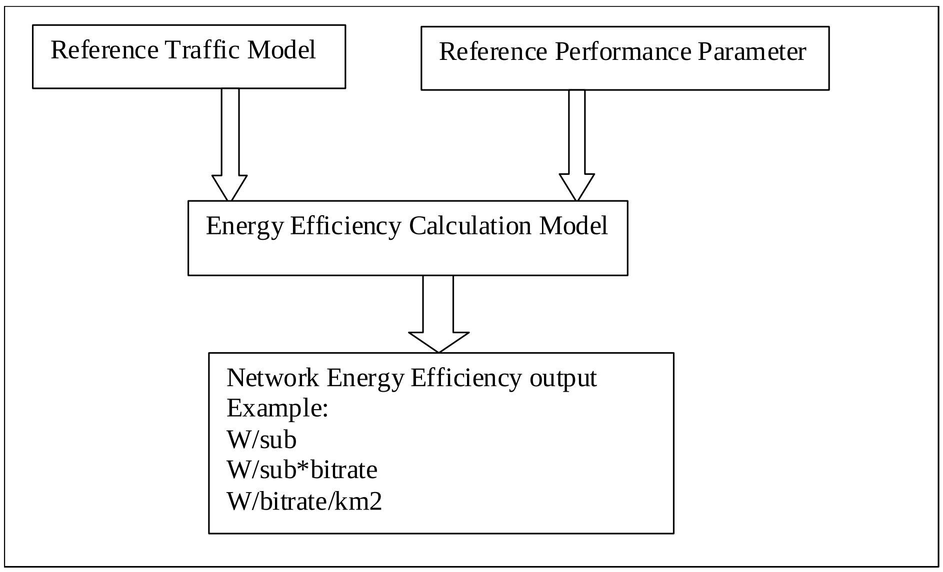


**Figure 22: Wireless Access Networks Energy Efficiency Calculation Model**

The Reference Traffic Model shall contain:

- Number of active users in the network
- Type of services the users are using
- Average number of attempts per user per service

The Reference Performance Parameter shall contain:

- Coverage performances and traffic handling capability of the system
- Site reference parameters (Power Supply, Cooling solution, Shelter solution and etc.)
- Product parameters (Number of Sectors, Frequency band, capacity, Bandwidth, and etc.)

Energy Efficiency Calculation Model shall contain:

- Calculation assumption and formulas
- Measured input values

The ETSI's EE group has developed Energy Efficiency measurement and calculation methods for Wireless Access Network Equipment.

#### 7.2.3.3 Energy Management of Wireless Access Networks

An array of technologies and techniques are available to reduce the energy consumption, by 30 percent or more, of wireless access network, especially the Radio Base Station (RBS) sites.

A number of energy management techniques can be deployed to improve the RBS energy efficiency:

- Shutting down redundant units or resources not needed during low traffic hours using sleep mode functions.
- Avoiding unnecessary DC/DC conversion typically saves about 15 percent in energy consumption and cost.
- An outdoor combined RBS and Battery Backup Unit (BBU) forms a streamlined site with a common cabinet/shelter that minimizes hardware and energy consumption.
- Remote power schemes, which enable several sites to be powered from one central point, as a result of advances in power transmission technology. The user sites could be RBS sites, handset charging stations or village power. The central site produces power using generator sets and distributes it to other RBS sites over specially-designed low-cost, copper-free cable in star, ring or chain configurations, over several tens of kilometers.
- On the infrastructure side, cooling costs can be reduced by optimizing air conditioner use or, preferably, by migrating to a more passive approach. These will reduce energy consumption and minimize the environmental impact.

### 7.2.4 Enterprise Equipment

Enterprises use ICT equipment both for running their offices and for conducting and operating their business. As such, enterprises can contribute toward the reduction of greenhouse gases in two ways: reducing the carbon footprint directly in the ICT equipment itself and also in its functions and activities as enterprises. The former consists of:

- In-building or campus telecommunications equipment, such as desk and mobile telephones, fax machines, PBX's, routers, switches, teleconference audio and video facilities such as cameras, monitors, Video Cassette Recorder's (VCR), Compact Disc (CD)/Digital Video Disc (DVD) players, etc.
- IT equipment and devices such as servers, computers, PCs and laptops, monitors, printers, data storage, chargers.
- Transportation fleets, such as corporate autos, jets, delivery trucks, etc.
- Motorized conveyer belts, automated processes, etc.

The latter consists of:

- Paper used for reports, letters, memos, records, etc.
- CD's, tapes, other recording devices.
- Participation in telecommunications network infrastructures which contain base stations, fixed stations, earth stations, IP routers, switches, mobile switching offices.

- Participation in commercial data centers.
- Facilities to enable tele-working of employees.
- Materials for production of goods and services.

It has been noted by numerous organizations that ICT equipment globally consumes about two percent of the global energy consumption. The use of ICT equipment in businesses and enterprises is likely to grow rapidly in both developing and developed countries; with a corresponding increase in its carbon footprint. Increased energy efficiency in the production and deployment of this equipment will thus have a direct benefit on the over-all environment. However, the greater benefit of the increased use of ICT equipment would be the multiplier effect obtained by enabling energy savings in fields such as transportation, power grids, assembly lines and other large scale operations requiring flexible load based management.

In order to progressively lead to reduction of greenhouse gases, Businesses and Enterprises must take the steps to reduce their own individual carbon footprint through the use of such advanced technology and processes as:

- Reduction of paper reports and memos.
- Use of reusable storage devices.
- Use of more energy efficient display devices rather than Cathode Ray Tubes (CRT's)
- Use of smart motors and variable speed drive control systems.
- Use of solar and other renewable energy resources for running their ICT equipment.
- Facilitating employee tele-working and telecommuting.
- Use of flexible fleet management, delivery services software and associated hardware.
- Encouraging IT partners to employ energy efficient techniques for data centers and networking equipment such as routers, switches, servers and storage devices.

The *SMART 2020* report estimates that ICT deployment could yield a five (5) times benefit in GHG emission levels through enabling abatement in other industry sectors by 2020. That is, although increased use of ICT will see its own absolute emissions rise from 0.5 to 1.4 $GtCO_2$ emissions by 2020, this will be abated by a reduction of 7.8 $GtCO_2$ emissions in other Sectors over this period. These efficiencies would be obtained in Sectors such as energy or power, transportation, manufacturing, real estate building management (mainly through more efficient load management) flexible deployment of resources and centralized control.

### 7.2.5 Home Networking and Communications Equipment

It is reasonable to assume that as the number of consumer electronic devices which are deployed in the home increases, more and more energy is required to support their use. It has been estimated that energy consumption by consumer electronic devices in the home amounts to approximately 15 percent of total residential electricity usage[41].

[41] Source: ENERGY STAR Factoid Worksheet for 2008, EIA Table 4_residential elec end use 2008, personal communication with John Cymbalsky at EIA (6/4/08), and "Energy Consumption by Consumer Electronics in U.S. Residences," Tiax, January 2007

It is not readily apparent that there is an all-encompassing view of the energy and environmental impact of home networking and communications equipment. Two entities that are addressing the issue are ENERGY STAR, and the Home Gateway Initiative (HGI) Energy Task Force.

#### 7.2.5.1 Home Networking Energy Entities

##### 7.2.5.1.1 ENERGY STAR

ENERGY STAR, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy, was originally developed in 1992 to promote energy-efficient computers. Since that time, the program has expanded to cover more than 35 different product groupings. Most of these groupings are outside the scope of Home Network devices – four of the exceptions are:[42]

- C*omputer/monitor* - penetration of ENERGY STAR compliant computers/monitors exceeds 97 percent (which is the highest penetration of any grouping in the ENERGY STAR program);
- *Televisions* - with an ENERGY STAR-compliant penetration of over 46 percent. This value is expected to increase dramatically with the replacement of older CRT-based televisions with newer, ENERGY STAR-compliant high definition televisions;
- *Set-top boxes* – estimated energy saving of 30 percent or more over STBs which are not ENERGY STAR compliant. Since most set-top boxes are given to consumers as part of their contract with a service provider, rather than sold independently at retail stores, it is incumbent on the service provider to provide an ENERGY STAR qualified set-top box ; and,
- *External power adapters* – ENERGY STAR qualified power adapters are often lighter and smaller in size, and on average are 30 percent more efficient than conventional models. Products with qualified adapters are identified with a special version of the ENERGY STAR label.

However, there still remain a large number of devices used in the home network that are not currently part of the ENERGY STAR program.

##### 7.2.5.1.2 Home Gateway Initiative Energy Task Force

Devices such as routers, modems, printers/scanners and other mobile devices are not included in the current ENERGY STAR efforts. The Home Gateway Initiative Energy Task Force[43] was created to look into the issues of defining operation states for customer premises equipment, as well as identifying targets for power consumption of each functional component of the home gateway.

The HGI Energy Task Force is currently working on specifying low power mechanisms that allow the home gateway to consume the minimum power corresponding to its current level of activity, by looking at the individual subcomponents and assessing the existing power

[42] U.S. Environmental Protection Agency: Energy Star, Energy Star – The Power to Protect the Environment Through Energy Efficiency (2003) 1-16. 30 March 2009 <http://www.energystar.gov/ia/partners/downloads/energy_star_report_aug_2003.pdf>.

[43] The Home Gateway Initiative, originally founded by nine telecom service providers in 2004, is a global organization whose main tasks are to establish home gateway-related technical and interoperability specifications and provide input to standardization bodies (ITU-T, ETSI, DLNA, DSL Forum, WiFi Alliance among others).

modes, and evaluating the implementation of additional low power modes. The work of the HGI on energy efficiency also extends deeper into the home network and involves the home gateway's unique role as an "always on device" which can be used to coordinate home automation.

#### 7.2.5.2 Consumer Electronics Recycling and Reuse

Consumer electronics recycling and reuse is a major issue. Recycling of residential electronic waste (electronic equipment, batteries) appears to be an initiative on a local level and accessibility to electronic waste recycling seems to vary considerably. Some computer manufacturers have also developed recycling/reuse programs for personal computers and peripherals when replaced by the purchase of newer models. Further information can be accessed on their web sites.

Another source of waste, lithium batteries – which are used to power many consumer electronics devices - also require additional consideration on disposal so as not to pose an environmental hazard in community landfills. Many retail outlets that carry these devices also provide a means for proper disposal of these batteries, but it is unclear as to the success of these efforts.

#### 7.2.5.3 Home Energy Management

The introduction of "Smart" appliances into the home provides another avenue for the residential user to impact energy usage. Smart metering, as managed by a home network, is expected to have a significant positive impact on residential energy usage. At present, however, these devices are currently part of a number of trials underway nationally and not deployed in large enough numbers by the majority of the population to significantly impact energy consumption.

#### 7.2.5.4 Considerations

Recent work by the recently completed ATIS Technology and Operations Council (TOPS) Home Networking Focus Group identified two areas regarding Home Networking and Energy Consumption that they felt needed to be addressed:

- *Sleep States of Consumer Premise Equipment (CPE)* – Coordination of sleep state behavior is immature from a standards perspective. This could result in a lack of interoperability as a result of differences in how protocols handle behavior in sleep states in user devices is implemented.
- *Different Energy Allowances* – standardization issues will be prevalent if Europe, Asia and USA come up will power level requirements that are different and/or take a different approach on how to specify energy saving requirements that devices will need to meet.

The recently-created ATIS Home Networking (HNET) Forum is expected to investigate the need for global coordination on activities ongoing in other standards organizations related to both of these identified gaps. If needed, the ATIS HNET Forum has been identified as the body which will develop sleep state level and power level requirements for home networking devices.

The ATIS Exploratory Group on Green supports these initiatives within the mandate of the ATIS HNET Forum.

# 8 APPLICATIONS AND SERVICES

There are numerous ways in which ICT technologies, tools, and methods can be deployed to reduce GHG emissions, both in the ICT industry itself and in other industries that have a large carbon footprint – especially transport and power. Clearly, a major impact will come from the production of energy efficient devices and systems – both from improving the efficiency of the fundamental technologies (e.g. integrated circuits) and from an intelligent approach to their usage (e.g. 'always-available' rather than 'always-on' networks).

Many of the efficiency measures come from the availability and usage of the right information, in the right place, at the right time. Particularly in the case of smart buildings, smart logistics and smart grids; this information enables each industry to maximize its use of energy hungry resources. For example, even if we never see the advent of 100 percent usage of electric vehicles, we can still reduce climate change through a severe reduction in the number of vehicle miles.

A global, real-time information network can ensure this level of energy efficiency. It will need networks and IT systems; appropriate devices and equipment both within and at the edge of the network; and a global data model to ensure consistency throughout its deployment. Supporting this information network will need to be a high performance network and IT infrastructure (which in itself can also enable the increased use of dematerialization).

## *8.1 ICT Role in Enabling a Low Carbon Economy*

There have been numerous studies conducted on the role of ICT with respect to environmental sustainability. *Appendix C: Overview of Studies* covers a number of these studies including the *SMART 2020* report that highlights the conflicting effect that the increased use of ICT has on the planet. On the one hand, ICT contributes to the growth of the world economy. It does so in two ways:

1) Directly, in that ICT has been one of the more recent growth industries. E.g. globally, the ICT sector contributed 16 percent of Gross Domestic Product (GDP) growth from 2002 to 2007, and the sector itself has increased its share of GDP worldwide from 5.8 to 7.3 percent. Furthermore, the ICT sector's share of the economy is predicted to jump to 8.7 percent of GDP growth worldwide from 2007-2020.
2) Indirectly, in that the use of ICT enables other areas of the economy to grow. Recent analysis suggests that one third of the economic growth in the OECD between 1970 and 1990 was due to fixed-line telecoms networks alone, which lowered transaction costs and helped firms to access new markets.

On the other hand, with increased usage of ICT come increased GHG emissions, mainly from the increased use of electricity required to power ICT devices, networks and systems. The ICT industry must strive to maintain the link between usage and economic growth but must reduce its own carbon footprint in order to break the link between use of ICT and climate change.

However, there are also opportunities for ICT to be used in a number of industries (some of which have a large carbon footprint) to reduce GHG emissions. The *SMART 2020* report highlights that, through the use of ICT solutions in buildings, transport, power, and manufacturing industry, ICT can reduce GHG emissions by 7.8 Giga-tonne of Carbon Dioxide emissions ($GtCO_2e$) by 2020. This is in contrast to the projected GHG emissions from the ICT industry of 1.4 $GtCO_2$ emissions by the same time. *Appendix D: Key ICT Environmental Factoids* presents other potentials for ICT.

The *SMART 2020* report is so named because it highlights five ways in which this carbon abatement can be accomplished:

- *Standardize*: ICT can provide information in standard forms on energy consumption and emissions, across sectors.
- *Monitor*: ICT can incorporate monitoring information into the design and control of energy use.
- *Account*: ICT can provide the software tools and platforms to improve accountability of energy and carbon.
- *Rethink*: ICT can offer new innovations that, if considered during the design phase of buildings, roads and other infrastructure can change our current ways of living.
- *Transform*: ICT can apply smart and integrated approaches to energy management of systems and processes, including benefits from both automation and behavior change.

The *SMART 2020* report has looked at five specific areas of carbon abatement: dematerialization, smart motors, smart buildings, smart logistics, and smart grids.

### 8.1.1 Dematerialization

Dematerialization refers to replacement of something physical with its digital equivalent, (e.g. a CD replaced by digital music, or a real meeting replaced by a video conference). Dematerialization can be applied to a range of current everyday practices and ultimately reduces the number of material objects that need to be produced. Examples of applications and services include:

- Integrated communications and messaging; audio and video conferencing; telepresence.
- E-health; patient records; remote care, consultations and surgical procedures; imaging.
- Telecommuting; virtual call centers; virtual operations; remote education.
- Online media; e-banking; online shopping; Business to Business (B2B), Business to Consumer (B2C), Citizen to Government (C2G) commerce and interactions.

Note: the use of applications and services such as those listed above are directly applicable to the ICT industry itself. For example, integrated communications, telecommuting, etc have the opportunity to make people in the ICT industry more productive without the need to travel or to produce physical items (such as documents) as part of their work.

Dematerialization has the ability to reduce annual global emissions by up to 500 $MtCO_2$ emissions by 2020.

### 8.1.2 Smart Motors

Motor systems lie at the heart of manufacturing industry, converting electricity into mechanical power. Most systems in place are highly inefficient, having been designed and constructed before climate change became a serious issue. Rising carbon emissions as a result of energy used by the growing manufacturing sector in regions like China and India are further exacerbated as most of the electricity required will be generated using carbon-intensive coal-fired power stations.

A 'smart motor' is one controlled to adjust its power usage according to its required output, usually through a variable speed drive or an intelligent motor controller. ICT's main role will be to monitor energy use and provide data to businesses so they can make energy and cost savings through changes in manufacturing systems. This data may also be useful for organizations setting standards for motor system efficiency. Simulation software is required to help improve plant and manufacturing process design. Wireless networks that allow inter-machine and system communication, would improve efficiency across an entire factory.

Examples of applications and services include:

- Monitoring of energy consumption and energy savings, including a central repository of energy consumption data
- Transfer of energy consumption data to local and central governments for regulatory compliance
- Database collection of energy audits integrated with business software
- Optimization of motor systems and wider industrial systems through using information on required output of motor system
- Simulation of systems by plant designers and operators
- Manufacturing process design technology
- Wired/wireless communications between systems and their controllers
- System intelligence and integrated control of devices across the plant and the wider business, including integration with sales and logistics interoperability

The use of smart motors has the ability to reduce annual global emissions by up to 970 $MtCO_2$ emissions by 2020.

### 8.1.3 Smart Buildings

The term 'smart buildings' describes a suite of technologies used to make the design, construction and operation of a building structure more efficient. These might include building management systems (BMSs) that run heating and cooling systems according to occupants' need or software that switches off all devices after everyone has gone home. Data from BMSs can be used to identify additional opportunities for efficiency improvements.

Examples of applications and services include:

- Occupancy-based heating, cooling, ventilation and lighting
- Monitoring and simulation of building energy efficiency
- Remote building management, operation and maintenance
- Energy modeling from design through building use
- Provide inter-building systems to improve energy efficiency across campuses, business parks, housing areas, shopping malls, etc.
- Design and build environment systems that link the efficient use of transport systems to the use and occupancy of buildings
- Telecommuting and collaborative technologies to reduce need for office space
- Appliance interconnectivity and networking and remote appliance control
- Deployment, operation and maintenance of energy generation systems (e.g. photovoltaic energy supply, wind power, etc)

The buildings industry is historically slow to implement new technology - a 20-25 year cycle for residential units and a 15-year cycle for commercial buildings are typical. Added to this is an unclear business case for investing in energy efficiency: energy consumption is a small part of building cost structure yet building automation costs can be high and payback periods are often long.

Note: the use of applications and services such as those listed above are directly applicable to the ICT industry itself. Data centers, network centers, office buildings and other areas where ICT people work can all benefit from SMART designs in which the use of those workplaces are optimized for reduced carbon emissions.

The use of smart buildings has the ability to reduce annual global emissions by up to 1.68 $GtCO_2$ emissions by 2020.

#### 8.1.4 Smart Logistics

Global goods transport is growing rapidly, driven by globalization and an increasing demand for products across the developed and developing economies. The logistics of this vast operation (including packaging, transport, storage, purchasing and waste management) are inherently inefficient. Many vehicles often carry little or nothing on return journeys. As fuel costs rise, the need to run more efficient logistics operations is becoming an increasing concern. 'Smart logistics' comprise a range of systems that monitor, optimize and manage the operation of this global supply network.

ICT can improve the efficiency of logistics operations through the deployment and operation of a global, real-time information network that matches supply and demand, and makes the most efficient use of the logistics infrastructure. Many of the measures discussed in smart logistics have tended to concentrate on the use of road transport. However, large climate change gains can be made through the application of ICT to air and shipping logistics as well and many of the measure proposed are common to all types of transport.

Examples of applications and services include:

- Tag and track inventory, stock and other items and assets throughout the supply chain.
- Track terrain and information for understanding of optimal routes.
- Information systems to provide the driver/pilot with real time information about the efficiency and behavior and both the supply infrastructure and route networks.
- Increase communication between devices, and between logistics providers and suppliers.
- Optimize and control inventory to reduce journey numbers.
- Model and optimize distribution network design throughout supply chain design.
- Track efficiency of supply against business performance.
- Transform load management systems to identify unused capacity within the supply chain.
- Reverse logistics to allow the back-loading of supply routes on the network and for the return of un-delivered goods to the supplier.
- Collaborative planning, forecasting and replenishment systems
- Electronic Freight Exchanges to allow for the 'auction' of spare space

Most of the freight market is fragmented, which creates natural inefficiencies and hampers capital investment in energy efficiency technologies. Inefficiency and a lack of industry standards prevent interoperability between the many different systems that currently exist within the industry. Added to this are some anti-competition regulations prevent cooperation between companies.

Note: the use of applications and services such as those listed above are directly applicable to the ICT industry itself. Most ICT companies have supply chains that involve both the receipt and dispatch of goods that are either particular to the provision of ICT goods and services or are typical of most companies engaged in business. Some will also have their own dedicated fleet of vehicles that can benefit from measures that reduce the number of wasted miles traveled.

The use of smart logistics has the ability to reduce annual global emissions by up to 1.51 $GtCO_2$ emissions by 2020.

#### 8.1.5 Smart Grids

Current centralized energy distribution networks are often huge, inefficient grids that lose power in transmission, require an overcapacity of generating capability to cope with unexpected surges in energy use, and only allow one-way communication — from provider to consumer.

A smart grid is a set of software tools that enable generators to route power more efficiently, reducing the need for excess capacity, and allowing two-way, real-time information exchange with their customers for demand-side management. It improves efficiency, energy monitoring and data capture across the power generation, transmission and distribution network. ICT has the opportunity to provide the information network required to make smart grids a reality.

Examples of applications and services include:

- Development and deployment of an information network that provides a real-time, demand-side management system for power grids.
    - Provides information for both consumers and producers of power
    - Enables remote monitoring, management, maintenance and operations
    - Enables better planning and forecasting
- Support for and integration of renewables and distributed generation
- Smart meters
- Asset inventory and network design systems (e.g. GIS tools)
- Workflow management systems for the grid
- Demand-response software that allows automated load maintenance
- Protocols for grid wide system interoperability
- Advanced communications to allow distributed energy producers to pool resources, and to handle variations in supply and demand

Note: the use of applications and services such as those listed above are directly applicable to the ICT industry itself, particularly in the use of power by ICT companies. That usage can be linked to those responsible for power provision to enable a more efficient grid. In addition, some ICT companies are sited on business parks in which the supply and distribution of power is a major consideration. The application of SMART grid applications can make such parks as efficient as possible. Moreover, a number of ICT companies are in the process of installing energy generation capability either from wind or solar power. There is the need therefore to marry this provision with that from the power companies and to ensure that maximum use is made of these secondary sources (including the feed of excess power into the national grid).

The use of smart grids has the ability to reduce annual global emissions by up to 2.03 $GtCO_2e$ by 2020.

# 9 PRODUCT DEVELOPMENT AND LIFECYCLE ASSESSMENT

Environment conscious design guidelines to foster product *life cycle thinking* and *best practices* to minimize environmental impact, address regulatory mandates, and customer and company requirements for environment conscious design are presently being adopted by some ICT companies. To the extent possible, internal company guidelines in support of these initiatives are based on existing specifications such as the IEC TC-108 and TC-111, and the ECMA-341 (2nd Edition, December 2004) standards.

In striving to make products environmentally responsible, designers place a strong focus on:

- Optimizing materials choices – minimize their material diversity and volume
- Reducing energy consumption and increasing design options for use of renewable energy sources in products
- Maximizing reuse and recycling

Focus is also given to following requirements regarding the use of certain substances such as:

- Banned (e.g., asbestos, ozone depleting substances, mercury, etc.)
- Restricted (e.g., those in the EU RoHS directive, sulfur hexafluoride, etc.)
- To be avoided (e.g., arsenic & compounds, perchlorate, etc.)
- Tracked (e.g., EU Registration, Evaluation, Authorization and Restriction of Chemical (REACH) substances, nickel, etc.)

### *9.1 General Development Principles*

When establishing guidelines, topics included should cover the following:

- Product Lifetime
- Energy Efficiency
- Electromagnetic Environment
- Acoustic Noise Emissions
- Substance Content – Material Restrictions
- End of Life / Disassembly
- Batteries
- Product Packaging/Packing

Tools and methods should also be established to help designers/developers in implementing these principles, along the different steps of the Product Lifecycle:

- *Eco-roadmap* (planning, pre-development): provide an outlook on future changes in product related eco-environmental requirements covering developments in legislation, standards, customer requirements and internal goals (5 year visibility)
- *Eco-requirements* (countries, customers): provide the current eco-environmental requirements for a particular country or countries where a product may be sold
- *Eco-design guidelines and checklist:* implement during the design and implementation based on standards (such as ECMA-341), these documents address regulatory, customer and requirements for environment conscious design. Checklist helps to ensure that designers use relative information during product design.
- *Eco-declaration* (validation/limited deployment/general availability): consider providing information on the eco-environmental aspects of products
- Recycler/Treatment Information (validation/limited deployment/general availability): implement control measures regarding substance content in products and packaging purchased or uses in finished products and operations, as well as the products for which the design and/or manufacturing is contracted.

### 9.2 *Lifecycle Stages of ICT Products*

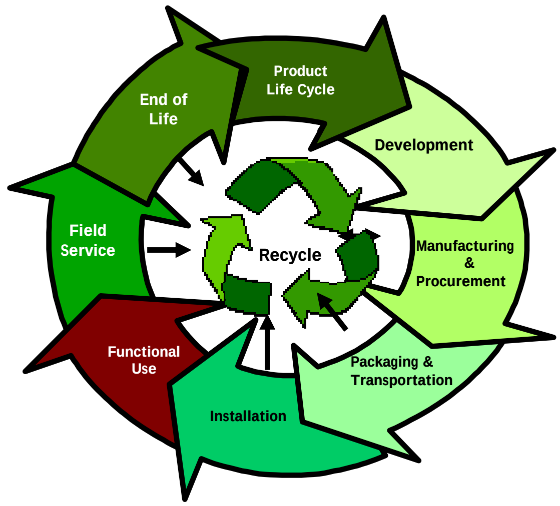


**Figure 23: Eco-environmental Lifecycle Stages of ICT Products**

Designing telecommunications products for reduced environmental impact requires full consideration and thorough knowledge of a product's eco-environmental aspects over its life cycle stages. These impacts include for example GHG emissions (e.g., via offsite electrical power production), heavy metals dispersion, summer / winter smog, generation of carcinogenic contaminants, and contaminants that cause waterbody eutrophication. The goal of eco-environmental life cycle thinking is to minimize eco-environmental impact by producing high value products and services relative to the resources needed to produce, operate, and recycle them.

Previous studies within the ICT industry have shown that throughout a product's lifecycle stages (Figure 23 illustrates the elements that go into the concept of a product life cycle) a network product's long usage phase (typically 15 to 20 years) consumes substantial amounts of energy, which subsequently produces the majority of its total impact to the environment. Although a LCA is a necessary tool in determining the significant environmental aspects of a product, there still remains considerable difficulty for designers to assess the best possible combination of technical performance, longevity, and eco-environmental impact minimization. Also, only limited data from LCAs has been included in product declarations to customers, and comparisons between companies have been minimal because inputs, assumptions, and methodologies have not been standardized across the industry. The following standards bodies have produced references and guidance on this subject.

- International Electrotechnical Commission Standard: IEC 62430 "Environmental Conscious Design for Electrical and Electronic Products and Systems"
- International Electrotechnical Commission Standard: IEC 62075 "Audio/Video, information and communication technology equipment – environmentally conscious design"
- International Standards Organization: ISO TR 14062:2002 "Environmentally Conscious Design - Integrating Environmental Aspects into Design and Development of Electrotechnical Products" (also named IEC Guide 114:2005)

- ETSI TR102530 (WI: DTR/EE-00002): "Reduction of Energy Consumption in Telecommunications Equipment and Related Infrastructure"

### 9.3 Reduce, Reuse, Recycle

| The three R's should permeate the decision making process for a range of business functions, consumption and generation activities. | | | |
|---|---|---|---|
| **Product** | **Process** | **Operations** | **Services** |
| Components | Specification | Consumption | Professional Services |
| Systems (hardware) | Procurement | Generation | Information, Communications and Technology Services (software) |
| Architecture (hardware) | Management | Fixed Assets | Civil and Commercial |
| Manufacturing | Systems (software) | Mobile Assets | |
| Supply Chain | Architecture (software) | Provisioning Human | |
| | | Asset Resources | |

**Table 3: Reduce, Reuse, Recycle**

## 10 SUSTAINABLE ENERGY

According to the U.S. Department of Energy, the average cost of electricity in 2008 across all sectors (i.e., residential, commercial, industrial) was 9.78 cents per kWh; up from 9.18 cents/kWh in 2007, and 8.96 cents/kWh in 2006[44].

The *Annual Energy Outlook 2009*[45] (AEO2009) report released in December 2008 by the Energy Information Administration[46] (EIA) reports updated projections for U.S. energy consumption and production through 2030. In the report, in which it assumes no changes in current laws and regulations, AEO2009 reference case projections include:

- Coal, oil, and natural gas meet 79 percent of total U.S. primary energy supply requirements in 2030, down from an 85 percent share in 2007.
- Total domestic production of natural gas reaches 23.7 trillion cubic feet by 2030. While exploration and production costs rise over time, higher natural gas prices support the projected level of production. Onshore production of unconventional natural gas, including shale gas, increases from 9.2 trillion cubic feet in 2007 to 13.2 trillion cubic feet in 2030.
- Ethanol use for gasoline blending grows to 12.2 billion gallons and E85 consumption to 17.3 billion gallons in 2030. The ethanol supply from cellulosic feedstocks reaches 12.6 billion gallons (including both domestic and imported production) in 2030. Biodiesel and biomass-to-liquid diesel fuel use both rise significantly, reaching nearly 2 billion gallons and 5 billion gallons, respectively, in 2030.

[44] "Summary Statistics for the United States." Energy Information Administration: Official Energy Statistics from the U.S. Government. 1 April 2009 <http://www.eia.doe.gov/cneaf/electricity/epa/epates.html>.
[45] Energy Information Administration. Annual Energy Outlook 2009: Department of Energy, 2008.
[46] "Home." Energy Information Administration: Official Energy Statistics from the U.S. Government. 28 February 2009 < http://www.eia.doe.gov/>.

- Total electricity consumption, including both purchases from electric power producers and on-site generation, grows from 3,903 billion kilowatthours in 2007 to 4,902 billion kilowatthours in 2030.
- New natural gas and renewable plants account for the majority of generating capacity additions. The natural gas share of electricity generation remains between 19 percent and 22 percent through 2030. Coal's generation share declines from 49 percent to 45 percent between 2007 and 2025, then rebounds slightly to 47 percent in 2030 as a small number of new coal plants are added.

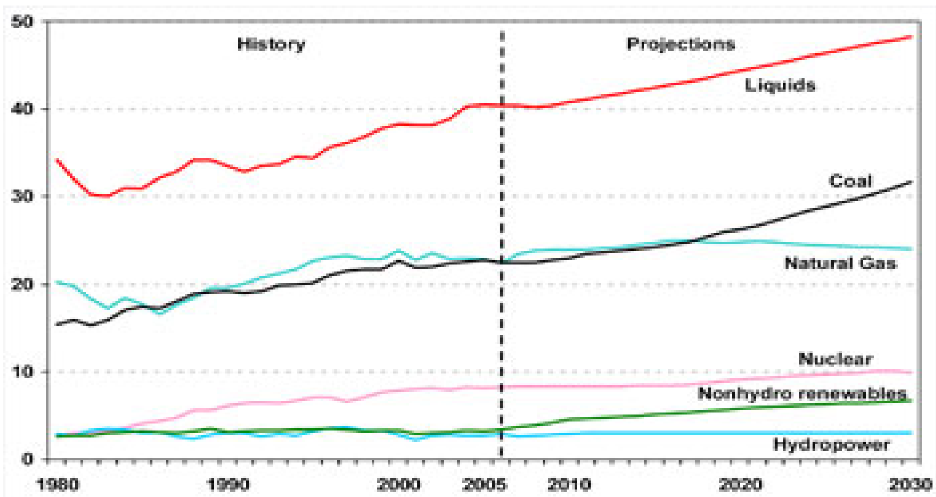


**Figure 24: U.S. Energy Consumption by Fuel (1980-2030) (quadrillion Btu)**

In the *International Energy Outlook 2008*[47] *(IEO2008*) report, it is stated that if the growth of world CO2 emissions continues unabated, the concentration of carbon dioxide in the Earth's atmosphere could reach 560 parts per million (ppm) by the middle of the 21st century; in 2008, the concentration level was about 380 ppm. To address this concern, *IEO2008* outlines several options that could be expected to mitigate 1 billion metric tons or more annually by 2030:

- Reductions in energy demand growth
- Increases in nuclear electricity generation
- Increased use of nonhydropower renewables for electricity generation in the OECD economies.
- Increased use of hydropower and nonhydropower renewables for electricity generation in the non-OECD economies
- Increased use of renewable fuels for transportation
- Carbon capture and storage
- Anthropogenic sequestration

[47] Energy Information Administration. International Energy Outlook 2008: Office of Integrated Analysis and Forecasting and U.S. Department of Energy, September 2008 < http://www.eia.doe.gov/oiaf/ieo/pdf/0484(2008).pdf>.

To reduce operating cost in conjunctions with $CO_2$ emission levels caused by the generation of electricity using fossil fuel, today alternative sustainable sources are being investigated as a supplement source of energy. Provided in the following section are several alternative sources being considered in the ICT sector.

## *10.1 Use of Alternative Energy Sources*

### 10.1.1 Solar Power

Solar power (i.e., photovoltaic (PV)) has very minimal environmental impact and it can be used to provide high-energy efficiency for low- and medium-capacity sites, or repeater sites. Solar power is a mature technology and has been used to power RBS sites for many years.

AT&T Silver City Radio Site as it appears today
Fuel Costs are negligible – Emissions near Zero – Reliability is Outstanding

**Figure 25: Solar Power Example**

Apart from having very low environmental impact, solar-powered sites also have the advantage of being low maintenance, with a warranted lifetime of 25 years. Solar power has a proven track record of reliability.

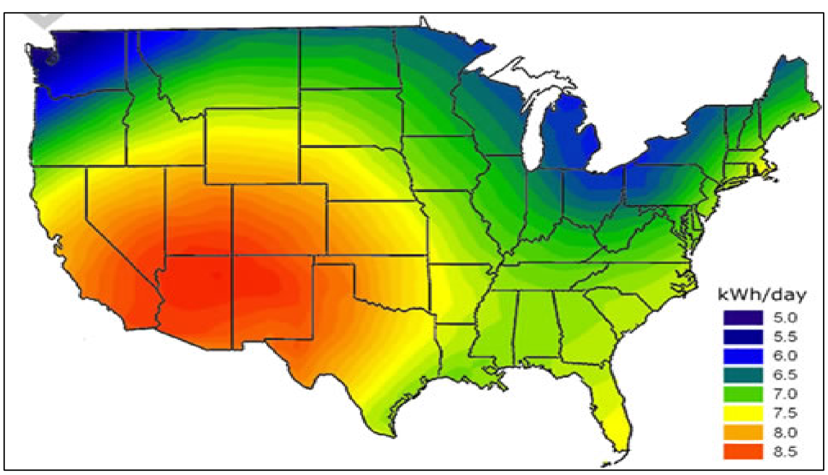


**Figure 26: Energy Production for a Typical 2 kW PV Array (Source: Florida Solar Energy Center FSEC-PF-380-04)**

Site selection is critical to the success of any PV array. Shade, even something as minor as a flag pole, can negatively impact the output of a PV array. An analogy is water running in a garden hose. Step on the garden hose. Even though only 6″ of the 50′ hose is being stepped on, significantly less water flows. Shade, even on a single panel, has a similar effect on the current produced by the PV array. A clear view of the southern and southwestern sky is critical.

For roof mounted PV arrays, the condition of the roof is important. It is foolish to deploy solar on a roof that is scheduled to be replaced in the next 5 years. Better to wait until the roof is replaced, and then deploy the PV array. Non-penetrating roof mounts should be pursued for telecommunications facilities, to eliminate the possibility of causing a leak and to facilitate panel removal and re-installation when the roof requires repair.

Tax incentives and rebates can improve the economics of PV. As previously noted, the DSIRE is a comprehensive source of information on state, local, utility, and federal incentives that promote renewable energy and energy efficiency.

Grid Tied refers to PV installations that work in unison with the commercial AC utility grid. Net metering programs serve as an important incentive for consumer investment in renewable energy generation. Net metering enables customers to use their own generation to offset their consumption over a billing period by allowing their electric meters to turn backwards when they generate electricity in excess of demand. This offset means that customers receive retail prices for the excess electricity they generate. Alternatively, a second meter can be installed to measure the electricity that flows back to the provider, with the provider purchasing the power generated at a tariffed rate.

### 10.1.2 Wind Energy

Wind energy is renewable, clean, and reduces GHG emissions when it displaces fossil-fuel-derived electricity. Therefore, it is considered to have less environmental impact than many other energy sources.

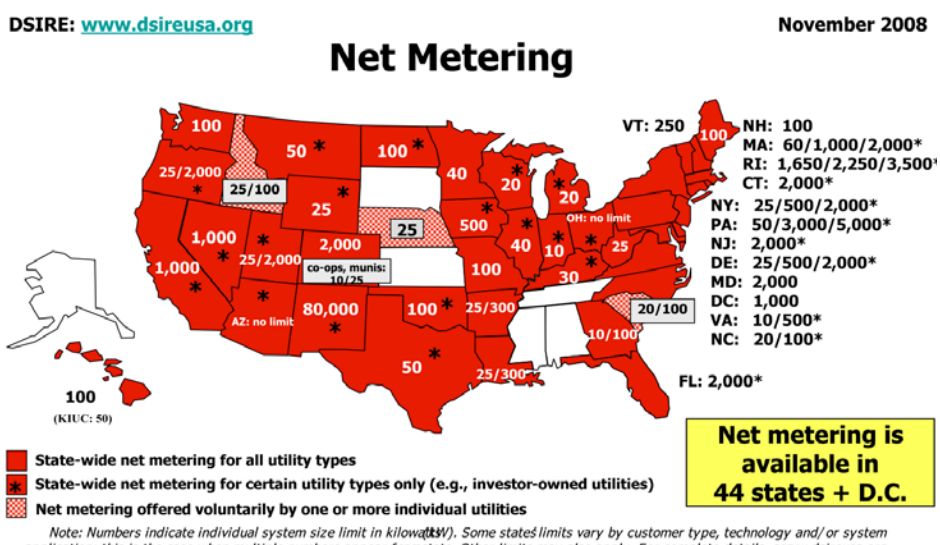


**Figure 27: Net Metering Wind Power**
**(Source: DSIRE)**

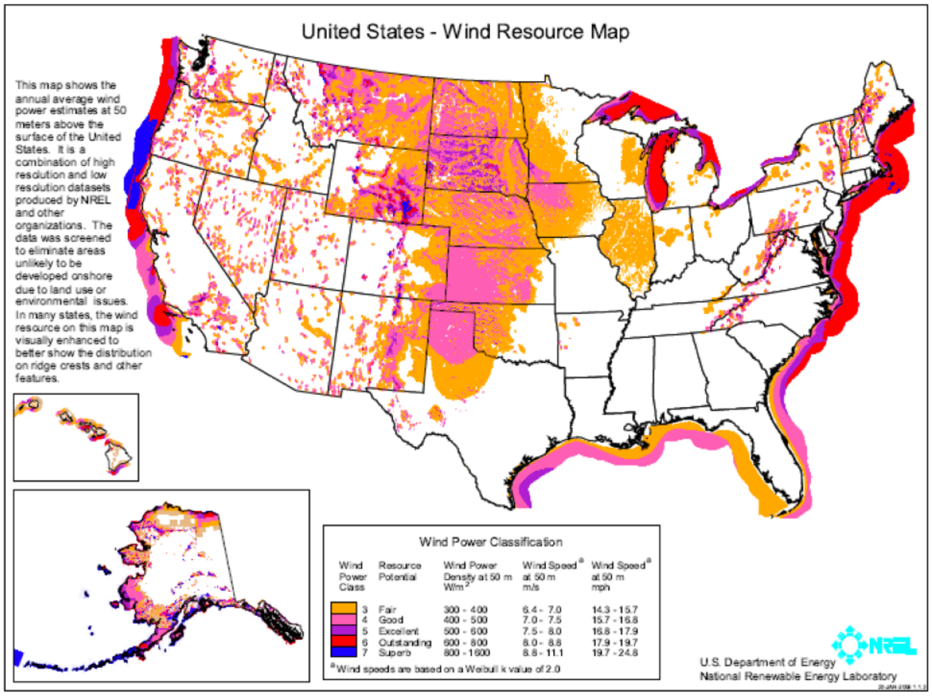


**Figure 28: United States – Wind Resource Map**
**(Source: U.S. Department of Energy, National Renewable Energy Laboratory)**

As with solar power, wind power can provide virtually free energy. The wind power industry is, however, moving towards very large wind turbines, and the challenge is to find a cost-effective solution for telecommunications sites.

Maintenance is higher with wind turbines than PV arrays, and warranties offered by manufacturers are minimal.

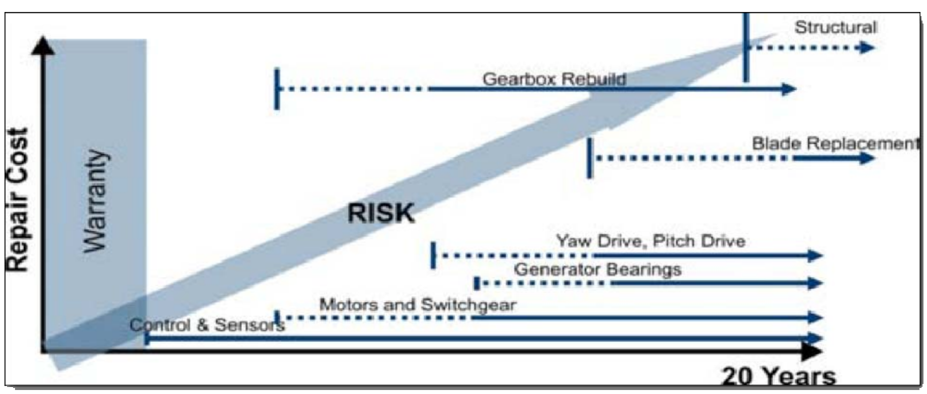


**Figure 29: Wind Turbine Life Expectancy**
**(Source: U.S. Department of Energy, National Renewable Energy Laboratory)**

The big advantage of wind power is that a turbine can support a traditional macro RBS site without too large an impact on cost. On the downside, there is the erratic nature of wind, which means that the site must be grid tied or, if off grid, equipped with a small diesel generator or other power source. Currently, wind power also demands extra site space, because of the need for an extra mast or tower to house the wind turbine.

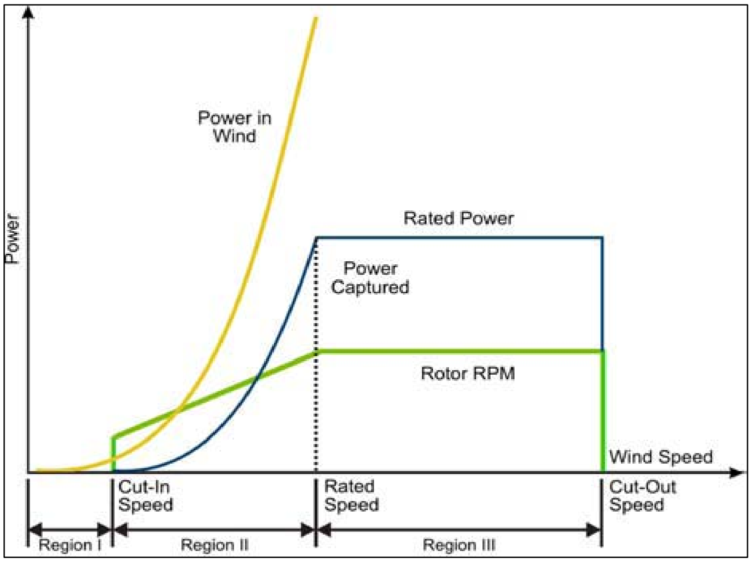


**Figure 30: Typical Wind Turbine Output Power versus Wind Speed (Source: U.S. Department of Energy, National Renewable Energy Laboratory)**

### 10.1.3 Fuel cells

Fuel cells are increasingly being considered as a viable alternative site energy solution for telecoms. They are highly reliable and efficient, and have the advantage of being scalable, which means sizing is not an issue, other than for hydrogen storage. Fuel cells can be deployed in place of diesel generators, and partly replace batteries, at remote sites with long back-up requirements. In addition to improving energy efficiency, they can also improve network up-time and reliability. Currently, fuel cells provide an alternative to battery banks and diesel generators for back-up purposes in markets with a stable power grid.

### 10.1.4 Biofuels

Biofuels include fuels such as biodiesel, vegetable oils, ethanol, methanol, biogas and other fuels derived from biomass. The fuel biodiesel can be produced from a number of feed-stocks including cold-pressed vegetable oils (primarily soy), waste vegetable oils (used frying oils from restaurants), animal fats, and fish oils.

The environmental benefits of biodiesel include:

- Reduction in emissions of carbon dioxide and sulfur dioxide, and a reduction in particulate matter and hydrocarbons, as a result of cleaner burning.
- Free of lead and sulfur, non-toxic, and bio-degradable within a matter of 21 days if spilled.
- Biodiesel is a natural solvent, which can assist with cleaning the engine.

2007 was a record year for U.S. production of biodiesel, approximately 450M gallons. Two thirds of U.S. production is exported, primarily to Europe. Heating oil, trucking industry, and fleet vehicles are the primary users. 2008 demand has dropped, due primarily to rising prices. The cost for B100 (pure biodiesel) in August 2008 was approximately $6/gallon[48].

[48] Wesley, Dean. "Biodiesel Backlash - What are the Major Factors and Where Do We Go From Here?." Frost & Sullivan 14 August 2008.

The environmental cons of biodiesel include:

- Feedstock issues – cost of soy doubled in 2008
- Questions regarding the environmental soundness of ethanol and biodiesel
- Production may be driving up food prices across the world

Biodiesel must meet either the EN 14214:2003 or American Society for Testing and Materials (ASTM) D6751 quality standard. Note that some biodiesel producers do not follow these standards – it is a "buyer beware" environment.

It is important to note the difference between pure biodiesel, and a biodiesel blend. For biodiesel blends, the DOE and ASTM D6751 have designated the nomenclature "Bxx", where xx is the percentage of biodiesel (for example, blends up to 20 percent (B20) is 20 percent biodiesel, B02 is two percent).

In order to comply with EPA ultra low sulphur diesel (ULSD) requirements, many refineries / distributors are adding up to two percent biodiesel blend (B02) to No. 2 diesel. Two percent Biodiesel improves the lubricity and is harmless to diesel generators.

B20 will work in diesel vehicles and generators without modifications, but there are concerns regarding long term storage, cold weather performance (higher cloud point temperature), algae growth, warranty voidance, and other factors. B20 has been used successfully in telecommunications facility standby generators after Hurricanes Katrina, Gustav, and Ike, when No. 2 diesel and B02 were unavailable. Use of B20 will require more frequent fuel filter replacement, in addition to other changes in maintenance routines.

Higher blend levels, such as B50 or B100, require special handling and fuel management and may require equipment modifications such as the use of heaters or changing hoses, seals, and gaskets that come in contact with the fuel. Use of these blends will void the manufacturer warranty. Their use in a telecommunications standby generator is not recommended.

The following table summarizes usage of biodiesel blends in Fleet and ICT facility standby generator applications:

| Biodiesel Blend | Fleet and Standby Generator Usage Recommendation |
|---|---|
| None (No. 2 Diesel) | Yes |
| B02 (2% blend) | Yes |
| B05 to B20 (5% to 20% blend) | See special handling instructions described in DOE "Biodiesel: Handling and Use Guidelines" and "Technical Recommendations for B20 Fleet Use Based on Existing Data", B20 Fleet Evaluation Team, June 2005. |
| > B20 (greater than 20% blend) | No |
| B100 (pure biodiesel) | No |

**Table 4 : Biodiesel Blend Usage Recommendation**

# 11 CORPORATE OPERATIONS CONSIDERATIONS

Operations within an ICT company's corporate facilities and those programs which enable it to provide services can also be assessed to identify energy saving and greenhouse gas reduction opportunities and can create an additional avenue to develop or enhance environmentally sustainable practices.

Some of the key corporate facilities and programs may include fleet management, procurement/supply chain and administrative/operations management.

## *11.1 Fleet Management*

Implementation of environmentally sustainable considerations with respect to the management of an ICT's fleet can lead to fuel and GHG reduction. Examples of such considerations include:

- Use of alternative energy/fuel vehicles which may utilize biofuels, compressed natural gas or even hydrogen. These fuels in most cases generate less greenhouse gas emissions than standard fuel options.
- Employing hybrid vehicles, which have a higher mile per gallon rating than most standard vehicles, and can reduce the fuel consumption of a fleet. However, hybrid vehicles in most cases require a longer return on investment (ROI) because of their higher initial costs. In some cases tax incentives exist for certain vehicles and can make the hybrid option a more economical one.
- Utilization of a route optimization/fleet dispatch management program either through a Global Positioning System (GPS) or another type of software can consolidate trips, reduce travel time and, in areas of heavier traffic, alter commute time.
- Implementing employee awareness training to educate employees on fuel saving driving habits such as reducing idling time, driving sensibly and stopping rapid acceleration, removing excess weight from equipment carried in vehicles and observing speed limits.
- Reusing vehicles and related equipment can reduce the costs of acquiring new fleet elements. When new equipment or vehicles are required, the existing elements can also be recycled.
- Maintaining vehicles properly, in addition to such acts as changing air filters regularly and ensuring proper tire pressure can increase the gas mileage of vehicles, reducing fuel consumption. For example, the DOE estimates that gas mileage can be improved by about three and three tenths percent by keeping tires inflated to the proper pressure. For every pound per square inch that all four of a vehicle's tires are under-inflated, a driver's gas mileage is lowered by four tenths percent.

## *11.2 Procurement/ Supply Chain Determination*

The Procurement or Supply Chain business unit of an ICT organization can influence the purchases by that organization towards more energy efficient or environmentally sustainable products and can also influence the ICT's supplier to reduce its environmental impact. Some ways that this can be achieved include:

- Developing and implementing a strategy for selecting suppliers and products which may include guidelines for "rating" a supplier or its products based on an environmental sustainability factor.
- Purchasing renewable energy (solar, wind, etc) directly from utilities or under a cap and trade program to "offset" the ICT organization's greenhouse gas impact. The use of renewable energy in the ICT organization directly as described in Section 5 can also reduce the organization's greenhouse gas impact.
- Managing contracts to include "sustainable" terminology that requires or encourages the supplier to meet environmental goals important to the ICT organization.
- Incorporating methods for reporting and assessing the effect on energy management and efficiencies for procurement decisions.
- Utilizing electronic processing/ordering/billing as a means for the supplier to reduce the environmental impact of mailing information, contracts, bills, etc, and in turn reducing paper use.

### *11.3 Administrative/Operations Management*

Other opportunities for energy savings and GHG emission reductions exist within the administrative or operations functions of any ICT organization. These include:

- Establishing procedures and processes for assessing energy efficiency opportunities which could take the form of energy audits mentioned above.
- Managing real estate functions in the area of consolidating facilities for both equipment and employees, which can reduce the energy needed for those buildings to operate and may reduce employee travel to and from their offices. Other opportunities in the real estate area may include utilization of more energy efficient lights and light-sensing devices which turn off lights when employees leave an area, in addition to achieving more energy efficiency in the building's HVAC units.
- Recycling or reusing of telecommunication/computer/electronic equipment, including cell phones, can reduce a company's environmental impact.
- Managing IT responsibilities in the form of software that automatically turns off or puts to sleep computers can reduce energy usage within the organization.
- Obtaining a LEED rating or using the factors that the LEED program uses for its rating. The LEED Green Building Rating System™ encourages and accelerates global adoption of sustainable building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria.) The LEED rating system has different certification levels; certified, silver, gold and platinum. These certification levels are based upon the number of sustainable practices that are implemented in a facility. The LEED program is run by the USGBC. The USGBC is a non-profit organization committed to expanding sustainable building practices. USGBC is composed of more than 15,000 organizations from across the building industry that are working to advance structures that are environmentally responsible, profitable, and healthy places to live and work.

Promoting the human factor through employee policies is another opportunity for the ICT organization to reduce energy costs and its greenhouse gas emissions. Some opportunities in this category may include telecommuting, teleconferencing, alternative work schedules (four 10-hour days versus five 8-hour days), office recycling, educating employees about turning off the lights and other nonimperative office equipment, reducing air travel and implementing commuter options for its employees (pretax commuter program, bus passes, etc.).

## 11.4 Guidance for Migrating to Green

Organizations seeking to establish a sustainability program may find the following five step process helpful. The guidance provided defines an action (i.e., "Definition") and its measurable outcome (i.e., "Key Metrics").

| Guidance for the Migration to Green | |
|---|---|
| ***Step 1: Focused on early awareness, education with no broadly adopted metrics.*** | |
| **Definition** | **Key Metrics** |
| Awareness of the resource constrained environment. | Percentage (%) of individuals in group/org who are aware of green value. |
| Awareness through pressure or by example | Top three influencers named by group |
| Gather information and seek "best practices" | Top three best practices articulated |
| Perception changes from charitable exercise to profitable growth area and business enabler. | Well defined green mission statement articulated. |
| Internal conscience raising. | Education program plan well articulated |
| Denial for "Call to Action" | Call to Action to affect change articulated |
| Little or no monitoring or energy consumption | Energy monitoring systems present or not |
| | |
| ***Step II: Begin to develop programs and study groups to understand the issues and scope.*** | |
| **Definition** | **Key Metrics** |
| Initial understanding of issues and scope | Identify study groups and/or programs |
| Green activities "emerge" | "Green" resources are identified |
| Gather information and seek "best practices" | Green champions named |
| Develop tactical solutions | Green tactical plan articulated |
| Issues viewed as "energy constraints" | Perception of green issues as a percentage |
| Consumer of low value "green" products | Identify green products to purchase |
| Influence others internally and externally | Attend internal/external "green" meetings |
| Develop and retrofit of existing products and processes | Transformation plan articulated |
| Develop basic metrics and standards | Standards and metrics articulated and defined |
| Isolated and fragmented programs identified | List programs |
| Taking ownership and responsibility | Perception of green |
| | |
| ***Step III: Move from tactical to strategic.*** | |
| **Definition** | **Key Metrics** |
| Move from tactical to strategic | Strategic plan developed & articulated |
| Support tactical programs | Tactical plan with owners developed & articulated |
| Executive green champions drive cross-organizational change | Green champions named, goals assigned |
| Customize metrics to support strategic plans | Revised metrics described & allocated |
| Form strategic partnership with organizations | Partnership announced, goals articulated |

| | |
|---|---|
| Awareness of global connectivity | Products, processes, operations and services interconnected |
| Holistic view of "green" adopted | Attend internal/external "green" meetings |
| Invest for new "green marketplace" | Perception of green scope and enablement |
| Invest in development and retrofit of existing products prior to end of life | Retrofit plan developed, scoped and articulated |
| Deliver green products and services | Marketing content developed and delivered |
| | |
| ***Step IV: An understanding of Global interconnectedness becomes prevalent, Green as an enabler.*** | |
| **Definition** | **Key Metrics** |
| Global community realization | Marketing intelligence studies conducted |
| Provide education and socially responsible products | Education and product campaign plans developed |
| Invest for a "green" future and real-time monitored managed growth | Investment plan leveraging real-time data developed |
| Realize business benefits | Press and Analysts report Tier IV status |
| Partnership with governmental bodies for standards and law development | Partnerships announced, goals articulated |
| "Green" becomes a corporate business unit | Announcement of organizational changes |
| Enterprise-wide, real-time energy monitoring leveraged heavily to develop sustainable futures accounting | Standardized management systems integrated for international monitoring and reporting |
| Document and validated figures support an X% reduction in growth for greenhouse gas emissions related to business operations | Trial adoption pilot for 20 percent of BU's that drive 80 percent greenhouse gas emissions |

**Table 5: Guidance for the Migration to Green**

## 12 REPORT FINDINGS

Based on the information contained in this report, group dialogue, current trends and projected outcomes, the ATIS Exploratory Group on Green concludes the following:

- The aim of environmental sustainability is to protect the environment and its resources while at the same time satisfying human needs (today's and tomorrow's generations) while boosting economical progress. Accordingly, the ICT industry's consideration of and actions toward sustainability must be balanced against its environmental responsibility, social acceptance, and economical viability.
- The ICT industry is well-positioned to help develop and advance solutions for reducing greenhouse gases by harnessing the power of ICT. ICT-enabled solutions could cut annual $CO_2$ emissions in the U.S. by up to 22 percent in 2020. *Appendix D: Key ICT Environmental Factoids* highlights the potentials of ICT.
- The Procurement or Supply Chain business unit of an ICT organization is well-positioned to influence the purchases by that organization towards more energy efficient or environmentally sustainable products whereby also influencing the ICT's supplier to reduce its environmental impact
- Industry standards for energy consumption by specific ICT equipment types can be beneficial if they are developed based on a systems engineering approach --- factoring in the end-to-end architecture, bandwidth capabilities and the

functionality of the equipment. Consuming slightly more energy in one part of a network could reduce even more energy consumption in other parts of the network, e.g. an access/core network component could mitigate energy consumption in many end-user devices; equipment/facilities with higher bandwidth or greater functionality can displace user activities, e.g. travel or multiple narrower-bandwidth capabilities, that have much higher energy consumption.

- Since ICTs can displace and replace technologies/uses that consume much more energy, government mandates or self-imposed industry metrics that would restrict the use of ICTs by limiting total ICT energy consumption would be counterproductive.
- Some ICT companies have robust and effective sustainability programs while other companies are just beginning or assessing the need for a program. Some ICT companies are partnering with other industry groups committed to the same environmental goals, such as:
  - the DOE and EPA ENERGY STAR data center initiative in conjunction with The Green Grid;
  - adoption of and advocacy for the findings enumerated in the *SMART 2020* study and its policy recommendations; and
  - standards development for measuring and stating of energy efficiency of communications equipment.
- Existing initiatives and programs across a variety of standards bodies, industry groups, and government regulators are currently addressing the needs of the ICT industry and must continue to be reviewed.
  - *Equipment level metric* – Industry standards have or are currently being developed for ICT equipment manufacturers and service providers to specify the methodology to calculate the energy efficiency rating of an individual piece of ICT equipment or network configuration.
  - *Facility level metric* – Industry groups such as the Green Grid have developed tools to allow for meaningful comparisons of facilities within similar geographical areas/meteorological patterns and data measurement methodologies (e.g., PUE/DciE). This work, as well as efforts in other industry groups, continues to evolve as demands increase.
  - *Corporate/Company level metric(s)* – ICT corporations are creating internal programs and adopting requirements to meet their responsibility as good corporate citizens such as ISO/TC207 and the GHG Protocol on environmental management.

# 13 CONSIDERATIONS AND RECOMMENDATIONS

To address the findings enumerated in this report and to better enable the industry's movement forward to sustainability, the following considerations are provided. Readers are encouraged to review this report in its entirety because not all the considerations and best practices presented in this report are contained in this section. The extent to which some of these considerations are incorporated and enacted is deferred to ATIS and its member companies, given potential procedural and organizational impacts. Despite existing best efforts, initiatives and programs, environmental sustainability is an ongoing challenge and therefore existing efforts must be constantly monitored, assessed and adjusted to meet evolving demands.

For the context of the considerations and recommendations, please see "Preface/Notice" on page ii.

## *13.1 General Considerations and Recommendations*

### 13.1.1 ATIS and its Member Companies

- ATIS member companies should establish a means to stay engaged in the work programs in the ICT industry with respect to sustainability in order to (1) report and share relevant data and information, and (2) better prepare to assist and support ATIS membership to respond to technical, operations or policy and/or legislation proposals regarding climate change and ICT at all levels of government (e.g., in Congress, FCC, EPA etc.).
- ATIS and its members should continue an ATIS Board-level study on the subject of sustainability. While this report sets the foundation of an industry roadmap, additional work is needed to include a more detail analysis across all the portfolios but especially in the area of wireless energy efficiency and LCA from an "end-to-end" perspective. In addition, this work should address the specific ICT needs of the adjacent industries highlighted in the *SMART 2020* report (power, transport, manufacturing, buildings), and any requirements this sets on technical standards and best practices.
- ATIS and its member companies should support the development of energy efficiency and management standards for network, enterprise and home equipment taking into account the Triple Bottom Line. Standard developers should also be encouraged to work closely together to harmonize technical criteria, as well as to work collaboratively with governmental agencies specifying targets and energy requirements; i.e., EU Code of Conduct, DOE/EPA. Existing standards work in the ATIS NIPP and other groups must also continue to be supported.
- ATIS members should educate policy makers and legislators on the ICT industry's position to help develop and advance solutions for reducing greenhouse gases by harnessing the power of ICT. Refer to *Appendix H: Informational Resource to Facilitate Interactions with Legislators, Administrators, and Policy Makers*, as a potential source of information.
- ATIS and its member companies should consider the development and implementation of internal sustainability policies and programs (taking into account the Triple Bottom Line), if not already in place. Areas to consider may include:
  - Encouraging IT partners to employ energy efficient techniques for data centers and networking equipment such as routers, switches, servers and storage devices;
  - Establishing an internal GHG/Energy audits and reporting in anticipation of regulatory federal legislation;
  - Creating an internal "Green Team" or coordinator to manage the company program, and;
  - In order to progressively lead to reduction of greenhouse gases, Businesses and Enterprises can take the steps to reduce their own individual carbon footprint through the use of such advanced technology and processes as:
    - Reduction of paper reports and memos
    - Use of reusable storage devices
    - Use of more energy efficient display devices rather than CRT's

  - Use of smart motors and variable speed drive control systems
  - Use of solar and other renewable energy resources for running their ICT equipment
- ATIS member companies should consider developing and/or implementing best practices and guidelines. A whole host of best practices are presented in previous sections of this report and readers are encouraged to review this report in its entirety. Sources of best practices that could be considered include facility management procedures such as the Green Grid's best practices entitled Guidelines for Energy Efficient data centers, February 2007, and the EU CoC.

### *13.2 Energy Efficiency Considerations and Recommendations*

ATIS member companies should consider the following:

- Enact simple energy saving practices to reduce the consumption of energy. For instance, turn-off unused equipment and devices, close doors, and turn off lights. Create a checklist of simple energy saving tips. Refer to the following Appendixes in this report.
  - *Appendix E: Operations Checklist*
  - *Appendix F: Property Manager Checklist*
  - *Appendix G: ENERGY STAR Maintenance Staff Energy Efficiency Procedures Checklist*
- Perform energy inventory and conducts audits on a per facility basis. Outline actions towards reducing energy consumption. Start by designing in energy conservation measures upfront in new builds, and define a plan to transition out non-efficient components with newer energy efficient devices.
- Look at power distribution systems and storage devices including redundant power sources. Utilize sustainable energy sources when possible including solar, wind and bio-fuels.
- Retire and de-power obsolescent or underutilized equipment identified in the Energy Audits.
  - *Systematic review of obsolescent technologies*
    - Coin
    - T1, T1-C CXR
    - 130V power plants, -24v power plants
    - MFT, D4, Asynchronous FOTs
    - TR008 Integrated DLC
- Improve the utilization of older ferro-resonant rectifier power plants to at least 50 percent. There are four strategies to improve utilization of ferro rectifier power plants:
  - Turn off superfluous capacity rectifiers until the utilization is ≥ 50 percent
  - Turn on manufacturer ferro rectifier energy management algorithms for plants with < 50 percent utilization
  - Replace the ferro rectifiers with SMRs
  - Implement a hybrid power plant (mixture of ferros and SMRs)
- Reduce (Class 5) switch size by grooming circuits from remaining line & trunk cabinets, and power down de-loaded cabinets.
  - Priority 1 – Single Switch locations
    - Target > 40K spare lines/trunks and < 50 percent utilization

  - Priority 2 – Multi-Entity Switch locations.
    - Cos with more than one switch where one switch can absorb the demand from another co-located switch.
- Replace energy inefficient DC power supplies throughout the OSP Network, targeting sites with:
  - Ferro-resonant power supplies that are:
    - Poorly utilized
    - At their end of service life
    - Manufacturer discontinued, or potential to recover 'real estate' for revenue generating equipment
- A number of energy management techniques can be deployed to improve the RBS energy efficiency:
  - Shut down redundant units or resources not needed during low traffic hours using sleep mode functions.
  - Avoid unnecessary DC/DC conversion typically saves about 15 percent in energy consumption and cost.
  - An outdoor combined RBS and BBU forms a streamlined site with a common cabinet/shelter that minimizes hardware and energy consumption.
  - Remote power schemes, which enable several sites to be powered from one central point, as a result of advances in power transmission technology. The user sites could be RBS sites, handset charging stations or village power. The central site produces power using generator sets and distributes it to other RBS sites over specially-designed low-cost, copper-free cable in star, ring or chain configurations, over several tens of kilometers.
  - On the infrastructure side, cooling costs can be reduced by optimizing air conditioner use or, preferably, by migrating to a more passive approach. These will reduce energy consumption and minimize the environmental impact.
- Reduce the "no-load" energy demand of chargers in accordance with the EPA ENERGY STAR, through product development techniques. For mobile devices in general, energy consumption during active use and when idle is already largely optimized due to mobility and the demand of limited battery capacity, accounting for about one-third of a device's lifetime energy consumption. The greatest potential for energy savings is in the use of chargers because two-thirds of the power consumed by a mobile phone is wasted when the battery is full but the charger remains plugged in to the mains – the "no-load" mode. One-third of this is used when charging a device's battery and two-thirds when the charger is unplugged from the device but still drawing on the mains – a charger's no-load energy consumption. With over three billion mobile phone users in the world, even small individual improvements can add up to substantial energy savings.
- Support the initiatives within the mandate of the ATIS HNET Forum. Recent work by the recently completed ATIS TOPS Council Home Networking Focus Group identified two areas regarding Home Networking and Energy Consumption that they felt needed to be addressed:
  - Sleep States of CPE – Coordination of sleep state behavior is immature from a standards perspective. This could result in a lack of interoperability as a result of differences in how protocols handle behavior in sleep states in user devices is implemented.

- o Different Energy Allowances – standardization issues will be prevalent if Europe, Asia and USA come up will power level requirements that are different and/or take a different approach on how to specify energy saving requirements that devices will need to meet.

#### 13.2.1 Considerations Related to Data Centers

ATIS member companies should consider the following:

- Application, performance, and energy-efficiency needs for each data center should be used to develop a dynamic data center plan.
- Member companies should consider establish energy training/awareness programs for data center management and staff. Training/awareness programs for data center management and staff could include awareness of how their decisions and actions can potentially negatively impact energy efficiency, e.g. "spring back".
- Member companies could also consider including energy efficiency as a factor in the compensation of data center management and staff.

### *13.3 Applications and Services Considerations (Role of ICT and ATIS)*

The *SMART 2020* report, as well as others studies noted in this report (e.g., *Appendix C: Overview of Studies*), has identified that the use of ICT can have a major effect in reducing the carbon footprint of a number of industries, including transport; power; logistics; and buildings. The ICT industry should pro-actively seek ways in which ICT solutions can be readily adopted in these areas. In particular, ATIS has a role to ensure that a) standards for efficient use of ICT are adopted; and b) standards developed in the adjacent industries (e.g., building regulations) enable the ease of ICT adoption.

Communication service providers and their suppliers, through ATIS, are well-positioned to make the recommendations in the *SMART 2020* report a reality. Particularly in the case of smart buildings, smart logistics and smart grids; a global real-time information network will be required and it is recommended that ATIS and its member companies set a high priority on its provision. It is likely that major investment will be needed to develop this network. A number of governments are currently looking at investments that can provide a fiscal stimulus to the world economy which provide lasting benefits. ATIS and its member companies should work with the appropriate government agencies for the provision of the global real-time information network.

#### 13.3.1 Dematerialization

The main barrier to increasing the use of dematerialization is the lack of a global high-bandwidth and high performance IT infrastructure. ATIS member companies have an opportunity to improve the delivery and take-up of the networks and IT services required.

#### 13.3.2 Smart Motors

The main barrier to increasing the use of smart motor systems is the cost associated with swap-out. Although current motor systems are not climate-friendly, they adequately perform the right function and cost/benefit analysis on introducing smart motors will often be based upon reduced energy usage. ATIS member companies have an opportunity to improve the take-up of smart motors by helping the development of internationally recognized ICT architectural standards for integration of efficient motor systems.

#### 13.3.3 Smart Buildings

ATIS member companies have an opportunity to improve the technologies available to the buildings industry and to engage with organizations responsible for building regulations. Interoperable technologies exist but are not uniformly deployed. Many experts agree that an open standard would be the most effective way to enable further innovation.

#### 13.3.4 Smart Logistics

ATIS member companies have an opportunity to improve the technologies available to the logistics industry and to engage with organizations responsible for regulating supply chains. Through the deployment and operation of a global, real-time information network, there is a real opportunity to make supply chain journeys as efficient as possible.

#### 13.3.5 Smart Grid

The power industry has a number of pressures already evident that drive the use of ICT in smart grids. Rising demand, rising energy production costs (especially with fossil fuels), and non-deterministic energy security are already forcing the industry into action, even without the need to assist in the fight against climate change. However, the use of smart grids is patchy and not co-ordinated across countries and even across energy providers within a single jurisdiction. ATIS member companies and the wider ICT industry can re-double their efforts to develop and deploy a global information network to support smart grids.

# APPENDIX A: Detailed Taxonomy

### A.1 Taxonomy

Taxonomy Levels:
Level 0 (L0): Top of Hierarchy
Level 1 (L1): Major Perspectives
Level 2 (L2): Key Aspects of Major Perspectives
Level 3 (L3): General Areas of Considerations and/or Solutions
Level 4, 5 (L4, L5): Tangible Areas or Specific Considerations and/or Solutions
Level 6, 7,… N: Hierarchal Decomposition/Types of Level 4/Level 5.

### A.2 Complete Taxonomy

|L0 |L1 |L2 |L3 |L4 |L5 |L6

**|L0: Sustainability Considerations for ICT Products, Services, and Operations**

**|L1: Environmental Perspective**

|L2: Generational Sensitivity

|L3: Environmental Policy

|L4: Energy Targets

|L4: Carbon Targets

|L4: Water Targets

|L4: Hazardous Materials Targets

|L4: Waste Targets

|L3: Environmental Programs and Certifications

|L4: EPA's ENERGY STAR™ Program

|L4: EPA's Resource Conservation Challenge (RCC)

|L4: EPA's Reduce, Reuse, Recycle Program

|L4: GREEN SEAL™ Program

|L4: USGBC's Leadership in Energy and Environmental Design (LEED™) Green Building Rating System™

|L2: Environmental Integrity

|L3: GHG/Carbon Inventory/Footprint

|L4: GHG/Carbon Measurement Methodologies

|L4: Product Lifecycle Analysis

|L3: GHG/Carbon Offsets and Carbon Trading

|L4: GHG/Carbon Neutral

|L3: Reduction, Reuse, and Recycling of Waste

|L3: Reduction of Water Usage

|L3: Reduction of Hazardous Materials (RoHS)

|L3: Disposal of Hazardous Material

**|L1: Social Perspective**

|L2: Social and Cultural Desirability

|L3: Socially Responsible Corporate Policies and Procedures

|L3: ICT Applications and Services

|L4: Home Energy Management

|L5: Support Time-of-Day Electric Usage Metering

|L5: Smart Appliances

|L4: Advanced Customer Service Provisioning, Configuration, and Fault Management

|L5: Zero Truck-rolls

|L5 Simple, Auto-configuration, Self-repair Customer Solutions

|L3: Macro Sustainability Benefits of ICT Applications and Usage

|L4: Smart Logistics

|L4: Smart Transportation

|L4: Smart Grid

|L4: Consumer Dematerialization (move bits not atoms)

|L5: Consumer Paper Reduction

|L5: Consumer DVD Reduction

|L5: Consumer Travel Reduction

|L2: Mass Communications

|L3: Positive/Accurate Communications regarding Sustainability benefits of ICT Applications and Usage

|L3: Positive/Accurate Communications regarding Sustainability Initiatives

**|L1: Economic Perspective**

|L2: Economically Sustainable

|L3: Positive Cash Flow

|L3: Return on Investment (ROI)

|L2: Technology Feasibility

|L3: Energy Related Measurement Methodologies

|L4: Equipment/System Specific Measurement Methodologies

|L4: End-to-End System Measurement Methodologies

|L3: Simple Energy Reduction Solutions

|L4: Auto-power off

|L4: Standby Modes

|L3: Practical Stretch Energy Reduction Solutions

|L4: Energy Usage Reduction Solutions

|L5: Understanding Theoretical and State-of-the-Art Minimum Energy/Power Usage

|L5: Characterization/Analysis of Energy Usage Reduction Solutions

|L5: Energy Usage Reduction Roadmap

|L4: Increased Energy Efficiency Solutions

|L5: Understanding Theoretical and State-of-the-Art Maximum Energy Efficiency

|L5: Characterization/Analysis of Increased Energy Efficiency Solutions

|L5: Increased Energy Efficiency Roadmap

|L2: Operational Viability

|L3: Conventional Electrical Energy Generation Sources

|L4: Fossil Fuel Based Power Systems

|L4: Nuclear Power Plants

|L4: On-grid/Off-grid Conventional Electrical Energy Sources

|L3: Alternative/Renewable Electrical Energy Generation Sources

|L4: Wind Power Systems

|L4: Concentrating Solar Power Systems

|L4: Photovoltaic Power Systems

|L4: Fuel Cell Power Systems

|L4: Biomass Power Systems

|L4: Hydropower Systems

|L4: Geothermal Power Systems

|L4: Wave-Motion Power Systems

|L4: Tidal Power Systems

|L4: Alternative/Renewable Conventional Electrical Energy Sources

|L3: Conventional Electrical Energy Storage Systems

|L4: Battery Systems

|L3: Alternative/Renewable Electrical Energy Storage Systems

|L4: Fuel Cell Electrical Energy Storage Systems

|L3: Electrical Power Distribution (within ICT Facility)

|L4: AC

|L4: DC

|L3: Energy Management

|L3: Data Center and Central Office Environmental Management

|L4: Central Cooling Systems

|L5: Conventional Cooling Systems

|L6: Compressive Refrigerant

|L6: Absorption Cooling

|L5: Alternative/Renewable Cooling Systems

|L6: Air-to-Air Heat Exchangers (Outdoor/Indoor Air)

|L6: Absorption Cooling (Geothermal Based)

|L6: Absorption Cooling (via Waste Steam)

|L6: Steam-jet Refrigeration (via Waste Steam)

|L6: Natural Chilled Water

|L4: Cooling Distribution Systems

|L5: Chilled Water

|L5: Forced Air

|L6: Hot-Aisle/Cold-Aisle

|L6: Raised Floor

|L3: Outside Plant Environmental Management

|L3: Corporate Operations

|L4: Fleet Management

|L4: Facilities Management

|L4: Corporate Travel Reduction Programs

|L5: Telecommuting

|L5: Tele-presence

|L5: Virtual Meetings

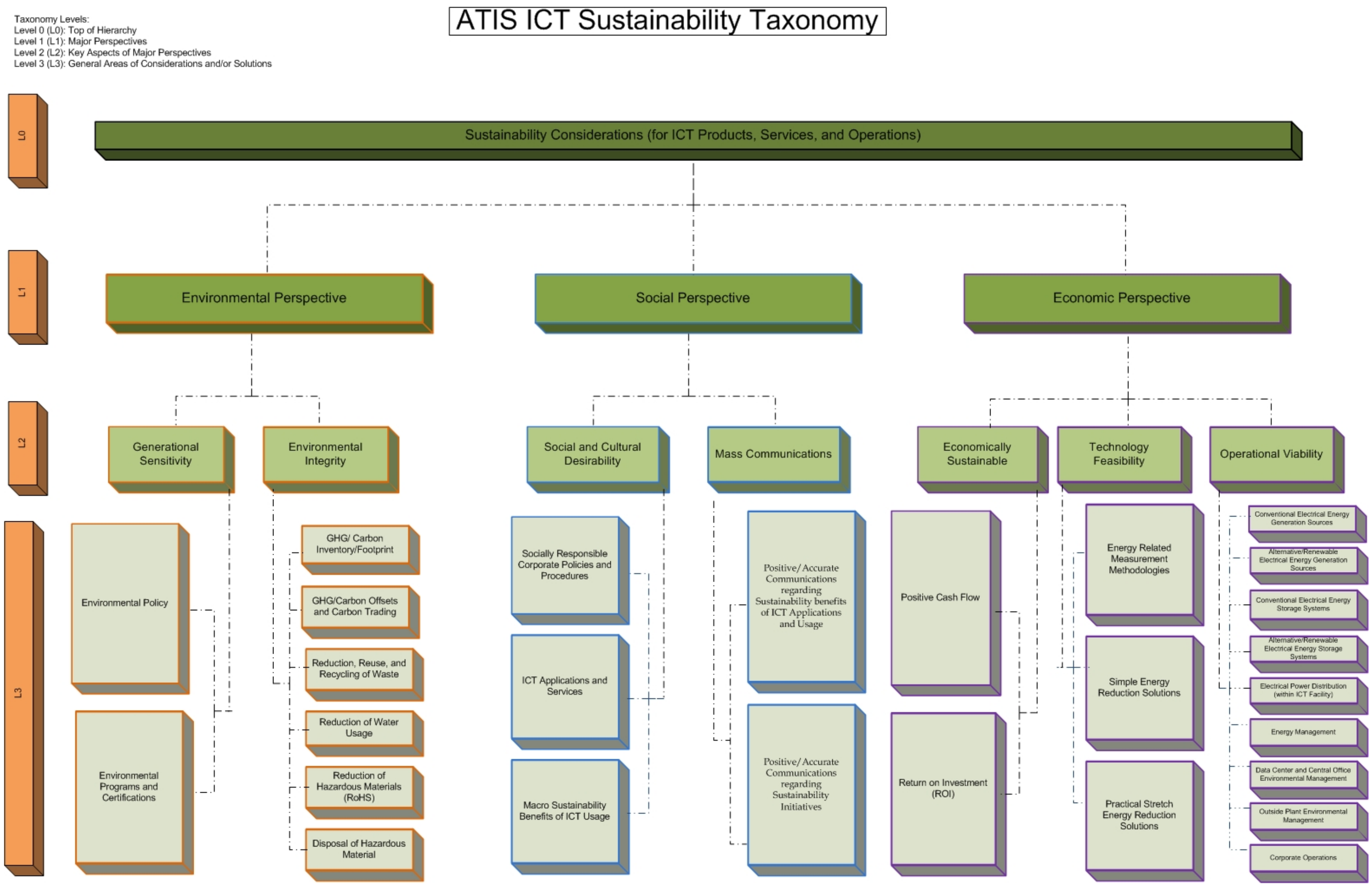


**Figure 31: ATIS ICT Sustainability Taxonomy [Enlarged]**

# APPENDIX B: Relevant Standards

***B.1 ATIS Detailed Listing***

- NIPP Issue #100: Heat Dissipation/Power Consumption Requirements for Network Telecommunications Equipment Utilized in Central Office and Outside Plant Environments. This Issue is in progress.

- Equipment Surface Temperature
  ATIS-0600004.2006, May 2006
  This standard sets forth the test methods and temperature limits for verifying surface temperatures of network telecommunications equipment. High exterior temperatures of exposed surfaces on equipment may cause injury or accidents to personnel working with or around the equipment.

- Equipment Surface Temperature
  ATIS-0600004.2006, May 2006
  This standard sets forth the test methods and temperature limits for verifying surface temperatures of network telecommunications equipment. High exterior temperatures of exposed surfaces on equipment may cause injury or accidents to personnel working with or around the equipment.

- NIPP Issue #091: Changes are occurring in multiple areas of Telecommunications Power Systems, including cables and connectors. In order to ensure continued reliability/integrity and interworking of the components of telecommunications power systems, there is an industry need to enumerate and specify certain attributes of power connectors.

**<u>Other NIPP Energy Efficiency Work:</u>**
With respect to hazardous waste reduction, the ATIS NIPP launched a working group in 2006 (NIPP-NPP Pb-Free Working Group).

- *RoHS-Compliant Standard for Structural Metals, Bus Bars and Fasteners* (ATIS-PP-0600009.2007) was completed in 2007, providing the physical technical requirements for telecommunications equipment systems and assemblies intended for installation in network equipment buildings and electronic equipment enclosures as well as the design and construction of mechanical hardware, cable assemblies and printed wiring boards.

- Additional work on reducing the use of lead-free solder in telecommunications equipment has been launched. Three documents are currently planned to address the following testing areas:
  - Pb-Free Acceptance Criteria for Modules
  - Pb-Free Acceptance Criteria for Pb-Free Assemblies
  - Accelerated Pb-Free Robustness Check

***B.2 ETSI Detailed Listing***

- Environmental Engineering (EE) The use of alternative energy sources in telecommunication installations
  Doc. # TR102 532

Ref. DTR/EE-00004 1.1.3 Draft available (2008-04-04)

- Environmental Engineering (EE) Environmental consideration for equipment installed in outdoor location
  Doc. # TR
  Ref. DTR/EE-00006 -- Draft available (2008-04-02)

- Environmental Engineering (EE) Energy efficiency of wireless access
  Doc. # TS
  Ref. DTS/EE-00007 -- Draft available (2008-09-04)

- Environmental Engineering (EE); Environmental Impact Assessment of ICT including the Positive Impact by using ICT Services
  ICT energy consumption and global energy impact assessment methods
  Doc. # TR
  Ref. DTR/EE-00008 -- Draft available (2008-09-20)

- Equipment Engineering (EE); Acoustic noise emitted by telecommunications equipment
  Doc. # EN300 753
  Ref. REN/EE-00009 -- Draft available (2008-09-02)

- Defining an environment class to cover IT equipments encountered in data centers
  Doc. # EN300 019-1-3
  Ref. REN/EE-00010 -- Draft available (2008-09-10)

- Guidance on Thermal Management of racks, cabinets and locations
  Doc. # TR102 489
  Ref. RTR/EE-00011 1.2.1 First Draft (2008-09-24)

- Thermal Management Guidance for equipment and its deployment
  Doc. # EN300 119-2
  Ref. REN/EE-00012 2.2.1 Draft available (2008-09-26)

- Thermal Management Guidance for equipment and its deployment
  Doc. # EN300 119-3
  Ref. REN/EE-00013 2.2.1 Draft available (2008-09-26)

- LCA assessment of telecommunication equipment/service
  Doc. # ES
  Ref. DES/EE-00014 1.1.1 Start of work (2008-09-26)

- Measurement method and limits for energy consumption in broadband telecommunications equipment;
  Doc. # ES
  Ref. DES/EE-00015 -- Start of work (2008-09-20)

- Power supply interface at the input to telecommunications equipment (DC powered)
  Doc. # EN300 132-2

Ref. REN/EE-00016 2.3.2 Start of work (2008-10-01)

- Power supply, rectified current source, alternating current source or direct current source
  Doc. # EN300 132-3
  Ref. REN/EE-00017 1.3.1 Draft available (2008-09-26)

- DC power system control and monitoring information model
  Doc. # ES202 336-2
  Ref. DES/EE-02037-2 0.0.5 Draft receipt by ETSI Secretariat (2008-11-23)

- AC UPS power system control and monitoring information model
  Doc. # ES202 336-3
  Ref. DES/EE-02037-3 0.0.1 Table of Contents and Scope (2007-02-27)

- AC distribution power system control and monitoring information model
  Doc. # ES202 336-4
  Ref. DES/EE-02037-4 0.0.1 Start of work (2006-10-13)

- AC diesel back-up generator system control and monitoring information model
  Doc. # ES202 336-5
  Ref. DES/EE-02037-5 0.0.1 Start of work (2006-10-13)

- Air conditioning system control and monitoring information model
  Doc. # ES202 336-6
  Ref. DES/EE-02037-6 0.0.1 Draft available (2008-08-15)

- Other utilities system control and monitoring information model
  Doc. # ES202 336-7
  Ref. DES/EE-02037-7 0.0.1 Draft available (2008-09-15)

# APPENDIX C: Overview of Studies

## OVERVIEW OF STUDIES (BY DATE PUBLISHED)

***SMART 2020: Enabling the low carbon economy in the information age: United States Report Addendum***

- Published November 2008
- Prepared by The Boston Consulting Group on behalf of The Global e-Sustainability Initiative
- An addendum to the original report, this addendum demonstrates the potential role for ICT solutions in the United States, showing that IT-enabled solutions could cut annual $CO_2$ emissions in the U.S. by 13–22 percent from business-as-usual projections in 2020. This translates to gross energy and fuel savings worth $140-240 billion – equivalent to a reduction in oil consumption of 11-21 percent and a cut in oil imports of 20-36 percent.

***Digital Quality of Life: Understanding the Economic Benefits of the Information Technology Revolution***

- Published October 2008
- Sponsored by The Information Technology and Innovation Foundation (ITIF)
- Authored by Robert D. Atkinson & Daniel D. Castro
- This study documents how IT, since the mid-1990s, has been the principal driver of increased economic growth not only in the United States but also in many other nations. However, IT is also at the core of dramatic improvements in the quality of life for individuals around the world. This report demonstrated how IT is the key enabler of many, if not most, of today's key innovations and improvements in our lives and society—from better education and health care, to a cleaner and more energy-efficient environment, to safer and more secure communities and nations.

***SMART 2020: Enabling the low carbon economy in the information age***

- Published June 2008
- Sponsored by The Climate Group and the Global the Global e-Sustainability Initiative
- This report is the world's first comprehensive global study of the ICT sector's growing significance for climate change. It outlines how ICT could enable other business sectors and consumers to achieve global reductions in annual man-made global emissions of 15 percent by 2020 and deliver energy efficiency savings worth over $946.5 billion worldwide.

***Connected: ICT & Sustainable Development***

- Published April 2008
- Sponsored by Forum for the Future, Sun Microsystems
- Authored by Peter Madden and Ilka Weißbrod
- This report confirms the important role of the ICT industry in delivering a low carbon, sustainable future. It recommends that the ICT sector move from a model based on the ever-increasing consumption of natural resources to a service-led future that is more efficient and less reliant on hard-wired solutions. The opportunities for implementing sustainable practices in the ICT sector lie in the

application of ICT (rather than in its production and use), specifically in the areas of work, travel, shopping, and meeting.

***Information Technologies and Telecommuting: Good for the Economy, Good for the Environment***

- Published April 2008
- Sponsored by the American Consumer Institute
- This short article finds that increased investment in and use of information technologies, such as broadband services, can facilitate telecommuting and produce significant economic and the environment benefits, without requiring consumers to sacrifice other important advantages of traditional communications practices.

***Searching for Green Electronics***

- Published March 2008
- Sponsored by Greenpeace, Intl.
- Authored by Yannick Vicaire, Mario Rautner, Dr. Kevin Brigden
- This article details a survey of the main brands of desktop PCs and notebooks, mobile phones and PDAs in an effort to find the greenest electronic devices available on the market during 2007. The survey assessed 37 products from 14 companies against four sets of environmental criteria. It shows that the industry has already made advances along the path to green electronics, yet there is still progress to be made.

***A Smarter Shade of Green: How innovative technologies are saving energy, time and money***

- Published February 2008
- Sponsored by the Technology CEO Council
- This report discusses how the ICT industry can use "smart technologies" to multiply their benefits and increase sustainable development. It aims to make ICT the leader in multi-sector and multi-stakeholder efforts that develop and disseminate environmentally-friendly practices without over-promising and making claims it cannot meet.

***High Tech: Low Carbon – The role of technology in tackling climate change***

- Published February 2008
- Sponsored by Intellect
- This report highlights the ways in which improved energy efficiency in computer hardware and consumer electronics can impact three of the main environmental problems facing the planet: climate change, resource degradation, and pollution. The report offers solutions for the problem, including some programs that have already begun.

***Information and Communication Technologies: The Power of Productivity***

- Published February 2008
- Sponsored by American Council for an Energy-Efficient Economy
- Authored by John A. Laitner and Karen Ehrhardt-Martinez
- This study explores the way ICT has revolutionized the relationship between economic production and energy consumption. Since the early 1990s, ICT applications have become critical energy and economic productivity tools for

consumers and industry alike and as a nation we should commit to the realization of the energy-saving opportunities that new ICT opportunities provide.

***The Economic Impact of Stimulating Broadband Nationally***

- Published February 2008
- Sponsored by Connected Nation
- Report details the potential state-by-state impact of legislation to accelerate broadband access and use. Report findings suggest that the U.S. could realize an economic impact of $134 billion annually by accelerating broadband availability/use across all states. Report also shows the potential for broadband that exists in every U.S. state.

***Managing the Company's Carbon Footprint: The Emerging Role of ICT***

- Published February 2008
- Sponsored by Economist Intelligence Unit, funded by AT&T and Cisco
- To better understand the role ICT products and services can play in helping customers live more sustainably, AT&T joined Cisco and the Economist Intelligence Unit in 2008 to explore how customers view ICT as a potential solution to reduce their own carbon emissions. Of the 345 top-level executives polled for the survey, 18 percent said their companies have a carbon-reduction strategy and 39 percent said they're in the process of developing one. Yet of those that have a carbon-reduction strategy or are developing one, nearly half said that the role of ICT was not mentioned in their strategy. In the same report, 43 percent of respondents surveyed selected increasing the use of virtual meetings as the biggest contribution in reducing their carbon footprint.

***Towards a High-Bandwidth, Low-Carbon Future: Telecommunications-based Opportunities to Reduce Greenhouse Gas Emissions***

- Published October 2007
- Sponsored by Climate Risk Pty Ltd
- Authored by Karl Mallon, Gareth Johnston, Donovan Burton, and Jeremy Cavanagh
- This Australian report is an attempt at a nation-wide quantification of the carbon savings and financial benefits resulting from using telecommunications networks to conserve energy and increase clean energy use at home, in the workplace and in ways people connect to enterprises and communities. The report finds that the telecommunications sector is uniquely placed to provide important services that can yield nationally significant reductions in greenhouse gas emissions and that many of the telecommunication solutions for living and working in a future carbon-constrained world can lead to cost savings for business and the consumer.

***Broadband Services: Economic and Environmental Benefits***

- Published October 2007
- Sponsored by the American Consumer Institute
- Authored by Joseph P. Fuhr Jr. and Stephen B. Pociask
- This study shows that reduced energy use and lower greenhouse gas emissions associated with information technology and broadband use are significant and deserve to be an important consideration in developing a comprehensive energy policy. It finds that wide adoption and use of broadband applications can achieve a

net reduction of 1 billion tons of greenhouse gas over 10 years, which, if converted into energy saved, would constitute 11% of annual U.S. oil imports.

***Advanced Electronics and Information Technologies: The Innovation-Led Climate Change Solution***

- Published September 2007
- Sponsored by the American Council for an Energy-Efficient Economy
- Authored by John A. "Skip" Laitner and Karen Ehrhardt-Martinez
- This study uses two examples to illustrate the larger opportunities that exist for energy-efficient improvements in ICT systems and technologies. The first deals with telecommuting and teleworking, and the second deals with the optimization of building energy management operations.

***The Energy and Greenhouse Gas Emissions Impact of Telecommuting and E-commerce***

- Published July 2007
- Sponsored by the Consumer Electronics Association
- Authored by TIAX LLC
- This report aims to investigate the impact of telecommuting and e-commerce on U.S. energy consumption, greenhouse gas emissions, and liquid fuel consumption. It found that, overall, the use of information technology equipment and the Internet provides opportunities to reduce energy consumption and the generation of greenhouse gases.

***Energy Efficiency Analysis For Mobile Broadband Networks***

- Published 4th Quarter, 2006
- Sponsored by ABI Research
- This study provides a theoretical and real-world analysis of the relative costs of deploying various types of mobile broadband solutions. It offers strategic recommendations to the industry as to the best ways of combating rising power consumption costs.

***A review of research on the environmental impact of e-business and ICT***

- Published December 2006
- Sponsored by the Geoenvironmental Research Centre at the Cardiff School of Engineering, Cardiff University
- Authored by Lan Yi and Hywel R. Thomas
- This paper reviews the way which studies are currently conducted on how e-business/ICT affects the environment. It finds that the dominant approach is either a micro-level case study or a macro-level statistical approach. The paper concludes that a more predictive and empirical model should be more beneficial in the long term because it can be applied within a sector of society.

***Saving the climate @ the speed of light: First roadmap for reduced $CO_2$ emissions in the EU and beyond***

- Published October 2006
- Sponsored by the European Telecommunications Network Operators Association and the World Wildlife Fund
- Authored by Dennis Pamlin and Katalin Szomolanyi

- This study is a roadmap for "Saving the climate @ the speed of light", a joint ETNO and WWF initiative that aims to make the ICT sector a leader in the effort to reduce EU greenhouse gas emissions 15-30% by 2020 and 60-80% by 2060. The roadmap presents two phases for the reduction of $CO_2$ across Europe, using ICT solutions.

***E-business and Sustainable Development***

- Published September 2006
- Sponsored by the Geoenvironmental Research Centre at the Cardiff School of Engineering, Cardiff University
- Authored by Lan Yi and Hywel R. Thomas
- This paper discusses the economic, social, and environmental impacts of e-business and ICT. Environmental effects are analyzed from various aspects, such as resource and energy consumption, transportation, waste, and land use. It outlines an integrated Decision Support System method, which should help an individual company better manage its e-business operations, specifically related to environmental and financial performance.

***The relevance of information and communication technologies for environmental sustainability – A prospective simulation study***

- Published July 2006
- Authored by Lorenz M. Hilty, Peter Arnfalk, Lorenz Erdmann, James Goodman, Martin Lehmann and Patrick A. Wäger
- Sponsored by Technology and Society Lab at Empa, International Institute for Industrial Environmental Economics at Lund University, Institute for Futures Studies and Technology Assessment, Forum for the Future
- This study modeled all known relevant positive and negative impacts on environmental sustainability on three levels (first, second, and third-order), using a System Dynamics approach in combination with scenario techniques and expert consultations. Using 2020 as a time-horizon, the study revealed great potential for ICT-supported energy management and for a structural change towards a less material-intensive economy, but strong rebound effects in the transport sector whenever ICT applications lead to time or cost savings for transport.

***Creating an Enabling Environment: Toward the Millennium Development Goals***

- Published April 2005
- Authored by The United Nations ICT Task Force
- The book is divided into two parts. The first comprises the proceedings of the November 2004 Global Forum of the UN ICT Task Force on "Promoting an Enabling Environment for Digital Development", focusing on the underpinning issues of policy and regulation, the role of different stakeholders and actors, and the issue of financing ICT for development. The second presents original work in four areas directly related to the MDGs (Millennium Development Goals): unleashing e-strategies, up-scaling pro-poor ICT policies and practices, MDG indicators, and innovation and investment in ICTs to meet the MDGs.

***The Future Impact of ICTs on Environmental Sustainability – Refinement & Quantification***

- Published 2004

- Sponsored by the European Commission's Institute for Prospective Technological Studies
- Authored by Lorenz Erdmann, et. Al. (Institute for Futures Studies and Technology Assessment)
- This is the fourth of five interim reports that contributed to "The Future Impact of ICTs on Environmental Sustainability". This interim report refined the scenarios from the previous report and ran a simulation model for the impact of ICT on selected environmental indicators, using the year 2000 as a starting point for simulation. The model aimed to find the most important variables for the future impact of ICT on environmental sustainability.

***The Future Impact of ICTs on Environmental Sustainability***

- Published August 2004
- Sponsored by the European Commission's Institute for Prospective Technological Studies
- Authored by Lorenz Erdmann (Institute for Futures Studies and Technology Assessment), Lorenz Hilty (Swiss Federal Laboratories for Materials Testing and Research), James Goodman (Forum for the Future), Peter Arnfalk (International Institute for Industrial Environmental Economics at Lund University)
- The study aims to explore and to assess the way that ICTs will influence environmental sustainability between now and 2020. The general conclusion was that ICTs have the capability to either improve the situation by reinforcing positive effects on the environment, or to worsen it. This suggests that environmental policies must be designed to ensure that ICT applications make a beneficial contribution to environmental outcomes while also suppressing rebound effects.

***The Future Impact of ICTs on Environmental Sustainability – Evaluation & Recommendations***

- Published 2004
- Sponsored by the European Commission's Institute for Prospective Technological Studies
- Authored by Peter Arnfalk, et. Al. (International Institute for Industrial Environmental Economics at Lund University)
- This is the fifth of five interim reports that contributed to "The Future Impact of ICTs on Environmental Sustainability". This interim report took the results from the previous reports and used them to make policy recommendations within the framework of current EU policy contexts.

***IT and sustainable development: a central issue for the future***

- Published August 2004
- Sponsored by the Swedish government's Forum on IT and environmental issues
- Authored by Dennis Pamlin and Ewa Thorslund
- The purpose of this report is to summarize and present strategic issues relating to ICT/IT and sustainable development and determine the ways in which the government should participate in sustainable development. The report is based on discussions with various actors, including representatives of the industrial and academic sectors, media, authorities and ministries.

***Environmental Implications of Wireless Technologies: News Delivery and Business Meetings***

- Published May 2004
- Sponsored by the Haas School of Business and the Department of Civil and Environmental Engineering at the University of California at Berkeley.
- Authored by Michael W. Toffel and Arpad Horvath.
- This paper compares the environmental effects of two applications of wireless technologies for the alternative that they can substitute: reading newspaper content on a PDA as compared to reading a physical newspaper and wireless teleconferencing as compared to business travel. In both comparisons, the results show that wireless technologies create lower environmental impacts.

***De-materializing and re-materializing: digital technologies and the environment***

- Published March 2004
- Sponsored by Science and Technology Policy Research, University of Sussex
- Authored by Frans Berkhout and Julia Hertin
- This paper identifies three main types of effects: direct impacts of the production and use of ICTs on the environment, indirect impacts related to the effect of ICTs on production processes, products and distribution systems, and structural/behavioral impacts (mainly through the stimulation of structural change and growth in the economy by ICTs, and through impacts on life styles and value systems.) It argues that the diffusion and use of ICTs are leading to both positive and negative environmental impacts, and that the relationship must be recognized as complex, interdependent, deeply uncertain, and scale-dependent.

***The Future Impact of ICTs on Environmental Sustainability – Scenarios***

- Published September 2003
- Sponsored by the European Commission's Institute for Prospective Technological Studies
- Authored by James Goodman and Vidhya Alakeson (Forum for the Future)
- This is the third of five interim reports that contributed to "The Future Impact of ICTs on Environmental Sustainability". This interim report identifies a set of key drivers that underpins the take-up of particular ICT applications by certain economic sectors, creates three scenarios for the development and take-up of ICT by in 2020 (technocracy, government first, and stakeholder democracy), and estimates how a set of external variables is likely to be affected by each scenario.

***The Future Impact of ICTs on Environmental Sustainability – Identification and Global Description of Economic Sectors***

- Published May 2003
- Sponsored by the European Commission's Institute for Prospective Technological Studies
- Authored by Lorenz Erdmann and Felix Würtenberger (Institute for Futures Studies and Technology Assessment)
- This is the first of five interim reports that contributed to "The Future Impact of ICTs on Environmental Sustainability". This interim report describes the ways in which each of seven economic sectors (freight transport intensity, passenger transport intensity, energy intensity of industry, energy intensity of the domestic sector,

energy intensity of the tertiary sector, greenhouse gas emissions from energy industries, and waste from daily household and commercial activities) contribute to the six Gothenburg environmental indicators (greenhouse gas emissions, energy intensity of the economy, volume of transport to gross domestic product, modal split of transport, urban air quality, municipal waste collected, land filled and incinerated).

***The Future Impact of ICTs on Environmental Sustainability – Script***

- Published May 2003
- Sponsored by the European Commission's Institute for Prospective Technological Studies
- Authored by Lorenz Erdmann and Siegfried Behrendt (Institute for Futures Studies and Technology Assessment)
- This is the second of five interim reports that contributed to "The Future Impact of ICTs on Environmental Sustainability". This interim report identified ten key trends in ICT which are expected to remain strong and assessed their impact on the environment across ten fields of application.

***Sustainability at the Speed of Light: Opportunities and Challenges for Tomorrow's Society***

- Published July 2002
- Sponsored by World Wildlife Fund, Sweden
- Edited by Dennis Pamlin
- This report contributes to the discussion on the role of ICT in tomorrow's society. It describes and summarizes the most important challenges for the future, asking experts in the field to weigh in on what they think the future role of ICT should be in sustainable development in their respective fields.

***The Internet and the New Energy Economy, Proceedings of the E-Vision 2000: Key Issues That Will Shape Our Energy Future Conference—Supplementary Materials: Papers and Analyses***

- Published 2002
- Sponsored by the Center for Energy and Climate Solutions, Global Environment and Technology Foundation
- Authored by Joseph Romm
- This report explores the way the growth in the Internet Economy appears to be increasing efficiency in every sector of the economy. Specifically, it focuses on the impact of the Internet economy on manufacturing, buildings, and transportation and considers the implications for growth in energy consumption and greenhouse gas emissions during the next ten years.

# APPENDIX D: Key ICT Environmental Factoids

## THE POTENTIAL OF ICT

In the U.S.

- ICT- enabled solutions have the potential to cut U.S. annual $CO_2$ emissions by up to 22 percent by 2020 – which translates into gross energy and fuel savings of as much as $240 billion.[49]
- In the United States, ICT has four main opportunities:
  - A **smart electrical grid** built on better information and communication, which could reduce $CO_2$ emissions 230–480 million metric tons (MMT), and save $15–35 billion in energy and fuel costs.
  - **More efficient road transportation** could reduce travel time and congestion, eliminating 240–440 MMT of $CO_2$ emissions and saving $65–115 billion.
  - **Smart buildings** that consume less energy could save 270-360 MMT of $CO_2$ and save $40–50 billion.
  - **Travel substitution** such as virtual meetings and flexible work arrangements could reduce $CO_2$ by 70–130 MMT and save $20–40 billion.[50]

Globally:

- ICT could enable other business sectors and consumers to achieve global reductions in annual man-made global emissions of 15 percent by 2020 and deliver energy efficiency savings worth more than $946.5 billion worldwide.[51]
- Five major opportunities for ICT-enabled solutions to drive emissions savings include:
  - **Smart motor systems**: Optimized motors and industrial automation could cut global emissions .97 $GtCO_2$ emissions in 2020, worth $107.2 billion.
  - **Smart logistics**: Through a host of efficiencies in transport and storage, the global emissions savings from smart logistics in 2020 would reach 1.52 $GtCO_2$ emissions, with energy savings worth $441.7 billion.
  - **Smart buildings:** Through better building design, management and automation, smart buildings technologies would enable 1.68 $GtCO_2$ of emissions savings, worth $340.8 billion.
  - **Smart grid:** Better monitoring and management of electricity grids were the largest opportunity found in the study, and could globally reduce 2.03 $GtCO_2$ emissions, worth $124.6 billion.
  - **Dematerialization:** Using technology to dematerialize the way we work and operate, replacing high-carbon physical products and activities (such as books and meetings) with virtual low carbon equivalents (e-commerce/e-government and videoconferencing) could deliver a global reduction of 0.5 $GtCO_2$ emissions in 2020.[52]

Of 345 top-level executives polled, 18 percent said their companies have a carbon-reduction strategy and 39 percent said they're in the process of developing one. Yet, of those that have

[49] SMART 2020: Enabling the low carbon economy in the information age: United States Report Addendum, November 2008
[50] SMART 2020: Enabling the low carbon economy in the information age: United States Report Addendum, November 2008
[51] SMART 2020: Enabling the Low Carbon Economy in the Information Age, a report by the Climate Group on behalf of the Global eSustainability Initiative, June 2008
[52] SMART 2020: Enabling the Low Carbon Economy in the Information Age, a report by the Climate Group on behalf of the Global eSustainability Initiative, June 2008

a carbon- reduction strategy or are developing one, nearly half said that the role of ICT was not mentioned in their strategy.[53]

**Benefits of Broadband Usage**

- Widespread use of broadband applications can achieve net reduction of 1 billion tons of greenhouse gas over 10 years.[54]
- Just a seven percent increase in U.S. broadband adoption could result in $6.4 billion per year in mileage savings from unnecessary driving and 3.2 billion fewer pounds of carbon emissions.[55]
- Additional benefits that could be derived include:
    - $92 billion through an additional 2.4 million jobs per year created
    - $662 million saved per year in reduced healthcare costs
    - $35.2 billion in value from 3.8 billion more hours saved per year from accessing broadband at home
    - $134 billion per year in total direct economic impact of accelerating broadband across the United States[56]

**Travel Replacement**

Telecommuting

- Over 10 years, telecommuting could reduce greenhouse gas emissions by:
    - 312.4 million tons due to energy saved by businesses;
    - 247.7 million tons due to less driving;
    - 28.1 million tons due to reduced office construction.[57]
- If Americans telecommuted 1.6 days per week, our nation could save 1.35 billion gallons of fuel annually.[58]

Teleconferencing

- If video conferencing substituted for 10 percent of business air travel, it would reduce carbon emissions in the U.S. by some 35 million tons annually.[59]
- 43 percent of respondents surveyed selected increasing the use of virtual meetings as the biggest contribution in reducing their carbon footprint.[60]
- Existing videoconference solutions indicate that if 5 – 30% of business travels in Europe was substituted by videoconferencing, more than 5.59 – 33.53 million tones of $CO_2$ would be saved.[61]
- Based on existing and on used audio-conference solutions, where the amount of travel replaced by audio conferences has been calculated, we can see that if 30 million audio conference calls were made it could save 661,500 tones of $CO_2$ and if 130 million calls were made it could save 2,866,500 tones.[62]

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[53] Economist Intelligence Unit, "Managing the Company's Carbon Footprint: The Emerging Role of ICT," February 2008
[54] American Consumer Institute (ACI), "Broadband Services: Economic and Environmental Benefits," Oct. 31, 2007
[55] Connected Nation, "The Economic Impact of Stimulating Broadband Nationally," February 2008
[56] Connected Nation, "The Economic Impact of Stimulating Broadband Nationally," February 2008
[57] American Consumer Institute (ACI), "Broadband Services: Economic and Environmental Benefits," Oct. 31, 2007
[58] Telework in the Information Age, American Electronics Association, April 2008
[59] American Consumer Institute (ACI), "Broadband Services: Economic and Environmental Benefits," Oct. 31, 2007
[60] Economist Intelligence Unit, "Managing the Company's Carbon Footprint: The Emerging Role of ICT," February 2008
[61] "Saving the Climate at the Speed of Light"
[62] "Saving the Climate at the Speed of Light"

**E-Commerce / Dematerialization**

- Online booksellers use 14 times less energy to sell $100 worth of books than a traditional store.[63]
- B-to-B and B-to-C e-commerce could reduce greenhouse gases by 206.3 million tons over 10 years.[64]
- Transitioning 50 percent of DVD/video rentals to broadband video-on-demand would save approximately 180 million gallons of fuel and avoid 1.3 million tons of carbon dioxide emissions annually.[65]
- E-commerce generates 36% less air pollutants, 23% less hazardous waste and 9% fewer greenhouse gases than conventional shopping.[66]
- Reading newspapers online would help prevent 60 million tons of $CO_2$ emissions.[67]
- If all Americans viewed and paid bills online, we'd save 16.5 million trees each year.[68]
- Between 2002 and 2006, first-class mail declined by 5.9 billion pieces. The drop, attributed primarily to e-mail, saved 4.4 million trees.[69]
- Researchers have estimated that eliminating the production of CDs and their plastic cases in the United States alone could save 42 million gallons of oil per year while reducing greenhouse gas emissions by half a million tons.[70]
- If 10 million customers shifted from traditional to virtual answering machines, then 330,000 tons of $CO_2$ could be saved, 90 million customers could achieve 2,640,000 tons $CO_2$ emission reductions.[71]
- Existing and implemented online phone bill services indicate that 10 million customers could save 10,943 tons $CO_2$ and 90 million customers could save almost 100,000 tons.[72]

**Energy Efficiency**

- Although IT itself consumes energy, the net impact of IT is overwhelmingly positive — for every unit of energy consumed by IT, there is a corresponding savings of between 6 and 14 units of energy.[73]
- One sector that accounts for a significant share of energy use in most nations — 29 percent in the United States in 2007 — is the transportation sector. IT can cut energy usage in the transportation sector by allowing the substitution of energy-efficient digital activities for energy-intensive physical activities.[74]

[63] American Consumer Institute (ACI), "Broadband Services: Economic and Environmental Benefits," Oct. 31, 2007
[64] American Consumer Institute (ACI), "Broadband Services: Economic and Environmental Benefits," Oct. 31, 2007
[65] TIAX LLC, The Energy and Greenhouse Gas Emissions Impact of Telecommuting and e-Commerce, Final Report by TIAX LLC to the Consumer Electronics Association (2007)
[66] Michael W. Toffel and Arpad Horvath, "Environmental Implications of Wireless Technologies: News Delivery and Business Meetings," *Environmental Science and Technology*, 2004, citing Matthews, p. A.
[67] Fuhr and Pociask, 2
[68] Javelin Strategy and Research as cited in "You can save trees by viewing and paying bills online," *USA Today*, 7/30/2007
[69] Fuhr and Pociask, 31
[70] Digital Quality of Life: Understanding the Economic Benefits of the Information Technology Revolution, October 2008
[71] "Saving the Climate at the Speed of Light"
[72] "Saving the Climate at the Speed of Light"
[73] Digital Quality of Life: Understanding the Economic Benefits of the Information Technology Revolution, October 2008
[74] Digital Quality of Life: Understanding the Economic Benefits of the Information Technology Revolution, October 2008

- For every extra kilowatt-hour of electricity that has been demanded by ICT technologies, the U.S. economy increased its overall energy savings by a factor of about 10.[75]
- Today, it takes less than half the energy to produce a dollar of economic output as it did in 1970. U.S. energy consumption per dollar of economic output has declined from 18 thousand BTUs in 1970 to less than 9 thousand BTUs by the end of 2008. Through that energy efficiency we have met approximately 75 percent of our new demand for energy.[76]

**Emerging Applications**

Education

- Tele-education is an area that could grow rapidly, not as a substitute for traditional education, but as a complement to it.[77]
  - It could improve the quality of learning especially in more specialized and advanced subjects.
  - For equity as well as innovation, solutions could be provided that allow children living in rural areas to have the same quality of education as children in urban areas.

Health Care

- One important area for the aging population is the use of different kinds of telemedicine and remote assistance services.[78]
  - Safety and health will always be the first priority in health care but by providing new ICT based working infrastructures, once people get used to the new technology, new solutions will be possible.
  - The reduced need to travel, plus overcoming the reluctance to go to the doctor that many people have today when they have to take time off could open up doors to preventive care that could reduce unnecessary suffering and waste of resources.
  - This could also help to reduced inequity between urban and rural areas.

[75] American Council for an Energy-Efficient Economy, Information and Communication Technologies: The Power of Productivity, February 2008
[76] American Council for an Energy-Efficient Economy, Information and Communication Technologies: The Power of Productivity, February 2008
[77] "Saving the Climate at the Speed of Light"
[78] "Saving the Climate at the Speed of Light"

# APPENDIX E: Operations Checklist

| | **Item** |
|---|---|
| 1 | Are all exterior doors kept closed? |
| 2 | Have all building "Infiltration" issues been addressed? (Doors, windows, cable openings, exterior walls? |
| 3 | If the building has an elevator, is there a "Use The Stairs" policy? |
| 4 | Are there "Turn-Off" lights reminders posted on switches throughout the building and on space exit doors? |
| 5 | Have all energy efficient lighting opportunities been addressed in the CO? |
| 6 | Have all prime areas for installing motion detection sensor switches for lighting been addressed? |
| 7 | Have all blockages of air vents by cable racks or equipment been addressed? |
| 8 | Are lights turned off in areas of the building where there are no people or activity? |
| 9 | Have all CO electric clocks been replaced with battery-powered clocks or eliminated? |
| 10 | Are cubical lights turned off at the end of the workday? |
| 11 | Have all portable heaters been removed? |
| 12 | Have all coffee pots, microwave ovens or any other appliances (refrigerators, TV's etc.) been provided by the company and located in a designated break area in accordance with corporate policy? |
| 13 | Are all computers, monitors and other peripheral equipment powered-down at end of tour? |
| 14 | Are printers & copiers on energy management, or turned off at end of workday? |
| 15 | Have the maximum number of older keysets been removed? |
| 16 | Are frame soldering irons being turned-off when not in use? |
| 17 | Have all freestanding fans in operation been identified as necessary? List the purpose/need. |
| 18 | Are CO personnel conducting their monthly and annual engine runs during Peak load periods? |
| 19 | Are stationery engine block heaters set at the correct temperature level? (80 – 120 degrees F.) |
| 20 | Have all 130VDC plant converters been reduced or eliminated? |
| 21 | Where multiple inverters are utilized, has office load been reviewed for opportunities to combine/eliminate inverters? |
| 22 | If Ferro-resonant rectifiers are used and are < 50 percent utilized, are the CO DC power plants being operated in the "Energy Management" mode? |
| 23 | Does DC Power Plant rectifier capacity exceed 200 percent of the load? |
| 24 | Have all transport equipment with minimal customers been combined and unnecessary equipment powered down? |
| 25 | Are technicians performing verification of Pair Gain 2B1Q span devices (UDCs), per established procedure, to removed all spare/unused cards? Unused, but powered, devices are a major consumer of energy. |
| 26 | Has all switch equipment with minimal customers been combined and unnecessary equipment powered down? |
| 27 | Have all unique energy consumption issues been identified and necessary. List all and why? |

# APPENDIX F: Property Manager Checklist

| | **Item** |
|---|---|
| | **LIGHTING** |
| 1 | Have all opportunities for energy efficient lighting (T-8 lamps) been addressed? If not, why? |
| 2 | Does interior light level meet corporate standards? |
| 3 | Are Exterior and Decorative lights operated only at appropriate times? |
| 4 | Have incandescent bulbs been eliminated wherever possible? |
| 5 | Are exit signs LED or Fluorescent? |
| 6 | Have occupancy sensors been installed in remote occupancy / prime areas? |
| | **POWER** |
| 7 | Phase Imbalance: Identify and record the voltage and current readings for each phase of AC. |
| 8 | Record commercial power company peak load information & date. |
| | **HEATING, COOLING and VENTILATION** |
| 9 | Have all air vents been cleared of blockages by cable racks or equipment? |
| 10 | Have all building "Infiltration" issues been addressed? (Doors, windows, cable openings, exterior walls, etc.)? |
| 11 | Are space temperature settings at corporate standards? |
| 12 | Is HVAC system in non-critical areas shut down during unoccupied periods? |
| 13 | Is the Economizer Cycle being used? |
| 14 | Are all non-critical exhaust fans shut off during unoccupied hours? |
| 15 | Are storage areas isolated and heated to no more than 60F? |
| 16 | Are air filters for heating/cooling clean? |
| 17 | Are HVAC coils clean? |
| 18 | Are static pressure set points set to design values? |
| 19 | Are ductwork/plenums/etc in good repair? |
| 20 | Are drive belts properly adjusted and in good condition? |
| 21 | Is pipe and duct insulation adequate and in good condition? |
| 22 | Are steam traps operating properly? |
| 23 | Do the boilers receive an annual Combustion Efficiency test? |
| 24 | Does the boiler start automatically based on the outside air sensor control? |
| 25 | Is the chiller condenser temperature being run as low as possible? |
| 26 | Does the chiller system start based on the outside air sensor control? |
| 27 | Are the cooling tower cells operating correctly with respect to the number of chillers? |
| | **MISCELLANEOUS** |
| 28 | Is the water heater temperature set correctly? |
| 29 | Have all portable heaters or mini fans been removed? |
| 30 | Is the roof insulated and in good repair? |
| 31 | Have all leaky faucets/fixtures been addressed? |

# APPENDIX G: ENERGY STAR Maintenance Staff Energy Efficiency Procedures Checklist

| | |
|---|---|
| 1 | Use T8 tubes and electronic ballasts for fluorescent lighting. |
| 2 | Use reflectors where appropriate. |
| 3 | Replace incandescents with compact fluorescent lamps. |
| 4 | Minimize discomfort from glare through the use of window blinds, lower ambient light levels, and task lighting. |
| 5 | Adjust operational schedules to ensure equipment is on only when necessary (including seasonal adjustments). Keep in mind that occupancy schedules may frequently change over time and may need to be adjusted accordingly. |
| 6 | If possible, schedule operations of certain equipment for utility off-peak hours. |
| 7 | Employ automatic controls in all applicable spaces. |
| 8 | Clean lamps, fixtures, and fixture diffusers to increase light output and decrease dirt depreciation. |
| 9 | Schedule group relamping and group cleaning to lower maintenance costs, and increase lighting performance and efficiency. |
| 10 | Check on thermostats and sensors out of calibration, and replace broken or poorly operating controls. |
| 11 | Seal air leaks in windows, doors, walls, and roofs with appropriate materials and techniques (weather-stripping on doors, proper insulation in walls and ceilings) to reduce air infiltration. |
| 12 | Use window films and interior and exterior shading to reduce radiation and other forms of heat transfer. |
| 13 | Check on leaky, broken or malfunctioning dampers, valves or steam traps. |
| 14 | Perform TAB (testing, adjusting, and balancing) on the HVAC system in situations where occupants have frequent complaints about hot or cold spots to ensure air supply and water flows match load requirements. |
| 15 | Make sure fans and pumps are operating at appropriate capacities. |
| 16 | Maintain and periodically clean filters and coils on the air distribution system to get rid of dirt and prevent blockage. |
| 17 | Clean heat exchanger tubes in the condenser, evaporator, and boiler to maintain optimal efficiency. |
| 18 | Avoid covering or blocking terminal fan coil units and baseboard radiators with books, boxes, or file cabinets which is a fire hazard and prevents proper air circulation. |
| 19 | Control ventilation rates to minimize energy loads by using time clocks that automatically reduce the rates during unoccupied periods. |
| 20 | Periodically inspect all areas of the facility to identify maintenance problems with equipment, changes to space use, etc. |
| 21 | Participate in regular training to learn about new technologies and maintenance procedures |

# Appendix H: Informational Resource to Facilitate Interactions with Legislators, Administrators, and Policy Makers

NOTE: The information in this appendix is for informational purposes only. It is not a position statement by ATIS, its members or the ICT industry.

The information and communications technology (ICT) industry is well positioned to help develop and advance solutions for reducing greenhouse gases (GHG), while protecting and promoting economic opportunities. To address the challenge of climate change, our country must consider new opportunities beyond conventional approaches. Harnessing the power of ICT is one of those new opportunities. Investment in the ICT sector can help strengthen the U.S. economy and transform the country to one that is less dependent on foreign oil. Here are a few reasons why:

- ICT promotes energy efficiency that results in reducing emissions.
- ICT promotes faster, more efficient and better informed decisions and actions.
- ICT decreases the importance of physical location of decision makers, workers and consumers.

The *SMART 2020: The U.S. Addendum* Report sponsored by the Global e-Sustainability Initiative in conjunction with the Climate Group, found that the ICT sector can enable GHG reduction six times larger than its own industry emissions.

ICT can play an important role in helping America reduce its dependence on fossil fuels, protect the environment, and promote innovation and growth. The full potential of ICT is on just beginning to be recognized. Examples of the ways in which ICT products/services can help reduce GHGs are detailed in section 8 of the *ATIS Report on Environmental Sustainability by Exploratory Group on Green,* March 2009, document and summarized as follows:

- Smart electric grid
- More efficient transportation – people, goods, and data
- Smart buildings, and
- Travel substitution

The sector has not been traditionally thought of as an enabler of GHG reduction, but studies show that the ICT sector can play a key – potentially unique – role. A few findings:

- ICT-enabled solutions could cut annual $CO_2$ emissions in the U.S. by up to 22 percent in 2020. This translates to gross energy and fuel savings of as much as $240 billion. (*SMART 2020*)
- A seven percent increase in broadband adoption could result in $6.4 billion per year in mileage savings from unnecessary driving and 3.2 billion fewer pounds of carbon emissions in the U.S. The equivalent to taking 273,858 cars off the road for a year. (Connected Nation)

- If we were to substitute video conferencing for 10 percent of business air travel, it would reduce carbon emissions in the U.S. by some 35 million tons annually. That's like saving the amount of energy it takes to provide electricity to more than 4.2 million homes each year. (American Consumer Institute)
- Widespread use of broadband has the potential to reduce carbon emissions by more than 1 billion metric tons. And that's equivalent to the annual $CO_2$ emissions of 215 coal fired power plants. (American Consumer Institute)

Any new regulation must encourage investment in the ICT sector. Additionally, any regulatory scheme should not stifle the substantial investments that ICT providers are undertaking.

- Consideration should be given to provide allowances or credits for the adoption of ICT in the context of a carbon-trading system, should such a system be adopted.
- Any regulatory scheme should encourage early action — to reward companies that have already taken action and encourage companies that have not yet started to do so now.
- The nation's broadband and communications infrastructure will play a critical role in efforts to reduce emissions and to ensure the full potential of ICT is reached, so policymakers must create a framework that incents investment and innovation.
- In short, any new legal or regulatory approach should promote collaborative innovation – not stymie it.

The ICT industry is "walking the talk" when it comes to collaborating with others to advance ICT solutions. ATIS member companies are partnering with other ICT companies and industry groups committed to the same environmental goals, such as:

- Collaborating with GeSI to produce U.S.-focused findings of the *SMART 2020* Report and policy recommendations – as announced on November 18 in Washington, D.C.
- Participating in The Green Grid and the EPA's ENERGY STAR data center initiative, and
- Developing industry standards for measuring and stating energy efficiency of telecommunications network equipment, as part of the ATIS Network Interface, Power and Protection – Telecommunications Energy Efficiency (NIPP-TEE) subcommittee.

Section 4 of the *ATIS Report on Environmental Sustainability by the Exploratory Group on Green,* March 2009, describes in detail the various initiatives and programs underway across a variety of standards bodies, industry groups, and government regulators. Some of the key technical based resources that are, or soon will be, available to legislators and policy makers include:

- *Equipment level metric* – ATIS TEER. This standard will provide ICT equipment manufacturers and service providers with a methodology to calculate the TEER of an individual piece of ICT equipment or network configuration. There will be separate TEERs for separate ICT equipment categories – just as there are with common kitchen appliances. Just as the ENERGY STAR rating of a refrigerator to a dishwasher cannot be compared, similarly, the TEER of a router to a fiber optic terminal will not be comparable. Comparison of the TEER of one router to the TEER of a similarly equipped competitive router will be possible. This tool will drive continuous improvement in the energy efficiency of virtually all types of ICT equipment.

- *Facility level metric* – Green Grid Power Usage Effectiveness and / or data center Infrastructure Efficiency (PUE / DciE). While not perfect, these metrics do allow for meaningful comparisons of facilities within similar geographical areas / meteorological patterns and data measurement methodologies.
- *Company level metric(s)* – ISO / TC207 and the GHG Protocol on environmental management.
- *Industry level* – ATIS, GeSI, CEA, ETSI, IEC, Green Grid, GIIC, and GSMA are some of the organizations working to promote ICT environmental best practices.

Actions legislators, administrators, and policy makers should consider, as outlined in *SMART 2020*: *The U.S. Addendum*:

- Recognize the important role ICT can play in realizing energy efficiency gains.
- Establish a national "Center of Excellence" to establish standards, metrics, consolidate and validate data, and share best practices.
- Encourage the deployment and adoption of ubiquitous broadband, since connectivity is the backbone of all ICT solutions.

# APPENDIX I: Acronyms

| | |
|---|---|
| 3GSM | 3rd Generation GSM |
| AC | Alternate Current |
| ANSI | American National Standards Institute |
| AS | Application Server |
| ASTM | American Society for Testing and Materials |
| ATIS | Alliance for Telecommunication Industry Solutions |
| B20 | Blends up to 20 percent |
| B2B | Business to Business |
| B2C | Business to Consumer |
| BBE | Broadband Equipment |
| BBU | Battery Backup Unit |
| BTS | Base Station Transceivers |
| C2G | Citizen to Government |
| CC | Climate Change |
| CD | Compact Disc |
| CDP | Carbon Disclosure Project |
| CE | Consumer Electronic |
| CEA | Consumer Electronic Association |
| CIO | Chief Information Officer |
| CO | Central Office |
| $CO_2$ | Carbon Dioxide |
| CoC | Code of Conduct |
| COP | Conference of the Parties |
| CPE | Consumer Premise Equipment |
| CREB | Clean Renewable Energy Bonds |
| CRT | Cathode Ray Tube |
| CSR | Corporate Social Responsibility |
| DC | Direct Current |
| DceP | Data Center Productivity |
| DciE | Data Center Infrastructure Efficiency |
| DG ENV | Environment Directorate-General |
| DG TREN | Transport and Energy Directorate-General |
| DOE | Department of Energy |
| DSL | Digital Subscriber Line |
| DVD | Digital Video Disc |
| EC | European Commission |
| ECMA | European Computer Manufacturers Association |
| EE | Environmental Engineering |
| EERE | Energy Efficiency and Renewable Energy |
| EEWG | Energy Efficiency Working Group |
| EGG | Exploratory Group on Green |
| EIA | Energy Information Administration |
| EICC | Electronic Industry Citizenship Coalition |
| EICTA | European Information & Communications Technology Industry Association |
| EPA | Environmental Protection Agency |
| EPACT | Energy Policy Act |
| EPEAT | Electronic Products Environmental Assessment Tool |
| ETNO | European Telecommunications Network Operators |
| ETSI | The European Telecommunications Standards Institute |
| EU | European Union |
| FCC | Federal Communications Commission |
| FEMP | Federal Energy Management Program |
| FG | Focus Group |

| | |
|---|---|
| FOT | Fiber Optic Terminals |
| FP | Framework Program |
| FTTx | fiber-to-the-x |
| GDP | Gross Domestic Product |
| GeSI | Global eSustainability Initiative |
| GHG | Greenhouse Gas |
| GIIC | Global Information Infrastructure Commission |
| GIS | Geographic Information System |
| GPM | Green Power for Mobile |
| GPS | Global Positioning System |
| GSI | Green Storage Initiative |
| GSM | Global System for Mobile |
| GSMA | GSM Association |
| GTCO2e | Gigatonne of Carbon Dioxide Emissions |
| HGI | Home Gateway Initiative |
| HNET | Home Networking |
| HVAC | Heating Ventilation and Air Conditioning |
| ICT | Information and Communication Technology |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| IOCG | Inter-operator Collaboration Group |
| IPCC | Intergovernmetnal Panel on Climate Change |
| IPTV | Internet Protocol Television |
| ISO | International Organization for Standardization |
| IT | Information Technology |
| ITC | Investment Tax Credit |
| ITP | Industrial Technologies Program |
| ITU | International Telecommunication Union |
| ITU-R | International Telecommunication Union- Radio |
| ITU-T | International Telecommunication Union- Telecommunications |
| JRC | Joint Research Center |
| KPI | Key Performance Indicators |
| KVM | Keyboard, Video, and Mouse |
| kWh | kilowatt-hours |
| LCA | Lifecycle Assessment |
| LEED® | Leadership in Energy and Environmental Development |
| LTE | Long Term Evolution |
| MTCO2e | Metric Ton of Carbon Dioxide Emissions |
| MTSO | Mobile Telephone Switching Office |
| NASA | National Aeronautics and Space Administration |
| NE | Network Element |
| NIPP | Network Infrastructure Power and Protection |
| NOAA | National Oceanic and Atmospheric Administration |
| NSF | National Science Foundation |
| OECD | Organization for Economic Co-operation and Development |
| OSP | Out Side Plant |
| PAR | Project Approval Request |
| PBX | Private Branch Exchange |
| POP | Point of Presences |
| PPM | Parts per Million |
| PTC | Production Tax Credit |
| PUE | Power Usage Effectiveness |
| PV | Photovoltaic |
| RA | Radiocommunication Assemblies |
| RBS | Radio Base Station |
| RCC | Resource Conservation Challenge |
| REACH | Registration, Evaluation, Authorization and Restriction of Chemical |

| | |
|---|---|
| | substances |
| RNC | Radio Network Controller |
| RoHS | Restriction of Hazardous Substances |
| ROI | Return on Investment |
| SA | Standards Association |
| SDO | Standards Development Organization |
| SG | Study Group |
| SMR | Switch Mode Rectifiers |
| SNIA | Storage Network Industry Association |
| SNW | Storage Networking World |
| STB | Set Top Box |
| SWAP | Size Wattage and Performance |
| TC | Technical Committee |
| TCO | Total Cost of Ownership |
| TDM | Time-Division Multiplexing |
| TEER | Telecommunications Energy Efficiency Rating |
| TOPS | Technology and Operations Council |
| TWG | Technical Working Group |
| U.S. | United States |
| ULSD | Ultra Low Sulfur Diesel |
| UMTS | Universal Mobile Telecommunications System |
| UN | United Nations |
| UNEP | United Nations Environment Program |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UPS | Universal Power Supply |
| USGBC | U.S. Green Building Council |
| VCR | Video Cassette Recorders |
| VoD | Video on Demand |
| WBCSD | World Business Council For Sustainable Development |
| WCDMA | Wide Band Code Division Multiple Access |
| WEEE | Waste Electrical and Electronic Equipment |
| WMO | World Meteorological Organization |
| WRC | World Radiocommunication Conferences |
| WRI | World Resource Institute |
| WWF | World Wildlife Fund |

# APPENDIX J: Exploratory Group on Green Members

| Company | Name |
|---|---|
| **Chair** | |
| Harris-Stratex Networks | Harald Braun, |
| | President & CEO |
| **Members** | |
| ADTRAN | Tom Dadmun |
| Alcatel–Lucent | Tom Orasinski |
| Alcatel-Lucent | Ken Biholar |
| AT&T | Steve Martin |
| AT&T | Steve Bernard |
| Bechtel | Brian Coombe |
| Bell Canada | Maarika Paul |
| BT | Paul Muschamp |
| Cisco Systems, Inc. | Art Reilly |
| Cisco Systems, Inc. | Paul Marcoux |
| Cisco Systems, Inc. | Leonid Rabinovich |
| Cisco Systems, Inc. | Luis Suau |
| Ericsson | Asfaw Negeri |
| Ericsson | Asok Chatterjee |
| Fujitsu | Jeff Holt |
| Harris-Stratex | Shaun McFall |
| Harris-Stratex | Vishnu Sahay |
| Huawei Technologies, USA | Mahmoud Elkenaney |
| Juniper Networks, Inc. | Daniel Kharitonov |
| NetTraffic | William Watkins |
| Nokia Siemens Networks | David Lewis |
| Nortel | Mahdi Smaoui |
| Qualcomm | Mark Epstein |
| Qwest | Mike Fargano |
| Qwest | Robin Seguin |
| Qwest | Pete Kawamoto |
| U.S. Cellular | Juan Victoria |
| Verivue | Rob Ryan |
| Verizon | Chuck Graff |
| Verizon | Craig Frost |
| Verizon | Todd Talbot |
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