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A standardization initiative for Green ICT

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ISO/IEC JTC 1 SWG-Planning[1]

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Abbreviations and acronyms:

This document uses the following abbreviations and acronyms:

AAU	Assigned Allocation Unit
AC	Alternating Current
ADSL	Asymmetric Digital Subscriber Line
API	Application Programming Interface
ASN.1	Abstract Syntax Notation One
ATIS	Alliance for Telecommunication Industry Solutions
ATTM	Terminals, Transmission and Multiplexing
BAU	Business-As-Usual
CATV	Cable Television
CC	Climate Change
CDM	Clean Development Mechanism
CE	Consumer Electronics
CPE	Consumer Premises Equipment
CSI	Climate Stabilization Intensity
DC	Direct Current
DCiE	Data Center infrastructure Efficiency
DES	ETSI Draft Standard
DNA	Designated National Authority
DOE	Designated Operational Entity
DSL	Digital Subscriber Line
DTR	Draft Technical Report
DTS	Draft Technical Specification
ECR	Energy Consumption Rating
EE	Environmental Engineering
EDGE	Enhanced Data rates for GSM Evolution
EMC	Electro Magnetic Compatibility
EMD	Energy Management Device
EN	European Standard
EPEAT	Electronic Product Environmental Assessment Tool
ETSI	European Telecommunications Standards Institute
EU	European Union
EuP	Energy using Products
FG	Focus Group

GDP	Gross Domestic Product
GHG	Green House Gas
GOS	Global Observing System
GSM	Global System for Mobile communication
HCFC	hydrochlorofluorocarbons
HSPA	High-Speed Packet Access
HVDC	Higher Voltage Direct Current
ICT	Information and Communication Technologies
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPCC	Intergovernmental Panel on Climate Change
ISMS	Information Security Management System
ISO	International Organization for Standardization
IT	Information Technology
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
JI	Joint Implementation
JCA	Joint Coordination Activity
JTC	Joint Technical Committee
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LTBP	Long Term Business Plan
LTE	Long Term Evolution
MIIM	Mobile Item Identification and Management
MM	Multimedia
NGN	Next Generation Networks
NIPP	Network Interface, Power and Protection
OECD	Organisation for Economic Co-operation and Development
PC	Project Committee
PCR	Product Category Rules
POSIX	Portable Operating System Interface for Unix

PPP	Polluters Pay Principle
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
PUE	Power Usage Effectiveness
QoE	Quality of Experience
QoS	Quality of Service
RFID	Radio Frequency Identification
RoHS	Restriction of Hazardous Substances
RTLS	Real-Time Locating System
SC	Sub-Committee
SDO	Standards Development Organization
SG	Study Group
SME	Small and Medium Enterprise
SWG	Special Working Group
TC	Technical Committee
TEER	Telecommunications Energy Efficiency Ratio
TR	Technical Report
TS	Technical Specification
TSAG	Telecommunication Standardization Advisory Group
UK	United Kingdom
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UPS	Uninterruptible Power Supply
USN	Ubiquitous Sensor Network
VDSL	Very high bit rate Digital Subscriber Line
WBCSD	World Business Council for Sustainable Development
WCDMA	Wideband Code Division Multiple Access
WD	Working Draft
WEEE	Waste Electrical and Electronic Equipment
WiMAX	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WMO	World Meteorological Organization
WG	Working Group
WP	Working Party
WRI	World Resources Institute

Conventions:

This document uses the following convention:

XXs	XX is an abbreviation or acronym and XXs means the plural notation of the abbreviation or acronym. For example, WGs means Working Groups.

Executive summary

1. Objective

This review document is the output of the SWG-Planning to meet the Resolution 32 of the Nara meeting, November 2008, of ISO/IEC JTC 1, dealing with standardization opportunities of JTC 1 in the field of Green IT.

2. Key terminologies

A few confusing terminologies such as IT vs. ICT, Green IT vs. Green ICT, and Green ICT vs. ICT sustainability were clarified to review the green initiative. The JTC 1 Long Term Business Plan (LTBP) defined the meaning of "ICT" as the convergence of IT, consumer electronics and telecommunications. The ICT includes the specification, design and development, integration and interoperability of systems, tools and applications dealing with the capture, representation, accessibility, processing, security, transfer, interchange, presentation, management, organization, storage and retrieval of information, and their related cultural, linguistic adaptability and societal aspects. Thus JTC 1 standardization activities naturally contribute to the overall ICT field.

There are four factors to see the green initiative called the Green ICT: reducing the use of hazardous materials; recycling and reusing ICT products; maximizing energy efficiency; and utilizing ICT products and technologies into other sectors for environmental improvement. The beginning three factors are handled by a subsidiary terminology of the Green of ICTs which means environmental improvement of ICT products and technologies within the ICT sector. The last factor is handled by the other subsidiary terminology of the Green by ICTs which means environmental improvement of other sectors by using ICT products and technologies. Therefore the Green ICT consists of both the Green of ICTs and the Green by ICTs.

The sustainability is still a vague term but has been conceived as all of human activity to meet current needs without hindering the ability to meet the needs of future generations in terms of economic, environmental and social challenges. It may be described in different words as a means of configuring civilization and human activity so that society and its members are able to meet their needs and express their greatest potential in the present while preserving biodiversity and natural ecosystems, and planning and acting for the ability to maintain these ideals indefinitely. Similarly to the Green ICT, the ICT sustainability may be taken into account by consideration of the sustainability of ICT products and technologies as well as the sustainability of using ICT products and technologies. That is, the Green ICT is one of methods to realize the sustainable society.

3. Market needs

There may be various market needs for the Green ICT but this document summarized three ones: lawful and political policies; energy efficiency requirements; and new profit models.

An international treaty may cause domestic laws and regulations to each relevant country. The UNFCCC imposed voluntary GHG emission targets to member countries and the

Kyoto Protocol imposed compulsory GHG emission targets to cope with the problem of a voluntary management system. The GHG emission targets are national-level commitments and most countries devolve their emission targets to individual entities according to their domestic laws and regulations. The Kyoto Protocol specified three flexible mechanisms such as Emissions Trading, Clean Development Mechanism and Joint Implementation to support GHG reduction activities of relevant entities. Most countries have prepared corresponding laws and regulations to enable the flexible mechanisms.

Every business entity may be forced to improve energy efficiency not only by lawful requirements but internal cost saving and external price cutting requirements. Additionally energy efficiency labelling schemes help penetrate ICT industries to tackle energy efficiency for their products and technologies.

The flexible mechanisms of the Kyoto Protocol provide financial incentives to ICT industries of which energy consumption reductions may be transformed into profits. GHG reductions are translated into energy savings which are associated with a new profit model in conjunction with the emissions trading and CDM programs. The efforts of power savings of ICT business fields result in cost savings and corresponding GHG reduction can make a profit on the trading of emission allowances. Thus, ICT sectors may enjoy money making as well as cost saving by the Green ICT activities.

4. Relevant standardization activities

There are some green-relevant standardization activities. Some of them are related directly to the Green ICT but others are related indirectly. The direct relationship means the activities are handling Green ICT issues and the indirect relationship means the activities are handling general environment protection issues and affecting Green ICT fields.

The standardization activities of IPCC, UNFCCC, GHG Protocol Initiative, ISO TC 207 and ISO PC 242 have the indirect relationship but those of IEC TC 100, IEC TC 111, ITU-T SGs, ETSI, ATIS and Ecma have the direct relationship.

The Intergovernmental Panel on Climate Change (IPCC) developed national GHG inventory standards which support the national territory concept that means national inventories include GHG emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction, and provide methodologies for estimating national inventories of anthropogenic emissions by GHG sources and removals by GHG sinks.

The United Nations Framework Convention on Climate Change (UNFCCC) manages the flexible mechanisms of the Kyoto Protocol and handles Designated National Authorities (DNA) for management of GHG portfolios of all member countries and Designated Operational Entities (DOE) for validation and verification of CDM project activities. It maintains also baseline and monitoring methodologies for CDM project activities and supports 15 sectoral scopes as of May 2009. Each sectoral scope has a few or several specific methodologies. The ICT sector is not covered yet.

The GHG Protocol Initiative developed two leading standards: *"A Corporate Accounting and Reporting Standard"* and *"The GHG Protocol for Project Accounting."* The corporate standard provides a step-by-step guide for organizations to use in quantifying and reporting their GHG emissions. The project protocol provides specific principles, concepts, and methods for quantifying and reporting GHG reductions – i.e., the decreases in GHG emissions, or increases in removals and/or storage – from GHG mitigation projects. These

standards do not cover how to verify GHG accounting results. This is the reason why ISO TC 207 has developed validation and verification standards. The GHG Protocol Initiative released sectoral calculations tools for GHG accounting. The tools are electronic Excel spreadsheets with accompanying step-by-step guidance documents. The ICT sector is not covered yet.

ISO TC 207 covers standardization in the field of environmental management tools and systems and has developed a set of standards to provide a general framework for environmental management. Its environmental labelling standards can provide information about a product in terms of its overall environmental character and/or a specific environmental aspect. Its Life Cycle Assessment (LCA) standards can address environmental aspects and potential environmental impacts (e.g. use of resources and the environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production and use to recycling and final disposal (i.e. cradle-to-grave). Its GHG management standards can support GHG accounting and reporting for organizations and development projects, validation and verification for GHG assertions, accreditation requirements for GHG validation and verification bodies, competency requirements for validators and verifiers, and carbon footprinting methodology for products. ISO TC 207 standards are industry-neutral ones and specify general principles and requirements. The ICT sector also may utilize them. But sector-specific guidance may be needed to help organizations get easier understanding and adoption.

ISO PC 242 deals with managing energy usages and is going to establish a framework for all types of organizations (industrial, commercial, institutional, large residential, and transportation sectors) as well as emerging economies and small and medium enterprises (SMEs) to manage their energy usage. The framework targets broad applicability across national economic sectors. It is expected to support the ICT sector also.

IEC TC 100 considered development of an international system of energy consumption classes including a labeling scheme to determine the energy consumption and energy efficiency of consumer electronic products, such as TV sets, set-top boxes, cable modems, DSL routers, etc. It also took into account both stand-by losses and off-mode losses in its product standards. IEC TC 100 got a proposal in 2008 for an energy saving system for home appliances and home network devices to tackle those energy losses. Since then, it is expected that IEC TC 100 has progressed relevant standards development works.

IEC TC 111 handles environmental standardization for electrical and electronic products and systems, dealing with determination of levels of six regulated and hazardous substances, environmentally conscious design and recycling for electrical and electronic products.

The European Telecommunications Standards Institute (ETSI) has worked on Green ICT issues such as energy consumption reduction, energy consumption measurement methods, and input power supply interface in telecommunication equipments, energy efficiency of wireless access network equipments, environmental impact assessment of ICT, power optimization for xDSL transceivers and alternative energy sources. Some of them have already been finished and some of them are on-going works.

The Alliance for Telecommunications Industry Solutions (ATIS) develops a document or suite of documents for use by ICT service providers to assess the true energy needs of equipments at time of purchase such as: energy use as a function of traffic; energy use as a function of environmental conditions; cooling requirements; suitability of a product for use with renewable energy sources; improvements in environmental footprint through LCA; standby and off-mode definitions; and standby and off-mode losses. It also provides the

methodology to be used by vendors and third party test laboratories in the formation of a Telecommunications Energy Efficiency Ratio (TEER).

The Ecma International also is dealing with energy efficiency issues for consumer electronics products. Especially it is developing measurement methods for energy consumption, performance and capabilities of ICT and consumer electronics products; energy saving network proxy for ICT devices; and environmental design for ICT and consumer electronics products.

ITU-T established the Focus Group on ICTs and Climate Change in July 2008 and took into account two study points: reducing energy consumption in ICT products and helping other sectors reduce their energy consumption. The Focus Group developed four Deliverables as follows:

- Deliverable 1, Definitions, deals with terms and definitions needed for the Deliverable 3 work. Definitions of unit(s) of energy and unit(s) of efficiency were highlighted as key.
- Deliverable 2, Gap analysis, deals with existing standards development activities to avoid "reinventing the wheel." Priority areas identified were to quantify the reduction of energy by using ICTs as a service substitute, a carbon calculator standard to compare short and long term benefits of different ICT networks and systems, and energy savings checklists for standardization activities.
- Deliverable 3, Methodology, aims to provide an internationally agreed method of calculating two elements – the energy usage and carbon impact arising from the ICT sector over the entire life cycle of ICT devices, and the mitigation that can be achieved by substituting ICT services and devices for intensive fossil-fuelled activities such as travel and transport through dematerialization.
- Deliverable 4, Direct and indirect impact of ITU-T standards, handles tools (e.g. Checklists) and guidelines to allow ITU-T Study Groups to evaluate, for each Question, the possible future CO2e reduction of technologies in terms of direct emissions from ICTs and possible savings in terms of Climate Change mitigation from the use of ICTs.

ITU-T SG 5 succeeded the Focus Group from May 2009. It established 5 Questions as follows:

- Q.17/5, Coordination and Planning of ICT&CC related standardization
- Q.18/5, Methodology of environmental impact assessment of ICT
- Q.19/5, Power feeding systems
- Q.20/5, Data collection for Energy Efficiency for ICTs over the lifecycle
- Q.21/5, Environmental protection and recycling of ICT equipments/facilities

Their standardization activities will start from the next meeting held in Geneva, October 12-16, 2009.

5. Gap analysis

Based on the existing standardization activities, following gaps were identified:

SDOs	Gaps
IPCC,	IPCC, GHG Protocol Initiative and ISO TC 207 have developed GHG

ISO TC 207, GHG Protocol Initiative	accounting standards separately for nations, organizations and projects. Additionally new GHG accounting standards may be needed for ICT systems or services and quantification of GHG reductions of other sectors by adopting ICT products and technologies needs to be provided. Also a systematic framework of GHG accounting standards is needed to incorporate different standards for all types of GHG accounting.
UNFCCC	UNFCCC does not have any CDM methodology for ICT areas such as green data center installations and green network establishments. A set of CDM methodologies needs to be developed for the ICT sector.
GHG Protocol	The GHG Protocol standards are industry-neutral ones and the ICT sector may use the standards. The GHG Protocol Initiative developed a set of practical guidance for several business sectors but the ICT sector is not supported. It may be required to develop practical guidance on how to incorporate GHG Protocol standards with taking account into ICT sector's characteristics.
ISO TC 207	The ICT sector may establish an environmental labelling scheme to promote low carbon ICT products. It may utilize ISO TC 207 standards but it needs to develop specific standards such as Product Category Rules (PCR) specifications based on the standards. Additionally LCA and carbon footprinting methodologies for ICT products need to be provided to the ICT sector.
ISO PC 242	The ICT sector may need practice guidance or a profile specification to use the general framework standard, ISO 50001, to cover ICT-specific characteristics.
IEC TC 100	ICT equipments also have the same concern about stand-by and off-mode energy consumptions.
IEC TC 111	IEC TC 111 is maintaining environmental protection and recycling matters for ICT hardware equipments. ISO/IEC JTC 1 has not worked on the environmental protection and recycling area and IEC TC 111 seems to cover every work item for the environmental protection and recycling of ICT products. But ISO/IEC JTC 1 needs to pay attention to the environmental protection and recycling issue because it is handling various ICT hardware equipments.
ETSI	All of ETSI works can be covered by JTC 1. Thus some collaboration is needed. But GHG accounting for the ICT sector is a missing part.
ATIS	ATIS standards cover energy use as a function of traffic, energy use as a function of environmental conditions, standby and off-mode losses, etc. An LCA of an ICT product shall cover these energy consumption factors. Thus, the ATIS works need to be aligned and integrated with a certain ICT-sector LCA methodology. But the ATIS doesn't intend to develop such LCA methodology but use an existing solution.
Ecma	Ecma has worked on measurement and improvement of energy efficiency for ICT and consumer electronics devices. It has similar work scopes to those of ETSI, ATIS and ITU-T. ISO/IEC JTC 1 also has the same concern.
ITU-T SGs	ITU-T SG 5 is at its initial stage yet but has discussed mainly on

	clarification of GHG mitigation techniques; environmental impact assessment methodologies for contribution by the Green of ICTs and the Green by ICTs, including ICT sector-specific LCA methodology and carbon footprint assessment methodology for ICT products based on LCA standards; DC power feeding system; energy efficiency metrics; universal power adapter for mobile cell phones; and environmental protection and recycling. ITU-T SG 5 has not considered much yet GHG accounting and reporting responsibility of ICT organizations.

6. Prospective standardization areas and topics for JTC 1

From the gap analysis results, the following ideas may be taken into account for standardization:

- Systematic framework standard for GHG accounting and reporting for the ICT sector (see Clause 6.1)
- Guidance on GHG accounting and reporting for ICT organizations (see Clause 6.3 and 6.4)
- Guidance on GHG accounting and reporting for ICT GHG projects (see Clause 6.3 and 6.4)
- A set of guidance and/or standards on GHG accounting and reporting for ICT systems, networks or services, and ICT facilities (see Clause 6.1)
- GHG inventory design guide for the ICT sector (see Clause 6.6)
- Carbon footprint assessment for ICT products (see Clause 6.4)
- LCA design guide for ICT products (see Clause 6.4)
- ISO 14025 Type III environmental labelling scheme for ICT products (see Clause 6.4)
- PCR specifications for ICT products (see Clause 6.4)
- CDM methodologies for the ICT sector (see Clause 6.2)
- Home and building energy management systems (see Clause 6.5)
- Environmental impacts assessment metrics for contribution by the Green ICT (see Clause 6.6)
- Environmental impacts assessment for contribution by the Green by ICTs (see Clause 6.6)
- Environmental protection and recycling (see Clause 6.6 and 6.11)
- Energy efficiency assessment methodologies for ICT products, including measurement of energy efficiency (see Clause 6.6, 6.7, 6.8 and 6.9)

In addition to those ideas for consideration by the gap analysis, the Green ICT market needs may ask the following standardization items:

- Reference model of the Green ICT technologies

- Common methodology for measurement of energy efficiency for the most energy consuming sectors (power plant, transportation, iron and steel, cement, lighting, building, industry, etc.)
- Document life cycle management
- Green data center standards such as Guidance for establishment of the green data centers; Battery specification; Energy efficiency measurement methods for data center equipments such as Power Supply Unit (PSU), server systems, AC/DC rectifiers, DC/DC converters, etc.; Data center energy efficiency methodology; and DC power distribution issues: DC power voltage, outlet and connector types.
- Real-time energy consumption monitoring
- CO2 emissions monitoring standards such as an operation architecture, network connections, data presentation, application interfaces, management, etc.
- Cloud computing
- Smart Grid standards such as Demand-based power generation system architecture; Efficiency test methodology for power generation systems; Renewable energy reservoir and real-time distribution technology; Power distribution architecture supporting power stability against accidents; Power price-based power distribution control standard; Data format for smart metering of integrated power, gas and water works; Smart metering-relevant standards for device networking, device platform and communication interfaces.

7. Recommendations for the green initiative of ISO/IEC JTC 1

After discussions about this review document, the SWG-Planning reached consensus on, as follows:

- All the expected items cannot be resolved by a certain option but has to be treated by a set of multiple options.
- The energy efficiency is involved with every standardization work. For example, each layer of the OSI Reference Model includes its own energy efficiency issues. Thus JTC 1 SCs need to study the energy efficiency within their work scopes.
- The building and home energy management systems seem involved with the work of JTC 1 SC 25. It needs to take account into them for standardization.
- The cloud computing can improve the energy efficiency for ICT hardware systems. But its standardization areas overwhelm the energy efficiency issue and needs to be considered separately from the Green ICT.
- The Smart Grid technologies have been developed so far and there are some relevant standardization activities. A further study is needed to identify market requirements and standardization gaps with particular attention to standards supporting the interoperability of Smart Grid technologies and necessary international standardization.
- The energy efficiency of data centers is a significant topic in the industry and a further study is needed to understand the current state of market requirements and relevant standardization activities and to explore a possible role for JTC 1.

- The best practices for green standards development needs to be studied to survey best practices for green technologies development and to document recommended attributes for JTC 1 standards development.

Finally the SWG-Planning prepared three key recommendations to establish one ad-hoc group, one Study Group and one SWG for further Green ICT study activities. Thus the following groups will be recommended to be established for the green initiative of ISO/IEC JTC 1:

- Establishment of an ad-hoc group on the best practices for green standards
- Establishment of a Study Group on Energy Efficiency of Data Centers
- Establishment of a Special Working Group on Smart Grid

A standardization initiative for Green ICT

1. Scope

At its last meeting held in Nara, Japan, 10-15 November 2008, ISO/IEC JTC 1 made the Resolution 32 to instruct its Special Working Group(SWG)-Planning to explore standardization opportunities in the field of Green IT, sustainability in IT and related areas in cooperation with relevant JTC 1 SCs, other technical committees, Liaison Organizations and fora. It also delegated authority based on the results of its research to its SWG-Planning to propose actions, as appropriate, to progress this work, and instructed the SWG-Planning to provide a report together with appropriate recommendations at the next JTC 1 Plenary meeting.

This document intends to provide an overall review on the specified topics in terms of exploration of standardization opportunities. The SWG-Planning will make the report based on this review result.

This review document deals with:

- reviewing current definitions and scopes of the Green ICT within and outside JTC 1;
- reviewing market needs to clarify standardization requirements;
- analysing standardization activities in international standardization bodies, consortia and fora where specifications related to the Green ICT are being developed;
- identifying standardization gaps for progress of the Green ICT; and,
- proposing prospective standardization areas and topics toward ISO/IEC JTC 1.

[Note] Even though the Nara Resolution 32 mentioned "Green IT," this study document took "Green ICT" instead of it because the LTBP of ISO/IEC JTC 1 identified ICT is the more suitable term than IT. See 3.1 in detail.

2. Review of ISO/IEC JTC 1 scope

Since this document is identifying prospective standardization topics within the scope of ISO/IEC JTC 1, it needs to review the work scopes of JTC 1.

ISO/IEC JTC 1 deals with all matters of standardization in the field of ICT, which include the specification, design and development of systems and tools dealing with the capture, representation, processing, security, transfer, interchange, presentation, management, organization, storage and retrieval of information. Its mandate is to develop, maintain, promote and facilitate ICT standards required by global markets meeting business and user requirements concerning:

- design and development of ICT systems and tools;
- performance and quality of ICT products and systems;
- security of ICT systems and information;
- portability of application programs;
- interoperability of ICT products and systems;

- unified tools and environments;
- harmonized ICT vocabulary; and
- user friendly and ergonomically designed user interfaces.[1]

ISO/IEC JTC 1 is composed of one WG on ICT governance, four SWGs on accessibility, strategic planning, archival and retrieval mechanisms, and directives recommendation, and 18 SCs. The work scopes of 18 SCs are described in Annex II of which contents are culled from their business plan.

3. Clarifications of Green IT, Green ICT and ICT Sustainability

3.1. IT vs. ICT

First of all, IT and ICT need to be clarified to pursue the Green IT and Green ICT. ISO/IEC JTC 1 N 9475 includes the JTC 1 Long Term Business Plan (LTBP) approved as the Nara Resolution 35 and contains a clarification on the ICT.

The document N 9475 reads, *"The concept of ICT takes into account the impact of digital techniques towards the convergence of various domains and technologies into a more global domain called ICT. Convergence is occurring in two dimensions:*

- *The three basic technologies - IT, consumer electronics and telecommunications – converge in the sense that the same fundamental technologies are applied in all three areas. This can be termed horizontal convergence; the resulting technology is often called ICT. The advent of ICT demands a closer overall cooperation, in the standardization arena, among the 3 key international standards organizations: ISO, IEC and ITU.*
- *Simultaneously, ICT progresses into all aspects of life (business, industry, home, administration, education, charity, etc.), with conventional processes and applications now exploiting the capabilities offered by ICT. This may be termed vertical convergence. New ICT applications are characterized by the involvement of different technologies and high complexity; in general, they cannot be covered by a single standard, but are of an interdisciplinary nature. This demands a closer cooperation between technology-oriented and application-oriented experts, both in product and in standards development.*

ICT includes the specification, design and development, integration and interoperability of systems, tools and applications dealing with the capture, representation, accessibility, processing, security, transfer, interchange, presentation, management, organization, storage and retrieval of information, and their related cultural, linguistic adaptability and societal aspects. JTC 1 standardization activities naturally contribute to the overall ICT field and take into account the additional elements included in the ICT definition (vs. IT definition)."

Thus ISO/IEC JTC 1 identified ICT as a broad concept incorporating convergence of IT, consumer electronics and telecommunications and has endorsed the following vision statement:

"JTC 1 is the standards development environment where experts come together to develop worldwide Information and Communication Technology (ICT) standards for business and consumer applications. Additionally, JTC 1 provides the standards approval environment for integrating diverse and complex ICT technologies. These standards rely upon the core

infrastructure technologies developed by JTC 1 centers of expertise complemented by specifications developed in other organizations."

3.2. Green IT vs. Green ICT

ISO/IEC JTC 1 defined for its standardization initiative that the ICT is more appropriate than IT. Thus the SWG-Planning takes the Green ICT instead of the Green IT even specified by the Resolution 32 of ISO/IEC JTC 1.

The Green ICT is being considered from two viewpoints in its market: *"Green of ICTs"* which means the environmental improvement of ICTs for themselves within the ICT sector, and *"Green by ICTs"* which means the environmental improvement of other sectors by using ICT technologies and products where the environmental improvement is accomplished by the four green factors described below. According to the market consensus, the Green ICT should cover both study points: the Green of ICTs and the Green by ICTs.

The ICT sector represents 2% of EU 25 GHG emissions in 2005 and is estimated to represent 4.5 % in 2020, considering the use phase only. Figure **1** shows an annual electricity consumption scenario of the ICT sector for the Business-As-Usual case. The EU 25 countries consumed 214 TWh, equivalent to about 93 MtCO2e and are prospected to consume 409 TWh in the year 2020.[2]

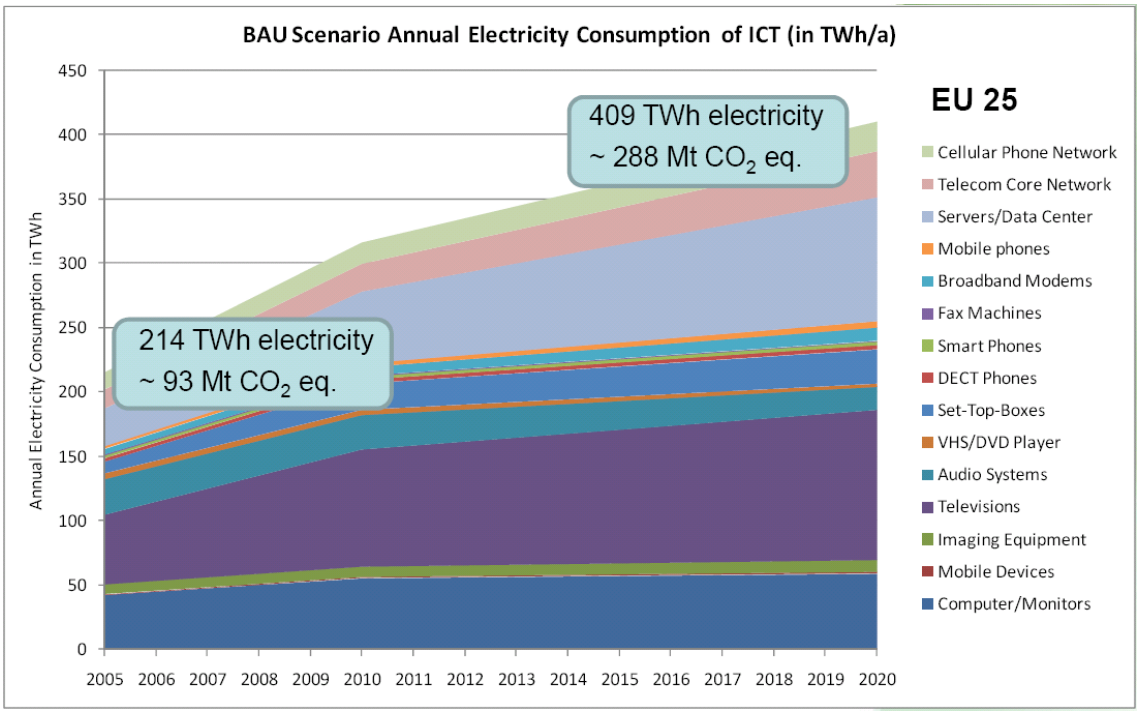

Figure 1 – BAU scenario annual electricity consumption of ICT

But if the ICT sector applies various energy efficiency techniques and approaches to ICT equipments, it is prospected that the ICT sector can save 121.5 TWh, i.e., 55.7 MtCO2e in 2020.

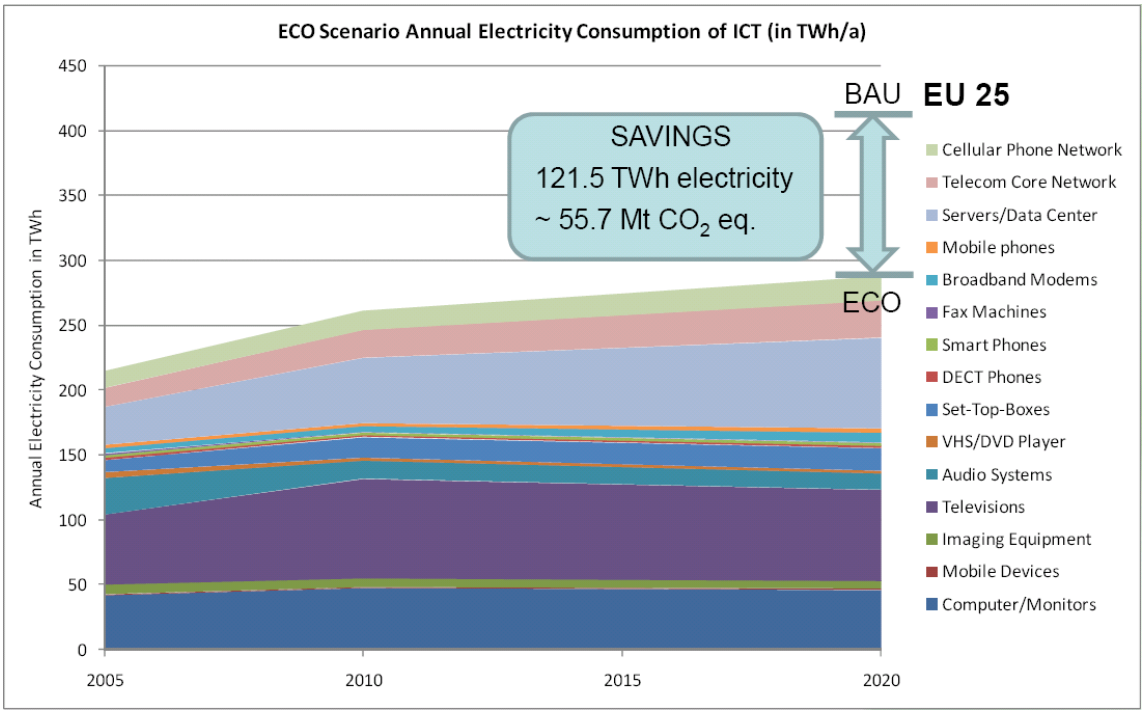

Figure 2 – Eco scenario annual electricity consumption of ICT

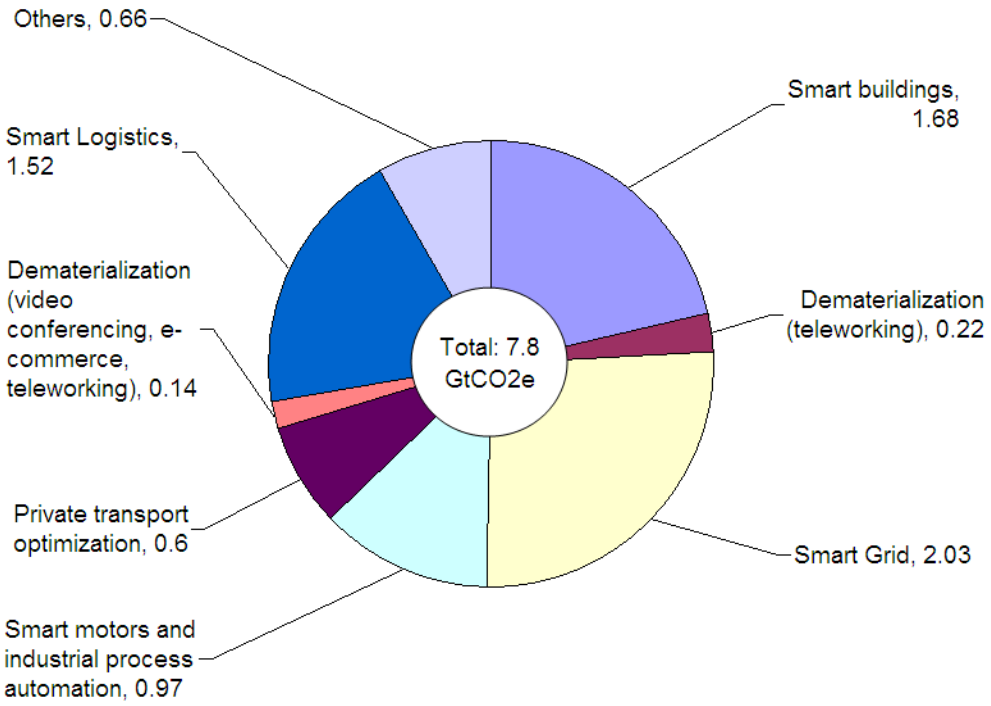

Figure 3 – Possible ICT-enabled savings in GHG emissions 2020, GtCO2e

Thus the Green of ICTs is a significant target to save energy consumption and reduce ICT-sector GHG emissions.

The Green by ICTs can save more energy consumption and reduce GHG emissions. That is, The ICT sector has a powerful role to play in tackling climate change by enabling other

sectors, such as transport, buildings, power and industry, to become more efficient. The Global eSustainability Initiative found that ICTs could reduce global carbon emissions by 7.8 GtCO2e by 2020 (from an assumed total of 51.9 GtCO2e if we remain on a BAU trajectory), an amount five times larger than its own carbon footprint. Savings from avoided electricity and fuel consumption would reach $946.5 billion. Figure **3** shows the opportunities of ICT reducing GHG emissions by sector.[3]

The *"Green"* of ICTs covers three goals to protect the environment and abate ICT sector's own GHG emissions:[4]

- reducing the use of hazardous materials;
- recycling defunct ICT products and ICT wastes, and reusing ICT products; and
- maximizing energy efficiency.

The *"Green"* by ICTs deals with how to bring ICT technologies and products into other business sectors for energy savings. Thus the Green ICT industry should care for all of these four objectives by the Green of ICTs and the Green by ICTs.

The European Union (EU) has tackled the three environmental ICT targets since 2003 and forced relevant Directives. The Restriction of Hazardous Substances Directive (RoHS Directive, 2002/95/EC) restricts the use of six hazardous materials (i.e. Lead, Mercury, Cadmium, Hexavalent chromium (Cr6+), Polybrominated biphenyls (PBB), and Polybrominated diphenyl ether (PBDE)) in the manufacture of various types of electronic and electrical equipment. The Waste Electrical and Electronic Equipment Directive (WEEE Directive, 2002/96/EC) sets collection, recycling and recovery targets for all types of electrical goods and imposes the responsibility for the disposal of waste electrical and electronic equipment on the manufacturers of such equipment. The Energy using Products Directive (EuP Directive, 2005/32/EC) requires improvements in energy efficiency throughout a products lifecycle, from the mining of the raw material through to recycling of end-of-life. Its focus is on the design phase since it is considered that this is the determining stage affecting the resources used in a product. The EuP Directive does not apply to means of transport (planes, cars etc.) but, apart from this, the scope is deliberately broad, covering, in principle, any product which when in use depends on, generates, transfers or measures energy (electricity, fossil fuel or renewable).

3.3. Green ICT vs. ICT sustainability

The ICT sustainability replaces the IT sustainability by the same reason described in the beginning paragraph of the clause 3.2.

[Note] ISO 14021 states, "The concepts involved in sustainability are highly complex and still under study. At this time there are no definitive methods for measuring sustainability or confirming its accomplishment. Therefore, no claim of achieving sustainability shall be made." As of June 2009, ISO TC 207/SC 3 is developing Amendment 1 to ISO 14021 to incorporate additional symbols and additional selected claims. The draft Amendment includes for the usage of "sustainable" that "Clause 5.5 states that self declared claims of achieving sustainability shall not be made. However the terms "sustainable," "sustainability" and "sustainable development" are becoming widely used in environmental labelling, and are frequently misused. It is re-emphasised in this clause that the terms "sustainable" and "sustainability" shall not be used in self declared environmental claims." The Amendment is

at an initial state and this amended requirement may be changed in the future. But it shows a consensus on avoidance of such usages.

The original term of sustainability was *"sustainable development"* adopted by a series of conferences of the United Nations. The most widely used definition of sustainable development is *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* The United Nations Environment Programme (UNEP) position for the sustainable development is *"the intensified and unsustainable demand for land, water marine and coastal resources resulting from the expansion of agriculture and uncontrolled urbanisation lead to increased degradation of natural ecosystems and erode the life supporting systems that uphold human civilisation. Caring for natural resources and promoting their sustainable use is an essential response of the world community to ensure its own survival and well being. (Source:* Sustainable Management and Use of Natural Resources*)"*[5]

Currently *"sustainability"* has been used as an umbrella term for all of human activity to meet current needs without hindering the ability to meet the needs of future generations in terms of economic, environmental and social challenges. Because it was insisted that the term, *"sustainable development"* implies continued development and the term should be reserved only for development activities. The sustainability may be defined as a means of configuring civilization and human activity so that society and its members are able to meet their needs and express their greatest potential in the present while preserving biodiversity and natural ecosystems, and planning and acting for the ability to maintain these ideals indefinitely.[5]

The sustainability is a general terminology to state a visionary goal for the sustainable society of the human beings. Every business and technology sector shall do appropriate actions within its scope and with its capabilities for other sectors. The three goals of the Green of ICTs are some of the methods to meet the sustainability by the ICT. Moreover the Green by using ICT products such as video conferencing, teleworking, web contact centers and distance learning is another method. That is, ICT technologies make positive impacts to other business sectors as well as the ICT sector and help them for their sustainable development. As shown in Figure **3**, the Green ICT can contribute significantly to sustainability through the enabling of more efficient processes and infrastructures.

Consequently the Green ICT is a solution for the sustainability and ISO/IEC JTC 1 should study ICT standardization aspects for the Green ICT.

4. Market needs

Market needs for the Green ICT may be created by various reasons such as lawful and political policies, consumer and customer requirements, and new profit models. The Green ICT can also be profitable by itself as shown in Figure **3**.

4.1. Lawful and political policies

Market needs of the Green ICT were initiated by international treaties of member nations, and subsequently by domestic laws and regulations of each member nation because any international agreement of a country may make corresponding domestic laws and regulations and will affect its business markets.

4.1.1. International treaties

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty that is aimed at stabilizing greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with the climate system. It was opened for signature in May 1992 and entered into force on March 21, 1994. Signatories to the UNFCCC are split into three groups:

- Annex I countries (industrialized countries)
- Annex II countries (developed countries which pay for costs of developing countries)
- Developing countries.

Annex I countries agree to reduce their emissions of greenhouse gasses to targets that are mainly set below their 1990 levels. They may do this by allocating reduced annual allowances to the major operators within their borders. These operators can only exceed their allocations if they buy emission allowances, or offset their excesses through a mechanism that is agreed by all the parties to the UNFCCC. Annex II countries are a sub-group of the Annex I countries. They comprise the OECD members, excluding those that were economies in transition in 1992. Developing countries are not expected to de-carbonize their economy unless developed countries supply enough funding and technology. Setting no immediate restrictions under the UNFCCC serves three purposes:

- it avoids restrictions on their development, because emissions are strongly linked to industrial capacity;
- they can sell emissions credits to nations whose operators have difficulty meeting their emissions targets; and
- they get money and technologies for low-carbon investments from the developed countries in Annex II.

Developing countries may volunteer to become Annex I countries when they are sufficiently developed.[6]

The treaty as originally framed set no mandatory limits on GHG emissions for individual nations and contained no enforcement provisions; it is therefore considered legally non-binding. Rather, the treaty included provisions for updates (called *"protocols"*) that would set mandatory emission limits. The principal update is the Kyoto Protocol, which has become much better known than the UNFCCC itself.[6]

The Kyoto Protocol is an agreement under which industrialized countries will reduce their collective emissions of greenhouse gases by 5.2% compared to the year 1990 (but note that, compared to the emissions levels that would be expected by 2010 without the Protocol, this limitation represents a 29% cut). The goal is to lower overall emissions of six greenhouse gases – carbon dioxide ($CO_{2)}$, methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs), averaged over 2008 to 2012. National limitations range from 8% reductions for the European Union and some others to 5% for Croatia, 6% for Japan, 0% for Russia, and permitted increases of 8% for Australia and 10% for Iceland. The Kyoto Protocol establishes legally binding commitments for the reduction of six greenhouse gases. As of February 2009, 183 parties have ratified the protocol, which was initially adopted for use on 11 December 1997 in Kyoto, Japan and which entered into force on 16 February 2005.[7]

4.1.2. Domestic laws and regulations

As described in Clause 4.1.1, although the GHG emission targets imposed by the Kyoto Protocol are national-level commitments, in practice most countries devolve their emissions targets to individual industrial entities. This devolvement is enforced by their domestic laws and regulations.

In November 2008, the United Kingdom made the Climate Change Act 2008 that states the GHG emission target for 2050 as follows: *"It is the duty of the Secretary of State to ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline."* The act covers amendment of 2050 target or baseline year, carbon budgeting for each succeeding period of five years beginning with the period 2008-2012, carbon units, carbon accounting, the net UK carbon account, procedure for regulations, national reports and programmes, reporting authorities, trading schemes, etc.[8]

Korea prepared a climate change correspondence law that is anticipated to be passed in 2009 by its National Assembly. It includes:

- a requirement of annual, mid-term and long-term emission targets until 2050 of which specific target values will be defined in other subsidiary laws;
- adoption of the cap and trade system for allowances;
- tax incentives and penalties;
- emission reductions;
- Polluters Pay Principle (PPP), etc.

Other countries also have similar laws and regulations that will enforce corporate duties to all their business sectors including the ICT sector.

4.1.3. Legal responsibility of ICT sector

The Kyoto Protocol and its successors in the future will impose compulsory GHG reduction targets to each member nation that will set its corresponding emission target. Most countries will devolve their emission targets to individual, industrial entities, such as a power plant, paper factory, or ICT operators. The devolved emission target is represented as the emission cap which is maintained by the cap and trade system as described in Clause 4.3. It is enacted as a legal responsibility.

Every industrial entity is not imposed with its emission target, but mostly heavy energy consumption organizations are imposed with devolved emission targets by a national management entity. Some of ICT organizations also have such responsibility for GHG reductions to meet their emission targets and should find appropriate ways to abate GHG emissions such as installation of energy efficient equipments, rebuilding of organization structures, change of management policies, etc.

Not only those ICT organizations but every responsible organization requires energy efficiency strongly to relevant vendors and manufacturers, which mean that ICT equipment and software vendors shall exploit energy efficiency.

4.2. Energy efficiency requirements

Every business entity may be forced to improve energy efficiency not only by lawful requirements but an internal cost saving requirement and external price cutting pressure. Finally these energy efficiency requirements apply to vendors, manufacturers and intervening stakeholders in the chain of every product. The product chain may be clarified by the Life Cycle Assessment (LCA) defined by ISO 14040 and 14044. The LCA covers the emissions in all phases of a product's life cycle: material extraction, production, transportation, use and disposal.

4.2.1. Energy efficiency labelling

The energy efficiency may be managed and promoted by labelling methodologies. Consumers and corporate customers may pay a lot of attention to good energy efficiency labels, which will become a market pressure. There are various ways proposed for evaluation of energy efficiency and savings as follows:

- The Power Usage Effectiveness (PUE) and Data Center infrastructure Efficiency (DCiE) are examples for data servers and data centers.[9]
- Juniper Networks exploited Energy Consumption Rating (ECR) to approximate energy efficiency for packet-based network and telecom equipments. ECR is normalized to Watts/Gbps and has a physical meaning of energy consumption to move one Gigabit worth of line-level data per second. It reflects the best possible platform performance for a fully equipped system within a chosen application and relates to the commonly used interface speed.
- Climate Stabilisation Intensity (CSI) is a simple and effective tool that links an organization's financial and environmental performance to the necessary carbon reductions the planet must make in order to avoid catastrophic climate change. That is, the CSI approach associates an organisation's total carbon emissions with the contribution its profits and employment costs make to the world economy. Targets for reducing the organization's carbon intensity (CO_2e per unit of contribution to GDP) are then set in line with world targets to reduce CO_2e emissions per unit of GDP.
- Energy Star was initially an attempt to reduce energy consumption and GHG emission by power plants and created in 1992 by the United States Environmental Protection Agency. Initiated as a voluntary labelling program designed to identify and promote energy efficient products, Energy Star began with labels for computer products. In 1995 the program was significantly expanded, introducing labels for residential heating and cooling systems and new homes. As of 2006, more than 40,000 Energy Star products are available in a wide range of items including major appliances, office equipment, lighting, home electronics, and more.[10]
- EPEAT is a system to help purchasers evaluate, compare and select electronic products based on their environmental attributes. The system currently covers desktop and laptop computers, workstations and computer monitors. It is based on the IEEE 1680 family of standards for electronic product environmental assessment. Desktops, laptops and monitors that meet 23 required environmental performance criteria may be registered in EPEAT by their manufacturers. Registered products are rated Gold, Silver or Bronze depending on the percentage of 28 optional criteria they meet above the baseline criteria. EPEAT operates an ongoing verification program to assure the credibility of the registry. [11]

- The evaluation results may be represented as grading labels to promote consumers' adoption. Thus evaluation methodologies drive service providers, equipment manufacturers and solution vendors to pay more attention to energy efficiency. Relevant grading labels toward consumers proliferate their efforts by more business opportunities.

4.2.2. ICT energy efficiency

IEA, ISO and IEC held a workshop on *"International Standards to promote energy efficiency and reduce carbon emissions,"* Paris, 16-17 March 2009. The workshop summarized discussions below on electrical and electronic appliances, and networks and data centers.[12]

Electrical and electronic appliances

- The residential and commercial sectors account for about 60 % of global electricity consumption, and the share is steadily growing.
- Energy efficiency policies targeting the efficiency of individual end-uses are often effective and in many countries have helped to curb the growth of appliance energy consumption over the past two decades. However, efficiency of energy use in the residential sector can be further dramatically improved. For example, according to the IEA, 35 % of total residential electricity use in OECD countries could be saved by the broader deployment of existing efficient household appliance technologies.
- The coverage of energy efficiency policies targeting improvements in residential electricity consumption is far from complete and existing measures need to be made more stringent. A number of development and implementation issues need to be tackled to enable the full savings potentials to be realized.
- International Standards continue to make an essential contribution to this effort in providing a common language, test procedures and calculation methods that can be used as solid foundation by policy makers.
- However, the situation is far from perfect. Whilst characterization of energy use might be straightforward, ambient and usage conditions of the various products vary considerably and to take them fully into account can be challenging and time consuming. Technical options do exist which would allow International Standards to be fully applicable to diverse locally specific situations, yet these require additional effort to be fully incorporated within the standards. The relatively weak engagement of many public authority stakeholders within the standardization arena was identified as an on-going constraint as was the limited resources committed to standards development.
- In order to make further progress and to unleash the full potential of International Standards in this field, it is important to pursue:
  - More engagement and representation of public authorities and consumer interests in standards setting
  - Development of smarter test procedures (able to accommodate local conditions and different usage patterns)
  - High level coordination between ISO and IEC with IEA and other relevant intergovernmental entities, aiming at coordinating strategy and overall priorities for the field

– Increased efforts to ensure timeliness of the standardization process.

Networks and data centers

- The electricity consumption of the ICT sector is still relatively small (as a fraction of total electricity use) but it is by far the fastest growing segment of energy demand. The growth is, in particular, driven by the exponentially growing volume of traffic over the Internet. For example, in Japan, the volume of traffic on the Internet is growing at an annual rate of 40 %. If this rate is maintained, within 10 years, sustaining Internet traffic will require the entire electricity generated in Japan today.
- Companies and institutions are addressing these challenges with technology (for example, through R&D of more energy efficient computer architectures and of advanced communication protocols that are orders of magnitude less *"power hungry"* than the current ones) and by defining good management practices, e.g. how to structure and operate data centres in an energy efficient way.
- These developments are all relatively recent. Metrics defining the energy consumption of systems and services and models characterizing patterns of use and consumption in different conditions (with the related test procedures), are in the early stage of development. The matter is intrinsically complex and further complicated by the high speed of technology development in the sector, which can quickly render obsolete existing models and performance targets.
- Several initiatives driven by industry consortia and by public institutions (e.g. within the EU and US) are underway and significant efforts have been made, for example, to define voluntary codes of conduct engaging manufacturers and operators in various market segments.
- However, the fragmentation of initiatives and actors generates confusion and tends to give mixed messages to industry and consumers while making it very difficult to establish a solid framework that can influence the overall market orientation.
- International Standards for terminology, metrics, measurement and best practices in this field are definitely needed and very welcome.
- In order to succeed, ISO, IEC and ITU should undertake a cooperative effort, building on the work already done by the relevant private and public sector actors and engaging, whenever appropriate, consumer interests (consumer awareness and behaviour is a critical factor). Particular attention should also be given to the speed of technology change, considering dynamic models.

4.3. New profit models

4.3.1. Cap and trade system

The Kyoto Protocol includes *"defined flexible mechanisms"* such as Emissions Trading, the Clean Development Mechanism (CDM) and Joint Implementation (JI) to allow Annex I economies to meet their GHG emission limitations by purchasing GHG emission reductions credits from elsewhere, through financial exchanges, projects that reduce emissions in non-Annex I economies, from other Annex I countries, or from Annex I countries with excess allowances. In practice this means that Non-Annex I economies have no GHG emission restrictions, but have financial incentives to develop GHG emission reduction projects to

receive *"carbon credits"* that can then be sold to Annex I buyers, encouraging sustainable development. In addition, the flexible mechanisms allow Annex I nations with efficient, low GHG-emitting industries, and high prevailing environmental standards to purchase carbon credits on the world market instead of reducing greenhouse gas emissions domestically. Annex I entities typically will want to acquire carbon credits as cheaply as possible, while Non-Annex I entities want to maximize the value of carbon credits generated from their domestic Greenhouse Gas Projects.[7]

The Emissions Trading is a *"cap and trade"* system that imposes national caps on the emissions of Annex I countries. On average, this cap requires countries to reduce their emissions 5.2% below their 1990 baseline over the 2008 to 2012 period. Although these caps are national-level commitments, in practice most countries devolve their emissions targets to individual industrial entities, such as a power plant or paper factory. This means that the ultimate buyers of credits are often individual organizations that expect their emissions to exceed their quota (their Assigned Allocation Units, AAUs or *"allowances"* for short). Typically, they will purchase credits directly from another party with excess allowances, from a broker, from a JI/CDM developer, or on an exchange, which results in a trading market.[7]

GHG reductions are translated into energy savings which are associated with a new profit model in conjunction with the cap and trade program. The efforts of power savings of ICT sectors result in cost savings and corresponding GHG reduction can make a profit on the trading of emission allowances. Thus, ICT sectors may enjoy money making as well as cost saving by GHG emissions reduction.

It is said that the next year carbon cap price will be $100 per ton in Europe. At European cap price the cost of GHG emission could be as much $10 - $50 million per year for medium size business in the next decade. This is money that must be paid into a carbon trust or exchange. Conversely medium size business (or telco) could earn $10 - $50 million per year if zero carbon.

4.3.2. Carbon offset program

The ICT sector may make additional revenue by brokering carbon offsets for corporate customers. For example, IBM is offering up $1 million in carbon offsets to customers who virtualize their computing facilities with IBM. The Japan Airlines Group started on February 3 2009, to offer via its website a carbon offset program which enables passengers using its flights to voluntarily offset the CO_2 gases generated by their trips.

Carbon offsetting is one of the ways people can reduce their own personal environmental footprint. By calculating the CO_2 emissions generated by the things people do, it is possible to purchase *"credits"* from a variety of emission reduction projects which wholly or partly decrease an equivalent amount of CO_2 somewhere else in the world.

5. Relevant standardization activities

5.1. ISO/IEC JTC 1 SWG-Planning

At its last meeting in Nara, Japan, November 2008, ISO/IEC JTC 1 did a Technology Watch activity on the Green IT and resolved to initiate a standardization assessment for the Green IT in terms of ISO/IEC JTC 1 Nara Resolution 32. This review activity for the Green ICT standardization initiative is an implementation of the Resolution.

5.2. IPCC

The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP). Its mandate reads, *"The IPCC was established to provide the decision-makers and others interested in climate change with an objective source of information about climate change. The IPCC does not conduct any research nor does it monitor climate related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio economic factors. They should be of high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage."*[13]

The main activity of the IPCC is to provide in regular intervals comprehensive Assessment Reports of scientific, technical and socio-economic information relevant for the understanding of human induced climate change, potential impacts of climate change and options for mitigation and adaptation. Four Assessment Reports have been completed in 1990, 1995, 2001 and 2007. The latest one is *"Climate Change 2007,"* the Fourth IPCC Assessment Report. The IPCC is currently starting to outline its Fifth Assessment Report (AR5) which will be finalized in 2014.

The IPCC produces also special reports; methodology reports; technical papers; and supporting material, often in response to requests from the Conference of the Parties to the UNFCCC, or from other environmental conventions.

The IPCC methodology reports provide practical guidelines for the preparation of GHG inventories. They are aimed to meet the inventory reporting requirements of the Parties to the UNFCCC. They are comprised of:

- (Obsolete) IPCC Guidelines for National Greenhouse Gas Inventories, 1994
- (Obsolete) IPCC Guidelines for National Greenhouse Gas Inventories, 1996
- IPCC Guidelines for National Greenhouse Gas Inventories, 2006
- Good Practice Guidance for Land Use, Land-Use Change and Forestry
- Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and Devegatation of Other Vegetation Types
- Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines) provide methodologies for estimating national inventories of anthropogenic emissions by GHG sources and removals by GHG sinks. The anthropogenic emissions and removals means that GHG emissions and removals included in national inventories are a result of human activities. The methodologies guidelines were intended for use by countries to estimate GHG inventories to report to the UNFCCC.

Unlike other GHG accounting standards for organizations and GHG abatement projects, the 2006 IPCC Guidelines support the national territory concept which means national

inventories include GHG emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction. There are, however, some specific issues to be taken into account, for examples:

- Emissions from fuel for use on ships or aircraft engaged in international transport should not be included in national totals. To ensure global completeness, these emissions should be reported separately.
- GHG emissions from road vehicles should be attributed to the country where the fuel is sold to the end user. The same allocation principle can be applied to other gases depending on the tier used to estimate emissions.
- Fishing includes emissions from fuel used in inland, coastal and deep sea fishing. Emissions resulting from fuel used in coastal and deep sea fishing should be allocated to the country delivering the fuel.

Even though the IPCC standards were designed to fit with national GHG inventories, corporations used to make use of them for their GHG accounting because they had no alternative solutions. After the GHG Protocol designed for corporate GHG inventories was published in 2001, corporations have replaced the IPCC standards with the GHG Protocol. It is said that the methodology standards of the GHG Protocol Initiative have been more popularized in the market and 63% of Fortune 500 companies use the GHG Protocol standards.

5.3. UNFCCC

The United Nations Framework Convention on Climate Change (UNFCCC) has worked as an operation body as well as the international treaty.

Since 37 countries (including the European Union), known as the Annex B countries under the Kyoto Protocol, committed to binding targets to reduce or limit GHG emissions, starting in 2008, the UNFCCC has published national reports on progress and the annual compilation and accounting report for Annex B Parties. This indicates the timeliness of the submission of data, the completion of a review by experts and by the Compliance Committee.

Annex B Countries now provide annual reports on the state of their compliance with their Kyoto targets, using generally agreed methodologies and formats. While the reporting format includes specific sectors and industries (e.g. energy and manufacturing), there is no requirement to date to report specifically on ICTs. The Kyoto Protocol defines a few flexible mechanisms as described in Clause 4.3.1 to support GHG reduction efforts of member countries.

The UNFCCC manages the flexible mechanisms and handles Designated National Authorities (DNA) for management of GHG portfolios of all member countries and Designated Operational Entities (DOE) for validation and verification of a CDM project activity. It maintains also baseline and monitoring methodologies for CDM project activities and covers 15 sectoral scopes as of May 2009. Each sectoral scope has a few or several specific methodologies[2]. The ICT sector is not covered yet.

Table 1 – Sectoral scopes for methodologies

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2 See its detail at http://cdm.unfccc.int/DOE/scopes.html

Scope number	Sectoral scope
9	Metal production

		10	Fugitive emissions from fuels (solid, oil and gas)
		11	Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride

	12	Solvent use
	13	Waste handling and disposal
	14	Afforestation and reforestation

	15	Agriculture

5.4. GHG Protocol Initiative

The Greenhouse Gas Protocol (GHG Protocol) is the most widely used international accounting tool for government and business leaders to understand, quantify, and manage GHG emissions. The GHG Protocol, a decade-long partnership between the World Resources

Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), is working with businesses, governments, and environmental groups around the world to build credible and effective programs for tackling climate change. It provides the accounting framework for nearly every GHG standard and program in the world – from the International Standards Organization to The Climate Registry – as well as hundreds of GHG inventories prepared by individual organizations. The GHG Protocol also offers developing countries an internationally accepted management tool to help their businesses to compete in the global marketplace and their governments to make informed decisions about climate change.[14]

The GHG Protocol consists of two leading standards: *"A Corporate Accounting and Reporting Standard"* and *"The GHG Protocol for Project Accounting."* The corporate standard provides a step-by-step guide for organizations to use in quantifying and reporting their GHG emissions. It does not require emissions information to be reported to WRI or WBCSD. While this standard is designed to develop a verifiable inventory, it does not provide a standard for how the verification process should be conducted. This is the reason why ISO TC 207 has developed validation and verification standards.

The project protocol provides specific principles, concepts, and methods for quantifying and reporting GHG reductions – i.e., the decreases in GHG emissions, or increases in removals and/or storage – from GHG mitigation projects.[14]

The GHG Protocol Initiative released calculations tools for GHG accounting. The tools are electronic Excel spreadsheets with accompanying step-by-step guidance documents. A guidance document includes:

- An overview of the protocol with information on the sector, sources, and process(es) that it covers;
- One or more approaches for determining CO2 and other GHG emissions, e.g., direct measurement, mass balance, etc.;
- Guidance on collecting activity data and selecting appropriate emission factors;
- Likely emissions sources and the scopes they fall under (specific to a particular sector);
- Additional information, such as quality control practices and program specific information.

The spreadsheets help carry out any necessary emissions calculations. The following tools for industry sectors are provided as June 2009: Adipic Acid; Aluminum; Ammonia; Cement; HCFC-22; Iron and Steel; Lime; Nitric Acid; Pulp and Paper; Refrigeration and Air-conditioning equipment (manufacturing, installation, operation and disposal); Semiconductors; and Wood Products. The ICT sector has different business characteristics and needs its own calculation tool.

5.5. ISO TC 207

ISO TC 207 was formed in 1993 and covers standardization in the field of environmental management tools and systems. It is the umbrella committee under which the ISO 14000 series of environmental management standards are being developed. The ICT sector may incorporate some of TC 207 standards.

TC 207/SC 3 covers the environmental labelling. Environmental labels and declarations provide information about a product in terms of its overall environmental character, a specific environmental aspect, or any number of aspects. Purchasers and potential purchasers can use

this information in choosing the products they desire based on environment as well as other considerations. The provider of the product hopes the environmental label or declaration will be effective in influencing the purchasing decision in favour of its product. Following four standards were developed:

- ISO 14020 (*"Environmental labels and declarations – General principles"*) defines guiding principles for the development and use of environmental labels and declarations. It is intended that other applicable standards in the ISO 14020 series be used in conjunction with this International Standard. It is not intended for use as a specification for certification and registration purposes. Here are some example principles: Principle 1 – *"Environmental labels and declarations shall be accurate, verifiable, relevant and not misleading"*; Principle 2 – *"Procedures and requirements for environmental labels and declarations shall not be prepared, adopted, or applied with a view to, or with the effect of, creating unnecessary obstacles to international trade"*; and Principle 3 – *"Environmental labels and declarations shall be based on scientific methodology that is sufficiently thorough and comprehensive to support the claim and that produces results that are accurate and reproducible."*

- ISO 14021 (*"Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling)"*) specifies requirements for self-declared environmental claims, including statements, symbols and graphics, regarding products. It further describes selected terms commonly used in environmental claims and gives qualifications for their use. This International Standard also describes a general evaluation and verification methodology for self-declared environmental claims and specific evaluation and verification methods for the selected claims in this standard. Self-declared environmental claims may be made by manufacturers, importers, distributors, retailers or anyone else likely to benefit from such claims. Environmental claims made in regard to products may take the form of statements, symbols or graphics on product or package labels, or in product literature, technical bulletins, advertising, publicity, telemarketing, as well as digital or electronic media, such as the Internet.

- ISO 14024 (*"Environmental labels and declarations – Type I environmental labelling – Principles and procedures"*) establishes the principles and procedures for developing Type I environmental labelling programmes, including the selection of product categories, product environmental criteria and product function characteristics; and for assessing and demonstrating compliance. This International Standard also establishes the certification procedures for awarding the label. Type I labels are awarded to products by a third party – either government or private. Products meeting a set of predetermined criteria earn the label. Criteria are established for distinct product categories by the labelling body and deal with multiple environmental aspects of the product. These labels are sometimes directed at specific types of products, such as the Environmental Choice1 label for paints and surface coatings, or Energy Star for lighting and appliances. These labels indicate that a product is environmentally preferable, in order to increase the demand for environmentally preferable products. These labels are usually represented by a logo on the product or product packaging.

- ISO 14025 (*"Environmental labels and declarations – Type III environmental declarations – Principles and procedures"*) establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations. Type III environmental product declarations provide environmental data about a product. These declarations are produced by the organization making the product, and are often certified by a third party. They usually take the form of

brochures, rather than a simple label or logo. The declaration is typically based on a life cycle study with the use of ISO 14040 and 14044. The declaration contains quantified data from various life cycle stages of the product, including: material extraction, production, transportation, use and end-of-life disposal or recycling. The declaration may also contain qualitative data about the product and the organization. Type III declarations allow consumers to compare products based on all of their environmental impacts and make their own decision about which product is preferable. Competition among organizations on environmental grounds is encouraged by this kind of declaration.

The ICT sector may refer to ISO 14025 because this standard covers a life cycle for an ICT product and can account for the GHG emission total of the ICT product. But ISO 14025 is a business sector-neutral standard and the ICT sector needs a sector-specific information to incorporate the standard which defines *"Product Category Rules (PCR)"* for this purpose. The PCR means set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories which are group of products that can fulfil equivalent functions.

TC 207/SC 5 deals with Life Cycle Assessment (LCA) defined as *"compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle."* LCA addresses the environmental aspects and potential environmental impacts (e.g. use of resources and the environmental consequences of releases) throughout a product's life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave). SC 5 released two international standards in 2006:

- ISO 14040 (*"Environmental management – Life cycle assessment – Principles and framework"*) describes the principles and framework for life cycle assessment (LCA) including a) the goal and scope definition of the LCA; b) the life cycle inventory analysis (LCI) phase; c) the life cycle impact assessment (LCIA) phase; d) the life cycle interpretation phase; e) reporting and critical review of the LCA; f) limitations of the LCA; g) relationship between the LCA phases, and h) conditions for use of value choices and optional elements; and
- ISO 14044 (*"Environmental management – Life cycle assessment – Requirements and guidelines"*) has the same specification scope with ISO 14040 but specifies requirements and provides guidelines for LCA. It includes the methodological framework for LCA and reporting of LCA results.

ITU-T is considering these LCA standards as the basic methodology to assess GHG emission impacts for ICT equipments. The LCA standards are designed for general purposes to any product.

TC 207/SC 7 deals with GHG management and related activities and has developed a set of relevant standards as follows:[15]

- ISO 14064 (Greenhouse gases) was developed to enhance environmental integrity by promoting consistency, transparency and credibility in GHG quantification, monitoring, reporting and verification. It enables organizations to identify and manage GHG-related liabilities, assets and risks. It also facilitates the trade of GHG allowances or credits. ISO 14064 comprises three parts, respectively detailing specifications and guidance for the organizational and project levels, and for validation and verification.
  - ISO 14064-1 (*"Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals"*) specifies detail principles and requirements for designing, developing,

managing and reporting organizational- or company-level GHG inventories. It includes requirements for determining organizational boundaries, GHG emission boundaries, quantifying an organization's GHG emissions and removals, and identifying specific organization actions or activities aimed at improving GHG management. It also includes requirements and guidance on inventory quality management, reporting, internal auditing and the organization's responsibilities in verification activities. Part 1 is consistent with best practice established in the Corporate Accounting and Reporting Standard developed by the WRI/WBCSD.

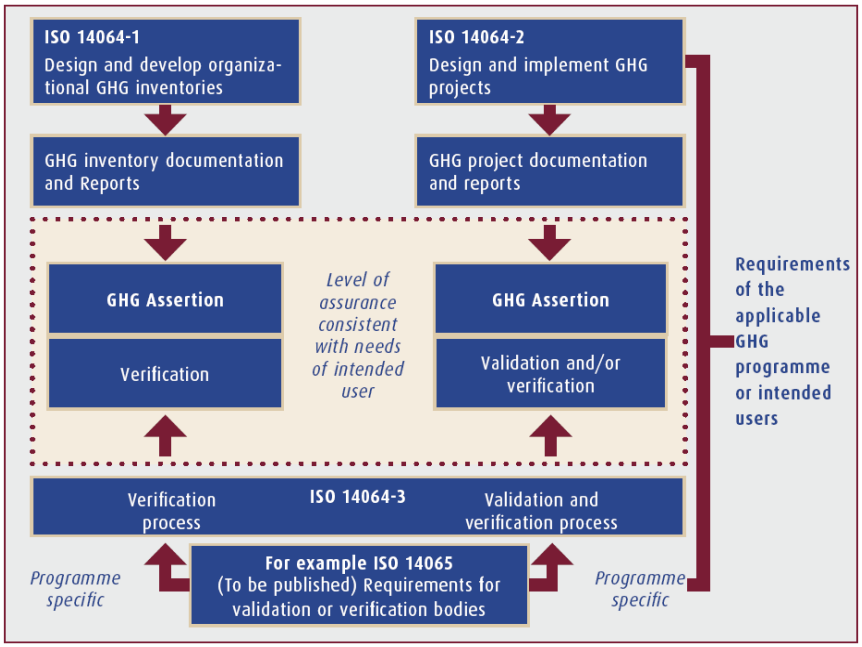


Figure 4 – Relationships among the three parts of ISO 14064 and ISO 14065

– ISO 14064-2 ("*Greenhouse gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions and removal enhancements*") focuses on GHG projects or project-based activities specifically designed to reduce GHG emissions or increase GHG removals. It includes principles and requirements for determining project baseline scenarios and for monitoring, quantifying and reporting project performance relative to the baseline scenario and provides the basis for GHG projects to be validated and verified.

– ISO 14064-3 ("*Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertions*") details principles and requirements for verifying GHG inventories and validating or verifying GHG projects. It describes the process for GHG-related validation or verification and specifies components such as validation or verification planning, assessment procedures and the evaluation of organization or project GHG assertions. ISO 14064 Part 3 can be used by organizations or independent parties to validate or verify GHG assertions.

- ISO 14065 ("*Greenhouse gases – Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition*") specifies requirements to accredit or otherwise recognize bodies that undertake GHG validation or verification using ISO 14064 or other relevant standards or specifications.

- ISO/WD 14066 (*"Greenhouse gases – Competency requirements for greenhouse gas validators and verifiers document"*) specifies competency requirements for GHG validators and verifiers. The standard details personal attribute, knowledge and skill (competency) requirements, required levels of proficiency and methods to evaluate competencies for GHG validators and verifiers by areas of competence. It is still being developed.
- ISO/WD 14067 (*"Greenhouse gases – Carbon footprint of products"*) was initiated from the end of 2008 and is being developed. It specifies requirements for the quantification and communication of greenhouse gases associated with the whole life-cycle or specific stages of the life cycle of products. It is intended to promote the monitoring, reporting, and tracking of progress in the mitigation of GHG emissions. The carbon footprint may show quantitative comparisons between different products and affect consumers when they choose products with the lowest climate impacts. While GHG emissions are reported at global, national or company levels, ISO/WD 14067-1 addresses emissions that arise from processes which constitute the life cycle of a product, in different organisations and independent from national boundaries. The standard will consist of two parts: Part 1 for quantification of carbon footprint; and Part 2 for harmonization of methodologies for communicating the carbon footprint information. The Part 2 is handling the labelling issue according to quantified results of carbon footprint of products.

Those LCA and GHG management standards are industry-neutral ones and specify general principles and requirements. The ICT sector also may utilize them. But sector-specific guidance may be needed to help organizations get easier understanding.

5.6. IEC TC 100

IEC TC 100 works on standardization for audio, video and multimedia applications for end-user networks. It has considered development of an international system of energy consumption classes including a labeling scheme to determine the energy consumption and energy efficiency of consumer electronic products, such as TV sets, set-top boxes, cable modems, DSL routers, etc. It also took into account both stand-by losses and off-mode losses in its product standards. This requires external power supplies (AC/DC converters) to be considered as integral parts of the pertinent appliances.

The stand-by loss means power consumption by a power consuming source, when connected to an external power supply, while not performing its primary functions or while awaiting instructions to provide full services. The off-mode loss means power consumption by a power consuming source, when its internal circuit still consumes stand-by power to wait for external cord/cordless signals even though a consumer switches off the power of the power consuming source.

In 2008, TC 100 got a proposal for energy saving system for home appliances and home network devices to tackle those energy losses.

5.7. ITU-T Focus Group on ICTs and Climate Change

The ITU-T Focus Group on ICTs and Climate Change (ITU-T FG ICT&CC) was established in July 2008 by the ITU-T Telecommunication Standardization Advisory Group (TSAG) as an open group tasked to perform a rapid impact analysis on *"ICTs and Climate Change,"* and

asked to work on four deliverables. The FG held three face-to-face meetings and 28 conference calls.

ITU-T took into account two study points: reducing energy consumption in the ICT sector, so called *"Green of ICTs,"* and helping other sectors reduce energy consumption, so called *"Green by ICTs."* ICTs include many devices which use electricity. Reducing the rate of electricity usage and increasing the use of non-fossil fuel sources are clearly key measures to help control the carbon footprint of the ICT sector. ICTs can be an important enabling technology to reduce GHG emissions in other sectors. The Focus Group has examined ways to promote the use of ICTs as a substitute for other sectors' costly, fossil-fuelled activities, such as travel and transport. To set an example, the work of the FG has been conducted mainly by teleconference using modern on-line tools.

The FG completed its mandates and produced the executive summary report and four Deliverables.[16] The four Deliverables were:

- Deliverable 1, Definitions: The aim of work under this Deliverable was to reach consensus on those key definitions that would be needed for work on *"methodologies"* under the Deliverable 3. Definitions of unit(s) of energy and unit(s) of efficiency were highlighted as key. Definitions were grouped into various categories: climate change, ICTs, energy and links between energy and climate change, climate change impact assessment, relationship between climate change and economic aspects, and energy efficiency of ICT. The Deliverable included a catalogue with one paragraph summary of 48 standards and standards-related bodies that are active in some way in ICTs and climate change.
- Deliverable 2, Gap analysis: This work was performed to identify existing standards that are relevant to ICTs and Climate Change, so as to avoid *"reinventing the wheel."* A variety of gaps were identified as suitable for work in ITU-T. Priority areas identified were to quantify the reduction of energy by using ICTs as a service substitute, a carbon calculator standard to compare short and long term benefits of different ICT networks and systems, and energy savings checklists for standardization activities.
- Deliverable 3, Methodology: This work aims to provide an internationally agreed method of calculating two elements – first the energy usage and carbon impact arising from the ICT sector over the entire life cycle of ICT devices, and second the mitigation that can be achieved by substituting ICT services and devices for intensive fossil-fuelled activities such as travel and transport through dematerialization. The Deliverable analyzed that the energy consumption is more suitable than CO2 emission for the metric system of the ICT sector. It also proposed that the ICT industry estimate the impacts of GHG emissions for the following: device, network, service, organization, and ICT sector.
- Deliverable 4, Direct and indirect impact of ITU-T standards: This work developed tools (e.g. Checklists) and guidelines to allow ITU-T Study Groups to evaluate, for each Question, the possible future CO2e reduction of technologies in terms of direct emissions from ICTs and possible savings in terms of Climate Change mitigation from the use of ICTs. The scope of this Deliverable includes: General checklists for an eco-friendly guidance of ICT systems and services; Examples of networks and systems, which influence climate change in the ICT field; and, ITU-T standards that have a positive impact on mitigation of climate change.

The Focus Group completed its mandates at its last meeting held in Hiroshima, Japan, March 2009, and was closed by the ITU-T TSAG meeting in April 2009. The meeting made three important decisions: ITU-T Study Group 5 was designated as the lead Study Group for the

subject of ICTs and Climate Change; its title was changed to *"Environment and Climate Change"* to reflect its new mandate; a Joint Coordination Activity (JCA) on ICTs and Climate Change (JCA-ICT&CC) was established under ITU-T SG 5 and the JCA shall report its activities to both ITU-T TSAG and SG 5. But other ITU-T Study Groups can study ICTs and Climate Change matters within their work scopes and ITU-T SG 5 will coordinate relevant activities within and outside ITU by a method of the JCA-ICT&CC.

5.8. ITU-T Study Groups

A few ITU-T Study Groups have considered ICTs and Climate Change issues.

5.8.1. ITU-T Study Group 5

At its May 2009 meeting, ITU-T SG 5 established the Working Party 3, *"ICTs and Climate Change,"* with four new Questions and one transferred Question. In addition to the WP 3 Questions as described below, one existing Question 14 of ITU-T SG 5 extended its work scope to cover ICTs and Climate Change matters and its title also was changed to *"Guides and terminology on environment and climate change."*

During its Geneva meeting, the Question chair persons of ITU-T SG 5/WP 3 prepared for expected work items to invite relevant contributions for work progress, modification, addition or deletion. They were not reviewed at the meeting and would be treated just as a seed material for further actions. Each action plan of the WP 3 Questions is included in Question descriptions below:

- Q.17/5 (Coordination and Planning of ICT&CC related standardization): This Question deals with developing and maintaining an overview of ICT&CC related Recommendations in ITU-T SG 5/WP 3, coordinating with Q.18/5 on Methodology, coordinating with other ITU-T SGs and other bodies on a regular basis to improve the planning of the work, promoting studies leading to new Recommendations in the areas of key mitigation technologies such as teleconferencing, teleworking, e-learning, and appliance control for energy efficiency in buildings, and providing the necessary liaison for the work to be established in the most appropriate SG. Work items expected are:
  - Handbook on climate change: an overview of ICT&CC related Recommendations
  - Handbook on Key mitigation technique: an overview of key mitigation technologies such as teleconferencing, teleworking, e-learning, appliance control for energy efficiency in buildings and their impact on GHG emissions.
- Q.18/5 (Methodology of environmental impact assessment of ICT): This Question addresses the methodologies to assess the impact of ICT emissions over the entire ICT life cycle and the impact of the mitigation achieved through the use of ICTs in other relevant sectors. It develops ITU-T Recommendations on methodology for environmental impact assessment of ICTs considering general principles and criteria for evaluating ICT impact, system boundaries, functional units, and environmental load intensity. It also develops Recommendations on collecting and calculating reliable rough data to inject in the assessment model (e.g. J per cm^2 or g of silicone wafer used in constructing in electronic chip). Work items expected are:
  - Methodology for environmental impact assessment of ICT

  - Recommendation on collecting and calculating reliable rough data to inject in the assessment model
  - Handbook making reference on available databases

- Q.19/5 (Power feeding systems): This Question works on the characterizations and specifications of the power feeding system, especially for the Higher Voltage Direct Current (HVDC) system. It also develops ITU-T Recommendations on safety for humans and equipment of the power feeding system, on the system configuration, architecture, and cable distribution including feeding, lightning protection, EMC, earthing, and bonding of the power feeding system, and on methodologies for evaluating the performance of energy feeding such as the environmental effect of the system and validity of the energy supply to the ICT equipment. Work items expected are:
  - Characterizations and specifications of power feeding system, especially for Higher Voltage DC system
  - Safety for humans and equipment of the power feeding system
  - System configuration, architecture, and cable distribution including feeding, lightning protection, EMC, earthing, and bonding of the power feeding system
  - Methodologies for evaluating the performance of energy feeding and its environmental impact
- Q.20/5 (Data collection for Energy Efficiency for ICTs over the lifecycle): This Question deals with issuing questionnaires on topics of interest such as *"Use phase of Broadband Devices"* (DSL, cable, WiMax and fibre), establishing databases related to results of surveys, coordinating with Q.18/5 on Methodology, coordinating with other ITU-T SGs/Questions and other bodies on a regular basis to collaborate effectively, and reporting on practical case studies such as standby mode implementation. Work items expected are:
  - Metrics for data collection on energy efficiency
  - Questionnaires on topics of interest in order to collect energy efficiency related data on relevant network elements
  - Handbook related to analysis of questionnaires issued previously and practical case studies on energy saving approaches
- Q.21/5 (Environmental protection and recycling of ICT equipments/facilities): This Question was transferred from ITU-T SG 15 with extending its work scope to cover ICTs and Climate Change matters. It deals with motivating ITU members to share their national experiences and spread the collected knowledge related to environmental and sustainability aspects of laws or directives, determining process to analyze the effect on the environment of products (materials, hazardous materials avoidance, manufacturing processes, operational procedures and disposal) and ways to minimize them, searching for new technologies of compounds / materials and operational process to use, assessing environmental effects of recycling related to ICT facilities, equipments, etc., analyzing safe, low-cost social recirculation of ICT equipments through recycling and reuse, preparing a questionnaire about environmental sustainability practices and regulations in outside plant, and studying on recycling of copper and optical fibre cables. Work items expected are:
  - Universal power adapter solution for mobile phone

- The use of life cycle analysis in outside plant
- Recycling of copper and optical fibre cables
- Handbook of environmental sustainability in outside plant and ICT equipments/ facilities

The extended Q.14/5 considers all terms, definitions, abbreviations, letter symbols and schematic symbols used in the SG 5 Recommendations, Handbooks and Directives harmonized with terminology used by other parties outside of ITU-T Study Group 5, and liaises with other bodies (e.g. IEC) regarding terminology used in the SG 5 Recommendations.

5.8.2. ITU-T Study Group 13

ITU-T SG 13 leads ITU's work on standards for the Next Generation Networks (NGN) and the Future Networks. Built upon the Internet protocol (IP), the convergence standards between networks and/or technologies such as public switched telephone network (PSTN), digital subscriber line (DSL), cable television (CATV), wireless local area network (WLAN) and mobile technologies have been developed.

The NGN and the new visionary goal, the Future Networks taken now as the title of ITU-T SG 13 during the study period from 2009 to 2012, have various work items to facilitate energy efficiency for ICT network technologies and products. But, specifically, it initiated Y.gms, *"GHG monitoring service over Next Generation Networks (NGN),"* at its January 2009 meeting. The work scope of the draft Recommendation is to address service scenarios for GHG monitoring over NGN, covering Service model for GHG monitoring over NGN, IP connectivity between NGN and Ubiquitous Sensor Network (USN) for GHG monitoring, and Service scenarios for GHG monitoring over NGN. This work describes the service scenarios that have the interactive real time report and cover the wide area (e.g., Mountain, farm field, forest, sea, industrial area, and rural area) to find the solution of the reductive emission by connecting NGN with USN.

The Future Networks is a new initiative of ITU-T SG 13's telecommunication technologies standardization. It is incorporating network virtualization, programmable networks, new layered functions (e.g., cross-layer communications), autonomous management and maintenance, new control and management functions for network resource sharing and isolation, context-awareness services, data-centric or content-centric services, media distribution, and customizable QoS/QoE. This visionary target will improve energy efficiency in telecommunication networks and data communications.

5.8.3. ITU-T Study Group 15

ITU-T SG 15 is the home of standards for the DSL. It also works on optical access and backbone technologies. It has studied on energy efficiency in the standardization and use of ICTs and developed an ITU-T Technical Paper for checklist on energy saving for standardization activities focusing on optical and other transport networks.

5.8.4. ITU-T Study Group 16

ITU-T SG 16 works on multimedia (MM) terminals, systems and applications. It is active in all aspects of MM standardization, including terminals, architecture, protocols, security,

mobility, interworking and quality of service. It focuses its studies on conferencing systems, directory services, speech, audio and visual coding, PSTN modems and interfaces, facsimile terminals, ICT accessibility, etc.

Its Question 25 develops standards on USN applications and services which can be an enabling technology to support real-time monitoring of energy consumption and climate change situations. Q.25/16 is considering working on USN service description and requirements to mitigate the climate change. USN is a logical and conceptual service network to provide a variety of sensor-triggered applications and services. Sensors and relevant sensor networks are a key enabler to mitigate the climate change because detection of current situation is a prerequisite to perform appropriate reactions against the climate change. Moreover Life Cycle Assessment of USN devices may be considered. Thus the work item intends to summarize use cases of USN applications and services against the climate change; clarify required service features and requirements; and then specify corresponding functional elements.

5.9. ATIS

The Alliance for Telecommunications Industry Solutions (ATIS) Network Interface, Power and Protection (NIPP) committee intends to produce a document or suite of documents for use by ICT service providers to assess the true energy needs of equipments at time of purchase such as:

- Energy use as a function of traffic
- Energy use as a function of environmental conditions
- Cooling requirements
- Suitability of a product for use with renewable energy sources
- Improvements in environmental footprint through Life Cycle Assessments
- Standby and off-mode definitions
- Standby and off-mode losses

It provides the methodology to be used by vendors and third party test laboratories in the formation of a Telecommunications Energy Efficiency Ratio (TEER). In general, each TEER will follow the formula below:

Where:

Useful Work = Defined in the supplemental standard based on the equipment function. Examples could be, but are not limited to: data rate, throughput, processes per second, etc.

Power = Power in Watts (dependent on the equipment measurement).

The TEER standards consist of three parts:

- ATIS-0600015.2009 (Energy Efficiency for Telecommunications Equipment: Methodology for Measuring and Reporting – General Requirements)
- ATIS-0600015.01.2009 (Energy Efficiency for Telecommunications Equipment: Methodology for Measuring and Reporting – Server Requirements)
- ATIS-0600015.02.2009 (Energy Efficiency for Telecommunications Equipment: Methodology for Measuring and Reporting – Transport Requirements)

The general requirements document serves as the ATIS base standard for determining telecommunications energy efficiency. It provides a uniform methodology to measure equipment power and defines energy efficiency ratings for telecommunication equipment. In this document, equipments have been classified based on the application and the location in the network with classifications such as core, transport and access. The latter two documents (server requirements, and transport system or network configuration requirements) are part of an ongoing series to define the telecommunications energy efficiency of various telecommunications components.[17]

5.10. ETSI

The European Telecommunications Standards Institute (ETSI) recognized the climate change was a global concern and required efforts from all industry sectors, including the ICTs. ETSI is strengthening its efforts by improving the tools for electronic work; introducing a check list that energy saving is considered for all new work items; and, initiating a number of new work items in the ICT and environment area. ETSI has published a few deliverables and has a few on-going work items as follows:[18]

Here are published deliverables:

- TR 102 530, *"Reduction of energy consumption in telecommunications equipment and related infrastructure"*: This document reports some techniques and some aspects to take in account during the evaluation of the possible reduction of energy consumption at equipment level and at installation level. The first version of this document refers principally at broadband equipment.
- TR 102 531 (2007-04), *"Better determination of equipment power and energy consumption for improved sizing"*: This document gives guidance on a more appropriate determination of equipment energy consumption with the goal to be able to realize a good design of power station and related power distribution network. A correct design help to

have a better energy efficiency of power station with impact on the energy saving and with a not oversized dimensioning of power network permits to reduce the use of material (copper) and as consequence a minor impact on the environmental and a cost reduction.

- TS 102 533 (2008-06), *"Measurement Methods and limits for Energy Consumption in Broadband Telecommunication Networks Equipment"*: This document establishes an energy consumption measurement method for broadband telecommunication network equipment; give contributions to fix target energy consumption value for wired broadband equipment including ADSL and VDSL.
- EN 300 132-3 (2003-8), *"Power supply interface at the input to telecommunications equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V"*: This document standardizes a new power interface able to supply both telecom and ICT equipment. This solution permits to build only a power network, with backup, to supply energies at all type of equipment present in a data center without using UPS or AC/DC converters at 48 V so the global energetic efficiency of the entire system is greater that other solutions contributing and the energy saving.

Here are on-going work items:

- DTS/EE-00007, *"Environmental Engineering (EE) – Energy efficiency of wireless access network equipment"*: This work will establish wireless access network energy efficiency metrics, define efficiency parameters and measurement methods for wireless access network equipment. In the first phase GSM/EDGE, WCDMA/HSPA and WiMAX are addressed. Other systems, such as LTE, will be added when a stable system data is available.
- DTR/EE-00008, *"Environmental Impact Assessment of ICT including the Positive Impact by using ICT Services"*: This work will define the methods to assess the environmental impacts of ICT, which have two aspects: 1) Negative impact caused by the energy consumptions or CO2 emissions of operators of ICT equipments and sites including telecom network, users terminals, data centers for residential and business services; and, 2) Positive impact caused by energy saving or CO2 emission saving by using ICT services. The method how to quantify such these impacts at national level will be proposed.
- DTS/EE-00004, TR 102 532, *"Environmental Engineering (EE) – The use of alternative energy sources in telecommunication installations"*: The use of alternative energy sources in the telecommunication installation/application such as solar, wind, and fuel cell is considered.
- DTR/EE-00006, *"Environmental Engineering (EE) – Environmental consideration for equipment installed in outdoor location"*: It is planned to write a technical report on the applicability of ETSI environmental classes to equipment installed in outdoor cabinet. Also acoustics noise emission will be considered.
- DTR/ATTM-06002, *"Power Optimization for xDSL transceivers"*: Possibilities to optimize the power consumption of the xDSL transceiver are investigated. These investigations may include power modes that are beyond the currently existing modes. The potential influence of power optimization schemes on the stability and performance of each line of the network due to power optimization, e.g. non-stationary noise, will be an important part of this work.
- DTS/ATTM-0xxxx: The TR 105 174 series will be stopped and a new TS series will be opened to work in this area as follows:

- Part 1 Overview and general aspects
  - TS 105 174-1-1 Generalities, common view of set of documents
  - TS 105 174-1-2 Operator sites
  - TS 105 174-1-3 Data Centre Engineering
- Part 2 Core, regional metropolitan networks
  - TS 105 174-2 Core, regional metropolitan networks
- Part 3 Access networks
  - TS 105 174-3 Access networks
- Part 4 Customer network infrastructures
  - TS 105 174-4 Customer network infrastructures
- Part 5 Power supply cooling, general topology
  - TS 105 174-5 Power supply cooling, general topology

ETSI also has more work items as follows:

- DTR/EE-00004, *"Alternative energy sources"*
- DES/EE-00014, *"LCA assessment of telecommunication equipment and service part 1: General definition and common requirement"*
- DES/EE-00015, *"Measurement method and limits for energy consumption in broadband telecommunications equipment"*
- DES/EE-00018, *"Measurement methods and limits for Energy consumption of End-user Broadband equipment (CPE)"*

5.11. Ecma International

The Ecma is working on energy efficiency issues in the following projects:

- ECMA-383, *"Measuring Energy Consumption, Performance and Capabilities of ICT and CE Products"*: This standard intends to apply to desktop computers and notebook computers, defining how to evaluate and report energy consumption, performance and capabilities being the vital factors for the energy efficient performance of testing targets, i.e. those computers. Additionally it provides a standardized results reporting format. The standard requires the user to measure and record a set of energy, power, time, and capability results (using a Benchmark), not a single metric of energy efficiency.
- ECMA-xxx, *"Network proxying of ICT devices to reduce energy consumption"*: This on-going work develops standards and technical reports for network proxying; a proxy is an entity that maintains network presence for a sleeping higher-power ICT device. It will specify:
  - the protocols that network proxies must handle to maintain connectivity while hosts are asleep;
  - the proxy behaviour including ignoring packets, generating packets and waking up host systems; and

  - the information exchanged between hosts and proxies. *[Note] the information syntax and exchange methods are out of scope.*

- ECMA-341, *"Environmental Design Considerations for ICT & CE Products"*: This standard applies to all audio/video, information and communication technology equipments referred to products, specifying requirements and recommendations for the design of environmentally sound products regarding life cycle thinking aspects, material efficiency, energy efficiency, consumables and batteries, chemical and noise emissions, extension of product lifetime, end of life, hazardous substances/preparations, and product packaging. This standard covers only criteria directly related to the environmental performance of the product. Criteria such as safety, ergonomics and electromagnetic compatibility (EMC) are outside the scope of this standard.

5.12. ISO PC 242

The first meeting of ISO's new project committee PC 242 which is to develop an International Standard on energy management was held on 8-10 September 2008 in Washington, DC, USA. The future ISO 50001 will establish a framework for all types of organizations (industrial, commercial, institutional, large residential, and transportation sectors) as well as emerging economies and small and medium enterprises (SMEs) to manage their energy usage. Targeting broad applicability across national economic sectors, the standard could influence up to 60 % of the world's energy use. It is planned for publication by the end of 2010.[19]

5.13. IEC TC 111

IEC TC 111, "Environmental standardization for electrical and electronic products and systems," started in 2005 development of standards that cover test methods for hazardous substances and help manufacturers declare which materials they are using in their products. The standards were very significant for the global electronics industry because of increasing legislation around the world such as the California Electronic Waste Recycling Act of 2003 and the European Union's RoHS and WEEE Directives. The standard for test methods is to give manufacturers a way to prove which substances their electrical and electronic products contain. The second will make importing and exporting those products easier through a uniform means of declaration which customs agents can use to ensure that products entering the market adhere to legislation concerning restricted substances, such as lead and cadmium.

It published following standards:[21]

- IEC 62321 (2008-12), Electrotechnical products - Determination of levels of six regulated substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers)
- IEC 62430 (2009-02), Environmentally conscious design for electrical and electronic products
- IEC/PAS 62545 (2008-01), Environmental information on Electrical and Electronic Equipment (EIEEE)
- IEC/PAS 62596 (2009-01), Electrotechnical products - Determination of restricted substances - Sampling procedure - Guidelines

Its on-going works are:

- Communication formats on recycling for electrotechnical equipment between manufacturers and recyclers
- Electrotechnical products - Sampling and determination of certain substances - Part 1: General aspects of sampling strategy
- Material Declaration for Electrical and Electronic Equipment - Proposed as horizontal standard
- Guidance for evaluation of product with respect to substance use restrictions in electrical and electronic equipment
- Environmental standardization for electrical and electronic products and systems - Standardization of environmental aspects - Glossary of terms
- End of life recyclability calculation for electrotechnical equipment

6. Gap analysis of relevant standards

6.1. IPCC standards

IPCC standards don't focus on specific business sectors but provide a national GHG accounting methodology. UNFCCC Annex 1 countries may use the IPCC standards to report their GHG accounting results to the UNFCCC to fulfil their GHG reduction commitments.

As described in Clause 4.1.3, the countries may devolve their GHG emission targets also called emission caps to individual and industrial entities which may usually use the GHG Protocol. Thus a national emission cap may be composed of all domestic emission caps allocated to the corporations.

Here may be a problem. The national emission cap and corporate emission caps can be maintained straightforwardly. But their GHG accounting systems may be different. That is, countries may use the IPCC standards but corporations may use the GHG Protocol or ISO 14064. Thus, how to interwork between them needs to be clarified.

Generally speaking, a systematic set of GHG accounting standards is necessary. A human activity may be performed by a systematic process. For example, in case of the ICT sector, ICT equipments may be atomic elements for GHG accounting; a set of ICT equipments may compose an ICT system or service; a set of ICT systems or services may compose an ICT facility or ICT project; and a set of ICT facilities may compose an ICT organization. Then finally all individual and organizations contribute to the national GHG inventory.

ISO 14040 and 14044, called LCA standards were developed and ISO 14067 is being developed as a general methodology to support GHG accounting for any products, and ISO 14064 and the GHG Protocol were developed to support GHG accounting for facilities and corporations. The IPCC standards were for the national GHG accounting.

There seems a missing standard for ICT systems or services. All relevant standards were developed independently but only ISO standards considered consistency within themselves. Thus, a systematic framework of GHG accounting standards seems needed to incorporate different standards for all types of GHG accounting.

6.2. UNFCCC standards

The UNFCCC maintains standardized methodologies for the flexible mechanisms defined by the Kyoto Protocol. Especially it specified 15 sectors for CDM methodologies as of May 2009 as described in Clause 5.3. The ICT sector is not covered yet.

The ICT sector may develop CDM projects such as green IDC installations and green network establishments. It will need appropriate methodologies for CDM projects of the ICT sector. Only the UNFCCC, however, can manage CDM methodologies by the Kyoto Protocol. Thus, the ICT sector should cooperate with the UNFCCC to develop ICT CDM methodologies.

6.3. GHG Protocol standards

The GHG Protocol standards are industry-neutral ones and don't include sector-specific considerations.

The ICT sector may use them for its organization and project inventories but it needs practical guidance on how to incorporate the GHG Protocol standards with taking account into ICT sector's characteristics. A GHG calculation tool also for the ICT sector will be very helpful and needs to be included in the practical guidance. Several sector-specific GHG calculation tools were published to help responsible parties.

6.4. ISO TC 207 standards

The ICT sector may establish an environmental label to promote low carbon ICT products. It may choose the ISO 14024 Type I environmental labelling scheme such as Energy Star and EPEAT and/or the ISO 14025 Type III environmental labelling scheme. It may develop another Type I environmental label and/or it may develop a new Type III environmental label for which it needs to create its PCR specification. That is, the ICT sector may need to develop a set of PCR specifications for ICT products to implement a Type III environmental labelling scheme.

The LCA standards, ISO 14040 and 14044 are industry-neutral ones and can apply to every business sector. Thus the ICT sector may utilize these standards to assess the life cycle of an ICT product from environmental points of view. But it may need practice guidance for ICT products because the standards specify a general framework for all sectors and it needs to consider how to incorporate the general framework with taking account into a variety of ICT characteristics. Moreover a Type III environmental labelling scheme for the ICT sector shall consider life cycles of ICT products.

The GHG inventory standards, ISO 14064-1 and 14064-2 also specify a general methodology for GHG inventories and emission accounting. Although ISO 14064-1 is consistent with the GHG Protocol for corporations but ISO 14064-2 is not with the GHG Protocol for GHG projects, the ICT sector may utilize the general methodologies, i.e. ISO 14064-1 and GHG Protocol for corporations and either ISO 14064-2 or GHG Protocol for GHG projects. But the ICT sector may need to develop practice guidance based on ISO 14064-1 and 14064-2 standards because a general methodology may need to be applied specifically to a sector and each business sector may have unique application characteristics in terms of energy consumption and relevant GHG emissions.

ISO/WD 14067-1 is being developed based on the LCA techniques for a general methodology to quantify the whole GHG emission during the life cycle of a product and aims at supporting

all business sectors. This general methodology for a product carbon footprint can apply to ICT products. But the ICT sector will need a sector-specific carbon footprinting methodology based on the general-purpose standard.

6.5. IEC TC 100 standards

IEC TC 100 focuses on reducing energy consumption and improving energy efficiency for consumer electronic products such as TV sets, set-top boxes, cable modems, DSL routers, etc. It is exploiting an external device to realize the goals.

The AIM Project has a similar idea. It is developing a new information and communication technology architecture for modelling, virtualising, and managing the energy consumption of home appliances. The main focus of the Project is to foster a harmonised technology for profiling and managing the energy consumption of appliances at home. The Project is making an apparatus called the Energy Management Device (EMD) that constitutes the local hub of the energy control system. It is conceived as an independent functional entity that conveys control logic for both active and stand-by appliances and energy management functions integrated through multimodal communication interfaces with the home network and the residential gateway, hosting the service logic. The EMD is controlled by the residential gateway, using a bus interface that grants access to multiple EMDs from a single access-point, either locally or remotely via an operator network. The residential gateway selects and conduits information to the proper device interface, applies the necessary centralized control logic, and enforces rigorous communication encryption.[22]

Although ISO/IEC JTC 1/SC 25 doesn't have such standardization projects, it has the same work scope with the work item. Thus there is no gap for that work item between them and a cooperative work is required between them.

6.6. ITU-T standards

ITU-T SG 5 is at its initial stage and thus has few work items in comparison to ETSI. But it is anticipated that ITU-T SG 5 is the lead Study Group on the ICTs and Climate Change in terms of telecommunication networks, equipments and services and will pursue a variety of standardization items. For the time being, ITU-T SG 5 has discussed mainly on study about:

- Clarification of GHG mitigation techniques
- Environmental impact assessment methodologies for contribution by the Green of ICTs and the Green by ICTs, including ICT sector-specific LCA methodology and carbon footprint assessment methodology for ICT products based on LCA standards
- DC power feeding system
- Energy efficiency metrics
- Universal power adapter for mobile cell phones
- Environmental protection and recycling

ITU-T SG 5 has not considered much yet GHG accounting and reporting responsibility of ICT organizations. As described in Clause 6.1, 6.2, 6.3 and 6.4, a national GHG inventory may force ICT organizations to quantify and report their GHG inventories. The ICT sector

should deal with its GHG inventory design and accounting for which following items will be helpful:

- ICT sector-inventory design guide
- ICT sector-specific calculation tool based on the framework of ISO TC 207 or GHG Protocol standards
- A systematic GHG accounting and reporting methodology incorporating national level, organization level, facility level, and product level, including project level, as described in Clause 6.1.

6.7. ATIS standards

The ATIS standards aim at providing energy efficiency assessment methodologies for telecommunication equipments to ICT service providers at their purchasing time. They cover energy use as a function of traffic, energy use as a function of environmental conditions, standby and off-mode losses, etc. An LCA of an ICT product shall cover these energy consumption factors. Thus, the ATIS work needs to be aligned and integrated with a certain ICT-sector LCA methodology. But the ATIS doesn't intend to develop such LCA methodology but use an existing solution.

An SDO needs to develop an ICT-specific LCA methodology based on the ISO LCA standards and should cooperate with the ATIS to incorporate the energy consumption factors clarified by the ATIS standards.

6.8. ETSI standards

ETSI has various work items and the current ETSI standards have similar work scopes to those of the ATIS standards. But it doesn't limit to study them from ICT service providers' points of view at purchasing time. It also covers ITU-T SG 5 study areas such as DC power feeding and environmental impact assessment of ICTs. But ETSI has overlooked GHG accounting and reporting responsibility of ICT organizations. Thus it has similar gaps as clarified in Clause 6.6.

6.9. Ecma standards

Ecma has worked on measurement and improvement of energy efficiency for ICT and CE devices. Thus it has similar work scopes to those of ETSI, ATIS and ITU-T. But it has focused on CE devices additionally.

CE products may be a good target for the Type III environmental label of ISO 14025 for which an ICT-specific LCA methodology is required. Ecma also doesn't take account into GHG accounting and reporting responsibility of ICT organizations.

6.10. ISO PC 242 standards

The on-going standard, ISO 50001 aims at supporting a general framework for energy management to all business sectors. The ICT sector also will be covered. Thus it will utilize the standard to manage its energy consumption within its boundary. But the ICT sector may

need practice guidance or a profile specification to use the general framework standard to cover ICT-specific characteristics. This necessity will depend on the content of the general framework standard.

6.11. IEC TC 111 standards

IEC TC 111 is maintaining environmental protection and recycling matters for ICT hardware equipments. ISO/IEC JTC 1 has not worked on the environmental protection and recycling area and IEC TC 111 seems to cover every work item for the environmental protection and recycling of ICT products. But ISO/IEC JTC 1 needs to pay attention to the environmental protection and recycling issue because it is handling various ICT hardware equipments.

7. JTC 1 perspective standardization areas and topics

As described in Clause 3.1, ISO/IEC JTC 1 has the mandates of ICT standards development for business and consumer applications. The Green ICT must belong to the work scope of JTC 1. ICT sector-specific issues also shall belong to JTC 1 although they are exploited based on general methodologies made by other SDOs.

7.1. Ideas from the gap analysis

From the gap analysis results, ISO/IEC JTC 1 may take account into following ideas for consideration to find its work items:

- **Systematic framework standard for GHG accounting and reporting for the ICT sector:** this item deals with a framework on how to integrate and incorporate ICT sector-specific methodologies exploited based on the existing general purpose methodology standards such as IPCC, UNFCCC, ISO and GHG Protocol standards. The framework standard shall support a systematic assessment of GHG emissions and removals for layered constitution elements of the ICT sector such as ICT materials, ICT equipments, ICT systems or services, ICT facilities and ICT organizations. The framework standard should fit with the national GHG inventory standard of IPCC. (see Clause 6.1)
- **Guidance on GHG accounting and reporting for ICT organizations:** this item describes how to apply existing general-purpose standards for organizations such as ISO 14064-1 and corporate GHG Protocol to ICT organizations. A GHG calculation tool also is included. (see Clause 6.3 and 6.4)
- **Guidance on GHG accounting and reporting for ICT GHG projects:** this item covers how to apply existing general-purpose standards for GHG project accounting such as ISO 14064-2 or project accounting GHG Protocol to GHG projects of the ICT sector. Establishments of IDC centers and telecommunication networks are typical examples of ICT projects. (see Clause 6.3 and 6.4)
- **A set of guidance and/or standards on GHG accounting and reporting for ICT systems, networks or services, and ICT facilities:** this item may be exploited into multiple guidance and/or standards. ICT systems, networks, services and facilities are a kind of intervening constituents for an ICT organization or project. They could be assessed by organization and project accounting standards. But they may be required to be assessed systematically in conjunction with national level, organization level, project

level, and equipment level methodologies. Thus, a set of methodology standards might need to be developed for the intervening elements. (see Clause 6.1)

- **GHG inventory design guide for the ICT sector:** this item describes guidance to help design a GHG inventory of an ICT organization or an ICT GHG project. The inventory design is a starting point for any GHG accounting and reporting activity and may be included in *"Guidance on GHG accounting and reporting for ICT organizations"* and *"Guidance on GHG accounting and reporting for ICT GHG projects."* But it may need to be developed separately for all GHG accounting and reporting targets of the ICT sector. (see Clause 6.6)
- **Carbon footprint assessment for ICT products:** the carbon footprint assessment activity is a different one from the GHG accounting activity as defined in the terminology of *"carbon footprint"* in Clause Annex I. The item specifies a work method to quantify the whole GHG emission during the life cycle of an ICT product. This work may be based on ISO/WD 14067-1. (see Clause 6.4)
- **LCA design guide for ICT products:** An LCA study is the basic work for carbon footprinting and ISO 14025 Type III environmental labelling activities. This item describes guidance to help design an LCI and do an LCA of an ICT product. (see Clause 6.4)
- **ISO 14025 Type III environmental labelling scheme for ICT products:** a third-party organization or SDO may develop this labelling scheme. This item specifies a Type III environmental labelling scheme taking account into the GHG emission totals of ICT products. (see Clause 6.4)
- **PCR specifications for ICT products:** this item is part of the ISO 14025 Type III environmental labelling scheme. But the PCR specifications may be used for other purposes such as the carbon footprint assessment for ICT products. Because ISO/WD 14067-1 is a general assessment methodology for all business sectors and PCR specifications for ICT products may realize the carbon footprint assessment for ICT products. (see Clause 6.4)
- **CDM methodologies for the ICT sector:** this item specifies information on baseline scenario and monitoring methodologies for ICT CDM project activities. (see Clause 6.2)
- **Home and building energy management systems:** these items may be exploited into a set of relevant standards. The energy management system may be specified by a management architecture, control protocol, system-internal interfaces, application interfaces, etc. Some cooperation activities with other SDOs are expected. (see Clause 6.5)
- **Environmental impacts assessment metrics for contribution by the Green ICT:** this item specifies required metrics for environmental impacts assessment in terms of the Green ICT study points defined in Clause 3.2. How much the recycling of ICT products has contributed to positive impacts to the environment needs to be measured. How to present some energy consumption and relevant GHG emission needs to be clarified. According to the GHG accounting and reporting standards, all energy consumptions shall be presented in terms of CO2e (CO2-equivalent). But the major energy source of the ICT sector is electric power. This item needs some cooperation with other SDOs such as ITU-T and ETSI. (see Clause 6.6)
- **Environmental impacts assessment for contribution by the Green by ICTs:** this item specifies how to quantify the GHG emissions and removals contributed by using ICT

products. This kind of GHG emissions and removals belong to other sectors. But the contribution volume of the ICT sector needs to be calculated by a standard methodology. This item needs some cooperation with other SDOs such as ITU-T and ETSI. (see Clause 6.6)

- **Environmental protection and recycling:** this item corresponds to national regulations for the ICT governance. But an SDO may provide a general guidance on ICT products for the environmental protection contributed by the ICT sector. This item needs some cooperation with other SDOs such as IEC TC 111, ITU-T Q.21/5 and ETSI. (see Clause 6.6 and 6.11)
- **Energy efficiency assessment methodologies for ICT products, including measurement of energy efficiency:** this item specifies energy efficiency assessment methodologies for ICT products such as telecommunication equipments, network components, information services, CE devices, etc. These methodologies make the energy efficiency visible through relevant indicators. (see Clause 6.6, 6.7, 6.8 and 6.9)

7.2. Ideas for consideration to ISO/IEC JTC 1/SCs

The principle study target for the Green ICT is energy efficiency. Saving energy consumption of an ICT product contributes to the mitigation activities against the Climate Change problem. Each SC of ISO/IEC JTC 1 may consider the following ideas to find some work items to improve the energy efficiency of ICT products within its work scope. *[Note] The following items have not been consolidated but are listed for seed materials for consideration.*

- SC 2 (Coded character sets)
  - **Smaller-size coded character sets:** the smaller-size coded character sets may contribute to saving memory and storage spaces which can improve energy efficiency.
  - **Simplified control functions:** simplified control functions may reduce processing burden, which can improve energy efficiency. Simplification may be initiated by strategic, political or regulatory decision.
- SC 6 (Telecommunications and information exchange between systems)
  - **Energy efficient PHY/MAC standards:** conventional PHY/MAC standards had lack of considerations on energy efficiency. Energy efficiency-improved standards are required.
  - **A network architecture to improve energy efficiency:** a network architecture to reduce network operations will improve energy efficiency. A network proxy could be a solution as developed in the Ecma International, Clause 5.11.
  - **Future Network standards:** one of its consideration points is energy efficiency so that network performance would be improved with less energy consumption.
- SC 7 (Software and systems engineering)
  - **An LCA model for ICT software:** an ICT service may be involved with hardware and software entities and the LCA standards, ISO 14040 and 14044 fit well with hardware products. An LCA methodology for software entities may be needed.

  - **Energy efficient systems and software engineering standards:** a set of standards may be developed to improve energy efficiency for systems and software engineering.

- SC 17 (Cards and personal identification) deals with standardization in the area of a)
  - **Identification cards recycling management for the environmental protection:** identification cards have produced a lot of environmental wastes so far. A proper recycling mechanism will improve energy efficiency and protect the environment.

- SC 23 (Digitally Recorded Media for Information Interchange and Storage)
  - **Higher volume of the storage media** will help save energy consumption by decreasing required number of storage media.
  - **Recycling management and waste treatment of the storage media:** these works will improve energy efficiency and protect the environment.

- SC 25 (Interconnection of information technology equipment)
  - **A set of technical standards for intelligent homes:** these standards are for use of the Green by ICTs. JTC 1/SC 25 gave the SWG-Planning group the following input about its WG 1:
    - Reduction of heating/cooling energy by adapting the demanded temperature to the current needs – depending and usage - for individual rooms, by automatically cutting off radiators when windows are open, by automatically closing shutters when it gets dark .
    - Reduction of lighting energy by automatically adapting the level of light provided to the current demand and brightness of the environment.
    - Reduction of copper needed by connecting switches to the control bus only thus the thick conductors only need to go to places where power is needed.
    - Reduction of electromagnetic radiation by connecting switches to the bus only and providing power only two places and only at times the power is needed by a consumer.
    - Shifting of power consumption out of times where there is a shortage of power by intelligently controlling consumption, e.g. do the washing when power is cheap and or hot water is provided by solar panels.
  - JTC 1/SC 25 gave the SWG-Planning group the following input about its WG 3:
    - Efficient distribution of power to DEE by information cabling.
    - Infrastructure for intelligent homes.

- SC 27 (IT Security techniques)
  - **Energy efficient cryptographic and security mechanisms:** the cryptographic and security mechanisms cause a lot of processing load consuming more energy. Energy efficient solutions are required.

- SC 28 (Office equipment)
  - **Standby and off-mode energy consumption management:** office equipments are vulnerable to standby and off-mode energy consumptions. A proper management technique will held save energy consumption very much.

- SC 29 (Coding of audio, picture, multimedia and hypermedia information)
  - **Energy efficient coding mechanisms:** multimedia encoding and decoding are energy consuming operations. Energy efficient coding techniques will help save energy consumption.
- SC 34 (Document description and processing languages)
  - **Languages for describing environmental data specified by the Green ICT standards:** the language standards support description of environmental data made by the Green ICT standards.
- SC 35 (User interfaces)
  - **Presentation standards of environmental data and labels:** a certain data by the Green ICT standards may need to be presented to consumers via the presentation standards.
- SC 36 (Information technology for learning, education and training)
  - **A standard for learning, education and training on the Climate Change problem and personal behaviors information to mitigate the problem**.
- SC 37 (Biometrics)
  - Energy efficient feature extraction and comparison algorithms: Energy efficient solutions may be required.
  - Stand-by energy consumption management: equipment is vulnerable to stand-by energy consumption.

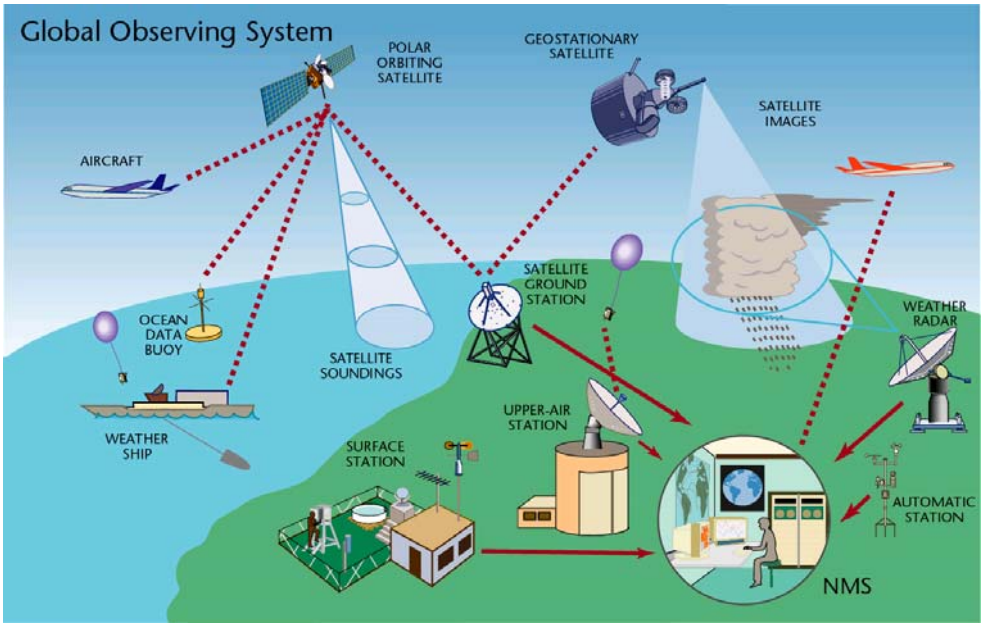
7.3. Other ideas for consideration

Following ideas also may be considered to find work items:

- **Reference model of the Green ICT:** various ICT technology fields such as Smart Grid, green data centers, green networking techniques and equipments, telematics and multimedia systems will study the Green ICT study points and they may deal with several or more identical functions. One of them is LCA because every constitution element of theirs needs to be analyzed regarding energy consumption over its life cycle. Real-time energy consumption monitoring and corresponding control of energy consuming functions and elements may be required. Recycling and disposal also have to be considered. Thus a logical reference model of key features of the Green ICT will be helpful to assess the environmental improvements of the Green ICT.
- **Common methodology for measurement of energy efficiency for the most energy consuming sectors (power plant, transportation, iron and steel, cement, lighting, building, industry, etc.):** It can make the energy efficiency visible through relevant indicators. The comparison of energy efficiency for these sectors can not be correctly performed without a common methodology for measuring it. The standard may be the basis for governance and corporate decisions as well as national strategies and regulation.
- **Document life cycle management:** usually a lot of electronic documents are not managed well and have kept remained in storages without a management plan. Thus as time goes, more and more documents are piled up, which causes more energy consumption as well as unnecessary storage space. A proper management standard is

needed for automatic treatment such as removing expired documents and saving some storage space.

- **Green data center standards**
  - **Guidance for establishment of the green data centers:** many data centers have exploited various techniques to improve energy efficiency such as inducing cold air into a server room in the winter season. The best practice guidance for establishment of the green data centers will be very helpful to save energy consumption of data centers.
  - **Battery specification:** server systems may be mounted internally with batteries instead of external UPS equipments due to cost problems of establishment, operation and maintenance of UPS equipments. A proper battery specification is needed.
  - **Energy efficiency measurement methods for data center equipments** such as Power Supply Unit (PSU), server systems, AC/DC rectifiers, DC/DC converters, etc.
  - **Data center energy efficiency methodology:** PUE and DCiE are unique evaluation factors developed by the Green Grid. The ICT sector may need more advanced methodology.
  - **DC power distribution issues:** DC power voltage, outlet and connector types need to be specified.
- **Real-time energy consumption monitoring:** real-time energy consumption monitoring can help manage and reduce energy consumptions of all types of industries and organizations. A monitoring infrastructure will be involved with various technical issues such as networking, system and application interfaces, and reference architecture. Relevant energy sources are electric power, fossil fuels such as coal, oil and natural gas, and renewable energy sources such as wind, solar, geothermal, hydrogen and biomass.
- **CO2 emissions monitoring:** detecting the current situation of CO2 emissions is a critical factor because this information will drive correspondence actions. This item may be covered by the Global Observing System (GOS) relevant standards. The World Meteorological Organization (WMO) described for the GOS as shown in Figure **5**, *"the coordinated system of methods and facilities for making meteorological and other environmental observations on a global scale in support of all WMO Programmes; the system is comprised of operationally reliable surface-based and space-based subsystems. The GOS comprises observing facilities on land, at sea, in the air and in outer space. These facilities are owned and operated by the Member countries of WMO each of which undertakes to meet certain responsibilities in the agreed global scheme so that all countries can benefit from the consolidated efforts."*[23] The GOS will need various standards for an operation architecture, network connections, data presentation, application interfaces, management, etc. Application interfaces and data handling standards might have to be covered by the WMO and/or its partnership SDO, but base standards for interworking among communicating parties belong to ISO/IEC JTC 1.



[Note] NMS = National Meteorological Service

Figure 5 – WMO Global Observing System

- **Cloud computing:** one of its main functionalities is virtualization of system resources such as computing, memory, storage, network bandwidth, etc. Such virtualization can reduce hardware system requirements and save energy consumption.
- **Smart Grid:** this is an emerging work area. The WIKIPEDIA defined the Smart Grid as follows: *"The Smart Grid is a simple upgrade of 20th century power grids which generally "broadcast" power from a few central power generators to a large number of users, to instead be capable of routing power in more optimal ways to respond to a very wide range of conditions."* It delivers electricity from suppliers to consumers using digital technology to save energy, reduce cost and increase reliability and transparency. Such a modernized electricity network is being promoted by many governments as a way of addressing energy independence, global warming and emergency resilience issues.[24] Moreover renewable energies should be integrated in power grids, which requires dealing with the non synchronisation of power demand and generation with the help of high capacity electricity storage and intelligent grids. This topic is involved with a lot of standardization issues such as load adjustment, demand response support and price signalling to consumers. Following items also are possible. (see the WIKIPEDIA for details)
  - Demand-based power generation system architecture
  - Efficiency test methodology for power generation systems
  - Renewable energy reservoir and real-time distribution technology
  - Power distribution architecture supporting power stability against accidents
  - Power price-based power distribution control standard
  - Data format for smart metering of integrated power, gas and water works
  - Smart metering-relevant standards for device networking, device platform and communication interfaces

8. Recommendations to JTC 1

8.1. Consensus of SWG-Planning

Basically standardization is recommended to be started first in areas for which high consumption savings are expected. The common general terminology, metrics, calculation methods and criteria in the domain of ICT energy efficiency should be a joint work of JTC 1 with ISO, IEC and ITU-T in collaboration with IEA.

The Green ICT makes a variety of new standardization items toward ISO/IEC JTC 1 and produces new standardization items for better energy efficiency to existing SCs of ISO/IEC JTC 1. The ideas for consideration of JTC 1/SCs clarified in Clause 7.2 must belong to corresponding SCs. But the ideas clarified in Clause 7.1 and 7.3 require JTC 1's considerations.

ISO/IEC JTC 1 has the following options to tackle all those ideas for the Green ICT:

Option 1– Creation of a new SC for the Green ICT standardization activities

Option 2 – Creation of a WG under a certain SC

Option 3 – Distribution of work items to relevant SCs

Option 4 – Creation of a WG under ISO/IEC JTC 1

Option 5 – Creation of a Joint Working Group

Option 6 – Creation of relevant Study Groups

Option 7 – Creation of relevant Special Working Groups

Each one has pros and cons. After its discussion, the SWG-Planning reached consensus on, as follows:

- All the consideration ideas cannot be resolved by a certain option but has to be treated by a set of multiple options.
- The energy efficiency is involved with every standardization work. For example, each layer of the OSI Reference Model includes its own energy efficiency issues. Thus JTC 1 SCs need to study the energy efficiency within their work scopes.
- The building and home energy management systems seem involved with the work of JTC 1 SC 25. It needs to take account into them for standardization.
- The cloud computing can improve the energy efficiency for ICT hardware systems. But its standardization areas overwhelm the energy efficiency issue and needs to be considered separately from the Green ICT.
- The Smart Grid technologies have been developed so far and there are some relevant standardization activities. A further study is needed to identify market requirements and standardization gaps with particular attention to standards supporting the interoperability of Smart Grid technologies and necessary international standardization.
- The energy efficiency of data centers is a significant topic in the industry and a further study is needed to understand the current state of market requirements and relevant standardization activities and to explore a possible role for JTC 1.

- The best practices for green standards development needs to be studied to survey best practices for green technologies development and to document recommended attributes for JTC 1 standards development.

8.2. Resolutions of SWG-Planning

The SWG-Planning discussed about the study results of this review document, reached to the above consensus, and agreed to provide the following recommendations to the ISO/IEC JTC 1 Plenary meeting scheduled in October 2009, Tel Aviv, Israel.

The SWG-Planning prepared three key recommendations to establish one ad-hoc group, one Study Group and one SWG for further Green ICT study activities.

- **Establishment of an ad-hoc group on the best practices for green standards**
  - SWG-Planning recommends that JTC 1 establish an ad hoc group on best practices for green standards development. The purpose of the ad hoc is to involve experts in green ICT, to survey best practices for green technology development and to document recommended attributes for JTC 1 standards development. The document will be shared with JTC 1 SCs and WGs for their use in standards development.
- **Establishment of a Study Group on Energy Efficiency of Data Centers**
  - SWG-Planning has identified the energy efficiency of Data Centers as a significant topic in the industry and wishes to understand the current state of relevant standardization and to explore a possible role for JTC 1 (see this document). To this end, SWG-Planning proposes the creation of a Study Group on Energy Efficiency of Data Centers (EEDC) to investigate market requirements for standardization, initiate dialogues with relevant consortia and to identify possible work items for JTC 1.
  - The Study Group will have the following terms of reference: 1) Provide a taxonomy of Data Centers and terminology used for energy efficiency; 2) Assess the current state of EEDC standardization within JTC 1, in other SDOs and consortia beginning with the review document; 3) Document standardization market/business/user requirements and the challenges to be addressed; 4) Liaise and collaborate with relevant SDOs and consortia related to EEDC; 5) Hold workshops to gather requirements as needed; and 6) Provide a report of activities and recommendations to JTC 1.
  - On topics of common interest (such as virtualization) coordination with the SGCC is required.
- **Establishment of a Special Working Group on Smart Grid**
  - SWG-Planning recognizes the continuing and important evolution of Smart Grid technologies, and notes that many standards consortia are planning to develop Smart Grid standards (see this document). The SWG-Planning believes that JTC 1 has specific interest in this area on a continuing basis and recommends that JTC 1 establish a Special Working Group on the Smart Grid (SWG-Smart Grid).
  - The Terms of Reference of the SWG are: 1) Identify market requirements and standardization gaps for Smart Grid with particular attention to standards supporting the interoperability of Smart Grid technology and needed international standardization; 2) Encourage JTC 1 SCs to address the need for ISO/IEC Smart Grid International Standards; 3) Promote JTC 1 developed International Standards

for the Smart Grid and encourage them to be recognized and utilized by the industry and standards developing organizations; 4) Coordinate JTC 1 Smart Grid activities with IEC, ISO, ITU-T and other SDOs that are developing standards for the smart grid; and 5) Periodically report results and recommendations to JTC 1 SWG-Planning and coordinate ongoing work with related plans. Provide a report of activities and recommendations at the next JTC 1 Plenary.

In addition to those three key recommendations, the SWG-Planning prepared one informative recommendation to JTC 1 SCs as below:

- **Information about ideas/opportunities for future standardization items**
  - SWG-Planning recommends that JTC 1 inform its SCs of the ideas/opportunities for future standardization items identified in this document, especially of the possible work items for JTC 1/SCs listed in Clause 7.2.
  - SWG-Planning recommends that JTC 1 submit this document as background material for further discussion and consideration on defining possible new work items to its SCs and NBs.

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Annex I – Terms and definitions

1. Terms defined elsewhere

This document uses the following terms defined elsewhere:

accreditation: third-party attestation related to a validation or verification body conveying formal demonstration of its competence to carry out specific validation or verification tasks [ISO 14065]

baseline scenario: hypothetical reference case that best represents the conditions most likely to occur in the absence of a proposed GHG project [ISO 14064-2]

Carbon dioxide equivalent, CO2e: a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO2 that would have the same Global Warming Potential (GWP), when measured over a specified timescale (generally, 100 years).[25]

environmental aspect: element of an organization's activities, products or services that can interact with the environment [ISO 14040]

environmental declaration *or* **environmental label**: claim which indicates the environmental aspects of a product or service [ISO 14025]

environmental impact: any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects [ISO 14001]

facility: single installation, set of installations or production processes (stationary or mobile), which can be defined within a single geographical boundary, organizational unit or production process [ISO 14064-1]

GHG: gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. *[Note] GHGs include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF6).* [ISO 14064-1]

GHG assertion: declaration or factual and objective statement made by the responsible party [ISO 14064-1]

GHG emission: total mass of a GHG released to the atmosphere over a specified period of time [ISO 14064-1]

GHG inventory: an organization's GHG sources, GHG sinks, GHG emissions and removals [ISO 14064-1]

GHG programme: voluntary or mandatory international, national or sub-national system or scheme that registers, accounts, or manages GHG emissions, removals, emission reductions or removal enhancements outside the organization or GHG project [ISO 14064-3]

GHG project: activity or activities that alter the conditions identified in the baseline scenario which cause GHG emission reductions or GHG removal enhancements [ISO 14064-1]

GHG removal: total mass of a GHG removed from the atmosphere over a specified period of time [ISO 14064-1]

GHG sink: physical unit or process that removes a GHG from the atmosphere [ISO 14064-1]

GHG source: physical unit or process that releases a GHG into the atmosphere [ISO 14064-1]

life cycle: consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal [ISO 14040]

organization: company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration [ISO 14064-1]

PCR: set of specific rules, requirements and guidelines for developing Type III environmental declarations for one or more product categories [ISO 14025]

product: any goods or service *[Note 1] The product can be categorized as follows: services (e.g. transport); software (e.g. computer program, dictionary); hardware (e.g. engine mechanical part); and processed materials (e.g. lubricant). [Note 2] Services have tangible and intangible elements. Provision of a service can involve, for example, the following: an activity performed on a customer-supplied tangible product (e.g. automobile to be repaired); an activity performed on a customer-supplied intangible product (e.g. the income statement needed to prepare a tax return); the delivery of an intangible product (e.g. the delivery of information in the context of knowledge transmission); and the creation of ambience for the customer (e.g. in hotels and restaurants). Software consists of information and is generally intangible and can be in the form of approaches, transactions or procedures. Hardware is generally tangible and its amount is a countable characteristic. Processed materials are generally tangible and their amount is a continuous characteristic.* [ISO 14040]

product category: group of products that can fulfil equivalent functions [ISO 14025]

responsible party: person or persons responsible for the provision of the GHG assertion and the supporting GHG information [ISO 14064-1]

self-declared environmental claim: environmental claim that is made, without independent third-party certification, by manufacturers, importers, distributors, retailers or anyone else likely to benefit from such a claim [ISO 14021]

Type III environmental declaration: environmental declaration providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information [ISO 14025]

Type III environmental declaration programme: voluntary programme for the development and use of Type III environmental declarations, based on a set of operating rules [ISO 14025]

validation: systematic, independent and documented process for the evaluation of a GHG assertion in a GHG project plan against agreed validation criteria [ISO 14064-1]

verification: systematic, independent and documented process for the evaluation of a GHG assertion against agreed verification criteria [ISO 14064-1]

validation body: body that performs validations of GHG assertions in accordance with ISO 14065 [ISO 14065]

verification body: body that performs verifications of GHG assertions in accordance with ISO 14065 [ISO 14065]

2. Terms defined in this document

This document defines the following terms:

carbon footprint: GHG emission total during the life cycle of a product *[Note 1] This terminology is being defined by ISO/WD 14067-1 of which initial definition is "parameter by which greenhouse gas emissions of a process, a system of processes or a product system is quantified in order to indicate their contribution to climate change." [Note 2] A carbon footprint result should not be included in the GHG accounting for organizations and GHG projects. Because the carbon footprint assessment covers the life cycle of a product but the GHG accounting does not cover such life cycle but assess all relevant activities in a yearly basis within the boundaries of an organization and GHG project.*

green data center: is an energy efficiency-improved data center.

Green ICT: consists of the Green of ICTs and the Green by ICTs.

Green of ICTs: means the environmental protection activity of the ICT sector with incorporating avoidance of the use of hazardous materials, recycling of defunct ICT products and ICT wastes, and maximization of energy efficiency into the ICT industry.

Green by ICTs: means the environmental protection activity of other business sectors with utilizing ICT technologies and products.

Annex II – Work scopes of ISO/IEC JTC 1 Sub-Committees

Each SC of ISO/IEC JTC 1 has following work scopes:

- SC 2 (Coded character sets) deals with standardization of graphic character sets and their characteristics, including string ordering, associated control functions, their coded representation for information interchange and code extension techniques, and excluding audio and picture coding.
- SC 6 (Telecommunications and information exchange between systems) deals with open systems including system functions, procedures, parameters, and equipment, as well as the conditions for their use. This standardization includes both the lower layers that support the physical, data link, network, and transport protocol and services, including private integrated services networking, as well as the upper layers that support the application protocols and services such as Directory and ASN.1. A vital aspect of this work is done in effective cooperation with ITU-T and other worldwide and regional standardization bodies e.g. IEEE and IETF. SC 6 is composed of WG 1 – Services and protocols in the physical and data link layers; WG 7 – Services and protocols in the network and transport layers; WG 8 – Services and protocols in Directory; and, WG 9 – Specification of Abstract Syntax Notation one (ASN.1), its Encoding Rules, Generic Applications and related Registration Authorities.
- SC 7 (Software and systems engineering) deals with standardization of processes, supporting tools and supporting technologies for the engineering of software products and systems within the scope of JTC 1 terms of references. But it excludes specific tools and technologies that have been assigned by JTC 1 to other SCs. Its key work areas consist of Software and systems engineering processes; Software system products; Techniques for Specifying IT Systems; Software engineering environment; Software and Systems Bodies of Knowledge and Professionalization; IT Service Management; and IT Governance Frameworks and Systems.
- SC 17 (Cards and personal identification) deals with standardization in the area of a) Identification and related documents; b) Cards and devices associated with their use in inter-industry applications and international interchange. It consists of WG 1 – Physical characteristics and test methods for identification cards; WG 4 – Integrated circuit cards with contacts; WG 9 – Optical memory cards and devices; and WG 10 – Motor vehicle driver license and related documents.
- SC 22 (Programming languages, their environments and system software interfaces) is responsible for the standardization of programming languages (such as Cobol, Fortran, Ada, C, C++, Lisp and Prolog) and their environments (such as POSIX). It also produces common language-independent specifications to facilitate standardized bindings between programming languages and system services, as well as greater interaction between programs written in different languages.
- SC 23 (Digitally Recorded Media for Information Interchange and Storage) deals with standardization in the field of removable digital storage media information interchange and/or storage, including:
  - algorithms for the lossless compression of data;
  - volume and file structures;

  - methods for determining the life expectancy of digital storage media; and
  - methods for error monitoring of digital storage media.

- SC 24 (Computer graphics, image processing and environmental data representation) deals with standardization of interfaces for information technology based applications relating to:
  - computer graphics,
  - image processing,
  - virtual reality,
  - environmental data representation and
  - interaction with, and visual presentation of, information

  Included are the following related areas: modelling and simulation, related reference models; application program interfaces; functional specifications; representation models; interchange formats, encodings and their specifications, including metafiles; device interfaces; testing methods; registration procedures; presentation and support for creation of multimedia and hypermedia documents. Excluded are character and image coding; coding of multimedia and hypermedia document interchange formats, JTC 1 work in user system interfaces and document presentation; ISO TC 207 work on ISO14000 environment management, ISO TC 211 work on geographic information and geomatics; and software environments as described by ISO/IEC JTC 1 SC 22.

- SC 25 (Interconnection of information technology equipment) deals with standardization of microprocessor systems; and standardization of interfaces, protocols and associated interconnecting media for information technology equipment, generally for commercial and residential environments, and for embedded and distributed computing environments, storage systems, and other input/output components. It excludes development of standards for telecommunication networks and interfaces to telecommunication networks.

- SC 27 (IT Security techniques) deals with development of standards for the protection of information and ICT. It covers generic methods, techniques and guidelines to address both security and privacy aspects, such as
  - security requirements capture methodology;
  - management of information and ICT security; in particular information security management systems (ISMS), security processes, security controls and services;
  - cryptographic and other security mechanisms, including but not limited to mechanisms for protecting the accountability, availability, integrity and confidentiality of information;
  - security management support documentation including terminology, guidelines as well as procedures for the registration of security components;
  - security aspects of identity management, biometrics and privacy;
  - conformance assessment, accreditation and auditing requirements in the area of information security; and
  - security evaluation criteria and methodology.

- SC 28 (Office equipment) deals with Standardization of basic characteristics, test methods and other related items, excluding such interfaces as user system interfaces, communication interfaces and protocols, of office equipment and products such as Printers, Copying Equipments, Digital scanners, Facsimile equipment and systems composed of combinations of office equipment.
- SC 29 (Coding of audio, picture, multimedia and hypermedia information) deals with standardization of coded representation of audio, picture, multimedia and hypermedia information – and sets of compression and control functions for use with such information – such as
  - audio information
  - bi-level and limited bits-per-pixel still pictures
  - digital continuous-tone still pictures
  - computer graphic images
  - moving pictures and associated audio
  - multimedia and hypermedia information for real-time final form interchange
  - audio visual interactive script ware

  The character coding is excluded.
- SC 31 (Automatic identification and data capture techniques) is responsible for standardization of data formats, data syntax, data structures, data encoding, and technologies for the process of automatic identification and data capture and of associated devices utilized in inter-industry applications and international business interchanges. It deals with linear symbologies, unique identifiers, RFID, RTLS and MIIM.
- SC 32 (Data management and interchange) deals with standardization for data management within and among local and distributed information systems environments. It provides enabling technologies to promote harmonization data management facilities across sector-specific areas. Specifically, its standards include:
  - reference models and frameworks for the coordination of existing and emerging standards;
  - definition of data domains, data types and data structures, and their associated semantics;
  - languages, services and protocols for persistent storage, concurrent access, concurrent update and interchange of data; and
  - methods, languages, services and protocols to structure, organize and register metadata and other information resources associated with sharing and interoperability, including electronic commerce.
- SC 34 (Document description and processing languages) deals with standardization in the field of document structures, languages and related facilities for the description and processing of compound and hypermedia documents, including:
  - languages for describing document logical structures and their support facilities
  - languages for describing document-like objects in web environments
  - document processing architecture and formatting for logical documents

  - languages for describing interactive documents
  - multilingual font information interchange and related services
  - final-form document architecture and page information interchange
  - hypermedia document structuring language and application resources
  - API for document processing

- SC 35 (User interfaces) deals with standardization in the field of User-system interfaces between users (including people with special needs) and systems encompassing input and output devices in information technology environments, with a priority of meeting the JTC 1 requirements for cultural and linguistic adaptability. Included are the following related areas:
  - interfaces between users and devices such as keyboard, mice, pointers, pens; visual displays, and forms of audio and tactile input/output, with the emphasis on functionality;
  - rules for system control by voice, vision, movement, gestures, etc.;
  - presentations of technical mechanisms, icons, graphical symbols, etc.; and
  - dialogue control and navigation in interactions between humans and systems assistance and tutoring.
- SC 36 (Information technology for learning, education and training) deals with standardization in the field of information technologies for learning, education, and training to support individuals, groups, or organizations, and to enable interoperability and reusability of resources and tools.
- SC 37 (Biometrics) deals with standardization of generic biometric technologies pertaining to human beings to support interoperability and data interchange among applications and systems. Generic human biometric standards include common file frameworks; biometric application programming interfaces; biometric data interchange formats; related biometric profiles; application of evaluation criteria to biometric technologies; methodologies for performance testing and reporting and cross jurisdictional and societal aspects. Excluded is the work in ISO/IEC JTC 1/SC 17 to apply biometric technologies to cards and personal identification. Excluded is the work in ISO/IEC JTC 1/SC 27 for biometric data protections techniques, biometric security testing, evaluations, and evaluations methodologies.