National IT and Telecom Agency
Ministry of Science
Technology and Innovation

WORKSHOP ON ICTS AND ENVIRONMENTAL CHALLENGES

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WORKSHOP SUMMARY

OECD
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Objectives

The workshop, jointly organised by the OECD and the National IT and Telecom Agency (NITA), Danish Ministry of Science, Technology and Innovation, had as objectives to take stock of the impacts of information and communication technologies (ICTs) on the environment, identify areas where further analysis of the application and use of ICTs to attain environmental goals was needed, and identify opportunities and best practices in the use of the Internet, sensor networks, *etc*. for environmental goals. Moreover, the workshop had the aim to consider implications of existing policies as well as identify policies to harness the potential of ICTs in tackling environmental challenges – involving the public sector, businesses, civil society, and individuals. Finally, it was important to define how OECD work can be co-ordinated with major stakeholders and other international organisations.

The results of the workshop will contribute to upcoming events such as the OECD Seoul Ministerial on the Internet Economy, the Hokkaido G8 meeting, the OECD conference on ICTs, the environment and climate change in 2009 (Copenhagen, Denmark), and the United Nations Climate Change Conference the same year (COP 15).

The workshop

The two-day workshop was hosted by the National IT and Telecom Agency (NITA), Danish Ministry of Science, Technology and Innovation and took place at Eigtveds Pakhus, the conference centre of the Danish Ministry of Foreign Affairs.

The workshop was attended by over 100 participants (65 from outside of Denmark) and saw 24 presentations. The workshop was attended by government delegations, national experts and scientists, representatives of international organisations, businesses and civil society besides representatives from the organising OECD and NITA. The Business and Industry Advisory Committee to the OECD (BIAC) and the Trade Union Advisory Committee to the OECD (TUAC) were also represented.

Presentations and a webcast of the entire workshop are available at www.oecd.org/sti/ict/green-ict and http://itst.media.netamia.net/green-ict.

Results

The workshop showed that ICTs can play a significant role in the near-term for mitigating the growth (even reducing) of the global energy footprint. And although this includes mitigating the growth of the ICT industry footprint itself, a consensus emerged that the role of ICTs in enabling energy savings and reducing negative environmental effects across all industry sectors is even more crucial. Participants agreed that near-term abatement in the global energy footprint is critical if major climate change is to be averted.

The workshop provided important insights into the following areas:

1. Analytical frameworks to measure and evaluate the environmental impact of ICTs,
2. Measurement of the environmental impact of ICTs,
3. Environmental impact of the ICT producing sector,
4. The innovation potential of ICTs to further environmental goals across all industries,
5. The role of governments as leaders and enablers through effective and coherent policies,
6. The importance of behavioural adjustment on the ICT demand-side, i.e. non-ICT businesses and consumers,
7. The role of the OECD in
    - *a)* Developing an overview of systemic effects of ICTs on the environment,
    - *b)* measuring and analysing the environmental impact of ICTs,
    - *c)* co-ordinating outreach activities with global partners (governments, international organisations, businesses, civil society),
    - *d)* identifying policy priorities, and
    - *e)* developing policy recommendations.

Analytical frameworks

The workshop identified three important aspects that any analytical framework of the environmental impact of ICTs needs to take into account:

> *i*) positive and negative effects of ICTs, which must be addressed within a framework that includes *a*) direct/first-order effects regarding the production and use of ICT goods, *b*) indirect/second-order effects regarding the application and use of ICTs more broadly, and *c*) systemic/third-order effects analysing societal changes through ICTs;
>
> *ii*) the ICT eco-system, which consists of much more than just the ICT producing sector. Participants agreed that it is essential to make the shift from simply calculating CO2 emissions of ICT production to evaluating the net impact of the technology life-cycle, including e.g. operating and use considerations, end-of-life management;
>
> *iii*) the dynamics of the ICT sector as an independent variable, which requires analytical frameworks to be flexible with regards to recent and future developments such as the current shift from fixed-line towards mobile broadband.

Impact measurement

Available studies suggest that **ICTs will have great long-term impact on the environment,** especially in areas such as building and transport, but **positive impact can only be realised by moving away from business-as-usual scenarios.** A number of alternative future scenarios were presented and speakers highlighted the importance of elaborating realistic scenarios as a basis for coherent policy recommendations. Criteria for establishing scenarios were discussed, e.g. regarding the transparency of underlying assumptions.

Recent studies show that around 2% of global CO2 emissions are caused by the ICT industry**.** During presentations and discussions two competing perspectives were discussed: *i*) ICTs pose major **environmental challenges**. Data centres in the United States, for instance, are reported to be responsible for 1.5% of domestic electricity use and growing; *ii*) ICTs provide enormous **opportunities to mitigate climate change**. They can enable large reductions of CO2 emissions in the bulk of the industry sectors responsible for the remaining 98% of emissions. A consensus appeared to emerge that a holistic view is important and studies, e.g. by the Ministry of Internal Affairs and Communications (MIC), Japan, suggest that CO2 savings through ICT usage far outweigh CO2 emissions of the ICT producing sector.

The ICT producing sector

The workshop identified **factors that contribute to CO2 emissions in the ICT sector,** but at the same time pointed to the **existence of "low-hanging fruit"**, i.e. solutions to minimise emissions that can be easily and quickly implemented. Speakers and participants often referred to increasing energy use of data centres and consumer electronics devices, the proliferation of standby and "always on" networked devices, rebound effects through increased efficiencies, rapid obsolescence of hardware, costly recycling and disposal of ICTs. Technology solutions exist to mitigate many of these environmental effects, codes of conduct are being developed and improved technologies researched. Although widespread application would result in immediate incremental improvements, concerns exist as to whether even the lowest of the "low-hanging fruit" will be adopted in time.

Other areas might have to be addressed in the longer term because of their wider implications: green design of ICT products, disposal and recycling of electronic waste as well as enacting environmental standards along supply chains and increasing service life of ICTs; participants agreed that concerted efforts by industry, consumers and policy-makers are needed. Speakers pointed to the **importance of financial incentives to engage businesses and reward innovation**.

ICTs as enablers

The **ICT industry is one of the most innovative**, it has one of the highest R&D intensities and is thus a key element of national innovation systems, **but it is still largely being neglected in high-level debates about innovative solutions to climate change**. Speakers highlighted the importance of

technologies such as broadband networks, RFID, software solutions to increase efficiencies and promote dematerialisation of manufacturing and services processes; virtualisation is key to improving awareness of the "real world", e.g. through remote pollution monitoring. Participants agreed that energy efficiency of urban infrastructures, e.g. buildings, transport and energy networks, will to a large degree depend on the use of ICTs to enable "smart" solutions. Further innovative solutions to environmental challenges can include carbon-offsetting through the establishment of teleconference centres as well as planting trees. Speakers emphasised the importance of connecting innovation systems from various industries as well as different national innovation systems.

The role of governments

Participants agreed that **governments have an important role as leaders in applying ICTs to tackle environmental challenges and in formulating policies that lever the enabling role of ICTs across industry sectors**. Leadership of governments is important to bring about wider behavioural changes and improve environmental efficiency, e.g. through environmental criteria in public ICT procurement, through training and education of users and IT managers, model use of teleconferencing, and facilitation of telework in public administrations. But governments should also provide incentives for businesses to invest in green ICTs. Speakers agreed that incentives must address major companies as well as small- and mid-sized enterprises (SMEs).

The workshop presented **policies and initiatives to harness the potential of ICTs and tackle environmental challenges**. Representatives of the Danish and Japanese governments presented their national "Green IT" programmes and the European Commission's (EC) recent focus on the "green role" of ICTs was highlighted. Speakers pointed to key policy areas where the application of ICTs could provide benefits for both businesses and the environment, e.g. building technologies, transport and logistics, communication and energy infrastructures. EC initiatives to address end-of-life issues (WEEE, RoHS) were discussed and their uptake beyond the European Union was acknowledged.

Behavioural adjustment on the demand side – non-ICT businesses

One aspect echoed throughout the workshop: **responsibility for environmental impact lies both with the ICT supply side** (manufacturers, service providers) **and demand side** (consumers, businesses, governments). Despite rapid technological progress, participants pointed for example to little facilitation of telework and very slow uptake of telepresence/teleconferencing applications. Changes in managerial culture are important and best practices were presented (e.g. the Danish Jyske Bank allowing online opening of accounts). At the same time, speakers underlined the importance of monitoring and independent auditing of these actions to avoid "green-wash".

Behavioural adjustment on the demand side – consumers

The workshop also underlined the **urgent need for widespread behavioural change towards environmentally sustainable behaviour of consumers** as the energy-intensity of households greatly increased due to the proliferation of electronic and electrical devices. Some speakers prioritised technology-based approaches to minimise the environmental impact of ICTs, but the majority of participants agreed that while this was part of the solution, awareness-raising and education are necessary to realise the green potential of ICTs. Most speakers agreed that consumers needed better information and guidance on energy efficiency, e.g. through labels such as Energy Star and TCO, and that ICTs are a key tool to increase demand-side efficiencies, e.g. through smart buildings and effective pay-per-use systems such as road pricing. Policy-makers were urged to take into account systemic environmental effects caused by new generations of ICT users entering the workforce with obvious, but rarely addressed environmental and socio-economic impact.

The role of the OECD

Participants agreed that the **OECD has a number of key functions in the debate**, the most prominent of which should be **to formulate a shared vision of how ICTs will enable systemic approaches to tackle global environmental challenges**. Participants highlighted that this vision will need to relate to other societal challenges and will have to engage stakeholders from the OECD and

non-OECD countries. Such a vision would help promote the important role of ICTs within the climate change agenda.

As a global forum, the OECD has an important role to play in **communicating the opportunities of ICTs in tackling environmental challenges**. Recent outreach activities of the organisation are important to engage in a dialogue with emerging economies such as China and India that already play a key role in addressing the environmental impact of ICTs. The OECD itself should consider different national innovation systems in its analyses of eco-innovation, including from non-OECD members. The OECD should work together with other international organisations.

Workshop participants pointed to the OECD's importance in **elaborating better indicators and providing comparable statistics and indicators**, especially for the evaluation of systemic global impact and eco-innovation. The OECD can build on its expertise to provide analytical insight into life-cycles of ICT products and services as well as their impact in other industry sectors. To this purpose, analytical work will have to consider various factors presented during the workshop such as greenhouse gas emissions during ICT production and operation, rebound effects, waste disposal.

Some topics that need **further analysis** include: intelligent software to reduce environmental impact in all industries, the impact of ICTs on other ecological issues such as biodiversity or land use and degradation, opportunities to reduce environmental impact by increasing service life of ICTs or deliberately reducing functionality, ICTs and environment in education curricula.

Finally, the OECD is an important forum to **formulate policy recommendations** and **identify key priorities for policy-makers**: what are major challenges, where are "low-hanging" fruit, what are the key value chains and networks of the ICT eco-system? The OECD can help ensure that policies in the area of ICTs and the environment are coherent with other policies, e.g. on regional development, development assistance, and environmental goals.

Follow-up

The workshop will provide input to the OECD Seoul Ministerial on the Internet Economy in June 2008 and the OECD conference on ICTs, the Environment and Climate Change in May 2009 in Copenhagen, Denmark. To raise awareness of the enabling potential of ICTs in the area of climate change and innovation, speakers underlined the importance of bringing the topic onto the agendas of global fora such as the G8 summit and COP15.

Detailed summary

Introduction

Marie Munk (National IT and Telecom Agency, Ministry of Science, Technology and Innovation, Denmark) welcomed workshop participants and thanked the OECD for the co-operation in organising the workshop. She underlined that climate change needs to be addressed by all industry sectors, including the ICT sector. This workshop should be seen as an opportunity for co-ordination and exchange between experts, governments, and organisations. Its results should feed into upcoming meetings such as the G8 summit in Hokkaido, Japan, the OECD conference on ICTs, the environment and climate change in 2009 (Copenhagen, Denmark), and the United Nations Climate Change Conference the same year (COP 15). It could moreover contribute to the OECD Ministerial Meeting on the Future of the Internet Economy and OECD's ongoing Innovation Strategy.

Munk underlined that the role of ICTs in tackling environmental challenges was gaining increased attention among policy-makers. She pointed to a recent communication by the European Commission, the Danish government's "Action Plan for Green IT", and others. As ICTs and their applications have become an integral part of everyday life, ICTs are coming under scrutiny regarding energy efficiency, hazardous waste generation, and CO2-emissions. But she said there was no need to roll back the ICT revolution, because ICT applications contribute to tackling climate change across all sectors of the economy, e.g. in transport, work organisation, households, education.

Graham Vickery (OECD) thanked the National IT and Telecom Agency and particularly Marie Munk and Henrik Kjær for the successful co-operation in organising the workshop and for hosting it. He outlined the aims of the workshop: to analyse the complex relationship between ICTs and environmental challenges and to indicate how the OECD can add value to this analysis. He mentioned the OECD's expertise in economic analysis, measurement, data collection, and formulating policy recommendations. Vickery asked participants for their input on how the OECD could leverage this potential to analyse the role of ICTs in tackling environmental challenges.

He pointed to upcoming meetings and conferences such as the G8 summit, the 2009 conference on ICTs and environmental challenges, and COP15. Furthermore, this workshop's results would contribute to the OECD Ministerial Meeting on the Future of the Internet Economy in Seoul, Korea, as well as to the OECD's ongoing Innovation Strategy.

Henrik Kjær (National IT and Telecom Agency, Ministry of Science, Technology and Innovation, Denmark) thanked the OECD and particularly Graham Vickery for successful co-operation in organising the workshop.

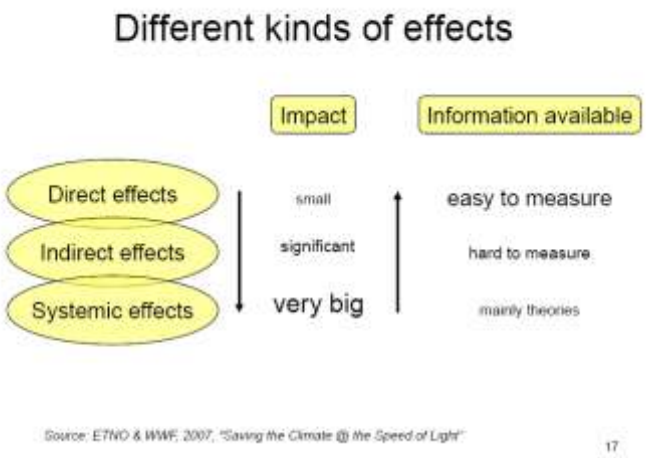
Session 1 – The environmental impact of ICTs in the knowledge economy

This session focussed on a general overview of the impacts of ICTs on meeting environmental challenges. Questions addressed included:

- To what extent can ICTs reduce energy intensity in energy-intensive activities?
- What are the overall magnitudes of the impacts of ICTs on reducing greenhouse gas (GHG) emissions and improving energy efficiency?
- What are the impacts of digitalisation and digital delivery on environmental performance?
- What are the environmental impacts of expanded use of ICTs in work and social organisation? How have ICTs affected transport and logistics patterns and what is the potential for further improvements?
- How large is the "rebound effect", where improvements in efficiency and environmental performance lead to greater use?

The session was chaired by **Marie Munk** (National IT and Telecom Agency, Ministry of Science, Technology and Innovation, Denmark).

Don MacLean (International Institute for Sustainable Development, Canada) presented a framework for modelling the impact of ICTs on the environment. Public policies have so far not been able to jointly achieve economic growth, social development, and environmental sustainability. More effective policies would have to consider the impact of ICTs on environmental challenges. MacLean identified necessary research directions to harness positive environmental effects of ICTs, e.g. in the areas of sensor-networking technologies.



MacLean proposed a three-layer framework that covers: 1) the impact of the ICT manufacturing sector (direct effects), 2) the impact of application and use of ICTs (indirect effects), 3) ICT-enabled changes in consumer behaviour and societal structures (systemic effects). The net environmental impact of ICTs could only be assessed by evaluating positive and negative effects on each level, but he emphasised the inverse relationship between increasing impact and decreasing availability of information from level 1 to 3. Especially the third level bears uncertainties that need further analysis and MacLean pointed to the importance of international fora such as the OECD and WSIS in this analysis. He presented various scenario-building methods to model the impact of ICTs according to the framework and announced the publication of two scenarios by the IISD later in 2008.

Per Morten Hoff (ICT Norway) presented "Green IT", a project initiated by the Norwegian ICT industry association to promote environmentally sustainable practices among members and to promote the potential of ICTs in tackling climate change across all sectors of the economy. Measures include logistics co-ordinated among members, environmental criteria for IT services off-shoring, joint environmental research as well as de-materialisation and video conferencing. He emphasised Norway's potential as a hub for data centre services due to the country's geographic location that results in lower cooling costs, availability of renewable energy sources and high levels of security.

Hoff accentuated the importance of changes in consumer behaviour and effective public policies on top of technological advance and industry commitments. Effective consumer guidance regarding environmental criteria of ICT products could, for instance, take the form of The Eco Declaration (TED) for energy labelling. Governments should provide leadership, e.g. by setting environmental criteria for public ICT procurement and promoting environmentally conscious behaviour in public

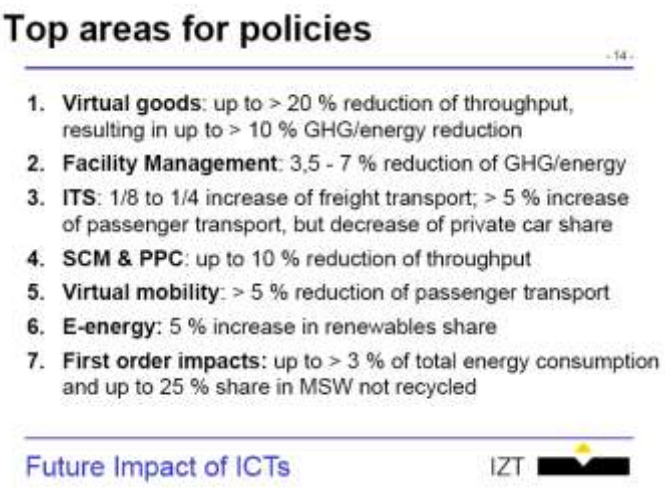
administrations. Hoff underlined the importance of economic incentives to promote energy efficient IT operations across all sectors and with particular focus on SMEs. He acknowledged the success of Norway adapting the EU's directive on waste electrical and electronic equipment (WEEE) to increase take-back and recovery of scrap metals and hazardous substances in ICT products.

Maj Munch Andersen (Technical University of Denmark) presented opportunities and challenges in linking ICTs with the larger theme of eco-innovation. She presented the concept of eco-innovation, which, despite elaborate policy visions such as China's "Circular Economy" concept, needs further analysis. As a working definition for eco-innovation, she proposed innovations that "create value to users while progressively reducing net environmental impacts". She emphasised that companies must be regarded as (eco-) innovators also, as opposed to polluters only.

Andersen argued that the ICT sector has an important role in eco-innovation because of its proven capacity to innovate. This includes: i) ICT systems to provide transparency in the knowledge-intensive process of innovation; ii) ICTs as facilitators of organisational change towards energy efficient production; iii) ICTs in "clever" technologies for buildings and various urban infrastructures. She also mentioned inherent challenges to eco-innovation, e.g. the environmental impact of the ICT sector, the complex division of labour between industry sectors in the eco-innovation process, and potential conflicts between overarching trends of globalisation and individual national innovation systems. She proposed a taxonomy of five categories of eco-innovation.

In the ensuing **panel discussion**, participants emphasised the need for holistic approaches in assessing the net environmental impact of ICTs. A focus on CO2-emissions only, for instance, could lead to unjustified negative branding of practices with otherwise positive environmental effects. The UNEP and TUAC representatives highlighted the importance of life-cycle approaches in the design of ICT products to reduce hazardous wastes and enable effective recycling. The role of governments and the OECD in creating incentives for green investments and formulating policies was underlined. Finally, the lack of independent data [not by companies] to measure eco-innovation and the impact of ICTs was highlighted.

Lorenz Erdmann (Institute for Futures Studies and Technology Assessment, Germany) presented a framework to systematically assess the long-term impact of ICTs on environmental sustainability and formulates policy recommendations. In line with previous speakers, he presented a three-tier framework covering the environmental impact of ICTs on three analytical levels: 1) first-order effects caused by production and existence of ICTs, 2) second-order effects caused by ICT use and applications, iii) third-order systemic effects caused by structural changes in behaviour.



A study conducted by the Institute concludes that ICTs will have significant impact on the environment under different scenarios, its quality depending on a number of policy choices. The possible impact of ICT applications is biggest in areas such as freight and passenger transport, energy consumption, and greenhouse gas (GHG) emissions. The scenario that could most significantly reduce GHG emissions was one where external costs such as energy consumption were internalised. Erdmann presented a number of policy priorities to harness the potential of ICTs in tackling climate change (see slide). He also presented methodological and qualitative criteria to be applied to studies on the environmental impact of ICTs.

Michel Petit (Ministry of Economy, Industry and Employment, France) highlighted the importance of behavioural change of ICT users and consumers in tackling environmental challenges. He underlined

the dramatic impacts and potential dangers of climate change and the topic's prominence on political agendas. At the same time, he emphasised the lack of conscience amidst experts and policy-makers regarding the role of ICTs in inducing behavioural changes, e.g. related to patterns of consumption.

Petit highlighted priority areas such as telework and sensor technologies in buildings. However, he accentuated that managerial practices in both the public and private sector were the main impediment to wider uptake of telework and teleconferencing. Public authorities needed to show leadership in these areas. Finally, he provided an example of how RFID technologies could be applied for carbon labelling and effective implementation of carbon taxing.

John Houghton (Victoria University, Australia) echoed earlier speakers in presenting a multi-layer framework to analyse positive and negative environmental effects of ICTs. Houghton presented the development of energy use and energy intensity over time in different areas of the economy, resulting in two priority areas for policy action: i) the transport sector had not declined its energy intensity as fast as other sectors and ICTs could facilitate change in this area, e.g. through telework and teleconferencing; ii) households had increased their energy intensity between 1990 and 2004, partly due to stand-by energy consumption.

Houghton pointed to existing studies on the environmental impact of the ICT sector and ICT applications, e.g. industry initiatives. But he also emphasised the further need for effective policies and incentives to induce behavioural adjustments, such as rising energy consciousness of ICTs in households. Policies should be based on an analysis of direct, indirect, and systemic impacts, should identify priority areas for immediate action, and should ensure leadership of the ICT sector. He formulated research questions to analyse rebound effects and identify key value chains in the environmental impact of ICTs.

The following **panel discussion**, focussed on the importance of behavioural change and uptake of energy-efficient technologies by businesses, governments, and consumers. While the potential for positive impact of ICTs was mostly acknowledged, some participants raised concern over insufficient knowledge of rebound effects, e.g. transport volume increasing despite advances in technologies for teleconferencing and telework. It was also highlighted that dealing with global challenges required co-ordination with global stakeholders, including key countries such as China and India. End-of-life treatment of electronic equipment is an area where international co-ordination especially with developing countries was needed and where life-cycle approaches lower the environmental burden of ICTs. A consensus emerged that better statistics were needed to capture and address issues around electronic waste.

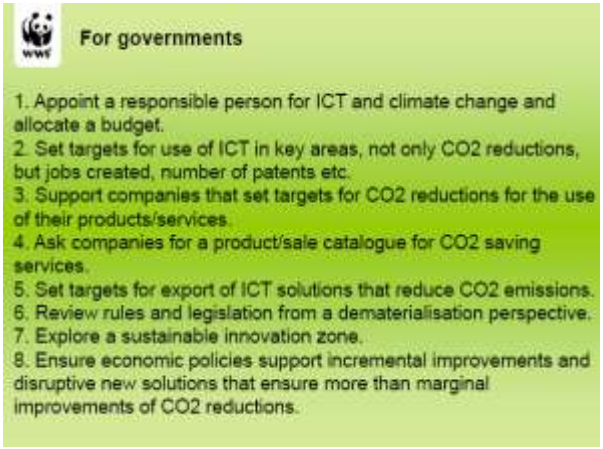
Session 2 – ICTs in pollution management, cleaner technologies and better resource management

This session focussed on more detailed applications and areas of "low-hanging fruit" in improving energy efficiency and reducing carbon emissions in buildings, lighting, heating and cooling applications, transport, and standby losses and where applicable control systems in the energy generation and distribution network.

The session was chaired by **Hedwig Verhagen** (Ministry of Economic Affairs, The Netherlands).

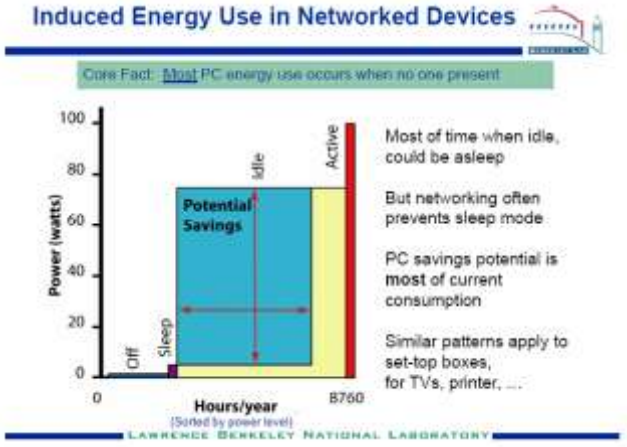
Sang Hyun Park (National Information Society Agency, Korea), circulated a presentation on selected ICT applications for environmental management in Korea. Examples include waste management, river and coast monitoring and pollution monitoring systems. Sensor-based technologies and RFID are key technologies applied in these monitoring infrastructures and Park provided information on ongoing projects. His presentation can be downloaded from the workshop website.

Dennis Pamlin (WWF Sweden) presented WWF analytical work on ICTs and the environment, including the "Outline for the first global IT strategy for CO2 reductions". Pamlin accentuated the importance of focussing on economic incentives to reduce CO2-emission by businesses beyond the ICT sector. Especially global investments in urban infrastructures such as buildings, transport (around USD 40 trillion in the coming years) should use ICT applications to increase energy efficiency.



Pamlin cited various best practices, e.g. by TeliaSonera and HP, and pointed to an upcoming WWF/Gartner study that would highlight efforts of business leaders such as Fujitsu and China Mobile to reduce their environmental impact and to indicate how ICT applications could increase energy efficiency across the economy. He highlighted the importance of coherent government policies and acknowledged the efforts made by the government of Japan in establishing policies to harness the potential of ICTs to tackle environmental challenges. He recommended the OECD should identify and promote best practices and he pointed to concrete measures for governments and businesses.

Rich Brown (Lawrence Berkeley National Laboratory, United States) highlighted energy efficiency and networking issues in buildings and presented the Energy Star label. He argued for a balance between research on ICT applications for energy savings across sectors on the one side and research on minimisation of the ICT sector's environmental impact on the other hand. In particular, power saving functions in ICT and consumer electronics (CE) devices were a cost-efficient way (i.e. low-hanging fruit) to tackle environmental challenges. Brown underlined that ICT and CE devices are responsible for 7% of all US electricity consumption, that most growth in energy demands of buildings results from electronic devices, and that data centres consume 1.5% of US electricity, a share likely to reach 2.5% by 2011. While the Energy Star power labelling scheme covers networked storage devices and data centre equipment, Brown indicated that future energy efficiency labels must evaluate induced energy use and idle power consumption of networked devices (see slide).



Brown emphasised the longevity of buildings and other infrastructures, which makes environmentally sustainable design at an early phase very important. A number of issues need to be addressed in order to achieve long-term environmentally sustainable buildings: guaranteeing network presence of devices in sleep mode; remote power management options; interoperability to coherently co-ordinate different domains such as climate control/air conditioning and lighting. Brown presented different scenarios that could dramatically increase or decrease energy use of buildings depending on the character of the networks.

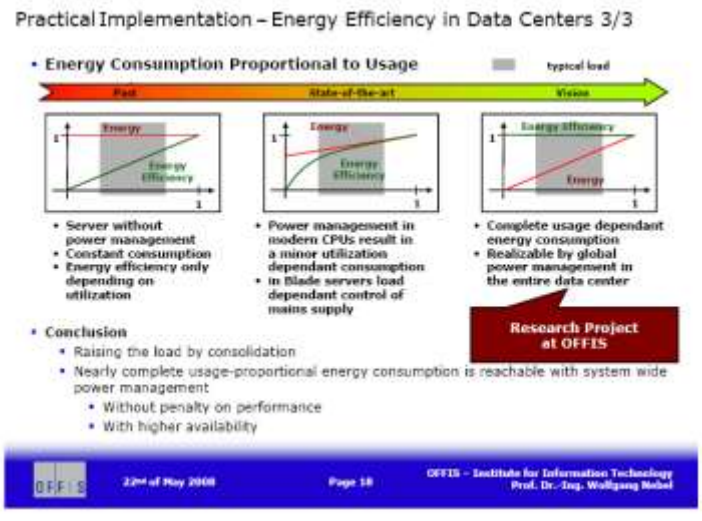
David Faulkner (BT, United Kingdom) presented an energy savings checklist developed by the ITU to assess energy use of broadband technologies and their applications across sectors. Power consumption of broadband is a critical issue as transmission capacity and the number of users will grow rapidly in coming years. Faulkner emphasised the importance of decoupling these growth trends from energy consumption so that transmission capacities of broadband technologies rise while their power consumption remains stable or even falls. He indicated various possibilities to increase energy efficiency, e.g. by tackling current always-on transmission interfaces (modem pairs, user ports) in broadband infrastructures. He cited a calculation by NTT on economy-wide CO2-emissions reductions resulting from uptake of the company's ubiquitous broadband services. Faulkner also addressed timing issues related to product life and implementation, indicating that standardised technologies might take up to 18 years before widely implemented.

Faulkner accentuated the ITU's primarily role in standardisation of telecommunications equipment, but said that co-ordination with other institutions was necessary to expand this scope and make checklists applicable across all industry sectors. He recommended the OECD worked to develop incentive mechanisms for uptake of energy efficient technologies, initiatives targeting consumer behaviour change, independent product and company audits. The ICT sector's environmental impact should be addressed in order to lead by example.

The **panel discussion** elaborated on energy efficiency of broadband technologies and speakers accentuated the importance to accommodate rapid technological changes when formulating standards, recommendations, and policies (e.g. wireless broadband and future technologies). Pamlin highlighted that the rapid spread of ICT applications across economic sectors needs further analysis to effectively measure their environmental impact.

TUAC indicated that technologies and policies targeted at using ICT applications to reduce environmental impact also impact labour markets and regulations. Analysis of behavioural patterns in companies should include analysis of organisational changes resulting from ICT applications and the impact on employees. It was, however, mentioned that companies' conservationism sometimes resulted from workers resisting the adoption of new technologies.

Wolfgang Nebel (OFFIS Institute for Information Technology, Germany) highlighted the importance of mitigating the ICT sector's environmental impact, especially in the area of global data centre operations. He pointed to a likely increase of the sector's current 2% share in industry-wide CO2-emissions in coming years and therefore argued that the ICT sector should provide leadership to other industry sectors. In Germany, for example, ICT companies together consume four times more power than wind power is generated in the country.



Nebel highlighted the issue of energy intensity of single servers to mitigate the environmental impact of the increase in data centres worldwide. Three basic measures to increase energy efficiency that can be applied to all ICTs are: a) optimising system effectiveness, b) increasing rate of utilisation, c) designing ICTs whose power consumption is proportional to usage. The latter could have strong impact on power use in data centres (see slide) and forms part of OFFIS research. He underlined the importance of economic incentives for businesses to implement power saving technologies. Nebel presented future scenarios that could lead to energy and cost savings as well as CO2-emissions reductions.

Chris Lloyd (Verizon Communications, United States) presented Verizon's efforts in improving the company's environmental impact and highlighted environmental benefits of fibre-based broadband infrastructures and applications. Although ICT companies are responsible for only a small part of global CO2-emissions, he emphasised that they needed to lead by example, also in order to provide credible energy-saving services and solutions to their clients.

Lloyd presented the potential of broadband in reducing CO2-emissions. Fibre-based broadband infrastructures consume less power than copper-based ones, increase the number of customers served per unit, and require less maintenance. Paired with other technologies, broadband could enable energy efficient applications such as teleconferencing, telework, smart homes, and improved logistics software. He suggested economic incentives to promote uptake of broadband technologies to enable efficient applications as well as introducing "cap-and-trade" schemes in order to internalise external costs of CO2-emissions.

Søren Jensen (TDC, Denmark) indicated how rapid advances in ICTs and ICT uptake among younger generations will have profound socio-economic effects and environmental implications. As ICTs and the Internet are changing communication patterns and behaviour, they also contribute to organisational change across all sectors of the economy. He stated that the on top of making information exchange easier, the Internet enables increased transparency, presence and real-time processes – from telework and telepresence through trains with Internet access to banks competing on the speed of providing loans. He pointed to newer generations of Internet users and their communications tools as well as best practices by businesses (e.g. Jyske Bank).

Jensen stated that these behavioural changes will increase the adaptation pressure on enterprises. Economic incentives were needed to implement ICT applications that help reducing CO2-emissions. He then recommended the OECD should promote governments uptake of ICT applications such as virtual meetings, telepresence and telework.

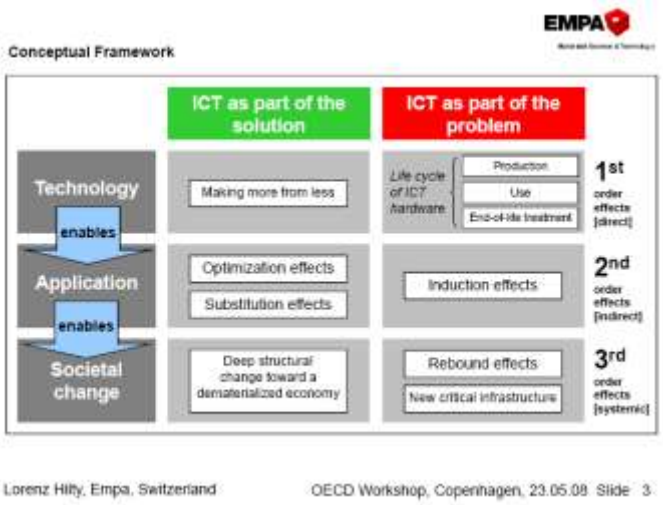
The ensuing **panel discussion** elaborated on the impact of virtual worlds and other ICT applications on various socio-economic processes. According to some participants, ICT applications such as sensor-based technologies and virtualisation could be used to improve users' awareness of "real world" processes, e.g. by providing transparent information on household energy consumption, real-time energy availability and tariffs. It was highlighted that this year's Internet Governance Forum will have a dedicated session on virtual worlds and online delivery of public services.

Session 3 – The ICT producing sector – challenges and progress

This session focussed on the ICT-producing sector and examine efforts to increase energy efficiency and improve environmental performance through better life-cycle audits of products and production processes, including reducing waste generation, the use of hazardous substances and recycling.

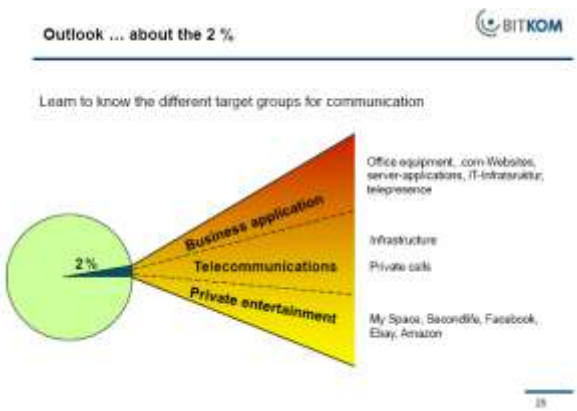
The session was chaired by **Mark Carvell** (Department for Business Enterprise and Regulatory Reform, United Kingdom). He mentioned the BERR's Green ICT strategy, an upcoming joint publication of a study by the UK government and Gartner, and work of the UK's cross-government CIO and CTO councils on the environmental impact of ICTs.

Lorenz Hilty (EMPA, Switzerland), presented an analytical framework to assess positive and negative environmental impacts of ICTs and recommended policies for environmentally sustainable ICT applications. As with previous speakers, his conceptual framework consists of three levels (see slide): 1) effects from production, use, and end-of-life treatment of ICTs, 2) effects of ICT applications, 3) long-term societal effects. On a side-note, he pointed to the risks of societies becoming increasingly dependent on ICT infrastructures.



Hilty showed that performance and energy efficiency of most ICTs is increasing, but that life-cycle assessments of devices remain problematic due to increased use of hazardous substances. Informal recycling processes create environmental and human health challenges, especially in developing countries. On the application level, optimisation and substitution processes through ICT products and services have positive environmental impacts across various sectors of the economy. But induction effects in the use phase can have negative environmental effects, e.g. when buying a printer results in consuming more paper. On the level of societal change, dematerialisation trends must be weighed against potential rebound effects, i.e. time and cost savings stimulating additional demand. He issued strategic recommendations to improve the environmental impact of ICTs that are geared towards individuals, organisations (in particular data centre providers), hardware and software designers.

Mario Tobias (BITKOM, Germany) argued for a holistic view of the ICT-ecosystem in order to assess the environmental impact of ICTs and suggested directions for OECD work. He underlined that net environmental impacts should consider the entire life span of an ICT product, i.e. including R&D activities, sales, marketing, etc. Areas where low-hanging fruit with immediate gains in energy efficiency could be materialised include data centres and miniaturisation. He accentuated the importance of effective ICT equipment end-of-life treatment, including consumer awareness-raising.



Tobias underlined need for improved communication on the environmental potential of ICT applications and referred to a BITKOM initiative comparing the energy consumption of two typical office environments, one from 2003 and the other from 2008. He furthermore suggested the OECD should analyse the composition of ICT industry CO2-emitters as well as identifying industry sectors

where ICTs can result in significant CO2-emissions reductions. The OECD should contribute to an understanding of how to decouple increasing use of ICTs from energy intensity and should co-ordinate between the various stakeholders.

The ensuing **Q&A session** dealt with the impact of the EU directives on WEEE and the Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) on a global scale, e.g. partial implementations in countries such as China, as well as with the ongoing evaluation of the WEEE directive.

Ewa Thorslund (Swedish IT and Telecom Industries) presented the Swedish Green IT industry initiative, the accociation's Green IT index, and findings from a recent survey on awareness of how to use ICTs to minimise environmental impact in Swedish companies. According to the 2008 survey, awareness exists, but action plans are mostly limited to bigger companies, often refer to hardware purchases, and rarely consider usage of and energy use by networked ICTs. The public sector scored better than the private sector; households were not yet included in the survey. A best practice of Telia Sonera in reducing CO2-emissions was mentioned.

Thorslund underlined the importance of behavioural and organisational change, e.g. managers developing more trust-based approaches towards telework in their companies, as well as necessary leadership of the public sector. She pointed to great socio-economic implications of young people with changed communication habits entering future workforces.

During the ensuing **panel discussion**, BIAC pointed out that indexes of private sector green ICT credentials must be sustainable over time, i.e. account for the longer-term impact of one-off measures.

Participants addressed social implications of ICTs and environmental challenges, especially where employees of ICT suppliers faced inappropriate working conditions. It was mentioned that Codes of Conduct, environmental and social standards must be effectively monitored along the entire ICT supply chain – potentially using the *OECD Guidelines for Multinational Enterprises*.

Participants suggested further OECD work: development of indicators like the Swedish Green IT index; knowledge-sharing; creation of task teams on i) leadership and policies for the ICT producing sector, ii) toolkits to apply ICTs in other industry sectors, iii) measurement of environmental impacts in co-ordination with climate change experts. Graham Vickery (OECD) pointed to joint work of OECD and Eurostat on environmental statistics in manufacturing industries (see references). Finally, attention was drawn to possible environmental trade-offs in ICT trends that need addressing: energy demands vs. GHG emissions; product demands vs. scarce resources.

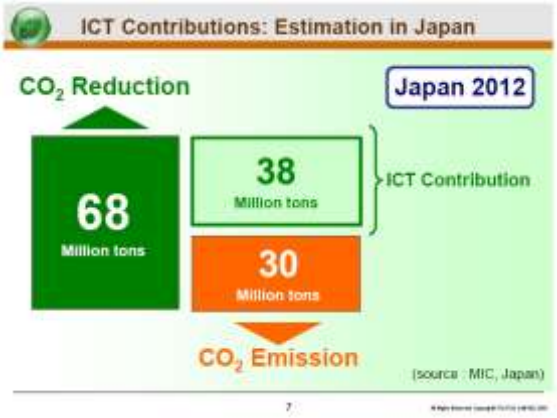
Emma Fryer (Intellect, United Kingdom) presented the industry association's study "High tech – low carbon" and outlined four important issue areas for the ICT sector. The ICT sector is facing i) sector-specific issues that are within control and are being addressed (e.g. device standby power usage and rapid obsolescence); ii) side effects of technological advance resulting in uncertainties and legacy issues; iii) external problems with limited potential to influence (e.g. user behaviour, pricing-based ICT procurement, legislation such as data archival under Sarbanes-Oxley). Finally, she mentioned timing as a prominent issue in bringing about continuous improvement, e.g. when deadlines in the far future lead to procrastination of implementation.

Fryer presented the results of an assessment of the ICT industry with regards to the sector-specific issues presented. While ICT equipment such as mobile base stations and CE devices have become more energy efficient and have improved standby power usage, she pointed to strong rebound effects. She suggested the need to internalise costs for permanent immediate access to digital information as opposed to archiving. She pointed to follow-up work by Intellect on drafting a Code of Conduct energy labelling in the United Kingdom's ICT industry.

Helena Nordin (TCO Development, Sweden) presented the TCO label, which is internationally known and measures product features such as usability, design and environmental impact. The TCO label covers various ICT products as well as non-ICT office equipment. Developed by the Swedish trade unions of professional employees, the label resulted from joint efforts of ICT users, manufacturers, and experts. Nordin stated that around 50% of monitors worldwide are TCO certified

and the organisation's expertise contributed to the EU's directives on eco-design of energy-using products (EuP) and RoHS. She pointed to the label's voluntary character and its simplifying effect on trade in ICT equipment. She proposed a white-list policy approach regarding the use of hazardous substances in ICT products as opposed to a black-list approach.

Tetsuo Karaki (Fujitsu, Japan) presented findings of study by Japan's Ministry of Internal Affairs and Communications (MIC) that indicated how ICTs could contribute to a net reduction of 38 million tonnes of CO2-emissions by 2012. The net reduction is calculated by weighing the sector's CO2-emissions against energy efficiency gains achieved through ICT applications (see slide). The study details these contributions by particular ICT sub-sectors and applications.



Karaki highlighted Fujitsu's measures to reduce CO2-emissions through energy-efficient ICT applications and underlined the changing nature of ICTs from being a productivity tool to becoming a tool for economy-wide efficiency gains. Fujitsu's measures include improved product design, server and data centre integration, virtualisation of product design process, and improved design for recycling. He estimated that these company measures could contribute to 7 million tons of CO2-emissions reductions by 2010. Karaki referred to the joint declaration of the 2008 Global Information Infrastructure Commission (GIIC) meeting. He underlined the importance of global fora such as the OECD and the G8 in analysing the relationship between ICTs and the environment.

During the **panel discussion**, the MIC's study and Fujitsu's efforts were acknowledged and the potential of Japan for becoming a leader in "Green ICT" issues was discussed. The view was brought forward that governments should create supportive regulatory environments for green investments, provide sound incentives, and lead by example. The TUAC representative pointed out that the TCO label may be regarded as trade distortion by some governments and Nordin replied that such views are voiced from time to time, but have been successfully addressed by TCO in the past.

Session 4 – Policy developments, policy issues and implications for future work

This session drew out issues for further analysis and examine policy implications. The underlying approach is that it is important to focus on areas where ICT applications have the greatest positive environmental impacts, for example improving energy efficiency in buildings, lighting, heating and cooling, transport applications, and reducing standby losses. Setting new goals for further improving the environmental performance of the ICT industry would be another key area. The aim would be to explore what policies could promote the development and increased use of ICTs for environmental sustainability and what new areas of work are necessary to underpin policy development.

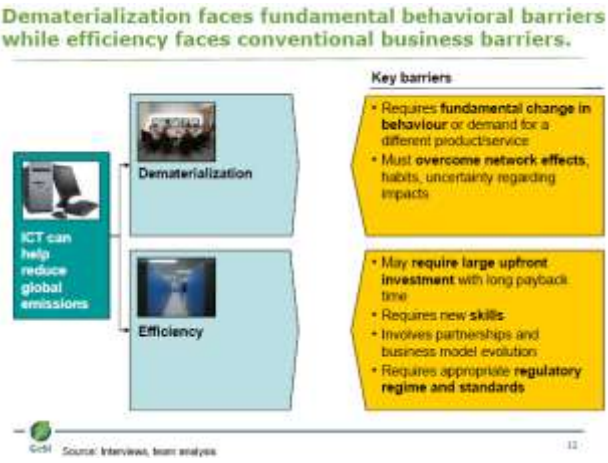
The session was chaired by **Daniela Battisti** (Agency for Inward Investments and Business Development, Italy).

Thomas Becker (Ministry of Climate and Energy, Denmark) presented his ministry's work in preparing the United Nations Climate Change Conference in Copenhagen in 2009 (COP15). The goal of COP15 is to sign an agreement to replace the Kyoto protocol, which is important in light of the findings of the 4th assessment report by the Intergovernmental Panel on Climate Change (IPCC). It states that CO2-emissions will have to peak in 12 to 15 years in order to reach 2050 targets. Essential building blocks for the agreement will include a shared vision, mitigation efforts, infrastructure building, financial incentives, technology transfers. Becker underlined the importance of developing country commitments for the success of COP15, e.g. by China and India, but also the United States.

Peter Johnston (European Commission, DG Information Society and Media) focussed on ICTs as an enabling technology to reduce CO2-emissions, at the same time acknowledging sector-specific issues. Energy efficiency gains from ICTs are important in the context of the EU's 2020 targets for CO2-emissions reductions, energy supply and energy intensity. He stated that the EU has not yet achieved the aim of decoupling energy use from GDP growth. He linked the sector's innovativeness to its potential in providing innovations towards a low-carbon society.

Johnston presented the European Commission's communication on addressing the challenge of energy efficiency through ICTs (see references) which will be used to commence co-operation between stakeholders. The roll-out of policies would need to be soon and they need to be co-ordinated with the OECD and other international fora. He further underlined the importance of coherent policies by linking the topic to other policy objectives, e.g. in the area of regional development.

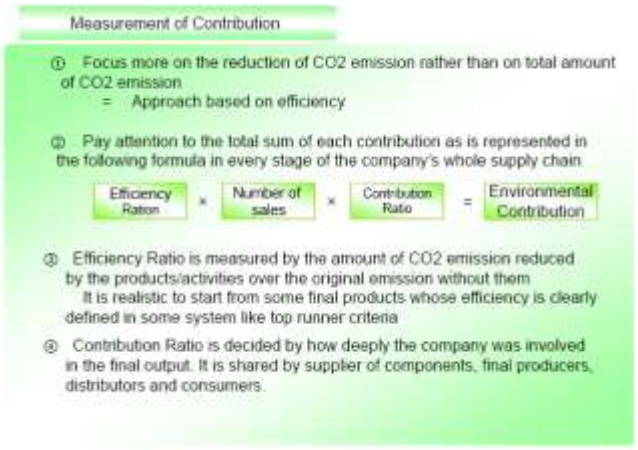
Luis Neves (Global e-Sustainability Initiative, Deutsche Telekom, Germany) presented joint work of GeSI – an ICT industry initiative – and The Climate Group. He announced the publication of a comprehensive study on the ICT sector's carbon footprint, including projections until 2020 for telecommunications, software, IT services and manufacturing firms. It will include measures to mitigate the ICT sector's footprint as well as to contribute to reductions in other sectors. He stated that the consortium members would commit themselves to a roadmap for achieving CO2-emissions reductions.



Neves mentioned existing barriers in applying ICTs for increased dematerialisation and energy efficiency: consumer behaviour, network and lock-in effects, uncertainty, lack of economic incentives, appropriate regulatory regimes and standards. He identified four areas with high potential for ICT applications to achieve environmental and economic benefits: buildings networks (especially in the United States), smart grids (in India), automotive industry (in China), and smart logistics (in Europe).

The ensuing **panel discussion** highlighted the importance of the ICT sector's innovation potential for finding solutions to environmental challenges. A number of company best practices were mentioned along with GeSI's announcement to develop a carbon credits mechanism for using teleconferencing facilities instead of travelling.

The discussion underlined the importance of behavioural changes in order to promote take-up of environmentally sustainable ICT applications. Participants agreed that the public sector needs to provide leadership, e.g. through environmental criteria in public procurement. The European Commission's support of the European Network of Living Labs was mentioned as another example. Participants furthermore emphasised the need to transport discussion of ICTs and environmental challenges into the general debate about climate change, e.g. by including ICTs in the framework to be developed at COP15.



Takayuki Sumita (Ministry of Economy, Trade and Industry, Japan) presented Japan's Green IT initiative, which proposes a framework to assess the net environmental impact of ICTs by calculating the sector's footprint as well as the contribution of ICT applications towards environmental sustainability in other industry sectors (see slide). The proposed framework includes an assessment of energy efficiency at production and operation. Furthermore, it includes a life-cycle approach towards ICTs, covering equipment end-of-life considerations. He stated that the ICT sector's innovation potential could be effectively harnessed to tackle environmental challenges, including a strong focus on SMEs.

Sumita said that the potential of ICTs in reducing CO2-emissions was widely acknowledged, but challenges related to measurement and communication of the issue remained. In Japan, the sector's share in CO2-emissions is around 1.5% of the entire economy, but the contribution of ICTs to reduce CO2-emissions are much harder to quantify.

Giovanna Sissa (OTE Technological Observatory for Schools, Ministry of Education, Italy) highlighted the importance of government leadership in using ICTs to induce environmentally sustainable behaviour. She pointed to public sector policies of "reduce, reuse, recycle" in Italy, aiming to reduce the amount of electronic waste generated. But she pointed out that this challenge required a global approach, including China, India, and other developing countries. She acknowledged that reuse policies must be balanced against energy inefficiencies of older ICT equipment. She referred to other policies to reduce the environmental impact of ICTs in the public sector, e.g. in public procurement.

Adam Lebech (National IT and Telecom Agency, Ministry of Science, Technology and Innovation, Denmark) presented Denmark's "Action Plan for Green IT". It focuses on ICT applications enabling energy efficiency gains across the economy as well as the public sector. The action plan foresees eight initiatives to promote behavioural change with consumers, within industry and the public sector. Concrete measures include promotion of best practices and public dissemination of information. Moreover, the Ministry will take the lead in implementing measures proposed in the action plan.

Lebech announced the OECD conference on ICTs, the environment and climate change in May 2009, hosted by the Ministry of Science, Technology and Innovation, Copenhagen, Denmark.

During the ensuing **panel discussion**, the Danish initiative was complimented and participants emphasised that it is essential to raise awareness for environmentally sustainable ICT usage among current and future users. ICT applications facilitating demand-side behavioural change can for instance include various pay-per-use schemes, e.g. in road pricing. The importance of software

applications to increase efficiencies in business processes and consumer behaviour was also highlighted.

Participants complimented Japan's initiative for formulating economic incentives to minimise environmental impact and for providing a life-cycle approach and holistic view of positive and negative environmental effects of ICTs. Other country approaches were mentioned, e.g. China's "Circular Economy" concept and its approach to reducing waste across the economy.

Conclusions and follow-up

Marie Munk summarised presentations made during the first session on general issues regarding the environmental impact of ICTs in the knowledge economy. She highlighted the analytical frameworks and future scenarios presented by MacLean, Lorenz, Houghton. She pointed to presentations that covered environmental impact of both demand-side improvements, e.g. through telework (Petit), and supply-side improvements, e.g. through co-ordinated logistics among ICT manufacturers (Hoff). ICTs were moreover linked to the topic of eco-innovation by Andersen.

Hedwig Verhagen pointed to the discussion in session 2 around the question of whether to focus on the ICT sector's energy use and CO2-emissions or on the potential of ICTs in reducing the 98% of CO2 emitted by other sectors. She highlighted Pamlin's argument for a focus on the latter and acknowledged other speakers' argument for a balanced approach since efficiency gains within the ICT sector were easy to achieve and the sector should provide leadership by "putting its own house in order". Brown, Faulkner, Lloyd, and Nebel provided examples of how the ICT sector could increase energy efficiency, e.g. in the areas of data centres, buildings networks, broadband infrastructures and applications. She underlined the importance of understanding systemic changes in user behaviour due to ICT applications, as indicated by Jensen.

Verhagen concluded that holistic and long-term approaches were necessary to tackle environmental challenges through ICTs as well as challenges emanating from ICTs. It is important to analyse structural differences in ICT usage through co-ordinated efforts, e.g. between the OECD and developing countries. The OECD could help in this regard as well as working on a comprehensive analytical framework and elaborating a future vision of desired systemic effects caused by ICT applications.

Mark Carvell summarised presentations on environmental challenges within the ICT sector. He emphasised that technologies and processes to reduce the sector's environmental impact have been identified and technologies in this area are advancing, e.g. recycling efficiencies, improved product design, data centre energy use. He pointed to existing legacy issues raised by speakers, e.g. with regards to network infrastructures, and to issues regarding electronic waste. He concluded that communication and awareness-raising about the environmental impact of ICTs was important, e.g. through energy labelling and promotion of best practices. He pointed to efforts made by telecommunications companies such as TDC, TeliaSonera, Verizon.

Daniela Battisti concluded from the fourth session and the workshop that a global and holistic approach to the ICT sector's environmental impact was necessary. This includes the analysis of interaction between different policy areas, holistic treatment of ICTs and environmental challenges as opposed to an exclusive focus on climate change, assessment of ICT product life-cycles. She said that policies should focus on the ICT supply-side and demand-side, as well as considering the dynamics of technology developments. She highlighted the importance of education to achieve behavioural changes that could lead to more efficient ICT applications. She underlined the role of the OECD in working towards improved measurement, data collection and analysis.

Graham Vickery concluded by indicating directions of follow-up work:

- Developing a holistic approach to puts ICT policies into the context of policies for the environment, energy, transport, science and technology, and others.
- Developing a global approach that assesses developments within the OECD and beyond, including developing countries.

- Conducting life-cycle assessments of ICT products, including improved recycling systems.
- Presenting and adapting best practices in information exchange between stakeholders.

He emphasised that governments should provide leadership through procurement and use policies. With regards to checklists and global standards, he referred to co-ordination with existing fora, such as the World Summit on the Information Society (WSIS). He underlined that education and research are important pillars of a strategy on ICTs and environmental challenges. As an R&D-intensive sector, the ICT industry is in a position to research environmentally sustainable applications of current and future technologies. Finally, he echoed participants' calls for improved statistics, data collection, and co-ordinated analysis on the multi-faceted relationship between ICTs and environmental challenges.

In her closing remarks, **Marie Munk** pointed to follow-up work by the OECD towards the Conference on ICTs, the Environment and Climate Change, to be held in May 2009, in Copenhagen, Denmark.

Annex: Overview of presentation topics

	Analytical, conceptual issues	Scenarios	ICT sector issues	Cross-sector ICT applications	Socio-economic implications	Industry initiatives	Policy suggestions	Suggestions for OECD work
MacLean	+	+	+	+	+			+
Hoff			+	+		+	+	
Andersen	+		+	+				
Erdmann	+	+		+			+	+
Petit		+		+	+		+	
Houghton	+		+	+		+	+	
Sang				+				
Pamlin			+	+	+	+	+	+
Brown		+	+	+			+	
Faulkner			+	+			+	+
Nebel	+	+	+					
Lloyd			+	+		+	+	
Jensen				+	+		+	+
Hilty	+	+	+	+	+		+	+
Tobias	+		+	+		+	+	+
Thorslund			+	+	+	+		
Fryer			+			+	+	
Nordin			+			+	+	
Karaki		+	+	+		+		+
Becker							+	
Johnston			+	+			+	+
Neves		+	+	+		+	+	
Sumita	+		+	+	+		+	
Sissa			+				+	
Lebech				+			+	+