ICTs and green innovation

ICT and Internet applications also have the potential to improve the environment and tackle climate change. Top application areas include manufacturing, energy, transport and buildings. Information and communication also foster sustainable consumption and greener lifestyles. At the same time, direct and systemic impacts related to the production, use and end of life of ICTs require careful study in order to comprehensively assess "net" environmental impacts. The resulting environmental impacts are more difficult to trace but need to be part of a comprehensive analytical framework. A better understanding of smart ICTs provides policy makers options for encouraging clean innovation for greener economic growth.

Direct impacts of ICTs on the environment

The **direct impacts** of ICTs on the environment (or "first-order effects") refer to positive and negative impacts due to the physical existence of ICT products (goods and services) and related processes. The sources of the direct environmental impacts of ICT products are ICT producers (ICT manufacturing and services firms, including intermediate goods production) and final consumers and users of ICTs. ICT producers affect the natural environment during both the production of ICT hardware, components and ICT services and through their operations (e.g. operating infrastructures, offices, vehicle fleets). In addition, the design of ICT products determines how they affect the environment beyond company boundaries. Energy-efficient components, for example, can reduce the energy used by ICT equipment. Modular ICT equipment and reduced use of chemicals in production can improve re-use and recyclability. OECD work has shown that improved R&D and design can help to tackle direct impacts throughout the entire life cycle of ICT goods, services and systems (OECD, 2010). Government "green ICT" policies can be instrumental in promoting such life-cycle approaches (OECD, 2009).

At the other end of the value chain, consumers and users influence the direct environmental footprint through their purchase, consumption, use and end-of-life treatment of ICT products. Consumers can choose energy-efficient and certified "green" ICT equipment over other products. The use of ICTs largely determines the amount of energy consumed by ICT equipment (widespread changes in use patterns, however, are part of systemic impacts). A large part of the sector's GHG emissions footprint still results from the production and use of consumer ICT products (including TVs). However, ICT products across the economy and modern ICT infrastructures are an increasing share, especially given the fast ascent of the Internet and its economic importance.

At the end of a product's useful life, consumers can choose to return equipment for re-use, recycling, etc. In the European Union, legislation is in place that prohibits disposal of electronic equipment in household waste. This is to lower burdens on the natural environment when household waste is disposed of in landfills or incinerated. Domestic electronic waste is becoming a major challenge in emerging and developing economies. Little comparable data are available, but recent trends are a cause for concern, given the low domestic absorption capacity for electronic waste and its sustainable treatment in non-OECD countries. Moreover, many non-OECD countries suffer from enforcement issues of strict international limitations on the exports of electronic waste.

Enabling impacts of ICTs (or "second-order effects") arise from ICT applications that reduce environmental impacts across economic and social activities. ICTs affect how other products are designed, produced, consumed, used and disposed of. This makes production and consumption more resource-efficient. When assessing "net" environmental impacts, issues such as greater use of energy by ICT-enabled systems compared to conventional systems must be accounted for. In general, ICT products can affect the environmental footprint of other products and activities across the economy in four ways:

- **Optimisation**. ICTs can reduce another product's environmental impact. Examples include embedded systems in cars for fuel-efficient driving, "smart" electricity distribution networks to reduce transmission and distribution losses, and intelligent heating and lighting systems in buildings which increase their energy efficiency.

- **Dematerialisation and substitution**. Advances in ICTs and other technologies facilitate the replacement of physical products and processes by digital products and processes. For example digital music may replace physical music media and teleconferences may replace business travel.
- **Induction effects** can occur if ICT products help to increase demand for other products.
- **Degradation** can occur if ICT devices embedded in non-ICT products create difficulties for local waste management processes. Car tyres, bottles and cardboard equipped with “smart” tags, for example, often require specific recycling procedures.

Large environmental benefits are possible in major industry sectors – e.g. transport, energy, housing – but to be effective, products must be co-developed and their diffusion well co-ordinated by stakeholders. As levels of technology adoption differ across industry sectors and individual countries, context-specific analysis is important to determine optimal application scenarios for ICTs. OECD governments are promoting cross-sector R&D programmes and local pilot projects, especially in areas where structural barriers (e.g. lack of commercial incentives or high investment costs), may hinder the rapid uptake of “smart” ICTs (OECD, 2009).

Systemic impacts of ICTs on the environment

Systemic impacts of ICTs and their application on the environment (or “third-order effects”) are those involving behavioural change and other non-technological factors. Systemic impacts include the intended and unintended consequences of wide application of green ICTs. Positive environmental outcomes of green ICT applications largely depend on wide end-user acceptance. Therefore, systemic impacts also include the adjustments to individual lifestyles that are necessary to make sensible use of ICTs for the environment. ICT applications can have systemic impacts on economies and societies in one or more of the following ways:

- **Providing and disclosing information**. ICTs and the Internet facilitate monitoring, measuring and reporting changes to the natural environment. Access to and display of data inform decisions by households (e.g. ”smart” meters), businesses (e.g. choice of suppliers, verifying “green” claims), and governments (e.g. allocation of emission allowances, territorial development policies). Sensor-based networks that collect information and software-based interpretation of data can be used to adapt lifestyles, production and commerce. For example, ICT-enabled research and observation of desertification trends provide data for long-term economic decision-making.
- **Enabling dynamic pricing and fostering price sensitivity**. ICT applications form the basis of dynamic or adaptive pricing systems, e.g. for the provision of electricity or the trade of agricultural goods. Utilities, for example, can choose to turn off non-critical devices at customer premises when cheap (and renewable) energy is scarce and turn them on again when it is more plentiful. Users can react to price signals, e.g. allowing electric cars to charge overnight when electricity is cheaply available instead of charging immediately.
- **Fostering technology adoption**. The “evolution” from desktop PCs to laptops to netbooks is one example of changing consumer preferences. Digital music, e-mail communications and teleconferencing technologies are affecting the ways in which their physical counterparts are produced and consumed, i.e. recorded music, written letters and physical business travel.
- **Triggering rebound effects**. Rebound effects refer to the phenomenon that higher efficiencies at the micro level (e.g. a product) do not necessarily translate into equivalent savings at the macro level (e.g. economy-wide). For example, nationwide application of a 30% more efficient technology does not necessarily translate into energy savings of 30%; higher energy efficiencies of semiconductor products must be weighed against the overall

growth of the use of ICT products. “Rebound effects” at the macro level partly offset efficiency gains at micro level. In areas such as personal car transport or household heating, higher efficiency (or lower price) of a product can increase demand in ways that offset up to one-third of the energy savings.

The smart grid

ICTs can also help to limit greenhouse gas emissions from the energy supply industry, which is responsible for one-quarter of global GHG emissions (IPCC, 2007). Electricity production is a major driver of the industry’s carbon footprint: over two-thirds of worldwide electricity is generated by plants using fossil fuels (IEA, 2009). Rising electricity consumption in households, businesses and industry continues to pose challenges to OECD countries, but even more to emerging economies: growth in final electricity consumption between 2006 and 2007 was 2.2% in the OECD area, compared to 8.7% in non-OECD countries (IEA, 2009).

ICTs and high-speed communication networks are a platform supporting innovation throughout the economy today in much the same way electricity and transportation networks spurred innovation in the past. ICT hard- and software, communications networks (notably the Internet) and innovative ICT-based services are the foundation for “smart” electrical grids. The smart grid in fact addresses a historical information gap between end-users and distributors. Enabling communication via fast Internet connections provides consumers with information on their electricity consumption in real time as well as the overall supply and demand situation, allowing them to adjust consumption based on price signals. On the utility side, the smart grid allows producers and operators to stabilise demand (“peak shaving”) by monitoring consumption in real time and influencing it through technical intervention or variable demand-based pricing. These applications of ICTs can help to limit greenhouse gas emissions from the energy supply industry, responsible for one-quarter of global GHG emissions.

Besides bridging the information gap, ICTs can more directly improve environmental efficiency along all parts of the electricity sector’s value chain: energy generation, transmission, distribution and consumption. For instance, networked sensors and monitoring applications could help reduce the amount electricity that is lost during transmission and distribution along the grid, amounting to up to 30% in India. ICTs facilitate new business models in the energy sector as well as new modes of operation from distributed (renewable) energy generation, intelligent load management, effective electricity storage and large-scale roll-outs of electric cars.

Smart meters are an essential component of making grids “smarter” because they allow for real-time communication between the end points of the electricity grid (e.g. residential or commercial premises), the grid operators and other system entities. Intelligent metering devices enable enhanced energy operations such as feeding locally generated electricity into the grid, turning non-critical appliances on or off depending on energy prices and availability (“demand response”) and distributing charging times for electric cars efficiently. Finally, smart meters can help households reduce their energy consumption, although success largely depends on behavioural changes by individuals. Research findings from pilot projects suggest that better (access to) information about the use and price of electricity can result in energy consumption reductions of up to 20%. However, customer acceptance of the smart meter is not guaranteed as questions about energy and cost savings for consumers, distribution of installation costs and potential privacy issues remain to be answered.

The surge in government and industry activities around the smart grid have contributed to strong innovation activities, notably in the amount of start-ups, venture capital and M&A activity in this area. In the United States, legislation such as the Energy Independence and Security Act (2007) and the American Recovery and Reinvestment Act (2009) provide government support and funding for nationwide modernisation of the electrical grid and stable mid-term prospects for private investors. This contributed to continued growth of commercial investments in smart grid ventures during 2009,

especially in smart metering, energy storage and smart grid communications. According to estimates, smart grid-related products sold in the United States in 2010 will exceed USD 2.8 billion in the categories of advanced metering infrastructures (AMI), distribution grid management and automated demand response (Cleantech 2010). This accounts for products only and does not include the investments and
revenues generated from the process of making electricity grids "smarter", i.e. IT consulting and systems integration, applications development, provision of value-added services for consumers. It is likely that these trends will further stimulate entrepreneurial activity and creation of high value-added "green ICT" jobs.

References

- International Energy Agency (2009), Electricity Information, 2009 edition, OECD/IEA, Paris.
- IPCC (International Panel on Climate Change) (2007), Climate Change 2007. Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, R.K. Pachauri and A. Reisinger (eds.), IPCC, Geneva.
- OECD (2009), Towards Green ICT strategies: Assessing Policies and Programmes on ICTs and the Environment, OECD, Paris, www.oecd.org/dataoecd/47/12/42825130.pdf [1].
- OECD (2010), Measuring Innovation: A New Perspective, OECD Publishing, Paris.
- OECD (2011), Fostering Innovation for Green Growth, OECD Green Growth Studies, OECD Publishing. http://dx.doi.org/10.1787/9789264119925-en [2].
- OECD (2012), "Transitioning to green innovation and technology", in OECD Science, Technology and Industry Outlook 2012, OECD Publishing. http://dx.doi.org/10.1787/sti_outlook-2012-5-en [3].

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