Background Paper[1]

1st Multinational Knowledge Brokerage Event

Green ICT for Growth and Sustainability?

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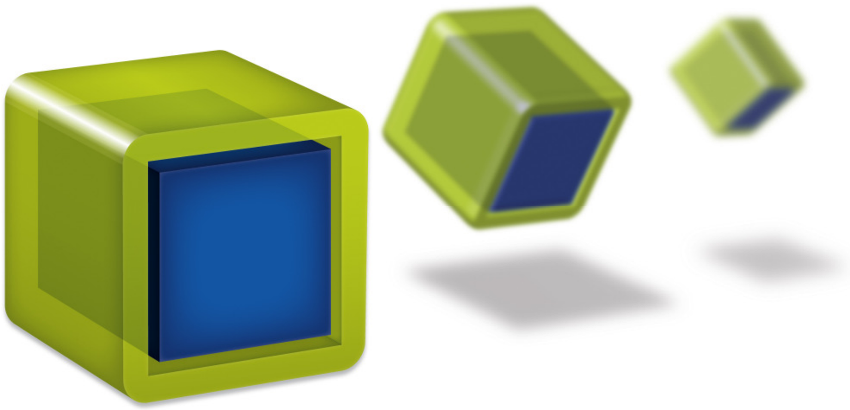
Authors:

Karin Dobernig, Vienna University of Economics and Business (WU)
Inge Røpke, Technical University of Denmark
Magnus Grubbe & Mareike Blum, Institute for Ecological Economy Research (IÖW)



RESPONDER – linking **RES**earch and **P**olicy making for managing contradictions of sustai**N**able consumption an**D** **E**conomic g**R**owth | FP7 Grant Agreement number 265297

[1] This Background Paper to a great extent draws on Røpke, Christensen & Jensen (2010), Røpke & Christensen (forthcoming), and Røpke (forthcoming).

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1 Executive Summary

RESPONDER aims to promote sustainable consumption by exploring novel ways of knowledge brokerage between science and policy the five policy areas food, housing, mobility, ICT as well as private savings and debts. The main objectives are to help improve the management of potential political, social and economic contradictions of sustainable consumption with economic growth, bridge the gap between science and policy, and foster mutual understanding between the "pro-growth community" and the "beyond-growth community". Participatory systems mapping as the core methodology serves as the basis for systematizing empirical findings, questioning different model assumptions, analyzing the effects of different policy options and identifying new research questions in the respective policy areas.

"Green ICT for Growth and Sustainability?" is the 1st RESPONDER Multinational Knowledge Brokerage Event focusing on Information and Communication Technologies (ICT) and their role for economic growth and sustainable consumption. As such, it serves as an arena for debate between policy-makers and researchers working on different aspects of ICT. At the heart of the event lies the co-creation of system maps which center on thematic policy questions; these maps explore and visualize the potential contradictions and synergies within the field of ICT with regards to sustainable consumption and economic growth in an easily understandable way.

ICTs can play a key role in the transition to a more energy-efficient, low carbon economy while at the same time driving "green growth" and fostering more sustainable consumption. By improving energy-efficiency in production and consumption, enabling the constant monitoring of energy use and carbon emissions as well as transforming existing consumption processes through dematerialization and substitution, ICT technologies could cut 7.8 $GtCO_2$ of global greenhouse gas emissions by 2020, a 15% reduction over business-as-usual projections. At the same time, the expansion of ICT often goes along with increased energy consumption in production and consumption, leads to high throughput of materials and scarce resources, and poses challenges for end-of-life treatment and recycling. Thus, it is crucial to rigorously assess the environmental, social and economic impacts of ICT on various levels and effective policy measures in order to nurture the potential of ICT to contribute to sustainable consumption without harming people, societies or the environment. This asks for strong interaction and a sustained dialogue among science and policy as well as other relevant stakeholders.

2 The RESPONDER Project

The overall aim of RESPONDER is to promote sustainable consumption by exploring novel ways of knowledge brokerage that help to improve the management of potential political, social and economic contradictions with economic growth.

The challenge is not just to bridge the gap between science and policy, but also to improve the mutual understanding between the "pro-growth community" (i.e. economists and policy makers oriented towards growth as an overarching policy goal) and the "beyond-growth community" (i.e. scientists oriented towards the limits to growth debate and policy makers involved in sustainable development). RESPONDER aims to improve the mutual understanding and knowledge transfer between these groups by using participatory systems mapping as a core methodology. So-called system maps serve as the basis for systematising empirical findings, questioning different model assumptions, analysing the effects of different policy options and identifying new research questions. Knowledge brokerage means that the project will not conduct new research in this area, but exploit existing research by new integrative modalities of linking research results to policy-making. In synthesis, RESPONDER:

- Links the sustainable consumption and growth debates: its overall aim is to promote sustainable consumption by exploring novel ways of knowledge brokerage;
- Links four communities: research, policy, pro-growth, and beyond-growth;
- Aims to improve mutual understanding and knowledge transfer between these groups by using participatory systems mapping, in a series of Multinational Knowledge Brokerage Events on five sectoral policy areas – food, housing, information and communication technologies (ICT), mobility and private savings/debts.

3 Reconciling Economic Development and Sustainability

A number of initiatives, at all levels of policy-making, reflect the desire to promote sustainable economic development and ensure that it does not jeopardise the well-being of the planet and of future generations. This section briefly outlines some of the key messages presented in a selection of recent initiatives promoted by the UN, OECD, EU and individual EU Member States. Not all of these proposals address the topic of sustainable consumption at great length. Nevertheless, most of them acknowledge that technological solutions are unlikely to solve the sustainability challenge and that behavioural change and altered lifestyles will have to play major roles.

3.1 UNEP Green Economy Initiative

Launched in late 2008, the UNEP-led Green Economy Initiative aims to provide the analysis and policy support for investing in green sectors and in greening environmentally unfriendly sectors. UNEP defines a green economy as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2011). In short, a green economy values and invests in natural capital, being low-carbon, resource-efficient and socially inclusive. In the report

"Towards a Green Economy" sustainable consumption is linked to increased resource efficiency in consumption patterns and the purchase of green goods and services. A case is made to invest 2% of global GDP in greening ten key sectors of the global economy in order to shift development and unleash public and private capital flows onto a low-carbon, resource-efficient path. The Green Economy report shows how a green economy presents a new engine of growth, how it generates new decent jobs, how it can reduce persistent poverty across a range of important sectors, and how this shift can be achieved. The report seeks to motivate policy makers to create the enabling conditions for increased investments in a transition to a green economy. UNEP's concept of a green economy does not replace sustainable development; moving towards green economies should unleash potentials to achieve sustainable development and poverty eradication on a scale and at a speed not seen before.

3.2 OECD Green Growth Strategy

At the OECD Ministerial Council Meeting in June 2009, Ministers acknowledged that "green" and "growth" policies can go hand-in-hand, and asked the OECD to develop a Green Growth Strategy that brings together economic, environmental, social, technological, as well as development dimensions into a comprehensive framework. The publications "Towards Green Growth" (OECD, 2011a) and "Towards Green Growth – Monitoring Progress: OECD Indicators" (OECD, 2011b) provide an operational and flexible framework for governments in developed and developing countries on how economic growth and environmental protection can be achieved. The overarching goal is to establish incentives or institutions that foster innovation, investment and competition that can give rise to new sources of economic growth that is consistent with resilient ecosystems – with the ultimate goal to increase well-being. The strategy explicitly calls for new production and consumption modes in order to sustain and raise living standards. Equity concerns are acknowledged but it is recommended to tackle them in separate initiatives together with other social issues of the sustainable development agenda. Overall, green growth is considered as a subset of sustainable development, rather than as a replacement.

3.3 Europe 2020

Europe 2020 has been launched in 2010 as a successor agenda of the Lisbon strategy. Proposed by the European Commission and endorsed by the European Council as a ten-year strategy of smart, sustainable and inclusive growth, it follows a consistent approach to converge the wide range of economic, social and environmental policies the EU is striving for. Five headline targets have been agreed for the whole EU for 2020 – regarding employment, R&D/innovation, climate change and energy, education and poverty/social exclusion. Similarly to the Lisbon strategy, the new strategy highlights the need to decouple economic growth from the use of natural resources, thus achieving "sustainable growth". This reconciliation is tackled under the Flagship initiative "Resource-efficient Europe". Equity issues are addressed by the Flagship initiative "European platform against poverty", but not explicitly targeted. Europe 2020 and the flagship initiatives serve as the umbrella of the European Sustainable Consumption and Production Policies. The key EU documents for reaching the EU 2020 targets were adopted in the September 2011 under the name the Roadmap to a Resource Efficient Europe (EC, 2011). The document calls for a modern, resource efficient mobility system, serving both passengers and freight and which can contribute significantly to competitiveness and sustainability.

3.4 Degrowth movement

The degrowth movement is capturing part of the growth-sceptical debate. The economist Nicholas Georgescu-Roegen is considered as the creator of the concept of degrowth already in the 70s, although to his view degrowth was not conceived as a voluntary societal idea, as put forward by the degrowth movement since 2001. Instead, it was considered an unavoidable necessity for a real durable development of humanity within the biosphere. The degrowth movement has been experiencing a popular upswing in recent years and is particularly active in France ("décroissance"), Spain ("decrecimiento") and Italy ("decrescita"). It comprises scientists as well as activists, who advocate an equitable downscaling of production and consumption in order to increase human wellbeing and enhance ecological conditions at the local and global level, in the short and long term (Schneider, Kallis, & Martinez-Alier, 2010). Degrowth ideas are based on an assumption that reducing "overconsumption", as a root cause of today's environmental and many social problems, does not require individual martyring and a decrease in well-being. Well-being can rather be achieved through non-consumptive means, such as work sharing, less consumption or more time for friends, family, culture and the community. The first international Degrowth Conference took place in April 2008 in Paris, the second one in March 2010 in Barcelona, and the third one is planned for early 2012 in Venice.

3.5 German Study Commission on Growth, Wellbeing and Quality of Life

The Study Commission of the German Parliament on "Growth, Prosperity, Quality of Life – Toward Sustainable Development and Social Progress in the Social Market Economy" is expected to determine the importance of economic growth in the economy and society with the aim of developing a holistic well-being and progress indicator. It also aims to investigate the possibilities and limits of decoupling growth, resource use and technological progress. Final results are expected by the end of the legislative period in 2013. The study commission consists of 34 members, including 17 members of parliament and the same number of external experts, appointed by the political groups according to the majority.

3.6 Growth in Transition

"Growth in Transition" is an Austrian initiative, which brings forward the question on what kind of growth is desirable for the future and which goals are targeted with it. Formed in 2008 by the Austrian Ministry of Agriculture, Forestry, Environment and Water Management as a stakeholder dialogue, the initiative intends to trigger a dialogue among institutions and people about how we can shape a transformation process towards sustainability. It also aims at contributing to current EU and international processes and at informing the Austrian public. The initiative covers different institutions that organise activities focusing on the same core issue but from different angles. It currently consists of 15 partner organisations – seven Austrian ministries, three Austrian provinces, Social Partners, companies, Oesterreichische Nationalbank and organisations from the civil society. Sustainable consumption has played an explicit role in an international conference with more than 550 participants held in January 2010. Findings exist from a workshop series 2009/2010, the conference and current work on a Policy-Science-Stakeholder Dialogue.

3.7 Policy initiatives to better measure progress

3.7.1 Beyond GDP

In 2007, the European Commission initiated "Beyond GDP" – a process that led to the adoption of a communication in 2009 with a concrete roadmap for developing new environmental and social indicators to measure the prosperity and well-being beyond GDP. The roadmap suggests five key actions to improve indicators of progress in ways that provide an improved basis for public discussion and policy-making: complementing GDP with environmental and social indicators; near real-time information for decision-making; more accurate reporting on distribution and inequalities; developing a European Sustainable Development Scoreboard; and extending National Accounts to environmental and social issues.

3.7.2 Commission on the Measurement of Economic Performance and Social Progress

French President Nicolas Sarkozy set up this high-level Commission in 2008, chaired by Joseph Stiglitz, recipient of the 2001 Nobel Prize in Economics. The Commission's final report (Stiglitz et al., 2009) was published in September 2009 and contains chapters on classical GDP issues (e.g. addressing the importance of improving existing measures of economic performance before going beyond GDP); quality of life (e.g. emphasising the importance to complement measures of market activity with measures of people's wellbeing); and sustainable development and environment (e.g. following the logic of a "wealth" or "stock-based" approach to capture sustainability). The report provides a general overview of the state-of-the art in the respective areas and comes up with 12 key recommendations.

3.7.3 OECD's Project on Measuring Progress of Societies and the Better Life Initiative

The OECD initiated a global project on "Measuring the Progress of Societies" (OECD, 2012) in 2004 to foster the development of key economic, social and environmental indicators in order to provide a comprehensive picture of how the well-being of a society is evolving. The project aims to encourage the use of indicator sets to inform and promote evidence-based decision-making, within and across the public, private and citizen sectors. The Better Life Initiative, launched in 2011, follows a similar objective of understanding what drives well-being of people and nations and what needs to be done to achieve greater progress for all.

The challenge of promoting sustainable economic development without jeopardising the well-being of the planet and future generations is also reflected in the five specific policy areas which the RESPONDER project focuses on. The remaining part of this background paper outlines the core issues discusses in the course of the 1st Multinational Knowledge Brokerage Event focusing on ICT as a consumption context and policy area in order to make it easier for the participants to engage in debates and the system mapping.

4 Green ICT for Growth and Sustainability?

ICT (Information and Communication Technologies) are widely regarded as enablers of "green growth" in various sectors of the economy and moreover as means to tackle environmental challenges and foster sustainable consumption. ICT have a significant potential to drive low-carbon economic growth by delivering climate and energy solutions. The SMART 2020 study estimates that ICT could cut 7.8 $GtCO_2$ of global greenhouse gas emissions by 2020, a 15% reduction over business-as-usual projections (Group, 2008). The key enabling aspects of ICT concern product-specific improvements (particularly with regards to energy efficiency), the potential for dematerialization (through the substitution of products by services) as well as the implementation of "smart technologies" in, for example, the transport or building sector (Johnston & Vanderhaeghen, 2010).

At the same time, the expansion of ICT goes along with increased energy consumption in production and consumption, direct environmental impacts in terms of materials throughput and end-of-life treatment as well as potential rebound effects resulting from efficiency gains. Hence, what is needed is rigorous research to assess the environmental, social and economic impacts of ICTs on various levels, as well as effective policies to nurture the potential of ICTs to contribute to sustainable consumption without harming people, societies or the environment.

4.1 Assessing the environmental impacts of ICT

When assessing the environmental impacts of ICT one can distinguish between first-, second- and third-order effects (Hilty, 2008; OECD, 2010):

- **First-order effects** refer to environmental impacts related directly to the life cycle of ICT hardware, including the production, use, recycling and disposal of ICT. These effects are sometimes referred to as *direct effects*.
- **Second-order effects** comprise environmental impacts that result from the change in production, transport and consumption processes due to the applications of ICT. This category, for instance, includes energy savings achieved by ICT-enabled optimization of production processes or substitution of a physical product with a service. These effects are sometimes referred to as *indirect effects*.
- **Third-order effects** relate to environmental impacts that emerge from the medium or long-term adaptations of behavior and economic structures following from the availability of ICT and the services it provides. Rebound effects emerging from efficiency gains can be included in this category. These effects are sometimes referred to as *systemic effects*.

According to studies conducted so far, the sum of first-order effects is negative, while the net impact of second-order and third-order effects, respectively, may be either positive or negative. However, the results from various studies differ, depending on the extent to which rebound effects are taken into account. Recent studies tend to concentrate on second-order effects, putting less focus on first-order and/or third-order effects (Erdmann & Hilty, 2010; Group, 2008).

4.2 Electricity consumption, materials throughput and e-waste

As far as first-order effects are concerned, various studies have highlighted the impact of ICT on residential electricity consumption (Crosbie, 2008; IEA, 2001, 2009) which is mainly driven by the digitalization of television, set-top boxes, increased screen size and standby consumption, as well as the increasing number of PCs and other small electronic devices. Global residential electricity consumption by ICT equipment grew by nearly 7% per annum between 1990 and 2008, and even with foreseen improvements in energy efficiency, consumption from electronics is set to increase by 250% by 2030. While important efficiency improvements have been made, these tend to be offset by the heightened demand for equipment which provides more functionality, or is larger or more powerful, and hence uses more electricity (IEA, 2009).

In the production phase of ICT equipment, high energy consumption is as well a critical issue in relation to the production of equipment and the running of the required infrastructure, such as server parks and sending masts. These effects are much less researched, but some studies indicate considerable impacts (Group, 2008; Hilty, 2008; Willum, 2008). Other first-order effects concern the mining of scarce metals and other resources, which may cause social conflicts and environmental degradation (Nordbrand & Bolme, 2007; Pöyhönen, 2009; Steinweg & Haan, 2007) as well as the use of toxic substances such as brominated flame retardants (OECD, 2009a). Generally speaking, the production of ICT equipment requires much larger quantities of materials than may be expected considering the small size of many devices. However, when functionality increases, the manufacturing process also tends to get more complex; hence, the ratio of indirect material consumption to material actually embodied in the product becomes extremely large (Ayres, Ayres, & Warr, 2004; Williams, Heller, & Ayres, 2003).

Finally, electronic waste[2] (e-waste) is currently one of the fastest-growing waste streams (Eurostat, 2011). In the EU, e-waste is growing almost twice as much as municipal waste every year (EEA, 2008; Huisman, Magalini, Kuehr, & Maurer, 2007) with an expected annual increase between 2.5% and 2.7% reaching about 12.3 million tons in 2020 (Huisman et al., 2007). However, although 9-10 million tons of e-waste were generated in 2008 in the European Union, only 3.1 million tons have been collected (Huisman, 2010). E-waste presents crucial recycling challenges that are expected to increase with the trend towards embedding ICT components into all sorts of products that are not considered to be ICT products (e.g. the diffusion of RFID tags) (Hilty, 2008). For some strategic materials, improved recycling is decisive to reduce the present dissipation and avoid serious scarcity in the future (Reller et al., 2009). E-waste is also linked to the short innovation cycles of consumer electronics and planned obsolescence which leads to a high turnover of devices (Vallauri, 2009). For example, the lifespan of central processing units in computers dropped from 4–6 years in 1997 to 2 years in 2005 (Babu, Parande, & Basha, 2007). E-waste is classified as hazardous because it contains many toxic ingredients, including heavy metals and harmful, persistent chemicals, with the potential to pollute the environment and damage human health when it is processed, recycled or disposed of (Greenpeace, 2008).

4.3 Optimization and dematerialization of production and consumption

With regards to second-order effects, ICT applications have the potential to optimize production processes and transport systems, and may foster dematerialization of consumption processes when physical products are substituted for a service or a "virtual good" (examples include the substitution of hard-copy books with e-books, the replacing of privately owned cars with car-sharing concepts, as well as telework and teleshopping) (Group, 2008; Tomlinson, 2010). For instance, life cycle assessments indicate a signifi-

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[2] Electronic waste, e-waste or waste of electrical and electronic equipment (WEEE) refers to "any appliance using an electric power supply that has reached its end-of-life" (OECD, 2001); this includes "white" goods such as refrigerators, washing machines, etc. and also includes "brown" goods such as ICT equipment (EC, 2002; OECD, 2001).

cant second-order energy saving potential related to purchasing music based on download of MP3 files as compared to physical CD delivery (Weber, Koomey, & Matthews, 2010).

However, these savings might be partly outweighed if streaming or easy access to downloading low-price/free music results in a significant increase in the data traffic on the internet, thus resulting in increased energy consumption for the internet infrastructure. Hence, optimization and substitution in production and consumption may work in opposite directions; for instance, when the aim is to optimize for just-in-time production rather than for resource savings, and when energy-using products (like the digital photo frame) replace simpler products. In addition to these modifications, negative impacts are particularly related to induction effects that occur when an ICT application stimulates increased use of a product or service (Hilty, 2008). In the case of paper consumption, for example, paper may be saved when errors are corrected on the PC before printing (optimization), and when information is received directly from the screen (substitution). But these effects are more than offset by induction effects, since PCs and printers make it so easy to make print-outs that the potential is used for increased convenience and higher quality rather than saving paper (Hilty, 2008). Thus, the induction effect is similar to the rebound effect that occurs when the intention of savings through increased efficiency is balanced off or even overcompensated by quantitative growth stimulated by increase in efficiency (Binswanger, 2001) but is not restricted to situations where the intention is to save resources, and thus can be seen as more general than the rebound effect.

4.4 Environmental information systems and structural dematerialization

The positive potential of third-order effects is related to environmental information systems and structural dematerialization. Environmental information systems are highly relevant for monitoring and understanding processes in the environment on the one hand, and for the implementation of environmental policies and environmental management on the other hand (Hilty, 2008). Structural dematerialization is based on the long-term potential of substitution effects related to, for instance, online shopping practices as well as telework and videoconferencing that may reduce needs for transportation (Hilty, 2008).

However, the energy saving potential of telework or teleshopping might be counteracted by several factors. Buying goods and services through the internet may save private transport related to traditional shopping, but as many goods are delivered individually by lorry or car, the savings in private transport energy consumption might be outweighed by the extra energy consumption related to distribution. Working remotely from home could reduce business travel and office building emissions by large percentages; however, studies have also found that the possibility of working from home a few hours early in the morning enables some employees to defer the departure from home to later in the morning. In this way, they avoid the heaviest traffic congestion on the roads, which makes it more attractive to travel by car instead of by train (Christensen, 2008). Similarly, the possibility of working from home can make it more attractive to live even farther from the workplace than would be reasonable if it were necessary to commute to work every day (Jørgensen et al., 2006). Moreover, employees come to rely more heavily on their electronics and telecommunication networks to stay in touch. These changes in settlement and transport and commuting practices illustrate possible "complementarities" (Buliung, 2011) between socio-technical systems. These environmentally negative third-order effects related to ICT usage partly offset the positive second-order effects of less work-related transportation due to teleworking (Rietveld, 2011).

4.5 Public regulation of ICT

Environmental regulation of ICT is mainly concerned with first-order effects, particularly in relation to electricity consumption in households and e-waste (OECD, 2009b). What has less been taken into account so far is the regulation of energy consumption related to the production of ICT equipment as well as to running the ICT infrastructure (networks, servers etc.). Moreover, environmental considerations also call for policies to extend the life of ICT products in order to tackle problems related to scarce resources, mining, waste and toxic substances (Hilty, 2008).

4.5.1 Regulation of residential electricity consumption

The electricity consumption of ICT equipment emerged on the regulatory agenda in the late 1980s, when it became apparent that offices were developing into much more energy consuming places with ICT. Both for economic and environmental reasons, energy savings were encouraged, and the U.S. EPA, for instance, introduced Energy Star labelling for office equipment in 1992. In households, the first implications of digitalization became visible in relation to standby power. With the emergence of teletext services in the late 1970s, more advanced wireless remote controls were developed for televisions and later for many other appliances. Since remote controls only work when appliances are (partly) turned on, this development implied a massive increase in standby electricity consumption – reinforced by the increased standby consumption from appliances not managed by remote controls. Over the last 15 years, particular attention has been devoted to the reduction of standby power consumption, partly because standby came to take up a significant share of electricity consumption (around 10% of residential electricity consumption in many OECD countries) (IEA, 2009) and partly because much of this consumption is considered not to serve any useful purpose. The contribution of each appliance to standby consumption is usually small, but over 100 appliances have a standby component, and the number is growing. Since policies tend to focus on up to 15 appliance types, which account for only about 25% of household standby consumption, standby consumption is still high (IEA, 2009).

Most public regulation of ICT has so far been based on instruments such as endorsement labels (or comparison labels based on energy performance), minimum energy performance standards, government procurement policies and consumer education to e.g. reduce standby consumption. While some improvements have been achieved – for instance through the combination of endorsement labels and government procurement for computers in some countries (IEA, 2009) – the implemented measures are not effective enough to meet the challenges, as much regulation is based on voluntary agreements rather than compulsory programmes. The lack of regulation for much ICT equipment is also due to various difficulties, such as the lack of credible test methods, the prevalence of proprietary technologies, difficulties with maintaining compliance in a market with large imports, the lack of tradition for energy regulation of electronics (IEA, 2009) and the fast entrance of new products and changes in the functionality of existing products, which makes it difficult to define individual devices and establish appropriate energy performance targets. To cope with the above mentioned problematic of establishing energy performance targets for individual devices due to the short-life cycles of electronic products, the IEA suggests increasing the use of horizontal policy measures that apply to functions rather than appliances. This approach is, for instance, reflected in the EU Ecodesign Directive from 2008 (effective from 2010) that requires limiting the maximum standby power level to one watt per device (with a few minor exceptions) and could be extended by relating energy performance to functions such as visual display, computing, audio and video recording and playback, printing and copying, and TV reception (IEA, 2009).

Further complexity arises when devices are connected to networks, as they increasingly are. A few network applications have energy efficiency as their primary purpose, but most residential applications are designed for comfort, control, security, or entertainment. The dedicated network products, like routers and switches, as well as the network interface components within each connected device consume relatively little energy, but with billions of connected devices the impact is considerable. In addition, the connection to networks may affect the ability of an appliance to utilize power management functions. Therefore, public intervention is highly needed to ensure industry-wide standards that combine interoperability with the support of power management (IEA, 2009).

4.5.2 E-waste management

In October 2002, the European Parliament and the Council adopted the WEEE Directive with the aim to improve e-waste management and the recycling of toxic e-waste (EU, 2003). A focus of the directive is to increase resource efficiency and ensure proper treatment of e-waste. The producers of electrical and electronic equipment thus have to take more responsibilities to recollect their obsolete products. However the directive has been criticized for not achieving reduced amounts of e-waste (Lauridsen & Jørgensen, 2010). In a statement, Environment Commissioner Janez Potočnik points out that, currently, only one third of electrical and electronic waste (WEEE) in the European Union is separately collected and appropriately treated (EC, 2012b). Therefore, a renewed version of the directive is currently being debated in the EU political system (Robinson, 2009; Vallauri, 2009). Furthermore it will give EU Member States the tools to fight illegal export of waste more effectively (EC, 2012a, 2012b).

4.5.3 Regulation of higher-order effects

Second-order and third-order environmental effects of ICT are strongly related to the actual use of the technologies in everyday life; thus, to the extent to which they are applied for reducing resource use and providing increased comfort, entertainment and security, as well as to the degree of the observed rebound effects. As it is difficult for policy-makers to question the social desirability of the mounting electronic equipment and increasing standards – for instance, larger screen sizes and 3D television –most policies focus on encouraging the realization of the potential of ICT for saving energy, for instance, in relation to "smart metering". Several countries support or require the installation of smart meters that provide feedback to households about their energy use and thus encourage savings – at least when the information is sufficiently frequent, disaggregated and appealing (Darby, 2006; Fischer, 2008). Smart meters are also expected to play a role in relation to the integration of wind energy and other renewable energy sources into energy systems by encouraging consumers to use energy when the renewable sources are available and to store energy for later use (e.g. in batteries for electric cars) (OECD, 2010).

When it comes to second-order and third-order effects, ICTs do have great potentials for reducing the energy intensity of everyday life through, for instance, the dematerialisation of various practices and the reduction of transportation. However, the realisation of these potentials does not come about automatically but requires public policies that actively encourage such trends. These policies range from energy taxation over innovation policies (to direct investments towards energy-saving applications) to efforts to reduce global inequality (that can increase prices of raw materials and wages in sweatshops and thus make ICTs into something expensive that must be applied with care).

4.6 Exploring links and contradictions between green ICT, economic growth and sustainable consumption

As has already been mentioned, RESPONDER aims to improve mutual understanding and knowledge exchange between policy and science by using participatory systems mapping as a core methodology. So-called system maps serve as the basis for systematising the links and contradictions between growth and sustainability in different consumption domains. With regards to ICT, three thematic questions, which are briefly outlined below, will be employed in the participatory mapping sessions taking place over the course of the event.

4.6.1 What impacts on residential energy consumption can be expected from the introduction of energy labelling on consumer electronics?

Eco-labels are introduced by governments and private organisations as a market-based, demand-side instrument to enable informed choices of consumers and encourage the demand for and supply of environmentally preferable products and services. The only mandatory label is the EU Energy Label for television sets. The requirements of this label are defined relative to the size of the TV screen, i.e. larger televisions are allowed to consume more energy than smaller devices to be awarded the same classification. A different approach in this respect is followed by the voluntary US Energy Star® label: Three different efficiency requirements are applied depending on the size of the screen. Hence, bigger televisions have to comply with higher efficiency standards. Besides these two labels national eco-labels, such as the German Blue Angel or the Nordic Swan, are available for a variety of consumer electronics comprising, amongst others, TV sets, desktop PCs, laptops, tablets, and mobile phones. These voluntary labels are differently wide-spread; in some product categories they are not used by suppliers at all.

The impact exerted by environment- or energy-related labels depends on whether they are obligatory or voluntary. Possible effects may encompass increased consumer awareness, higher willingness-to-pay, informal standard-setting for a product sector, green market transformation, competitive advantages for eco-pioneers, etc. However, it has been criticized that eco-labelling fails to address overall product demand as a label awards best-in-class products without questioning the need for the product as such or the way it is used.

4.6.2 What is the potential of smart metering in encouraging energy savings in the long run?

Smart meters are electronic meters that enable two-way communication between the household meter and the electricity supplier and more detailed recording of the electricity consumption in intervals of, for example, an hour or less. These functionalities open up a number of new applications, including more detailed feedback to customers about their electricity consumption as well as demand management.

Feedback is often expected to lead to energy savings. The underlying assumption is that detailed and real-time (or close to real-time) information about electricity consumption raises consumers' awareness of their electricity consumption and motivates them to save electricity by either investing in more energy-efficient appliances or by changing their behaviour. In this way, feedback builds on a conceptualization of the consumer as a rational agent, but many studies demonstrate that they are based on a problematic representation of why "people do as they do", ignoring the social, cultural and socio-technical embeddedness of energy-consuming everyday practices.

Smart meters are expected to play a vital role as the access point and mediator of data between the households and the operators of the electricity system in the future smart grid where much more intermittent renewable energy is integrated in the system. Demand management becomes important to avoid massive investments in upgrading the capacity of the grid and to ensure balance on the grid between electricity generation and consumption. While demand management is needed to shave peaks and ensure balance, it is less obvious how the emerging system will influence total energy consumption, since smart home technologies may have the potential of creating both entirely new practices and also normalizing new expectations to comfort, convenience, entertainment, security, and health care.

4.6.3 Will cloud computing lead to overall savings of energy and other resources?

Cloud Computing is often regarded as form of "green computing"; it appears to be environmentally friendly due to the economies of scale offered by cloud computing resources and facilities. On the individual consumer level, some cloud computing services replace offline activity that is equally or more energy intensive, and hence make a positive contribution to emissions reduction (e.g. digital purchase of music, online browsing of newspapers, skype audio or video meetings, etc.).

However, the growth of cloud computing is also accompanied by an increasing demand for energy. For all of this content to be delivered to users in real time, virtual mountains of video, pictures and other data must be available for almost instantaneous access and stored in massive data centres. These data centres are the fastest growing source of IT energy use. Data centres currently consume 1.5 to 2% of global electricity – this figure is expected to grow at a rate of 12% per year (Greenpeace, 2011). While many considerations go into determining where new data centres are located – such as a reliable and low-cost source of electricity, tax incentives and proximity to end-user – availability of renewable energy to power the data centre is currently low on most cloud companies' lists (Greenpeace, 2011). Instead, data centre clusters (Google, Facebook, Apple) are cropping up in places like North Carolina and the US Midwest, where cheap and dirty coal-powered electricity is abundant. The greatest effort to reduce the environmental footprint of data centres have so far focused on efficiency gains through e.g. improving data centre design, increasing server energy efficiency or reducing waste associated with cooling and other 'non- computing' energy demands. However, what this approach fails to consider is the kind of energy used to feed consumption.

Hence, the net environmental impacts of cloud computing are still not clear, mainly due to a lack of utilization data provided by the major cloud companies. Much greater transparency is needed from data centre operators on their energy footprint in order to establish meaningful leadership to advance the debate among peers and government regulators and substantiate claims of 'green IT'.

5 Outline of the Event

The first Multinational Knowledge Brokerage Event on "Green ICT for Growth and Sustainability?" takes place from May 30 to June 1, 2012 at the Vienna University of Economics and Business (WU) in Vienna, Austria.

On **Thursday, May 31**, following the welcome and introductory address by **Sigrid Stagl (WU)** and **André Martinuzzi (RIMAS & WU),** the event kicks-off with a keynote presentation by **Inge Røpke (Technical University of Denmark)** that sets the scene for the core issues and questions relating to ICT and sustainability that are addressed over the course of the event. Next, participants have the chance to get in touch while discussing selected key aspects in the course of a **poster walk**. Following a short coffee break, **Peter Johnston (European Policy Center & Club of Rome)** outlines opportunities for ICT innovations to drive green growth and foster sustainable consumption; in contrast, **Lorenz Hilty (University of Zurich & Empa)** presents a critical perspective on green ICT and sustainability. Subsequently, all participants are welcomed to pose questions and comments on the two keynote speeches with the plenary and plenum.

The remaining Thursday is dedicated to the core methodology RESPONDER employs for exchanging knowledge and fostering mutual understanding between stakeholders - **participatory systems mapping**. After a brief introduction to the method by **Michal Sedlacko (RIMAS)** participants in three parallel working groups are invited to jointly construct and debate system maps on one of the three thematic policy questions outlined in section 4. These system mapping sessions are facilitated by André Martinuzzi, Michal Sedlacko and **Gerald Berger (RIMAS).** After the mapping, participants are encouraged to share their experience and learning with the rest of the group.

On **Friday, June 1**, **Lorenz Erdmann (Fraunhofer Institute for Systems and Innovation Research)** discusses the impact of ICT on greenhouse gas emissions both on a macro and micro level with a special focus on indirect and rebound effects. Afterwards, **Vida Rozite (International Energy Agency)** shares her insights and experiences on standby energy consumption. Following a period for questions and discussion, a second session on **participatory systems mapping** takes place in which the maps from the first day are discussed with members of the other groups and finalized. After another feedback round, the whole debate is wrapped-up and a brief outlook provided on upcoming events and activities planned in the RESPONDER project.

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