IMPLEMENTATION OF GREEN ICT FOR SUSTAINABLE ECONOMIC DEVELOPMENT

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Abstract - In the past few years, a new aspect of ICT use has emerged and become a focal point of attention in order to realize development goals respecting in the same time ecological standards and norms. This "green" potential of ICT is oriented to use of ICT in transforming activities to be more energy-efficient and, as a result, to reduce greenhouse gas emissions. There is much hope that ICT can be a major part of the solution in tackling climate change and related environmental challenges.

I. INTRODUCTION

Modern, global world based on the richnes of information and ever more oriented on information society and e-economy put sustainable development in the focus of its existance. Sustainable development must incorporate social and environmental considerations, respecting human and natural resources along with economic factors.

World Commission on Environment and Development defined the sustainable development as „development that meets the needs of the present, without compromising the ability of future generations to meet their own needs" [1]. It implies considering the desired quality of life and the attainable speed of social development, as well as the need to balance different social values. In accordance with theoretic explanations such dvelopment relies on three pillars: the economy and improved standard of living; social equity through the reduction of poverty and enhanced quality of life; and the environment enabling the preservation of natural resources for the future generations. Policy-makers are an important factor in establishing synergies and complementarities among the three pillars.

In 2008, the world was confronted with multiple crises (fuel, food and financial). As a response at negative effects of economic development on environment, but also at the financial crisis, the international community seeks solutions for creating a sustainable economy and society. In this context the concepts of "green economy", "green growth", „and green society" became more present on the international level and in the developed countries. The 'green' economy can be considered synonymous to a 'sustainable' economy. However, the Green Economy concept often carries a more distinctive meaning, one that focuses specifically on the fundamental changes that are required to ensure that economic systems are made more sustainable. That is, green economy is seen as a framework for restoring economic growth meanwhile responding to the climate change and other subjects of environmental sustainability [2].

One of the key roles in this framework has information-communication technologies (ICT) through creation of digital economy. Miller and Wilsdon [3] sustain that digital economy modifies the relation of human being with environment, changing the business models. They propose the concept of „sustainable digital economy" as a solution for the environmental issues and consider the possibility to use the creativity and dynamism of digital economy for the good of economy, environment and society. Green digital economy is based on sustainable business practices as opposed to those which function based on non-renewable resources and inefficient methods. It seeks to promote financial, business and other economic transactions without depending on or damaging the environment.

II. GREEN ICT POTENTIALS

As a "general purpose technology" or an "enabling technology" ICT are widely used in different domains, and have a profound effect on the entire economy. ICT use in business is not only becoming more pervasive, it is also progressing towards more advanced and sophisticated applications.

The role of ICT in economic development is in particular recognized for innovation, for competitiveness and for sustainability. The three domains are strongly

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interrelated. For example, if a company increases its energy efficiency ("sustainability"), it reduces costs and becomes more competitive. However, there can also be conflicts of interests between these domains: investments in innovative green technology may increase the environmental sustainability, but not pay off for the company, at least in the short term [4].

All three domains of ICT impact – sustainability, competitiveness and innovation – are relevant at different levels: at the micro level of the individual company, the meso level of the industry and the macro level of the economy as a whole. Because of the meso and macro effects, industrial and innovation policy in advanced economies has for many years been paying close attention to ICT.

In the past few years, a new aspect of ICT use has emerged and become a focal point of attention: the "green" potential of ICT, in particular the use of ICT to become more energy-efficient and, as a result, reduce greenhouse gas emissions. There is much hope that ICT can be a major part of the solution in tackling climate change and related environmental challenges [4].

Over the past 5–10 years a consensus has emerged that ICTs can support the development of the green economy in three principal ways [5]:

1. by decreasing *direct effects* on the environment of the production, distribution, operation and disposal of ICTs through improved energy and materials efficiency, increased use of renewable energy sources, reduced use of toxic materials and improved recycling and end-of life disposal of ICTs;
2. by increasing the *enabling effects* of ICTs on the development of the green economy through improvements in the efficiency of production, distribution and consumption of goods and services throughout the economy and society; by reducing demand for energy and materials through the whole or partial substitution of virtual products and services for their physical equivalents; and through the dematerialization of human activities and interactions;
3. By supporting *systemic effects* that result in the transformation of behavior, attitudes and values of individuals as citizens and consumers; economic and social structures; and governance processes.

The ICT industry, in partnership with other sectors, has a key role to play in helping to make society's impact visible and to demonstrate the demand for new ways of reducing that impact.

III. GREENING ICT - REDUCING THE ENERGY AND CARBON FOOTPRINTS OF ICT SECTOR

The use and application of information and communication technologies in economic and social life is rapidly increasing throughout the world. For example, it is estimated that there are now some 6 billion mobile phone users and over 2.4 billion Internet users. ICT products and systems are resource-intensive in manufacturing and distribution, consuming ever-greater amounts of energy while in use, and creating escalating volumes of solid and toxic waste. ICT products may also have negative effects on human and social health as they are produced, used, and discarded [6 and 7].

Statistical data show the following [6 and 7]:

a) Energy consumption

- It is estimated that the 1.5 billion computers in the world consume about 90.000 MW of electric power, which is about 10% of global consumption.
- Energy consumption for servers worldwide has doubled over the period from 2000 to 2005. Recent estimates proclaimed that worldwide Internet usage, via the necessary computers and servers, needs the equivalent of fourteen power stations and produces the same amount of carbon dioxide as the entire airline industry.
- Estimates confirm that total electricity consumption by ICT range from 3 percent to 10 percent in the United States and Europe.

b) Carbon emissions

- Global carbon emissions for ICT as an industry are estimated at 2 percent to 2.5 percent of world totals, but would be much higher (14 percent) if indirect energy use were included. IT now causes the release of as much carbon dioxide into the atmosphere as nearly 320 million cars. According to some calculations, worldwide IT now generates CO^2 emissions of about 600 million metric tons a year. And if the sector continues growing at the current rate, emissions in Germany alone, for example, are expected to increase by another 60% by the year 2020.
- In Europe - the use of ICT equipment in the delivery of services represents about 1.75% of carbon emissions and further 0.25% of carbon emissions come from the production of ICT and consumer electronic equipment.

The ICT industry has a major challenge to adopt and implement additional standards for increased energy efficiency of networks and services. In fact, the ICT sector needs to focus on **s**ystemic improvements and further reduce the energy consumption of its own processes (including operations, manufacturing, service delivery and the supply chain). If the sector were to adopt a more systematic approach to monitoring and measuring energy consumption at every step in a process, it could generate verifiable and comparable data, allowing it to identify opportunities for improvements and reduce energy required to deliver ICT product and services [8].

Concerning the carbon emission, the environmental footprint of ICT is large and growing rapidly. The 'carbon footprint' of an organization is the volume of greenhouse gas emissions it generates. It is calculated by assessing energy usage, business travel, and all components of the organization's operations that consume power or generate waste and by-products. An organization is 'carbon neutral' when there is balance between the amount of carbon released and the amount of carbon sequestered (for example, by planting trees). The ICT industry is in a unique position to demonstrate leadership in reducing its footprint, through *structural change* and *innovation* as well as by leading the way in identifying and creating efficient solutions for other socio-economic sectors to follow.

Good example is announcement made by the Microsoft Corporation at Rio+20 Conference. Microsoft promised to become carbon neutral in just a single year—by the start of its fiscal year beginning July 1, 2013. Registered with the UN Global Compact, an Action Network of commitment-makers from business and industry, and under the SE4ALL initiative, Microsoft's promise was to achieve zero net carbon missions (CO_2e) for it's all data centers, software development labs, offices, and employee air travel. Microsoft, one of the most reputable computer technology companies in the world

with almost 100,000 employees in more than 100 countries, generated more than 1.6 million metric tons of CO_2 in 2011. Its pledge to become carbon neutral is significant given the size of its global operations, but it is also an important demonstration of private sector leadership in the global drive to a low-carbon economy [9].

The ICT sector should be called upon to engage collectively in a process of self-improvement by agreeing on common methodologies and metrology tools to generate data about its energy performance, set realistic targets and benchmark progress. Such efforts should give due consideration to the full life cycle and related environmental impact. The ICT sector should lead by example and will be encouraged to commit such innovative practices that can be replicated in other industries.

TABLE I. ICT – VOLUNTARY ICT SECTOR COMMITMENTS TO DECREAS GHG EMISSIONS, AND RISE ENERGY EFFICIENCY

Companies	Target reduction %	Baseline *	Target date	Comment
Bell Canada	15	Not given	2012	GHG emissions
British Tele-Comm.Plc	80	1996	2020	CO 2 emissions per unit of contribution to GDP
Cisco Systems	25	2007	2012	GHG emissions
Dell	Additional 15	Not given	2012	Operational carbon intensity
Deutsche Telecom AG	20	2006	2020	CO 2 emissions
France Telecom	20	2006	2020	CO 2 emissions
IBM	7	2005	2012	GHG emissions
Intel	20 30	2007 2004	2012 2010	Carbon footprint GHG emissions per production unit
Motorola	6	2000	2010	CO 2 emissions
Nokia	6	2006	2012	Energy consumption of offices and sites
Sun Microsystems Inc.	20	2007	2015	GHG emissions
Vodafone Plc	50	2006/2007	2020	CO 2 emissions
European Union (all sectors)	**20** **20**	**1990** **Projected energy use in 2020**	**2020** **2020**	CO 2 emissions Energy savings/efficiency

Source: SMART 2020: Appendix 4, p.75

IV. ICT FOR MONITORING AND CONTROLING PROCESSES IN THE WHOLE ECONOMY

In order to realize "green sustainable economy" it is **crucial to encourage structural changes** aimed at realizing the potential of ICT to enable energy efficiency across the economy. 'Structural change' means re-engineering the way an organization operates. This can be done for instance by replacing products with on-line services ('dematerialization'), by moving business to the internet (e.g. costumer's support), by adopting new ways of working (tele-working and flexi-work enhanced by video-conferencing and tele-presence tools) and by exploring the viability of using green suppliers and energy from renewable resources.

ICTs can be an opportunity for a sustainable and inclusive future by revolutionizing business models and behavior, by making management of energy distribution and transportation more efficient, by enabling new ways of working, learning, e-health and providing public services, and by helping countries adapt to climate change and reducing disaster risk. Green ICT can improve business processes that are not directly involved in ICT, and dramatically lower CO^2 emissions throughout the process chain helping in this way to significantly reduce the other 98 % of all CO^2 emissions not caused by ICT.

With ICTs now an intrinsic element of every economic sector, the need to integrate ICT-based solutions into the environmental actions of each industry sector has become essential.

Company-level - On the company level it is increasingly important to use ICT solutions to support business processes. These solutions can streamline processes and have enormous potential for reducing CO^2 emissions, because they improve the utilization of resources and allow them to be shared. ICT also permits in-depth monitoring of energy consumption and CO^2 emissions throughout the value chain, so processes and organizational structures can be enhanced accordingly.

Fore modern companies "Green IT" is what analysts, manufacturers and providers call all IT solutions that save energy at business organizations. These include hardware, software and services [6].

Where hardware is concerned, energy-efficient desktop PCs, thin-client architectures and data-center hardware offer answers, and so do energy supply and cooling systems.

In the software and service area, there is significant potential in virtualization, in solutions for dynamic capacity management and data-center planning, and in storage-system off shoring.

And with the increasing convergence of IT and telecommunications, it possible to take the Green concept a step further. Green ICT extends to other, less commonly considered aspects of the entire life cycle. This includes eco-friendly procurement, employee behavior, running data centers on sustainable generated energy, environmentally sound disposal of used electrical equipment, and as much recycling as possible.

The most obvious benefits of Green ICT for companies are reduced environmental impact and cost savings. Besides cost reduction a comprehensive Green ICT strategy offers many other benefits – appealing to all stakeholder groups: employee satisfaction increases, the company's standing with capital markets and with society as a whole improves, and the business can attract new customer groups.

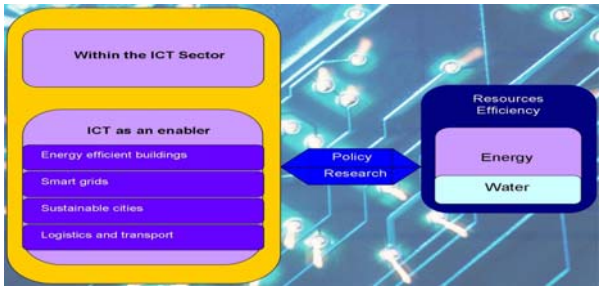
A survey carried out by Forrester in 2009 to identify the three most important reasons for Green IT activities revealed that the principal motivation was to cut spending on energy (69%). The second was to cut down on IT costs (40%) and the third to improve image. The fourth

reason cited was legal compliance (15%). It is remarkable that cost considerations play an above-average role in the United States, while image and legal compliance are more important in Europe [11].

Industry level - The potential savings are particularly great in industries with extensive, complex supply chains. Examples are involving automotive components, and the development and manufacture of cars. ICT can also have a major impact on supporting processes, i.e. via resource utilization in offices. In EU special focus on the industry level is given to buildings and construction, and to transport and logistics [8].

Buildings account for approximately 40% of energy end-use in the EU, of which more than 50% is electrical power. The sector has significant untapped potential for cost-effective energy savings which, if realized, would mean an 11% reduction in total energy consumption in the EU by 2020. There is scope for ICT to contribute to energy and environmental performance, through the application of building and energy management systems, smart metering technologies, solid-state lighting and lighting control systems, intelligent sensors and optimization software.

Transport systems represent about 26% of energy end-use in the EU. Many opportunities exist for improvements in energy efficiency and rationalization, notably through logistics. The focus is on the deployment of ICT to promote modal shift, notably on transport corridors for freight, and through the provision of multi-modal journey planners for passengers to enable significant reductions in congestion.



Picture 1. Resource Efficiency through ICT

Country level - Studies in various countries, generally suggest broad potential for ICT to cut energy use and carbon emissions. One U.S. study projects that changes enabled by broadband networks could save the equivalent of 11 percent of U.S. oil imports through transportation substitution and "dematerialization." A recent study supported by the U.S. Department of Energy demonstrated significant results from "Smart Grid" technologies to monitor and adjust home energy consumption, reducing average household consumption by 10 percent. Proactive management of home energy use by consumers in this way could reduce peak loads on utility grids up to 15 percent annually. The UK RAC Foundation has estimated that "through the use of ICT, there is potential within 10 years for a 15 percent reduction in commuter travel, 18 percent reduction in heavy freight, and a 10 percent reduction in shopping journeys by car" [7].

Partnerships between the ICT sector and other industry sectors are encouraged to identify where and how ICTs can play a role in improving efficiency and reducing emissions in those sectors and thus accelerate the delivery of tools to assess and to optimize energy performance on a comparable basis.

V. ICT IN ENERGY PRODUCTION AND DISTRIBUTION

There are two aspects of the links between energy and ICT [12]. On the one hand, ICT plays a daily part in the production and use of electricity, from the operation of power plants to electricity transport. ICT is used to model, simulate and optimize these processes in order to improve energy efficiency and reduce costs. On the other hand, ICT itself uses a lot of electricity, and work has begun on reducing the consequent economic and ecological costs.

The Information and Communication Technologies are an enabling factor in developing innovation in the whole energy sector. The main initiatives implemented by countries to reach energy efficiency targets are: increased efficiency in generation plants and reduction of network losses (technical and non technical losses). Also challenges deriving from the integration in the network of: large scale renewable sources, electric vehicles, systems for multidirectional flows management, new equipments and power electronics and real time information devices can be faced only with a strong, reliable and fast ICT infrastructure.

The energy transformation sector, dominated by electricity generation, uses around one-third of all primary energy. Given the potential for improvement in electricity generation (estimated at 30-40%) and the considerable losses in transport (2%) and distribution (8%), it is critical to improve transformation efficiency, address losses and identify any potential problems before they compromise supply. ICTs have a major role to play not only in reducing losses and increasing efficiency but also in managing and controlling the whole processes in energy production to ensure stability and reinforce security as well as in supporting the establishment of a well functioning electricity retail market [13].

Smart metering is an activity which introduces ICT potentials in energy sector. Smart metering, introduces ICTs into traditional energy-metering, can be deployed in many ways, taking advantage of ICTs to a greater or a lesser extent. Information can flow between the meter and the energy provider and between the meter and the consumer. The so-called "one-way" implementation, that only serves the energy supplier, is often favored over the 'two-way' implementation which serves both supplier and consumer.

According to the French regulator CRE, with the implementation of smart metering, they estimate an increase in supplier switch capability by factor of 10, decrease residential consumption by 5% and decrease CO2 emissions by 5% [13].

Smart metering is just a first step on the path to smart electricity grids. Smart Distribution network solutions embrace the changing structure of generation, market and use of electricity, and improve the efficiency, reliability, flexibility, accessibility and cost-effectiveness of the end to-end system. Ultimately, smart grids should facilitate, not just a better management of energy consumption, but the integration of alternative and renewable energy sources on a far greater scale than is possible today, with positive impacts for energy security and for the environment. The

liberalization of market for energy, the multiplication of local energy networks, the integration of renewable energy sources (RES), the spread of co- and micro-generation (micro-grids, virtual power plants), and new user demands require the use of the most advanced technologies for monitoring and control as well as for electronic trading of electricity enabled by the smart grids implementation [8].

The grid becomes "smart" because it will not only transport electricity but also information that will become an active part of the electricity supply system. This shall be considered as a paradigm shift in the way the electricity distribution grids are today and how they will become in the future: user and customer centric, service oriented, accommodating all needs and providing adequate solutions, supporting the migration towards and shaping of the low-carbon economy and society.

The energy efficiency targets can only be achieved with the contribution from many different sources, coming from all the energy system stakeholders, mainly customers, utilities, manufacturers, industries, governmental actors and regulators. In fact, the road towards a society without energy waste can be made easier thanks to the availability and the management of large amount of information on energy consumption for all the actors.

VI. GREEN ICT IN EU

Energy security and climate change are becoming more and more prominent on political agendas worldwide and across all sectors of the economy, so that it ranks highest among the EU's priorities. The resolve of the European Council to transform Europe into a low-carbon, high energy efficiency economy means that the continued growth of the European economy, essential to achieve full employment and inclusion, needs to be decoupled from energy consumption. The current trends are unsustainable. Indeed, if nothing were to change, final energy consumption in the EU is predicted to increase up to 25% by 2012, with a substantial rise in greenhouse gas emissions [14].

At the 2007 Spring European Council, the Heads of State and Government highlighted the development of a sustainable integrated European climate and energy policy as a top priority and adopted an energy and climate package to guide the EU towards a competitive and secure energy economy while promoting energy savings and climate-friendly energy sources. That is, Europe has set itself ambitious targets for 2020: saving 20% of primary energy consumption, reducing greenhouse gas emissions by 20% and raising the share of renewable energy to 20%. Fulfillment of these targets faces Europe following main challenges — tackling climate change, guaranteeing secure, sustainable and competitive energy, and making the European economy a model for sustainable development in the 21st century.

Information and Communication Technologies have an important role to play in reducing the energy intensity and increasing the energy efficiency of the European economy, in other words, in reducing emissions and contributing to sustainable growth. In order to achieve the ambitious targets set and meet the challenges ahead, Europe needs to ensure that ICT-enabled solutions are available and fully deployed.

The European Union policy answer to above mentioned challenges can be described as some strong combination of the Knowledge Economy and a Green New Deal. It means putting together economic recovery, by the creation of new ICT markets that address the environmental crisis, with the need to move up the value scale, to a knowledge economy. Essentially the vision is of a *Green Knowledge Society* – a Europe in which citizens and enterprises are empowered through ICT in an inclusive, innovative, secure and sustainable knowledge society [15].

In order to create the *Green* Knowledge Society the following policy issues should be included in an ICT policy agenda for Europe to 2015 [14]:

- A stimulation programme for application of ICTs in energy saving roles across all relevant industry sectors;
- Ensuring ICT is used in more sustainable behavior patterns by citizens and business;
- EU production of a next generation of green ICTs with new technologies and usage patterns – as an opportunity for Europe.

VII. GREEN ICT IN SERBIA

Serbian economy consumes 2.5 times more energy per unit of GDP than the world average and four times more than the average in the EU and can be considered as energy inefficient country. Negative statistics data further confirm need for economic structural change and transition to more energy efficient and environmental responsible economy [16]:

1. Serbian households spend 2.5 times more energy per square meter of living space from some EU countries;
2. Public lighting consume 50 percent more energy than the EU countries;
3. Serbia is dependent on energy imports - even 33.6 percent of the whole import;
4. Emissions of greenhouse gases from the energy sector in Serbia amounts to 76 % of total emissions.

Investing in the use of modern technology and IT solutions is one of the ways to increase energy efficiency and competitiveness of Serbian industry and economy as the whole. Some calculations confirm that the use of advanced ICTs in Serbian enterprises would provide savings of up to 40 percent of the energy. Current data confirm that for the most companies in Serbia energy spending usually accounts up to 30 percent of the operating costs.

Implementation of the advanced IC technologies for the increase of energy efficiency and renewable use, would directly contribute to better position and greater competitiveness of domestic companies, communities and the entire country.

Improving energy efficiency is also one of the key initiatives of the energy policy of the Republic of Serbia. New Law on efficient energy use in Republic of Serbia was adopted by the Serbian Parliament on 15 March 2013. This law establishes a system of organized energy management (energy management) for large energy consumers and the public sector (responsible for about 70 % of primary energy consumption). This Act also introduces minimum energy efficiency requirements for new and revitalized plant in the manufacturing, transmission and distribution, introduce

charges to metered energy consumption and labeling of products that affect energy consumption, and introduce eco-design requirements. The final aim is to open the market for energy services and to implement energy audits in order to identify potential energy efficiency improvements [16].

This Act is also in line with the international obligations of Serbia to save at least 9 % of gross final energy consumption to 2018, and to reduce carbon dioxide emissions by about 9 % to 2030 [17].

VIII. CONCLUSION

Nowdays world is facing multiple crisis and challenges that are mutually interlinked. We have unique opportunity to rethink current perception of growth consumption, inclusion, and how we utilize our limited resources. The transition to a resource-efficient economy and society requires new levels of innovation, breaking out of locked-in systems and technologies. It will be led by forward-looking countries, companies, researchers, inventors and investors.

Such innovations and solutions can be realized only by increasingly closer cooperation among all stakeholders with the aim of unlocking the potential of ICTs to improve energy efficiency, thereby promoting the competitiveness of industry, creating a wealth of opportunities, jobs and services, and building an everyone-wins momentum for industry, users, and society at large.

The private sector can and should have a key role, but it needs the right framework conditions and well-functioning markets. Good regulation and its effective implementation are there to provide a level playing-field and the right incentives and rewards.

Only in such well defined framework the role of ICTs can be fully explored and exploited in the following respects: a) as an enabler of energy efficiency across the economy including fostering the change in citizen's behavior, b) in improving efficiency in the use of natural resources while reducing pollution and dangerous waste.

To put ICTs at the core of the energy efficiency effort and to enable them to reach their full potential, it is necessary to foster research into novel ICT-based solutions and strengthen their take-up — so that the energy intensity of the economy can be further reduced by adding intelligence to components, equipment and services. On the other side, efforts should be made so that ICT leads by example and reduces the energy it uses**.**

The transformation to a Green Economy asks not just business (including producers and retailers), but also consumers, to change behavior. Consumers have the right to be informed about products and they are increasingly asking for more information. However, recent surveys show some worrying trends: half of EU citizens do not trust environmental claims, while 1/3 of them encountered misleading environmental claims. Consumers need to be better informed on how they can contribute to reduce their footprint on the planet and its resources [13].

Increasing social awareness through policies and communications to explain the urgency of the issue and urge conservation is also needed.

The above efforts require that quantifiable benchmarks and metrics be developed to gauge their effectiveness and ensure progress towards established goals.

Final conclusion is that ICT products, systems, and networks are the essential driver of productivity improvements and innovation for the 21st century. They will be the enabler of sustainability solutions in all networks: energy production and use, mobility, water and sewage, open spaces, education, and public health and safety. ICT innovation is also the catalyst for changes in personal, work, and community life that will be a fundamental requirement for sustainable economic development.

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