

# Climate Changes and Green Information Technologies

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*The control of climate changes is one of the greatest historical challenges facing humanity in the 21st century. All economy sectors need to contribute as much as possible, and clearly the information technologies (ITs) have a key role. ITs are recognized as important enablers of the low-carbon transition. They offer mostly untapped significant potential to mitigate our emissions, empower energy users and create completely new business opportunities. However, ITs have also a carbon footprint. Due to significance they could have and hazardous effects that they can cause, ITs are subject to international and national regulations. An increasing number of laws define the principles, establish standards, stipulate jurisdictions and prescribe penalties for those who violate the law. The entire network of regulations is being established in order to minimize environmental problems. Moreover, the Republic of Serbia is not that much behind and nowadays is increasingly included in the network.*

## 1. Introduction

Human economy depends on the Planet's natural capital that provides all ecological services and natural resources. As a result of population increase and economic development, humans have exerted a considerable impact on the earth and are facing a series of incompatibilities among the natural resources, environment, and economy, such as the dichotomy of population growth and depression of resources and environment deterioration [17, 18].

A growing awareness of the necessity to reverse the process of environmental degradation and move toward sustainable business practices currently appears [8]. In spite of a burgeoning list of ecological problems, a lot of people, including the leaders of the most influential organizations, think that environmental problems are not detached from their everyday business lives and behavior patterns.

Further, the fact is that traditional firms have to change their strategic orientation and business operations in order that they should remain competitive in the changed conditions and with new electronic infrastructure (e.g. the managers make business decisions in an environment characterized by a network infrastructure, both the hardware and the software used in communication) [13]. For instance, as organizations leverage their productivity with an ever increasing rate of information technology and system (IT/S) use, they often become part of the larger problem of environmental sustainability [13]. The use of IT/S is exploding, growing two times faster than the Gross World Product [21], and consuming larger fractions of business' energy costs. In most cases, more than half of this energy is wasted by inefficient technologies, poorly designed systems, or uninformed behaviors.

IT/S might have a detrimental influence on the environmental organizations' footprint [16, 18, 21]: IT/S have short product life spans (e.g., laptops 3–4 years; networks 5–7 years); their manufacture and disposal have resulted in toxic hotspots; and a large portion of organizations' electricity costs (and concomitant greenhouse gas emissions) due to IT energy use (e.g., office buildings 26%; data centers 95%) [13]. Thus, IT energy spending has important implication for the environment.

## 2. Environmental impact

Environmental sustainability is defined as “development that meets the needs and aspirations of the present without compromising the ability of future generations to meet their own needs” [26], and therefore, is linked to ongoing economic growth and development.

Although, several papers already discussed organizations' environmental impacts, the precise meanings of this construct often remains unclear and badly-defined [8]. Possible reason for this ambiguity is that perceptions of environmental impact “differ depending on one's view of the environment and the components of the environment that one values” [19]. In this paper, a definition of environmental impact that focuses solely on issues related to the natural environment, rather than the triple-bottom line that also includes financial and social impacts is adopted. Further, environmental impact is defined as the degree to which an organization's business processes, activities and operations positively or negatively affect the natural environment. Environmental impact is the consequence of the organization's actions in relation to the quality and cleanliness of air, water and soil and, more generally, to the short-term and long-term health of Planet Earth's global ecosystem.

### 3. Climate changes

Over the last several decades, evidence of human influences on climate change has become increasingly clear and compelling. There is indisputable evidence that human activities such as electricity production and transportation are adding to the concentrations of greenhouse gases that are already naturally present in the atmosphere. These heat-trapping gases are now at record-high levels in the atmosphere compared to the recent and distant past.

Warming of the climate system is well documented, evident from increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level. The buildup of greenhouse gases in the atmosphere is very likely the cause of most of the recent observed increase in average temperatures, and contributes to other climate changes.

The majority of scientists today believe that climate change is caused by human-induced emission of greenhouse gases to the atmosphere. Greenhouse gases in the atmosphere absorb and reemit some of the outgoing energy radiated from the Earth's surface, causing that heat to be retained in the lower atmosphere. Some greenhouse gases remain in the atmosphere for decades or even centuries, and therefore can affect the Earth's energy balance over a long time period. Factors that influence Earth's energy balance can be quantified in terms of radioactive climate forcing. Positive radioactive forcing indicates warming (for example, by increasing incoming energy or decreasing the amount of energy that escapes to space), while negative forcing is associated with cooling. The most common greenhouse gas is carbon dioxide (CO<sub>2</sub>) which is emitted as a result of consumption of fossil fuels in the energy sector. All sectors of society require energy to perform their function - thus contributing to climate changes.

The effect of climate changes is global warming that causes melting glaciers, rising sea-levels, floods and droughts, more extreme weather events and so on. Climate changes refer to any significant changes in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate changes might result from natural factors and processes or from human activities:

- **Human causes** include burning fossil fuels, cutting down forests, and developing land for farms, cities, and roads. These activities all release greenhouse gases into the atmosphere.

- **Natural causes** include changes in the Earth's orbit, the sun's intensity, the circulation of the ocean and the atmosphere, and volcanic activity.

The term "climate change" is often used interchangeably with the term global warming. Global warming refers to an average increase in the temperature of the atmosphere near the Earth's surface, which can contribute to changes in global climate patterns. However, rising temperatures are just one aspect of climate changes.

As greenhouse gases trap more energy in the Earth's atmosphere, average temperatures at the Earth's surface are expected to rise. However, because climate changes (both natural and human-driven) can shift the wind patterns and ocean currents that drive the world's climate system, some areas might experience more warming than others, and some might experience cooling. Changes in air temperature can, in turn, cause changes in sea surface temperature, precipitation patterns, and other aspects of climate.

At the current rate, the Earth's global average temperature is projected to rise from 1.6 to 2.7°C by 2100, and it will get even warmer after that. As the climate continues to warm, more changes are expected to occur, and many effects will become more pronounced over time. For example, heat waves are expected to become more common, severe, and longer lasting. Some storms are likely to become stronger and more frequent, increasing the chances of flooding and damage in coastal communities. Climate changes will affect different regions, ecosystems, and sectors of the economy in many ways, depending not only on the sensitivity of those systems to climate change, but also on their ability to adapt to risks and changing conditions. Throughout history, societies and ecosystems alike have shown remarkable capacity to respond to risks and adapt to different climates and environmental changes. Today, effects of climate change have already been observed, and the rate of warming has increased in recent decades.

For this reason, human-caused climate changes represent a serious challenge - one that could require new approaches and ways of thinking to ensure the continued health, welfare, and productivity of society and the natural environment.

Climate changes and global warming are the effects of unsustainable consumption patterns in an industrialized world. And most people are by now convinced that we need to solve the problem, to avoid severe consequences on the environment and on our livelihoods.

Stabilizing greenhouse gas emissions requires the transformation of patterns and practices of society into a low-carbon society. It is the solution that allows societies to develop and thrive based on sustainable and resource efficient principles, without negatively impacting the environment or causing further climate changes.

#### **4. Responses to climate changes**

The observed climate changes across the world force us to initiate responses in order to avoid nature disasters. People react at two levels - to mitigate the problem by reducing emissions of greenhouse gases, and by adapting to the problem, by making communities more resilient to the occurring changes. Mitigation and adaptation are both crucial. Neither adaptation nor mitigation alone can avoid all climate change impacts; however, they might complement each other and together significantly reduce the risks of climate changes.

##### **4.1. Adaptation**

Adapting to climate modulations is necessary for all society sectors in order to respond to changes that have already happened and also to prepare for the changes that will occur in the future. As already stated, there will be a great variety in how hard different geographical areas could be hit by climate changes - developing countries generally are in the centre of the worst changes.

A number of actions need to be taken, to prepare societies and sectors for following events. New structures, such as new infrastructure and early-warning systems – supported by new technologies and knowhow need to be established. Both technology transfer and knowledge dispersal, including education and capacity building, are required in order that indigenous people should be empowered to help themselves and their livelihoods.

##### **4.2. Mitigation**

The evidence suggests that with the current climate changes mitigation policies and related sustainable development practices, global greenhouse gas emissions will continue to grow in the next few decades. Continued greenhouse gas emissions at/above current levels will cause further warming and induce many more changes in the global climate during the 21<sup>st</sup> century that will possibly be a lot worse than the ones observed during the 20<sup>th</sup> century.

The urgent need to mitigate emissions of greenhouse gases is intensified by the fact that greenhouse gases stay in the atmosphere for hundreds of years. Therefore, global warming will continually increase in the future due to the time scales associated with the cli-

mate processes and feedbacks, even if greenhouse gas concentrations are stabilized. In order to stabilize the greenhouse gases concentration in the atmosphere, emissions need to peak and thereafter decline. The lower the stabilization level is, the quicker this peak and decline would need to occur.

Many impacts can be reduced, delayed or avoided by mitigation. However, mitigation efforts and investments initiated over the next two to three decades will determine the speed of global warming, in order to achieve lower stabilization levels. Delayed emission reductions significantly increase the risk of more severe climate change impacts. Technology will take us far in mitigation efforts, and will surely support stabilization of emissions towards 2020. Stabilization can be achieved by deployment of technologies portfolio that are either currently available or expected to be commercialized in coming decades, assuming that appropriate and effective incentives are in place for their development, acquisition, deployment and diffusion, as well as addressing related barriers.

Yet, no single technology can provide all of the mitigation potential in any economy sector. The potential economic mitigation can only be achieved when adequate policies are in place and barriers removed. A wide variety of policies and instruments are available to governments due to create the incentives for mitigation action. But their applicability depends entirely on national circumstances and sector context.

#### **5. The low carbon society and information technologies**

In the low-carbon society, industrial processes have been optimized; energy production has been turned green (based on renewable energy) and consumption in general has been transformed to a more sustainable path. The low-carbon society is characterized by low consumption of fossil fuels - thus keeping greenhouse gas emissions from sectors at a low level. The low-carbon society is the first step to the zero-carbon society - where production and consumption are entirely based on renewable energy sources. Reaching the low-carbon society is a matter of changing production and consumption of energy to a more sustainable path. It is about changing the energy system away from fossil fuels to renewable energy sources as well as a matter of making energy use more efficient and saving energy in general. Changing the energy sector is vital to support green growth, cleaner development and creating new consumption patterns, as changing the energy production system will enable feed-back to all other sectors of

the economy that consumes energy - by feeding them with sustainable energy.

The low-carbon society is about integrating all aspects of the economy, from its manufacturing, agriculture, transportation and power generation etc. around technologies that produce energy and materials with little greenhouse gas emission - thereby forcing change in populations, buildings, machines and devices, which use those energies and materials. Low-carbon societies are not emission free, as there will still be a minimum of emissions for instance from livestock and food production that is based on nature and living animals - and therefore can never be completely free of emissions.

The change to a low-carbon and resource efficient economy is not going to be easy. There are no readily available one-step solutions or obvious choices that will take us there. Yet, IT plays an important role in the transformation stages due to its potential to further optimize processes and routines. Also, the IT sector will play a major role both in wider dispersal and use of renewable sources and in energy efficiency - and for this reason greening IT will be a solid base for the low-carbon society.

## 6. Defining green information technologies

The concept of Green IT consists of two main building blocks - "green" and "information technology". Information Technology refers to computer-based information and communication systems, particularly software applications and computer hardware. In our context "green" is in relation to the environmental problems due to climate changes and greenhouse effects. The "green" in Green IT refers to the environmentally sustainable application of Information Technologies. Therefore, Green IT describes a situation where Information Technologies support reductions of greenhouse outcomes.

Traditionally, Green IT discussions have been focusing on how to make the technology itself greener, e.g. reducing energy consumption. However, this paper mainly deals with the process of Greening IT, which is about using technology to green the society. Greening IT is based on the application of Green IT, but Greening IT is not only associated with the application of the technology, it is a much progressive process that educates and transforms our entire society.

The definition of Green IT is thus rather wide - firstly, it can be applied to situations where IT enables greenhouse gas emission reductions (Green IT) and second-

ly, to situations where IT enables structural modulations that lead to changes in broader societal patterns, which takes us closer to the low-carbon society and leads to further emission reductions (*Greening IT*). In this sense, Greening IT is used to explain the process of "Greening society with IT".

In contrast to harmful effects on the environment, "Green" IT can have positive impacts, with the potential to reduce global emissions by 15% [22]. Green IT refers to information technology that addresses environmental sustainability [21]. The effects of Green IT, which have the potential to be substantial, can be either direct - by reducing negative IT impacts on the environment - or indirect - using IT to support other business initiatives in reducing their negative environmental significance. The IT components of Green IT have been distinguished based on their focus and impact on the environment. Green IT, addressing energy consumption and waste associated with the use of hardware and software tends to have a direct and favourable impact. Examples include improving the energy efficiency of hardware and data centers, consolidating servers using virtualization software, and reducing waste associated with obsolete equipment [23, 1].

The IT industry has recognized the issues and identified a variety of consulting opportunities [6, 9, 11, 12, 14, 21], such as IBM's Green Sigma consulting practice [10]. Nevertheless, the gaps in actual practice still remain. In addition, very little data exists [1, 3, 16] and that is a reason why Green IT is suitable for further research.

## 7. International regulation

The environment abuse has led to accelerated activities of numerous international organizations such as the United Nations, OECD, EU, Council of Europe, the International Labor Organization, World Trade Organization, World Health Organization and many others. They form separate, specialized bodies and agencies, aimed to investigate monitor, analyze, warn and prepare the appropriate legislation governing environmental problems, defining rights, duties and responsibilities or sanction certain behaviors that degrade the environment. Thus, to date, for example, only the UN have over 15 different expert programs, working groups, bodies, agencies, specialized organizations [2], such as: the Global Programme on Globalization, Liberalization and Sustainable Human Development, United Nations Environment Programme and International Centre for Genetic Engineering and Biotechnology; Geographic Information Working Group; as well as The Working Group on

Environmental Monitoring and Assessment within the United Nations Economic Commission for Europe that was organized in Belgrade in 2007, as the Sixth Ministerial Conference “Environment in Europe” or the Division for Sustainable Development, Commission on Sustainable Development and the Environment Management Group. All these bodies are preparing a new United Nations Conference on Sustainable Development (Rio +20) in 2012. Recently, dozens of international acts (resolutions, recommendations, declarations), organized independently or in cooperation with other international organizations, world summits that have discussed the issues related to the endangerment and protection of the environment (e.g., together with OECD held in 2009. “Climate Conference”) are adopted. OECD is an international organization that has for long meticulously studied environmental issues and climate changes and their impact on the global, local and individual levels. It adopted over 350 different documents regulating various questions and solve many problems. Thus, in its organization in 2010, “Innovation, Jobs & Clean Growth” forum was held. During the Forum a special Green Growth Strategy is defined, preceded by a Declaration on Green Growth (adopted at the Meeting of the Council at Ministerial Level on 25 June 2009), as an effort to provide direction to overcome the world economic crisis through investment in Protection and restoration of green innovation (Eco - innovation) and implementation of green technologies. The act obligated a number of member states (and invited those who are not) to [4]:

- **intensify efforts** in implementing green growth strategies as part of crisis response;
- **encourage green investment** and sustainable management of natural resources. Thus, it was decided to make further efforts in the field of efficiency and effectiveness of climate policy mix, including market instruments, regulations and policies in order to change behaviour and encourage the involvement of private sector;
- **encourage national reforms and policies**, in order to avoid or eliminate those that are environmentally harmful and opposed to the green growth;
- **ensure coordination** of green growth measures of labour market policy and human capital formation as well as international cooperation of participants.

During the 2011 OECD already organized several meetings and conferences that directly or indirectly affected the information society, the low-carbon society, climate change and the use of Green IT [4]:

05-Jan	<i>Climate Policy and Technological Innovation and Transfer: An Overview of Trends and Recent Empirical Results</i>
03-Feb	<i>Fisheries and climate change: governments must plan for social and economic consequences</i>
11-Feb-	<i>Cities central to climate change response</i>
14-Apr-	<i>Cities and Carbon Market Finance</i>
19-Apr	<i>Cities and carbon markets: Press conference and roundtable event</i>
06-May	<i>The age of carbon is over. Renewable energies are the only viable source if we want to protect life, says Ángel Gurría, the 25th Anniversary of the Spanish Energy Club, Madrid</i>

European Union for many years tried to confront and counter the numerous agents which disrupt the environment. Till the major incident in the Italian town of Seveso that caused a different approach to the environment and the excesses of its violation, this struggle was not equal or efficient. Soon after, the first act of the Seveso Directive 82/501/EEC Original (“Seveso I” Council Directive of 24 June 1982 on the major-accident hazards of certain industrial activities) was adopted and initiated the entire explosion of activities [2].

Green information technologies, rapidly after the formation of awareness of their risk to the environment have become the subject of EU regulation. In fact, since 1960, EU pays special attention to “series of new policy initiatives to address further negative environmental and human health impacts of hazardous substances,” including the waste electrical and electronic equipment [19]. In 2002 it brings: EU WEEE and RoHS Directive (Directive 2002/96/EC on waste electrical and electronic equipment - WEEE, Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment - RoHS), and Waste Framework and the REACH directive [5]. The following amendments in 2003 and 2008, as regard implementing power conferred the Commission, Proposal and Directive for waste electrical and electronic equipment. In March 2011. Council of the European Union adopts Revised rules on recycling of electronic devices.

In addition to these key documents Commission adopted a series of decisions in which they act, such as: decision 2004/249/EC of 11 June 2004 concerning a

questionnaire for Member States reports on the implementation of Directive 2002/96/EC of the European Parliament and of the Council on waste electrical and electronic equipment; Decision 2005/369/EC of 3 May 2005 laying down rules for monitoring compliance of Member States and Establishing data formats for the purposes of Directive 2002/96/EC of the European Parliament and of the Council on waste electrical and electronic equipment (notified under document number C (2005) 1355); Decision 2004/312/EC and Council

Decision 2004/486/EC, as well as acts related to the accession of new Member States, provide for some derogations, limited in time, as concerns the targets set by Directive 2002/96/EC (WEEE), Regulation (EC) No. 282/2008 on recycled plastic materials and articles intended to come into contact with foods and amending (Regulation (EC) No. 2023/2006).

They are followed by studies, research, comparisons of situations in the Member States, such as: study for the simplification for RoHS/WEEE, whose aim is “...

identifying proposals to revise the Directive with a view to improving its cost effectiveness while maintaining the same level of environmental protection. The proposals need to make the legislation less burdensome, easier to apply and therefore more effective in achieving its goals and aspirations to accept the proposed solutions and extend to non-member countries (China, Japan, USA), that have a different approach to these problems. Actually, all measures are grouped into four groups and related to: Scope and Standards (clarify scope and careful monitoring); IPR (Ensure producer responsibility and common approach); harmonization (eup - eco-design, opening registers, the EU Centralized registration system, reporting, labeling and information, disassembly and recycling); competition (increased market surveillance, collective compliance schemes, waste trade) in order to minimize the adverse environmental impact of hazardous products and properly manage their waste [22]”.

Therefore, in the last decade, many international organizations initiated the generation of network norms, formulated principles, established standards to define concrete solutions to the growing problems and thus, enabled forming a basis for the international environmental law. It was the expected result of growing global environmental problems and their impacts. However, the development of international environmental law shows a tendency of parallel growth in the global and regional levels, so policies and the environmental protection are not just limited to pollution control at the local level, but have an overall global impact, that is very difficult to control. The global ecological balance every day becomes more and more prominent, requiring the application of appropriate instruments. Although the global pollution problem has worldwide scale, the primary responsibility to solve it is the duty of the developed countries [2].

In addition, many no-government organizations (NGOs) participate in the battle for a healthy environment and green development. Some of them just point to problems, while others are active in making decisions and solving the problems. Either active or passive their role is even more important if the forms of threats are more diverse and far-reaching.

National laws increasingly respond to environmental problems by making specific laws and regulations or by the adoption and ratification of international acts.

Common is that the problems of electronic waste and the impact of IT on climate and other changes in the environment have complex, multidisciplinary access

and aspects: Technologies and Market Developments, Environmental Impacts, Economic Impacts (Administrative Burden, Quality Costs); Social Impacts etc.

## **8. The republic of Serbia – possible solutions**

In Republic of Serbia the importance of environmental protection has been confirmed in the Constitution and defined in the fundamental human rights, the article 74: “everyone has the right to a healthy environment.” In addition, the Constitution guarantees to citizens full data about the state of the environment. On the other hand, it is determined that everyone, especially the Republic of Serbia and autonomous regions, are responsible for environmental protection. Finally, the Constitution establishes the obligation of all citizens to preserve and enhance the environment.

Furthermore, legal framework of environmental protection in the Republic of Serbia is mostly based on the laws (e.g. Environmental Protection Law, Environmental Law, Law on Strategic Environmental Impact Assessment, Law on Integrated Prevention and Control of Environmental Pollution). With these legislations, the current frame become sub-laws and other regulations that are enacted to enforce these laws.

In order to join the European Union, Serbia has for several years managed the process of harmonization of the national law with the European law, and among the important areas are environment and its protection. The table of compliance, compiled by the Office of European Integration of Serbia, in accordance with Article 111 of the Stabilization and Association Agreement, expresses the country’s commitment to cooperation with other countries in the field of the environment in effort to stop its degradation. National Program for EU integration and sustainable development strategy is defined to be one of national priorities “to protect and promote the rational use of natural resources.”

The problem of waste management, as well as hazardous electrical and electronic, is regulated by special law and the small number of under-laws. Adopting the Waste Management Law in 2009 and changes in the 2010 provided the integrated, efficient and systematic waste management in accordance with European principles. In Article 1 of the Act are defined: “the types and classifications of waste, waste management planning, waste management entities, the responsibilities and obligations in waste management, waste manage-

ment organization, management of specific waste streams, and conditions permitting, cross-border movement of waste reporting Waste and databases; financing of waste management, supervision, and other issues of importance for waste management". All are identified as an activity of general interest. The management practice of special types of waste and liabilities of entities with their handlers are next. Further regulation is anticipated with detailed by-laws. Still missing is special treatment of electrical and electronic waste, as well as strategy for the development of Green IT.

The Strategy of Information Society in the Republic of Serbia, adopted in 2005, in key strategic issues have not defined the further development of these technologies and established a low-carbon society. This failure has a significantly negative effect on other regulations and their implementation.

However, the biggest problem is not legislation, but organizational and other measures to implement it in the regulation of the current situation and prevention of future risks, as well as defining the responsibilities of the division, building capacity, ensuring financial and other resources and tools [2].

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