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The role of green ICT in enabling smart growth in Estonia

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The role of green ICT in enabling smart growth in Estonia

Ernst & Young

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Foreword

Ernst & Young Baltic AS carried out a study "The role of green ICT in enabling smart growth in Estonia" on a request from the Estonian Ministry of Economic Affairs and Communications. The purpose of the study was to give information about the current state and growth potential of green ICT in Estonia, also its development and application from the perspective of public and private sector. The analysis was carried out from July 2011 to December 2011.

Global trends analysis revealed that a rapid uptake of greening with ICT (reducing environmental impact of processes, products, services with ICT) as an enabler of smart growth could be assumed although currently policy making and business actions still focus on greening of ICT (reducing environmental impact of ICT). So far not much practical policy actions have taken place regarding green ICT as enabler of smart growth.

The study showed that Estonian companies are rather innovative and quite frequently innovate in order to make their products, services or business processes more efficient and environment friendly.

Nevertheless, it was revealed that there are four obstacles that constrain wider and more pervasive development and adoption of green ICT in Estonia: low awareness, uncertainty concerning advantages, constrained cooperation, scarcity of financial resources.

Policy recommendations to ease and overcome the constraints are following:

- Rising awareness about green ICT by compiling green ICT products and solutions database, consulting businesses on green ICT, and acknowledging and inspiring companies with green ICT award.
- Clarifying the advantage of green ICT by reviewing and developing green ICT auditing and evaluation methodology, doing follow-up study of greenness of green ICT solutions, and disseminating the best practice of evaluation of greenness of green ICT.
- Advancing cooperation by initiating public-private partnership in developing and implementing exemplary green ICT solutions, greening ICT and other technology clusters, and clarifying the limits of cooperation.
- Increasing funding by conditioning public procurements, grants, investments on greenness and use of green technology, including green ICT, and allocating resources for public-private partnership projects for developing green ICT solutions.

We would recommend addressing the constraints, and outlining and mainstreaming the policy measures in soon to be renewed Estonian Information Society Development Plan. Therefore, also, the coordinative role in the implementation process would be the responsibility of the Ministry of Economic Affairs and Communication. But to mainstream the measures, also cooperation with other ministries and public sector organizations is required.

Table of Contents

Executive summary . . . 7

1 Introduction . . . 8
1.1 Scope of the project . . . 8
1.2 Methodology . . . 10
1.3 Defining green ICT . . . 10

2 Background of green ICT . . . 11
2.1 Introduction . . . 11
2.2 The global history of green . . . 11
2.3 The history of ICT . . . 13
2.4 Conclusion . . . 15

3 Global trends in green ICT public policy . . . 16
3.1 Introduction . . . 16
3.2 General trends in green ICT . . . 16
3.2.1 Moving towards greening with ICT . . . 16
3.2.2 Green ICT is becoming a new policy area . . . 18
3.2.3 Clusters are becoming the leaders . . . 19
3.2.4 "Non-green" approach to greening with ICT . . . 20
3.2.5 Governments lag behind industries in greening with ICT . . . 21
3.3 Green ICT trends on the EU and OECD level . . . 22
3.3.1 The EU's approach to green ICT . . . 22
3.3.2 OECD's approach to green ICT . . . 23
3.4 Governmental policy . . . 24
3.4.1 Country comparison . . . 24
3.4.2 Case studies of country initiatives . . . 28
3.5 Conclusion . . . 31

4 Trends in green ICT solutions, products and services in Estonia . . . 33
4.1 Introduction . . . 33
4.2 Greening ICT products and services . . . 33
4.2.1 Power management . . . 33
4.2.2 Software and deployment optimization . . . 34
4.2.3 Material recycling . . . 34
4.3 Greening with ICT products and services . . . 34
4.3.1 Smart motors . . . 35
4.3.2 Smart logistics . . . 35
4.3.3 Smart buildings . . . 35
4.3.4 Smart grids . . . 36
4.3.5 Dematerializations . . . 36
4.4 Conclusion . . . 37

5 Evaluation of current and potential green ICT policies in Estonia . . . 38
5.1 Introduction . . . 38
5.2 Green ICT business environment: companies' readiness and motivation to develop and implement green ICT solutions . . . 38
5.3 Green ICT policy measures . . . 40
5.3.1 Raising awareness about green ICT . . . 41
5.3.2 Clarifying the advantage of green ICT . . . 43
5.3.3 Advancing cooperation . . . 45
5.3.4 Financial support . . . 47
5.4 Implementation and evaluation of green ICT policy . . . 48
5.5 Conclusion . . . 49

Appendixes . . . 51
Appendix 1 Analysis of green ICT relevant policy documents . . . 51
Appendix 2 Study methodology . . . 59
Appendix 3 Abbreviations . . . 64

List of Figures

Figure 1 Converging trends and emerging opportunities that affect green ICT . . . 12
Figure 2 Today's and tomorrow's main focus for green . . . 12
Figure 3 ICT in a historic perspective: The early 21st century is the turning point . . . 13
Figure 4 The 21st century infrastructure bringing old sectors together in new networks . . . 14
Figure 5 Number of government programs by type of effect . . . 17
Figure 6 The asymmetric triangle . . . 17
Figure 7 Green IT readiness index by industry . . . 21
Figure 8 Unfavourable views on public procurement . . . 21
Figure 9 Neighbor's perspective on UNFCCC and broadband strategies . . . 24
Figure 10 Greening with ICT in UNFCCC national communications . . . 25
Figure 11 Greening with ICT in broadband strategies . . . 25
Figure 12 Global perspective on UNFCCC and broadband strategies . . . 26
Figure 13 Neighbor's perspective on EU 2020 and EU Digital Agenda . . . 26
Figure 14 Greening with ICT in the EU Digital Agenda . . . 27
Figure 15 The EU's perspective on EU 2020 and EU Digital Agenda . . . 27
Figure 16 Number of times the key words are mentioned in the Danish "IT and telecommunications Policy Report" 2006–2011 . . . 28
Figure 17 The number of times the words "IKT" (ICT), "klima" (climate) and "smart" (smart) are all mentioned in a document on "Government.no" . . . 30
Figure 18 Innovation in Estonian Companies . . . 39
Figure 19 Importance of efficiency and environmental concerns as driving force for innovation . . . 39
Figure 20 Green ICT motivational factors . . . 40
Figure 21 Companies' estimation of importance of different green ICT barriers . . . 41

List of Tables

Table 1 Calculation of the index "integration of low-carbon ICT in broadband plans" . . . 59
Table 2 Calculation of the index "integration of low-carbon ICT in UNFCCC communication" . . . 60
Table 3 Interviews' sample . . . 61

Executive summary

Ernst & Young Baltic AS carried out a study "The role of green ICT in enabling smart growth in Estonia" on a request from the Estonian Ministry of Economic Affairs and Communications. The purpose of the study was to give information about the current state and growth potential of green ICT in Estonia, also its development and application, from the perspective of public and private sector. The analysis was carried out from July 2011 to December 2011.

Study consisted of two main parts:

- Analysis of green ICT global trends
- Analysis of green ICT current state and potential in Estonia

In order to analyze global trends in green ICT documentation analysis was carried out. Analysis of Estonian situation and potential green ICT policy was based on interviews with industry leaders, solution providers, solution implementers, academic institutions, policy makers. Also, web-survey of Estonian companies was carried out to collect information regarding Estonian situation.

Main findings

Global trends analysis revealed that a rapid uptake of greening with ICT as an enabler of smart growth could be assumed although currently policy making and business actions still focus on greening of ICT (reducing environmental impact of ICT). So far only few practical policy actions have taken place regarding green ICT as enabler of smart growth.

The study showed that Estonian companies are rather innovative and quite frequently innovate in order to make their products, services or business processes more efficient and environment friendly.

Most of products and services identified are related to software and advisory services. Complex solutions which typically combine different components relay on third party hardware products which are imported from external vendors. Therefore development of successful complete solutions requires efficient cross-border cooperation in product development and marketing.

Product and service developers usually do not limit their ambitions with Estonian market and are eagerly looking for ways to expand into other countries. So far, the number of success stories has been limited by the small size of Estonian companies and the lack of cooperation. Improving these areas would greatly increase export possibilities.

The study showed that Estonian business environment is fairly innovative and open to consider products, solutions and processes that could lead to increased efficiency and decreased environmental impact. During the analysis four broad barriers that constrain development and adoption of green ICT products and solutions where identified:

- Low awareness – The awareness problem itself has two sides. Firstly, stakeholders probably do not have a comprehensive conception of green ICT as possible solution for improving energy and material usage efficiency and environmental friendliness. Secondly, even if they do, information about potential of green ICT or greening business practices and products by ICT is limited.
- Uncertainty concerning advantages – Companies on the demand side are not proficient in comparing different products and solutions based on their environmental impact and efficient use of resources and energy.
- Constrained cooperation – Global trends analysis pointed out and the analysis of Estonian situation confirmed that new green ICT ideas and initiatives come from business clusters. Smooth and speedy development and implementation of ICT based solutions for improving energy and material usage efficiency and environmental friendliness depends on cross-sector cooperation between companies enabled by public sector and supported by (academic) research and development organizations.
- Scarcity of financial resources – As Estonian companies rarely have internal resources for development, public sector could encourage innovation in the field and speed up development and adoption of green ICT products and solution by channeling resources into the field.

Policy recommendations

Several policy recommendations could be made to address the barriers that constrain development and adoption of green ICT products and solutions.

In order to improve companies and entrepreneurs awareness on green ICT to increase demand for and supply of corresponding products, services, and solutions we suggest considering following measures:

- Compilation of database of green ICT products and solutions that are instrumental and have proven themselves as proper greening business practices.
- Business consulting on clean-technology and green ICT potential and good practice.
- Acknowledging and inspiring companies via Green (ICT) Company Award.

To overcome the problem of uncertainty concerning the advantage of adopting green ICT solutions studying feasibility of improving performance, energy and material usage efficiency, and environmental friendliness of green ICT products and solutions could be recommended. We suggest considering following policy measures:

- Public sector initiative in reviewing and developing analytical tools for pre-assessing and follow-up evaluation of potential advantages and disadvantages of Green ICT solutions.
- Public-private partnership in follow-up cost-benefit analysis of already implemented and publicly marketed, but also drafted green solutions; and successive dissemination of best practices.
- Distribution of methodology for auditing green ICT solutions.

There is a need for improving cooperation between stakeholders of ICT product, service, solution providers and implementers to increase synergy and creativity in the field. We suggest considering following policy measures:

- Public-private partnership in co-developing exemplary, pioneering, visionary, inspiring green ICT solutions, including cross-sector solutions (also using public sector organizations and services as test and demo sites).
- Integrating green ICT to other clusters would initiate the devising, developing and marketing greening solutions (industrial and consumer solutions) for other economic activities and markets.
- Clarifying limits of cooperation.

In order to speed up the adoption of green ICT it is suggested to increase public transfers for developing and implementing green ICT products and solutions. We recommend considering following policy measures:

- Conditioning public procurements and businesses, entrepreneurship benefits and high risk investments on their greenness and use of green ICT solutions.
- Budget funding of exemplary, pioneering, visionary and inspiring green ICT products, services, solutions.

We recommend addressing the constraints, and outlining and mainstreaming the policy measures in soon to renewed Estonian Information Society Development Plan. Therefore the coordinative role in the implementation would be the responsibility of Ministry of Economic Affairs and Communication. But to mainstream the measures, also cooperation with other ministries and public sector organizations is required.

1 Introduction

Ernst & Young Baltic AS has carried out a study "The role of green ICT in enabling smart growth in Estonia" on a request from Estonian Ministry of Economic Affairs and Communications, in order to give information about the current state and growth potential of green ICT in Estonia from the perspective of public and private sector, development and application. The analysis was carried out from July 2011 to December 2011. This report describes the main results of the study.

The report is divided into four main parts:

- Background of green ICT
- Global trends in green ICT public policy
- Trends in green ICT solutions, products and services in Estonia
- Evaluation of current and potential green ICT policies in Estonia

1.1 Scope of the project

Information and communication technology (ICT) is a rapidly evolving economic sector with many directions of development. Greening ICT means not only improving ICT industry's environmental performance, but also that ICT applications have large potential to enhance performance across the economy and society, as ICT directly influences many other business areas.

ICT solutions have been widely adopted by many companies and institutions to improve their core business effectiveness and optimize costs. ICT affects most areas of economic activity, including sectors such as manufacturing, transport and energy, but also public administration. Fostering innovation in ICT and encouraging development and adoption of modern ICT solutions can significantly boost country's economic growth, in short and long term. In addition to improving overall productivity, ICT also has a significant impact on environmental performance and resource management and it helps tackle climate issues by reducing carbon footprint.

The OECD had estimated that ICT industry itself is responsible for around 2–3% of the global carbon footprint. This means that ICT solutions as enablers for other sectors that are responsible for the remaining 97–98% of the global carbon footprint have great potential to support green growth.[1]

In a context of current study green ICT is mainly approached as ICT solutions that enable smart growth. Also some aspects of solutions that reduce the carbon footprint of ICT industry itself are covered within the description of green ICT solutions, products and services. Green ICT policy relates to several policy areas (for example environmental, economics, entrepreneurship and technology policy). Current analysis of potential policy measures has a narrow focus on green ICT and does not produce recommendations on other policies that might affect green ICT development (for example environmental policy).

The purpose of the study was to give information about the current state and growth potential of green ICT in Estonia and make policy recommendations to increase the demand and supply of green ICT products and solutions. The study comprised following research questions (RQ):

- **Global trends in green ICT public policy**
  - RQ: What are the prevalent global trends in green ICT policies in medium and long term perspective?
- **Trends in green ICT solutions, products and services in Estonia**
  - RQ: Which are and likely continue to be the most prominent fields (also in terms of products and services) that use green ICT related tools, methods and technologies?
- **Evaluation of current and potential green ICT policies in Estonia**
  - RQ: To what extent do Estonian policy measures correspond to global trends in medium and long term perspective?

1 OECD; Towards Green ICT Strategies: Assessing Policies and Programs on ICT and the Environment. http://www.oecd.org/dataoecd/47/12/42825130.pdf, 22.11.2011

- RQ: What is the current level of competence and potential in Estonia for applying green ICT products and services in the aforementioned fields?
- RQ: What is the current level of competence and potential in Estonian IT-sector to develop green ICT products and services for the aforementioned fields?
- RQ: How synchronized are Estonian R&D activities in green ICT with current and future market needs and demand?
- RQ: What are the appropriate steps to be taken in order to succeed in developing a coherent action plan for green ICT?

1.2 Methodology

In order to analyze research questions data collection was carried out. Following methods were used to gather information:

- **Secondary data** – Policies and other strategically relevant documents, also previous research conducted on global and Estonian level were gathered and analyzed.
- **Interviews** – in-depth interviews with policy makers, industry leaders, solution implementers and providers were carried out in order to gather information about current and potential green ICT solutions (the prominent fields and examples of solutions), companies motivation to implement and develop green ICT solutions and green ICT policy measures or initiatives in Estonia. Also, academic institutions were interviewed in order to collect information regarding R&D activities relevant to green ICT.
- **Web-survey of Estonian companies** – information from around 400 Estonian companies with more than 4 employees was collected by web-survey. The purpose of the web-survey was to collect representative quantitative information regarding the awareness, motivation, restrictions and potential of green ICT in Estonia.

The analysis was based on the collected data. The analysis consisted of global trends analysis, analysis of Estonia's current state, and potential and policy recommendations development.

1.3 Defining green ICT

No conventional definition on green ICT exists. Green topics could be approached from the perspective of a "problem" (focusing on reducing the emission) or from the perspective of a "solution" (focusing on new green solutions). This is reflected in the approach to green ICT, which can be divided into greening of ICT, where the focus is on reducing direct emissions and pollution of the ICT industry, and greening with ICT, where the focus is on enabling contributions to environmental sustainability with the help from ICT.

The term "greening of ICT" refers to the direct effects of ICTs, and the term "greening with ICT" to the enabling effects of ICTs. Greening of ICT in a narrower sense refers to ICTs with low environmental burdens, but using ICT as an enabler reduces environmental impact across the economy outside of the ICT sector.

Green ICT, as greening with ICT, is a new concept and even the leading countries and stakeholders have only about five years of experience, therefore the potential to leapfrog from zero into becoming a global leader is still significant. It is important to note that both the traditional "problem" approach and the new "solution" approach are needed. Pollution needs to be regulated and companies need incentives to address their own emissions. However, ensuring that new generation of solution providers get the right incentives is equally important.

2 Background of green ICT

2.1 Introduction

In order to understand the global green ICT trends the current dynamics and directions of different sub-trends should be understood. The context of current green ICT trends should be explained, including the evolution of green trends and the history of ICT.

2.2 The global history of green

From the perspective of green ICT, it is important to distinguish three different green trends, each of them alive today, but with different logic and history:

- **First generation: Local conservation 1860–…**
  The first green movement followed the idea that nature was static and should be protected against industrialism. The main focus was on the creation of national parks, nature was primarily seen as an object of study and a place for recreation. Protecting nature just because it is beautiful and because we can spend recreational time there is still a significant part of the green agenda in many countries.

  This link to green ICT can be seen today when companies plant trees to improve their image. There are still companies who think that a donation to a conservation project is a key part of their green work and many of the major environmental NGOs still approach ICT companies as a source of funding for conservation projects.

- **Second generation: Pollution control and CSR 1960–**
  The second generation is different as instead of protecting individual patches of nature, companies and policymakers were informed that the industrialization was on a collision course with the planet. The second generation saw companies mainly as a source of environmental problems, therefore, rules and regulations were created to minimize the negative impact of companies.

  The response of most companies was to establish environmental health and safety (EHS) staff and later corporate social responsibility/public relations (CSR/PR) staff. Focus was on the end-of-pipe technology and communication. Many companies, and especially business associations, viewed environmental regulation as a threat to their business and this perspective still exist in many processes related to green issues.

  Several governments still define green or environmental technology as the end-of-pipe technology also renewable energy is ever increasingly similarly regarded. But some include transformative low-carbon ICT solutions, such as teleworking, e-books, smart control systems for buildings, even though these are of key importance to reduce emissions and the need for natural resources.[2]

- **Third generation: Solutions, transformative change and profit: 2000–**
  At the early 21st century the need for transformative change and sustainability moved to a new phase. Instead of biologists and environmental organizations identifying problems, a new generation of stakeholders started to present solutions. This third generation of green thinking was the result of a number of converging trends (see figure 1).

Also, a new generation of entrepreneurs and business leaders saw the opportunity to link the need for dramatic resource efficiency with the sales of new products and services. Instead of approaching green as a threat that only demands an incremental improvement in existing systems, these entrepreneurs have realized that new smart solutions, which challenge existing business models and ways of providing services, are ready. Underlying this shift was ICT development and the fact that many ICT experts had moved to new areas. E-books, smart grids, electric cars, video conferencing and mobile applications that allow people to use cars as a service instead of buying one, are just a few examples of ICT driven and disruptive solutions.

2 Environmental Technology. http://en.wikipedia.org/wiki/Environmental_technology, 22.11.2011

Converging trends and emerging opportunities that affect green ICT

- Geopolitical shifts (the importance of BRICS setting the agenda)
- Accelerated technological development (speed and price of technology)
- Growing ecological footprint/the need for fertile soil (price and conflicts)
- Climate change/increased-decreased use of fossil fuel (price and conflicts)
- Increase of toxic chemicals/endocrine disrupters (declining health)
- Growing population (approximately 30% more people in 2050)
- Aging population (older adults in China > population of the US in 2050)
- Pandemics (need for rapid responses + possible protectionism)
- Antibiotic resistance (food security)
- Gender imbalance (f.e frustration)
- Urbanization (2008 – first time in history there was more people in cities … 75% by 2050)
- Terrorism (insecurity and reduced/increased collaboration)
- Shifting ethical boundaries (new consumption patterns)
- Decentralized production/ globalization (shifts in industry)

Figure 1. Converging trends and emerging opportunities that affect green ICT

This third generation of green often creates significant tensions within existing structures in relation the older generations on multiple levels. The figure below, "today's and tomorrow's main focus for green, provides an overview of the different spheres and approaches related to business and policy makers, where "today" comprises the older generations and "tomorrow" the third generation.

The figure illustrates not just the tensions between the problem perspective and the solutions perspective, but also the tension between different institutions with different roles and mandates. While most stakeholders agree, and also say, that there is a need to move beyond the pure problem focus, the actual implementation that is called green, is currently almost exclusively taking place in the bottom half. To complicate things, several of those very important initiatives by solution providers that deliver green results (e-reading, e-banking, videoconferencing, smart buildings, teleworking etc) are not carried out as part of a green strategy.

Figure 2. Today's and tomorrow's main focus for green
Source: 21st Century Frontiers, building on a graph developed by SAM and Stuart Hart

In the upper part of the matrix, companies focus on what society needs and use sustainability as a driver for innovation and profit. Events taking place here are usually happening because entrepreneurs, business leaders and thought leaders within the government come together, but green alone is seldom the key driver.

This tension between different spheres in society, resulting from tensions between different spheres within governments, NGOs, media etc., is a significant problem. Often the tensions make it hard to implement greening with ICT solutions, as they require collaboration between multiple stakeholders. The result is a lot of green initiatives that only focus on companies, including ICT companies, as the source of emissions. Yet, companies that are solution providers implement a number of smart green solutions, but a number of them are not called green and in many cases the people using the solutions are not even aware of the green benefits.

It is important to note that both the traditional problem approach and the new solution approach are needed. Big polluters still need to be regulated and all companies need incentives to address their own emissions. But equally, or even more important is to ensure that a new generation of solution providers get the right incentives.

2.3 The history of ICT

To comprehend the current green ICT trends it is important to understand not only the history of green but also the history of ICT. For the last 20–30 years the ICT infrastructure has been built, the performance and density will continue to improve and increase, but a turning point has now been reached. Current threshold is similar to the turning point all industrial eras have experienced. During installation phase, new solutions are used to increase the efficiency in the old system, during deployment phase the new system reaches maturity, allowing it to deliver entirely new solutions.

Initially, the transformation happened in the "information sectors", within e.g. music, video or book sectors etc, and now we start to see the first signs of a serious change in the "heavy sectors", such as car and mobility, construction, agriculture and retail sectors, as well as in basic business models.

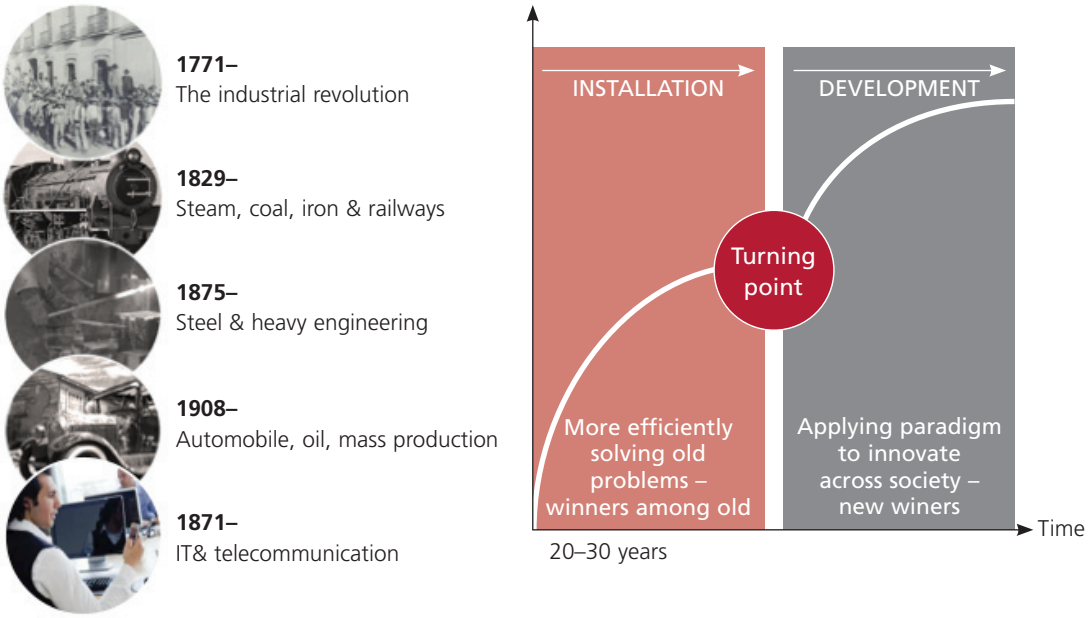


Figure 3. ICT in a historic perspective: The early 21st century is the turning point
Source: Ericsson material based on Professor Carlota Perez, Universities of Cambridge, Tallinn and Sussex

The shift from improving existing systems to providing new solutions is supported by two trends that are important to understand in relation to the ICT development and green ICT. Firstly, ICT companies are now influential economic players. For the first time in history, an ICT company – Apple – was the largest company in the US.[3] The fact that Apple overtook Exxon is obviously an unimportant event in itself, but that the symbol of the old fossil economy, Exxon Mobile, would be overtaken by Apple, demonstrates that ICT companies can no longer be dismissed as something new that can be ignored by policy makers.

Secondly, the ICT companies are now part of a ubiquitous network that is connecting almost everyone and almost everything on the planet. Already, more people are connected than during any other time in human history and we have started to connect things. It is estimated that by 2020 there will be about 50 billion connected devices.[4] The exact number is not as interesting as the fact that society will gain access to data and experience a transparency that is radically different from what any society has ever experienced before.

3 Apple Briefly Passes Exxon Mobil in Market Cap.
http://blogs.wsj.com/marketbeat/2011/08/09/apple-briefly-passes-exxon-mobil-in-market-cap/, 22.11.2011
4 More than 50 billion connected devices – taking connected devices to mass market and profitability.
http://www.ericsson.com/news/110214_more_than_50_billion_244188811_c, 22.11.2011

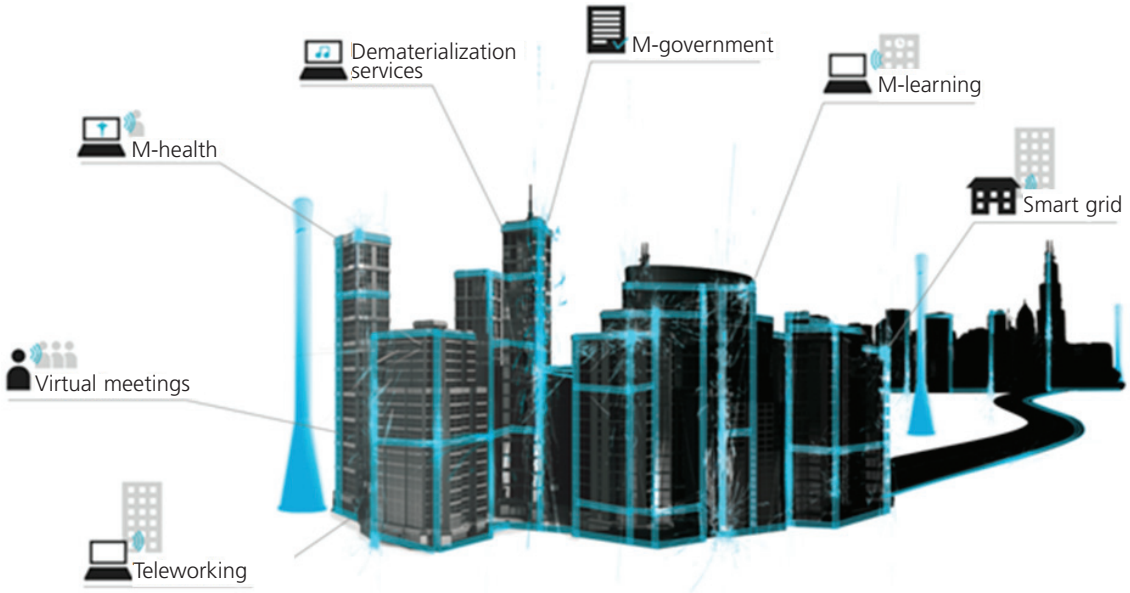


Figure 4. The 21st century infrastructure bringing old sectors together in new networks
Source: A five-step-plan for a low carbon urban development[5]

One of the major challenges is that the new green ICT solutions not only have to compete in a regulatory environment with rules and regulations that were created for a 19th century industrial structure, but it also has to deal with the prejudices among people unfamiliar with the disruptive change and the fast development of ICT solutions.

The prejudice is partly due to the fact that the current technological development is so fast that policy makers, business leaders, economic experts, journalists etc. can experience all the stages of execution, from an idea to full scale implementation, in only few decades. This will result in a paradoxical trend of constant surprises when well known ideas finally become reality.

If we look at the disruptive solutions we see today, like music players, video streaming, e-books, teleworking, virtual meetings etc, all these were discussed about 30 years ago, when many of the current decision makers where young.

In order to understand the confusion, we can study the phases of a long-term disruptive solution. Initially, something triggers an idea that spreads, e.g. the first personal computers. These brought about ideas such as paperless office, virtual meetings etc. An early prediction of a paperless office was made in a Business Week's article in 1975.[6] At that time, it was only an idea, but people got excited. However, after a while it was mainly those doing research that discussed the issue. Then, in the 80s, working prototypes where introduced and many companies invested in very expensive but hardly working prototypes of videoconference equipment. The technology was too new and no viable business model was used, instead, these prototypes were bough and managed by the companies themselves.

Multiple hype cycles over time resulted in a situation that many decision makers had been repeatedly excited by the idea of ICT as a disruptive force in different areas, that they finally thought it would never come to happen. This "hype-numbness" created a situation that many senior decision makers in industries such as music or movie industry did not recognize the new business models after these had grown into something more than a communicative hype, into a real change in the market.

As we now see that the solutions exist for net producing buildings (a disruptive situation as buildings generate 40% of world's emissions and use a similar amount of energy), and some of the world's largest companies promise to deliver them. The need for traditional power stations that have been a backbone of the industrial society is no longer something we can take for granted. Similarly, even though e.g. electric cars that are charged with decentralized renewable energy back home or products that are rented instead of sold etc can disrupt some of the biggest and most influential industrial sectors, very little happens. This is the situation before 3D-printing and other technologies that are close to maturity are included in the assessment.[7]

5 Joint WWF/Ericsson paper. http://www.pamlin.net/new/wp-content/uploads/wwf_ericsson_5-step-plan.pdf, 22.11.2011
6 Paperless Office. http://en.wikipedia.org/wiki/Paperless_office, 22.11.2011
7 3D printing. The printed world. http://www.economist.com/node/18114221, 22.11.2011

A trend today is that policy makers do not consider significant change that will be made by green ICT. Many are still planning investing in new coal power plants, as they listen to power utilities that want to sell electricity, and because they use the same economic model as they used previously. This is happening when major companies like GE say that they can make all buildings from 2015 home net-zero energy if policy makers are interested, and also maybe if they are not.[8] Germany Siemens just announced that they support a 25% target for renewables and are ending their nuclear power business.[9]

In conclusion, the history of ICT's development shows that society now is at an inflection point where ICT solutions move from making old systems better to create new solutions. Two important trends in relation to ICT development could be pointed out. First, the fact that ICT companies now are a powerful economic and can be a source of economic and political capital. Second, that ICT solutions and companies now are so ubiquitous that new clusters of solutions providers can emerge. There is however important to understand the difference between what is hype and what ICT solutions actually can deliver. Policy makers could gain from identifying different phases of green ICT trends as new solutions are discussed.

2.4 Conclusion

Green ICT is not a thing in itself, but includes the use of ICT solutions in order to support smart growth. Therefore, in order to examine green ICT, the context of current green ICT trends should be understood. While until the 21th century, green was seen as nature conservation or pollution control, a significant shift took place at the beginning of the 2000s. A focus moved from problem perspective (pollution control) to solution perspective and a new generation of business leaders saw the opportunity to link the need for dramatic resource efficiency and sales of new products and services.

Parallel shift was in the ICT development that moved from improving existing systems to providing new solutions. New ICT solutions were created in order to support energy efficiency and green growth. E-books, smart grids, electric cars and video conferencing are just few examples of ICT driven and disruptive solutions.

8 GE: By 2015, we will make every home net-zero energy. http://www.smartplanet.com/blog/smart-takes/ge-by-2015-we-will-make-every-home-net-zero-energy/5174, 22.11.2011
9 Siemens to quit nuclear industry. http://www.bbc.co.uk/news/business-14963575, 22.11.2011

3 Global trends in green ICT public policy

3.1 Introduction

The global trends analysis was carried out in order to find out what are the prevalent global trends in green ICT policies in medium and long term perspective.

Global trends analysis was carried out based on the documentation analysis. Relevant documentation related to green ICT were identified and, based on the documentation, relevant green ICT related policy trends at the EU and global level were mapped. Analysis concentrated on various EU and OECD strategy documents and targets (e.g. OECD Green Growth Strategy, EU 2020 strategy, Digital Agenda etc), but also on previous researches and case studies from other countries in this field.

The analysis is divided into four main parts. Firstly, general trends in green ICT development will be described, secondly, a more throughout overview of green ICT trends in the EU and the OECD will be presented. Countries will be compared from a neighborhood and global perspective in the third part of the chapter. Also, case studies from three countries (Norway, Denmark and Sweden) will be presented.

3.2 General trends in green ICT

General trends regarding green ICT development could be pointed out based on the analysis of global level policy papers. These trends will be described in detail with accurate evidence in the following chapters.

3.2.1 Moving towards greening with ICT

Green ICT, as greening with ICT, is a new concept and even the leading countries and stakeholders have not worked practically for more than five years. The potential to leapfrog from zero into becoming a global leader is still significant. The fact that the area of greening with ICT is so new means that it is hard to establish any best practice for a country to safely follow. In two to four years such a standard has probably emerged, also it will be hard for latecomers to claim leadership.

While most policy makers, major studies and business groups clearly state that the greening with ICT is significantly more important, the actual programs and policies in countries, NGOs' work, research at universities, business initiatives etc still focus on the direct effects. This means that greening of ICT, built on the old risk approach and incremental improvement in existing systems and saving money, is still prevalent when it comes to implementation.

A number of studies have shown that both governments and business initiatives still focus on greening of ICT not greening with ICT. The following is the conclusion from a study by the OECD, published in June 2009: "OECD analysis shows that most "reen ICT" initiatives concentrate on the direct effects of ICTs themselves rather than tackling climate change and environmental degradation through the use of ICTs as an enabling or "smart" technology".[10]

Figure 5 illustrates the different governmental programs, and shows a strong bias towards greening of ICT and the direct effect, but the situation is actually more serious that the figure indicates. A closer look at the programs reveals that almost all of the programs that are in the category "both" pay only lip service to the enabling effects.

10 OECD countries agree to tackle global environmental challenges through information and communication technologies (ICTs). http://www.oecd.org/document/26/0,3343,en_2649_33757_45073498_1_1_1_1,00.html, 22.11.2011

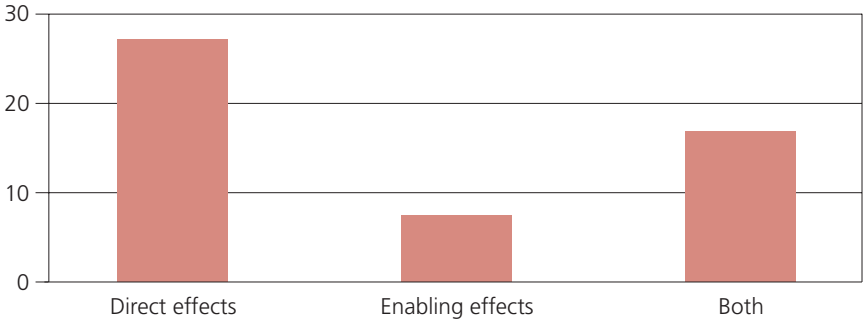


Figure 5. Number of government programs by type of effect[11]
Source: OECD Report "Towards Green ICT Strategies"[12]

Based on OECD analysis, the government programs considering the enabling effects of ICTs most often promote the ICT applications used for the dissemination of environmental information, also smart transportation, smart grids (including smart metering), and smart buildings. Smart engines and software for energy optimization have been promoted in fewer cases.

The challenge is not only semantic, but it is a matter of different responsibilities and goals that have very practical implications. The asymmetric triangle illustrates the gap between the rhetoric's sphere, where most of the stakeholders focus on greening with ICT, and the implementation or action sphere, where most of the stakeholders still focus on greening of ICT (see figure 6).

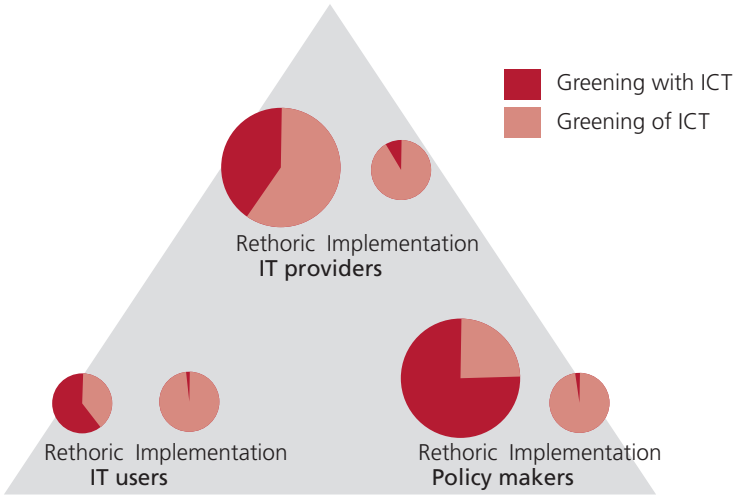


Figure 6. The asymmetric triangle
Source: From "Green IT" to "Greening with IT" in 2009[13]

Different conclusions can be drawn based on the "asymmetrical triangle". The cynical view is that without actually doing anything, policy makers and ICT companies just talk, in order to look good in the public eye. The more reasonable conclusion is that current institutions and framework makes it hard to implement the solutions providers, users and policy makers want to see. It could be assumed that the implementation of green ICT could see a rapid, or even disruptive uptake, when policy makers and businesses implement new rules and regulations in support of greening with ICT.

In order to understand the possibilities and the challenges, it is important to understand the groups and reasons behind the idea of greening of ICT compared with the idea of greening with ICT.

11 The graph is based on 50 policies and programs of governments in a survey of 92 programs and initiatives across 22 OECD countries plus the European Union (42 initiatives of industry associations).
12 Towards Green ICT Strategies: Assessing Policies and Programmes on ICT and the Environment. http://www.oecd.org/dataoecd/47/12/42825130.pdf, 22.11.2011
13 Illustration from the paper: "From "Green IT " to "Greening with IT " in 2009: A white paper on the financial crisis as an opportunity to ensure accelerated CO 2 reductions with low carbon IT solutions". http://www.pamlin.net/new/wp-content/uploads/Greening_with_IT.pdf, 22.11.2011

For greening of ICT mainly the following stakeholders are involved:

- **ICT users** – The Chief Information Officer (CIO), maybe together with the corporate social responsibility (CSR) person, is browsing for equipment and wants it to be as inexpensive as possible. Additionally, this means low energy cost.
- **ICT providers** – Traditional sales people that consider the energy efficiency/cost reduction as one the key points in selling. The CSR department communicates the energy efficient equipment as the key part of company's environmental strategy.
- **Policy makers** – the ministries of environment and communication work together. The ministry of environment asks ICT companies to reduce their emissions, including the emissions resulting from the use of their products. Ministry of communication encourages purchasing energy efficient equipment to save money.

For the new concept greening with ICT often no business relations exist, as the following stakeholders need to collaborate among each other:

- **ICT solution users** – often a strategic decision by the board or senior management team to change the business model is required, so that the company could do things in entirely new ways, e.g. start selling their newspaper in a digital format instead of paper format, start providing common transport instead of cars, start renting buildings that are net producers of renewable energy instead of energy inefficient buildings, use crowd sourcing and allow staff to have flexible work time etc. These ICT solutions can significantly influence the environmental impact of the company and are beyond the responsibility of most CIOs and CSR staff.
- **ICT solution providers** – Current ICT companies often sell products, even if they are inclining towards services. They sell laptops, rent server halls or install software programs, but they very seldom participate in the discussion on how these products are used. Companies like IBM, Cisco, Fujitsu, Siemens, Ericsson are beginning to move in the direction of greening with ICT solutions, but they all struggle to mainstream their transformative business solutions.
- **Policy makers** – Hardly any ministry in the world has an obvious responsibility to accelerate the uptake of greening with ICT solutions. Typical situation is that a ministry of environment has the mandate to address green issues, but they are unfamiliar with solution providers and know even less about transformative ICT solutions. The ministry of information technology does not have a mandate to address green issues, and know nothing about business development (yet, they are experts when it comes to spectrum allocation, regulation and policies to ensure that people are provided with communications). The ministry of industry/enterprise does not have the mandate to promote transformative solutions and seldom understands the potential of greening with ICT.

In conclusion, greening with ICT is a new concept and current institutions and framework makes it hard to implement the solutions that most providers, users and policy makers want to see. This has caused a situation that the majority of policy makers, major studies and business groups clearly state that the greening with ICT is significantly more important, but countries' actual business initiatives and policies still focus on the direct effects (greening of ICT). It could be assumed that the implementation of green ICT could see a rapid uptake when policy makers and businesses implement new rules and regulations in support of greening with ICT.

3.2.2 Green ICT is becoming a new policy area

A selection of the most important documents and events regarding green ICT were studied during a global trends analysis, in order to give insight on long-term trends in global policy making[14]. Even if only a selection of the most relevant global documents has been assessed, it is reasonable to assume that nowadays more attention is directed towards potential solutions than ten years ago. Based on the selection of studies, it is also

14 The study comprised following selection of green ICT relevant milestones:
1992: United Nations Conference on Environment & Development (UNCED)
2002: World Summit on Sustainable Development (WSSD)
2003: Word Summit on the Information Society (WSIS)
2003: A Sustainable e-Europe
2006: ETNO-WWF
2007: World Economic Forum
2008: G8 Ministerial
2008: OECD workshop on ICT and environmental challenges
2009: EU: ICT for Energy Efficiency
It is important to note that comparing the documents directly is restricted due to the fact that the documents are very different and some documents focus on sustainability in general, others ICT in general and still others on green ICT.
See Appendix 1 for detailed analysis of these events and documents.

reasonable to assume that over the last 10 years, greening with ICT has shifted from being an almost non-existing idea into being an important matter.

In the 1990s, no attempts were made to try to include greening with ICT in global strategy documents or policy making. By the beginning of the 21th century, the role of ICT in sustainable development had become well know among thought leaders, yet, it was almost completely ignored by both policy makers and industry groups. The challenge was that those in the leading positions were from ministries of environment, focused on the second generation of green and most of them had very little knowledge about the ICT sector and the kind of solutions this sector could provide.

Changes in policies on strategy level in 2002 and 2003[15] officially recognized that businesses should be part of solutions development and that ICT could be used to help support a more environmentally sustainable development. Previously, companies were seen as polluters, which should reduce their emissions, not as sources of solutions that need to accelerate sales of sustainable solutions. The idea that ICT could be used to help support an environmentally more sustainable development was a new one for most governments and organizers, as so far they had mainly focused on the physical creation of the ICT infrastructure and the standards and rules related to issues such as spectrum allocation.

Starting from 2007, first attempts to include industries and governments in a discussion about greening with ICT were made. In 2008, the chair of G8, held in Japan, brings up green ICT on the top-level for the first time. The reason why ICT solutions were discussed was because it had become clear that significant reductions require transformative solutions. G8 leaders agreed on the need for the world to cut carbon emissions, blamed for global warming, by at least 50 percent by 2050, and the issue of green ICT was brought up. [16] In 2008 and 2009, OECD and the EU verified the trend towards increased focus on greening with ICT.[17]

It can be concluded from this overview that greening with ICT has become a relevant policy area, although it is still more on a rhetorical side. Greening with ICT has been acknowledged as a policy area, but is currently in an "implementation gap", which is usual when it comes to new, developing areas, as firstly ideas are generated and discussions held and then the implementation follows. The challenge for businesses is to know when the shift from word to action takes place and how they can make their contribution, as not all the ideas become reality.

It is too early to say how significant greening with ICT will become in mainstream policy making. The global climate meeting in Durban 2011 and the Rio+20 conference in 2012 will provide an indication of how mainstreamed greening with ICT will become. Ultimately, integration into the international policy making will depend on how many leading countries want greening with ICT to become part of the global agenda. If leading countries see competitive advantage in developing and exporting greening with ICT solutions, they might be less interested in pushing for international processes to include it.

3.2.3 Clusters are becoming the leaders

All major international stakeholders work in the area of greening with ICT, but the intensity and focus still varies greatly and no individual organization is in the lead of the area. OECD and the European Commission are important stakeholders, but many of new ideas have emerged from business coalitions and thought leaders outside these organizations. A trend for greening with ICT is clusters, which focus on implementation on a city level. This increases the importance of groups working with cities, such as C40, association Local Governments for Sustainability (ICLEI) and twin-city initiatives.

Current structures, for example the way we organize society around certain sectors, helped building the industrial society. When these sectors were created, it was done by creating new clusters in the pre-industrial society. Now these clusters are taken for granted and called sectors/industries, even though they are combinations of several different skills. As we step into the post-industrial/knowledge economy, new groups need to be created to deliver new solutions.

15 Based on analysis of World Summit on Sustainable Development (WSSD) (2002), Word Summit on the Information Society (WSIS) (2003) and A Sustainable e-Europe (2003).
16 Based on the analysis of ETNO-WWF (2006), World Economic Forum (2007) and G8 Ministerial (2008).
17 Based on the analysis of OECD Workshop on ICT and environmental challenges (2008) and EU: ICT for Energy Efficiency (2009) .

New clusters need to ensure everything from new supply chains with new materials and new productions methods to new business models. The electric car is an interesting example that also demonstrates the need for new clusters, as companies like Better Place, BYD and Tesla have approached the challenges with fresh ideas, compared with old car companies that tried to fit the electric car in old structures and old business models. Now, after they have been shown how to approach the challenge they are making a better job, but the question is – how well?

Similar challenges have been faced in renewable energy, where traditional utilities failed to deliver solar and wind solar solutions, because when collaboration between construction companies and architects is necessary, these solutions often require new business models and integrated solutions.

At the beginning of the 21st century, ICT companies are very often at the center of these new clusters, while their largest customers often happen to be the big polluting companies the ICT companies' new solutions are competing with, creating challenges for the large ICT companies to be transformative.

In conclusion, no individual organization (for example European Commission, OECD) leads the green ICT area. Number of the new ideas have emerged from business coalitions and thought leaders outside these organizations. In order to deliver new greening with ICT solutions business clusters need to be created.

3.2.4 "Non-green" approach to greening with ICT

Greening with ICT solutions are seldom driven by green demand or traditional green strategies. Instead, most greening with ICT solutions are a result that follow smart strategies that are looking for resource efficiency and innovation in areas such as construction, grid, transport etc. This creates an ad-hoc approach to greening with ICT where many synergies are lost and where old stakeholders and approaches are in control of the development.

Procurement, both public and the procurement done by companies, is a good example of non-green approach to greening with ICT. Those talking about green ICT and arranging conferences on these topics almost always approach "green" and "ICT" marginally and focus on greening of ICT. This is because those selling (ICT companies) have products to realize and those purchasing (CIOs) are stuck in old ways structures and are not responsible for solutions like teleworking, virtual meetings and development of new business models (such as a magazine shifting to e-distribution instead of paper).

Those requesting new smart "greening with ICT" solutions or providing such solutions often do so without knowing and/or caring about the green benefits. Two famous example of unknowing/uncaring promoters of greening with ICT are Amazon, that has done a lot for dematerialization of world's books and magazines, and Apple, that reformed world's music industry and made it a lot more resource efficient. Smaller companies like Skype and Spotify have played important roles in challenging old resource intensive business models and habits, but without realizing their conduct was green.

The disconnection between those that often understand the opportunities (ICT companies and CIOs) and those developing new products and services is a major challenge, if society is to move beyond ad-hoc approaches and also encourage a shift in the areas where significant change is needed, such as buildings, mobility and food.

The lack of strategies and definitions of greening with ICT also creates problems, as some new "smart" solutions are seen as "green" regardless of actual results. Smart grids is probably the clearest example of a trend where the transformative potential with new ICT solutions, such as smart grids, is lost after the traditional stakeholders highjack the agenda. In the case of smart grids, the power utilities label their solutions as "smart", but in reality they seldom do more than cement old business models and large scale utility structures.

In sum, a trend could be pointed out that greening with ICT solutions are mainly driven by smart strategies not by green demand or green strategies. Greening with ICT solutions are developed and implemented to obtain energy efficiency and innovation (for example in construction, grid, transport etc).

3.2.5 Governments lag behind industries in greening with ICT

Fujitsu's report "Green IT: The Global Benchmark" contains findings of a multi-country benchmark to determine the maturity of Green IT practices and technologies in end user organizations. Although the study mixes "green with" and "green of", it is still interesting to note that governments score below industries' average in the "green IT readiness index".[18] The fact that in many cases when it comes to using "greening with ICT" the governments lag behind industries, is a significant problem according to many experts (see figure 7).

Figure 7. Green IT readiness index by industry[19]
Source: Green IT: Global Benchmark[20]

A UK study from 2006 investigated how companies view government procurement. Four areas where identified where the government was regarded as a problem. Firstly, companies do not believe that the government fosters innovation, it does not engage to define solutions and is not an early adopter. Smaller companies in particular, where most of the new "greening with ICT" have been born, see these areas as a problem in relation to the government (see figure 8). As long as public procurement does not support greening with ICT is will be very difficult to deliver concrete results, regardless of general policy statements.

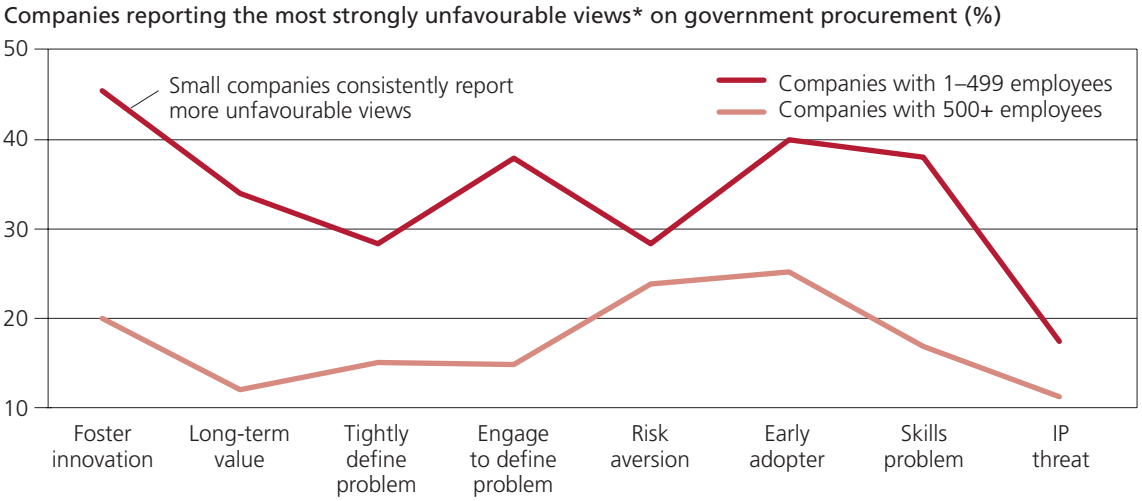


Figure 8. Unfavourable views on public procurement
**Strongly agree on the negative propositions. Strongly disagree on the positive and neutral propositions*
Source: Innovation and public procurement A new approach to stimulating innovation[21]

18 The creation of the index is described in the report. https://www-s.fujitsu.com/au/whitepapers/greenit_global_benchmark.html, 22.11.2011
19 Green IT readiness index presented in the graph is calculated by Fujitsu base on five key areas of Green IT: Green IT Lifecycle (Procurement and Disposal), End User IT Efficiencies, Enterprise and Data Center IT Efficiencies, Usage of IT as a Low-Carbon Enabler and Green IT Measurement and Monitoring
20 Green IT: The Global Benchmark. https://www-s.fujitsu.com/au/whitepapers/greenit_global_benchmark.html, 22.11.2011
21 Innovation and public procurement. A new approach to stimulating innovation. http://www.nzrise.org.nz/assets/Uploads/innovation-brief-1006.pdf, 22.11.2011

In conclusion five main trends in green ICT could be pointed out based on the analysis of global policy documents. Firstly, greening of ICT is still prevalent when it comes to current business actions and policy making, but a rapid uptake of greening with ICT could be assumed. Secondly, green ICT is becoming a relevant policy area, although there is still a lot of rhetoric and at the moment it is too early to predict how mainstream green ICT will become part of the policy making. Third trend is that new ideas and initiatives come from business clusters and thought leaders (no individual organization (for example the EU or the OECD) is in leading position when it comes to greening with ICT). There is also a trend that greening with ICT solutions follow smart strategies, rather than green demand or traditional green strategies. Finally, it can be pointed out that other industries tend to outrace governments when it comes to greening with ICT.

3.3 Green ICT trends on the EU and OECD level

3.3.1 The EU's approach to green ICT

The European Commission has been on the forefront when it comes to research in the area of greening with ICT, but has been slow in moving from research to action. However, current trends indicate a willingness to ensure action in a number of strategic areas (listed below).

Research in this area intensified in 2007, when ICT for Energy Efficiency was introduced as a specific theme under the ICT priority of the 7th Framework Program for Research and Technological Development (FP7). Once an area becomes part of the research priority, scientists all over Europe begin to look in the direction of funding. The result is that most countries in the EU have scientists that can support with greening with ICT issues.

In 2009, the European Commission Recommendation "on mobilizing Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy" SEC(2009) 1315, was presented. This work has resulted in increased activity among many member states in areas with little previous activity.

Current work of the commission includes policy work on multiple levels that are relevant for greening with ICT. This is expressed by following initiatives:

- **EU2020** – EU2020 agenda has included ICT and sustainability as key themes, thus making these part of a comprehensive strategy. Out of the key priorities – smart growth, sustainable growth, inclusive growth and economic governance – greening with ICT is directly relevant for the first two.
- **Digital agenda** – The digital agenda for the EU includes measures and policy areas that are also very important for greening with ICT. Number of these measures are also linked to the work on the "ICT for sustainable growth":
  - Action 70: Support partnerships between the ICT sector and major emitting sectors
  - Action 71: Assess contribution of smart grids and define minimum functionalities to promote interoperability
  - Action 73: Member States to agree common additional functionalities for smart meters
  - Action 74: Member States to include specifications for total lifetime costs for public lighting in public procurement
  - Action 75: Give Europeans secure online access to their medical health data
  - Action 76: Propose a recommendation to define a minimum common set of patient data
  - Action 77: Foster EU-wide standards, interoperability testing and certification of eHealth
  - Action 78: Reinforce the Ambient Assisted Living (AAL) Joint Programme
  - Action 79: Propose a sustainable model for financing the Europeana digital library
  - Action 81: Issue recommendation on promoting digitisation of European cinema
  - Action 83: Propose a Council and Parliament Decision on mutual recognition of e-ID
  - Action 84: Support seamless cross-border eGovernment services in the single market
  - Action 85: Review the Public access to Environmental Information Directive
  - Action 86: Implement cross-border eEnvironment services
  - Action 87: Issue White Paper on inter-connecting e-procurement capacity in EU
  - Action 92: Apply the Intelligent Transport System Directive in support of interoperability and rapid standardization

The list indicated that construction, transport, health and education are key areas as well as standards which can support the EU-wide solutions.

- "ICT for sustainable growth" – it is a specific process that focuses on greening with ICT (and also on greening of ICT). Six policy areas have been selected as priorities[22]:
  - Energy Efficiency of the ICT Sector (greening of ICT)
  - Smart Sustainable Cities (greening with ICT)
  - Energy Efficient Buildings (greening with ICT)
  - Smart Grids (greening with ICT)
  - Water Management (greening with ICT)
  - Climate Change Management (greening with ICT)

In conclusion, EU has been slow in moving from research to action. European Commission has had number of initiatives that relates to sustainability and ICT. The trend is to focus on the key areas where considerable amount of emissions are emitted, less on the lifestyles and new business models. These areas are similar to those that have been identified in the last decade or so, and seem to be shared by almost all initiatives. EU sees construction, transport, health, and education as key area.

3.3.2 OECD's approach to green ICT

In June 2008 the OECD Ministerial Meeting on the Future of the Internet Economy concluded that research and analysis of the environmental impact of ICTs and the Internet and the introduction of appropriate policies are essential for the development of the global Internet economy.[23]

At the OECD Ministerial Council Meeting in June 2009, Ministers acknowledged that green and growth can go hand-in-hand, and asked the OECD to develop a Green Growth Strategy. Initial results were presented in May 2011. Among these results is the document "Monitoring Progress: OECD Indicators", which in its nature is very traditional. Neither transformative solutions nor ICT have been included in any significant way; except being mentioned once in the monitoring document.[24]

In the main document, "Towards Green Growth", the role of green ICT is mentioned once and not in a very noteworthy way: "Much transformative innovation results from spill-over effects from other sectors, as demonstrated by the impacts of ICT on the transport and energy sectors"[25].

How the OECD will approach green with ICT in the future is an indicator of the role the OECD will play. If the OECD was to lead the development of greening with ICT, it would probably include greening with ICT as one of the categories in environmental goods and services (EGS). It would also separate end-of-pipe technologies, which improve the current systems incrementally, from transformative solutions that provide services in ways that are radically new. One way of making sure that green ICT solutions are included would be to ensure that the OECD includes solutions that help reduce natural resource use and/or pollution/CO2 emissions by more than 80%.

If such change took place, the next summary for policy makers would not ignore the ICT as one of the technologies, when presenting "The innovation-science link in selected green technologies".[26]

Ensuring space for greening with ICT is especially important for the indicators under "Economic opportunities and policy responses"[27]. OECD's references are also added to the "UNEP's Green Economy Initiative", where green ICT has hardly been included at all. This document does mention telecommunication in the general discussion on transport, but in the concrete action plan the focus is on incremental improvements and changes in physical transport.

To sum up, OECD did move into the greening with ICT agenda and took a leading role but since 2009 not a lot has happened[28]. OECD is still important, because the "green growth" strategy could support accelerated uptake of greening with ICT solutions. The current trend is, however, more towards traditional EGSs and less towards new innovative solutions where greening with ICT belong.

22 The selection was based on a two step approach where first studies that identified potentials where selected and then workshops conducted with experts to discuss where EU's strength were in relation to existing work.
23 ICTs, the Environment and Climate Change. http://www.oecd.org/document/30/0,3746,en_2649_34223_42906974_1_1_1_1,00.html, 22.11.2011
24 Towards Green Growth: Monitoring Progress – OECD Indicators. http://www.oecd.org/document/56/0,3746,en_2649_37465_48033720_1_1_1_37465,00.html, 22.11.2011
25 Towards Green Growth. http://www.oecd.org/dataoecd/37/34/48224539.pdf, 22.11.2011
26 Towards Green Growth. http://www.oecd.org/dataoecd/32/49/48012345.pdf, 22.11.2011
27 Towards Green Growth: Monitoring Progress – OECD Indicators. http://www.oecd.org/document/56/0,3746,en_2649_37465_48033720_1_1_1_37465,00.html, 22.11.2011
28 OECD took a leading role in greening with ICT under the leadership of Graham Vicker. Since Vickery left in 2009 not a lot has happened.

3.4 Governmental policy

3.4.1 Country comparison

Governments over the world approach greening with ICT differently and very few, if anyone, can claim to have a coherent strategy. One of the countries with something like a coherent strategy is Japan, and anyone who is interested in greening with ICT should visit Japan, either virtually or physically. The following chapter presents country comparison based on green ICT relevant indicators.

A significant challenge in understanding green ICT leadership is that there is no single common process the green ICT leadership could follow or data reporting system that allows the measuring of the effects.

A global benchmark and EU benchmark are used to compare governmental policies. For global benchmark integration of low-carbon ICT into broadband plans and United Nations Framework Convention on Climate Change (UNFCCC) communication is used[29]. The details of the assessments are described in two benchmark studies[30]. EU benchmarking is based on EU Digital Agenda and EU2020.

Global benchmark: Integration of low-carbon ICT into broadband plans and UNFCCC communication

This first graphs show how well greening with ICT is integrated in broadband plans and in UNFCCC communication from a neighbor's perspective. This can be considered as an indicator of how well a ministry responsible of information technology has integrated greening with ICT and how well a ministry of environment has integrated greening with ICT.

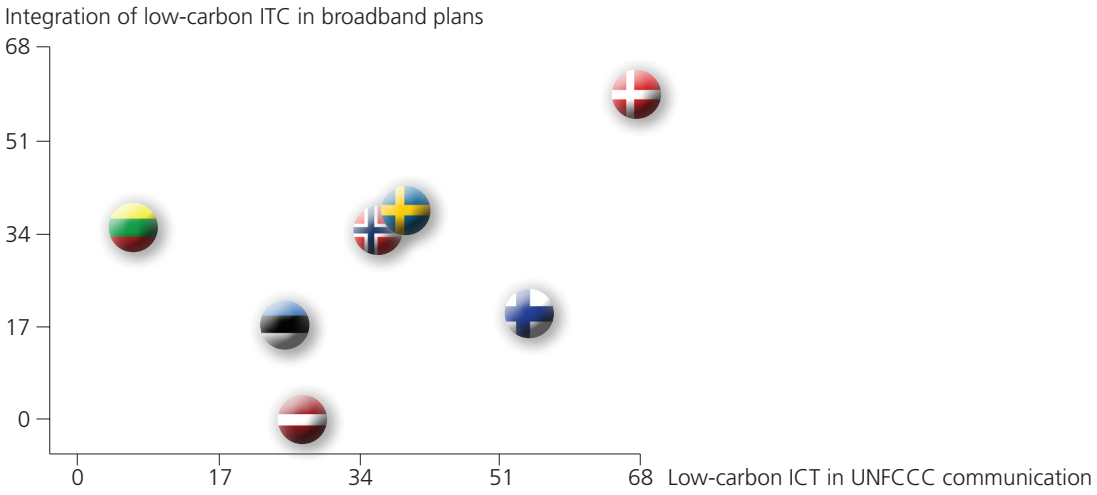


Figure 9. Neighbor's perspective on UNFCCC and broadband strategies
Source: 21st Century Frontiers estimations, using the tool developed for GeSI at http://www.global-ict-leadership.net
See Appendix 2 for the calculations that the index is based on.

Comparison shows clearly that Estonia has adopted a well-balanced approach. Yet, Sweden, Finland and Norway are more focused on greening with ICT in both broadband plans and UNFCCC communication. The most interesting country is Denmark, as it is the only neighboring country that is among the best in the world, but its results are merely just good compared with the other Nordic/Scandinavian countries.

29 The low-carbon ICT assessments of the national communications are based on the submissions by countries to the UNFCCC. The objective was to assess how well countries had integrated low-carbon ICT solutions in their climate strategies. National communications to the UNFCCC contain information on national greenhouse gas (GHG) emissions, climate-related policies and measures, GHG projections, vulnerability and adaptation to climate change, financial assistance and technology transfer to non-Annex I Parties (http://unfccc.int/national_reports/non---annex_i_natcom/items/2979.php), and actions on raising public awareness on climate change.

30 Low-Carbon ICT Leadership Benchmark 1: An assessment and way forward for the integration of low-carbon ICT in communication to the UNFCCC. http://www.pamlin.net/new/?publication=low-carbon-ict-leadership-benchmark-1, 22.11.2011
Low-Carbon ICT Leadership Benchmark 2 : An assessment and way forward for the integration of low-carbon ICT in broadband strategies. http://www.pamlin.net/new/?publication=low-carbon-ict-leadership-benchmark-2-report, 22.11.2011

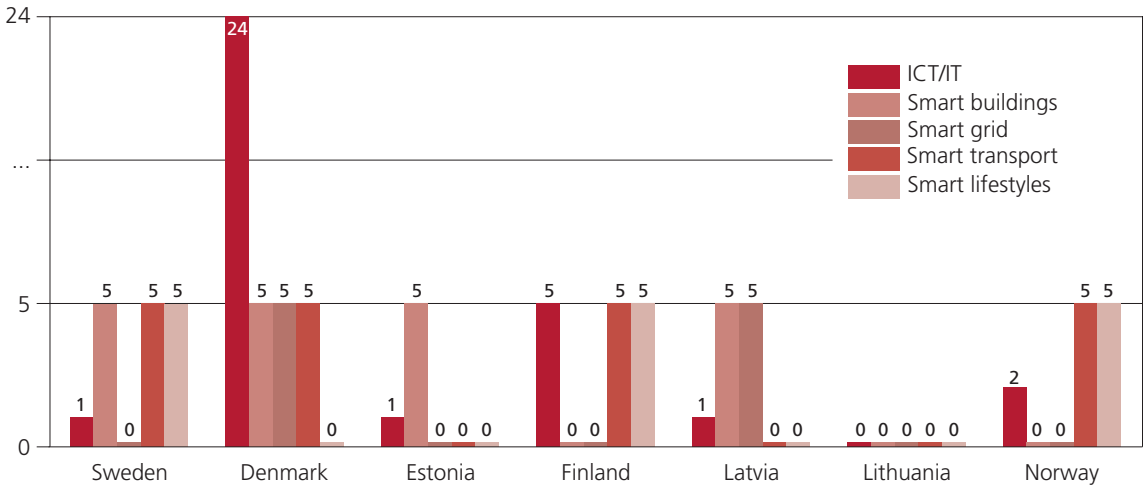


Figure 10. Greening with ICT in UNFCCC national communications

Source: 21st Century Frontiers estimations, using the tool developed for GeSI at http://www.global-ict-leadership.net
See Appendix 2 for the calculations that the index is based on.

A closer look at Estonia and its neighbors reveals some significant differences when it comes to integration of greening with ICT in the national communications to the UNFCCC. First and most striking finding is the number of times ICT or IT is mentioned. Denmark is well ahead of its neighbors. Estonia, together with other Baltic countries, is lagging behind, not only when it comes to explicitly referring to ICT, but also referring to important greening with ICT areas such as smart grid, smart transport and smart lifestyles (see figure 10). Smart lifestyles include all initiatives that help individuals make more environmentally friendly choices. Right now food choices are discussed and many leading stakeholders use ICT tools to help provide people with feedback regarding the footprint of different choices as well as the impact of food waste. Only smart buildings are mentioned by Estonia as an important greening with ICT area in the UNFCCC communications.

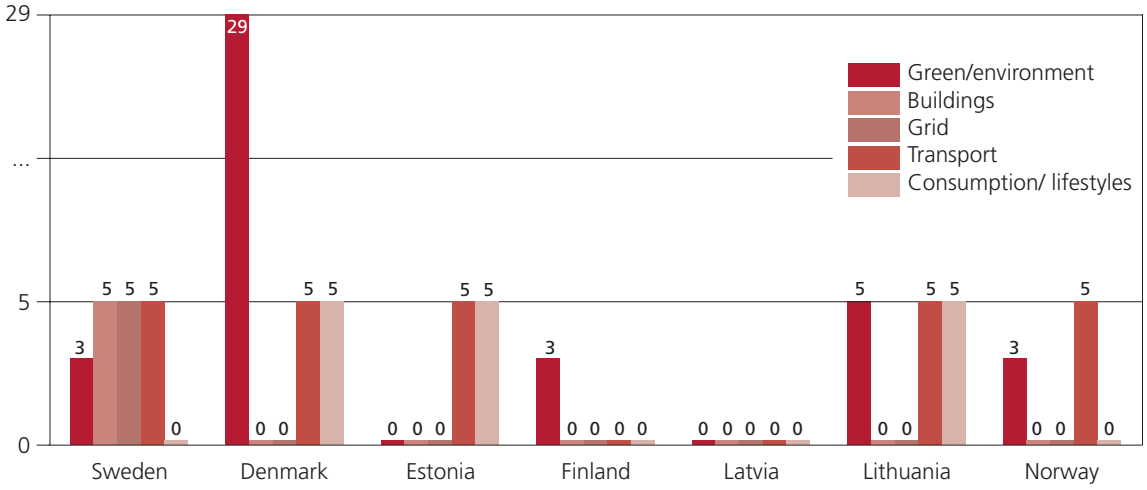


Figure 11. Greening with ICT in broadband strategies

Source: 21st Century Frontiers estimations, using the tool developed for GeSI at http://www.global-ict-leadership.net
See Appendix 2 for the calculations that the index is based on.

A closer look at Estonia and its neighbors unveils similar differences when it comes to integration of greening with ICT in the broadband plans. Again, Denmark is way ahead of the rest of the countries, this time in using green/environment in the broadband plans. When it comes to specific areas, only transport, and often incremental solutions like Intelligent Transport Systems (ITS), that are mentioned in the broadband plans. The fact that Estonia has included references to smart consumption/lifestyles is interesting as this is something that only the world leaders use. This indicates that there are parts of the Estonian government that are either very well connected, or very forward looking, maybe both.

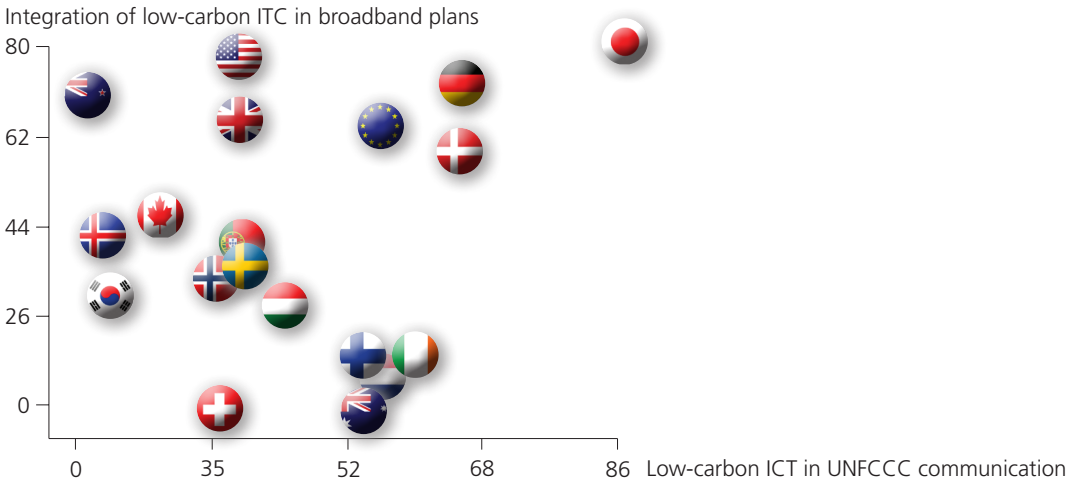


Figure 12. Global perspective on UNFCCC and broadband strategies
Source: 21st Century Frontiers estimations, using the tool developed for GeSI at http://www.global-ict-leadership.net
See Appendix 2 for the calculations that the index is based on.

It is important to note that while Sweden and Norway surpass Estonia, none of them are even close to being a global leader. Japan and Germany are interesting, as they deploy a very balanced approach. It is also worth nothing that by copying the Commission's positions, Estonia would surge from the bottom of the scale to the position of one of the top countries.

EU benchmark: EU Digital Agenda and EU2020

When taking a closer look at the EU's situation, we use the greening with ICT aspects of EU Digital Agenda and EU2020. The graph shows the balance between policy intentions (EU2020 Low Carbon; Y) and actual implemented solutions as measured in the digital agenda (EU Digital Agenda; X). EU2020 strategy documentation is purely a policy document, where countries state their intensions. The EU's digital agenda is statistic regarding the use of ICT. The assessments are based on seven indicators in the Digital Agenda Scoreboard, and use the same framework as above for the EU2020 to assess leadership. [31]

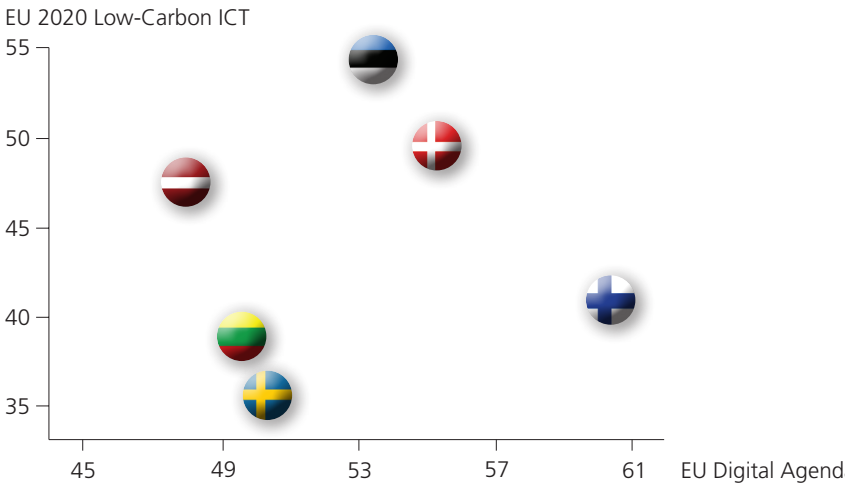


Figure 13. Neighbor's perspective on EU 2020 and EU Digital Agenda
Source: 21st Century Frontiers estimations, using the tool developed for GeSI at http://www.global-ict-leadership.net
See Appendix 2 for the calculations that the index is based on.

31 The index for EU Digital Agenda is created by measuring the following aspects of the Digital Agenda:
% of internet users reading / downloading online newspapers / news magazines
% of internet users using online banking
% of internet users playing or downloading games, images, films or music
% of internet users seeking online information about health
% of internet users doing an online course (in any subject)
% of population selling goods or services online (e.g. via auctions)
% of enterprises sending or receiving e-invoices in a format suitable for automatic processing

When it comes to integrating greening with ICT in the EU2020 documentation, Estonia is ranking the highest among the neighboring countries. Nonetheless, we are behind Denmark and far behind Finland when it comes to the actual use of greening with ICT as collected by the Digital Agenda. The significant gap between how countries claim they will use ICT and the actual use in some strategic areas is intriguing.

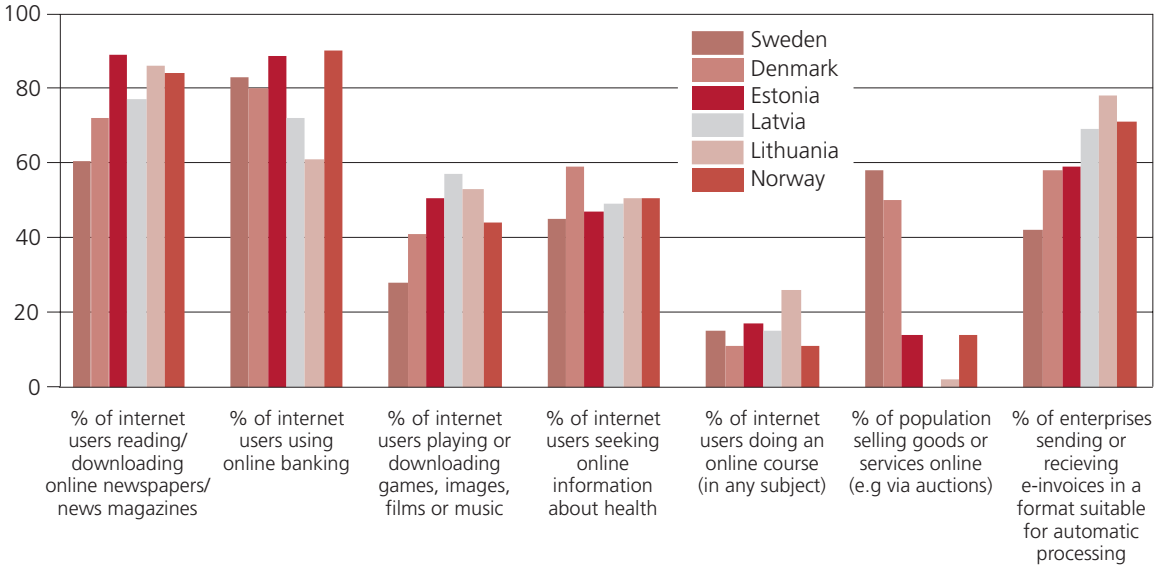


Figure 14. Greening with ICT in the EU Digital Agenda
Source: 21st Century Frontiers estimations, using the tool developed for GeSI at http://www.global-ict-leadership.net

The lack of clear link between the actual use and integration of greening with ICT in key policy documents is noteworthy. Though so far, Estonia has not been at the forefront of integrating greening with ICT in policy areas, a positive general ICT policy has resulted in a high use of greening with ICT solutions. This could be further accelerated with an improved policy framework, as more advanced greening with ICT solutions (such as teleworking, smart buildings and smart grids, as well as solutions that require new business models) will require a support framework to be successful. In basic areas such as online banking, e-reading, use of e-invoices Estonia is however an EU leader and the success in these areas could be a good starting point for both estimations of the greening with ICT savings that already have happened as well as more sophisticated greening with ICT solutions.

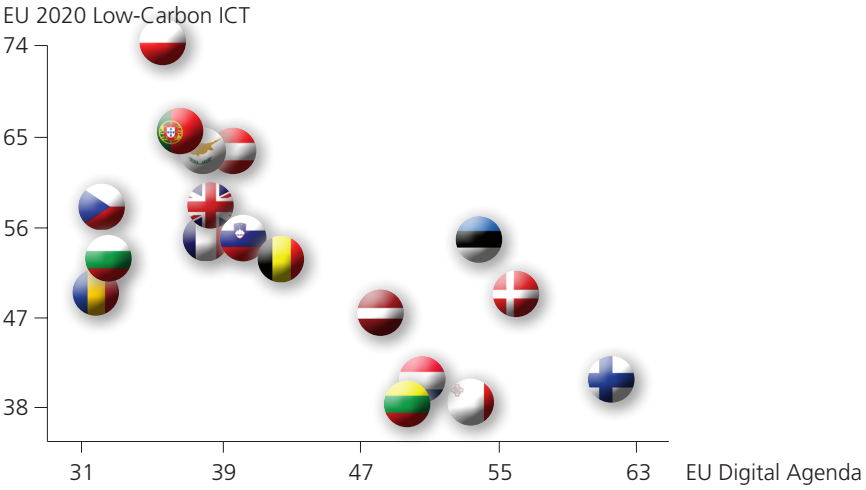


Figure 15. The EU's perspective on EU 2020 and EU Digital Agenda
Source: 21st Century Frontiers estimations, using the tool developed for GeSI at http://www.global-ict-leadership.net

Estonia's situation improves, when we look at the EU as a whole. Estonia is actually the top country when it comes to balancing a strategy on the use of greening with ICT and the actual delivery. This means that the integration of ICT in the 2020 agenda is matched by actual use of smart ICT solutions such as online-banking and e-reading. Poland on the other hand talks a lot about ICT but have almost no concrete implementation.

On the other extreme is Finland where the use of simple ICT solutions is wide spread, but now supporting policy exists. It is interesting to note that a number of those using several greening with ICT solutions often do not mention these in their strategy plans. Whether this indicates that other counties will soon seize the top positions or if integration is so fundamental that greening with ICT does not have to be mentioned is hard to know.

Countries that focus on solutions a lot seem to include greening with ICT more than those that focus more on problems. Those using "green" instead of "environmental" also tend to link greening with ICT also to business development, not just to environmental results.

3.4.2 Case studies of country initiatives

In the following chapter three case studies of country initiatives will be described. The example of Denmark is included because they are probably one of the world leaders when it comes to greening with ICT. Norway is an interesting example of a country that is struggling to find a place for green ICT. Sweden is an example of early start in green ICT.

Denmark (Moving from national greening of ICT to global greening with ICT)

Denmark is probably the most advanced Nordic country and one of the world leaders. A closer look at the history reveals that the path to this leadership position was not straight. Until 2007, Denmark focused only on greening of ICT, using the problem perspective and dealing with ICT's own emissions. An example of this was an initiative for an action plan on green ICT that focused on CO2 emission that ICT equipment contributes to[32].

In 2008, the focus had shifted more onto greening with ICT and onto international collaboration with the OECD. The OECD and Danish Ministry of Science, Technology and Innovation held a high-level conference on "ICTs, the environment and climate change" and Denmark declared the need to focus on green IT in order to improve the performance of the ICT industry as well as to boost beneficial IT applications across all spheres of society[33]. This shows how important it is to have an open perspective, as very few countries and ministries have managed to push this shift beyond rhetoric. In Denmark, the shift also resulted in new policies and engagement with stakeholder that focus on ICT as a solution provider.

The change in rhetoric is interesting, as it has been followed up by actual policy making. Below is a simple count of key words used in the Danish "IT and telecommunications Policy Report" over six years. While the 2009 climate conference in Copenhagen probably created extra interest in green and climate issues, it is clear that Denmark has managed to institutionalize greening with ICT.

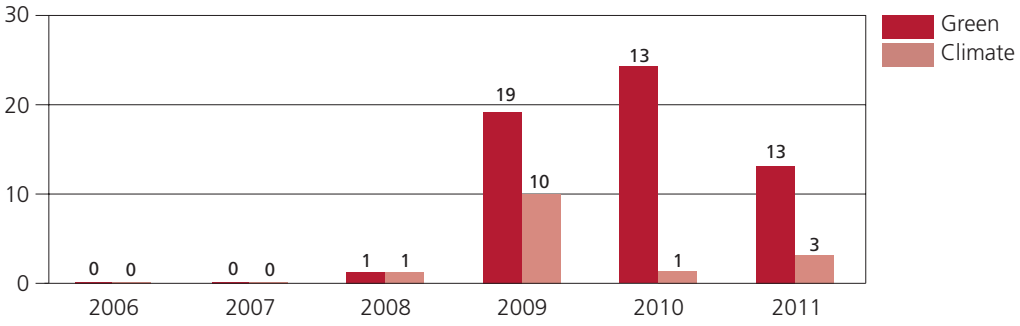


Figure 16. Number of times the key words are mentioned in the Danish "IT and telecommunications Policy Report" 2006–2011

Source: Authors calculations of 21st Century Frontiers calculations

32 Denmark to be in the Lead with Green ICT. http://en.vtu.dk/press/2007/sander-denmark-to-be-in-the-lead-with-green-ict/, 22.11.2011

33 OECD and Danish Ministry of Science, Technology and Innovation to hold a high-level conference on "ICTs, the environment and climate change. http://en.vtu.dk/press/2008/oecd-high-level-conference-icts-environment-climate-change/, 22.11.2011

The graph above is interesting as it shows how fast Demark moved from having no mentions of "green "or "climate" (as an indicator for greening with ICT) in their key document for "IT and telecommunication policy" to becoming a world leader and integrating the idea in only two years. It is also interesting to note that Demark initiated collaboration with the OECD in 2008, before greening with ICT was an integrated part; in fact, as we have noticed above, Denmark initiated collaboration with the OECD in a situation where they were still focusing on greening of ICT. The trend to start exploring new ideas in international collaboration before the country has formulated a policy is an interesting one among several leading countries.

Furthermore, it is worth mentioning that while the word "climate" almost disappeared from the documents compiled after the big climate conference in Denmark in 2009, the "green" approach looks as if it has institutionalized in policy documents.

The policies are still relatively new for Denmark, therefore, the concrete results are not numerous, but as Denmark has gained experience on building new successful businesses from the wind industry, it is an interesting case to follow. Three interesting events should, however, be mentioned.

First, an example of the institutionalization of greening with ICT is that The Ministry of Science, Technology and Innovation opened a Knowledge Centre for Green IT on 1 January 2010. The centre's mission is to promote awareness and use of green IT among the public authorities, businesses and citizens. In 2010, the centre launched a website from where businesses and public sector organizations can find inspiration and guidance on how to implement green IT solutions to the benefit of their budgets as well as the climate. The knowledge centre also collaborated with the IT industry to launch a knowledge bank[34] which contains examples of documented green IT use in Danish businesses and institutions.

In 2011, the knowledge centre partnered with DI ITEK to publish a video conference analysis tool with advice and guidance on video conferences. The tool also includes a web-based calculation device able to give users an initial indication on whether it is worth investing in IT equipment to support video conferences. The National IT and Telecom Agency and DI ITEK have also studied the potential of using video conferences in Danish businesses, which showed a cost savings potential of up to DKK 4 billion.

Second, The Villa Watt exhibition in Taastrup is a sample home, showcasing solutions for intelligent energy management, smart grid technology and video conference facilities. "Smart grid" is the electricity network of the future, which will enable intelligent management of the electricity production and electricity consumption to a much greater extent than is possible today. In addition to making electricity distribution more effective, smart grid will provide much better opportunities for integrating the electricity production from sustainable energy sources.

Since the opening in 2009, the exhibition at Taastrup has had over 120 visits from politicians, executives, researchers, journalists, international delegations etc. The Ministry of Science, Technology and Innovation helped with the design and financing of Villa Watt at EXPO 2010 in Shanghai, where the sample home was presented to a number of specially-invited key Chinese officials.

Third, smart energy system supported by Dong and the Government, DONG Energy is working on the following projects:

Smart grids – activities to optimize our existing grids by turning local assets and active customer participation into subsidiary system devices.

- Smart buildings – developing solutions based on green, efficient energy technologies enabling the use of green electricity from the grid.
- Smart mobility – working to integrate more electricity into the transport sector and have invested in Better Place Denmark to use surplus wind power in the battery systems of electric cars.

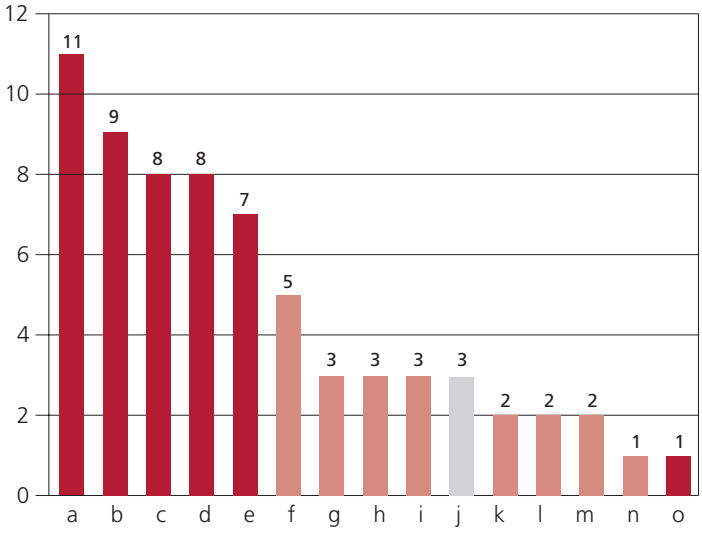
Norway (Struggling to find a place for green ICT)

Norway is an interesting example of how an overarching policy, export of oil and focus on the oil industry have left little room for policies that support greening with ICT. Still, knowledge about the potential of greening with ICT and solutions exist in Norway within the private sector (Tandberg originates from Norway, even though it has been purchased by Cisco), and even one of the most important global players – Telenor, with

34 See GROENIT knowledge bank: www.groenit.dk, 22.11.2011

more than 200 million customers around the world – is from Norway. Norway could become a leading greening with ICT country, but that would require the government to pay more attention and support such initiatives.

It is interesting to note that when it comes to using the combination of ICT, climate and smart, among all the other ministries the ministry of environment (Miljovernedepartmentet, with the score 1) is the least successful authority (see figure 17).



a Ministry of Governmental Administration Reform & Church Affairs
b Ministry of Trade and Industry
c Ministry of Education and Research
d Ministry of Transport and Communication
e Ministry of Local Government and Regional Development
f Ministry of Oil and Energy
g Ministry of Finance
h Ministry of Foreign Affairs
i Ministry of Labour
j Europe Forums
k Ministry of Agriculture and Food
l Ministry of Fisheries and Coastal Affairs
m Ministry of Health and Care Services
n Ministry of Children and Equality
o Ministry of Environment

Figure 17. The number of times the words "IKT" (ICT), "klima" (climate) and "smart" (smart) are all mentioned in a document on "Government.no"

Note: The colors in the graphs are based on what stakeholders, including the ministries themselves, thought to be most important for greening with ICT. The yellow are those seen as important, blue less important. The gray is not applicable, as it refers to an information portal about the EU.

Source: Norway and global leadership in the 21st Century: Supporting transformative low carbon ICT solutions[35]

Norway is now in a situation where those pushing for greening with ICT have, if not given up, taken a break. The focus is now on establishing a green data centre and if successful, Norway might be able to move forward. There is, however, a network of progressive stakeholders, including people from the Ministry of Environment, that see the programs for smart cities as a possible way to move beyond the current deadlock and identify concrete solutions. This could bring about rapid results, if the right constellation of stakeholders is brought together.

The main initiative regarding cities is the program "Framtidens byer" ("The cities of the future"), where the Norwegian government is doing interesting work, but mainly though research by bodies like Cicero, although 13 cities have been included.[36] One of the leading low-carbon cities in Norway is Trondheim, where a number of initiatives are ongoing and where initially, like in most cities/villages in Norway, ICT initially played no more than a marginal role. However, as the projects began to be implemented, the role of greening with ICT grew in importance.[37] Areas such as smart buildings, smart mobility and smart grids are now receiving more attention.

Sweden (Early start with little result)

In 2001, the Swedish Government established a Forum for IT and environmental issues with a mandate until December 2003. The Forum's purpose was to provide a natural platform for information and communication technology (ICT) and ecologically sustainable development.

35 Norway and global leadership in the 21st Century. Supporting transformative low carbon ICT solutions. http://www.pamlin.net/new/wp-content/uploads/Norway-and-global-leadership-in-low-carbon-ICT-110309.pdf, 22.11.2011
36 See the article: http://www.regjeringen.no/en/dep/md/kampanjer/klimatilpasning-norge-2/bibliotek/forskning/kommunene-kan.html?id=662280, 22.11.2011
37 See the article: http://www.trondheim.kommune.no/framtidensbyer, 22.11.2011

The Swedish Environment Minister, Lena Sommestad, was appointed as the Chairperson of the Forum. The Forum's aim was to analyze how the increased use of IT applications can be harnessed to promote sustainable development, and how various actors can be encouraged to contribute to this goal.

The group's mandate included studying ways in which IT use can contribute to the development of new infrastructures and products and services with lower resource consumption and environmental impact. The Environmental Protection Agency was responsible for the Forum's secretariat. A report, "An outline for a sustainable e-strategy", with recommendations for the government, was written by Dennis Pamlin and Ewa Thorslund within the framework of the Forum.[38] None of the recommendations were adopted by the government.

In 2007, the VINNOVA Centre of Excellence for Sustainable Communications was founded. Some interesting studies have been produced, but the main focus is on incremental improvements and changes in the current system rather than on transformative solutions that could be used by nine billion people.[39] The challenge is how to balance existing good relationships with business stakeholders with ongoing research that also includes disruptive elements.

In 2010, Sweden issued a report "ICT for a greener administration – ICT for the environment 2010–2015 "(only in Swedish)". This focused only on the government's own activities, and except for the possibility to use ICT for telemeetings, all the focus was on ICT's own emissions.

Only as a response to commission's reply to the European Commission's recommendation (C2009 (7604)) on "mobilizing Information and Communication Technologies (ICT) to facilitate the transition to an energy-efficient, low-carbon economy" did the Sweden government communicate something beyond the direct emissions.

In 2011, a "Digital council" was created. So far little of significance has emerged from this process, but the final verdict has to wait until it is published, estimated to happen at end of 2011.

Similarly to most countries, a number of supporting policies that help enable an infrastructure and an understanding of the potential for greening with ICT have been implemented, e.g. the following two examples:[40]

- The Total Project aims to develop a methodology to maximize the effect of energy efficiency measures in existing business premises while maintaining healthy profitability for the property owner. This methodology includes utilizing building simulation programs to calculate the effect of both individual energy efficiency measures and of entire packages of measures.
- The SVEBY Project aims to provide guidance to the construction and property sector in calculating, erecting and verifying buildings, in order to fulfill the energy performance requirements laid down either by the National Board of Housing, Building and Planning or the building purchaser. The guides already been published contain, among other things, concrete and detailed routines for when and how energy simulations should be implemented.

The greening with ICT is growing among the ICT users and, for the first time, greening with ICT is the single most important issue when buying green ICT. This is an interesting trend, but Sweden is still at such an early stage that all different greening with ICT solutions are treated as one single group.

3.5 Conclusion

Based on the global trends analysis it could be pointed out that although greening of ICT is still prevalent when it comes to current business actions and policy making, a rapid uptake of greening with ICT could be assumed. Green ICT is becoming a relevant policy area, although so far only few practical policy actions have taken place regarding green ICT as enabler of smart growth.

Greening with ICT solutions are increasing among companies, but most of this is not happening though green strategies. Developing and adopting green ICT solutions is often motivated by smart strategies (looking for resource efficiency) not by environmental goals. It became apparent that governments tend to have lower

38 An outline for a sustainable e-strategy – Sweden and a central issue for the future. http://www.pamlin.net/new/wp-content/uploads/a_sustainable_e-strategy_for_Sweden.pdf, 22.11.2011
39 Centre for Sustainable Communications. http://cesc.kth.se/, 22.11.2011
40 The two examples are from: ICT and energy efficiency in Sweden: Sweden's response to the European Commission's recommendation (C2009 (7604)) on mobilising Information and Communication Technologies (ICT) to facilitate the transition to an energy-efficient, low-carbon economy. http://www.sweden.gov.se/sb/d/574/a/159191, 22.11.2011

green ICT readiness than industries in average. Governments used to lead when it comes to many green areas including greening of ICT, but when it come greening with ICT they are getting further and further behind. It could be assumed that clusters are becoming the leaders in greening with ICT as many new ideas and initiatives have come from business coalitions.

At a policy making level there is no individual organization in a lead position when it comes to greening with ICT. The EU is focusing on the key areas where considerable amount of emissions are emitted, less on the lifestyles and new business models. Little of the OECD's current works is aimed at towards new innovative solutions (greening with ICT).

Based on the country comparison it could be pointed out that though so far, Estonia has not been at the forefront of integrating greening with ICT in policy areas, a positive general ICT policy has resulted in a high use of greening with ICT solutions. This could be further accelerated with an improved policy framework, as more advanced greening with ICT solutions (such as teleworking, smart buildings and smart grids, as well as solutions that require new business models) will require a support framework to be successful.

4 Trends in green ICT solutions, products and services in Estonia

4.1 Introduction

To understand Estonian companies and institutions ability, readiness and willingness to operate on green ICT field, limited market analysis was conducted as a part of the study. This section provides an overview of results of the market analysis of green ICT related products and services available in Estonia. The analysis included local companies, representative offices of foreign corporations and public institutions. The section provides answers to the following research question:

- Which are and likely continue to be the most prominent fields for (also in terms of products and services) using green ICT related tools, methods and technologies?

As whole, green ICT products and services can be divided into two main categories:

- Greening ICT – products and services, which are mainly focused on energy efficiency and electronic waste recycling.
- Greening with ICT – products and services which are using ICT components to enhance existing solutions. This type of products and services cover a wide range of areas, from energy and material efficiency to process automation.

The structure of the following chapter is also based on this division.

4.2 Greening ICT products and services

Greening ICT products and services are mainly related to hardware energy efficiency. Therefore, the topic is more relevant to bigger organizations, which have data centers or other ICT infrastructures, e.g., commercial banks, telecommunication service providers and large government institutions.

Green ICT products and services can be divided into following categories:

- Power management
- Software and deployment optimization
- Materials recycling

The following paragraphs describe products and services identified during study and are divided by classifications above.

4.2.1 Power management

Power management solutions are focused on reducing energy consumption of ICT resources and using alternative environment friendly energy sources.

The study covered several organizations that have multiple datacenters. The majority of them have reduced the number of datacenters to 2 or 3; also cross border datacenters are rather a norm than an exception. The main reasons for doing that are cost efficiency and increasing security. Reduction of number of datacenters also caused the growth of the remaining datacenters, in the sense of energy consumption and area. This has forced to consider different green solutions and better planning of datacenter cooling and room arrangement. There are companies in the market who provide green datacenter consultancy services.

Largest telecommunication companies in Estonia, EMT and Elion, are successfully piloting a project, which uses datacenters to heat homes and offices. The efficiency of this type of initiative is highly dependent on location. Some of Elion's datacenters are located in Tallinn's suburbs and are surrounded by apartment buildings. Those datacenters are connected to buildings' central heating system; one of EMT's office buildings is heated with neighboring datacenter's energy.

EMT pilots different technologies to integrate wind turbines with mobile network masts. It will help run mobile network on green power and also increase network's availability. One of the common problems with mobile networks is the power shortage occurring with windy weather and caused by short-circuits in the power network. Using local wind turbines will help avoid this type of failures. A working solution would also have great export potential.

4.2.2 Software and deployment optimization

Software and deployment optimization solutions concentrate on reducing the number of ICT hardware components and increasing the products' lifespan.

A clear trend among medium and large size organizations is to reduce the number of physical servers by using virtualization technologies. It will greatly reduce overall power consumption by utilizing server resources better. According to the best practice of specialized company, one physical virtualized server can replace up to ten physical non-virtualized servers. Most of large and mid size companies in Estonia has virtualized their server infrastructure partly or fully.

Another aspect of greening ICT is to extend hardware longevity to reduce electronic waste production. Several governmental organizations and private companies are moving towards renting desktop computers instead of acquisition. There are companies in the market who have specialized in concluding this type of contracts in cooperation with finance institutions and hardware utilization companies. Typically, returned equipment is resold to developing countries or recycled by specialized companies. Another widely used initiative is to donate old computers to employees, orphanages and nursing homes.

Several organizations have launched internal initiatives to reduce paper printouts. There have been simple actions, e.g., raising employees' awareness and introducing duplex printing. Many companies have also made investments to shift to digital document handling by implementing document management and exchanging systems and providing tablet computers for employees who need to elaborate large amount of documentation.

4.2.3 Material recycling

Material recycling initiatives take care of environmentally friendly utilization of used ICT equipment and establish standards for hardware products' manufacturing. In the case of Estonia, most of ICT equipment is imported from other countries, therefore, this type of initiatives mainly focus on waste collection and its transport to recycling facility.

Electronic waste collection from population is organized by the governmental authorities free of charge. Some global hardware vendors have initiated programs to collect electronic waste from their customers. For example, IT vendor HP collects old servers when a customer buys new ones. These programs have gained popularity among customers, year after year.

4.3 Greening with ICT products and services

Greening with ICT provides a tremendous amount of opportunities for software development and consulting companies and also for hardware vendors, to build special purpose computers and other technological solutions. These solutions are often very specific, meant for implementation in a particular area and related to computer aided process optimization and automation.

Greening with ICT products and services can be divided by usage area. SMART 2020[41] used following categorization:

- Smart motors
- Smart logistics
- Smart buildings
- Smart grids
- Dematerialization

The following paragraphs describe products and services identified in Estonia during the study and divided by the classification above.

41 "Evaluating the carbon-reducing impacts of ICT". http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf, 22.11.2011

4.3.1 Smart motors

Smart motors are technologies that reduce the energy consumed by industrial motors, or support industrial process' automation. These motors can, for example, run at variable speeds, using only the energy required for the task at hand, rather than operating at full capacity regardless of load.

Typically, ICT's role in this type of projects is to provide specialized software for hardware management. In Estonia, one software development company, Proekspert, is specialized in developing management software for different industrial solutions, e.g., software for frequency converter and solar panel management. Working with industrial solutions requires close cooperation between scientific research institutions and hardware providers. According to Proekspert's practice, partners vary by project depending on projects' area and specifics. Usually, a project is initiated by a customer who is looking for optimization possibilities for their solutions and processes.

The smart motor solutions are usually industry and solution specific. This limits the possibility to transfer a solution built for one customer to other similar customers. However, it is simple to export experience with programming languages, technical solutions used and project's setup.

4.3.2 Smart logistics

Smart logistics include technologies that enable fuel reduction and energy efficiency through improved route and load planning. For example, operations management software can reduce inventory storage, fuel consumption, distance traveled and decrease the number of vehicles traveling empty or partially loaded.

Due to Estonia's small size, smart logistics projects might be quite limited, because the possible savings do not cover the investments required for smart solutions. However, some good examples can be found. For instance, the Union of Estonian Automobile Enterprises has initiated a project for timber and log transportation companies to optimize truck routes. All trucks will be equipped with GPS, laptops, internet connection and access to central information system. Information system holds data about logging areas, forest owners and transportation companies, and calculates optimal routes for trucks. The creation of information systems and technical solutions has been complete and the project has reached the launching phase.

Another sample of smart logistics is the recently initiated electric car project in Estonia. Project's goal is to build an electric vehicle charging network all over Estonia and distribute about 500 electric cars to social workers. Estonian mobile broadband company EMT has developed mobile software application for car owners to locate the nearest charging station and pay for charging via mobile phone.

Smart logistics projects are quite easily transferable to other countries where similar problems are arising. However, as projects are typically related to infrastructure, the size of a project can be challenging for smaller organizations. Therefore, government's and professional unions' support is encouraged.

4.3.3 Smart buildings

Smart buildings cover solutions that maximize energy efficiency in buildings, such as building management systems that run heating and cooling systems according to occupants' needs.

Estonia's construction sector experienced rapid growth during the past 10–15 years and was severely affected by the economic downturn. During the growing phase, smart technologies were considered as niche solutions for exclusive projects. Recession has turned the tables and smart solutions are now seen as added value and as a way to reduce exploitation costs.

Yoga, a small Estonian company is specialized in smart buildings solutions. They started with electronic access control systems, but have shifted to building's heating and ventilation system management. According to company's own measurement results, heating costs can be easily reduced up to 30% by smart management. Smart management is room based measurement of temperature, C02 levels and illumination and adjusting the heating, ventilation and illumination solutions according to the current requirements. The company is currently collaborating with Elion to make the solution available for small customers, e.g., residential buildings and private houses.

Export of smart building solutions is relatively easy when these are packaged into products. The main concerns are market awareness and cooperation with landlords, energy and telecommunication companies.

4.3.4 Smart grids

Smart grids are digital technologies that allow greater visibility of energy use and power flows. For example, smart meters give consumers real-time information on the energy they use, while demand management systems automate the reduction of appliances' energy load at peak times.

From consumer's perspective, smart grid field is closely connected to smart buildings, and the solution offered by Yoga, described in an earlier paragraph, can be used for home or building energy usage monitoring as well.

There is one innovative smart grid project in Estonia, called Smart Vormsi. The goal of the project is to build energy independent community into island Vormsi. The project is collaboration between different organizations and stakeholders, who are interested in testing new technologies in an integrated environment. On the other hand, the project has created value for local people as well. Electricity shortages is a typical problem for small islands, these are caused by storms and freezing of sea during winters. Energy independence would significantly raise living standards of the local people and encourage more people to move to the island.

One of the companies who have been supporting the Smart Vormsi project is a system integration and software development company Netgroup. They have a software product called Synerall, which can be used by electricity distribution companies as customer portal and billing system. Customers can monitor their energy consumption on hourly basis and adjust it according to energy prices on free market.

Estonian Energy is preparing a project that foresees equipping most of the households in Estonia with smart energy meters that the central system could read automatically. Project is planned to begin in 2012 and be completed by 2017. It will enable consumers to easily shift from one energy supplier to another. The purpose of the project is to provide enabling technology for consumers by the time Estonian energy market is fully opened to all European electricity producers.

4.3.5 Dematerializations

Dematerialization is the substitution of high-carbon products and activities with low-carbon alternatives, such as replacing paper bills with e-billing. This provides numerous opportunities to replace existing processes and technologies with software solutions and e-services. Dematerialization projects can be divided into enabling infrastructure projects and point solutions.

Enabling infrastructure

The building of dematerialization services requires standardized, intelligent and secure infrastructure, in order to communicate between different organizations and citizens. Estonian government has been playing a leading role here by having introduced the ID-card and X-road projects about 10 years ago. Both projects experienced a lot of skepticism in the beginning, but nowadays are widely used. The X-road provides secure service based data transfer layer for governmental institutions, and the ID-card offers common electronic authentication and electronic signature for all the inhabitants in Estonia.

Another great challenge for dematerialization is the creation of fast network connections between service providers and consumers. Urban areas in Estonia are mostly covered with reasonably fast ADSL-connections, but the technical solutions providing high speed connections in smaller towns and villages are limited. As a solution, the Estonian government initiated a large scale EstWin project. The project's goal is to build a high speed trunk network that is based on fiber optics technology and covers most of the villages. All interested service providers can connect to this network to provide connection services to end users. The network is widely used by mobile operators to build 3G and 4G mobile network.

Point solutions

Point solutions are focused on a specific area to replace manual or resource consuming activities with electronic services. For the most part, these services provide electronic communication between external parties.

A lot of companies that have multiple offices have invested in video conferencing equipment. Using video conference instead face to face meetings helps to reduce traveling and therefore lowering CO2 emissions. During the study, majority of the interviewed companies admitted that they are using video conferencing rather for cost and time efficiency and employees' convenience than due to environmental considerations.

Public sector has developed a remarkable amount of electronic services for citizens and organizations. These services utilize the enabling infrastructure heavily and are strongly support by legal regulations, i.e. digital signature is considered equal to handwritten signature. The services for citizens include e-voting, e-health, e-school, e-tax bureau and digital document exchange with of the majority of government's institutions. Most of these services have consolidated into e-citizen web-portal where ID-card holders can also request information about themselves from different government registries. Services for entrepreneurs include starting new company electronically and digital stamping.

Other great examples from the public sector are the recently introduced speed cameras for traffic regulation. The solution comprises speed cameras and information system to monitor and track car owners who exceed speed limits. The whole process is automated up the level that only 90 seconds of manual work is required per incident. This includes incident review by two officers, as is required by law to make penalty decision.

Private sector has been developing several smart services as well. EMT introduced mobile parking service in Estonia more than 10 years ago. This solution has been successfully exported to other countries as well.

Private sector has also initiated several projects related to financial services. Internet banking has been a standard in Estonia for more than 10 years. Recent services have added electronic invoice systems, enabling customers and service providers to exchange electronic documents to reduce the number of paper invoices. According to statistics by Estonian Association of Information Technology and Telecommunications, 25% of invoices in Estonia in the business to consumer segment are exchanged electronically as at 2010. Currently, private companies make preparations and compile studies to introduce e-check concept, which is supposed to replace retail paper checks with electronic information system.

Government has played an active role in promoting innovative services to other countries as well, which have created the "e-republic" imago for Estonia and provided export opportunities for Estonian ICT companies. This type of services often involve a several different parties, which lay export limitations onto smaller companies, who are unable to break administrative overhead and put enough effort into lobby. To increase export opportunities, cooperation and dedicated support is needed from private companies, professional unions and public sector.

4.4 Conclusion

The study identified a number of products and services, both in greening ICT and greening with ICT area, that are currently in use in Estonia. Greening with ICT products and services hold a larger share and attract more attention. The market is ready to accept green solutions, and especially individuals are looking for ways to use smart and green technologies. However, the most influential drivers of solution adoption are the direct or indirect cost savings.

Most of products and services identified are related with software and advisory services. Complex solutions, which typically combine different components, relay on third party hardware products imported from external vendors. Therefore, the development of successful complete solutions requires efficient cross-border cooperation on product development and marketing.

Product and service developers usually do not limit their ambitions with Estonian market and are eagerly looking for ways to expand into other countries. So far, the number of success stories has been limited by the small size of Estonian companies and the lack of cooperation. Improving these areas would greatly increase export possibilities.

By building electronic authentication and digital signing infrastructures, the Estonian government has established good preconditions to moving into electronic document management and electronic communication, both in private and in public sector.

5 Evaluation of current and potential green ICT policies in Estonia

5.1 Introduction

This section focuses on the research question about what is the current level of competence and potential in Estonia in applying green ICT products and services, and what are the appropriate steps to take in order to succeed in developing a coherent action plan for green ICT.

Green ICT policy measures are expected to improve both environmental and economic challenges. This way, green ICT products and solutions are instrumental for other more general policy objectives. Environmental objectives are achieved by using green ICT products and solutions that have no or less negative effect on climate, ozone layer depletion, biodiversity, natural resources depletion and pollution of land and water. Economic challenges are met by improving competitiveness of companies and economy as a whole via making the usage of energy and natural resources more efficient. Additionally, innovations in the area are expected to make economy smarter and increase the added surplus value.

Policy measures that support development and implementation of green ICT solutions to achieve these environmental and economic policy objectives are twofold. Firstly, on the one hand, green ICT policy is a segment of environmental, economic, entrepreneurship, and technology policy. For instance, the European Union's waste electrical and electronic equipment directive (WEEE Directive)[42], Ecodesign Directive[43], and Regulation concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)[44] directly influences greenness of ICT products throughout their lifecycle. Also, initiatives at the European Union level to develop common energy policy (for instance, see the proposal "Energy for a Changing World"[45]) and smart, sustainable, inclusive growth strategy – Europe 2020[46], proposed by the European Commission – drive clean-technology and cleaning with technology innovations in Europe. This way, European level policy initiatives and corresponding national policies are expected to substantially support the development and implementation of green ICT products and solutions in the member state.

Secondly, on the other hand, because previously exemplified policy measures are general in nature and support clean technology industry and implementation overall, policy consideration to target green ICT specifically would also require evaluation of potent policy measures that specifically target the development and implementation of green ICT products and solutions.

The following analysis of potential policy measures that target innovation and adoption in the area of green ICT focuses to a large extent on the latter and only contextualizes these with more general policy initiatives.

The analyses firstly studies Estonian business environment focusing on innovativeness and current adoption and the adoption potential of green ICT. Thereafter it will focus on the evaluation of policy recommendations that were suggested by industry leaders, academic institutions, solution provides and solution implementers during the interviews. Lastly, the analysis focuses on appropriate steps required in order to succeed in developing an action plan for green ICT and on evaluating the progress of the implementation of the action plan.

5.2 Green ICT business environment: companies' readiness and motivation to develop and implement green ICT solutions.

Before focusing on green ICT policy measures that could support the development and implementation of green ICT, we briefly analyze Estonian business environment. Overview of the business environment is crucial as the readiness and motivation to develop and implement green ICT depends on innovativeness of companies and valuation of energy and material usage efficiency and of environmental impact. Also, the conditions of business environment indicate the feasibility to motivate companies to adopt green ICT via policy measures.

42 Waste electrical and electronic equipment directive (Directive 2002/95/EC). http://ec.europa.eu/environment/waste/weee/index_en.htm, 22.11.2011
43 Establishing a framework for the setting of ecodesign requirements for energy-related products (Directive 2009/125/EC). http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:01:EN:HTML, 22.11.2011
44 Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (EC 1907/2006). http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm, 22.11.2011
45 Energy for a Changing World. http://ec.europa.eu/climateaction/index_en.htm, 22.11.2011
46 Europe 2020. http://ec.europa.eu/europe2020/index_en.htm, 22.11.2011

The following evaluation of business environment and potential for green ICT policy is based on company survey on green ICT carried out in October 2011. The target population of the survey is companies with more than 4 employees (for more information see Appendix 2).

Firstly, the potential to influence the development and implementation of green ICT products and solutions is dependent on the general innovativeness of companies. The survey indicates that 38% of companies have introduced a new product or service to the market or initiated a new business process (Figure 18).

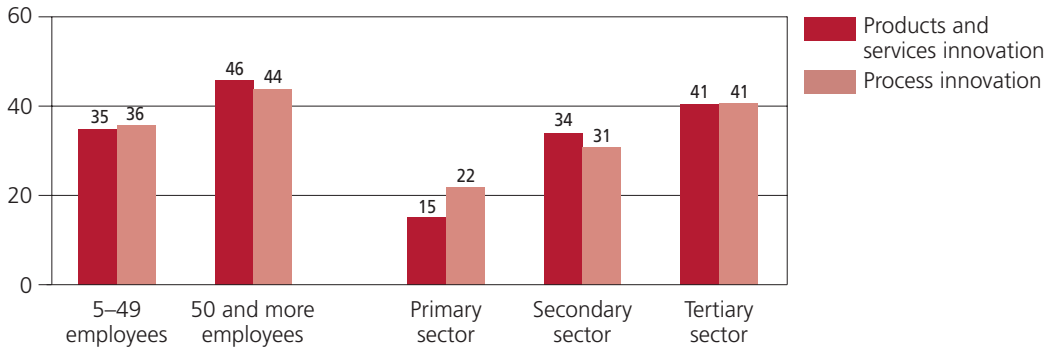


Figure 18. Innovation in Estonian Companies
Source: Company survey on green ICT

As expected, larger companies and companies engaged in industry (secondary sector) and services (tertiary sector) are more likely to innovate either their products and services or business processes than smaller companies and companies in agriculture, forestry, fishery (primary sector).

Secondly, the survey indicates that striving for efficient use of energy and materials and the reduction of environmental impact has been a rather important driving force for the innovation (see figure 19).

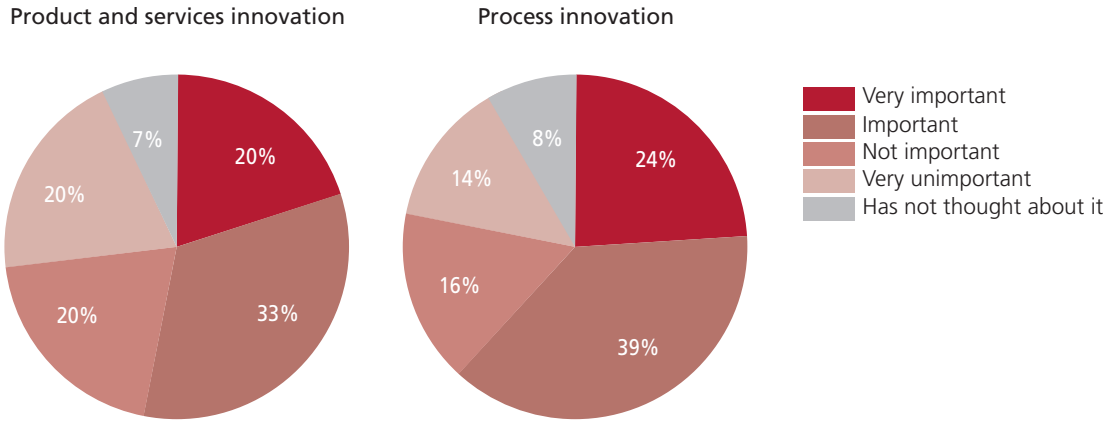


Figure 19. Importance of efficiency and environmental concerns as driving force for innovation
Source: Company survey on green ICT

54% of companies that have introduced innovative products or services and 63% of companies that have introduced process innovations consider the ambition to increase energy and material usage efficiency and decrease environmental impact as important or very important driving force.

This leads us to the question whether efficiency and greenness are important to only the innovative establishments or as a whole? According to the survey, 78% of companies consider improving energy efficiency and environmental friendliness very important or important.

It follows that Estonian business environment is fairly innovative and open to consider products, solutions and processes that could lead to increased efficiency and environmental friendliness.

Business environment's readiness to adopt green ICT could be to certain extent characterized by the current prevalence of green ICT products and solutions in Estonian companies. According to the survey, 26% of companies that have innovated their products and services and 31% companies that have innovated their business processes claim that they used ICT products or solutions to increase energy or material usage efficiency or environmental friendliness. The wider adoption of green ICT could also be characterized by the fact that 37% of all companies claimed that they have been working on decreasing the energy consumption of their ICT equipment. These results indicate that as during the last couple of decades, ICT prevalence has increased substantially, also numerous Estonian companies have noticed its direct effect on energy consumption and also the potential to use ICT to monitor and optimize products', solutions' and processes' efficiency and greenness.

The other side of willingness to adopt green ICT products and solutions could be described with motivating factors. Figure 20 below describes to what extent different factors motivate Estonian companies to develop or implement ICT for improving energy and material usage efficiency or environmental friendliness.

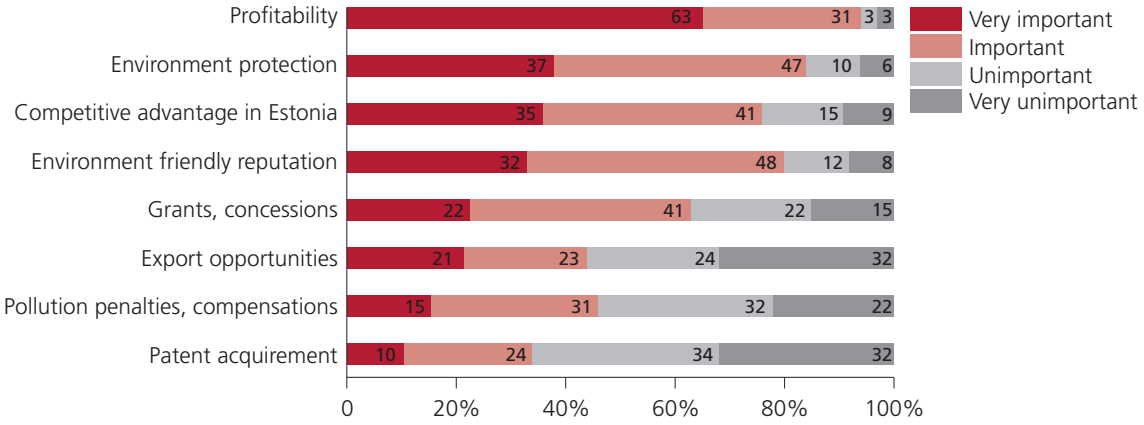


Figure 20. Green ICT motivational factors
Source: Company survey on green ICT

According to the survey estimates, the four most important motivating factors are profitability, environment protection, competitive advantage and reputation of environment friendliness. This indicates that although the companies put their economic performance the first, as expected, they also feel responsible for their businesses' impact on environment.

All in all, the brief statistical overview of the business environment indicates that Estonian companies are rather innovative, and in consequence of the need to make their products, services or business processes more efficient and environment friendly innovate rather frequently. Also, one third of companies that have innovated their products, services or businesses processes, have used ICT to make their products or services more energy or material efficient or environmental friendly. Taking all this into account, we can see that the business environment is rather supportive of developing green ICT products and solutions for both efficiency and environmental protection concerns. It is expected that this would also facilitate the development of policy initiatives that aim at wider and more pervasive development and adoption of green ICT products and solutions.

5.3 Green ICT policy measures

The following mapping and evaluation of potential green ICT policy measures is grounded on interviews with industry leaders, solution providers, solution implementers, academic institutions and policy makers, carried out from September to November 2011. And yet, the quantity of potential policy measures suggested in the interviews is larger than that evaluated here. Occasionally, interviewees suggested measures that have already been implemented, that were not clear enough or were too general. These suggestions were usually abandoned.

The qualitative, descriptive data from interviews is complemented by quantitative data from the survey that describes to what extent certain problems that could be targeted by the policy measures are spread among companies.

During the interviews, four broad barriers that constrain development and adoption of green ICT products and solutions where identified:

- Low awareness
- Uncertainty of advantages
- Constrained cooperation
- Scarcity of financial resources

Results from the quantitative estimation of the prevalence of these barriers are described in figure 21.

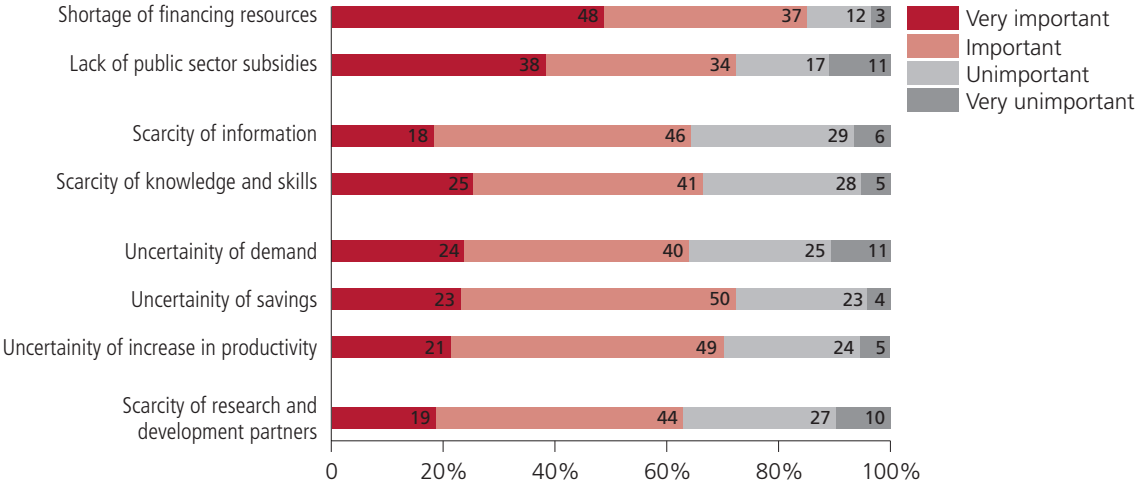


Figure 21. Companies' estimation of importance of different green ICT barriers
Source: Company survey on green ICT

The figure indicates that companies estimate the importance of the barriers quite similarly, except for the shortage of financial resources, which is most frequently considered as a very important or an important barrier. At the same time, it should be kept in mind that the prevalence of a certain barrier does not directly indicate its importance, as its impact might be dependent on some other characteristics.

Throughout the 26 semi-structured interviews, the bulk of policy recommendations to support green ICT development and implementation were suggested. In general, the policy measures that correspond to the barriers are in nature soft policy measures that focus on motivating establishments to develop and implement green ICT products and solutions, and complement existing regulations (for instance, a waste act) that in practice restrict certain activities. These constraints are described in detail on the following pages, also potential policy measures to prevent or overcome these are have been outlined. Sequence of the analysis follows the logic that firstly there has to be awareness about green ICT on both demand and supply side, secondly, rationally acting enterprises need accurate information about costs and benefits of green ICT products and solutions, thereafter, enterprises have to cooperate during the green ICT development and implementation process, and, finally, costly technology development and implementation need external financial support.

5.3.1 Raising awareness about green ICT

Readiness to develop and implement green ICT products and solutions is dependent on stakeholders' awareness of efficiency and environmental friendliness concerns of business practices and processes, and of ICT solutions that could improve these issues.

Currently, on the one hand, Estonian companies are rather knowledgeable about the possibility to increase the competitiveness of their products and services by increasing the efficiency of energy and material usage. According to the survey, both economic and environmental concerns motivate companies to rearrange their business practices and processes or advance products and solutions. On the other hand, companies are not that well aware of different clean technologies, including green ICT products and solutions, which could be used to reduce environmental impact or increase the efficiency of energy and material usage. According to the survey, 65% of establishments estimated that the scarcity of information, knowledge and skills is very important or important green ICT development and adoption barrier.

This awareness problem itself has two sides. Firstly, stakeholders probably do not have a comprehensive concept of green ICT as a possible solution for improving energy and material usage efficiency and environmental friendliness. Secondly, even if they do, the information about potential of green ICT or greening business practices and products by ICT is limited.

Therefore, as the analysis indicates, improving the awareness of both supply and demand side stakeholders about the issues related to competitiveness disadvantage due to inefficient use of energy and materials and competiveness potential brought about by improving environmental friendliness could enhance attentiveness towards clean technologies. Also, increasing companies' awareness about the feasibility to be more successful by developing and implementing clean technology's solutions based on ICT, could advance the demand for and supply of green ICT products and solutions.

We propose three policy measures to specifically target the further development and adoption of green ICT products and services.

Compiling green ICT solutions' database

To increase awareness about clean technology and green ICT it would be crucial to collect and disseminate information about green ICT and its potential role in environmental policy and environment management. In good faith, public sector has indeed directed some attention to the growth potential of clean, environmentally friendly technologies. For instance, Estonian Development Fund has previously mapped Estonian cleantech companies and pointed out that the cleantech sector has the potential to pull the industry toward greater growth ("Industry Engines 2018"[47]). Also, Estonian Development Fund have recently launched a foresight as a strategic look into future potential of energy- and green-economy[48].

Still, during the interviews, it was stated that even if the green ICT concept is attractive, there is scarcity of information about green ICT products and solutions, and about potential positive returns of implementation. In other words, stakeholders consider that lack of adequate and practical information about green ICT is the main reason behind low awareness.

To overcome the deficiency of business applicable information, we would recommend compiling a database of green ICT solutions and products that are instrumental and have proven themselves as proper business practices. For that purpose, several foreign initiatives of similar nature, like The Electronic Product Environmental Assessment Tool (EPEAT)[49], UL Environment[50] could be extensively used.

Still, compiling the database, especially about greening with ICT solutions, would rather quickly face the challenge that the solutions have not always been evaluated (for instance the total cost of ownership) and therefore their applicability in business remains unclear. Therefore, it is crucial to consider whether the dissemination of the information should be dependent on the evaluation of these green ICT products and solutions, as without the evaluation the information about counterproductive solutions could also picked up by stakeholders. As the evaluation of different green ICT products and services is also important for decreasing the uncertainty of advantages of the products and services, it will be discussed further below (see also 8.3.2 "Clarifying the advantage of green ICT").

To sum up, increasing the awareness is dependent on the availability of high-quality information about green ICT. Therefore, we would recommend compiling a database that in detail and in a practical manner would describe proven green ICT products and solutions that could be used by or would inspire stakeholders.

Business consulting on green ICT

In addition to making the relevant and applicable information about green ICT available, attention should also be given to proactively bringing it to entrepreneurs' and establishments' attention. Enterprise Estonia and Estonian Develop Fund have been consulting start-up and growing companies, including technology companies, for years. During the interviews it was revealed that energy and materials usage efficiency issues have often emerged during business consulting. At the same time, especially solution providers and implementers argument that it is highly difficult to get high quality business consulting on optimization of energy and material usage and environmental friendliness. They argued that although plenty of general information and suggestions are available, the lack of business and problem centered consultations is considered a significant challenge in consulting practices.

47 Industry Engines 2018. http://www.arengufond.ee/foresight/industry, 22.11.2011
48 Arengufond käivitab energia- ja rohemajanduse seiresuuna. http://www.arengufond.ee/news/foresight/news2073/, 22.11.2011
49 The Electronic Product Environmental Assessment Tool (EPEAT). http://www.epeat.net/, 22.11.2011
50 Ul Environment. http://www.ulenvironment.com/ulenvironment/eng/pages/, 22.11.2011

Therefore, for proactive dissemination of the information about green ICT and applicable green ICT products and solutions, public sector would also have to pay attention to enterprise consulting on green ICT via Enterprise Estonia. Success of the consultation would depend on increasing the preparedness of business consultants to raise awareness about green ICT and its applicability for solving problems related to environmental impact and efficient use of material resources and energy.

Acknowledging and inspiring companies

The awareness about clean technology and green ICT could also be increased by acknowledging companies that have been able to use ICT to make their products, services or processes efficient and greener, or to develop ICT solutions that could be used for this purpose, and in this way inspire others to follow. Since 2000, Enterprise Estonia, in cooperation with Estonian Chamber of Commerce and Industry and Estonian Employers Confederation, has been issuing the Entrepreneurship Award[51]. Similarly, since 2004, the Ministry of Environment has held a contest the Environmental Award of the Year (*Aasta Keskkonnategu*)[52], and during the contest the award of the Environmental Award for Business (*Aasta Keskkonnategija*) is presented to a company that has succeeded the most in environmental protection via carrying out environment management, introducing an environmentally friendly product, service or process, or undergoing an international cooperation.

During the interviews, industry leaders suggested that receiving feedback and acknowledgement is vastly important for companies and entrepreneurs, and suggested introducing a green company award that is closely connected to green ICT. This proposal reflects, on the one hand, that the current company/enterprise and environmental friendliness awards might not be that well known. On the other hand, the existing awards might not be targeting clean technology and green ICT providers and executors as well as the industry leaders would like them to be.

Consequently, we are proposing evaluating the current contests and awards, and suggest more close cooperation between the Enterprise Estonia and the Ministry of Environment, to issue green company awards in order to recognize successful Estonian companies that have developed or implemented a clean technology solution. In addition, it should be considered whether it is wise to specifically target green ICT developers and implementers, or would this fragmentize the effort too much. In one way or another, the cooperation could be more successful at disseminating information about successful companies, presenting them as role models for others for developing and implementing clean technologies, including green ICT products and solutions.

All in all, to increase companies' awareness about green ICT we would recommend compiling a public database of green ICT solutions and products that are instrumental and have proven themselves as proper business practices, and disseminate proactively the information via business consulting. In addition, we would recommend acknowledging companies, which have been successful in developing and implementing green ICT solutions and could act as role models for others; such actions could also disseminate information about visionary and inspiring green ICT solutions.

5.3.2 Clarifying the advantage of green ICT

In theory, green ICT products and solutions are supposed to be more resource and energy efficient and have a lower impact on environment. At the same time, it is obvious that ICT products and solutions differ from one to another and their expected impact on efficiency and environment varies. Opinion based on the interviews suggests that companies on the demand side are not accustomed to comparing different products and solutions based on their environmental impact and efficient use of resources and energy. The complexity of comparing clean-technology, including green ICT products and solutions is due to lack of valid, reliable and comparable data. Also, even if suppliers provide data based on auditing and evaluation research, the methodology that is used across products and solutions varies and the results are often not exactly comparable. Therefore, companies are often understandably skeptical about choosing technologies that are marketed as green or efficient, but rarely supported by adequate analysis. The survey estimates indicates that about 70% of companies consider that uncertainty concerning savings, increase in productivity and demand are very important or important factors that de-motivate companies to adopt of green ICT products and solutions.

51 Estonian Entrepreneurship Award. http://www.eas.ee/ettevotluse-auhind/auhind-2011/auhind/ueldist, 22.11.2011
52 Environmental Award of the Year. http://www.envir.ee/keskkonnategu, 22.11.2011

To sum up, the adoption of green ICT solution is often constrained by the lack of distinction, clarifying which green ICT solutions to what (quantitatively gauged) extent help increase efficiency in use of energy and materials or decrease impact on environment. Therefore, the analysis indicates that studying the feasibility of improving performance, energy and material use efficiency, and environmental impact by using green ICT product, services, and solutions, would assist companies in selecting environmentally sound and operationally efficient designs, and consequently increase demand for and supply of green ICT products and services.

It is our understanding that currently there are no state level policy measures or initiatives that are aimed at developing, implementing or consulting companies related to auditing and evaluation methodology that could help estimate efficiency of energy and material usage and environmental impact of different business processes and outputs. Based on the interviews we recommend three closely interrelated policy measures to clarify the potential of green ICT.

Reviewing and developing green ICT auditing and evaluation methodology

Firstly, public sector could compile a list of and review the existing relevant performance, efficiency, environmental impact evaluation and auditing initiatives and methodologies that could be used for both pre- and follow up analysis of effect of ICT products and solutions on environment and efficiency of material and energy use. It is relevant to notice that although there are number of well recognized tools for evaluating greenness of ICT equipment, for instance the EPEAT[53] (i.e. Electronic Product Environmental Assessment Tool), the same could not be said about evaluating greening with ICT solutions (enabling effects of green ICT solutions, also transformative solutions). Partially this is due to the circumstances that greening with ICT solutions are often vastly different and a single evaluation methodology could not be applicable. Still, as the business problems are common, a compilation of fundamental data collection and analysis techniques and developing green ICT specific evaluation and auditing methods that rely on these, is expected to help to overcome the challenge. This way, it would be beneficial if public sector helped companies figure out how to evaluate greening with ICT solutions.

Follow-up study of green ICT solutions

Thereafter, in addition to reviewing existing and advancing the development of potential auditing and evaluation methodologies, we would recommend that public sector put both these tools into test by assessing the greenness of already implemented green ICT products and solutions that are considered or marketed as green or energy and resource efficient. This way public sector could both receive feedback on the auditing and evaluation methodology and produce reliable and valid data about the feasibility of achieving both environmental and economic objectives by implementing green ICT products and solutions. What is more, the dissemination of results from these case studies could be used in raising the awareness of solution providers and solution implementers. This would also increase both the demand for and the supply of the green ICT product and solutions that in real life have a significant effect on reducing impact on environment and increasing efficiency in energy and material usage (see also 8.3.1 "Raising awareness about green ICT").

Dissemination of best practice

In addition to reviewing and testing methodologies that could be used for evaluating green ICT products and solutions, it is also crucial that public sector would disseminate both methodology and related relevant skills and competencies to companies. Enterprise Estonia have trialed consulting companies on efficiency of business processes, but due to lack of preparedness and skills and low competence level the initiative was not that successful, according to Enterprise Estonia and industry leaders. Therefore, we recommend that public sector should also consider assisting companies in using these tools by elaborating business consultants' competencies on performance, efficiency and environmental friendliness evaluation and auditing. Arguably, this would be crucial for unfolding the potential of green ICT and helping companies in making considered and calculated choices in developing and implementing green ICT products and solutions.

All in all, to clarify whether and to what extent different green ICT solutions could improve the environmental impact and efficiency of business practices and products, public sector should take initiative in reviewing and developing analytical tools, then using the tools to analyze the feasibility of achieving the expected effects and eventually disseminating the methodology and results to companies and organizations.

53 Electronic Product Environmental Assessment Tool. http://www.epeat.net/, 22.11.2011

5.3.3 Advancing cooperation

Smooth and speedy development and implementation of ICT based solutions for improving energy and material usage efficiency and environmental friendliness depends on cross-sector cooperation between companies, enabled by public sector and supported by (academic) research and development organizations. This is due to, for instance, the fact that ICT solutions that could be used for greening business practices, products or services are often developed in ICT or in another technology sector and implemented in some other sector. The problem of limited cooperation is initially expressed in the conception of green ICT products and solutions. Solution providers are often not that good at noticing problems in other sectors that could be improved by ICT. Similarly, potential solution implementers are often unaware that their practices and products could be improved by ICT. The problem also extends to actual development and implementation, as a close working relationship is required for specifying the requirements of the solution, and its development, implementation and evaluation.

During the interviews, the industry leaders, solutions providers and implementers noted that although over the recent years the cooperation between companies, research and development institutions has considerably improved and there have been specific collaborations with the intention to develop green ICT solutions, constrained cooperation is still considered to be a substantial limiting factor. This is also quantitatively reflected in the survey estimates, according to which 63% of companies consider the scarcity of research and development partners as very important or important green ICT development and adoption barrier.

It follows that improving cooperation between (potential) stakeholders of green ICT would increase synergy and creativity in the field, and consequently could lead to increased demand for and supply of green ICT products and solutions that could lessen environmental impact and improve energy and material usage efficiency.

Currently, there are several initiatives to improve cooperation between ICT products and services stakeholders. For instance, Estonian Association of Information Technology and Telecommunications has initiated an Estonian ICT cluster project that among other activities organizes seminars and workshops that aim to determine cooperation potential between different companies from different economic sectors. Similar technology cluster initiatives that frequently include ICT sector companies have been launched and supported by Enterprise Estonia via clusters development program[54]. Also, there are rather good examples of fruitfulness of this kind of cooperation on developing green ICT solutions. For instance, The Union of Estonian Automobile Companies, State Forest Management Centre and Elion devised and are currently in implementation process of an ICT solution that optimizes the transport of timber by decreasing empty or partially filled transport units circulating in the logistic network.

The cooperation is also supported by research and development institutions. Both University of Tartu and Tallinn University of Technology have organized units that focus on applied research to develop technology solutions often in cooperation with companies. The support is thereupon facilitated by Enterprise Estonia by both intermediating companies and R&D organizations and giving financial support (i.e. innovation voucher grants)[55].

Altogether, there are several initiatives that support cooperation and partnership in developing new technology solutions. Still, to further address green ICT potential and channel stakeholders' actions and resources, the following policy measures are suggested.

Public-private partnership in developing and implementing exemplary green ICT solutions

Firstly, as discussed previously, the two other constraints that limit the development and implementation of green ICT products and solutions are the low awareness and the uncertainty of advantage. To concurrently improve awareness, clarify potential and enhance cooperation, we suggest public-private partnership in co-developing exemplary, visionary, inspiring green ICT solutions and, also, using public sector organizations and public services as test and demo sites for green ICT solutions. This way, initiating the cross-sector cooperation that also involves applied research and development institutions would help increase synergy and creativity in the field and potentially lead to the conceptualization and development of green ICT solutions.

54 Cluster development plan. http://www.eas.ee/for-the-entrepreneur/development-of-the-company/cluster-development-programme, 22.11.2011
55 Innovation Grants. http://www.eas.ee/for-the-entrepreneur/innovation, 22.11.2011

One of the motivation factors for the public-private cooperation would be to associate the research and development projects with public sector infrastructure and public services that rely on these. Public sector has been truly agile at developing and implementing internet based public services (for instance X-road, ID-card etc based solutions for simultaneously making queries to different databases and creating corresponding services). Nonetheless, enabling and encouraging cooperation by enlarging and perfecting the infrastructure or solutions based on it, and improving access to infrastructure and solutions could enable to develop ICT solutions that could transform business practices and processes in business and life towards efficiency in material and energy use and environmental friendliness.

One of the possible directions is to target data and the technology delivering the data. Recently, open data initiative has emerged in many countries, aiming to put the data collected for public purposes back to the public domains. Simplifying access to non-personal data could enable developing green ICT products and solutions. For instance, opening special data available in machine readable form would enable businesses to make up ideas for services that green business and life practices. Similarly, assisting the development and implementation of electronic billing, which could also partially be based on X-road and ID-card solutions, could help saving material resources.

Also, public-private cooperation in researching and developing green ICT would also be beneficial for raising awareness and clarifying the potential of the technology. We would encourage public sector to use its organizations and services as test and demo sites. Testing green ICT products and solutions via auditing and analyzing their output could clarify the potential of green ICT for improving efficiency and environmental friendliness. Demoing working products and solutions could at the same time inspire other private sector organizations to develop or implement green ICT.

Greening ICT and technology clusters

Development of green ICT products and solutions could be enhanced by integrating green ICT to other technology clusters. Currently, Estonian technology clusters have been rather good at making their first steps in developing innovative products and solutions. These clusters that cover different economic activities have good potential in devising, developing and commercialization of both industrial and consumer solutions that could improve environmental impact and efficiency of energy and material usage. Enterprise Estonia has had a program for developing technology clusters since 2008. It would be feasible that Enterprise Estonia could succeed in integrating green ICT to current clusters by promoting cooperation between companies of the same and different sectors and the companies and the research establishments. Also, as green ICT is a rather specific technological domain, it would be reasonable to initiate cooperation between clean technologies companies abroad, for instance in neighboring Scandinavian countries. Expanding the reach of the green ICT cluster would increase the success potential by seizing a larger scope of skills and competencies for the research, development and commercialization.

Clarifying the limits of cooperation

The interviews with industry leaders, solution providers and implementers revealed that there is confusion about the similarities of and differences between (1) legal cooperation and (2) the prohibitions on agreements, concerted practices and decisions by associations of undertakings which restrict competition. Cooperation between companies, for instance, in the form of technology research and development clusters are not illegitimate, but to diffuse the hesitation to cooperate, it is advisable to raise the awareness of public sector consultants, employer's organizations, entrepreneurs' chambers and bottom line companies concerning the advisable extent of collaboration.

In brief, as the implementers and developers of green ICT solutions are often from different companies and organizations of different economic sectors, cooperation is vital for conceiving, developing and commercializing green ICT products and solutions. Public sector could advance the cooperation by using public sector organizations and services as test and demo sites for green ICT products and solutions. This would help studying the feasibility to reduce environmental impact and to increase efficiency of energy and material use by ICT product and solutions. Also, the awareness of visionary and inspiring, and at the same time applicable and operational green ICT products and solutions would increase. Clarifying the potential and limits on cooperation between establishments, and incepting the development of green ICT products and solutions in knowledge-based business clusters would support overcoming the problem of constrained cooperation.

5.3.4 Financial support

Availability of sufficient financial resources is crucial for technology innovations. The development and commercialization of innovative clean technology solutions is often costly due to long development period, expensive human capital and sophisticated equipment. The green ICT survey indicates that 85% of establishments consider shortage of financial resources as very important or important constraining factor. As Estonian companies rarely have internal resources for development, public sector could encourage innovation in the field and speed up the development and adoption of green ICT products and solution by channeling resources to the field.

In fact, there are already applicable policy measures that support research and development of clean technologies by allocating financial resources. For instance, according to research- and development projects assistance conditions and procedures[56]' companies can apply for financial assistance aimed to support the research and development of technology solutions that could lead to sustainability and environmental friendliness. Still, based on the interviews, we recommend three related policy measures to increase the supply of financial resources for development of green ICT products and solutions.

Green public procurements, grants and investments

Although the Public Procurement Act[57] advises to prefer environmentally safe solutions, if possible, in real life this advice is rarely adhered. At the same time, as the total value of public procurement is close to 10% of GDP per year, public sector could have significant effect on the development and implementation of clean technology products and solutions. In brief, green public procurements, with which public authorities seek to procure goods, services and activities operating with a reduced environmental impact throughout their life cycle when compared with goods, services and activities with the same primary function that would otherwise be procured[58]' could support the development and implementation of green ICT products and solutions.

Also, public sector, more specifically Enterprise Estonia, Estonian Development Fund, Kredex, has been active at increasing Estonian companies performance sustainability by improving the availability of financial resources and managing financial risks. Still, according to expert interviews, the greenness or efficiency in material or energy usage rarely emerges as a criterion for selecting the case. Similarly to public procurements, the transfer scheme has not taken into account the greenness of the products and solutions that the companies are developing and commercializing. The opportunity here is to condition start-up and development grants (Enterprise Estonia), technology and start-up loans, business loan guarantees (Kredex) and venture capital investments (Estonian Development Fund) on their greenness and use of clean technology solutions including green ICT solution. This conditioning would channel financial resources to development and implementation projects that take environmental impact and efficiency of material and energy use into account and thus also motivate companies to develop such products and solutions.

It is true that the pre-evaluation of greenness of ICT based products and solutions could often be challenging, but if public sector would initiate the compiling and evaluation of differ rent evaluation and auditing methodologies, the challenge could be overrun (see also 8.3.2 "Clarifying the advantage of green ICT").

Green ICT development grant

Still, procurements, transfers and investments described above result, to a large extent, in developing and implementing clean technology solutions, which have certain characteristics and fairly well foreseeable market potential. Innovation process and its output in technology sector are often uncertain because the solutions and products are expected to transform industrial and consumer practices. Hence, the development and implementation of transformative green ICT solutions might need financing arrangements that would, to a large extent, redistribute business risks from companies to public sector and thereby enable investing establishments' and research and development institutions' creativity, skills and competencies in green ICT products and solutions. Currently, Enterprise Estonia, for instance, issues Innovation voucher grant and Product development grant.

Additional policy measure for this type of resource allocation could be related to public-private cooperation projects, to develop inspiring and visionary green ICT products and solutions and use public sector organizations and services as test sites and demo sites (see also 8.3.1 "Raising awareness about Green ICT"). Allocating

56 Teadus- ja arendustegevuse projektide toetamise tingimused ja kord. https://www.riigiteataja.ee/akt/117052011007?leiaKehtiv,, 22.11.2011
57 Public Procurement Act. http://www.legaltext.ee/text/en/XXX0005.htm, 22.11.2011
58 Buying Green! A Handbook on Green Public Procurement. http://ec.europa.eu/environment/gpp/pdf/handbook.pdf, 22.11.2011

public sector resources to clean technology research, development and demoing would also help to lessen divisibility and enable focusing on bigger and potentially transformative solutions that could change business processes on a larger scale.

In conclusion, public sector could help lessen the scarcity of financial resources for clean technology innovations by, on the one hand, conditioning public procurements and transfers to companies on the greenness of their products and solutions, and, on the other hand, allocate resources for public-private cooperation projects of developing and implementing green ICT products and solutions.

5.4 Implementation and evaluation of green ICT policy

In addition to mapping possible green ICT policy measures, attention has to be paid to the implementation and evaluation of the policy measures.

As briefly discussed before, green ICT policy is, to a large extent, horizontal, as it is directly instrumental for achieving environmental and economic policy objectives. Although potential green ICT specific policy measures outlined previously are expected to help enable growth potential by specifically targeting contingencies that are not that well targeted by general policy measures, they still contribute to general policy objectives and measures (for instance use of sustainable solutions and technology). Based on the interviews with stakeholders in public and private sector, we would not recommend the implementation of these green ICT policy measures by focusing on developing green ICT strategy or corresponding action plan. Although specific action plan might succeed in highlighting the potential and in increasing the awareness of green ICT, it would unnecessarily divide institutional and organizational resources across different policy initiatives that target technology innovation and make business practices more environmentally sound.

General, macro level expectations to economic and social development and corresponding policy measures are specified, for instance, in National Reform Program Estonia 2020[59] and corresponding Action Plan[60] via Enterprise Estonia, the Ministry of Economic Affairs and Communication has acknowledged the potential synergy of ICT and environmental considerations[61]. It seems that green ICT specific policy measures and an action plan for implementation and evaluation would be best outlined and mainstreamed to other policies, via soon to be renewed Estonian Information Society development plan. The ICT focused development plan would target general development challenges of ICT sector in Estonia that are not in the scope of the current analysis, and thus completely target development and implementation of green ICT. The development plan would also outline the principles of mainstreaming proposed green ICT policy measures to other public sector institutions' field of responsibility.

Indeed, successful development and implementation of the green ICT policy measures would depend on dividing roles and responsibilities between different public sector stakeholders. As the policy measures complement already employed policy measures, also the implementation of the measures would have to rely on current organizational structures. The proposed green ICT specific policy measures most of all target companies. Therefore we would suggest that the coordinating role for the implementation would be the responsibility of the Ministry of Economic Affairs and Communication. Responsibility for the implementation of the specific green ICT policy measures would become divided then as follows:

- Enterprise Estonia would:
  - Advance business consulting on efficiency, environmental friendliness and green ICT
  - Review company awards in cooperation with the Ministry of Environment
  - Initiate the integration of green ICT into other technology clusters
  - Conditioning transfers based on use of cleantech
- The Ministry of Economic Affairs would:
  - Compile green ICT products and solutions database
  - Compile, review and advance methodology for assessing greenness of green ICT
  - Analyze costs and benefits of existing green ICT solutions
  - Oversee the funding of research and development of exemplary green ICT solutions

59 National Reform Programme Estonia 2020. http://www.valitsus.ee/UserFiles/valitsus/en/government-office/growth-and-jobs/estonian-positions-on-eu-2020/National%20Reform%20Programme%20Estonia%202020.pdf, 22.11.2011
60 National Reform Programme Estonia 2020: Action Plan. http://www.valitsus.ee/UserFiles/valitsus/en/government-office/growth-and-jobs/estonian-positions-on-eu-2020/ENG_Estonia_2020_action_plan_2011-2015.pdf, 22.11.2011
61 Eesti Infotehnoloogia tulevikuvaated. http://www.arengufond.ee/upload/Editor/EST_IT/Eesti_Infotehnoloogia_tulevikuvaated__Marek_Tiits_&_Kristjan_Rebane.pdf, 22.11.2011

- The Ministry of Finance would:
  - Promote green public procurements

Succeeding in the implementation of green ICT policy measures would also require the evaluation of the process. Due to methodological and data considerations, it would be practically impossible to evaluate the effect of green ICT at macro level, i.e. developments like impact on environment or economic growth and competitiveness at the society's level. The evaluation would presuppose that it is possible to quantitatively decompose the variability of these indicators into determinants (for instance green ICT) and their absolute and relative effect on variability (for instance, it is virtually impossible to estimate the effect of Environmental Award for Business on economic development).

Therefore, the evaluation of green ICT policy measures should mainly focus on the success of developing and implementing the green ICT policy measures. This way, the green ICT action plan should specify output and output quality indicators that indicate the expected program results, and, also, principles of information gathering, analysis, and dissemination for evaluating the progress and achievements.

5.5 Conclusion

The analysis indicates that Estonian companies are rather innovative and rather frequently innovate in order to make their products, services or business processes more efficient and environment friendly. Also, one third of companies that have innovated their products, services or businesses processes, have used ICT products and/or solutions to make their products, services or processes more energy or material efficient or environmentally friendly. Taking all this into account, we can see that the business environment is rather supportive of developing green ICT products and solutions for both efficiency and environmental protection concerns. It is expected that it also facilitates the policy initiatives that aim at wider and more pervasive development and adoption of green ICT.

It was revealed that there are four obstacles that constrain wider and more pervasive development and adoption of green ICT in Estonia:

- Low awareness
- Uncertainty concerning advantages
- Constrained cooperation
- Scarcity of financial resources

Policy recommendations to address these issues are summarized in the following table.

No	*Restriction*	*Opportunity description*	*Policy measure*
1	**Low awareness**	Improving companies' and entrepreneurs' awareness about green ICT would increase the demand for and supply of corresponding products, services, solutions.	■ Compilation of database of green ICT products and solutions that are instrumental and have proven themselves as proper greening business practices ■ Business consulting on clean-technology and green ICT potential and good practice ■ Acknowledging and inspiring companies via Green (ICT) Company Award
2	**Uncertainty concerning advantage**	Studying the feasibility of improving performance, energy and material usage efficiency and environmental friendliness by using green ICT products and solutions, would help companies when selecting environmentally safe and operationally efficient designs; and consequently increase demand for and supply of green ICT products and solutions.	■ Public sector initiative in reviewing and developing analytical tools for pre-assessing and follow-up evaluation of potential advantages and disadvantages of green ICT solutions ■ Public-private partnership in follow-up cost-benefit analysis of already implemented and publicly marketed, but also drafted green solutions; and successive dissemination of best practices ■ Distribution of methodology for auditing green ICT solutions

No	*Restriction*	*Opportunity description*	*Policy measure*
3	**Constrained cooperation**	Improving cooperation between stakeholders of ICT product, service and solution providers and implementers would increase synergy and creativity in the field.	■ Public-private partnership in co-developing exemplary, pioneering, visionary, inspiring green ICT solutions, including cross-sector solutions (also using public sector organizations and services as test and demo sites) ■ Integrating green ICT to other clusters would initiate the devising, developing and marketing greening solutions (industrial and consumer solutions) for other economic activities and markets. ■ Clarifying limits of cooperation
4	**Scarcity of financial resources**	Increasing public transfers for developing and implementing green ICT products and solutions would speed up the adoption of green ICT.	■ Conditioning public procurements and businesses, entrepreneurship benefits and high risk investments on their greenness and use of green ICT solutions ■ Budget funding of exemplary, pioneering, visionary and inspiring green ICT products, services, solutions

We would recommend addressing the constraints, and outlining and mainstreaming the policy measures in soon to renewed Estonian Information Society Development Plan. Therefore, the coordinative role in the implementation process would be the responsibility of the Ministry of Economic Affairs and Communication. But to mainstream the measures, also cooperation with other ministries and public sector organizations is required.

Appendixes

Appendix 1 Analysis of green ICT relevant policy documents

Following paragraph presents an overview of how greening with ICT has been included in the key documents that have influenced global policy over the years.

1992: United Nations Conference on Environment & Development (UNCED)

While no one was actively trying to include greening with ICT in the UNCED conference in 1992, it is still important to understand the structure and approach of the outcome, because much of the global, national and local work with sustainable development is based or inspired by Agenda 21, the action plan that was the result of the conference.

In several ways, many working with green/environmental issues still regard this conference as a reference point, as it managed to develop an action plan that was very concrete compared with the results of many latter conferences.

From a greening with ICT perspective, it is, however, a problem that the current work that is based on Agenda 21 is very seldom focused on companies as solutions providers, on transformative solutions, or on ICT as an issue.

Numbers of times the key words[62] are mentioned in Agenda 21, 351 pages:[63]

ICT/IT: 0	Environment: 1379
Intelligent: 0	Sustainable: 647
Smart: 0	Problem(s): 109
Green: 16	Solution(s): 22
	Solution/problem score: – 5.0

2002: World Summit on Sustainable Development (WSSD)

20 years after UNCED, a new major conference took place, the World Summit on Sustainable Development (WSSD). This time the role of ICT was well know among thought leaders, but it was still almost totally ignored by both policy makers and industry groups.

Few days before the opening of the World Summit on Sustainable Development (WSSD), in Johannesburg, South Africa, WWF launched a publication that showed how Information and Communication Technology (ICT) could play a positive role in achieving sustainable development.[64] At The World Summit for Sustainable Development in 2002, WWF also arranged a workshop where the findings in the report where discussed. There was, however, no mention of ICT in the outcome of the WSSD.

Numbers of times the key words[65] are mentioned in the outcome document, 173 pages:[66]

ICT/IT: 0	Environment: 377
Intelligent: 0	Sustainable: 638
Smart: 0	Problem(s): 35
Green: 7	Solution(s): 11
	Solution/problem score: – 3.2

62 Regarding the term "environment", the word is counted only when it refers to the natural environment, not "business environment", etc. The solution/problem score is calculated by dividing the larger number with the smaller. If the larger is the solution, it is a positive value, if the larger number is problem, it is a negative value.
63 Report of the World Summit on Sustainable Development: Johannesburg, South Africa, 26 August-4 September 2002. http://daccess-ods.un.org/access.nsf/Get?Open&DS=A/CONF.199/20&Lang=E, 22.11.2011
64 New WWF report highlights potential for technology to protect the planet. http://wwf.panda.org/wwf_news/press_releases/?2651/New-WWF-report-highlights-potential-for-technology-to-protect-the-planet, 22.11.2011
65 Regarding the term "environment", the word is counted only when it refers to the natural environment, not "business environment", etc.
66 Report of the World Summit on Sustainable Development: Johannesburg, South Africa, 26 August–4 September 2002. http://daccess-ods.un.org/access.nsf/Get?Open&DS=A/CONF.199/20&Lang=E, 22.11.2011

The challenge was that those in the leading positions were from the ministry of environment and focused on the second generation of greening, also, most of them had very little knowledge about the ICT sector and the kind of solutions it can provide.

The most important outcome of WSSD from a greening with ICT perspective was probably the official recognition that business sector should be part of solution development. This recognition has probably been the root of one of the major problems, but it has also created opportunities. Post WSSD work has often included the business sector, which is good, on the other hand, big polluters and the industry associations, who are trying to protect the worst companies have often been invited, rather than the solution providers.

This is due to the second generation of greening, which focuses on incremental improvement and regards companies as polluters who should reduce their emissions, not as sources of solutions who need to accelerate sales of sustainable solutions.

Below is the key recommendation from WSSD concerning industry:[67]

> *Encourage industry to improve social and environmental performance through voluntary initiatives, including environmental management systems, codes of conduct, certification and public reporting on environmental and social issues,*

The focus of this policy, representing companies as sources of problems and incremental improvements, is an important problem in relation to greening with ICT solutions as it requires companies to become solution providers and deliverers of more incremental improvements.

General recommendations did include some important elements to guide policy makers, but very little has happened due to the vagueness of recommendations' nature. Below are the policy recommendations for government authorities:[68]

> *Encourage relevant authorities at all levels to take sustainable development considerations into account in decision-making, including on national and local development planning, investment in infrastructure, business development and public procurement. This would include actions at all levels to:*
>
> - *Provide support for the development of sustainable development strategies and programmes, including in decision-making on investment in infrastructure and business development;*
> - *Continue to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the costs of pollution, with due regard to the public interest and without distorting international trade and investment;*
> - *Promote public procurement policies that encourage development and diffusion of environmentally sound goods and services;*
> - *Provide capacity-building and training to assist relevant authorities with regard to the implementation of the initiatives listed in the present paragraph;*
> - *Use environmental impact assessment procedures.*

It should be noted that public procurement is seen as the key policy area to ensure sustainable development; yet, greening with ICT are almost never included in governmental procurement strategies.

2003: Word Summit on the Information Society (WSIS)

Right after WSSD in 2002 a preparation committee meeting in the WSIS process[69] was held. A coalition led by WWF and GeSI, together with UNEP, Grid Arendal and the UN University, engaged in the WSIS process, as this process had completely ignored the environmental aspect of ICT.

67 Report of the World Summit on Sustainable Development: Johannesburg, South Africa, 26 August–4 September 2002. http://daccess-ods.un.org/access.nsf/Get?Open&DS=A/CONF.199/20&Lang=E, 22.11.2011
68 Report of the World Summit on Sustainable Development: Johannesburg, South Africa, 26 August–4 September 2002. http://daccess-ods.un.org/access.nsf/Get?Open&DS=A/CONF.199/20&Lang=E, 22.11.2011
69 Sustainability Implications of the Knowledge Society – the environmental dimension. http://www.itu.int/wsis/docs/pc2/inf/environment/gesi.pdf, 22.11.2011

A joint paper was issued, with the key message was that a new work stream was needed: "Sustainability Implications of the Knowledge Society"[70]. For the majority of governments and organizers the idea that ICT could be used to help support a more environmentally sustainable development was a new one, as so far they had focused mainly on the physical creation of the ICT infrastructure and on the standards and rules related to issues like spectrum allocation.

The challenge was that people responsible for the WSIS process were usually from the ministry of information technology and had neither any knowledge nor a mandate to engage in greening with ICT issues.

Numbers of times the key words[71] are mentioned in the outcome document, 62 pages:[72]

ICT/IT: 88+ 0=88	Environment: 9
Intelligent: 0	Sustainable: 23
Smart: 0	Problem(s): 2
Green: 0	Solution(s): 3
	Solution/problem score: 1.5

For compiling the final report, the negotiators listened to the suggestions put forward by the coalition of businesses, NGO's, academics and UN organizations, but mainly vague references to ICT as a solution provider were mentioned[73] in the report.

> *20. E-environment*
> - *Governments, in cooperation with other stakeholders are encouraged to use and promote ICTs as an instrument for environmental protection and the sustainable use of natural resources.*
> - *Government, civil society and the private sector are encouraged to initiate actions and implement projects and programmes for sustainable production and consumption and the environmentally safe disposal and recycling of discarded hardware and components used in ICTs.*
> - *Establish monitoring systems, using ICTs, to forecast and monitor the impact of natural and man-made disasters, particularly in developing countries, LDCs and small economies.*

One significant policy recommendation was included in the document:

> *By 2005, relevant international organizations and financial institutions should develop their own strategies for the use of ICTs for sustainable development, including sustainable production and consumption patterns and as an effective instrument to help achieve the goals expressed in the United Nations Millennium Declaration.*

However, the post WSIS work has not significantly contributed to the greening with ICT, and the process is a good illustration of the challenges met, when the lack of knowledge and the reluctance to change old structures are combined. An important lesson for policy making and resource allocation is that focusing on processes only because they use the right terminology it is not enough, the ability to think anew and deliver results is more important.

The recommendation "Governments, in cooperation with other stakeholders are encouraged to use and promote ICTs as an instrument for environmental protection and sustainable use of natural resources" and the deadline set for 2005 was, however, used by WWF and ETNO to challenge the European Commission to work with businesses as a solution providers more closely (see below).

70 The Global e-Sustainability Initiative (GeSI). www.pamlin.net/new/wp-content/uploads/WSISprepcom-2.pdf, 22.11.2011
71 Regarding the term "environment", the word is counted only when it refers to the natural environment, not "business environment", etc.
72 Report of The Geneva Phase of the World Summit on the Information Society. http://www.itu.int/dms_pub/itu-s/md/03/wsis/doc/S03-WSIS-DOC-0009!R1!PDF-E.pdf, 22.11.2011
73 Report of The Geneva Phase of the World Summit on the Information Society. http://www.itu.int/dms_pub/itu-s/md/03/wsis/doc/S03-WSIS-DOC-0009!R1!PDF-E.pdf, 22.11.2011

2003: A Sustainable e-Europe

The European Commission, DG Enterprise commissioned a study in 2003 to identify "Relevant Aspects of the Relationship Between the e-Europe Programme and Sustainable Development"[74]:

> *"Transforming Europe into the most competitive and dynamic knowledge-based society in the world is at the heart of the European Strategy for Growth, Employment, Social Cohesion and Sustainable Development. The Digital Europe project should play a vital role in identifying synergies between the fields of e-business and sustainable development. I commend it to all involved in Europe's modernization and construction."*
>
> *Erkki Liikanen, European Commissioner*

Focus was not directly on the greening with ICT aspects, but on how the policy for ICT is generally related to sustainable development.

The policy recommendations in the aforementioned paper are interesting, as they are very similar to what is still being discussed, almost 10 years later. This indicates that the issue lies not in understanding what the opportunities are, but in the matter of how to create a policy framework that supports such development.

- *Examine the role of building codes in facilitating the development of ICT infrastructure in residential and commercial buildings, and the opportunities these might create for the greater use of "smart services"*
- *Develop a knowledge base on the extent of under-used capacity within the European economy, and opportunities to increase utilization through better yielding management and other ICT-based approaches*
- *Develop a new award scheme, either independent or linked to existing schemes, to highlight e-business initiatives that create significant environmental and social benefit (including helping SMEs to overcome problems which they face vis-à-vis larger organizations)*
- *Stimulate greater awareness among European businesses – and especially among SMEs – about the opportunities to reduce space costs, and create other business benefits, through advanced forms of e-work*
- *Encourage the development of sector-specific reporting guidelines for other parts of the ICT sector than telecommunications (e.g. hardware producers)*
- *Support initiatives to develop common data coding standards for on-line reporting so that information can be easily transmitted and integrated by users*
- *Encourage the development of collaborative initiatives to address e-sustainability issues among the non-telecommunications' areas of the ICT sector, either through existing mechanisms, such as GeSI, or by creating sub-sector specific organizations*
- *Extend the remit of the European Information Technology Observatory to gather data relevant to e-sustainability*
- *Develop an on-line consultation initiative to gain further information about the relationship between e-sustainability issues and competitiveness*
- *Examine the implications of open source software for sustainable development*

Numbers of times the key words[75] are mentioned in the report, 31 pages:[76]

ICT/IT: 106 + 3=109	Environment: 57
Intelligent: 0	Sustainable: 33
Smart: 4	Problem(s): 12
Green: 1	Solution(s): 3
	Solution/problem score: -4

74 A Sustainable E-Europe: Can ICT Create Economic, Social and Environmental Value? www.edis.sk/ekes/ict.pdf, 22.11.2011
75 for "environment" the word is only counted when it refers to the natural environment, not "business environment", etc.
76 A Sustainable E-Europe: Can ICT Create Economic, Social and Environmental Value? www.edis.sk/ekes/ict.pdf, 22.11.2011

2006: ETNO-WWF

The project and roadmap "Savings the climate @ the speed of light" was launched in 2006.[77] It was hard to identify leadership in the Commission as at that time DG InfoSoc approached greening with ICT as a research issue, DG Environment focused on problem sectors, DG Enterprise did not regard the idea of greening with ICT important in their work etc. So while everyone could see the relevance, no one took responsibility.

The following two recommendations were made for targets in the roadmap:[78]

> *The first phase is a concrete (numerical) target for 2010 of 50 million tonnes CO2 annually. This target is based on the implementation of several strategic ICT applications, e.g. virtual meetings, e-dematerialization and flexi-work. This also includes some additional tasks like policy revision (e.g. energy, tax, transport, innovation, etc.) and supplementary, parallel actions.*
>
> *The second phase is a target for 2020. This target should be set before 2010 and should include more services and system solutions, where a number of services are combined, as well as a more ambitious target for CO2 reduction. Possible focus areas for the second phase are sustainable consumption, production, city planning and community development.*

The challenge regarding targets for greening with ICT is that no agreed methodology exists to calculate the savings gained with greening with ICT. The current trend is dividing groups into two groups. One group wants to develop a close to perfect methodology before anything else is done, the other one to use existing methodologies to get a sense of the magnitude of reductions and base preliminary targets on those. Both sides are represented within most governments. The Commission seems to focus on getting a methodology for greening of ICT in place before greening with ICT.

Numbers of times the key words[79] are mentioned on the roadmap's 40 pages:[80]

ICT/IT: 155 + 3= 158	Environment: 41
Intelligent: 7	Sustainable: 69
Smart: 6	Problem(s): 21
Green: 11	Solution(s): 82
	Solution/problem score: 3.9

2007: World Economic Forum

During 2007 the World Economic Forum begun work aiming at including CEOs and Ministers at Davos in a discussion about greening with ICT. This work was delivered into a broader cross-industry climate change dialogue, and supported submissions put before ministers of energy and environment as part of the Gleneagles Dialogue on Climate Change, Clean Energy and Sustainable Development at their meeting in Chiba, Japan in March 2008. The aim was to make green ICT part of a business policy statement to be delivered to the G8 in Japan 2008. ICT would thus have a powerful and resonant voice at the highest political level.[81] In February 2008 the paper was agreed.

Here the challenge was that the structure of the World Economic Forum and those engaging in the preparations where mainly governmental affairs people and wanted to make sure that nothing surprising was included. Still it was clear that business could move a lot faster than governments if they wanted.

77 Saving the climate @ the speed of light First roadmap for reduced CO2 emissions in the EU and beyond. http://www.etno.be/Portals/34/ETNO%20Documents/Sustainability/Climate%20Change%20Road%20Map.pdf, 22.11.2011
78 Saving the climate @ the speed of light First roadmap for reduced CO2 emissions in the EU and beyond. http://www.etno.be/Portals/34/ETNO%20Documents/Sustainability/Climate%20Change%20Road%20Map.pdf, 22.11.2011
79 Regarding the term "environment", the word is counted only when it refers to the natural environment, not "business environment", etc.
80 Savings the climate @ the speed of light. http://www.etno.be/Portals/34/ETNO%20Documents/Sustainability/Climate%20Change%20Road%20Map.pdf, 22.11.2011
81 The Contribution of ICT to Climate Change Mitigation. http://www.pamlin.net/written/documents/Contribution%20of%20ICT-%20detailed%20paper.pdf, 22.11.2011

Numbers of times key words[82] are mentioned in the document, 23 pages:

ICT/IT: 95+7= 103	Environment: 23
Intelligent: 8	Sustainable: 12
Smart: 42	Problem(s): 3
Green: 17	Solution(s): 36
	Solution/problem score: 12

The WEF document is probably the first ICT paper from an organisation engaged with all the areas of business, not just ICT companies that have established a clear focus on greening with ICT and included all the important sectors, as well as the potential for information gathering and new sustainable lifestyles.

Infrastructure innovation
- *Increase energy efficiency of Buildings/infrastructure through intelligent systems & design*
- *Reduce the energy use of the manufacturing sector through intelligent systems, design and business models*
- *Enable smarter management of energy supply and demand*
- *Sustainable energy production*

Behavioural change & green enablement
- *Enable carbon accounting and the tracking of Green House Gas emissions through the Supply Chain*
- *Enable virtual meetings*
- *Energy efficiency of ICT products and solutions*
- *Increase energy efficiency of data centers and electronic devices*

2008: G8 Ministerial

In 2008, the chair of G8 that was held in Japan, brings green ICT up on the top-level for the first time. The reason why ICT solutions were discussed was because it had become clear that significant reductions require transformative solutions. Until the G8 meeting in T-yako only the Kyoto protocol existed, which focused on small reductions where incremental improvements could be enoughAt the G8, leaders agreed on the need for the world to cut carbon emissions, blamed for global warming, by at least 50 percent by 2050.[83] The fact that the Japanese government is on the forefront when it comes to greening with ICT, obviously made it easier to bring up the issue of green ICT.

Since then, the G20 has taken over much of the G8's role as a global clearing house and green ICT has not been on the agenda since 2008. There could be an opportunity to raise it again during the Mexican presidency of G20 in 2012, as a way to build on the Guadalajara declaration.[84]

2008: OECD workshop on ICT and environmental challenges

Together with the Danish government the OECD arranged the first high-level workshop with the aim of providing input for a global climate meeting, COP15 in Copenhagen.[85]

Numbers of times the key words[86] are mentioned in the workshop summary, 21 pages:[87]

ICT/IT: 128+22 = 150	Environment: 140
Intelligent: 1	Sustainable: 11
Smart: 5	Problem(s): 2
Green: 23	Solution(s): 9
	Solution/problem score: 4.2

82 For "environment" the word is only counted when it refers to the natural environment, not "business environment", etc.
83 34th G8 summit. http://en.wikipedia.org/wiki/34th_G8_summit, 22.11.2011
84 Guadalajara declaration for transformative low-carbon solutions. http://www.gesi.org/LinkClick.aspx?fileticket=5j52dDBfUZQ%3D&tabid=130, 22.11.2011
85 Workshop on ICTs and Environmental Challenges. http://www.oecd.org/document/63/0,3343,en_2649_33757_41732095_1_1_1_1,00.html, 22.11.2011
86 For "environment" the word is only counted when it refers to the natural environment, not "business environment", etc.
87 Workshop on ICTs and environmental challenges. http://www.oecd.org/dataoecd/34/20/40808014.pdf, 22.11.2011

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

- *Positive and negative effects of ICTs, which must be addressed within a framework that includes*
  - *direct/first-order effects regarding the production and use of ICT goods,*
  - *indirect/second-order effects regarding the application and use of ICTs more broadly, and*
  - *systemic/third-order effects analysing societal changes through ICTs;*

- *The ICT eco-system, which consists of much more than just the ICT producing sector. Participants agreed that it is essential to make the shift from simply calculating CO2 emissions of ICT production to evaluating the net impact of the technology life-cycle, including e.g. operating and use considerations, end-of-life management;*
- *The dynamics of the ICT sector as an independent variable, which requires analytical frameworks to be flexible with regards to recent and future developments such as the current shift from fixed-line towards mobile broadband.*

The OECD workshop verified the trend towards increased focus on greening with ICT, but, maybe even more importantly, also the need to include systemic impacts, such as impacts on lifestyles.

2009: EU: ICT for Energy Efficiency

Different sections of the Commission have been active in the green ICT for a long time and have demonstrated leadership in this area, even if the focus is still very much on incremental improving of existing systems (e.g. intelligent transport systems or smart meters. Both can be transformative, but in the EU their development is often supported by the old industry that does not want any significant change, that wants to keep to a business model based on selling as many cars and as much electricity as possible).

It was not until Viviane Reding took the lead in the Commission during 2008, that things started to move at a faster pace.[88] Just one year later, the EU arranged a major conference to discuss ICT for energy efficiency. [89]

The Commission's recommendations on mobilizing Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy" from 2009 are very interesting. On the one hand, these cover most important areas and the recommendations to the ICT sector focus on greening with ICT. On the other hand, the concrete recommendations to governments are still mainly about the greening of ICT.

Recommendations to the ICT sector are in the area of greening with ICT and include supporting clusters in a way that is world leading: [90]

- *In close cooperation with the buildings and construction sector identifies ICT solutions to improve the environmental and energy performance of new and existing buildings, and construction and renovation practices, leading to a joint roadmap for large-scale adoption of such solutions.*
- *In close cooperation with the buildings and construction sector addresses barriers to the wider use of ICT modelling and simulation tools and other relevant applications that facilitate and assist compliance with applicable regulatory regimes governing buildings performance.*
- *In close cooperation with the transport and logistics sector identifies ICT solutions to improve the environmental and energy performance of their services, leading to a joint roadmap for large-scale adoption of such solutions, in coordination with the work carried out under the ITS Action Plan.*
- *In close cooperation with the transport and logistics sector drafts a systematic framework to provide comprehensive, comparable and reliable data on the energy consumption and carbon emissions*

88 European Business Summit – Agreement about the need for a revolution, but little action. http://pamlin.net/blog/2008/02/european-business-summit-agreement.html, 22.11.2011
89 Working Together for Low Carbon Economy. http://ec.europa.eu/information_society/events/ict4ee/2009/conference/index_en.htm, 22.11.2011
90 COMMISSION RECOMMENDATION of 9.10.2009 on mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy. http://ec.europa.eu/information_society/activities/sustainable_growth/docs/recommendation_d_vista.pdf, 22.11.2011

Recommendations to member states are more focused on greening of ICT[91]:

- *Adopt and implement procurement practices that leverage the strength of public sector demand to promote the dematerialization of ICT goods and services.*
- *Through their national, regional and local authorities, pursue, and, where necessary, upgrade strategies for the roll-out of a dependable, high-speed, broadband infrastructure to facilitate monitoring and management of consumption, distribution and production of energy including renewables, and the introduction of community-wide systems such as smart metering, smart-grids and smart-cities.*
- *Through their national, regional and local authorities, extend the benefits of substituting offline administrative processes with online applications and services, which realize energy efficiency improvements, to all segments of their communities.*

The current situation creates tension in the domains where companies expect to see action in the area of greening with ICT, governments talk about greening with ICT, but the specific work focuses almost exclusively on greening of ICT.

One of the most important trends is a growing understanding that governments must take the lead in driving ICT-based solutions. The paragraph below is an excerpt from the document named "Mobilizing Information and Communication Technologies to facilitate the transition to an energy-efficient, low-carbon economy", European Commission Communication – COM(2009) 111.[92]

"Member States, central, regional and local authorities should be called upon to take the lead in driving demand for innovative ICT-based solutions that will help them to incorporate energy efficiency into all aspects of service delivery and infrastructure management, urban planning and policy-making. The use of advanced software optimization tools, in combination with reliable data, will be essential to effective decision-making."

One of the most difficult trends to assess is how the greening with ICT within the EU will develop – will it become part of the mainstream policy that is very concrete, or will it remain only as a vision for the EU, that does not bring about a notable amount specific improvements? Right now it seems that the DG InfoSoc is focusing on research activities, methodology development and few demonstration projects. It is therefore a significant opportunity to be part of and influence the EU's agenda, focus and approach for greening with ICT.

Numbers of times key words[93] are mentioned in the communication, 13 pages:[94]

ICT/IT: 38+0=38	Environment: 8
Intelligent: 3	Sustainable: 5
Smart: 20	Problem(s): 1
Green: 3	Solution(s): 14
(two of them relating to greenwashing)	Solution/problem score: 14

91 COMMISSION RECOMMENDATION of 9.10.2009 on mobilising Information and Communications Technologies to facilitate the transition to an energy-efficient, low-carbon economy.
http://ec.europa.eu/information_society/activities/sustainable_growth/docs/recommendation_d_vista.pdf, 22.11.2011

92 COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on mobilising Information and Communication Technologies to facilitate the transition to an energy-efficient, low-carbon economy.
http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2009_111/com2009-111-en.pdf, 22.11.2011

93 For "environment" the word is only counted when it refers to the natural environment, not "business environment", etc.

94 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on mobilising Information and Communication Technologies to facilitate the transition to an energy-efficient, low-carbon economy.
http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2009_111/com2009-111-en.pdf, 22.11.2011

Appendix 2 Study methodology

2.1 Introduction

The current study of green ICT is based on three different data collection and analysis methodologies:

- **Document analysis** – relevant strategic policy papers and other relevant documents and research papers, which are material on the global and Estonian level, were gathered and analyzed;
- **Interviews** – in-depth interviews with policy makers, industry leaders, solution implementers and providers, were carried out and analyzed:
- **Web-survey of Estonian companies** – information from around 400 Estonian companies with more than 4 employees was collected with a web-survey and statistically analyzed.

Analysis of collected data was carried out; it consisted of the analysis of global trends and Estonia's current state and potential, and policy recommendations for development. Next, we will take a closer look at each of the methodological parts.

2.2 Document analysis

The first part of the study focuses on global green ICT trends and future prospects. The data for this analysis was gathered from strategy documents relevant to green ICT trends, with a focus on the EU and the OECD documents. We present an overview of whether green ICT has been included and to what degree a word count was conducted (i.e. a quantitative content analysis) within a selection of strategic documents.

The following tables describe the calculation of the indexes presented in the global trends analysis.

Table 1. Calculation of the index "integration of low-carbon ICT in broadband plans"

Factors	*Weighting*	*Thresholds*	*Measure*
If "ICT" or "IT" is included in the text	10		Yes/no
ICT/IT as s source for emissions	2		Yes/no
Examples of ICT/IT solutions that help reduce emissions	20		Yes/no
Amount of current savings from ICT/IT solutions stated	10		Yes/no
Individual targets for ICT/IT solutions CO2 savings	5		Yes/no
Aggregated target for ICT/IT	5		Yes/no
Smart buildings	5		Yes/no
Smart grids	5		Yes/no
Smart transport	5		Yes/no
Sustainable lifestyles	5		Yes/no
Smart health/education	5		Yes/no
Innovation	8	8	Number
Efficiency	5	50	Number
Transformative	5		Qualitative
Dematerialization	5		Qualitative
TOTAL	100%		

Table 2. Calculation of the index "integration of low-carbon ICT in UNFCCC communication"

Factors	*Weighting*	*Thresholds*	*Measure*
If "ICT" or "IT" is included in the text	10		Yes/no
ICT/IT as s source for emissions	2		Yes/no
Examples of ICT/IT solutions that help reduce emissions	20		Yes/no
Amount of current savings from ICT/IT solutions stated	10		Yes/no
Individual targets for ICT/IT solutions CO2 savings	5		Yes/no
Aggregated target for ICT/IT	5		Yes/no
Smart buildings	5		Yes/no
Smart grids	5		Yes/no
Smart transport	5		Yes/no
Sustainable lifestyles	5		Yes/no
Smart health/education	5		Yes/no
Innovation	8	8	Number
Efficiency	5	50	Number
Transformative	5		Qualitative
Dematerialization	5		Qualitative
TOTAL	100%		

Selecting a number of key words can only provide a very rough indication of focus in documents, but the main purpose of using this kind of methodology in this paper is to identify when and where greening with ICT was introduced as an issue in the first place. As the area of green ICT matures more sophisticated approaches are needed to understand the trends, but at this initial state it helps to identify areas and processes where green ICT is included and thereby it is possible to spot early trends.

2.3 Interviews

In order to describe current developments, future prospects of green ICT in the economy and map challenges and policy recommendations, we carried out personal face to face interviews with green ICT stakeholders. Interviews were semi-structured by research questions and focused on the following topics:

- The readiness and awareness in Estonia to apply and develop green ICT,
- The current level of competence and potential to develop green ICT,
- Green ICT applied research,
- The challenges and obstacles organizations face when implementing and developing green ICT.
- Possible policy recommendations to enable and facilitate development and implementation.

Altogether, 23 interviews with policy makers, industry leaders, solution providers, solution implementers and applied research institutions were carried out from the end of September to the beginning of November. The following table presents the complete list of interviews.

Table 3. Interviews' sample

Nr	*Name*	*Structure*	*Function*	*Date*
1	Jarmo Tuisk, Aivo Lepp, Katrin Rits, Kristiina Kitsik	Ministry of Economic Affairs and Communications	Department of State Information Systems, Technology and Innovation Division	13.09.2011
2	Kristjan Tiik	Enterprise Estonia	Client Relationship Manager (Technology Development)	16.09.2011
3	Kristjan Rebane, Lauri Matsulevitš	Estonian Development Fund	Foresight division	21.09.2011
4	Tarmo Hanga	Estonian Informatics Centre	Department of Infrastructure, Head of Department	22.09.2011
5	Madli Kaju	n/a	Green ICT expert	23.09.2011
6	Agu Leinfeld	Ministry of Internal Affairs Information Technology and Development Center	Strategy Division, Head of Division	30.09.2011
7	Keit Parts, Henry Kattago	Estonian Government Office	Strategy Unit	4.10.2011
8	Mart Engelbrecht	Hewlett & Packard	HP Estonia Entity and Sales Lead	6.10.2011
9	Tiit Tammiste	AS EMT	Head of Technology Division	6.10.2011
10	Seth Lackman	Estonian Association of Information Technology and Telecommunications	Member of the Board	7.10.2011
11	Margus Danil	IBM	Country Leader, IBM Global Technology Services	10.10.2011
12	Mari-Liis Vihul	AS Elion	Head of purchasing office	11.10.2011
13	Taavi Talvik	AS Eesti Energia	IT Director	11.10.2011
14	Villem Tori	Union of Estonian Automobile Enterprises	Managing Director	13.10.2011
15	Margus Nael	Proexpert	Chief Operating Officer	13.10.2011
16	Priit Vimberg	Yoga Systems	Chief Executive Officer	17.10.2011
17	Maris Ojamuru	AS Swedbank	CSR Manager	19.10.2011
18	Erik Puura	University of Tartu	Director of the Institute of Technology	20.10.2011
19	Toomas Mõttus	Net Group	IT Infrastructure Division Manager	26.10.2011
20	Gediminas Misevičius	Swedbank Group IT	Logistics & Cards Support Department Manager	27.10.2011
21	Nele Nilb	AS Tallinna Vesi	Environmental specialist	By e-mail (31.10.2011)
22	Kalle Tammemäe	Tallinn University of Technology	Vice-Rector for Academic Affairs	2.11.2011
23	Kristo Reinhold	Schneider Electric	Managing Director Estonia	By e-mail (10.11.2011)

Collected textual data was analyzed qualitatively. Qualitative analysis focused on describing variance and argumentation in the text. Based on the scope of interviews and the description of readiness, potential, challenges and recommendations, we can deem the general nature of the qualitative data to be very good.

2.4 Web-survey

The purpose of the web-survey was to quantitatively estimate the readiness and potential of Estonian companies to develop or implement green ICT solutions.

Questionnaire

The questionnaire comprises three parts:

- Part A: Background questions about the companies for comparative analysis
- Part B: Innovative practices and uses of ICT within companies
- Part C: Companies' readiness to develop and implement green ICT

The complete questionnaire in Estonian is presented in Appendix 4.

Population and sample

The target group of the survey was companies, which have at least five employees. Planned minimum volume of the net sample of current study was 400 companies.

The sample was compiled based on random selection from the Commercial Register. Companies with less than five employees (according to the information from the Register) were censored form the extract used for the creation of the contact base. Because some companies do not include any data on the number of employees in the data base of the Commercial Register (estimated amount of such companies is approximately 15%), in order to guarantee the representativeness of the sample, also the companies that had not disclosed the number of their employees were included.

Due to time factor, the sample is mainly based on the data base of the Commercial Register owned by the Ministry of Economic Affairs and Communications. As the section of economic indicators of this particular data base is somewhat outdated (from 2009), in order to guarantee the representativeness of the sample, around 20% of the total volume of the initial contact base was compensated with a supplementary excerpt from 2010 and companies' data base that was created afterwards.

The sample was compiled using the idea of disproportionate stratified sample: the aim was to include equal number of respondents in all the strata – 67 (total sample with 400 respondents, divided among six strata).

The strata of the sample were the following (K1–K6):

- Primary sector (EMTAK 2008 section A–B)
  - K1 Small companies in the primary sector (5–50 employees)
  - K2 Large companies in the primary sector (50+ employees)
- Secondary sector (EMTAK 2008 section C–F)
  - K3 Small companies in the secondary sector (5–50 employees)
  - K4 Large companies in the secondary sector (50+ employees)
- Tertiary sector (EMTAK 2008 including the rest)
  - K5 Small companies in the tertiary sector (5–50 employees)
  - K6 Large companies in the tertiary sector (50+ employees).

Data collection

Average time for filling in the questionnaire was eight minutes (median was six minutes). To ensure the quality of the data, every respondent received a unique link, which forwarded them to the questionnaire. All the links could be used only once; the questionnaire could be filled in during multiple sessions.

A bit more than 5,000 invitations to participate in the study were sent out; around 1,000 replies with error messages (companies' contact address was obsolete, the inbox was full) were received. It should be kept in mind that due to the nature of e-mail correspondence the number of obsolete contact addresses could be larger.

In addition to the invitations, reminders to participate in the study were sent via e-mail; depending on the stratum, up to three reminders were sent. Additional phone drafting was carried out for strata that were difficult to fill up.

866 respondents in total responded to the invitations, out of them 594 completed filling in the questionnaire and, in the end, 416 qualified for the sample (at least five employees).

Final sample and weighing

Composition of the cross-section of the strata of the final sample can be seen in the table below (in case of an ideal distribution, each stratum would contain at least 67 respondents)

	50+ employees	*5–49 employees*
Primary sector	23	90
Secondary sector	67	89
Tertiary sector	50	97

Table displays the issue of finding large primary sector companies to be included the sample, as according to Statistics Estonia, currently there are only 49 such companies in Estonia. Therefore, on the larger scale, the results of the 23 companies interviewed should be considered more than presentable, even though they may seem modest at first.

To guarantee the representativeness among all the companies of a target group, data with the following weights was weighed representative:

	50+ employees	*5–49 employees*
Primary sector	0,1	0,2
Secondary sector	0,2	1,3
Tertiary sector	0,4	2,5

All in all, the statistical data is representative of companies with at least five employees.

Appendix 3 | Abbreviations

CIO	Chief information officer
CSR	Corporate social responsibility
EC	European Commission
EGS	Environmental Goods and Services
EHS	Environmental health and safety
EU	European Union
GeSI	Global e-Sustainability Initiative
GHG protocol	The Greenhouse Gas Protocol
ICT	Information and communication technology
ITS	Intelligent Transportation Systems
IT	Information Technology (in this report used as a synonym to ICT)
NGO	Non-governmental organizations
OECD	Organisation for Economic Co-operation and Development
PR	public relations
R&D	research and development
RQ	research question
UN	United Nations
UNCED	United Nations Conference on Environment & Development
UNFCCC	United Nations Framework Convention on Climate Change
WEEE Directive	Waste Electrical and Electronic Equipment Directive
WSIS	Word Summit on the Information Society
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund

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