# Green Mobile

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# GREEN MOBILE - EXPLORING THE ENVIRONMENTAL IMPACT OF STRUCTURAL CHANGE IN KNOWLEDGE-BASED ECONOMY

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**ABSTRACT**

This paper explores the role of the mobile industry in enhancing "green" behaviour both generally in the economy and within this industry itself thereby promoting an energy efficient knowledge-based economy contributing to CO2 reduction. The paper discusses how ICTs can facilitate long term structural changes towards sustainable behaviour of individuals and organisations. The benefits of using ICTs in work and everyday life are evident and its contribution to growth and jobs are irrefutable. Now there is a need for a radical transformation towards an eco-efficient knowledge-based economy. The companies that drive the knowledge-based economy need to be more innovative and eco-friendly than before. Information and Communication Technologies have an important role to play in reducing the energy intensity and increasing the energy efficiency of the economy. The paper will also discuss the driving forces and, e.g., the resulting new business models developed under increasing pressure from customers, shareholders and proposed legislative changes to improve their environmental credentials.

**KEY WORDS:**

Green mobile, ICT, Knowledge-based economy

## INTRODUCTION

We live in the era of a knowledge base economy. Information and communication technologies have transformed the way the society live and work. The ICT industry has a very significant role to play in improving energy efficiency to reduce greenhouse gas emissions through the deployment of new and innovative ICT developments.

Innovation in ICT and advances in technology are streamlining processes, creating more energy efficient equipment, improving business models and help domestic consumers reduce their energy consumption and costs. In particular, innovations in ICT can encourage improvement of environmental performance along the entire ICT life cycle and promote ICT applications to make the life cycles of non-ICT sectors more resource efficient.

The mobile industry, as part of the ICT sector, is in a unique position to demonstrate leadership in energy efficiency and CO2 reduction through structural changes and innovation. Mobile technologies and services can help reduce carbon emission and improve energy efficiency: by the replacement of material goods by non materials substitutes (e-ticketing, e-books), by moving business to the Internet, by adopting new ways of working, and by facilitating the integration of renewable energy sources.

In this paper the focus is on three areas relating to Green IT: first, the development of a greener lifecycle of ICT hardware; second, the development of solutions that can reduce the impact on the environment with the help of IT, and finally on the macro-level indirect effects resulting from structural and behavioural changes and adaptation to the ICT services as a part of everyday life and business.

The paper also outlines green business models as well as awareness and demand for green mobile solutions in other sectors such as the building sector (smart buildings), the energy sector (smart grid), the industry and the service sector (smart manufacturing). The specific cases of green mobile solutions implementation are also described. The paper ends with a conclusion including a suggestion for a framework promoting 'Green Mobile' solutions.

## GENERAL ECONOMIC IMPACT

Today's economies are increasingly based on knowledge and information. Knowledge is recognised as the driver of productivity and economic growth, leading to a new focus on the role of information and communication technologies. ICT opens new opportunities in the global economy and makes it possible to create new ways of working and living. Therefore it is crucial to encourage structural changes aimed at realising the potential of ICT to enable energy efficiency across the economy, e.g.:

a) in organization of business processes through the use of ICTs, e.g. substituting physical products by on-line services 'dematerialisation', substituting high carbon activities such as travel through the use of mobile communication technologies,
b) in virtualization of business, moving to the Internet (e.g. m/e-banking, m/e-commerce),
c) in developing new ways of working, learning and living (virtual meetings, teleconferencing, teleworking, m/e-learning, m/e health, m/e governance, smart

manufacturing and transport system, smart buildings and smart electric grid).

## THE ROLE OF INNOVATION IN THE KNOWLEDGE - BASED ECONOMY

From Adam Smith onwards all economic schools recognize in various ways technological improvements as an important factor of economic growth. The importance of technological changes is recognised by practically all mainstream economic theories. Overall we can say that the evolution of economy is based on the evolution of knowledge in general and on the evolution of technological knowledge in particular (Bormotov, M., 2009) and therefore knowledge and information are at the very heart of economic activity and wealth creation in advanced economies.

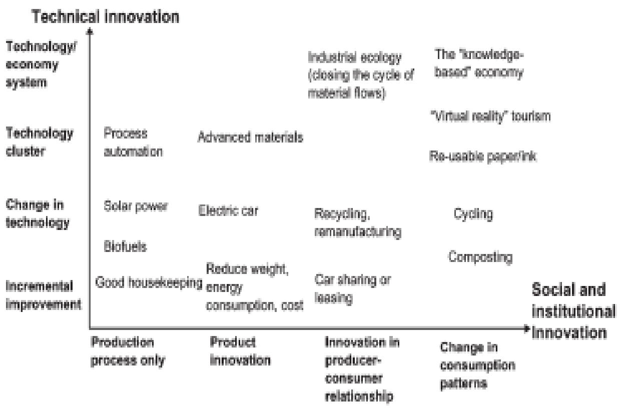
The term "knowledge based economy" results from a fuller recognition of the role of knowledge and technology in economic growth. Innovation is an element of great importance in the knowledge-based economy. Present economies are more dependent on the production, distribution and use of knowledge than ever before - they are increasingly based on knowledge and information. In many countries, knowledge is recognized as a driver of productivity and economic growth, leading to a new focus on the role of information, technology and learning in economic performance (OECD, 1996).

Innovations in ICT offer the possibility of modernizing the economy in the way that technology and society will be attuned to new needs and new solutions will create new opportunities. Innovation in ICT will not only improve energy efficiency but will also stimulate the development of a large market for ICT enabled energy efficient technologies that will create new business opportunities and new social behaviour.

The process of innovation, the production, and particularly the application of knowledge to generate new products or processes is central to the idea of the knowledge-based economy. As figure 1 shows, technological and social changes are closely connected.

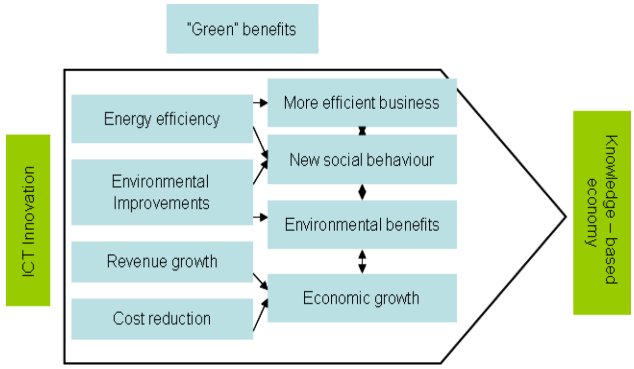
Figure 1.The technical and social dimensions of innovations.

( Ecoefficiency. OECD, 1998)




There are good financial results to be obtained from Green ICT innovations, mostly because energy prices are expected to rise, both as a consequence of the increased global demand and political requirements for reducing CO2 emissions. Figure 2 present the benefits for knowledge based economy from the implementation of "green" ICT innovation.

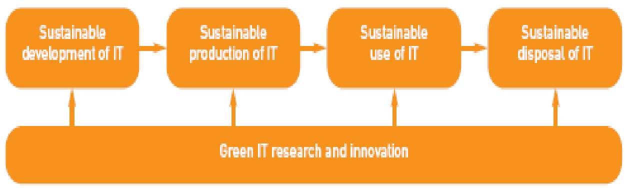
Figure 2. ICT Innovation (source?)




ICT-based innovations may provide one of the potentially most cost effective means to help reduction of the energy use across society and the economy.

Presently, there are a variety of new and existing technologies available that promotes Green ICT. Green ICT can be defined as research in- and use of IT in an efficient and environmentally friendly manner. The Action Plan for Green IT in Denmark present the Green IT approach that include different phases in the lifecycle of a product and all of these phases are supported by research and innovation in Green IT(figure 3).

Figure 3. Green IT research and innovation (National IT and Telecom Agency, 2008)




In the new economy, knowledge can do more than increase economic growth, it can also lead to structural changes in an economy and therefore in the society.

## THE ROLE OF GEEN ICT IN STRUCTURAL CHANGE

Structural change means re-engineering the way an organization operates. This can be done by e.g. substituting physical products by on-line services (dematerialization); moving business to the Internet; by adopting new ways of working; and by exploring the viability of using green suppliers and energy from renewable sources (Commission of the European Communities , 2008).

In knowledge-based economy, the energy consumption of the ICT sector should be put into the perspective of the potential energy savings that the use of ICT technologies can enable in other sectors such as the building sector, the energy sector, the industry and the service sector.

The mobile industry, as a part of the ICT sector, is in a unique position to demonstrate leadership in CO2 reduction and energy efficiency through structural change and innovation.

## SMART BUILDINGS

The energy consumption of buildings is mainly related to (European Commission DG INFSO, 2008):

- active and passive heating systems (ventilation and cooling)
- lighting and security (fire and burglary protection, access control and video surveillance)
- individual power supply
- large electrical and electronic equipment (e.g. elevators, escalators)

In all the mentioned areas, ICT-applications can reduce energy consumptions by e.g utilizing sensor-based monitoring and control in order to optimise lighting, ventilation and equipment performance.

40 pct. of the overall energy consumption is used in buildings, and this can be reduced with 50 % by using already existing technologies. From occupancy based lightning and heating solutions to automatic systems to capture sunlight, provide shade from unwanted warmth or developing energy positive buildings and neighbourhoods which generate the energy they need and sell any surplus generated - ICT has a role to play.

Starting in 2010, a European Union directive and legal regulations in some countries, e.g. Germany, will require all new and modernized buildings to be equipped with smart meters (Siemens, 2009). Customers will have control over electricity use while utilities will be able to more accurately predict demand, and to manage demand within their network by introduction higher rates at peak times.

## SMART TRANSPORTATION SYSTEMS

Transportation is third to the industrial sector in term of world energy use. Energy use in the transport sector includes the energy consumed in moving people and goods by road, rail, air, water, and pipeline. (Energy Information Administration, 2009). Growth rates for economic activity and population are the key factors for transportation sector energy demand.

Transport and logistics industries rely heavily on the use of ICT for the functioning and optimization of their overall operations. Therefore, transportation can benefit greatly from implementation of the ICT solutions. Mobile-enabled initiatives as: fleet tracking systems, load optimisation, onboard telematics, and synchronised traffic and notification systems can facilitate better communication and trip planning and driving a reduction in GHG emissions.

The ICT sector offers a number of other, non mobile-specific solutions to further reduce global GHG emissions and use of. energy such as software applications and monitoring equipment, These solutions enable optimal choices and transfer between different modes of transport of goods, i.e. intermodal shift, which support eco-driving and provide the means for truck route optimisation and inventory management.

## SMART GRID

The ICT sector provides various hardware and software components required for integrated smart electricity grids. Up to 30% energy saving is possible worldwide through better monitoring and management of electricity grids. ICT can make not only the management of power grid more efficient but also facilitate the integration of renewable energy sources. For example, Denmark generates half its electricity through decentralized grids, with wind power accounting for 20% of all electricity.

## SMART MANUFACTURING

Smart manufacturing refer to improvement in manufacturing processes to reduce waste and energy consumption through technology which supports activities such as:

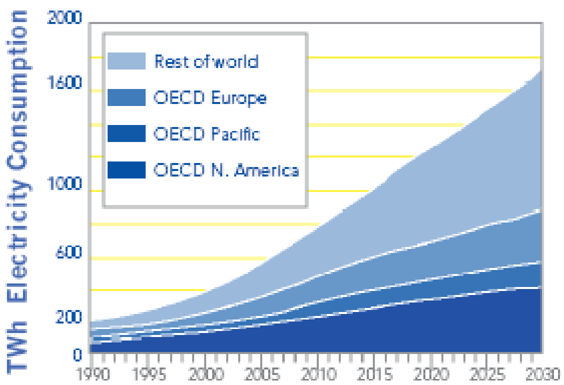
- Monitoring and management of production process
- Dematerialization of products at both the early design and delivery stages
- Improvement of logistics for the delivery of final products to end-customers and consumers

Further environmental benefits of ICT applications are also evident in areas such as water management, biodiversity protection, pollution reduction.

All sectors of economy will benefit to a varying degree, although the main focus is on the power grid, on energy smart homes and buildings and on smart lightning.

In the International Energy Outlook Projections (Energy Information Administration, 2009), total world consumption of marketed energy is projected to increase by 44% from 2006 to 2030. Therefore efficient energy use is essential to slowing the energy demand growth. (figure 4)

Figure 4. Estimated electricity consumption by ICT and consumer electronic equipment in the residential sector, by region, 1990-2030 (Forge, S. et al., 2009)




According to the SMART 2020 report, an energy efficiency revolution introducing more ICT in logistics, power distribution, motor systems and buildings could save 15% of global emissions in 2020, or five times the size of the ICT sector's own footprint from the internet, data centres, mobile phones and PCs (The Climate Group and GeSI, 2008).

## SECTOR SPECIFIC IMPACT

The relationship between ICTs, innovation and the environment is often examined in terms of three distinct kinds of impact:

- direct impact, which arise from the lifecycle of ICT goods and services: design, production, distribution, maintenance and disposal;

- indirect impact, which arise from the application and use of ICTs throughout the economy and society;
- systemic impact, which arise from changes in economic and social structures and behaviour enabled by the availability, accessibility, application and use of ICT goods and services.

## DIRECT IMPACT

### Terminals

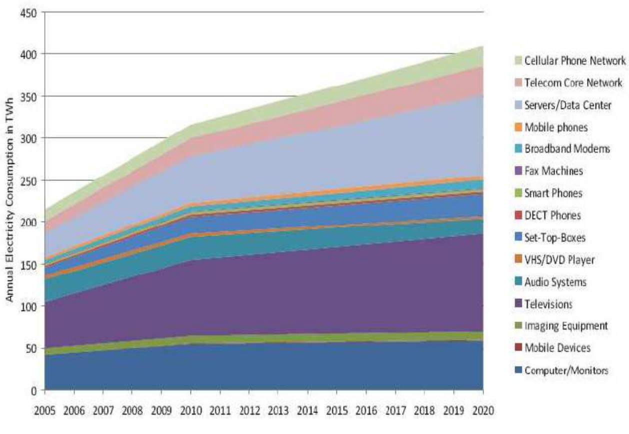
The most important life-cycle environmental issues for mobile phones are:

- carbon emission associated with handset production process,
- energy consumption during the usage,
- presence of some materials of concern in phones,
- collection of unwanted phones and their recycling.

Issues related to size and weight of mobile phones are already optimised as they are driven by business/customer requirements. Issues regarding energy consumption, more environmentally friendly production, presence of harmful materials, and recycling of mobile phones are, however, still open in relation to environmental improvements.

The energy consumption related to mobile phones is difficult to assess due to fact that the efficiency of IT devices depends on how it is used, e.g. always on and high on-line utilisation which lead to frequent charging. Annual electricity consumption by various equipments is presented in figure 5.

Figure 5: Annual electricity consumption by various equipment (Energy Information Administration, 2009)




In order to save energy, device manufacturers are working on increasing energy efficiency in the handset, increasing energy efficiency of the charger, using solar-power for handsets or for charging etc. Nokia estimates that if just 10% of the world's mobile phone users turned off their chargers after use, the energy saved in one year could power 60 000 homes.

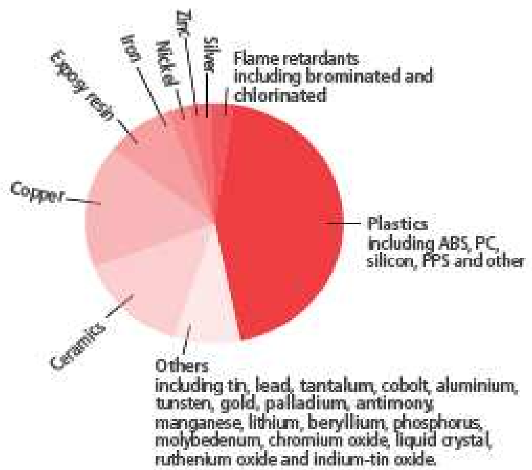
Even though power consumption per mobile phone will decrease due to higher charger efficiency, power demand of the mobiles will increase due to higher functionality. Most phones today support one or more of the standards 3G, GSM, and WiFi for data transfer. For example, the penetration of 3G is estimated at over 15% of cellular subscriptions worldwide and is over 70% in some countries and 3G Phones, e.g., need more power than 2G ones (due to more advancedInternet access, digital signal processing, polyphonic ringtones etc). Integrating different applications in a single general-purpose device, will result in much higher energy consumption and consequently much reduced battery life.

A major contribution of mobile (and ICTs) to climate change comes from the growing number of user terminals/ devices. Short product life cycle which is driven by the evolution of technology and the tendency of consumers to have a device with more applications is a further burden. Therefore designing a phone for easy dismantling will also be an important factor, as this would reduce the cost of refurbishment and recycling.

According to the GSMA Association, 80% of the mobile phones can be recycled and more than 70% of collected handsets from developed markets can be refurbished.

Reusing mobile phones can be the most environmentally friendly way to lengthen their lifecycle. The only problem seems to be lack of the necessary recycling infrastructure for end-of-life electronic equipment in developing countries. Data presented by GSMA Association shows that less than 4% of used phones were collected for reuse or recycling (GSM Association, 2008).

Figure 6 : Materials in a typical mobile phone (GSM Association, 2009)




Experience from operators shows that one of the most important factors influencing "take-back" scheme is the consumer education, awareness, convenience as well as the incentives provided to customers.

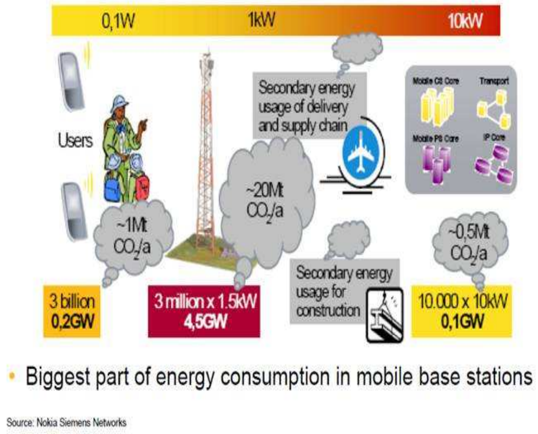
### The Networks

A mobile network infrastructure comprises of: radio network with radio base stations and radio network control equipment, a core network with switches, routers, servers and workstations and transmission equipment.

Most of the energy in a typical telecommunication network is consumed by the wireless network's base station sites.

From the perspective of a mobile system, radio networks account for around 80% of the total electricity used by an operator. Therefore radio network solutions that improve energy-efficiency are not only good for the environment, they also make commercial sense for operators and support sustainable, profitable business.

Figure 7: Energy consumption in Mobile (Skouby, 2009)




Mobile operators are improving the energy-efficiency of their radio networks through using energy-efficient products, optimal network design and by introducing the innovative use of alternative energy sources to run these networks. In the future, mobile towers could be self sufficient if wind turbines and solar system are used to power them. Currently mobile towers in developing countries are powered by diesel generators, which are not only harmful for the environment but also very expensive to operate. In Africa over 30 million litres of diesel per annum is consumed powering base stations (an average of 18,000 litres per base station per year). In this context wind and solar power is a feasible and cost effective alternative to using fuel generators at places where the main grid connection is not available. ABI Research is forecasting that in 2009 more than 800,000 base stations will utilize wind or solar energy and there is a potential for a 30% reduction of carbon emission (ABI Research, 2009).

Base station energy efficiency can also be improved by utilizing a wide range of software features in order to balance consumption according to load. For example, because night-time base-station traffic is much lower than during peak daytime hours, part of the base station can be shut down or its capacity can be set on power save mode at night. (Nokia Siemens Networks' intelligent network management solution).

The power demands of data centers are also increasing. Currently 15-20% of the money spent to operate data centres goes towards power and cooling (SMART 2020).

Traditional base station sites are located indoors, where the typical temperature of 25˚C is maintained with high energy-consuming air conditioning. By increasing the ambient temperature to up to 40˚C, energy consumption can be reduced by up to 30 percent in existing base station equipment.(Mobile Europe, 2008)

The high power consumption of 3G infrastructure is proving to be one of the most significant problems facing the wireless industry. Shift towards 3$^{rd}$ generation (UMTS) will increase the total number of components such as: base transceiver stations, main switch control, and further links to the backbone telecom network. Furthermore, the environmental impact of deploying large numbers of power-hungry base stations is becoming a major concern.

The four main elements of the solution for energy efficiency are:

- minimizing the number of base station sites;
- minimizing the need for air conditioning to cool the sites;
- using the latest base station technology;
- and, deploying software features that optimize the use of radio access for wireless communications.

Greater emphasis on energy savings in the whole economy, together with new legislation mandating the use of renewable energy, will drive the adoption of Green IT solutions in the network infrastructure.

## INDIRECT IMPACT

The green role of ICT not only includes emission reduction and energy savings within ICT sector, but also very broadly encompasses the adoption of ICT technologies to influence and transform the way the society works and the way people behave.

Some recent studies have estimated that potentially significant reductions in GHG could result from the use of ICTs to improve the efficiency of transportation systems, and from the substitution of ecommerce and tele-work for their physical equivalents. Illustrative examples include:

- Green IT services in the Asia-Pacific region (even excluding Japan) will grow to a US$2 billion opportunity by 2011, (Springboard Research)
- M-commerce: it is expected that by the end of 2009 74,4 million people will be using m-commerce worldwide; this number will double by the end of 2012.This will reduce person-transport and paper work.
- E-working - close to 100 million workers are expected to e-work either full-time or part-time by 2010. By implementing e-work companies will be able save money, enhance distributed work through e-collaboration, and manage the virtual workforce through effective communication
- Videoconferencing: There is an increased awareness and emphasis on reducing carbon footprint by cutting back on travels. This is one of the factors positively impacting the demand for videoconferencing.
- Globalization and an increasing number of remote workers is another factor behind the demand for new ICT solutions. Remote workers can communicate and collaborate regardless of localization, time, network or devices, also reducing travels and transportation.

Dematerialization; efficiencies in transportation, energy use, and production; and travel replacement are a few of the anticipated positive contributions. Conversely, some argue that efficiency gains from ICTs can actually encourage net increases in energy usage and consumption by lowering time and investment barriers.

## SYSTEMIC IMPACT

Systemic impact has arisen from changes in economic and social structures and behaviour enabled by the availability, accessibility, application and use of ICT goods and services. These ICT-enabled changes affect economic and social parameters such as: the attitudes, expectations and behaviour of individuals, the demand and supply of goods and services;

organizational structures; production, distribution and service processes; and governance in the private and public sectors.

One could said that systemic impact is a macro-level indirect effect resulting from structural and behavioural changes and adaptation to the ICT services as a part of everyday life and business.

Changes in economic and social structure are driven mostly by ICT innovation. Comprehensive Green ICT solutions offer numerous benefits for economy as a whole. It increases employee satisfaction, comfort, enable new knowledge, save resources, enhance safety and security, protect health, improve food and water quality, improve productivity.

ICT applications and wireless sensor networks provide not only new ways to communicate and transfer information, but also have a significant impact on the environment, e.g. smart buildings, logistics and transportation, environmental monitoring, security and surveillance, health care, animal tracking and precision agriculture, and smart grids & energy control systems).

ICT technologies can also enable a number of dematerialisation initiatives, such as teleworking, teleconferencing, etc., which generate significant environmental, economic, and social benefits by reducing the need for physical goods and travel.

Dematerialisation through the use of ICT can translate into:

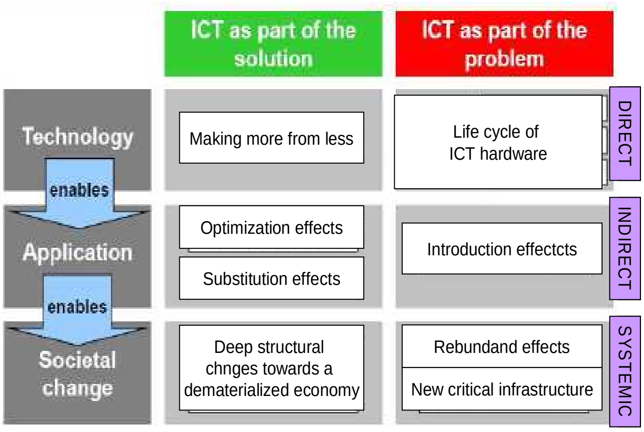
- the replacement of material goods by non materials substitutes e.g. letter replaced by e-mail, e-ticketing, e-invoicing, e-books,
- the reduction in the use of material systems, e.g. e-work, teleconferencing instead of driving to work/meeting.
- the conception and manufacture of products using less materials and energy and conception of a smaller or lighter products.

Advances in communication technologies have made it possible for consumers to have a high degree of access to financial services without travelling to a financial institution. Similarly, e-commerce, e-health, e-government or e-billing, reduce the need for travel, printing, in person meetings, office and commercial space. All these initiatives are enabled by ICT technologies in one or more ways.

More specifically, there are spill over effects on the rest of the economy as ICT diffusion leads to innovation and efficiency gains in other sectors.

To fully assess the potential role of ICTs in energy efficiency and GHG emission reduction it is necessary to look into three mentioned impacts: direct, indirect and systemic, by systematically identifying various changes in individual behaviour, economic and social structure (figure 8).

Figure 8. Conceptual framework (Lorenz H., 2008)




It is widely assumed that increased energy efficiency will result in reduced GHG emissions. In the case of the ICT sector, increased energy efficiency can result directly from the improved efficiency of ICT equipment itself, or indirectly in the application and use of ICTs in smart meters, congestion control systems, and other innovative products and services. The most energy efficiency and with high potential to CO2 reduction ICT services and applications are:

- teleworking, flexi-working, audio/video conferencing,
- m/e commerce
- m/e health, m/e learning, m/e governance
- smart buildings (heating ventilation and air conditioning, lighting and security systems, elevators and escalators)
- smart transport system
- smart electric grid (supply and demand management, advance metering infrastructure)
- information, monitoring and control

## GREEN BUSINESS MODEL

ICT is an enabler to improve energy efficiency across the economy, through enabling new business models and improved monitoring and finer control of all sorts of processes and activities.

As oil becomes more scarce and expensive, renewable energy will be used more and more to power telecommunications networks anywhere that grid power is not available. Using alternative power solutions, such as wind and solar energy, will help lower an operational expenditure and reduce the environmental impact.

The major suppliers of base stations have anticipated the growing demand for green networks and have introduced a variety of low-energy products as well as renewable energy power solutions. New entrants are also emerging, providing tailored bolt-on power solutions for base stations.

Implementing green business model means for companies being efficient and not wasting money, resources and time, particularly as wholesale energy prices increased considerably during the last few years. In the long term, energy prices are expected to rise, both as a consequence of the increased global demand and of political requirements for reducing CO2 emissions. As energy supply is becoming an increasingly important cost factor for companies, it is in this area in particular that green ICT offers significant savings potential, through more efficient hardware and the intelligent use of energy.

Green ICT has, however, a positive impact not only on costs, but also on the company's revenue. According to a recent study by the market research company McKinsey, 21% of end customers already deliberately choose products from companies acting in a sustainable and environmentally-aware manner and accept a higher price for this. A further 13% are also prepared to "pay" for this commitment to the environment, but have not yet put this willingness into action. The noticeable environmentally-aware behaviour of the company thus represents an additional - and perhaps decisive selling point towards end customers and thus also opens up new customer groups. [14].

Moreover there are further good results to be obtained from Green ICT initiatives. Renewable energy solutions can in certain geographical areas simultaneously expand access to energy services, help the environment, and boost revenues for operators. It is estimated that 485 million mobile users worldwide have no access to the electricity grid, e.g. more than 40 percent of Kenyans own a mobile phone, but only 23 percent of the population has access to the electricity grid [15]. Uganda has 30 million inhabitants, but 93% of the population has no access to electricity. They rely on small shops and kiosks that charge phones for a fee, in some cases through hook-ups to portable car batteries. This inconvenience means that most of the time the mobile phone is powered off and operators are missing revenue opportunities.

New mobile phones, chargers and charging docks attached to a base station (mobile phone tower) or a solar charging station in a village center that uses solar power can vastly expand phone usage among new, mostly low-income users of the developing world. A study conducted by the GSMA Development Fund, 'Mobile Phone Use in 2009' found strong interest in off-grid charging among mobile operators covering Africa, Asia, and Latin America. Sixty percent either already had such technologies or were investigating them. The association estimates that solar charging, if made widely available at affordable cost, could boost average revenues per phone user by 10 to 14 percent, and that means, off-grid charging offers a lucrative business opportunity for operators [16].

The precise value of green ICT technologies has been difficult to quantify in a simple cost-benefit analysis due to the multi-tied benefits they provide to the various sectors, the consumers, and society.

### Greener behaviour in mobile industry - examples

Recently more and more companies have decided to ensure more environmentally friendly production and to implement recycling programs in their green initiatives, e.g.:

- Motorola Renew is a basic terminal made out of recycled water bottles. - no bluetooth, no GPS, no video player, no camera, no Wi-Fi
- Nokia's "Remade" - concept phone is built almost entirely out of recycled materials, including aluminum cans, plastics from drink bottles, and old car tires.
- Nokia 3110 Evolve is an eco-friendly and energy-efficient mobile phone made from over 50% renewable material. It's also packaged in 60% recycled content and comes with an efficient charger that uses 94% less energy than the old ones used.
- Samsung Blue Earth (launched in 2009) – is a touch screen solar-cell mobile phone made from recycled plastic culled from plastic water bottles. Both handset and charger are free of toxic materials. A full solar charge – 10 to 14 hours – provides power for four hours of talk time
- Digicel, phone operator which operate in developing countries across the Caribbean, Central America and the South Pacific – launched the Coral-200-Solar, claimed to be the world's first ultra-low-cost solar-powered mobile phone. Coral-200-Solar has an integrated solar charger built into the phone,
- T-Mobile USA has announced the introduction of Green Perks, a new application promising exclusive discounts on environmentally conscious products and services.
- Safaricom, Kenyan mobile network operator, launches Solar-Powered Mobile Phone (2009). Simuya Solar has been manufactured under a partnership with ZTE, the handset has been made by them from recycled materials and it possesses an in-built solar panel. Safaricom has got more than 60 Base Transmission Stations (BTSs) that are being operated on renewable energy sources wind and solar-driven turbines in various parts of the country.
- Sony Ericsson plans to make all phones green
- Telenor (Pakistan) has announced a new energy efficient GSM network that will reduce its energy consumption by 50 percent.
- >100,000 Huawei green base stations have been deployed reducing CO2 exhaust by 170,000 tons - equal to the CO2 exhaust volume of 70,000 Chinese in one year.
- Global auditors, KPMG is replacing a fixed LAN with a Wi-Fi solution at its new Global Headquarter in Amsterdam saving US$2 million on its network building and reducing its annual OPEX by an estimated US$760,000

## CONCLUSIONS

Above a number of arguments for Green Mobile are presented. The actual implementation in contrast so far has been rather limited Real changes need a coherent effort addressing the different aspects and make them support each other. Use of ICT is expected to continue to grow following the pattern so far transmitted data increases 10-fold every five years resulting in 15-20% increase in energy consumption. But ICT can decrease energy consumption and decrease GHG effects from all other industries by 15-12% by year 2020.

To achieve the benefits from ICT development innovative government policies and social actions are needed including activities on many levels, e.g.

- Deconstruction of conventional public services and replacing them with ICT-based solutions services
- Deconstruction of conventional business models and replacing with ICT solutions
- Using the ICT ecosystem to enable energy efficiency, virtualization and energy-aware software architectures
- Standards for green design

Considering that the global aspect is dominant in ICT in as well production and use as in environmental effects, solutions need to be found at the global level to be efficient. Global agreements and treaties are, however, likely to be quite hard to arrange at this level of details in a foreseeable future as evidenced by the recent COP15 in Copenhagen. The combined demand pressure from consumers and economic self interests at the supply side may, however, promote a green development as illustrated by the industry examples above.

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