ICT for Development and Climate Preservation? On the Need for more Realism and more Courageous Business Models

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The ICT business is now busy adapting to the message from the The Intergovernmental Panel on Climate Change (IPCC). Hence, consultancy companies are now re-launching energy saving applications invented in the ICT research labs and taken to market a decade or two ago: distance work, distance education, Intelligent Transportation Systems (ITS), video conferencing, software for logistics support, virtual project rooms, smart homes, etc. (e.g. Mellon et al. 2008 for Telstra; McKinsey 2008 for The Climate Group on behalf of the Global eSustainability Initiative (GeSI)[1)]). Also, the ICT business and politicians alike have for a decade or two argued for ICT to be an essential tool in lifting the world's poor out of poverty by cutting costs, freeing capacity, and creating work. Its effect as to spurring economic growth has even created revival-like enthusiasm, and forms a platform in its own right for forwarding the ICT business as being socially responsible, important, and wishable (e.g. Vodafone 2005; Entner & Lewin 2005; Deloitte & Touche LLP 2008).

There is no doubt that ICT applications can help us save on resources and (fossil[2)]) energy, and make us much more efficient in our tasks. It is also next to self-evident that rolling out such large and new infrastructures as mobile telephony spur economic growth. It even seems clear that we are nowhere near harvesting the full potential from applications like the ones now re-launched as being particularly "green". So far, so good. But worse, it seems that those same ICT efficiency gains make energy and resource consumption increase substantially. If so, there are some problems here that should be brought to the table and discussed to help shape the initiatives needed so that there will actually be gains harvested, not just an increase in non-sustainable consumption.

The purpose of this article is not to suggest simple, realistic and ready made solutions, but to expose the problems and to shed some light on what needs to be done to harvest the gains in ways that can contribute to environmental sustainability and to sustainable social development. To this author, such alternative strategies will need to take less conventional directions that will have substantial implications for business models and business strategies. It seems a good start simply to draw the picture as it emerges when listening to those who have been studying the topics of environment and development for some decades. Unrealistic and impractical? Yes, but no. Realism is a next step.

1 The Challenge: Ecologic Sustainability at Odds with Economic Growth and Development Theory

"The world can in effect get along without natural resources, so exhaustion is just an event, not a catastrophe."

This 1970s quote from the renowned economist Solow (quoted in Smukkestad 2005) demonstrates that a theoretical discipline can get pretty far away from real life. Commonplace as such attitudes were, they provided the intellectual basis for the ideas of "de-materialization", i.e. the "de-coupling" of economic development spirals from natural resources. ICT became a growth engine that should create sustainable economic growth, create jobs, and eradicate poverty in a world facing depleted resources. Such visions got reflected in numerous initiatives and plans for ICT for Development, ICT for sustainability, *e*Government, the EU "Bangemann report" (European Union 1994), etc.

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1) *The Climate Group and The Global e-Sustainability Initiative (www.gesi.org) are two cases in point: GeSI is an organisation supported by UNEP and ITU to contribute to the realisation of the Millennium Development Goals. It supports the view that ICT is a powerful instrument, increasing productivity, generating economic growth, and improving the quality of life of all, and states that "GeSI considers this a crucial principle to extend the influence of ICT into all aspects of socio-economic development, applying these technologies to both rich and poor countries to achieve sustainable development across the globe." The Climate Group consists of 30+ corporations, 80+ governmental bodies and various supporters working to "promote the development and sharing of expertise on how business and government can lead the way towards a low carbon economy whilst boosting profitability and competitiveness." (www.theclimategroup.org)*

2) *For practical purposes energy is used here as synonymous to fossil energy, and all energy efficiency gains mean fossil energy efficiency gains: Within the timespan relevant and for most geographic areas, all energy use, even hydropower based, has alternative use as replacement of fossil fuel.*

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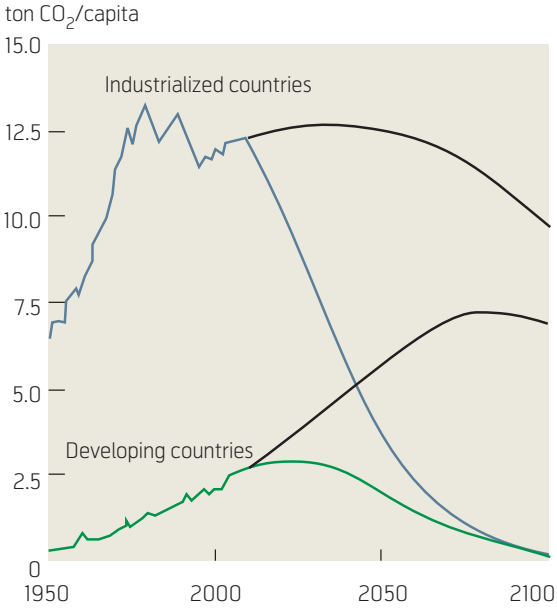
However, while years of large investments in various e-initiatives have gone by and many have no doubt harvested large gains from making services or indeed entire sectors more efficient, economists have also come to understand that ecology imposes limits on all economic development as to material welfare, and that – although complicated – there is a connection between economic growth and the use of energy and other resources, subjecting growth to limits as to the increase in resource use that might result from it, or be used to achieve it.

It took the ex-NASA scientist James Lovelock 30 years to get acceptance for his "Gaia theory", the theory that the earth (i.e. "Mother Earth" or "Gaia") is a homeostatic system, or indeed a system of systems, with certain thresholds that should not be exceeded if humans are to live on this planet (Lovelock 2006). The Gaia theory is now generally embraced, also by the IPCC (International Panel on Climate Change), after 30 years of being ridiculed and being declared unscientific. The IPCC reports state that within a generation or two resource use has to be reduced substantially not to surpass these thresholds. Calculations based on the IPCC data and a reckoned target of ≤ 2 °C temperature rise show that fossil energy emission reductions must be in the range of 90 % in the industrialized countries and 98 % even in the non-industrialized countries where per capita resource use is already low, to reach such a goal (Magnus 2008; Holtsmark 2008). Accordingly, the great vision of lifting the poor South out of material under-consumption, eventually by reducing material over-consumption in the rich North, is relegated to the status of a once sweet dream, if there shall be such a "moderate" temperature rise, and is now to be replaced by more realistic ambitions.

The two positions taken by Solow and Lovelock demonstrate two fundamentally different mindsets:

Normative economics is about how to create relentless economic growth, reflected in GNP or in a company's value creation, with growth as a proxy measuring stick – though a dubious one – for increase in welfare for the stakeholders, whether owners or society as a whole. Impact on the environment is either not part of the model, or can be represented by a cost (e.g. in the form of the present value of a future cost), which may be considered acceptable or not. Growth is success and spurred by incentive systems, status quo is backwardish and no fun, and "negative growth" is failure. The models are conscientiously simplistic, leaving out by purpose the many factors that the agent is not responsible for by convention, and forcing real life to conform to the model.



Source: Holtmark 2008, based on IPCC's A1-MESSAGE scenario

Figure 1 The content of development needs a revision: Historical and needed paths of fossil energy emissions to keep temperature within 2° C (coloured), versus predicted emissions by business-as-usual (black)

In the ecologist mindset, however, homeostasis (i.e. balance in a feedback based system) is the very foundation and criterion of success: Normative ecological theory is about how to keep the resource metabolism – whether caused by humans or others – within acceptable thresholds, so as to *avoid* setting off the spiralling or accelerating developments that follow from breaking homeostasis. Ecological systems are intricate and intertwined natural systems with floors and ceilings that metabolism cannot trespass without bringing the system out of balance. While self-enforcing growth spirals are the Mother of all development in economics thinking, and an attractive goal, self-enforcing growth spirals create collapses and havocs in ecology when the carrying capacity of their resource base is exceeded, and the system – be it technological, political, social – might return to higher entropy (more chaos, more even distribution) as it dissolves. From an ecologist mindset, ideas of eternal advances of mankind and relentless growth appear as mindless, dangerous, and backwardish. The models are complex, and seek to include the many factors that man cannot control, but has to adapt to.

Are the two – economic growth and maintaining an ecological balance – reconcilable? That is, may economic growth and ecological balance happen simultaneously? The Rio Declaration on Environment and Development states in 1992 that such reconciliation is indeed feasible and coins the term "sustainable development" for it. Still, the going rhetoric sounds as if it were. However, it seems that the whole idea of "sus-

tainable growth" was a legacy from Solow and mates, a political necessity of the time, and a contradiction in terms that would later be de-masked: Beyond exploiting nature's yield, economic growth forcibly leans on extracting natural resources. At some point, economic growth creates material consumption levels that surpass the thresholds of ecological sustainability. In the message from Lovelock and IPCC and their precursors that energy and resource consumption is since long surpassing those thresholds, lies the message that sustainable ecosystems and sustained economic growth are compatible within some limits only, and not with the present levels of energy and resource consumption, resulting in resource depletion, distructed eco-systems, and greenhouse effects.

Hence, what the IPCC tells us between the lines is that "modern society" is a social configuration variety about to fail in its project, as societal varieties mostly do when they surpass the thresholds for their ecosystems (Diamond 2006). There is an evident case for Luddites[3)] here: Any traditionalist – be he from the countryside of Texas, Afghanistan or the Caucasian plains – is in his rights to set up a defence against "modernisation", which from his angle most naturally emerges as a project to destroy social configurations which have kept on with relatively stable ecological adaptations for hundreds of years. Most traditional societies may claim a longer and more successful track record as to being compatible with their resource base, than modern mass consumer society.

What then about 'development'? What has development theory to offer? The very idea of 'development' is a brainchild of the Western Enlightenment (18th century), i.e. the large project of bringing the people of Europe out of impoverishment, a laborious life with fear, plagues and superstition, as well as the subjection to the brutal forces of nature and tyrants (Smukkestad 2005).[4)] The remedies were what today are the characteristics of the Western idealized image of "modern society": *reason*, *education* and *science*, law and *justice*, *virtues* and *industriousness*, the *free individual* as the central unit of society (contrary to clans, kinship, and guilds, or being subjected to serfdom etc), *roles achieved* in society instead of inherited, as well as *standardisation* and formal law to regulate transactions and benefit from scale, *technology* to extract resources as well as improve efficiency in production and bring new knowledge, *economic reasoning and regulation* to organize society's dispositions of wealth, and efficient and impartial *political and financial institutions* as the organisational framework of it all. The success stories of this historical mission, e.g. in the form of welfare and social security, are evident to all. These lines could not have been written without them. Europe in the late medieval ages was not an attractive place.

The idea that change would and should be to the better, and that the meaning of life was to strife for it, got deeply embedded in professional as well as conventional understandings of 'evolution' in all areas of life and academic disciplines – be it politics or culture, religion, biology, history, social sciences, polytechnics or linguistics: 'Development' and 'evolution' meant not just changes over time, but change from the simple to the more complex, from the inferior to the superior, from the primitive to the modern, from the darkness of ignorance to Enlightenment by "true knowledge and science", from scarcity and subjection to nature to abundance and liberation from nature. To spur and guide such a development among people "backwardish" or "primitive" or "uncivilized" was understood as a mission that the more advanced had to undertake – if not for other reasons, then for purely altruistic and moral ones – to bring welfare and prosperity to the lower classes, to the countryside, and to the global South and East.[5)]

Hence, the European explanatory as well as normative models as to the roots of backwardness and how to create progress were based on the evolution that took place in England in the 18th century and later, and they became the basics of development theory from the 1950s and onwards, "economic growth" being a key: The roots of the "initial state of backwardness" from which society should depart, were found in traditional inefficient production methods, in lack of practical know how, in lack of practical skills, in limiting traditions, and in lack of impetus (or triggers by today's lingo), all of which considered to be deficits which were to be mended to bring about development.

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3) *Term for opponents of technological change, named after Ned Ludd, an English worker who is supposed to have destroyed weaving machinery around 1779 (www.thefreedictionary.com).*

4) *The main points and some details in the description here of the evolvement and state of development theory lean on the eminently simplified overview given by Smukkestad.*

5) *It seems to the author, having the Germanic Norwegian as his mother tongue, that the extensive use of Latin in educated English makes it harder to see how deeply the Western historical perspective connects the passing of time with positive and wishful change, leaving other combinations to be impossible, unimaginable or unwished. "Advanced" means "having come further forward", as in German "fortgeschritten", or the Norwegian "fremskreden". It is closely paralelled to "progress, -ive", from "pro-" (forward) and "gredi" (to step forward in a proud or esteemed manner). Accordingly, evolving without improving, or development without progression, appear as being contradictions in terms.*

Typically the thinking was that some new sector, e.g. mechanical industry, would induce change that would "trickle down" to the rest of society. The manpower to this industry would come from the supposedly underemployed people in the countryside (mainly in agriculture), who would then constitute a new urban working force. In the next run, new and more efficient production methods and more efficient distribution systems, market information systems, and other mechanisms that reduce "friction" in economy, would then create increased production, increased wealth, increased demand, increased supply, hence increased welfare, and – through taxation – income to government. Hence, government would become able to provide infrastructure and other government services spurring new growth, and so on.

The idea of "developing countries" was firmly based in this development mindset, with a practical political and commercial twist: In 1949, as the colonial regime went towards its end, US president Harry Truman launched the idea of "developing countries", i.e. countries on the way to an economy, a society and a culture similar to, i.e. "as advanced as", the ones in the West. Hence, by implication, "developing the underdeveloped" would contribute to the advance of humanity.

Since then various "development schools" have fought regarding the definitions of the concept of development, goals, strategies, interests, measurements (indicators/indexes), and over the measuring of failures and successes. However crucial the differences might have seemed and still seem, and however important they have been in shaping history, they have still mostly operated within the cosmology of growth economics – without being concerned by global carrying capacity limitations.

Wolfgang Sachs, one of the leading critics of traditional development theory and a forerunner in transforming it to include the ecological perspective, sums up the status of development theory as it stands confronted with the global environmental threats with the following words:

> *"The idea of development stands to-day like a ruin in the intellectual landscape. Its shadow obscures our vision."* (Sachs 1992, quoted in Smukkestad 2007)

Gilbert Rist, a development scholar and theorist of French academic tradition, takes this warning even further (Rist 1997 & 2006): To him, the world view of economics is incapable of relating to the needs for ecological homeostasis. Why? Rist shows how basic assumptions are heavily inspired by European 17th century cosmology and religion and lead us astray by false assumptions that provide their own proofs by changing the world into their image: The norms, ethics and behaviour it leads us to adopt and impose, are destructive to traditional exchange patterns which carry important social values and in the same token impose limitations as to the exploitation of nature. Hence, the kind of development that economics imposes on the rest of the world ultimately embeds a European belief system that expands and "invades" other social systems, reshaping them to conform to the model behaviours of economists' thought – fostering behaviours which are non-sustainable from an environment perspective.[6)]

If Sachs and Rist were alone, we could write them off as eccentric. But they are not. They are voices from a huge and multifaceted, loosely tied global alliance of persons and movements. The common message of this organisational swarm, as its common features emerge once one starts to look for them, may be summed up as follows:

"Modernisation" is an instrument for *weakened* ecological sustainability – at a global, regional, national, or local level – imposing a growth based economy, population increase, and a culture with ambitions of material consumption beyond the carrying capacity of the ecosystem. Corporations, governments, and local (urban) elites seem caught in thought patterns that are instrumental to this destructive system, and their *raison d'être* is at odds with sustainable life. Development towards more sustainable ways of life would therefore often mean "de-development" into more locally based economic systems, reverting to traditions and local knowledge that is adapted to nature's carrying capacity.

Such views are easily found as ingredients in the ideologies or motivations behind many causes fought for on the world scene and come in all kinds of wrappings: religious revivals, regionalists, anarchists, Islamists, clan upheavals, New Age adherents, green movements, left, right, and third world rhetoric. The views might not form coherent and all-encompassing belief systems like the great ideologies of the 19th and 20th century, and they often lead to standpoints that seem bewildering or even reactionary as well as leftist through the lenses of conventional left-to-right political thinking.[7)] In our context here, what unites them, is first and fore-

6) *(Fukuyama 1992) even argues that we have passed a "year zero", as all cultures of importance have accepted the modernisation model. Hence it would be too late to revert to such more traditional cultural values. Economists have through the last decennials tried to bring the limitations of nature into theory. Herman Daily and Gretchen C. Daily are among the outstanding ones.*

most that they claim – with the support from many of the world's foremost minds within economics, politics, technology, relief organisations, and social sciences – that the concepts of growth and development must be re-defined to mean something else: They offer a "third road to development", under slogans like "Another world is possible!". Some meet in Quran schools[8], some meet in conventions like The World Social Forum, some in local community groups or on their thousands of web sites on the Internet.

In a world where globalization and universal principles as well as practical solutions to eradicate miseries have been the order of the day for several decades, such counter-forces are weak and fragmented. But their views are bound to gain ground: They make the world understandable – in ways combinable with any religion, any local culture. They provide a counter-current to "the world system"[9] and an alternative to the feeling of just being a puppet in a string on the world scene. Such views also provide an enemy, a target, a platform for action. They even provide Utopian goals and an understanding of oneself combinable with traditions, self-esteem and involvement, as an alternative to strive for a new and foreign identity provided by Westernized mass society.

To the ICT industry and its adherents, like the proponents of ICT for Development and ICT for Environment (ICT4D and ICT4E), these movements pose two challenges of very different order:

1. How to relate to such movements and views?
2. What has ICT to offer to such perspectives?

As to the first of these challenges, society at large – traditional as well as modern – offers a multitude of mechanisms as to reconciliation of opposing views and interests (clan and neighbourhood meetings, consumer and environmental protection laws, consultative organs, freedom to speak, to organize, etc). *Stakeholder theory*[10], the precautionary principle, *LCAs* (Life Cycle Assessments), ecological design principles (e.g. the *Hannover principles*, see later), and the forthcoming *ISO 26000 standard on Social Responsibility* (planned to be finalized in 2010) are some examples of new tools designed particularly to reconcile project planning, government and industry with nature as well as other interested parties within its surroundings. Such tools shift the focus from end-of-pipe evaluation of effects to the planning or pre-planning phases and to design methodology and management and process systems. Hence, any development project or business initiative should expect to be subject to early-in-the-process evaluations as to environmental as well as social sustainability at levels ranging from local to global.

As to the second of these challenges – what ICT has to offer – this will be the topic in the second half of this paper.

2 ICT and Sustainable Development – Is ICT Here to Help?

The potentials of ICT as a welfare instrument are evident. It is still a technology – or a family of such – characterized by continued innovation as to its applications, where huge efficiency gains can be harvested. Plans and policy declarations for social development abound accompanied with ambitions such as to close the gap between the West and the Rest, alleviate poverty, make public services more efficient, improve market information and the like. Accordingly, a large number of academic and non-academic studies analyze the use of ICT and dissect the various causes, corollaries, effects, conditions, etc. that contribute to social change through the use of computers, software, mobile phones, telco products and services, and so on (Donner 2008).

The validity of these studies and the social beneficial effects of such projects are not discussed below, neither is any doubt cast on them. This is however not contradictory to the main point made below: The power of ICT applications lends them to turning local economies into growth spirals – a most wanted good, but problematic at a higher level of analysis, as growth

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7) *An interesting example is the blend of arguments about ethics, terrorism, technology, ecology, psychology, economics, sociology and politics put together in "The Unabomber's Manifesto" or "Industrial Society and Its Future" by "the Unabomber", Theodore John "Ted" Kaczynski, the American mathematician who from the late 1970s into the 1990s mailed bombs to people at universities and airline companies he found were hubs in driving technological and social change (Kaczynski 1995).*

8) *(Hobsbawm 2007) shows in detail how religious revival, terrorism, banditism and the Modernization project are intimately connected.*

9) *"The world system" is a term coined by the world system theorists of the dependency school within development theory (Wallerstein 1974, as well as later works where the theory is expanded to present times). A main point is that poverty is explained as a result of "de-development" in the peripheries resulting from unequal exchange through power and trade relations with centers, i.e. through exploitative relations built mostly over long time spans.*

10) *A normative theory originally by R. Edward Freeman (1984) as to whom and what should be considered interested parties to a corporation. See e.g. http://en.wikipedia.org/wiki/Stakeholder_theory. Stakeholder theory expands the list of interested parties in e.g. an enterprise from owners and employees to include i.a. local inhabitants, future generations, and could in principle even comprise an ecosystem or a way of life.*

also triggers energy increase and extraction economics. These effects need to be addressed at a strategic and business model level. They therefore lead us in the next run to sketch up some elements for business models that could become part of the solutions.

3 Potent, Pervasive – and Perilous?

Investments in ICT globally amounted in 2005 to somewhere around 3 trillion USD, which makes ICT among the strongest shaping forces on the globe – economically, culturally, as well as politically (www.nepalit.com/Feb2006.htm)[11]. Of the main and most spectacular shapers of the globalized, "flat world", the lion's share has to do with ICT – in the restricted sense of PCs, World Wide Web and the Internet, software for cooperative work, open sourcing, outsourcing of the Y2K measures, offshoring, insourcing, in-forming, as well as individual, fast terminals (like laptops, software game equipment, mobile phones and PDAs) (Friedman 2005). If we also take into account that ICT is now present in almost everything else, like aircraft, cash registers, automatic door openers, echo sounders as well as puppets and dog neclaces, the shaping force of ICT becomes overwhelming.

This extreme pervasiveness and influence makes ICT the realm for business development *ad infinitum*. ICT components now embedded in practically all production based on the former technological revolutions such as the mechanical, chemical and biological – enforce this picture even more so, and bring about tremendous and rapid improvements as to capacities, energy efficiencies and cost in production.

Simply put, ICT is a bundle of technologies for realizing ideas developed in the 19th century and before: mathematical and logical operations to be performed by technological devices, speech and other information streams that are carried, stored and forwarded by mechanics or electricity. Seen as such, ICT is just a particular group of the many technologies all serving the purpose of helping mankind in its value creation activities. All technologies that prove viable, do so in terms of offering some kind of efficiency gain. Such gains are created and harvested, i.e. used somehow by someone for some purpose, when the technology is applied. At some point in time the technology might be "absorbed", i.e. the efficiency gain has become the norm, and the advantages it offers are regularly disposed of for some purpose. Hence, the room for twisting the way the gains are harvested is larger when a specific technology is new. Business models and organisational forms connected have similar attributes and opportunity windows.

In the general enthusiasm over what extraordinary gains mankind can have from ICT, we may – as we did with e.g. PCB – underestimate negative impacts, particularly indirect effects, not instantaneously observable: If it is right that ICT is a driver for increased energy consumption and weakened sustainability, it would mean that the energy efficiency improvements marketed by the ICT business as "green", may, paradoxically, add to the climate problems, and that measures should be taken to amend it, instead of adding to the problem by believing – or worse, pretending – to solve it by increasing the use of ICT.

To drill further into this view, we have to establish a basic distinction that seems frequently overlooked, causing development strategies to emerge that most probably have detrimental effects on the aggregate level.

4 Efficiency Improvements by Factor 10, 5, 4 – and 1

In the early 1990s, the Wuppertal Institute for Climate, Environment and Energy developed the idea of a "Factor 10" improvement, i.e. that utilizing the same amounts of energy and resources ten times more efficiently *for any unit of production*, would be an appropriate ambition for the industrial world to cope with environmental problems and resource scarcity. Among environmentalists, the idea caught on. Later, the environmental movement settled for the less ambitious "Factor 4" in an attempt to gain acceptance from politicians and industry, i.e. getting resource spending down by 75 %, in other words a 400 % improvement in resource efficiency. (Indeed, the Telenor headquarter at Fornebu near Oslo is a Factor 4 building as to the reduction of energy consumption per man/year compared to total energy use in the company's many previous facilities in the Oslo area (Høyer 2003).)

Various rough figures have been around as to the *reduction in total consumption* of energy needed in the *industrialised* world by 2050 if there were to be room for a rise in welfare in the *developing* world. 80 % reduction has been a commonly mentioned figure. 80 % reduction means "Factor 5", and equals a

[11] *The origin of this source is unknown. OECD figures are of similar orders, though split such that this author has not found any global aggregate figures. Of much more importance, however, is that although high, one might expect the figure to be far too low as an indication of the importance of ICT as shaper of society and ecology, as it probably only comprises products where ICT is considered the main feature, e.g. not cars, watches, kitchen apparel, lawn mowers, radios, sun panels, air conditioners, welding machines and other equipment where ICT significantly enhances functionality and/or efficiency.*

500 % improvement in all energy efficiency, i.e. getting five times more production volume or welfare out of the same amount of resources.

For comparison, the European Union's perspective on energy efficiency in its "Renewable Energy and Climate Plan Package" is that energy consumption all along the supply chain should be reduced by an amount permitting a 20 % reduction in import of fossil fuel by 2020. If benevolently interpreted as a 20 % energy efficiency increase, it would mean a modest Factor 1.25 as goal for 2020[12]. Such figures tell that industry cannot wait for the politicians to come up with reduction schemes: Stimulating consumption increases in parts of the world without corresponding decreases in others, means unsustainable growth. Industry has a role here to provide politicians with the needed legitimacy to make braver decisions, and help with solutions.

4.1 Efficiency Gains with ICT: a Piece of Cake, as with Consumption Increase

"Factor 5" might seem harsh. As to efficiency gains from ICT, however, it might seem to be a piece of cake: Efficiency gains from ICT are frequently much larger, as was documented in 2000, when then environmental manager of Telenor, Ellen-Birgitte Strømø and the author commissioned a literature study as to what research could at that time tell us on the topic (Evjemo & Paulsen 2000): Already in the 1990s, the CO_2 emissions throughout the lifecycle of voicemail, mobile phones and video conferences had been calculated, and estimates had also been made on energy savings from using e-mail. The resource efficiencies were found to be miles above the ambitions of the Wuppertal Institute. For example, the life long, i.e. from cradle to recycling, CO_2 emissions from a mobile telephony hand set – network use included – was estimated to equal one single 1.8 km car drive. In such a case, Factor 1000+ seems more appropriate as to the effect of using mobiles instead of car driving, and Factor 10 a pale ambition!

There is a vast pool of similar examples that were brought to the fore in the 1990s: ICT enabled traffic control systems result in higher throughput and less cars running on idle. Route planners (logistics software) were developed to provide more efficient distribution of merchandise. Video conferencing and telephone meetings and a number of other ICT-based services were developed to provide business expansion for telcos as well as opportunities for replacing CO_2-generating transport of molecules with next to "CO_2-free" transport of bits. Also, since the mid 1990s, "virtual project rooms" have triggered net-based cooperation and "flat" organisational forms, "materialized" so to speak in a host of virtual fora.

The gains from creating platforms for "remote cooperation" replacing transport of flesh, blood and documents with transportation of text, sound and images, are obvious. We are thus in possession of a fantastic arsenal of environmentally sound solutions, by and large the arsenal of "green solutions" that are now launched by the ICT business as a means to de-materialize transportation. Hence, we could start anew to calculate the number of meetings that can be replaced by meetings over the net, while freeing road capacity and time, and reducing CO_2 emissions. – Yes, we did calculate such things a long time ago. See for example (Aardal 1982). (McKinsey 2008) and other consultants now address a new generation, pointing at business opportunities as well as positive climate effects.

So, the findings were – and are – that ICT certainly has the potential to contribute considerably to more energy efficient and hence sustainable welfare creation.

This potential adds to the potential of what is normally called "eco-design" or "sustainable design", applicable to ICT as well as non-ICT items. Such design principles are described in a rich body of literature (see e.g. Wikipedia: "Sustainable design").[13] With ICT having become almost ubiquitous in parts of the world and in all kinds of products and tools, such design principles will increasingly become a demand. Such "greening" of the business has been demanded since long, and has finally become mainstream through regulations regarding pollution, as well as "Green ICT" and Climate Challenge Programmes.

4.2 But it's the Total that counts!

Most environmental policy issues, most "greening" of private or public enterprise, as well as most ICT for sustainable development initiatives, are about *energy or resource efficiency improvements*, at the level of production costs, per units of transactions, and the like. However, what counts in the context of climate change, is the level of *aggregate resource use or emissions*. The two are not directly related: Efficiency

12) *It is not a simple task to figure out how this "Renewable Energy and Climate Plan Package" has been put together and what it actually does consist of. One might use the following as a starting point: http://www.euractiv.com/en/energy/energy-efficiency-eu-action-plan/article-143199.*

13) *While eco-design initially addressed waste and pollution in manufacturing, and continued through establishing environmental requirements into the design process of things to minimize impact on nature, this tradition now also addresses replacing things with services, as well as the development of services that reduce environmental effects.*

gains at the individual equipment level may be achieved without resulting in reductions in aggregate levels. Lack of distinction blurs the view and the seeking for solutions.

So, even this coin has a flip side: As ICT develops and takes efficiency gains to new levels as per unit processed (e.g. bit/km) it also creates opportunity spaces for increased energy consumption and makes us consume more of them, a challenge not yet properly addressed.

5 A Flip Side Called "Rebound": Efficiency Gains Lost to Increased Volume

While efficiency gains might come easily with ICT, it is on the other hand highly possible that the gains obtained will be used for new resource consumption. It might even happen that the gains achieved become the driver as such for far more consumption. Hence, the ever more pervasive use of ICT may then trigger resource demands to such an extent that it might zero out the gains, and – worse even – cause a net increase. This downside effect is known as "the rebound effect", and was – together with the upsides – reported in (Evjemo & Paulsen 2000).

Examples abound:

Replace the old POTS phone with an ISDN phone or a PC with a "softphone" (e.g. Skype) and energy consumption will increase substantially. How much? A very rough and sketchy estimate, not even including the added energy needed to make the network run at higher bandwidths, is achieved by multiplying the number of broadband (XDSL and ISDN) subscribers in a country by the electricity consumption per day of a PC (e.g. 150 W always on). As to Telenor's fixed broadband customers (mainly located in Norway) this added consumption would amount to somewhere in the order of 1800 GWh per year. Even with ample tolerance for lack of precision we see that substantial power consumption is involved, and that at least a substantial share, is taking place at the edge of the networks. (In a climate sustainability context such consumption of energy as well as resources are intimately connected to the network and must be part of the same strategic plans to be addressed properly, as the edge is where the customer value is located.)

Good ICT-based flow regulating transport systems, e.g. "green waves", in conjunction with low energy prices cause increased traffic volumes.[14] Just-in-time based logistics is often mentioned to lead to increase in the number of deliveries, such as to sushi restaurants and car factories, which base their business on high-frequency deliveries and minimal warehousing. Hence, total traffic volumes go up. Web based consumer markets might save on warehousing, but also increase energy demands, as far more small packages are sent individually across long distances instead of whole pallets being sent the first legs, and than repacked before delivered to their close-vicinity final destinations. Also, the higher product availability due to the virtual markets on the World Wide Web, i.e. lower information cost, should be expected to lead to increased consumption.

In the early 1980s an often referred example of rebound within "office automation" was the case of two regional bank offices in the cities of Bergen and Oslo, 400 mountainous kilometres apart, integrating their IT systems for efficiency purposes and to reduce travel expenses[15]. However, the staff travels between the two cities increased – caused from getting more projects in common between the two branches, and therefore more reasons to meet to get to know each other and coordinate activities face to face in addition to doing so by email, fax and telephone calls. So also, e-mails seem to lead – as do phones, mobile phones and faxes – not only to reductions by substitution, but also to massive increases in communication, to more cooperation at a distance, and, as a result, more reasons to meet, and more involvement at locations we would otherwise only have dreamed of visiting. As percentage of transactions physical travel might well decrease, but in absolute volumes it might well increase. Overall figures show it does, and that is where the climate sustainability problem lies.

So, from an efficiency point of view, ICT often means more efficient value creation, higher rationality, and higher welfare. However, from a climate policy or sustainability point of view, we have – whether we are business, government or consumers – a problem here.

Is this anecdotal evidence of any practical importance? That is, are we talking losses to rebound that really matter? Are ICT induced efficiency gains not at least helping us in the right direction by substitu-

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14) *Such effects on traffic were calculated and reported in the early 1990s by the Fraunhofer Institute. My reference is a report on telecom and transportation from then, too well archived somewhere in my bookshelves for me to find! The fact that better roads create total traffic increase, not just cars to move from other roads to the new ones, is also well known to the roads and transportation professionals.*

15) *Also here, the source is lost in history. The two local banks that merged, were, according to the author's memory, Kreditkassen (Oslo) and Bergen Bank (Bergen).*

tion larger than rebound? We are talking volumes that matter, and at least sometimes, substitution of less importance:

Take "World of Warcraft" – played by millions of youngsters scattered around the globe – as an extreme, though clear, example: At the specific activity level, the energy saved from "de-materializing" long distance connections between hundreds of thousands of players should mean increased sustainability account of ICT. However, "World of Warcraft" can hardly be said to substitute other transportation, but is bit-transportation added, mostly substituting playing in the nearest park with wooden swords. Even the air conditioners to get rid of the heat from the players' scores of always-on-PCs might be considered part of the communication system, adding to the environmental footprint of ICT.

Similar cases might be made of broadband and mp3 players: They substitute music distribution on disc by music distribution over the net, but with a simultaneous massive increase in the number of players, batteries and melodies copied. World energy consumption will probably not decrease from this, but more likely increase. Databases take over paper archives, and word processors and email replace typewriters and mail. But we profit on the occasion to increase the information flow, e.g. by adding millions of new web-pages per day. Global paper consumption goes up, not down.

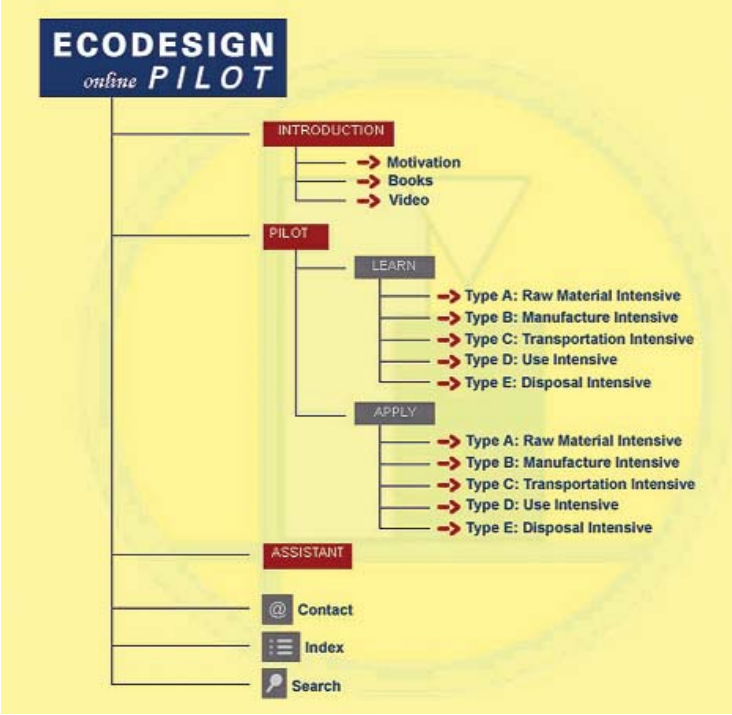

Figure 2 Overview of an interactive online tool for product eco-design, developed by Institut für Konstruktionswissenschaften, Technische Universität, Vienna (source: www.ecodesign.at)

The most shocking news might be that this knowledge about rebound effects from ICT is not new at all. But it has not been listened to: It has been a source of concern for a long time, with seminars, hearings and warnings. For example, we find a flood of papers focusing on e-trade and energy consumption (see e.g. Behrendt et al. 2003), and many authors have since long described the internet as a Trojan horse for increased electricity consumption (see e.g. Barthel, Öechtenböhmer & Thomas 2001).

In fact, experience based suspicions have been on their way to be given theoretical support since William Stanley Jevons in 1865 published his warnings that the demand for coal did rise after the breakthrough of James Watt's far more efficient steam engine. – The demand for coal did not fall as would then be expected[16]. The "Jevons' paradox" has in more recent research on energy use been labelled "the Khazzoom-Brookes postulate". In 1992 the economist Harry Saunders showed that this postulate – "that improvements in energy efficiency work to increase, rather than decrease energy consumption – was consistent with neo-classical growth theory under a wide range of assumptions" (http://en.wikipedia.org/wiki/Jevons_paradox, 8/25/2008), both by making the use of energy relatively cheaper, and by leading to increased economic growth, which in turn leads to a general increase in energy use, even if energy use within the specific market originally considered might fall.

More generally, the Khazzoom-Brookes postulate challenges the belief deeply embedded in modern man that technology and growth are synonymous to progress, not to decay. Hence, as to the longer term effects of ICT for development (ICT4D) and for environment (ICT4E), the analogy of using petrol to extinguish a fire comes to mind. Paradoxical though as it might seem, and as it also was to William Stanley Jevons as to his coal, ICT efficiency measures seem at odds with the need for development to contribute to ecological sustainability. The efficiency gains will, as follows from the Khazzom-Brookes postulate, in general be outpaced by the demand they cause themselves: 10 Gb drives in mp3 players cause more network traffic than 10 Mb drives, and, in the next run, more downloads stimulate the spread of mp3 players with even cheaper and larger memory.

The European Information & Communications Technology Industry Association, EICTA, reckons this

16) *Jevons, William Stanley: The coal question : An inquiry concerning the progress of the Nation, and the probable exhaustion of our coal-mines, (Reprints of economic classics), A.M. Kelley; 3rd rev. ed. edition (1965).*

state of the matter and states in exceptionally clear terms how crucial it has become to include rebound and aggregate climate effects in the analysis as well as in ICT business strategy (EICTA 2008):

> The boom in technology is likely to grow [for] three underlying reasons: Moore's Law (computer technology continues to get faster, smaller, cheaper and better), Metcalfe's Law (which states that the value of a network is proportional to the square of the numbers using it and explains the popularity of the web and social networking technologies), and the autocatalytic nature of ICT (computers and associated technology actively contribute to the development of new improved components and products). This is both a benefit and a challenge for the digital technology industry – whilst we, like any sector, want to grow and sell more products and services, energy efficiency measures that we implement will have to be robust enough to outweigh the kind of rapid growth and increasing proliferation that we have seen over the last decade and which look set to continue.

Grasping the essential dilemma in a single paragraph, the EICTA though prescribes a pact with the Devil: to fight the galloping proliferation of ICT equipment and applications and the resulting increase in resource use by new efficiency increases! Such a strategy, though understandable from a short sighted business perspective, seems not just to be a draconian challenge, but worse still: a strategy for spurring an ever *growing* net energy and resource demand from ICT.

The dubiousness of such a strategy might as well be demonstrated with the proliferation of mobile phones: A global increase from 3 to 4.5 billion in the next four years (Portio Research 2007), mainly from new subscribers living in low income rural communities, will more likely than not spur increased (fossil) energy demand, although some physical transportation will be substituted. Anything else would be at odds with trends, expectations, and with how mobile phones are marketed.[17)]

5.1 Time for Better Tools as to Environment as well as Development – and for Using the ones already there

Resolving the problem requires other tools than those that created them. Which ones? At least we know where to look, as environmentalists, economists, development thinkers, as well as designers have searched for – and developed – a score of tools that we find as soon as we start searching for them:

1. Does energy use decrease?
2. Do we use renewable energy sources?
3. Do we increase nature's resource building capacity?
4. Do we increase biological diversity?
5. Do we create closed circuits for the material involved?
6. Do we keep within the limits for nature's and humans' sustainability?
7. Do we solve several problems together without creating new ones?
8. As everything cannot be calculated beforehand, do we adapt the precautionary principle in a reasonable way?

Figure 3 Simple tool to use in development projects to get the big picture: "Directional analysis"

Within *climate and environment*, researchers, activists, bureaucrats and politicians have for more than three decades developed

- *principles* (e.g. precautionary principle, the Hannover principles, The Bellagio principles, etc., see an overview at www.nextstep.state.mn.us /res_detail.cfm?id=217);
- *guidelines for eco-design* (design rules, hints, and evaluation software, see example in Figure 2);
- *standards* for reducing environmental impact (e.g. ISO 14000-series);
- various *measuring tools* for ecological impact (e.g. "Life Cycle Analysis" (LCA) and analysis of "ecological footprints");
- as well as simple *rules of thumb for project evaluation*.

A simple such tool for the latter is the "Directional analysis" launched in 1991 by the Swedish Association of Local Authorities. The eight questions that form its base constitute a simple check list to evaluate whether new products or services contribute positively or negatively as to sustainable development (Figure 3, Månson 1992).

17) *Not to spur energy consumption increase would mean 1) that new handsets with similar functionalities use just a fraction of the energy of the old, 2) that the buyers would not go for more functionalities when buying new handsets, 3) that a very high percentage of the first 3 billion get themselves new and less energy demanding handsets, 4) that the handsets are not successful as catalysts of economic growth, and that they will not generate their own growth in physical transportation and other energy use in addition to what they might substitute, or 5) that the energy needed for handsets and networks would be emission free. None of these points seem likely.*

- Basic for all development is to satisfy human material and immaterial needs, and a reasonably egalitarian society. Redrawing from market economy is an option when free market induced economic growth happens at the expense of the poor.
- Development shall be endogenous in the sense that local societies shall decide themselves on their visions and values for own development. They shall dispose of local resources themselves and shall be self-sufficient at the local or regional level. They shall not be subjected to the development logic of external forces, like the state or the international "world system".
- The "territorial principle" should be reinforced, implying that areas should to a larger degree become self-sufficient, and not just fill a role in a system of division-of-labour or specialization between regions, which is a basic principle on which Modernization is based.
- Development shall be based on self-reliance, not dependency on external resources (aid or trade).
- Development of the local society shall aim at ecological balance, i.e. sustainability, at the premises of the local ecology (within the limits set by the global). Hence, "development" must always be understood in terms of the local environment and its resources, and has no universal meaning. (The industrialized West is no natural frame of reference.)

Figure 4 "Alternative road for development" guidelines

Such tools constitute frameworks based in ecology and homeostasis thinking, i.e. resource consumption within thresholds given by nature. A different current has tried to construct economic models for attributing Net Present Values to ecological features, i.e. prices one might decide to pay or not to maintain nature – a perspective far to "economistic" to be acceptable by many ecologists. Other economists, like Herman Daily, have since long worked for the introduction of absolute ecological limitations on economics, and have developed the topics theoretically (Daily 1999). In such models, there is room for economic growth, but only if there is ecological capacity.

As to *social development*, we find that frameworks have been developed for an equally long period within the loosely organized *"Another development movement"*[18], as response to the failed theories of modernisation. The frameworks envision a better match between needs, environment and people, and may be summed up as a set of *guiding principles for social development*[19], see Figure 4.

For societies to be re-shaped according to principles such as those outlined in Figure 4, structural changes quite different from the ones implied in modernization would be needed. Such changes would go much in the same direction as the principle of "subsidiarity", i.e. pushing responsibility down to the local level and out of central government, but not necessarily into the marketplace. The ideas seem related to the Utopias constructed by earlier European visionaries (de Geus 1999): Central is the principle that all essential functions of society, production, consumption, government, culture, etc. shall take place within the lowest/most local level found practical. Society shall be "self reliant", i.e. not isolated or closed, but able to make it on its own if necessary, and shall function without destructing its ecological base. To achieve this, the tools are, i.a., *consciousness rising*, *self-organizing*, *de-centralizing*, and *change agents*. These ideas are both ideologically and tactically based.

Utopian though, many aid and development organisations, like the GrameenBank in Bangladesh, have followed these ideas in the field for a long time. Some have succeded in combining them with large business projects, like the world-wide known "village phone ladies" project within Grameenphone (Singal, Svenkerud & Flydal 2001), a kind of "social business", later to grow beyond that model by it own success. Grameenphone has grown beyond all expectations to become an extremely successful new national infrastructure in its own right, and thereby a new service platform. By the same token it has set free the forces of modernization and economic growth by easing communication. A more recent example is Danone and Grameen Bank's enterprise in nutritional yogurts, also based on small distribution units financed from microcredit.

Such successes in social development are exactly the kind of successes that are the problem in the wider context of this paper.

We may therefore note that the principles of the *alternative road for development* contain ideas that might be *compatible* with combating climate change, but also with the opposite: Locally based social development is not necessarily good for energy preservation.

The works of the designer John Thackara and the network he has built around himself bring us one step further, trying to combine eco-design and social development. When many would equal "sustainable life" and "low carbon future" to a de-volution towards traditional society, John Thackara has taken on the task to generate

18) *(Smukkestad 2005) mentions some important contributors from several continents to "another development" thinking. Different in their approaches though, they share roughly the ideas summed up here. To mention a few: Marc Nerfin, Ignacy Sachs, Johan Galtung, Paul Ekins, Manfred Max-Neef, Paul Ehrlich, Bade Onimode, Fante Cheru, Vandana Shiva. The list of contributors could easily be expanded with names from all continents.*

19) *The list in Figure 4 as well as the next paragraphs on consequences as to development strategy draw on the summaries given by (Smukkestad 2005), but are here colored by this author's translation, additions and abridgements.*

and proliferate design goals for high tech based sustainable life, as well as triggering self-governed local innovation processes for sustainable ICT and non-ICT sustainable applications in his numerous activities around the globe – putting social issues at the center of technology innovation. His cannonade of ideas, visions and practical suggestions – wild as they might seem – comprise things as well as services, "bottom-up", "top-down" as well as participatory strategies, and address high tech and rich populations as well as low tech and poor ones, urban or not. His general rules of thumb are summed up in (Thackara 2005) and fit well with what we have seen from both the ecologists as well as the developmentalists – with a slight touch of New Age or Eastern focus on the inner self (Figure 5).

However, Thackara's suggestions, though rich and stimulating, fail in the same way as we have seen eco-design and development theory fail: They do not comprise mechanisms as to how to harvest efficiency gains at the level of the individual transactions in order to avoid it getting lost in increased total consumption: His wake up call for more efficient design might – unintended though – in our framework be understood as a call for increased total energy and resource use.

"Sensitivity to context, to relationships, and to consequences are key aspects of the transition from mindless development to design mindfulness. At the heart [...] is a belief that ethics and responsibility can inform design decisions without constraining the social and technical innovation we all need to do. Design mindfulness involves a determination to

- think about the consequences of design actions before we take them and pay close attention to the natural, industrial, and cultural systems that are the context of our design actions;
- consider material and energy flows in all the systems we design;
- give priority to human agency and not treat humans as a "factor" in some bigger picture;
- deliver value to people – not deliver people to systems;
- treat "content" as something we do, not something we are sold;
- treat place time, and cultural difference as positive values, not as obstacles;
- focus on services, not on things, and refrain from flooding the world with pointless devices."

Figure 5 Eco-design principles – Thackara style (Thackara 2005)

6 Business Environments and Models Made Tools for Confiscating Efficiency Gains

We have seen above that the tremendous efficiency gains from ICT stimulate more energy and resource consumption in an already overburdened global ecosystem – even when wrapped as ICT4D and ICT4E. This happens in ways that closely parallel the mechanisms behind the Khazzoom-Brookes postulate regarding energy efficiency gains (mentioned earlier). Economic growth, modernization and development in the standard sense are blueprints for such increased resource consumption – intended tools for welfare as they are.

Since The Club of Rome more than 30 years ago (Meadows et al. 1972), and more recently from the numerous analyses carried out by IPCC, we know that modernization's demand for energy and other resources – and a population increase that devours all efficiency gains achieved, itself being a result of modernization – cannot continue. So, how do we go about to ensure that the new and more energy efficient ICT solutions do not just result in energy and resource consumption added?[20)]

Eco-design and other tools to enhance resource efficiency provide only partial solutions: They do not comprise mechanisms against rebound. On the contrary, they even add to the problem by reducing the costs of further growth – just like more energy efficient cars make total traffic, steel and petrol consumption grow. To make them instrumental, some mechanism against rebound must be introduced, which means confiscating the benefits, for ICT as for other efficency increasing means:

> *... for a world facing the twin challenges of oil depletion and global climate change, there has never been a more urgent need for both (energy efficiency and conservation, EF). But in order for total efficiency to actually curb total energy usage, as opposed to energy intensity, consumers must be kept from reaping the benefits of those initiatives in ever-greater energy consumption. Otherwise, energy usage will be the beneficiary of our best efforts towards greater energy efficiency.*
> Jeff Rubin, Chief Economist at CIBC World Markets (Rubin 2007)

Is it possible to shape some mechanisms that stimulate ICT investments for applications with high efficiency gains, and – at the same token – confiscate the efficiency gains that have been created before spent on more energy or other resource consumption?

20) *There is no such solution as finding alternative sources that permit energy use to continue or raise at habitual levels. See e.g. (MacKay 2008). Mechanisms to restrict the supply of energy and resources are a speciality not considered here. We limit ourselves to a relatively simple field within what the ICT business can initiate: business models.*

It seems that such mechanisms would be simplest and easiest to create not at the end of pipe but at the start of pipe, and that they would have to be shaped in close co-operation between business and the local powers (government or others) that could impose general measures. Hence, it seems that confiscating energy gains should be part of business models, as should the partnerships necessary for them to work. Using business models for such purposes is a far cry from the present attitude, where business insists on marketing just efficiency gains, leaving to governments' or users' neglect or descretion if saved time, costs and energy would be saved or spent to rebound on the total emissions.

Why business models and not other means? Business models are mostly stronger tools than ethics and regulations. They are adhered to even when ethics and regulations are not. Tony White, of the British venture fund Climate Change Capital, provides us with a case in point when he airs his frustration as to the energy business having incentives contrary to the political aims of energy saving and investing in new capacity (White 2008): As investment is high and inflexible, production costs fairly fixed, and margins mostly low, profit depends highly on volume. Selling electricity by the watt to the customers makes you want the customers to consume as much as you can deliver. Thomas A. Edison had a different model after having invented the light bulb: He sold home lighting, which urged him to get as much light (measured in lumen) out of the watts as possible. That business model made watts an input factor, not the end product, and urged him to save on the input factor per lumen. Similarly, "Gaia", or the global system of climate systems needs the ICT business to change from isolated and individual efficiency gains as the basic value proposition offered to the customer, into net accumulated efficiency gains turned into a production goal. Somehow this would imply confiscation of efficiency gains or regulation of some of the other few parameters of the equation: population size and culture, product and services availability, availability of purposes for spending efficiency gains.

Below are some unfinished lines of thought on the way towards identifying some such mechanisms. Rephrasing them into some measures that can be put into practice, eventually testing the realism of them, is beyond the ambition here. However, the reader will easily see that some lines of thought are simpler and more realistic to convert to business models than others. Some would need forms that do not trigger large ethical and political controversies, and some might depend on finding ethically and politically more palatable methods for change unless some bright new ideas come up.[21] One might fear that the range of options will narrow as time passes.

- Energy efficiency gains may be thought of as *"value added"* (positive or negative) to the ICT product or service in question. Value added is conventionally stimulated or reduced by tax incentives and/or confiscated by VAT (value added tax). Hence, in principle,

  - taxation might be used to reduce investments in ICT, or to set a price on ICT to reflect (at least) the expected costs of sequestering from the biosphere extra emissions of CO_2 caused by the ICT investment.[22]

  - subsidies or similar incentives on ICT investments might be used to stimulate investments in ICT when measures are taken that effectively confiscate the efficiency gains from being spent on more energy and resource consumption. The level of incentives should reflect less than the costs saved.[23]

- ICT induced energy efficiency gains are *opportunities for reducing capacity on energy and resource consumption*. Hence, confiscation of energy efficiency gains might take the form of capacity reductions in a bundling operation that involve co-operation between business, local and central government, or other relevant partners, e.g. NGOs, each responsible for its part of such operations.

  - The larger the expected energy efficiency gains from ICT, the more capacity reduction in the most carbon consuming activities of society. Accordingly, road widths should be narrowed proportionally to the number of mobile phone handsets. Cost of fuel should increase with the spread of "de-materialised" products. Tax on newspapers should increase with the availability of TV sets, information panels, and broadband – or even the other way round if paper production and distribution were proven the more efficient

21) *The lines of thought presented below are not contrary to mainstream marketing of "green products", nor to the search for new energy solutions, etc. They are just derivations from the basic argument of this paper that such mainstream strategies seem by far insufficient or even counterproductive, as long as they are marketed without informing that their positive effect is highly conditional, and not reinforced with measures such as outlined here.*

22) *Carbon quotas trading and CO_2 deposits are a range of solutions addressing the end-of-pipe problems. As the gains are hard to specify when accounting for direct as well as indirect effects from ICT, such taxation would be similar to general taxes on luxurious items. Frequent upgrading of equipment would be an evident target.*

ways! Mobile telephony subscribers should be offered price schemes for public transport that would stimulate them not to keep private cars, to reduce their travelling, and to go by public transport if necessary.

- ICT could be a strong means to *decrease world population*. Without such a decrease in population increase as well as absolute size, even strong energy efficiency measures are quickly neutralized from population growth.[24] The causes behind population growth in poor countries are mixed, being among other things improved health and less disease, poverty, lack of family planning and birth control, lack of other social security systems for the elderly, culture, and need for work force in the individual family. Aid activities (and businesses) have largely failed to stop population growth, apart from in China, and world population has multiplied since the Modernization era started with industrialization.

  - There is a vast opportunity space for all kinds of innovative applications that will stimulate population reduction: Conventional measures would be family planning campaigns, better social security systems, law enforcement, and enlightenment. Innovative initiatives with much stronger and faster effects than before are now needed. Such initiatives carried out in ethically acceptable ways are hardly thinkable without massive use of ICT in combination with some kind of large-scale public services and regulations – e.g. in the form of TVs and village information systems, sterilization surgery assisted at a distance, family planning shows, efficient social security services, re-distribution and compensation schemes, etc.

7 Conclusion

Information and communication technologies (ICT), market mechanisms, development theory, eco-design and economic growth do all lack the mechanisms necessary to cope with the challenge of climate change: Efficient as they may be for their purposes, and although being key elements in the great and global Modernization project, they do simply not address the problem of confiscating the detrimental aggregate effects that now set the climate at stake. Instead, they all contribute to increasing the negative impact, as they open for, or even urge for, increased energy use.

This is not sustainable, and changes are needed. A rich variety of tools are available for the design of products and services more compatible to such demands, but even new and stronger tools are needed. This seems to make necessary a fresh look at business models, to find mechanisms to confiscate the tremendous efficiency gains from ICT before they are spent on activities that trigger aggregate energy consumption increase. Some lines of thought, preliminary indeed, have been put forward as to how such business models might look.

Such a transformation is not simple – to say the least. But climate challenge seems to force the ICT business, as most other businesses, to take on more responsibility along its value chains – as well as beyond. This is fully in line with strong international currents since the Rio declaration on sustainability, and should astonish nobody.

To search for what ICT can contribute, might in a way be to search for ICT's role in helping industrial society to learn from traditional societies as to how to live without triggering metabolism growth spirals.

The ICT business – along with its stakeholders in government, NGOs and consumers – serves its proper long run interests by exploring this further, and to formulate its practical consequences as to business models and partnerships. Neither business nor consumers or government can justify – nor should wish – to leave the responsibility for such thinking or practical measures to the other parties alone.

So, where does it take us? Can the complex ICT business adapt, or will only the simpler low-energy value creation forms that do not need such complex organisations and partnerships do?

Or can we imagine equally trajectory disruptive but still ICT based responses? What would make us switch off the electricity based infrastructures of daily life, or not spend the time saved on more consumption? Poverty? Massive and frequent Internet fall-outs, like the one that we saw February 2008 in the Middle East and India? Politically motivated or fraud-investigation related close downs of the net of entire countries, like it happened earlier in Iraq, Afghanistan and Kazakhstan? Can we for example imagine a new variety of the virtual Second Life not based on electricity? Or would it more energy-efficiently be substituted by some hallucinogen? Can we imagine a "Facebook" alike not seducing the user to always stay

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[23] *Heat pumps would be a case in point. But how do you avoid savings from using a heat pump being spent on e.g. an air flight?*

[24] *Lovelock suggests about half a billion humans (500 million) to be a suitable number to permit for some flexibility in life forms (Lovelock 2006). That would imply a reduction to 1/18 of prognosticated world population in a few years from now.*

on-line? Or could it then be replaced more energy-efficiently by local friends? Eventually, could we return to more robust and low-technology solutions, like the Fido Net?[25)]

The simple answer is that we do not know. We are striving with the concequences of Modernity, and are on board the Jagannath wagon, as Anthony Giddens since long coined it (Giddens 1990). But we do know that – borrowing a metaphor from Herman Daly, quoted by Lovelock – "now that we have no choice but to move from acknowledgement of the problem to throwing ourselves into the foggy space of finding practical solutions that really do help, where even the most rudimentary parachutes are better than exact altimeters."

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