Sustainability in the Information Society:
From Life Cycles to Lifestyles

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I. Goal and Scope. Sustainable development and the emerging information society are two major visions that characterize the beginning of the new century. This article discusses the interrelation between the emerging information society and the goal of sustainability. How can information technology contribute to sustainable development? What are the opportunities and risks of the information society with regard to the goal of sustainability?

The greatest challenge for today’s economy is to find a sustainable development path. Information technology is in principle able to do this by making it possible to reduce the use of certain production factors, especially natural resources, while increasing the use of the production factor information. This gain in ecological efficiency will be necessary if the earth is to feed 10 billion people in a few decades from now. But how do we have to use the factor information so that we approach the goal of sustainable development?

If we take a historical perspective, we see that industrialization was a transition from a labor-intensive to a resource-intensive mode of production. The factor human labor was replaced by using more natural resources, especially fossil fuels to operate machines, and with astounding success. In some areas, such as mining, labor productivity rose by a factor of 50.

Today we are on the cusp of an information-intensive economy, an Economy, in which nothing can be done without heavy utilization of information society technologies. This is at the same time a bifurcation point in economic development: Will we succeed in reducing natural-resource intensity (left path in the figure) and thus in achieving a sustainable information society, or will resource consumption in the information society increase even further (right path in the figure)?
II. Methods. Two major areas of interaction between information society technologies (IST) and sustainability can be distinguished: (1) Using IST as a tool to shape a sustainable information society. This is done mainly with regard to the environmental dimension of sustainability. The experience of three decades of environmental information processing can serve as a basis for the more general task of using ICT to achieve sustainable development. (2) The positive and negative impacts of the more general IST applications with regard to the goal of sustainability are listed in the table below. In the following, we will focus on the second type of interaction. See [Rautenstrauch 2001] and [Hilty/Ruddy 2000] for more detail on environmental information processing.

<table>
<thead>
<tr>
<th>Environmental information processing (EIP)</th>
<th>Public sector: Environmental Information Systems (EIS) operated by public authorities</th>
<th>Public awareness about condition of public goods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prerequisites for political decisions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Executing instruments of environmental policy</td>
<td></td>
</tr>
<tr>
<td>Private sector: Environmental Management Information Systems (EMIS)</td>
<td>Legal compliance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Environmental reporting to stakeholders</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Eco-efficiency and material flow management</td>
<td></td>
</tr>
<tr>
<td>Information Society Technologies (IST)</td>
<td>Direct impact on material intensity of economy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Material intensity of ISTs' product life cycles</td>
<td></td>
</tr>
<tr>
<td>Indirect impact on material intensity of economy</td>
<td>Substitution potential</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimization potential</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Induction potential</td>
<td></td>
</tr>
</tbody>
</table>

**Indirect Impacts on Material Intensity**

According to a widely accepted scheme, the effects of IST on the realm of physical processes can be classified under the following three types. The scheme was originally introduced to classify the impacts of telecommunications on physical traffic and can be explained best using this special case as an example. Note, however, that we are generalizing this scheme to cover all kinds of IST and their respective impacts on all kinds of physical processes.

- **Substitution**: Telecommunications is substituted for physical traffic
- **Optimization**: Telecommunications helps to optimize traffic systems.
- **Induction**: Telecommunications induces traffic (e.g. by enabling distributed forms of production).

Let us demonstrate how this scheme applies to other domains as well, using paper consumption as an example. The PC as the modern form of typewriter and especially the PC as a medium to access e-mail, WWW and other Internet services has in fact the potential to reduce paper consumption. Plenty of textual and graphical information can be received directly from the screen, which in fact is substituted for paper in many cases. There is also an optimization effect, since for instance many errors can now be corrected before a text or picture is printed for the first time. However, as the reader may know from every-day experience, the induction effect offsets the other effects by far, because today’s PC and printer technology enables the user to print out hundreds of pages with just a few mouse clicks. Therefore, all in all, IST contributes to the same general trend for paper that has been observed for the past 60 years [Ehrenfeld 1997]. Moreover, per-capita paper consumption is now seriously considered an indicator of affluence. Newspapers recently celebrated the fact that an average Swiss
person now consumes 240 kg of paper per year, and the trend is getting worse. Is this what we expected from the Information Society?

Still, the domain of traffic is probably the most important field in which the substitution and optimization effects of IST are presently being overcompensated by induction effects. While the substitution effect arising from telecommuting and various forms of tele-services (e.g. tele-banking) can reduce physical traffic, the induction effect arising from the globalization of markets and distributed forms of production due to telecommunications networks clearly leads away from the path to sustainability.

A recent Swiss conference was assembled to collate results from a major National Research Programme on transport and the environment (NRP 41). The conference résumé speaks of "hopes being dashed for using ‘telecommunications instead of traffic’". "Telecommunications [in conjunction with globalization] facilitates the division of labour", it continues, "and thus causes more traffic. Nor will electronic commerce avoid much traffic." [NRP41 2000].

The Rebound Effect

The counter-intuitive trends that can be observed in traffic development and paper consumption are examples of a phenomenon known as the rebound effect. This concept refers to a potential created by efficiency gains that is balanced off or even overcompensated for by quantitative growth [Binswanger 1999].

Originally the rebound effect was discovered in the energy sector. Energy productivity (the quotient from gross domestic product and total energy consumption) has been growing for a few decades now in highly developed countries by about 1 % per annum. This "savings", though, is overcompensated by growth in the gross domestic product (about 3 % per annum), so that in absolute figures more energy is consumed every year.

The situation will be hardly different in the information society: Every substitution or optimization effect achieved by IST creates new degrees of freedom which tend be used for quantitative growth. Very often, it is the old technologies that continue to grow, while the new ones are used additionally, helping to extend the limits which the old technologies would have eventually hit.

The most striking example of the rebound effect is ICT itself. According to Moore’s law already mentioned, digital electronics dematerializes by a factor of 4 every 3 years. That raises the question as to why this continuing dramatic dematerialization has not caused a corresponding reduction of the total energy and material flows caused by ISTs. On the contrary: Electronics’ share of energy consumption continues to increase, and the amount of electronics waste indicates that material throughput is growing just as fast. This apparent contradiction is a typical example of the rebound effect: the rapid dematerialization has been compensated for – even definitely overcompensated for – by growth in the demand for computing and communication power for several years now.

Under current economic framework conditions the most probable IST scenario predicts a continuing exponential growth of the IST market until 2015, resulting in linear growth of the total physical mass contained in the IST devices that are in use (if ongoing dematerialization is assumed) [Hilty et al. 2000].

We can conclude that technical progress in the direction of eco-efficiency is a necessary, but not a sufficient condition for approaching the goal of sustainability. At the same time, politics must create global framework conditions which lead to a worldwide optimal allocation of scarce ecological resources through market mechanisms.

The limits of LCA

We will only achieve a sustainable economy if we have methods with which we are able to compare rationally the effects of alternative paths with regard to their resource intensity and other effects of relevance to sustainability. One approach for this that has been well developed is the life cycle assessment (LCA) method. For the questions that come up in the information society, though, this approach has its limits. The problem is that the functional equivalence which always serves as a prerequisite in LCA studies is seldom to be found in real decision situations. Are telework and work at home functionally equivalent? In reality information society technologies prevail because they offer completely new functions, for which there was no equivalent before them. This development cannot
be understood with the approach of functional equivalence. The danger exists that the LCA community will act like the man who didn’t look for this lost keys where he had lost them, but rather under the streetlamp -- because there was light there.

What alternatives exist to the functional unit as a reference in LCAs (or in other test methods expanded to include all three aspects of sustainability)? We see only one solution, namely, to use time as the reference variable. Every person has 24 hours of time per day to consume resources. How that person applies time to tasks is a question of lifestyle, and lifestyles will change in the information society. From this perspective questions can be posed and answered that are radically different from those posed from the perspective of functional equivalence; and the former are, we think, more productive questions. We don’t look anymore at an isolated function such as handwashing and ask whether environmental stress can be minimized best with cloth, paper or hot air. Instead we ask how people in the 21st century are spending and will spend their time in various cultures and societal groups, influenced by the rapid technological change taking place. Will they go through the city wearing cybergoggles and thus not require any more PCs, mobile phones, etc.? Will work disconnect itself from location even more than it has already and thus contribute to a further increase in physical mobility? How will a person apply the limited quantity of attention, when s/he has almost infinite information channels available everywhere? Methods that will provide answers to such questions as these are just starting to emerge.

III. Results and Conclusions. The transition to a global information society holds many opportunities for sustainable development. Environmental information processing leads to a better understanding of the complex natural environment on which our lives depend, and how it evolves under the influence of society. The information society also offers great potential to dematerialize products and services, i.e. to increase ecological efficiency, and enables society to make a transition to new and attractive lifestyles which take advantage of a variety of immaterial services.

However, information society technologies contribute only a necessary, but not sufficient condition for attaining the goal of sustainable development. As developments up to now have clearly shown, there is a risk that this technology may in fact induce more material and energy throughput through the economic system than it saves. The direct contribution of IST hardware to material and energy flows and – more important – indirect induction effects, which are just new examples of the well-known rebound effect, are the problems that have to be faced here. How society can counteract these risks on its way to an information society is clearly a political and cultural issue.

The LCA method comes up against limits whenever decisions of this type are to be supported. This is because it relies on the concept of functional equivalence, which in a rapidly changing information society is no longer applicable to an ever-larger number of relevant decision situations. Using time as the reference variable, appears to be more adequate as the functional unit, and new methods using time and based on lifestyle models and scenarios are needed for adequate decision support.

IV. Recommendations and Outlook. As they mature, information society technologies will provide us with virtual alternatives that will enter our lives because they fulfil requirements different from their conventional counterparts. Sustainability will only be attainable through such a change of lifestyles. Accepting more virtual, immaterialized goods and services is in fact a change in culture. This change can only be attained if the concept of an information society is not understood as doing the same things in a new way by using a different medium. Instead, the information society should be understood as a vision of a variety of new services reshaping our lifestyle; services that let us do things virtually whenever that has clear advantages, and leave to the real what can be done better physically.

References

[Binswanger 1999]

Keywords: dematerialization; environmental information systems; information society technologies; lifestyles; sustainable development