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ORIGINAL PAPER

The implications of new information and communication technologies for sustainability

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Abstract This paper discusses the relationship of new information and communication technologies (ICTs) and sustainable development. It deconstructs popular myths about a sustainable information society. One myth is that telework has reduced the need to travel and hence environmental pollution. The reality is that teleworkers make up only a small share of the total workforce, telework can generate new social relationships and hence the need for more travelling, work-related travel produces only a small amount of the total carbon dioxide emissions, and that the total distance travelled per employee is constantly rising. Another myth is that information economy is weightless and dematerialized which reduces environmental impacts. The energy and resource intensities of the ICT sector are indeed lower than the one of the total economy. The ICT sector also emits less CO_2 than the total economy. But the ICT sector constitutes only a small portion of the total value added and fossil fuel combustion is still the dominant activity of modern industrial economies. Some stakeholders argue that virtual products allow resource, energy, and transport savings. But burning digital music on compact discs and DVDs, printing digital articles and books, etc. results in rebound effects that cause new material and energy impacts, computers have a low life span of 2–3 years, reusable and upgradeable computers and computer equipment are hardly used and might not be as profitable as non-reusable ones, computers are consuming much energy. Alternatives such as energy consumption labels on ICTs and green ICTs that consume less energy contradict dominant economic interests. A sustainable information society is a society that makes use of ICTs and knowledge for fostering a good life for all human beings of current and future generations by strengthening biological diversity, technological usability, economic wealth for all, political participation of all, and cultural wisdom. Achieving a sustainable information society costs, it demands a conscious reduction of profits by not investing in the future of capital, but the future of humans, society, and nature.

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Introduction

Related to the rising production, use, and diffusion of ICTs there are a lot of hopes, dreams, and myths. This also applies for the ecological subsystem of society where discussions focus on the question if ICTs can advance ecological sustainability, i.e. biological diversity and environmental protection. ‘‘Our contention is that, as ICT becomes more sophisticated and more embedded in our organizational structures and everyday life, we are in a better position than ever before to make sustainable development work’’ (Alakeson, Aldrich, Goodman, & Jorgensen, 2003: 5). Counter to this quotation I don't think that ICTs automatically advance ecological sustainability, but that they pose both new opportunities and risks for the ecosphere. There is a positive and a negative tendency: ICTs allow the reduction of travelling by doing parts of necessary communications online, it is a medium of ecological communication and the communication and co-operation of the ecological protest movement, but it also contributes to ecological degradation e.g. in the form of computer scrap and the waste and emissions generated in production processes of ICTs. I will discuss the implications of ICTs for sustainability in the areas of transport, business, ecological activism, and developing countries. Section 2 considers the question if telework and teleconferencing reduce the need for travel. Section 3 addresses the notion of a weightless economy. Section 4 discusses the role of the internet in ecological protest. Section 5 points out the implications of ICTs for the developing countries that have been discussed under the issue of sustainability. Section 6 addresses the notion of a sustainable information society.

ICTs, transport, and ecological sustainability

‘‘Fast, cheap global communications could reduce the need for travel, so pollution levels would fall. (...) The ability to transfer information virtually, at high speed and almost no cost, and to communicate effectively at a distance would allow companies to locate away from established economic hubs, free workers to work from anywhere and, in doing so, reduce the environmental impact of goods and people moving from place to place’’ (Alakeson et al., 2003: 3f, 9). The question is whether private and business Internet communication automatically reduces the need for travelling. This can be the case if people consciously choose to avoid unnecessary travelling and transport by plane and car, but Internet communication also makes it easier to connect people globally and to initiate and maintain social relationships and hence it can also raise the desire or need to meet people face to face more frequently.

Some scientists argue that due to the fact that telework allows knowledge workers to overcome spatio-temporal distances and to work from home the need for transport and hence environmental pollution would be reduced. The same argument can be employed for teleconferencing saying that by substituting personal meetings by teleconferences travelling can be reduced. But teleworkers normally don't work full time at home because they need to stay connected personally and face to face with their social work environment, the number of teleworkers is generally relatively low (in Europe the share of teleworkers in the total labour force ranges from less than 2% to more than 10%, cf. Schallaböck et al., 2003: 9). Travelling to work produces only a relatively small share of total carbon dioxide emissions. Working from home doesn't automatically imply less transport because online work can produce new contacts that might generate the need for meeting people personally. Working at home can have negative environmental effects, e.g. people can't go shopping on the way home from work, but might take an extra trip by car from home to shops and supermarkets. A German study has shown that the total distance travelled per employed person has been constantly rising (cf. Fig. 1). Hence telework doesn't yet seem to have positive effects on work-related transport.

Companies often paint an optimistic picture of the effects of teleworking on the ecosystem, but studies show that although teleworkers frequently reduce their commuting distances ''the overall distance travelled for commuting is growing though not very fast. That the last 3 years represent the highest figures, does not support the thesis which suggests that transport savings have been made because of telework'' (Schallaböck et al., 2003: 26).

A study of the Wuppertal Institute for Austria, Germany, Japan, the Netherlands, and the US, concludes ''the general experience shows, that growing functionality of and access to ICT correlates with growing demands for business travel. (...) Although the advantages provided by mobile telework are very clear, it obviously may contribute to an expansion of both the number of hours worked, and the number of hours travelled. (...) Individual case studies and panel surveys which are mostly based on small quantities of teleworkers show that teleworkers typically work about 1.5 full days per week at home as an average. As a result they save about 2500 km distance travelled for commuting annually. This is based on single commuting distances, which are estimated to be rather high and far above the average for all employees. (...) Looking from a macro perspective at passenger transport does not reveal a significant influence from home-based telework on the number of commuting trips nor the commuting distances travelled. (...) From the macro view on passenger transport, business trips (and in particular the respective distances travelled) prove to be increasing in number significantly. This does not support the hypothesis of transport

Table 4-10: Business trips: distance travelled per employed person, km, Germany

	by feet	by bicycle	p.t., road	p.t., rail	Car driver	Car pass.	Air (1)	Total (1)	Air (2)	Total (3)
1991	8	8	91	150	3,282	158	256	3,952	1,546	5,498
1992	8	8	92	160	3,381	160	295	4,104	1,668	5,772
1993	8	8	93	168	3,441	165	286	4,170	1,707	5,877
1994	8	8	91	188	3,376	166	294	4,136	1,646	5,782
1995	8	8	92	203	3,378	167	355	4,208	2,004	6,211
1996	9	8	92	220	3,413	167	372	4,277	2,059	6,336
1997	8	8	87	215	3,494	168	394	4,376	2,190	6,566
1998	8	8	86	212	3,522	170	424	4,434	2,365	6,799
1999	8	8	85	214	3,497	168	464	4,445	2,558	7,002
2000	8	8	85	216	3,480	167	494	4,461	2,716	7,177

(1) over national territory; (2) outside national territory; (3) incl. estimated full length of air trips
source: German Institute for Economic Research; Wuppertal Institute; cf. Appendix 2, below

Fig. 1 Source: Schallaböck et al. (2003)

saving due to teleconferencing, but emphasizes the impression that business trips and the use of enhanced ICT in business grow together'' (Schalläböck et al., 2003: 35, 52f).

The European reality seems to be that telework and teleconferencing are simply too unimportant for having positive effects on transport savings and that there are rebound effects from online communication on the increase of travelling. About 5% of the labour force in Europe can be considered as teleworkers. Roughly 10% of the working days of the complete European labour force can be considered as home-based telework (Schalläböck et al., 2003: 52). The result of another study is that ''homeworkers are spending more time travelling than conventional workers'' (Marletta et al., 2004). A German study has shown that the distance travelled by teleworkers per week (360 km) is three times as large as the one travelled by conventional workers (120 km, cf. Fig. 2, Table 1).

Telework and teleconferences certainly pose an opportunity for reducing travelling, but this opportunity has thus far not been adequately realized. What is needed is a conscious commitment of business and individuals to reduce the amount of travels by car and plane. ICTs alone don't solve the problem. The reality of work and life today is that in a flexible economy and society individuals have to be flexible and have to travel long-distances in order to maintain work-related and private social relationships.

ICTs, business, and ecological sustainability

A weightless economy?

Some scientists argue that the shift from the ''industrial society'' to the ''information society'' means that the economy becomes less resource-intensive and that hence there is a ''dematerialization'' of production that creates a ''weightless economy''

Table 4-12: Estimated changes in average speed und duration of commuter trips for selected cases of home-based telework

Case	Number of trips per week	Duration per trip (minutes)	Speed (km/h)	Distance per trip (km)	Distance travelled per week (km)	Commutin g time per week (minutes)	Average speed (km/h)
no telework	10	24	30	12	120	240	30
(basis)	(8)	24	30	12	96	192	
(addition)	(8)	6	60	6	48	48	
20 per cent telework	8	30		18	144	240	36
(basis)	(6)	24	30	12	72	144	
(addition)	(6)	16	60	16	96	96	
40 per cent telework	6	40		28	168	240	42
(basis)	(2)	24	30	12	24	48	
(addition 1)	(2)	24	60	24	48	48	
(addition 2)	(2)	72	120	144	288	144	
80 per cent telework	2	120		180	360	240	90

Source: Wuppertal Institute

Fig. 2 Source: Schalläböck et al. (2003)

Table 1 Myths and realities of ICTs and telework

Myth	Reality
Telework reduces the need to travel and hence environmental pollution	Teleworkers make up only a small share of the total workforce Telework can generate new social relationships and hence the need for more travelling Work-related travel produces only a small amount of the total carbon dioxide emissions The total distance travelled per employee is constantly rising

(Coyle, 1997; Kelly, 1999; Leadbeater, 2000; Quah, 1999) that advances ecological sustainability. ''On the one hand, there are (in the service sector) the traditional occupations that statisticians call 'community, social and personal services': haircuts, cleaning, babysitting, teaching, nursing, government administration and so on. On the other there are 'high value added' services such as currency trading, creating financial derivatives, software development, gene research or making programmes for satellite television. Most of these are high-technology, depending for their existence on modern computer power and telecommunications. They are also dematerialized, or weightless'' (Coyle, 1997: 2). The argument here is that knowledge-based industries and services are less resource-intensive than industrial production, that ICTs can reduce negative environmental impacts of traditional industries by allowing more efficient ways of production and distribution, that certain products and services could be dematerialized/virtualized which would reduce their environmental impact, that such goods are traded and transported over the Internet which would reduce the amount of physical transport, and that ICTs can increase the efficiency of transportation.

A study of the Wuppertal Institute concludes: ''The ICT sector's resource productivity (as measured by several ratios) is clearly higher than the resource productivity of the total economy—for direct as well as cumulated environmental pressures, i.e. the ICT sector is significantly 'cleaner' per unit value added generated. CO_2-emissions and energy use per unit gross value added generated is comparably low in the ICT sector. (...) The ICT sector's (...) contribution to overall value added is moderate, ranging from 5% to 8%. The 'old' economy is still significant. (...) Regarding product-based e-commerce, the possible dematerialization potentials appear to be small. The case study findings suggest that product-based e-commerce might even be more resource intense than traditional retailing business. While information-based e-commerce has the potential to decouple economic growth from resource consumption, significant savings on a macro scale are not expected, for various reasons. First, up to date e-commerce is just another sales channel, built-up and maintained in parallel with the traditional channels. Second, the number of products that can potentially be reduced to an 'informational core' is limited. In the sectors of building, food, clothing and community as well as large parts of health and leisure most products cannot be digitized. This leaves only a fraction of the total material intensity, in which information-based e-commerce can potentially contribute to a decoupling. Third, consumer habits and rebound effects are likely to have a counterbalancing influence. Whether, with changed framework conditions, the benefits can outweigh the risks, remains to be seen. (...) Teleshopping (B2C) only has the potential to generate small transport savings. This is because shopping travel represents only a small portion of the overall distances travelled, teleshopping generates additional delivery transport, bigger potential for additional transport due to possible compensating passenger transport and rebound effects'' (Kuhndt et al., 2003: 23, 60, 81).

Figure 3 shows that in Germany the energy intensity and the CO_2-emission of the ICT sector is lower than in the traditional economy. In 1999 the production of information goods with a total value of 34 million Euros resulted in the emission of one tonne CO_2, whereas in the total economy goods with a value of 2 only million Euros resulted in the same emissions.

Figure 4 shows that in Germany the ICT sector made up only 7.9% of the total value added in 2000.

A study of the World Resource Institute concludes: ''These findings indicate that technological progress and restructuring toward service-based economies in the study countries have substantially weakened the link between economic growth and resource throughput. The development of new patterns of economic growth, such as e-commerce, may weaken the link further. However, actual dematerialization has not been achieved. We see here that, despite decoupling between growth rates in GDP and material throughput, quantities of wastes and emissions generated by the study countries have increased in absolute terms over the 21-year study period. (...) Part of the explanation for the continued increase in overall waste quantities lies in the fact that traditional industries, despite their declining relative economic importance are not necessarily declining in terms of their physical operations. In addition, even economies with sophisticated high technology sectors continue to use older generation, inefficient technologies where they represent low-cost options. (...) Fossil fuel combustion is the dominant activity of modern industrial economies and is the single largest contributor to material outflows to the air and on land. Most of these flows are hazardous to human health or the environment. Technological advances and economic restructuring have contributed to significant decoupling between rates of economic growth and material throughput but they have not achieved any overall reduction in resource use or waste volumes'' (WRI, 2000: 19, 41).

The reality of dematerialization seems to be that fully virtualized products and the ICT sector constitute only a small portion of the economy, that the total resource use of the economy is constantly rising, and that hence thus far there has not been a massive ''greening'' of production and consumption induced by knowledge products and ICT. It is not true that ''economic value is dematerializing'' (Coyle, 1997: 1). Post-industrial capitalism as a dematerialized ecologically sustainable economy is a ''dangerous myth'' (Foster, 2002: 24). Touraine has argued in this context that the information society is a ''hyperindustrial society'' (Touraine, 1988). It is not a new

Table 3-4: Resource productivities based on 4 environmental pressure variables – ICT and total economy, Germany 1991-1999.

	ICT sector		change (%)	total economy*		change (%)
	1991	1999	'91-'99	1991	1999	'91-'99
direct CO_2-emission productivity (1000 Euro per tonne CO_2)	17.133	33.929	98,0%	2.037	2.667	31,0%
cumulated** CO_2-emission productivity (1000 Euro per tonne CO_2)	2.937	4.337	47,7%	990	1.331	34,4%
direct energy productivity (1000 Euro per Peta Joule energy)	764.746	1.209.450	58,2%	144.030	172.677	19,9%
cumulared** energy productivity (1000 Euro per Peta Joule energy)	189.458	250.841	32,4%	68.345	81.111	18,7%

* total refers to production sectors, not including private households
** considering indirect CO_2-emissions and energy-use induced by domestic and foreign intermediate consumption
Source: Federal Statistical Office Germany 2001 and 2002

Fig. 3 Source: Kuhndt et al., 2003: 23

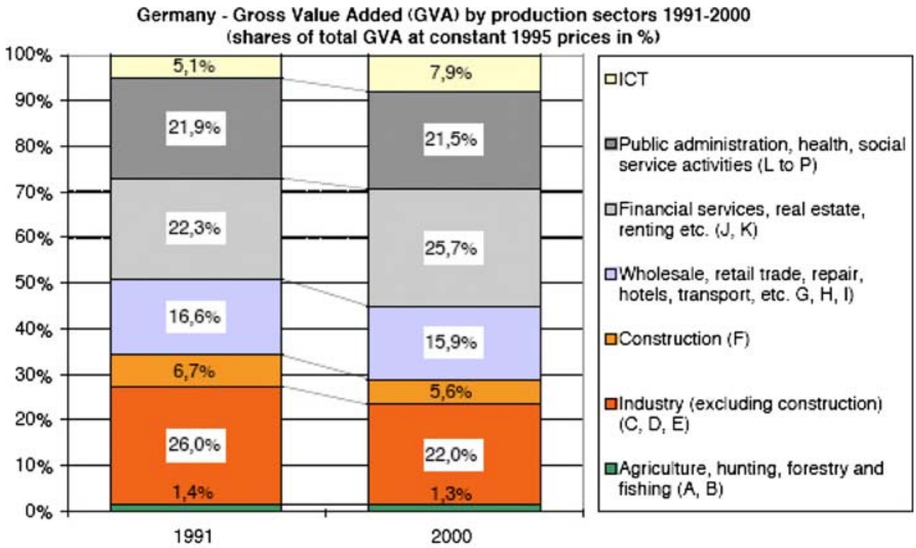

Figure 3-2: GVA share of ICT compared to other production sectors – Germany 1991 compared to 2000

Fig. 4 Source: Kuhndt et al., 2003: 19

society that is characterized by immaterial goods, but a new phase of development of capitalism that is both continuity and discontinuity of industrial capitalism and has emergent qualities such as the central importance of cognitive, communicative, and co-operative labour.

The knowledge economy is not an economy of invisible and intangible goods. There indeed are many physical information commodities that are transported and sold. Huws (2001) argues that in capitalism there is a major tendency to transform services into physical products (commodification, cf. Fleissner, 2005; Fuchs, 2005) because with the help of the latter capital accumulation would be easier to achieve than with the first due to higher potentials for technological rationalization and outsourced/globalized production (Table 2).

Virtual products as a foundation of a sustainable society?

Another argument is that certain products and services can be entirely virtualized and transported in digital format over the Internet and that hence material and energy savings can be made. E.g. the Wuppertal Institute (Türk et al., 2003) found out in an analysis that downloading a CD over the Internet is 2.5 times as resource efficient as buying it in a music store. This way savings concerning energy and matter in production and transport surely can be made. But many users have the habit of not only storing files on their computers, they rather choose to burn music files on CDs because they prefer to play music on their CD players. Hence there are again material and energy impacts.

MP3 players that are portable and can be connected to a hi-fi system surely pose a good alternative that to a certain extent allows resource savings, but the example

Table 2 Myths and realities of ICTs and the information economy

Myth	Reality
The information economy is weightless and dematerialized which reduces environmental impacts	The energy and resource intensities of the ICT sector are lower than the one of the total economy. The ICT sector also emits less CO_2 than the total economy But the ICT sector constitutes only a small portion of the total value added Fossil fuel combustion is still the dominant activity of modern industrial economies
Virtual products allow resource, energy, and transport savings	Burning digital music on compact discs and DVDs, printing digital articles and books, etc. results in rebound effects that cause new material and energy impacts Computers have a low life span of 2–3 years Reusable and upgradeable computers and computer equipment are hardly used and might not be as profitable as non-reusable ones Computers are consuming much energy. Alternatives such as energy consumption labels on ICTs and green ICTs that consume less energy contradict dominant economic interests

shows that virtualization doesn't automatically result in ecological sustainability. The same is true for books, journals, and newspapers. If they are distributed in digital format online resource savings in production and distribution can be made. Also new flexible production technologies that are based on just-in-time-production (e.g. books on demand) allow resource savings. But almost no one wants to read a book or a whole newspaper online because it is not very comfortable to read on screen. Therefore many people print out articles or whole books which results in a high consumption of paper, toner, and ink. There are certain alternatives such as e-paper that can be reused. Companies thus far have not widely supported reusable or eco-friendly equipment (such as e-paper, the ''green PC'', or refillable ink cartridges for printers) because reusable computer equipment is not only less resource-intensive but also in the long-term maybe less profitable. ''The PC as the modern form of a typewriter and in particular the PC used as a medium to access e-mail, WWW and other Internet services do in fact have the potential to reduce paper consumption. (...) 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, ICT contributes to the same general trend for paper that has been observed for the past 60 years'' (Hilty & Ruddy, 2000: 6). The antagonism between capitalism and ecology has thus far also had negative influences on companies' support for ecologically sustainable ICT equipment. The use of recyclable and reusable equipment could indeed reduce the environmental impact of ICTs, but for doing so the logic of capital accumulation needs to be subordinated under ecological and social awareness. The relationship of ICTs and sustainability is not only a question of ethical consumerism, but also one of corporate social and ecological responsibility. In capitalism not those technologies that most benefit society and ecology are promoted, but those that enable capital accumulation. Hence it is e.g. not solar or wind energy or the reusable computer that are promoted, but nuclear energy, fossil fuels, the automobile, and non-renewable computer equipment. ''In recession times, decision-makers try to survive. Questions beyond the survival of their companies do not interest them at all; most common recipe: replace people by machines and save money, i.e.: jobs are played against profits and (ecological) reforms'' (Mettler, 1997: 7). As long as a company is profitable, it might be open-minded for ecological and social goals, but capitalism is based on competition and economic crisis is an inherent feature of the system, hence in the end in many cases the logic of profit will outstrip social and ecological awareness.

Moore's Law says that the speed of computers doubles every 18 months. Thus far this law has proven true. It results in a fast moral depreciation of computers and people frequently buy new computers in order to participate in technological progress. For ecological sustainability we don't necessarily have to slow down technological progress, but the ways hardware is manufactured and diffused surely have to change because the low life span of computers is detrimental to reaching ecological goals. Advances in chip technology today (under capitalist conditions) result in an increasing reduction of the life span of computers. The average lifetime of a business PC is 2–3 years, the one of a mobile phone 18 months in Europe (EITO, 2002: 256). What is needed are reusable, recyclable, and upgradeable computer hardware and periphery.

One should also add that ICTs are industrial products, their production and disposal generates waste and emissions. The knowledge society is not an immaterial society, but a new phase in the material reality of capitalism. It requires a large material infrastructures made up by computers, periphery, servers, routers, switches, network cables, etc. The hardware industry makes profit by selling computers and periphery. If computers were used for a longer time or if it were increasingly possible to renew only certain parts in order to come up to date with technological progress and not to have to buy a whole new computer, environmental improvements could indeed be made. But this would require some steps away from the logic of profitability towards the logic of ecological sustainability. Hence it would mean to accept lower profits in order to protect the environment. Such moves are possible, but they contradict the dominant economic logic. If corporate social responsibility shall not only be an ideology, corporations must be ready to go beyond and to question to a certain extent capitalist logic.

Computers and the internet run by consuming energy. The Wuppertal Institute found that in 2000 the internet accounted for 5% of Germany's total energy use (Barthel et al., 2000). It is not only based on a material infrastructure, but also consumes energy that constitutes another material aspect of the information society. A study by the Fraunhofer Institut für Systemtechnik und Innovationsforschung in co-operation with the Centre for Energy Policy and Economics (2005) has found out that ICTs in business and households account for about 8% of total energy use in Germany. It is estimated that until 2010 ICT energy use will rise from 38 TWh (2001) to 55.4 TWh (ibid.: 275). Especially television sets, hi-fi systems, computers, servers, mobile phone infrastructure networks, mobile phones, and fixed phone lines are considered as being very energy-intensive (ibid.). There are technological possibilities to reduce the energy consumption of television sets and monitors (by using LCD monitors and television sets and selling such machines at reasonable prices) as well as computers (by including components that automatically detach computers from energy supply if they are not used for a certain time, Switched Mode Power Supply). But the interests of the energy industry might be detrimental to establishing ''green ICTs'' because high amounts of energy use mean high profits, what is needed are political pressure and unified laws that define minimum standards of energy efficiency of ICTs and require producers to include energy consumption labels on ICTs. This might have negative consequences on profitability, but if sustainability shall be achieved the domination of society by economic logic must be challenged.

The miniaturization of ICTs doesn't automatically result in less environmental impacts because ICT production itself produces wastes and toxic emissions. ICT equipment such as personal computers or mobile phones contains toxic substances such as lithium or cadmium batteries. Environmental performance assessments of computer technologies show that the latter doesn't heavily reduce material outputs, the production of one PC requires 16–19 tonnes of material resources and more than 5000 kWh energy, the emission of the production of one piece include 60 kg waste, 1850 kg carbon dioxide, 2 kg sulfur dioxide, and 1 kg nitrogen oxide (Grote, 1994). ''One study showed that the production of the average computer chip requires 45.46 l of water, used primarily for washing. One chip plant in the USA uses between 4.5 and 13.5 million litres of water a day. (...) A study for the European Union in 1998 suggested that the production of a personal computer, including material production, manufacture and distribution, would lead to the release of 0.19 tonnes of greenhouse gases, 36 kg of overall waste, and require 3.6 GJ of energy'' (EITO, 2002: 255). In Germany 15% of electronic waste is computer waste (Briefs, 2000: 19), the EU produces 6 million tonnes of waste of electrical and electronic equipment a year (EITO, 2002: 256). ''Der Gesamtprozess der Informatisierung (...) ist durch ein Dilemma geprägt: Einerseits erlauben die IuK-Techniken, vor allem in den Betrieben einen wirksameren Umweltschutz zu erreichen. Andererseits tragen ihre produktivitätssteigernden Effekte zu weiterem Wachstum und damit zur Umweltbelastung und -zerstörung bei. (...) Festzuhalten ist, dass—im Gegensatz zur gelegentlich geäußerten Ansichft—die IuK-Techniken nicht an und für sich saubere, oder gar umweltfreundliche Techniken sind'' (Briefs, 2000: 10, 20).

Ecological online-communication and ecological cyberprotest

The ecological movement like other protest movements makes use of ICTs in order to spread environmental information, raise environmental consciousness, co-ordinate environmental protest online, and protest against ecological degradation online. Hence there is a cognitive, a communicative, and a co-operative dimension of cyberprotest (Fuchs, 2006). With the help of the Internet NGOs can organize protests against environmental degradation offline and online.

Also companies are increasingly providing information and reports on their environmental and social performance online because they are pressured by civil society to show ecological awareness. It remains an open question to which extent such information is ideological or reflects real material changes in patterns of production and consumption. The problem with eco-reports of companies published on the Internet frequently is that these analyses are not conducted and written by external observers such as NGOs, but by representatives of the companies themselves. Furthermore there is often a difference between ideas and material reality. Companies often argue that they support ecological and social sustainability. But ideas are easily voiced, real changes much harder to achieve.

Figure 5 shows an example of ecological cyberprotest: On the website of Friends of the Earth UK it is possible to sign online petitions (in this case one that calls Tony

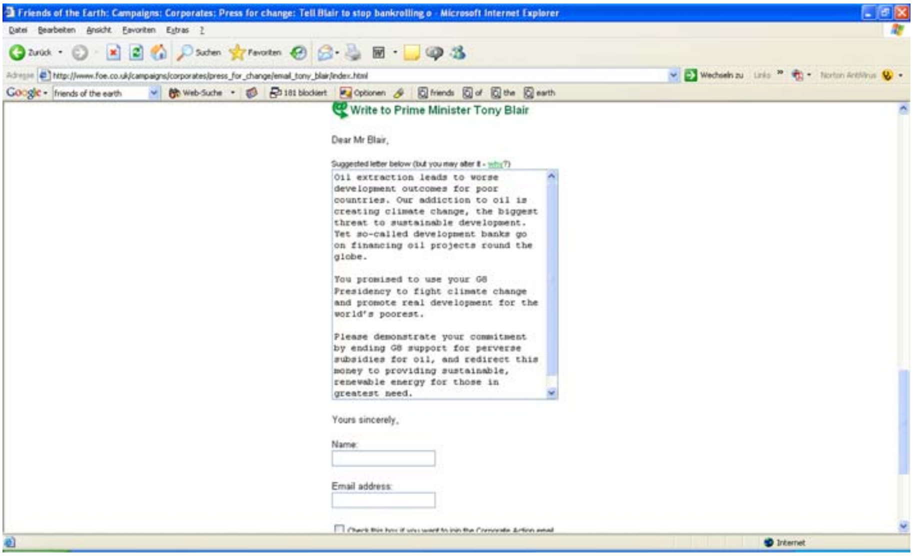

Fig. 5 Friends of the earth: An example of environmental cyberprotest

Blair for ending G8 subsidies for oil and redirecting this money to providing renewable energy) that are automatically sent to the relevant stakeholders per e-mail. The Greenpeace Cybercentre is the online-community of Greenpeace (http://act.greenpeace.org, http://act.greenpeace.org/cl2/de/de/actions), on this website cyberactivists can sign online petitions, send e-cards, and discuss Greenpeace-related topics in online discussion boards. In the petition section it is possible to generate petition letters that are sent per e-mail (cf. Fig. 6). These examples show that NGOs belonging to the ecological movement increasingly make use of cyberprotest. Cyberprotest seems to be an aspect of the information society that has positive influence on the societal diffusion of ecological information.

Strategies for sustainable development ‘‘depend critically on awareness, trust, co-ordination and mechanisms for dialogue’’ and hence are in need of ‘‘effective communication’’ (Dalal & Bass, 2002: 226). Environmental Informatics is concerned with developing computer applications that allow the monitoring, simulation, modelling of environmental processes and the storage, assessment, and communication of environmental data with the help of databases (environmental information systems) (Junker & Lang, 2002). Environmental information systems, environmental reporting, and environmental information on the World Wide Web can provide public information on environmental issues, concerns, and data and can support learning and education strategies for making the ideas and possible practices of sustainable development more widely known. ‘‘In order to improve awareness, change attitudes and encourage action on sustainable development, various information products will be required, notably: documents and audio-visual, events, networks, databases, electronic media, and mass media’’ (Dalal & Bass, 2002: 236).

Fig. 6 Greenpeace Germany Cybercentre: Online Petition (“Bush Shall Sign Kyoto!”)

Reports on Shell’s environmental and social impacts are available on the company’s website. In the “Shell Report 2004” (http://www.shell.com/home/Framework?siteId=shellreport2004-en) the corporation e.g. argues: “In 2002, the most recent year for which international data is available, the Group produced energy products that delivered nearly 11.7 exajoules of energy. That was 20 times the power needed to provide electricity, heating and transportation for London, and equivalent to 3.9% of the world’s final energy consumption. Our customers emitted an estimated 763 million tonnes of CO_2 using these energy products. We released a further 111 million tonnes of CO_2 and other GHGs making them. This is calculated on an equity ownership basis, including our share of joint ventures which we do not operate. Together, this is equivalent to 3.6% of global CO_2 emitted from the combustion of fossil fuels. We recognize that our response to climate change means more than reducing our own emissions. A shift to lower carbon-emitting energy products is also needed, so the rapid rise in energy use does not bring an equally big increase in GHG emissions. Expanding our natural gas business will help. In the longer term, so will our efforts to lower the costs and increase the use of biofuels, wind and solar power, and hydrogen, and to develop efficient ways to capture and safely store the CO_2 from fossil fuels But both meeting the energy supply challenge and first slowing, and then eventually reversing, the rise in carbon emissions will remain a major challenge for energy producers and users alike”.

Shell admits that CO_2 emission is a serious environmental problem and promises that its own CO_2 emissions will be 5% lower in 2010 than in 1990. It also realizes that alternative energy forms are needed and argues that it will support alternative technologies in the long-term. The latter could be empty promises because it is obvious that the consumption of fossil fuels produces profits for Shell.

The company benefits from the ecological degradation caused by fossil fuels. Shell presents itself in this report as a company that is concerned for ecological and social sustainability. Greenpeace in its report on corporate crimes paints a much less optimistic picture of Shell: ‘‘Shell Chemicals started production of the ‘‘drins’’ (endrin, dieldrin and aldrin) in 1952—ending completely in 1990. [...] As a result of drin production in Pernis, the Netherlands, river sediments, residential areas and several dumpsites were severely polluted. The production of drins by Shell in the US at the Rocky Mountain Arsenal has also led to a huge pollution scandal. Leaking basins and pipes have contaminated 70 km^2 of land. The pollution caused by the Shell drins-producing plant in La Paulínia, Brazil, is described in separately in this report. Exposure of people to drins has led to many poisonings and deaths. Many incidents have been reported, for example the consumption of bread made from endrin-contaminated flour that affected at least 936 people and caused 26 deaths. Large quantities of expired, prohibited and unwanted drins are in storage world-wide8. In many cases the storage facilities are inadequate and packaging of the drins are in very bad condition. Exposure of workers, local communities and the environment to these very toxic pesticides cannot be excluded and accidents with these old pesticides can easily happen. Although the use of drins has been virtually banned in the USA and the Netherlands since the late 1970s due to known toxic effects, Shell continued the production and sales to industrializing countries up until 1992. Today, the drins are also banned by the United Nations (UN) because they are associated with the incidence of cancer and reproductive, endocrine and immune system dysfunctions. [...] The existence of stockpiles of these banned and obsolete pesticides in deteriorating conditions is known to Shell and other pesticide producing companies. Shell has removed some of the drin stockpiles and drin waste from several African countries. But the pesticide companies including Shell refuse to take full responsibility for the complete removal of stockpiles. Several known stockpiles, including drins, have not been treated and continue to put local communities and environment at great risk. Only in the US and partly in the Netherlands has Shell had to pay a share of the costs. As far as is known, Shell has not been held liable for poisoning or for the costs of removal of obsolete pesticide stockpiles. This case shows that Shell continued the production and sales of drin pesticides long after the company knew the product was very toxic and affected peoples' health. However, it seems almost impossible now to hold Shell liable for the negative impacts of the product. There is no global instrument available to make Shell accountable to the removal of banned and obsolete pesticides stockpiles including drins. Pesticides companies should be obliged to take full responsibility for the removal and safe destruction of the obsolete pesticides in industrializing countries’’ (Greenpeace, 2002: 68f).

Virtual reality produces a difference between actual and virtual reality, what exists in virtual reality must not necessarily correspond to actual reality, but can be as Baudrillard (1983) has stressed a simulation and hyper-reality. Due to the information overload, information found in the World Wide Web is not automatically true (according to facts), but can be a simulated reality. Corporate online reporting sometimes sheds a positive light on certain companies by leaving out certain information and emphasizing other information. The Shell-example shows that Internet reporting is related to the problem of simulation and hyperreality in Cyberspace.

Marletta et al. (2004) have shown in a study that political participation, education, and internet usage are positively related to environmental sensibility and that ‘‘those internet users with the strongest environmental sensitivity are those who are most likely to have used the net to access environmental information''. The internet is mainly a sphere of commerce, sex, and entertainment where ecological information and communication are only minority phenomena. Hence I think that ecological knowledge on the Internet is today more an insider affair than one of raising public ecological consciousness.

ICTs and the Third World

In the book ''Knowledge Societies. Information Technology for Sustainable Development'' edited by Mansell and Wehn there is a chapter on ''The Potential Uses of ICTs for Sustainable Development'' that wants to focus on ICT applications that could assist developing countries to reap the ''social and economic benefits associated with extremely rapid innovation in advanced ICT-based goods and services'' (Mansell & When, 1998: 82). Sustainable development is here understood as social and economic development. The chapter lists and discusses a number of ICT applications in the areas of e-travel, e-government, e-transport, e-health, e-education, e-inclusion, and e-learning. These are technologies that today are mainly developed in Western countries and benefit the latter. The Third World is not only largely excluded from wealth, but also from technological progress. In 1999 there was 56 billion dollars in Western foreign aid for the Third World and the latter paid 136 billion dollars debt service to Western countries (Fuchs, 2002: 370). Hence in total there was a value transfer from developing countries to developed countries. Human aid in its current form is more ideology than real help. Although Africans make up 14.0% of the world population, Africa only accounts for 1.7% of the number of global Internet users (data from July 2005, source: World Internet Usage Statistics, http://www.internetworldstats.com/stats.htm).

I think what is needed for improving the situation of developing countries is on the one hand a radical global redistribution of wealth starting with measures such as the increase of human aid, basic income for the absolute poor in the world, the elimination of debt burdens on Third World countries, and on the other hand a non-colonizing technology that is adapted to the needs of people in Third World countries and integrates their traditional knowledge and technologies. The authors of the chapter mention that ''policy measures are needed to address the key areas within each country's overall development strategy that could benefit from the use of ICT applications to promote initiatives that will generate financial resources'' (Mansell & When, 1998: 95) and that ''a major goal of initiatives to implement ICT applications in developing countries is to help to alleviate poverty'' (ibid.: 98). Can solutions to the problems of developing countries be provided by Western technologies that are applied in Third World countries? One should not neglect that local and traditional ideas are of high cultural importance in solving the problems of the Third World. Western solutions are frequently perceived as a form of cultural imperialism. Western habits, colonialism, and post-colonial practices are part of the causes of the problems that Third World countries are facing today. What is hence needed in addressing issues such as poverty and ICTs in the Third World is unity in diversity management.

In the Declaration of Principles of the World Summit on the Information Society (WSIS) passed in Geneva in 2003 technology transfer and ICT manufacturing is understood as a means for achieving a sustainable information society for developing countries: "33. To achieve a sustainable development of the Information Society, national capability in ICT research and development should be enhanced. Furthermore, partnerships, in particular between and among developed and developing countries, including countries with economies in transition, in research and development, technology transfer, manufacturing and utilization of ICT products and services are crucial for promoting capacity building and global participation in the Information Society. The manufacture of ICTs presents a significant opportunity for creation of wealth. [...] 43. Sustainable development can best be advanced in the Information Society when ICT-related efforts and programmes are fully integrated in national and regional development strategies. We welcome the New Partnership for Africa's Development (NEPAD) and encourage the international community to support the ICT-related measures of this initiative as well as those belonging to similar efforts in other regions. Distribution of the benefits of ICT-driven growth contributes to poverty eradication and sustainable development." (WSIS, 2003a, Principles 33, 43).

A sustainable information society is by WSIS considered as one where ICTs promote participation and poverty eradication. Furthermore sustainable production and consumption patterns, usability, e-health, and e-learning are considered as aspects of a sustainable information society: "51. The usage and deployment of ICTs should seek to create benefits in all aspects of our daily life. ICT applications are potentially important in government operations and services, health care and health information, education and training, employment, job creation, business, agriculture, transport, protection of environment and management of natural resources, disaster prevention, and culture, and to promote eradication of poverty and other agreed development goals. ICTs should also contribute to sustainable production and consumption patterns and reduce traditional barriers, providing an opportunity for all to access local and global markets in a more equitable manner. Applications should be user-friendly, accessible to all, affordable, adapted to local needs in languages and cultures, and support sustainable development. To this effect, local authorities should play a major role in the provision of ICT services for the benefit of their populations" (WSIS, 2003a, Principle 51).

The WSIS Plan of Action (WSIS, 2003b) argues that for achieving a sustainable information society governments, businesses, civil society, and international and regional institutions must take responsibility. WSIS argues in favour of a mixed strategy of political practice and economic investment for achieving a sustainable information society. Government should devise national strategies for digital inclusion, promote public access, e-government, e-business, e-learning, e-health, e-employment, e-environment, e-agriculture, e-science, etc. For achieving a sustainable information society in developing countries, the WSIS Plan of Action argues on the one hand that debt cancellation is needed, on the other hand that more private national and international markets for ICTs should be provided by developing countries. "D2. c. For those developing countries facing unsustainable debt burdens, we welcome initiatives that have been undertaken to reduce outstanding indebtedness and invite further national and international measures in that regard, including, as appropriate, debt cancellation and other arrangements. Particular attention should be given to enhancing the Heavily Indebted Poor Countries initiative. These initiatives would release more resources that may be used for financing ICT for development projects. d. Recognizing the potential of ICT for development we furthermore advocate:

i. developing countries to increase their efforts to attract major private national and foreign investments for ICTs through the creation of a transparent, stable and predictable enabling investment environment;
ii. developed countries and international financial organizations to be responsive to the strategies and priorities of ICTs for development, mainstream ICTs in their work programmes, and assist developing countries and countries with economies in transition to prepare and implement their national e-strategies. Based on the priorities of national development plans and implementation of the above commitments, developed countries should increase their efforts to provide more financial resources to developing countries in harnessing ICTs for development;
iii. the private sector to contribute to the implementation of this Digital Solidarity Agenda'' (WSIS, 2003b).

What is missing here is the insight that markets don't automatically eliminate poverty because they don't determine how wealth is distributed. Hence what is needed are regulatory practices that ensure that the benefits from ICT and economic production can be shared by all. Capital here is assessed only as a positive factor in achieving sustainable development. WSIS assesses IC markets as very positive means of advancing social sustainability, it neglects aspects of political regulation of the economy and income distribution and gives priority to economic logic.

ICTs and sustainability

During the last decade there has been a shift from considering sustainability as a purely ecological concept to defining it in broader societal terms. Hence the discourse on ICTs and sustainability shouldn't halt at ecological issues. I have argued that there are ecological, technological, economic, political, and cultural aspects of sustainability and that goals of sustainability are biological diversity, technological usability, economic wealth for all, political participation and justice for all, and cultural wisdom and unity in diversity management. ICTs pose both new opportunities and risks in all of these subsystems of society. They are antagonistic and produce various tendencies that run counter to and contradict each other.

Depending on how ICTs are socially designed and applied they can have positive and/or negative effects on society. They can either have positive or destructive effects on the ecosystem, they can be designed in user-friendly ways or not, can be treated as free goods available to all for free or as commodities that are unequally accessed and distributed (the same is true for knowledge), can either support political participation or surveillance, can advance participatory online-media and the plurality of political information and communication or one-dimensional mass media, can foster a higher publication rate and speed in science (scientific online journals and reviews) or have due to the increasing publication speed negative effects on quality standards provided by the peer-review system, can put forward new forms of art (cyberart, electronic art) that involve audience-participation or have negative influences on the authenticity of

Table 3 Dimensions of ICTs and sustainability

Dimension	Quality	ICT-related opportunities and risks
Ecological sustainability	Biological diversity	Ecologically sustainable versus ecologically destructive ICTs
Technological sustainability	Usability	User-oriented, user-friendly, enabling versus unusable, constraining ICTs
Economic sustainability	Wealth for all	Free knowledge and ICTs versus knowledge and ICTs as commodity and private property
Political sustainability	Participation of all	Participation versus control enabled by ICTs
Cultural sustainability	Wisdom	Wisdom versus false
Sustainability of:		Consciousness advanced by ICTs
Mass media	Wise knowledge and media	Participatory, wise online-journalism versus manipulative, one-dimensional online-journalism
Science	Truth	Speed versus quality of e-science
Art	Beauty and imagination	Aura gain and participatory art versus Aura and authenticity loss of works of art in cyberspace
Education	Literacy and good skills	Co-operative versus individualized e-learning
Ethics	Openness, unity in diversity of values and rights	Open versus fundamental cyberethics
Medicine	Health	Positive versus negative effects of ICTs on health
Sports	Fitness	Advancement/socialization versus limitation/individualization of physical activity and games
Social relationships	Love and understanding	Cyberlove versus cyberhate

artworks, they can support more co-operative or more individualized forms of learning and ethics, can foster both cultural diversity or fundamentalism, can have positive or negative effects on health and medical awareness, can advance and socialize or individualize and limit physical activity and games, and they can be helpful in advancing friendships and love or the sowing of hate (as in the case of right-wing extremists using the World Wide Web). In all cases today ICTs don't either have solely positive nor solely negative effects, but both positive and negative ones at the same time. There are enabling and constraining tendencies of ICTs in society and ecology today, it is a political task to advance and realize opportunities and to avoid risks that are related to ICTs (Table 3).

Conclusion

In researching the relationship between information society and sustainability important results have been achieved concerning the ecological dimension (cf. e.g. Alakeson et al., 2003; Hilty & Ruddy, 2000; Hilty et al., 2004a, b, 2005). Hilty in this context speaks of a sustainable information society (Hilty & Ruddy, 2000; Hilty et al., 2005). "Sustainability in the information society is a more recent field of research, which concentrates on the consequences of information and communication technology (ICT) for the objective of sustainable development'' (Hilty et al., 2005: 38). Thus far sustainable development in the context of information society research has primarily been considered from the ecological perspective. A recent publication entitled ''Towards a Sustainable Information Society'' acknowledges that sustainability is now a multidimensional concept, but it doesn't give an explicit definition (Servaes & Carpentier, 2006: 5–15).

A sustainable information society is a society that makes use of ICTs and knowledge for fostering a good life for all human beings of current and future generations by strengthening biological diversity, technological usability, economic wealth for all, political participation of all, and cultural wisdom. Achieving a sustainable information society costs, it demands a conscious reduction of profits by not investing in the future of capital, but the future of humans, society, and nature.

Environmental problems are social problems, not technological problems, they are neither caused by science and technology as such, nor can they be solved by science or technology as such. Science and technology have due to their unsustainable social design contributed to environmental degradation, they have been turned into destructive forces by social forces. Heavy promotion of computer usage is not an appropriate means and automatism for achieving ecological sustainability, the latter requires alternative models of economic production. If humankind is interested in a sustainable society, the destructive character of the economy must be sublated, new models of economic production and social relationships are needed.

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