

Environmental Effects of E-Business and Internet Economy

First Insights and Environment-political Conclusions

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by Dr. Klaus Fichter
Borderstep
Institute for Innovation and Sustainability
P.O. Box 37 02 28
D-14132 Berlin
Germany
Tel. +49.30.342 31 04
Fax +49.30.30 10 85 55
E-Mail: fichter@borderstep.de

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Preliminary Remark

The present paper is based on the results of the expert discussion on "E-business and environment", organized by the German Federal Environment Ministry (BMU) on February 23, 2001, as well as on an underlying working paper produced by the Borderstep. It draws on major insights of the expert forum, yet does not merely summarize the conclusions of the forum as a kind of protocol. Instead, it represents them as the author's (subjectively) condensed and prepared reflections, on the basis of which he develops new environment-political perspectives and formulates proposals for further measures.

The expert hearing on "Strategy for a sustainable information society"¹ of September 1999, organized by the UBA, the German Federal Environmental Protection Agency, as well as the fourth of the Dessau Debates, on "Information society – consequences for environment protection"², had discussed the ecological relevance of information and communication technologies with respect to the entire society. In contrast, the BMU expert discussion of February 2001 focussed its reflections in two respects: Firstly, not information and communication technologies in general were debated but infrastructure and utilization of electronic communication nets, in particular the Internet. And secondly, not all societal areas were considered. Instead, the focus was on online activities in the economic process (e-business, e-commerce). The present paper concentrates on these points, too, yet it does not look at environment-political tasks and perspectives of the Internet economy as isolated phenomena but discusses them within the broader context of a sustainable information society.³

¹ cf. Griebshammer, R.: *Strategie für eine Nachhaltige Informationsgesellschaft*, evaluation of the expert discussion on information and communication of November 10, 1999.

² cf. Angrick, M.: *Vierte Dessauer Gespräche: "Informationsgesellschaft – Konsequenzen für den Umweltschutz"*, summary of results, Z 2 – 92 46/10, Berlin, November 9, 2000.

³ cf. Schneidewind, U.; Truscheit, A.; Steingraber, G. (eds.): *Nachhaltige Informationsgesellschaft*, Marburg, 2000.

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Summary: 10 Messages for Environmental Policy

1. Presently, information and communication technologies (ICT), and in particular the Internet, are revolutionizing economy and society. A preventive environmental policy will have to consider these fundamental changes in structures of value creation, in mechanisms of market function, in professional life, and in consumption patterns, as well as the related environmental effects, in its analyses and its strategy development.
2. Virtualization of value creation and trade does by no means lead to a "weightless economy". The ecological relevance of the Internet economy is considerable. It implies substantial opportunities and risks, which oppose each other.
3. Opportunities: Utilization of the Internet allows for considerable optimizations along the value-added chain. Thereby, not only costs can be reduced but also significantly improved resource productivity and eco-efficiency can be achieved. This means important potentials for environment-political and politico-economic win-win strategies. Furthermore, new online services to support sustainable patterns of buying and using provide opportunities to less pollute the environment, and the increased market transparency due to the Internet can be utilized for more intense consideration of environmental criteria in procuring and buying of products.
4. Risks: Environment-political achievements regarding reductions of CO₂ emissions and energy consumption may be annihilated by increased use of computers and ICT. In the USA, office equipment and Internet infrastructure are estimated to account for a share of about 3 per cent of the overall energy consumed, with growing tendency. The total electricity consumption for Internet use (PCs at home and in offices, web servers, routers etc.) in Germany is estimated to be about 1 per cent. This could rise to about 2 to 6 per cent in 2010, depending on the extent of energy efficiency measures. Another risk is the acceleration of economic processes with its ensuing potential generation of additional traffic and additional material flows due to a further shortening of product cycles.
5. Consequences of the Internet revolution for environment and climate protection cannot yet be definitely determined. Electronic communication nets like the Internet are not environment-friendly or environment-hostile in themselves. Their environmental effects are not immanent to the technology but depend on social and economic framework conditions and on how intelligent new media will be used.
6. Three levels of environmental effects of e-business and Internet use can be distinguished: direct environmental effects of the information-technological infrastructure (energy consumption of PCs, servers etc.), secondary effects due to Internet use (e.g. online shopping), and tertiary effects due to consequences and rebound effects (e.g. increased online utilization as a result of dropping prices).
7. Whereas primary effects of information and communication technologies (e.g. the aspects of electronic scrap, energy labelling of devices etc.) are being addressed by environmental policy in various ways today, secondary and tertiary effects have hardly been considered so far. Environmental policy will have to care more for applications of ICT, for Internet use and the related ecological opportunities and risks (secondary effects) as well as for consequences and rebound effects (tertiary effects).
8. As little is known so far about secondary and tertiary effects of e-business and Internet use, and as dynamic utilization of new media and electronic communication nets is only in its initial stages today, research should concentrate on secondary and tertiary effects as well as on the analysis of potentials and framework conditions for de-materialization and increase in resource productivity. Government and politics can only indirectly influence the manifold and complex ways of applica-

tion of new media and electronic communication nets. Therefore, processes of dialogue and reflection together with social actors are of particular importance as "soft" ways of environment-political intervention.

9. Any environmental policy for the network economy will have to combine consistency strategy with efficiency and sufficiency strategies. The consistency strategy will have to care for ecological sustainability of the network economy and the information society as a whole, and will have to create clearly oriented system designs and ecological development paths by means of models, scenarios, set environmental targets and concrete goals of environmental action (e.g. no further increase in energy consumption by information-technological devices and Internet infrastructure).
10. The second wave of the network economy: 1993 is said to be the "year of birth" of the Internet economy. With the breakthrough of the World Wide Web (WWW), the Internet has developed into a global service-integrating computer network and into the net of nets. With increasing application of microchips as transmitters and receivers in everyday products like washing machines, cars, clothing (wearables) etc., a second wave of network economy is approaching, which will multiply chances and risks of the first wave.

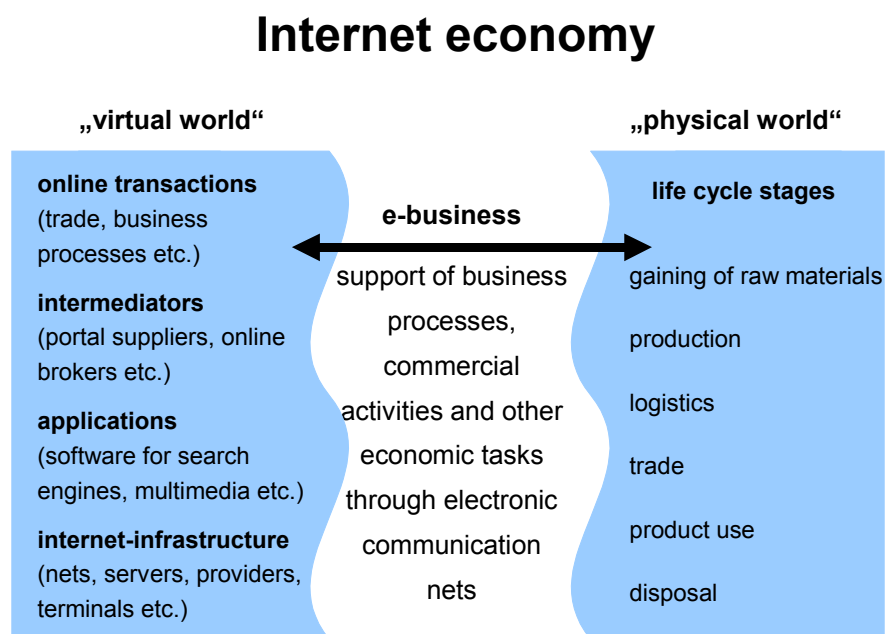
1 Concepts and Subject of Consideration

It is only a few years now that concepts like "e-business", "e-commerce", "Internet economy", "digital economy", or "new economy" exist. Therefore, there is no consistent and systematic interpretation of them so far. Their use and importance, however, reflect the rapid development in the field of Internet use and utilization of new information and communication technologies (ICT).

Whereas the concept of "new economy" focusses primarily on the new actors of the Internet world (dot-com companies, Internet service providers etc.) and emphasizes the new rules in the economic process⁴, the concept of "digital economy" focusses on the digital technology of data and information processing and transfer and its use in the economic process. The concept of "Internet economy", on the other hand, emphasizes the networking of economic actors and processes by means of electronic communication media, and the related change in structures of value creation, mechanisms of market function, professional life, and consumption patterns.

The following text will use the concept of "Internet economy"⁵ as an all-encompassing notion, as it emphasizes the new quality of networking economic actors as well as the resulting change in the whole economic process.

Figure 1: Internet economy



Source: the author⁶

The notion of "Internet economy" comprises both micro and macro perspective and covers the whole range of economic transactions (profit-oriented or not). Besides, the Internet economy is not restricted to dot-com companies and Internet service providers ("new economy") but also includes the use of electronic communication nets as well as the application of e-business in the "old economy". Borders

⁴ cf. Kelly, K.: New Rules for the New Economy, 10 Radical Strategies for a Connected World, Penguin Books, New York, 1998.

⁵ It is a disadvantage of the notion of "Internet" that so far it is understood as synonymous to a global computer network. In the future, however, Internet, portable radio network, television/radio will converge (media convergence).

⁶ The subdivision of the "virtual world" presented above is based on the four-layers model of Cisco Systems and the University of Texas: cf. Cisco Systems/University of Texas: Measuring the Internet Economy, Austin, 2000.

between "new" and "old" are becoming more and more blurred today. This dichotomy will therefore dissolve sooner or later.

"E-commerce" and "e-business" are application forms of the Internet economy. Both notions are to be classified as micro-economic concepts. Until recently, discussion had centered on "e-commerce". Usually, this notion is understood as denoting all possibilities to electronically support processes in the field of sales and procurement.⁷ Insofar, its emphasis is on commercial activities among market participants. "E-business", on the other hand, covers a larger range of activities and, apart from market transactions, also includes business processes within firms and along value-added chains. The notion was adopted in the context of an IBM market campaign ("eBusiness") and has been used increasingly since.⁸

The present paper orients by a classification of these notions according to which "e-commerce" is understood as part of "e-business". On the basis of so far available definitions⁹, the terms "e-business" and "e-commerce" can be defined as follows:

„E-Business“ means support of business processes, commercial activities or other economic tasks through electronic communication nets. Meanwhile, e-business covers all economic branches, it extends to company-internal, inter-firm and market-related application fields as well as to all life cycle stages, from the gaining of raw materials via production and use of products up to recycling and disposal.

„E-Commerce“ describes the possibility to support processes in the areas of sales and procurement through electronic communication nets. Thus, e-commerce denotes primarily commercial activities among market participants.

⁷ Rebstock, M.; Hildebrand, K. (eds.): E-Business für Manager, Bonn, 1999, p. 17.

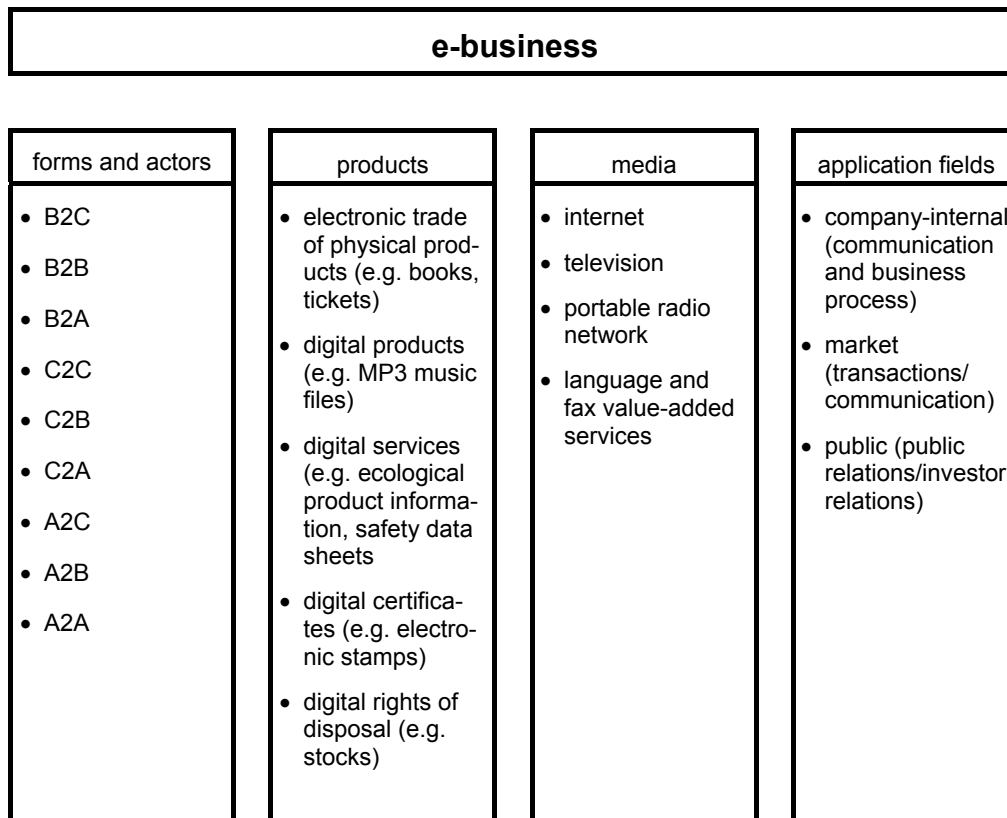
⁸ cf. Amor, D.: Die E-Business-(R)Evolution, Bonn, 2000, p. 42.

⁹ cf. Merz, M.: Electronic Commerce, Marktmodelle, Anwendungen und Technologien, Heidelberg 1999; see also Rebstock/Hildebrandt 1999; Amor 2000

2 E-business: Forms and Applications

In recent years, the Internet has most dynamically developed into an economic platform and has produced multiple forms of e-business¹⁰, which can be classified according to the following criteria:

Figure 2: Classification of e-business



Source: Behrendt, S.; Fichter, K., unpublished working paper, Berlin, 2001.

Further criteria to classify e-business applications are the type of user access (Internet, intranet, extranet), the types of sender/receiver (human being to human being, human being to machine, machine to machine), or the application area within firms (sales, acquisition, logistics, personnel management, finance and cost accounting etc.).

E-commerce focusses on commercial activities among market participants and denotes the support of market transactions by electronic communication nets. A major distinctive feature is the type of actor relation. While in the first place, electronic commerce had developed along the relation from business to consumer (B2C), today business-to-business applications (B2B) are the driving force of development and the fastest growing sector of digital economy. Apart from that, there are initial approaches

¹⁰ cf. Brodie-Smith, J.; Leonhardt, S.; Melter, D.: Mobile eMarkets – Überall und jederzeit einkaufen, in: Diebold Management Report no. 1 – 2000. KPMG study: Preparing Europe for UMTS, October 1998. The Boston Consulting Group Study: Mobile Commerce – Winning the on-air consumer, November 2000. Amor, Daniel: Die E-Business (R)Evolution. Bonn, 2000. Morgan Stanley Dean Witter (2000): The B2B Internet Report. Collaborative Commerce: via: <http://www.msdcw.com/techresearch/b2b/info.html>. Picot, A.; Reichwald, R.; Wigand, R.T.: Die grenzenlose Unternehmung: Information, Organisation und Management, Wiesbaden, 1996. Zerdick, A. et al.: Die Internet-Ökonomie: Strategien für die digitale Wirtschaft, Berlin, 1999. Kaplan, S.; Sawhney, M.: E-Hubs: The New B2B Marketplaces, in: HBR, May/Jun 2000, p. 97ff.

towards a relation from customer to public administrations (business/consumer-to administration B2A/C2A). Besides, the intense use of auction platforms has brought about a new category, which is difficult to quantify: the e-commerce from consumer to consumer (C2C).

Table 1: Market and transaction fields of e-business

| | | Demanding actor | | |
|-----------------|----------------|---|--|--|
| | | Consumer | Business | Administration |
| Supplying actor | Consumer | consumer-to-consumer e.g. exchange of music files, purchase/sale of second-hand goods | consumer-to-business e.g. product evaluation by the consumer | consumer-to-administration e.g. tax transactions of individuals |
| | Business | business-to-consumer e.g. ordering in Internet shops, download of software and music, online newspapers | business-to-business e.g. data mining, software downloads | business-to-administration e.g. tax transactions of companies |
| | Administration | administration-to-consumer e.g. welfare payment transactions (unemployment benefits etc.) | administration-to-business e.g. procurement measures of public institutions via Internet | administration-to-administration e.g. transactions among authorities via Internet (e.g. Bonn – Berlin) |

Source: IZT 2001, unpublished working paper, according to: EBUS REPORT 2/00

3 Environmental Effects of E-business: First Insights and Conclusions

While the information-technological and communication-technological infrastructure, and in particular terminals (more than networks) have been the subject of scientific investigations and the focus of production development for years, and a wide range of data about relevant material flows is already available in this field¹¹, the application side of information and communication technologies in an ecological perspective has rarely been the focus of scientific studies up to now. So there are only few research results. Merely a few empirical studies on environmental effects of e-business and Internet use are available so far.¹² The key insights of these studies may be summarized as follows:

Environmental Effects of Media Utilization

- There is no general answer to the question whether the utilization of new media will increase or decrease environmental impacts.
- As with life cycle assessment in general, results of studies in this field crucially depend on the underlying assumptions and defined system borders.
- New and classic media each have their specific advantages: so, for instance, with respect to selective search for information, electronic media are usually more efficient and more environment-friendly (time-saving search functions, energy use and environmental exploitation crucially dependent on use). With respect to entertainment and unspecific background input, however, conventional media are often more advantageous.
- Frequently, electronic media are not so much a substitute as rather a supplement for printed or other media, thus tending to increase environmental impacts. There is the risk of summation effects and incomplete substitution.
- Environment-friendliness of Internet use and electronic media does heavily depend on the way of electricity production, hence on the respective shares of the technologies used for current generation. As to printed media, the aspect of paper recycling does strongly influence environmental effects.
- Of considerable relevance with regard to energy consumption and environmental exploitation is – apart from the terminals – the network infrastructure (server, router etc.).
- Important factors influencing the environmental effects of Internet use and e-business are: frequency and duration of media use, degree of utilization of individual devices/media (difference between professional and private use), multifunctionality of the devices/media, utilization forms/behaviour
- There is only limited choice about using a medium or not. Therefore, the question is primarily how to optimize and increase efficiency of the respective medium (focus on optimization of media rather than on "either – or").

¹¹ cf. Reichl, H.; Griese, H. (eds.): Electronics Goes Green 2000+, Joint International Congress and Exhibition, Proceedings Volume 1, Technical Lectures, Berlin, Offenbach, 2000. Behrendt, S.; Pfitzner, R.; Kreibich, R., Hornschild, K.: Innovationen zur Nachhaltigkeit - Ökologische Aspekte der Informations- und Kommunikationstechniken, Berlin, Heidelberg, New York 1998. Inquiry commission of the 13th German Bundestag on: "Protection of human beings and environment": Konzept Nachhaltigkeit - Vom Leitbild zur Umsetzung, Bonn, 1998.

¹² see the survey of initiatives and research at the end of this paper.

Environmental Effects of Digitalization

- Digitalization of products (music, news, e-mails etc.) does not automatically lead to de-materialization but often rather entails subsequent effects. So, for instance, digitalized music files downloaded from the Web (e.g. via Napster) are often burned onto CDs, received e-mails are printed out on paper etc. These are re-materialization effects.
- Side-effects of digitalized media, like packaging of CDs, or printed user manuals, do considerably influence the eco-balance.

Effects on Resource Productivity

- Potentials for increasing resource productivity appear in outlines above all in the business-to-business (B2B) area. First American studies point at considerable potentials in the fields of increasing the quantities delivered (16% to 28%) and improving quality and accuracy of delivery (25% to 80%), while stocks are reduced (25% to 60%). According to first estimates, B2B Internet platforms and e-business in supply chain management allow to increase productivity by 10 to 16 per cent.¹³
- Savings potentials are also presumed to exist in the B2C area, for instance as a result of reduced numbers of bank branch establishments because of home banking, and as a result of the shift from energy-intensive retail shops to less energy-consuming storehouses because of home delivery.

Traffic-related and Logistics-related Effects

- The "virtual world" of e-business and e-commerce is closely interlinked with the "physical world". Extended and complex logistic processes (freight traffic, transshipment of goods, passenger traffic etc.) occur behind online shopping and market transactions.
- Any assessment of the environmental effects of e-commerce on traffic and environment is linked to multiple assumptions and requires complex modelling. The results of respective analyses of environmental effects are thus extremely dependent on the underlying assumptions.
- Online orders tend to accelerate the delivery of goods and to change the structure of shipped freight towards smaller units, thus lead to an increase in courier, express, and parcel deliveries.
- On the other hand, Swedish studies show that e-commerce does not necessarily entail more traffic. Under certain preconditions, online shopping has a potential of pollution and traffic reduction. The realization of that potential depends crucially on: the respective population density as to home delivery service, the share of e-commerce users, the delivery distances, and the modal split of the respective region.
- Altogether, the present state of research implies that hopes for a reduction of physical traffic have not been met so far. On the contrary, there is rather an acceleration and extension of flows of goods due to e-commerce.

¹³ The mentioned figures are taken from a study of the US-American consulting firm Pittiglio Rabin Todd & McGrath (PRTM): cf. www.prtm.com.

Rebound Effects and Macro-observations

- Existing micro-studies (analyses of environmental effects at the micro-economic level) do not address system and rebound effects.
- While there is a considerable number of micro-studies, hardly any investigation is available so far at the macro-economic level. So far there are only data for the USA and Germany. According to a first study, in the USA in the years 2000 to 2010, the shift towards an Internet economy will result in a lower increase in CO₂-emissions than was originally prognosticated. Nevertheless, this will not prevent an overall increase of about 10%.¹⁴ Energy consumption of all office, telecommunication and network devices and technologies (including their production) is estimated to amount to about 3% of the overall US electricity consumption.¹⁵ The total electricity consumption for Internet use (PCs at home and in offices, web servers, routers etc.) in Germany is estimated to be about 1 per cent. This could rise to about 2 to 6 per cent in 2010, depending on the extent of energy efficiency measures.¹⁶

Methodical Problems of Research on Environmental Effects

- A principal problem consists in defining a unit of use. The paradigm of "functional equivalence" is difficult to apply in comparisons of different media.
- Data validity is often insufficient, the data inventories for ICT devices and facilities are outdated.¹⁷
- Question about appropriate system borders: (Micro) product technology assessments or LCAs so far register neither consequences in the value-added chain nor rebound effects.
- Quality/test criteria for studies on environmental effects of e-business applications are still lacking.

Classification of Environmental Effects

- As to the environmental effects of e-business and Internet use, three levels can be distinguished: direct environmental effects of the information-technological infrastructure (energy use etc. of networks, servers, receiver systems, terminals), secondary effects caused by Internet applications, and tertiary effects due to consequences and rebound effects. This distinction is suitable for an analysis of environmental effects of information and communication technologies in general.¹⁸

¹⁴ cf. Laitner, J.A.; Koomey, J.G.: *Re-estimating the Annual Energy Outlook 2000*, forecast using updated assumptions about the Internet economy, see <http://enduse.lbl.gov/Projects/InfoTech.html>.

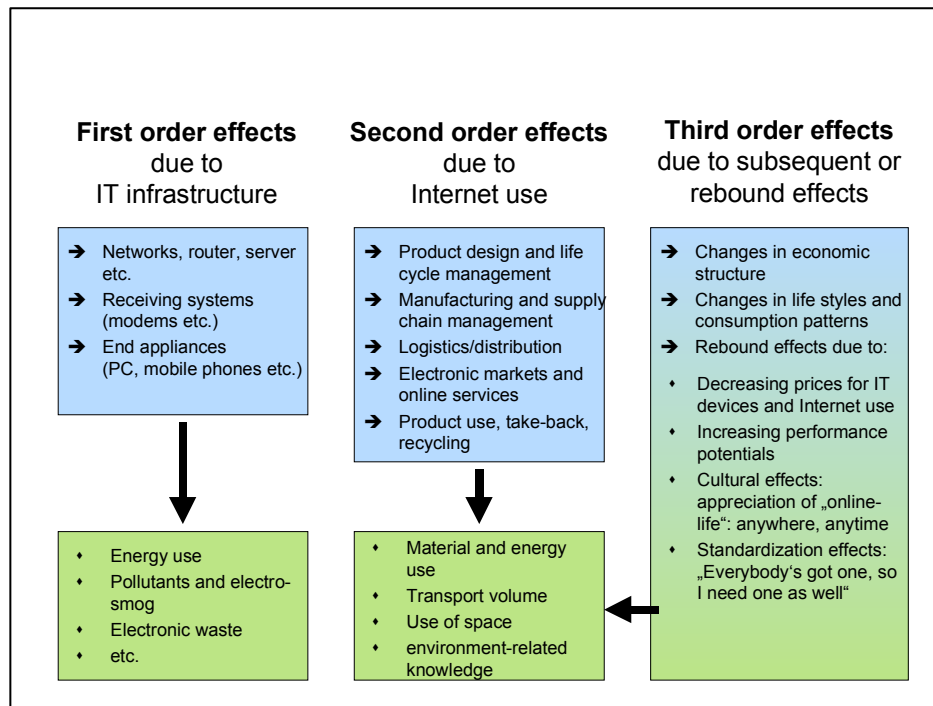
¹⁵ cf. <http://enduse.lbl.gov/Projects/InfoTech.html>.

¹⁶ cf. Langrock, T.; Ott, H.E.; Takeuchi, T. (eds.): *International Climate Policy & the IT-Sector*, Wuppertal Spezial 19, Wuppertal Institute, 2001, p. 64f.

¹⁷ With respect to this problem, and in particular for improved availability of data, the UBA is presently promoting the project "Basic data on environmental management" (BaUm). Besides, a feasibility study has been produced for the BMBF to the end of establishing a register "ProRegis" (Productivity Registry – Center for Resource Productivity Factors for Wealth Creation, Nov. 2000).

¹⁸ A comparable classification is proposed by Berkhout and Hertin: cf. Berkhout, F.; Hertin, J.: *Impacts of Information and Communication Technologies on Environmental Sustainability: Speculations and Evidence*, Report to the OECD, Brighton, January 2001.

Figure 3: Environmental Effects of e-business and Internet use



Source: the author

Conclusion

- Internet use and "new economy" do not automatically solve the sustainability problems of the "old economy", neither in an ecological perspective (traffic amount, energy consumption etc.) nor in a social view (poverty, hunger, human rights etc.).
- There is no general answer to the question whether e-business and Internet use entail increased or decreased environmental impacts. Up to now, there are examples of both environment-friendly and environment-damaging effects. Differentiated considerations, research efforts and answers are required.
- While a number of data and insights on the environmental effects of e-business and Internet use at the micro-level are available, only few statements about environmental effects at the level of macro-economy or entire society (macro-level) exist so far.
- Existing studies at the micro-economic level only represent the situation at a specific point in time and mostly define narrow system borders ("micro-consideration" of individual product or media alternatives). Consequences along value chains or potential rebound effects are not taken into account so far.
- The new media will not replace the old ones but complement them. Environment policy should focus on the question of how respective media utilizations can be optimized in view of environment and sustainability perspectives and how their positive potentials can be realized.

In an environment-political view, the following positive potentials of e-business and Internet economy can be identified:

- increase in resource productivity and eco-efficiency by means of intelligent processes of design, production, use, logistics, and recycling
- de-materialization of physical products due to digitalization
- new services to support sustainable patterns of buying and using
- improved possibilities of searching and acquiring environment-friendly products, services, and environment-relevant information
- accelerated structural change, from material-intensive economic branches towards branches centered on information and knowledge

These opportunities are contrasted by the following risks:

- dynamization and acceleration of economic processes, bearing the risk of generating new traffic flows and of further shortening of product cycles
- risk of incomplete substitution in the field of digital media/products. Conventional physical products (books, newspapers, letters etc.) are not or not completely replaced by digital alternatives. This leads to addition effects
- rebound effects
- re-materialization effects.

4 Trends

The following description of trends does not claim to systematically or completely cover social, economic or technological developments. Instead, it summarizes several important aspects and suggestions of the BMU expert discussion in Feb. 2001:

- The mega-trend towards an Internet economy cannot be stopped. In the medium term, almost every German household will have an Internet connection at its disposal. Internet use and e-business are to be seen against the background of a development towards network organizations and network societies.
- Many services are no longer supplied in any other than an Internet-based form (e.g. a number of banking services). Thus, in some areas there is a certain "compulsion to use the Internet". At the same time, Internet use becomes a matter of routine and something normal.
- E-business development is only in its initial stages: in the field of e-commerce, presently and in the longer term the B2B area is seen as the most relevant sector (sales shares, sales development). The introduction of the UMTS standard for portable radio networks could possibly increase the relative portion of B2C activities as well as their relevance.
- The spatial range of action for economic actors is enlarged through ICT and Internet use.
- Re-configuration of value chains: new potentials of productivity and efficiency may be used, and will have to be used, too, for reasons of competitiveness.
- Distance trade in Germany will increase from its present share of 5% of retail turnover to the amount of 10% by the year 2010.
- Internet access for all parts of the population will be ensured in the medium term – at least in industrialized countries. Yet in global respect, the problem of the digital gap will remain a crucial issue (today, for instance, Switzerland, has the same number of Internet connections at its avail as

all African countries together). Besides, the digital gap is not only a question of Internet access but refers also to user competence and costs of use (charges for Internet services etc.).

- Trends go towards media convergence and multimedia patterns of supply and utilization, towards interlinking and parallel use of different media (e.g. the service of the Financial Times Germany, "One brand, all media"), but there are also potentials for multifunction terminals.
- Consumption and life styles will undergo changes due to new media, but the way they will change and will influence environmental exploitation is not yet recognizable.

5 Research Questions

A number of research questions have been raised in the context of the BMU expert discussion, which are listed below:

Fundamental Issues of Environment-Political Control in the Information Society

- forms of appropriate (environment-)political control concepts in the information society, search for suitable and clearly oriented system designs, framework preconditions for ecological rough control, guidelines, transparency, accounting.

Primary Environmental Effects Due to Information-technological Infrastructure

- energy consumption and environmental effects of the Web infrastructure (terminals excluded) ?
- availability of valid and up-to-date life cycle assessment data for ICT devices and modules (computers etc.)
- environmental potentials through multifunction terminals and intensified use of devices (e.g. also by mobile Internet use), net laptops in the professional area
- possibilities to establish improved ways of using terminals ?
- mobile devices as throw-away products ?

Secondary Environmental Effects Through Internet Use

- studies regarding environmental effects of e-business with focus not only on individual applications (e.g. online catalogue or telephone number inquiry) (micro-studies) but consideration of effects in the value-added chain
- environmental potentials of Internet use for optimization of business processes and in the B2B area: local, regional products, mass customization, "technofactory" (manufacture on the basis of integrated specialized competences and know-how), networks of small firms
- reliable figures about increase in courier, express, and postal service traffics due to e-commerce (acceleration of deliveries) and their environmental effects; ascertainment of influence possibilities
- relief potentials through e-mailing? Transport of letters avoided, but rebound effects due to low costs and low forwarding expenses (increase in communication, printing out of e-mails etc.) ?
- potentials of telework/video-conferencing etc. in view of new technologies (net PC/laptop): effects on number of devices, on intensity of use, on the saving of working space, on energy, and on desk places as compared to homework, saving of commuter traffic, effects of Web infrastructure (servers etc.)?

Tertiary Effects in Form of Consequences and Rebound Effects

- influence of Internet and media use on consumption and life styles, consideration of existing results in the fields of milieu, life style, and consumption research (e.g. Sinus milieus, trend studies like Shell study on adolescents etc.) ?
- potentials of Web platforms as to the formation of communities ?
- effects of the "new economy" on occupation largely unknown so far: they may be classified into the following categories: direct job effects in the "new economy" (dot-coms etc.), job effects in the "old economy" (cut-back in the network of branch establishments due to home banking etc.), occupation effects in small and medium-size firms – in particular in craftsmen's trade – due to Internet use, occupation effects in the environmental economy, effects of new online services related to environment protection)
- consideration of existing results in the fields of milieu, life style, and consumption research (e.g. Sinus milieus, trend studies like Shell study on adolescents etc.)

6 Environment-political Strategies

Existing studies on environmental effects of e-business and e-commerce show that the use of electronic communication nets in the economic process includes potentials of de-materialization and multiple opportunities to reduce environmental exploitation. Apart from substitution effects, however, also generation effects can be recognized (e.g. in the field of traffic), and risks exist due to rebound and side effects, e.g. due to re-materialization of digital products (printing out of e-mails, burning of digital music files on CDs etc.)

Moreover, it can be seen that environmental effects of media use are influenced, above all, by the "classic" fields of environmental policy. For instance, the decision whether electronic or print media are preferable from an ecological point of view, is crucially dependent on kind, frequency and intensity of their use, or, for instance, on the respective shares of technologies used for current generation, or on the extent of paper recycling. So, there is no general answer to the question whether e-business and Internet use will lead to increased or decreased environmental exploitation. Environmental effects are predominantly not determined by a technology or a medium in themselves, i.e., effects are not immanent to the technology. Instead, they are dependent on framework conditions and forms of use. There is the need for more differentiated observations, investigations and answers.

To create suitable environment-political framework conditions for the Internet economy, the fundamental changes in value-added structures, mechanisms of market function, professional life and consumption patterns will have to be included into the analysis, and differentiated analyses of environmental effects will have to be performed at the micro and macro level. In this respect, e-business and environment and the environment-political perspectives of the Internet economy will have to be analysed and shaped in the overall context of a sustainable information society.

The following basic environment-political strategy approaches¹⁹ for a sustainable Internet economy can be formulated:

Consistency Strategy

- creating clearly oriented system designs and development paths for an Internet economy and an information society (sustainability goals and indicators for the Internet economy, environment-

¹⁹ cf. Behrendt, S.; Pfitzner, R., Kreibich, R., Hornschild, K.: *Innovationen zur Nachhaltigkeit - Ökologische Aspekte der Informations- und Kommunikationstechniken*, Berlin, Heidelberg, New York, 1998, p. 261f.

political long-term planning, strengthening of processes of dialogue and reflection, strengthening of civil social institutions and groups, increased reporting and accounting)

- ensuring framework preconditions for a sustainable information technology (by means of fostering design for environment, roadmapping initiatives, schemes of obligatory take-back of used devices etc.)

Efficiency Strategy

- ensuring framework preconditions for an increase in resource productivity through ICT and Internet use, e.g. by means of research and funding policies
- utilizing potentials of de-materialization due to digitalization (considering rebound effects, tendencies of re-materialization and risks of incomplete substitution)

Sufficiency Strategy

- promoting forms of resource-saving use and application of ICT and Internet
- supporting patterns of sustainable buying and using by means of new media and electronic communication nets

7 Recommendations for Further Measures

In the context of former studies and expert discussions, important recommendations for action fostering a sustainable information technology and society have already been worked out.²⁰ Partly, the proposed measures for an environment-friendly information technology have already been adopted or are being implemented – so, for instance the proposal for a EU Directive on Waste from Electrical and Electronic Equipment (WEEE), labelling (proposal of an EU Directive for a programme of labelling energy-saving devices in the field of information and communication technology), and an initiative regarding roadmapping for a sustainable information technology (www.roadmap-it.de).

Apart from these proposals and implementation projects, which in the first place deal with the information-technological infrastructure and its direct environmental effects (primary effects), environmental policy should, in the future, concentrate more on the application of ICT, on Internet use and on the related ecological opportunities and risks (secondary effects) as well as on consequences and rebound effects (tertiary effects). This implies two short term focuses for further measures:

1. analysis and research
2. dialogue and definition of goals

As up to now little is known about secondary and tertiary effects of e-business and Internet use, and as only first experiments are made with a dynamic use of new media and electronic communication nets, research should center on investigating secondary and tertiary effects as well as on analysing potentials and framework conditions for de-materialization and for an increase in resource productivity.

A second focus should be on dialogue and goal definition for a sustainable information society and Internet economy. Government and politics can only indirectly influence the manifold and complex application forms of new media and electronic communication nets. Therefore, on the one hand, dialogue and reflection processes with social actors, these "soft" forms of environment-political shaping, are of particular importance. In addition, the development of clearly oriented system designs and eco-

²⁰ cf. *ibid.*, p. 261ff. See also Grießhammer, R.: *Strategie für eine Nachhaltige Informationsgesellschaft*, evaluation of the expert discussion on information and communication of November 10, 1999.

logical development paths by means of guidelines, scenarios, set environmental targets and concrete goals for ecological action are required for the Internet economy. In that respect, dialogue and goal definition with regard to ecological sustainability should be closely linked to social and economic aspects.

As concrete measures, the following are recommended:

1. Preparation of a Research Map "Sustainability in the Networked Economy"

An inquiry across national, European and international levels should identify completed, current, and planned research projects that deal with the ecological sustainability of a networked economy (Internet economy). This inquiry should provide a concise and systematic survey of the current research landscape and identify possible research deficits. It should be compiled together with or in accordance with important providers of research funds like the BMBF or the EU commission. The resulting research map will then be the basis for planning further projects. It will allow the German Ministries for Economy and for Education and Research or the European Union to attend research-politically motivated initiatives regarding information and communication technologies as well as e-business in an environmentally oriented way.

2. Preparation of Short Studies

As a basis for further expert discussion (see below) and for the development of environment-political strategies and measures, the preparation of short studies is proposed to corroborate the identified perspectives of environmental opportunities and risks due to e-business and Internet use by means of case analyses and by the gathering and compilation of concrete data and quantified estimates of the respective potentials. These short studies should draw on existing studies and data as far as possible²¹ and should, for instance, supplement the latter by individual case analyses. Short studies are proposed for the following areas:

- Business-to-business (B2B): focus on potentials to increase resource productivity by means of e-business in supply chain management, with cooperations along the value-added chain, and through utilization of electronic markets (B2B Web platforms). Identification of de-materialization potentials due to digital products, and assessment of rebound and re-materialization effects.
- Business-to-consumer (B2C): focus on online service models of supporting sustainable patterns of buying and using, and on digital products or system applications that foster resource-saving forms of utilization and application of ICT and Internet (intensified use, multifunction devices etc.)
- Business-to-administration (B2A): focus on environment-oriented procurement through Internet use, and promotion of resource-saving forms of utilization and application of ICT and Internet.
- Environmental responsibility in the "new economy": focus on the attitude of Internet start-ups, online service providers and Web traders as well as on the state of their environment and sustainability management.
- E-business and sustainable regional/urban development.

²¹ Among them are the project on e-commerce of the Baden-Württemberg Academy of Technology Assessment, the study "*E-Commerce und Logistik*" of the North Rhine-Westphalia Ministry of Economy and Transport, as well as the project "*E-Commerce*" ordered by the German Bundestag (TAB/ITAS), in the second phase of which a number of branch studies and a literature review on "E-commerce and ecology" are to be performed.

3. Expert Discussions to Go Deeper into the Subject

The results of the short studies should be discussed in four hearings with experts and relevant actors. The following subjects are proposed:

- B2B: resource efficiency through e-business, examples, potentials and framework conditions to increase resource productivity
- B2C: offers of online services that support sustainable consumption patterns, examples, potentials and framework conditions for a de-materialization in the area of buying and using products
- B2A: environment-oriented procurement through Internet use: present state and perspectives for the future
- Dot-com ethics: what is the environmental responsibility of Internet firms?

On the basis of the research map, the short studies and the expert discussions, advanced research and implementation projects can be initiated. Apart from the already listed subjects, those questions should, at any rate, be included that have largely remained uninvestigated so far. Primarily, this concerns:

- rebound effects and
- macro effects.

4. Initiation of a Dialogue Project "Digital Futures: Sustainability in the Networked Economy"

In Great Britain, a globally so far unique dialogue project has been successfully established, in which chances and risks of Internet and e-commerce regarding a sustainable development are discussed in a large-scale social discourse. The project "Digital futures" involves government, economy, science, and further social actors. In view of the fertile results of "Digital futures" and its strong impact on the participating actors, the initiation of a comparable participative dialogue process in Germany is proposed, meant to:

- identify and discuss chances and risks of a networked economy regarding a sustainable development
- design scenarios and possible futures
- formulate needs for action, and
- create public awareness and sensitize economy and society for these issues

Such a dialogue could, for instance, be imbedded into the action programme of the German Federal Government "Innovation and jobs in the information society of the 21st century" and be interlinked with the governmental Council for Sustainable Development. Besides, it could be networked with other relevant initiatives, like, e.g., the roadmapping initiative "Strategies for a sustainable information technology" of the German Bundestag, the company initiative "D21", and the EU-supported project "Digital Europe"²²

²² See the short description of the project in the survey of initiatives and research.

5. International Conference on "Sustainability in the Networked Economy"

An international conference on "sustainability in the networked economy" is proposed, to be organized by the BMU, possibly in cooperation with further institutions, either to be linked to the above proposed measures or independently of them. In this conference, the current state of scientific results, best-practice examples from the economic sector, as well as environment-political and sustainability-political positions and concepts will be discussed with the expert public and presented to the press and the general public. Apart from the exchange among experts, this conference will serve to position the issue on the political agenda and to distinguish Germany internationally with regard to the respective debate.

6. Extension of the UBA-Study "Sustainable Germany"

The UBA study "Sustainable Germany" should be extended by the aspects of information and communication technologies, Internet use, and requirements of a sustainable information society.

7 Other Measures

Furthermore, the following aspects should be taken into account:

- support and attending of the roadmapping initiative "Strategies for a sustainable information technology" of the German Bundestag
- establishment of special rubrics "sustainable information society" and "e-business and environment" on the BMU web site as well as on the list of data and facts of the UBA web site
- establishment of a special Internet platform regarding "e-business and environment" and a respective newsletter, possibly in cooperation with publishing houses and research institutions
- creation of scenarios in the context of a separate study or as part of the dialogue project "Sustainability in the networked economy". Such efforts for scenario development could, for instance, draw on scenarios developed in the context of the British project "Digital futures"
- test of feasibility of and potentials for an environmental label for Internet services and applications
- environmental management as well as environmental and sustainability reporting by Internet service providers
- application of environment protection requirements to the Internet infrastructure ("Internet farms", aerials for portable radio networks, electro-smog, protection of landscapes etc.)
- development of a set of criteria for a critical review of empirical studies on the environmental effects of ICT and media/Internet use
- data quality and availability: solutions for up-to-date LCA modules for information and communication technologies and Internet applications, in connection with the UBA project BaUm (Basic data on environmental management) or the BMBF project ProRegis (Productivity Registry – Center for Resource Productivity Factors for Wealth Creation)

8 Survey of Initiatives and Research Concerning Internet Economy and Environment

8.1 Initiatives

- **Roadmapping:** On May 11, 2000, the German Bundestag accepted the motion "Strategy for a sustainable information technology" (BT-Drs. 14/2390), submitted by the governing parties. This motion asks the government to initiate a project to produce a road map for sustainable information technology in Germany. The project has been launched in July 2001 (www.roadmap-it.de),
- **Digital futures** was a project of the British Forum for the Future. It was started in February 2000 by the British minister for Internet and ICT (e-minister), Patricia Hewitt. In the context of this project, which deals with the effects of Internet and digital economy on society and environment, studies in eight areas have been produced. The results were presented on March 1, 2001, in a conference in London (www.digitalfutures.org.uk)
- As a result and follow-up project of "Digital futures", "**e-lab**" was founded in March 2001 by the Forum for the Future. "E-lab" is a competence centre located in Great Britain with the goal of fostering sustainability opportunities of the "new economy". It is sponsored, for instance, by the firms Sun Microsystems and Vodafone and is supposed to initiate further innovative projects in the years to come.
- In the context of the "Information Society Technologies Programme" of the **European Commission**, the Forum for the Future (UK), the Fondazione Eni Enrico Mattei (Italy), and the Wuppertal Institute for Climate, Environment, Energy (Germany) are conducting the project: "**Digital Europe: e-business and sustainable development**". This project has the goals of quantifying the extent to which e-business could possibly contribute to de-materialization and eco-efficiency, of ascertaining the effects of e-business on the social responsibility of firms, and of forecasting the structural and regional changes to be expected as a consequence of e-business (e-commerce and e-work). By means of eight case examples and in cooperation with companies, consumer organizations and governmental institutions, effects at the micro level are analyzed and classified into B2B, B2C, or B2G, and trends at the macro level are determined with the help of scenario techniques. The project is a successor to the UK project "Digital futures" and intends to work out strategies for decision-makers in politics and companies regarding a sustainable e-Europe and e-business. Contact: Michael Kuhndt, (michael.kuhndt@wupperinst.org); upcoming: <http://www.digital-europe.net>
- The office for technology assessment linked to the German Bundestag (**TAB**) is conducting a study on perspectives of e-commerce. In the context of the second phase of this study (2001), investigations on special economic branches are to be performed, and a "**literature review on ecological consequences of e-commerce**" is to be produced (by October 2001). Contact Klaus Fichter: fichter@borderstep.de.
- In October 2000, the **Gesellschaft für Informatik** (society for informatics) has founded a working group "Information society and sustainable development". (For more detailed information: lorenz.hilty@empa.ch)
- As a result of the globally first conference on "E-commerce and the environment" (October 2000, New York City), a **web platform** to the end of networking actors and exchanging information was established: www.green-ecommerce.com
- The Swedish firm Forseback IT & Euro Intelligence AB has produced "**Case Studies of the Information Society and Sustainable Development**". This report (of May 2000) describes vari-

ous initiatives in Europe. It deals, for instance, with the following issues: de-materialization, process re-engineering for e-business, product improvement, services, and structural changes.

- By order of the **OECD**, the Science and Technology Policy Research of the University of Sussex, SPRU, has produced a report on "Impacts of information and communication technologies on environmental sustainability: speculations and evidence".²³

8.2 Energy-related and Material-related Consequences

- first assessments about the **ecological relevance of online media** (as compared to print media). Among them the following:
 - Plätzer, Edik Tibo: *Papier versus Neue Medien: Eine Analyse der Umweltverträglichkeit von Presseinformationen im Licht des technologischen Wandels*, doctoral dissertation at the department of jurisprudence and economy of the Technical University of Darmstadt, 1998
 - Kortmann, Jaap, de Winter, Saskia: *Online applications in The Netherlands. Looking up telephone numbers by Internet*, IVAM, Universiteit Amsterdam, 1999
 - Greusing, Inka, Zangl, Stephanie: *Vergleich von Print- und Online-Katalogen: Akzeptanz, ökologische und ökonomische Analyse*, thesis at the department of environmental technology of the Technical University of Berlin, 2000. Available as IZT workshop report no. 44, Berlin 2000
 - Reichart, I.; Hischier, R.; Schefer, H.: *Ökologische Auswirkungen der Mediennutzung*, study of the Swiss federal laboratories for materials testing and research, EMPA, St. Gallen, Switzerland, 2000
- a Swedish study about **effects of online shopping** on transport, energy consumption and emissions into the air, conducted for the Swedish Environment Protection Agency by Prof. Gunilla Jönson, university of Lund, Lund Institute of Technology, (Gunilla.Jonson@tlog.lth.se, <http://www.swedenenvironment.environ.se/no0001/0001.html#art13>)
- a comparison of **online buying of books** (at Amazon's) versus traditional buying of books in bookshops, (providing empirical data), by Dr. H. Scott Matthews, Carnegie Mellon University Pittsburgh, hsm@andrew.cmu.edu, phone +1.(412) 268-3645, <http://www.pcwelt.de/content/news/newinternet/2000/12/xn191200005.html>
- a case analysis on environmental effects of B2C and B2B electronic commerce in production and sales of desktop computers, in the context of a "Lifecycle Environmental Study of the Impact of eCommerce on Electronic Products", by Prof. Dr. Reggie J. Caudill, Multi-Lifecycle Engineering Research Center, New Jersey Institute of Technology, Newark, NJ, <http://merc.njit.edu>
- a study on "**Office equipment electricity use ...**", by Jonathan Koomey, Lawrence Berkeley National Laboratory (JGKoomey@lbl.gov). This study disproves Mark Mills's statement in his article "The Internet begins with coal" for the US journal Forbes (May 1999), declaring that energy consumption attributable to the Internet (i.e. by computers, computing centres etc.) would account for 8% of the overall US energy consumption. Actually, the respective figure is estimated as amounting to about 1%. (For further information: <http://enduse.lbl.gov/Projects/InfoTech.html>)
- an investigation on **energy consumption of portable radio networks** by Christian Schaefer and Christoph Weber of the Institut für Energiewirtschaft und Rationale Energieanwendung IER (institute for energy management and rational energy application) of the university of Stuttgart (cf.

²³ cf. Berkhout, F.; Hertin, J.: Impacts of Information and Communications Technologies on Environmental Sustainability: Speculations and Evidence, report for the OECD, Brighton, January 2001.

Schaefer, C., Weber, Ch.: *Mobilfunk und Energiebedarf*, in: *Energiewirtschaftliche Tagesfragen*, vol. 50, 2000, no. 4, pp. 237-241)

Studies at the Macro Level

- In 2001 the Wuppertal Institute for Climate, Environment and Energy and the Japanese Institute for Global Environmental Strategies (IGES) published a report on **energy use and greenhouse gas emission trends of the Internet in Germany and Japan** and recycling and labelling issues of IT products.²⁴
- In 1999 already, a study on "**The Internet economy and global warming**" was published by Joseph Romm et al. (www.cool-companies.org/ecom), which deals with the effects of the growing Internet economy on energy consumption in the USA.
- The **US-American Environmental Protection Agency EPA** has produced a study on **effects of the digital economy on energy consumption in the USA** (Newsgroup "Network for energy, environment, efficiency and the information economy (N4E)": <http://N4E.lbl.gov>).
- The research project "**Institutional dimensions of a sustainable information society**" is an exploratory project in the context of research focus "Socio-ecological research" of the German Ministry for Education and Research BMBF. It is conducted by the university of Oldenburg (Prof. Uwe Schneidewind), in the years 2000/2001. It is supposed to yield a socio-ecological evaluation frame for institutional feedback in the information society (www.uni-oldenburg.de/produktion).

8.3 Traffic-related and Logistics-related Effects²⁵

Important contributions on application of information and communication technologies are available, for instance, regarding the use of telematics in the traffic sector²⁶ and regarding the ecological effects of telework²⁷. As to specific effects of e-commerce and traffic-related consequences, however, only few studies have been completed so far. But intensive research is being carried out particularly in this area.

Starting point of current research is the modification of individual behaviours due to use of ICT in the field of supply with goods and services. The following projects may be listed as examples:

- **Virtual Mobility**. Mobility behaviour and mobility requirements of Internet users. A project of the working area for theoretical empirical applied urbanity research at the geographical institute of the Free University Berlin
- **EUCAR**. Impacts of future trends in individual shopping behaviour and of modern distribution/delivery system concepts on spatial structures and traffic systems in selected European countries. European Centre for Transport and Logistics (ECTL). TU Hamburg Harburg
- **EVITA I + II**. New communication media: use in firms and impacts on traffic. In the context of "Transport and environment", a national research programme of the Swiss National Science Foundation

The respective projects and publications have to situate themselves within a field of contrasting hypotheses. Until recently, for instance, discussion focussed above all on potential **substitution effects**

²⁴ cf. Langrock, T.; Ott, H.E.; Takeuchi, T. (eds.): *International Climate Policy & the IT-Sector*, Wuppertal Spezial 19, Wuppertal Institute, 2001, (www.wupperinst.org).

²⁵ compilation by the Institut für Zukunftsstudien und Technologiebewertung IZT (institute for studies on the future and technology assessment), Berlin.

²⁶ see, e.g., Gaßner, Robert: *Verkehr und Telematik*, Weinheim, 1996.

²⁷ cf. Öko-Institut: *Cyberspace*, Freiburg/i.Br. 1998.

as one form of reducing private and commercial mobility due to ICT uses. In most cases, however, the underlying hypothesis is based on certain preconditions. So, for instance, significant changes in user behaviour in certain application fields (e.g. telework²⁸, online shopping) will be a presupposition for making saved mobility due to tele-activities result in recognizable environmental relief effects.

- In this respect, **digital distribution** of goods and services has to be mentioned, which may contribute to a decrease in traffic.²⁹
- The same holds for the avoidance of traffic due to **telematic support** of new structures of settlement, production, and companies.
- Furthermore, real travelling in the context of private and business contacts can be replaced by **remote communication**.³⁰

The complementary hypothesis (**induction effects**), on the other hand, assumes an increasing transport of persons and goods. It is corroborated by the fact that optimistic prognoses about potential savings due to ICT use could not have been verified so far – any achievements have been counterbalanced by rebound effects.³¹

- It is true that customers may avoid a part of their private supply mobility through use of e-commerce. But probably, the saved time will be used for an **increased leisure mobility**.³²
- The same holds for the suppliers' side: companies offering product information in the Internet are able to reach customers all over the globe. This will result in an acceleration and **globalization of logistic processes**, i.e., international flows of goods will grow.³³
- Moreover, there is an **"atomization of shipments"**. With direct orders, suppliers will have to trade consumer-size shipments, too. This will inevitably lead to a growing freight traffic.³⁴

According to the current state of research, hopes for a reducing effect on physical traffic have not come true so far. On the contrary, e-commerce has rather led to an acceleration and expansion of flows of goods.

8.4 Regional and Spatio-structural Effects³⁵

Spatio-structural and settlement-structural effects of e-commerce have been highlighted by various studies.³⁶ Dissense remains, for instance, with respect to the questions about how much, how fast, in what direction, and due to what e-commerce application areas certain developments will have an effect on occupation of space or on suburbanization.

²⁸ cf. Harmsen, D.-M.; König, R.: Möglichkeiten der Substitution physischen Verkehrs durch Telekommunikation, Fraunhofer-Institut für Systemtechnik und Innovationsforschung, Karlsruhe, 1994.

²⁹ cf. Wiegand, Alexander: Auswirkungen von Commerce im Internet auf die Logistik, Düsseldorf, 1999.

³⁰ cf. report and recommendations of the inquiry commission on "Development, chances and effects of new information and communication technologies in Baden-Württemberg" (multimedia inquiry), 1995.

³¹ cf. Radermacher, F.J.: Verkehrsvermeidung durch Telekommunikation – kein Selbstläufer, in: umis-magazin 04/99, <http://www.umis.de/magazin/99/04/telematik2/tele2.html>.

³² cf. Burgdorff, Getzmann, Heinze, Steinmüller: Online-Shopping und die Stadt. Auswirkungen des Internet-Handels im Privatkundengeschäft auf räumliche Strukturen. Gelsenkirchen 2000.

³³ cf. Wiegand: Auswirkungen von E-Commerce im Internet auf die Logistik. Düsseldorf, 1999.

³⁴ cf. Aden: Electronic Commerce und Logistik. Düsseldorf, 1999.

³⁵ compilation by the Institut für Zukunftsstudien und Technologiebewertung IZT (institute for studies on the future and technology assessment), Berlin.

³⁶ see, e.g. the hints of the inquiry commission on "Protection of human beings and environment" in its final report "Konzept Nachhaltigkeit - Vom Leitbild zur Umsetzung", Bonn, 1998, pp. 166-168

Opinions regarding spatial effects of ICT in general are largely based on a theoretical model which, in view of new media, was already discussed in the 80s. Its key hypotheses, supplementing each other but also contradicting each other, are the following:

- The possibility to transcend time and space through information and communication media will counterbalance certain agglomeration advantages and will support de-concentration (**de-concentration hypothesis**³⁷).
- Existing spatial disparities will be increased through widespread use of information and communication media (**concentration hypothesis**³⁸).
- As a result of re-organized control competences, certain areas will become either losers or winners in urban competition (**centralization or de-centralization hypothesis**).
- ICT cannot bring about any changes but can only reinforce existing trends (**trend reinforcement hypothesis**³⁹).

Further studies and current research⁴⁰ deal with various individual aspects of structural change due to e-commerce and with spatial impacts of e-commerce:

- As to the **system of cities**, the widespread application of information and communication media will lead to concentration processes with regard to highly specialized functions in agglomerations. Global cities, i.e. towns that are more closely linked to international exchange processes, will continue to gain in importance.⁴¹
- At the same time, opportunities emerge due to **re-regionalization** of production processes and structures as well as organizational and logistic optimization of e-commerce at the regional level.⁴²
- **"Soft" site features** will gain in importance in view of the new optionality of sites.⁴³ The fact that companies will be able to more flexibly choose sites will lead to an overall reduced ability to plan, and to shortened "response times" in planning.

Urban subspaces will be particularly affected by trends. E-commerce will exert its influence in various areas of living, like dwelling, working, culture, consumption etc. Different development perspectives result:

- The trend of **suburbanization of services**⁴⁴, to be observed for years now, can be further promoted by the spreading of e-commerce.

³⁷ see, e.g.: Klaus Fischer, Telekommunikation, Raumordnung und regionale Strukturpolitik, Stuttgart, 1984.

³⁸ see, e.g.: Michael Fritsch, Hans Jürgen Ewers, Telematik und Raumentwicklung, Bonn, 1985.

³⁹ see, e.g.: Dietrich Henckel et al., Informationstechnologie und Stadtentwicklung (Schriften des Deutschen Instituts für Urbanistik, vol. 71), Stuttgart 1984.

⁴⁰ Daniel Z. Sui, associate professor in the department of geography, Texas A&M University, has been given a one-year fellowship by the US department of commerce to study the effects of e-commerce on consumption of space and on spatial development (d-sui@tamu.edu)

⁴¹ Sassen, Saskia: The Global City: New York, London, Tokyo, Princeton, 1991; Castells, Manuel.: The Rise of the Network Society (The Information Society: Economy, Society and Culture, vol. I), 1996, p. 378 ff.

⁴² With regard to this issue, the Fraunhofer institute for system technology and innovation research is conducting the research project "CuRa: Cooperation for environment-friendly resource exchange to utilize potentials of cost reduction".

⁴³ cf. Grabow, Busso et al.: Weiche Standortfaktoren, Stuttgart, 1995.

⁴⁴ cf. Bade, Franz-Josef: Die Entwicklung der Dienstleistungen in der Stadt. In: Busso, Grabow (eds.): Die Zukunft des Dienstleistungssektors in der Stadt - Dokumentation eines Workshops im Rahmen des Projektes „Entscheidungsfelder städtischer Zukunft“, Berlin, 1996, Difu-Materialien, vol. 1/96, pp. 37 – 85; and ILS (ed.): Handel, Dienstleistung und Stadtentwicklung in der Informationsgesellschaft – Entwicklungstrends, Handlungsoptionen und Chancen, Dortmund, 1999.

- E-commerce supports **new production concepts and organizational forms** and structures of firms, like, for instance, the just-in-time production, which, in turn, will lead to a flexibilization of choice of site.⁴⁵
- Tele-communicative networking will, in addition, allow for a spatial **separation of office functions**.⁴⁶
- Altogether, the telematic infrastructure has been of subordinate relevance as to choice of site so far.⁴⁷ In the future, however, **flexibilization of the linkage to a site** due to e-commerce may have considerable spatial impacts on cities.

Dependent on the spatial impacts of partial aspects of e-commerce, the ecological consequences of these developments will take the form of traffic-inducing or traffic-substituting effects, of changes in area utilization or of material consumption due to construction measures etc., and will have to be ascertained individually.

⁴⁵ cf. Holger Floeting, Dietrich Henkel: Lean Production, Telematik, Just-in-Time, Stadträumliche Wirkungen neuer Produktions- und Logistikkonzepte, in: Stadtbauwelt, no. 120, December 1993, pp. 2620-2629.

⁴⁶ cf. Holger Floeting, Stefan Golm: San Francisco Bay Area – Strukturwandel einer Stadtregion, Qualitative Umstrukturierung im Dienstleistungsbereich und ihre räumliche Dimension, in: Die Erde, no. 122/1991, pp. 145-160.

⁴⁷ see, e.g. Regine Quentmeier-VierEGge, Dietrich Storbeck: Möglichkeiten und Hindernisse der Telematik am Beispiel eines Mittelzentrums: Herford, in: Akademie für Raumforschung und Landesplanung (ed.), Räumliche Wirkungen der Telematik, Hannover, 1987, pp. 447-469.