Future Impact of Digital TV Services and Broadband Internet Connections on Residential Energy Consumption

Clemens CREMER[1], Michael FRIEDEWALD[1], Barbara SCHLOMANN[1], Alois HUSER[2]

[1]Fraunhofer Institute Systems and Innovation Research, Germany
[2]Encontrol GmbH, Germany

1 INTRODUCTION

The electricity demand caused by electrical and electronic appliances have been the subject of increased research for some time both internationally and in Germany (as e. g. [1][2[3][4]). It is generally accepted that the demand for information and communication services will increase and thus also at first the associated electricity consumption. Increasing power consumption for ICT applications represents a basic risk both with regard to climate protection and - in Germany - against the background of the expected shutdown of nuclear power stations. On the other hand, the prospects for improved energy use due to ICT applications should not be neglected. These are found in existing electricity saving potentials in the ICT sector itself, which could be exploited to a greater extent, as well as in possibilities to save energy in other sectors through increased use of new ICT applications (e. g. through remote monitoring in the transport sector, in the intelligent home, in energy technology auxiliary systems). Therefore, on the policy level there are a series of initiatives dealing with this topic[3]. These activities focus on the reduction of the no-load or standby consumption of electrical and electronic appliances.

2 ELECTRICITY DEMAND FOR ICT IN GERMANY UP TO 2010

In Germany, a detailed survey was conducted, in order to determine the current and the future direct electricity demand of ICT appliances and their associated

[3] For example the Standby Initiatives of the European Commission and the International Energy Agency , the 1 Watt Plan of the LBNL, and in Germany a Standby Campaign in Schleswig-Holstein and an ongoing Campaign (“Initiative Energieeffizienz”) at the national level.

infrastructure in households and offices [5]. A bottom-up model was applied considering the stock of appliances, the power input in three operating modes (normal, standby, off-mode) and the operating times in these modes (Fig. 1). The main data sources for the base year of the survey (2001) were official and semi-official statistics, statistics of market research institutes and associations, information of manufacturers and from existing studies, and own measurements of the power demand of several appliances. The basis of the forecast (up to 2010) was a business-as-usual-scenario including the following assumptions: a further spread of information technologies in households, a moderate but continual growth of e-commerce, an increasing effective output of many appliances (100 Hz TVs, faster CPUs), and a moderate intensification of information technology use.

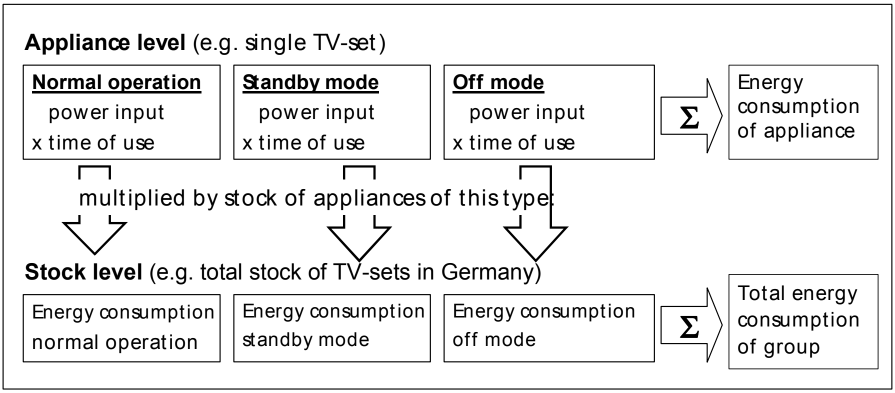

Fig. 1. Model to determine the power demand of ICT appliances and the associated infrastructure

As a result, the total electricity demand for the use of ICT in households and offices in Germany amounted to around 38 TWh in 2001 (Fig. 2). A further increase of the power demand for ICT by about 45 % to 55.4 TWh is anticipated up to 2010. This is equivalent to an annual growth of 4.3 %.

In 2001, the energy demand for ICT was clearly dominated by end-use appliances in households, which account for half of the total electricity consumption. About half of the consumption in households is caused by TVs and the infrastructure for television, and the broadband Internet connections in households. Until 2010, a consumption increase by 30 % to 24.5 TWh is expected for household end-use appliances, and a stronger increase by 90 % for the associated infrastructure (Fig. 2). This considerable growth has to be attributed to both the television infrastructure (especially to the growth in digital set-top boxes) and the internet infrastructure (especially the growth of broadband Internet connections).

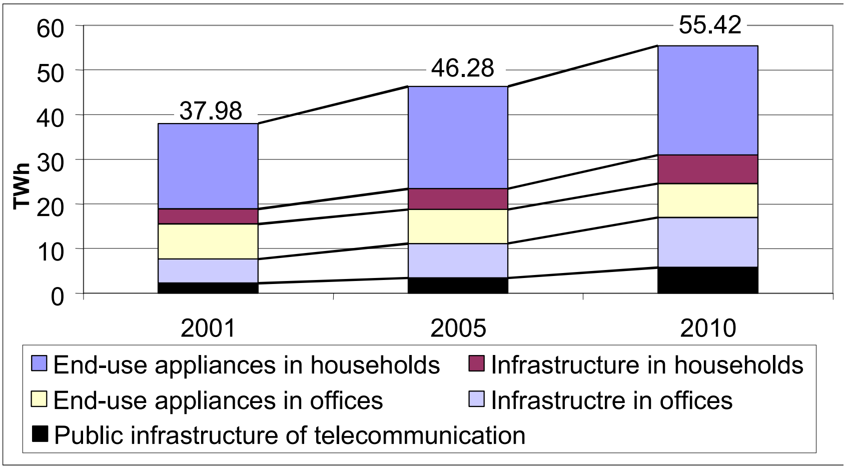

Fig. 2. Electricity demand for ICT appliances and associated infrastructure in houshoulds and offices in Germany 2001-2010: Business-as-usal scenario

3 SCENARIO ANALYSES

In addition to the reference case described above, which represents a business-as-usual-scenario from the authors' point of view, three more cases have been examined for selected appliances. Doing so the effects of today uncertain or argued developments have been analysed. At first a more optimistic scenario of the diffusion of networking technologies and services has been created. Based on the reference case and on the ubiquitous-network case, an energy efficiency scenario has been created. This efficiency scenario allows examining the impact of energy efficiency strategies on the projected ICT-stock and usage in both the reference case and in the ubiquitous-network case.

3.1 Ubiquitous network

The future extent of information interchange by digital networks, especially the Internet is one of the very vague points in any projection for the energy demand of ICT. On the one hand, a large variety of services can be imagined and is already offered at present times. Fast digital subscriber lines or video on demand stand as examples for these services. On the other hand their success on the market is hardly predictable and the history of consumer electronics shows both examples for unforeseen market successes and failures.

The actual penetration of the network services and equipment in private households is strongly influenced by investment costs. The most spectacular recent example for the introduction of a new technology driven service is the mobile communication, which has been fostered by very low investment cost offers by the service providers. Although digital subscriber lines (DSL) have not yet reached such a market penetration by far, a comparable marketing strategy of the telecommunication companies can be observed. One key factor to the success of DSL has been once again the low investment costs.

Based on the assumption that the telecommunication companies will continuously reduce prices for theses networking services and that the prices for private network equipment such as routers or switches will go down, the ubiquitous-network scenario projects that literally every PC and notebook computer will be linked to a fast internet access. Part of the scenario is as well, that the importance of computers (PCs and Notebook computers) for every day's activities will increase strongly [6]. This means for example that bills regularly will be sent out by email and no more by physical mail. The higher importance consequently leads to a longer usage time of the computers in households in the ubiquitous network scenario compared to the reference case. Alongside with the projections on services and usage, it has been concluded that, the number of PCs and notebook computers in households will be larger. As a consequence, the ubiquitous network scenario incorporates a penetration rate of roughly one computer per every second person. Corresponding to the ubiquitous use of networking computers the penetration rate of appliances for high-speed Internet access and for local area networks in households is higher than in the reference case, too.

3.2 Efficiency increase

Whereas the reference case incorporates projections for modest improvements in energy efficiency of ICT appliances only, the energy efficiency scenario concentrates on examining the impact of high efficiency technologies for household computers and televisions. This is especially important, as there is an ongoing debate about the business as usual development to expect, about the impact of technology adaptations and about the influence user behaviour. Already today, there are PCs with highly efficient standby operation mode. However it is also known that software conflicts make users to disable the standby mode function. In other cases these conflicts directly prevent computers to reach the efficient mode. Unfortunately there is no representative data on the usage and functioning of the standby operation technologies.

In the energy efficiency increase scenario significant reductions for the energy consumption of TVs, PCs and notebook computers in **normal operation mode** were projected. All the projections range within benchmarks that have been reached already today or imply technologies on the market. So there are no general technical constraints against reaching the values in this scenario. For the **standby operation mode** the efficiency scenario incorporates that new end-use appliances reach an average value of 1Watt power consumption. This is much better value than the actual requirements of the energy star, which allows standby power consumption of PCs of 20 Watts and more. Different to the end-use appliances, a power consumption of 2 Watts for new TV-infrastructure appliances has been projected. The **off-mode** will be avoided completely. The efficiency strategies include a larger success of the power management of computers in households, which yields a reduced usage time in normal operation to the benefit of standby mode operation.

3.3 Appliances analysed

The additional analysis based on the reference case was performed for few selected types of appliances only. In the field of consumer electronics, the TVs together with the associated TV-infrastructure in households were chosen; in the field of IT-appliances the computers in households together with the monitors and the associated to them. They were chosen as the response to the change in scenario parameters is relatively undoubted. On top, the effects of the differing parameters can be observed very well with these appliances.

3.4 Scenario results

The ubiquitous network case and the efficiency case show the expected increase in energy demand or decrease in energy demand respectively. As networking strategies will not directly influence TVs the invariance of the networking scenario for these appliances is not a surprising result either. The outcome of the combined networking and efficiency scenario has been less predictable. The calculations reveal a reduction in energy demand for all examined appliances. This means that energy efficiency strategies are capable to overcompensate the high-energy demand of the appliances highly affected by intensively used networks (see Fig. 3)

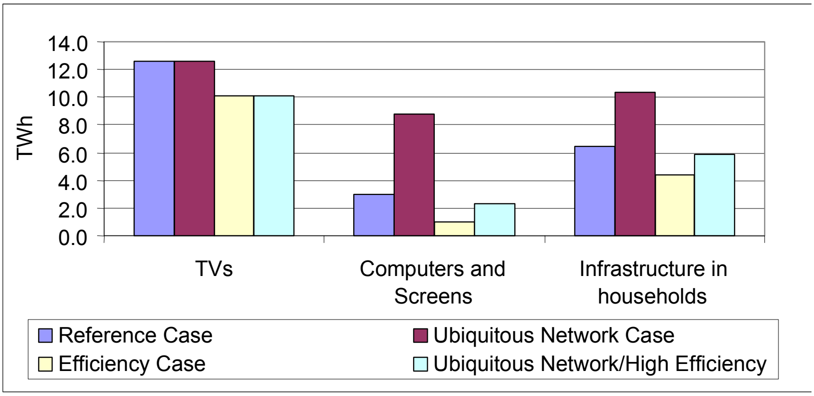

Fig. 3. Overall results of the four scenarios examined for television- and computing-appliances in households.

The televisions show only minor differences between the scenarios, the infrastructure appliances already strong differences and the end-use computing equipment a comparatively drastic response to the varying parameters.

4 DISCUSSION AND CONCLUSIONS

The large variation in energy consumption of ICT appliances in the examined scenarios proves ones again the high uncertainty, which lies in the development of these technologies. However, the differences among the appliances indicate fields of higher certainty and of lower certainty. Televisions with the highest overall energy consumption are less subject to changes as the large stock is relatively stable. Technology changes in the signal processing usually are not implemented in the appliances themselves but by use of set-top boxes. As a consequence, efficiency strategies and networking trends yield a higher effect on the side of these infrastructure appliances.

The strongest effects can be observed in the area of end-use computing appliances because there, all three factors influencing energy consumption are affected: the specific power consumption, the time of usage and the stock of appliances. These findings give valid indications where efficiency strategies can have a significant effect and where possible developments like the ubiquitous networking can have severe effects.

5 REFERENCES

[1] Langrock, T., Ott, H.E., Takeuchi, T. (Ed.): *Japan & Germany: International Climate Policy & the IT-Sector*. Wuppertal: Wuppertal Institute & IGES, 2001

[2] Kawamoto, K., et al*.: Electricity Used by Office Equipment and Network Equipment in the U.S.: Detailed Report and Appendices*. LBNL-45917, Lawrence Berkeley national Laboratory, Berkeley 2001, CA 94720

[3] Rosen, K., Meier, A.: *Energy Use of U.S. Consumer Electronics at the End of the 20th Century*. In: Bertoldi, P., Ricci, A., de Almeida, A.: Energy Efficiency in Household Appliances and Lighting. Berlin: Springer-Verlag 2001

4] Roth, K.W.; Goldstein, F.; Kleinman J.: *Energy Consumption by Office and Telecommunicatios Equipment in Commercial Buildings*. Volume I: Energy Comsuption Baseline. Cambridge, MA: Arthur D. Little 2002. www.eren.doe.gov/buildings/documents/pdfs/office_telecom-vol1_final.pdf

[5] Cremer, C. et al.: *Energy Consumption of Information and Communication Technology (ICT) in Germany up to 2010*. Summary of the final report to the German Federal Ministry of Economics and Labour: Karlsruhe/Zurich: Fraunhofer ISI, January 2003 http://www.isi.fhg.de/e/eng/publikation/online/iuk/iuk-e.htm

[6] Langheinrich, M., Coroama, V. et al. (2002): *As me may live – Real-world implications of ubiquitous computing*. Distributed Systems Group, Institute of Information Systems, ETH-Zürich

Paolo Bertoldi
Flavio Conti
Roberto Pagani
Editors

Energy Efficiency in Domestic Appliances and Lighting

Proceedings of the 3rd International Conference on Energy Efficiency in Domestic Appliances and Lighting

1 – 3 October 2003, Turin, Italy

Part I

PAOLO BERTOLDI
European Commission
Directorate General Joint Research Centre
I-21020 Ispra (VA)
Italy

FLAVIO CONTI
Energy Consultant
Via Scirello 11
I-21100 Luvinate (VA)
Italy

ROBERTO PAGANI
Softech s.r.l.
Via Cernaia 1
I-10121 Turin
Italy

ISBN 88-901329-0-6 Softech- via Cernaia 1 10121 Torino Italy

Energy Efficiency in Domestic Appliances and Lighting: proceedings of the First InternationaI Conference on Energy Efficiency in Domestic Appliances and Lighting, 01-03 October 2003, Turin, ItaIy; / Paolo Bertoldi ... ed. – Softech Turin, 2004
ISBN 88-901329-0-6