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Networking in private households

Impacts on electricity consumption

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on behalf of
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Abstract

The Internet – the most important driver for future electricity demand in households

With the rapidly increasing use of the Internet for private purposes, it is possible that the concept of the "intelligent home", which has been a matter of wishful thinking for many years now, will become reality in the near future. The fusion of the various media is both the catalyst and, at the same time, the first visible sign of this evolution. The development of user-friendly people-to-machine interfaces and new services, together with the possibility to "have a look" back home and intervene from there at any time and from any location, will also foster the interconnection of white goods and the intelligent control of other building equipment and services.

The impacts of this development on energy demand are wide-ranging and could take on considerable dimensions. Inside the house, the induced increase in energy demand is probably far more significant than the quantity of energy saved by more efficient control. It is estimated that electricity demand in the private households sector will increase by a maximum of 1.3% per annum over the next two decades. Even if this Internet-induced increase should only be half as fast, the interconnection of equipment and services would still be the most important driver of electricity demand in the household sector. The most promising measure to slow down this increase consists in minimising the electricity consumption of components and equipment in standby and off modes. We recommend an internationally co-ordinated procedure supported by national information and education campaigns.

Résumé

Internet - le facteur clé de l'évolution future de la consommation d'électricité des ménages

Prévue et souhaitée depuis longtemps, "la maison intelligente", avec ses équipements interconnectés et contrôlables à distance, devient possible avec l'entrée en force d'Internet dans les foyers. La fusion des différents média est le catalyseur de cette évolution et simultanément le premier signe visible. De nouveaux services, des interfaces hommes-machines conviviales, les possibilités de contrôler en absence et à distance les installations du foyer vont induire l'interconnexion des équipements domestiques et le contrôle intelligent des autres équipements et services des bâtiments en général.

L'impact sur la demande d'énergie de l'interconnexion des équipements à l'intérieur et à l'extérieur du foyer a plusieurs aspects et peut devenir considérable. La consommation induite à l'intérieur du foyer est probablement plus importante que les économies réalisables par un meilleur contrôle. Les prévisions de la demande d'électricité dans les ménages pour les 20 prochaines années conduisent à des augmentations annuelles pouvant atteindre 1.3%.

Même si cet effet est réduit de moitié, l'interconnexion des équipements et les services associés resteront les principaux facteurs d'accroissement de la demande d'électricité des ménages. Pour réduire cette croissance, la mesure la plus prometteuse reste de minimiser la consommation des composants et des équipements dans les modes veille et "off".

Nous recommandons que soit mise en place une procédure de ce type, coordonnée internationalement et basée sur des campagnes d'information, de formation et d'éducation.

Kurzfassung

Das Internet ist mit seinen vielfältigen neuen Möglichkeiten im Bereich der Multimedia der treibende Faktor für die Vernetzung im Haushalt.

Mit der steigenden Nutzung des Internets in den privaten Haushalten wird die seit vielen Jahren prognostizierte Vernetzung der Geräte und Anlagen im Haushalt immer wahrscheinlicher. Das Zusammenwachsen der verschiedenen Medien ist dabei sowohl Katalysator wie erstes sichtbares Zeichen dieser Entwicklung. Die Entwicklung von einfach zu handhabenden Mensch-Maschinen-Interfaces, die Entwicklung neuer Dienstleistungen und nicht zuletzt die Möglichkeit immer und von überall in den Haushalt „reinzuschauen“ und einzugreifen wird auch die Vernetzung von Haushaltgrossgeräten und die intelligente Steuerung der Haustechnik fördern. Die Auswirkungen auf den Energieverbrauch sind vielfältig und können beträchtliche Ausmasse annehmen. Für den Stromverbrauch im Haushaltsektor wird für die kommenden 20 Jahre ein maximales Wachstum von 1.3% pro Jahr berechnet. Auch wenn dieses vernetzungsinduzierte Wachstum nur halb so gross ausfallen wird, dürfte die Vernetzung in den Industrieländern die wichtigste Wachstumskomponente für den Stromverbrauch im Haushalt darstellen. Als wichtigste Massnahme zur Reduktion dieses Zuwachs bietet sich die Minimierung des Stromverbrauchs der Komponenten, Geräte und Anlagen im Standby- und Auszustand an. Es wird ein international koordiniertes Vorgehen empfohlen, das durch nationale Ausbildungs- und Informationskampagnen unterstützt wird

Summary

For the purpose of conducting this study of the impacts of networking in private households, we used the following three application categories:

1. Process control technology: remote control, telemaintenance and automation of systems for basic requirements, i.e. heat, lighting and security. The demands placed on bandwidths and speeds are low
2. White goods: remote control, telemaintenance and documentation (operating instructions)
3. Multimedia services: telephone, Internet, information technology, TV, video, audio

Category 3 represents the decisive factor with respect to the pace of the spread of applications, for experts everywhere agree that the growth of networking in private households is Internet driven. For the majority of consumers, it is only when external connections are available that it is possible to speak of a sufficiently attractive value-added. Alongside entertainment and the procurement of information, the option of carrying out everyday household activities (e-commerce) electronically – and perhaps professional activities (teleworking) too – is becoming ever more important. The use of process control technologies for lighting and security is increasing constantly, though slowly, while the integration of white goods has not yet begun to take place.

The question of which transmission media and which technologies will prevail remains open at the moment. The most likely scenario is that all will continue to be used alongside one another for some time to come, depending on the area of application. Residential gateways to the public network are generally regarded as the most important strategic component, and various companies in the computer and network products industry, as well as telecommunications providers, are currently focusing on establishing their proprietary solutions in the central intelligence systems of household networks.

In some countries, houses have been networked using the most up-to-date technologies for demonstration purposes, and this includes Switzerland, where a large number of single-family dwellings have already been networked. At present, the main focus is on multimedia services and process control technologies (esp. lighting and security). In most cases, a number of different networks have been installed alongside one another, e.g. process control technology bus and Ethernet or coaxial cable as bandwidth transmission network. As far as white goods are concerned, manufacturers do not offer any standard solutions for networking as yet, but we can certainly expect them to do so within the next few years.

The standby consumption of an electric device is decisively influenced by the type of power supply to its components. In particular, the type and quantity of conversions from 230 V to electronic low voltage influence the standby capacity. The power consumption levels of components of bus systems in private households are as follows:

- Sensors, actuators: < 0.5 W (if supplied by the bus with low voltage, otherwise approx. 2 W)
- Intelligent control devices: approx. 2 W
- Broadband gateways: approx. 15 – 25 W

In a process control system with an installation bus (EIB), the bus system requires a standby capacity of approx. 20 to 30 W, the greater portion of which is attributable to lighting control. With an Ethernet network, an additional standby capacity of around 4 W per connected device has to be anticipated. For the two case studies (without networking of white goods), the additional standby consumption is around 75 W, which results in an additional annual electricity consumption of 657 kWh, or 16 percent for an average household.

By making simulation and scenario calculations, the “potential range” for additional electricity consumption as a result of networking in households was estimated up to 2020. For this purpose, the vision of a fully-networked household – to the extent that this was deemed reasonable – was applied as the upper threshold to the whole of Switzerland. Here, “inductive” impacts of networking (additional devices and increased use of household appliances and systems) were also taken into account. With this threshold variant, in 2020 the increased electricity consumption resulting from networking amounts to around 30% of the present-day consumption in private households. Approximately ¼ of this is attributable to power consumed in standby and off modes. Potential energy savings through networking have not been taken into account in this maximum variant. This potential is dealt with separately, but the figure is estimated to be relatively low, since intelligent control of household systems is also possible without having to network the individual control devices, and has in fact already been widely implemented, especially in the field of heating.

The impacts of networking in private households on energy consumption outside the house are discussed using the examples of e-commerce and remote workstations. Both applications give rise to a reduction in energy consumption in the industry and services sectors. Energy savings are also to be anticipated in the area of transport, given the existing applications for e-commerce (products and services that are mainly supplied electronically and by post) and the definition of remote workstations which includes self-employed persons who work exclusively from home. However, the potential energy savings in these areas are (at least) a scale lower than the maximum additional electricity consumption (measured at the end-energy level) in private households.

Electricity consumption in private households can be reduced with the aid of the following technical measures:

- Use of as few network components as possible: a central power supply via a communication bus lowers the standby consumption (EIB bus, USB bus)
- Use of separate and adapted power supply units for additional communication components in white goods and electronic entertainment equipment
- Use of high-frequency automatic power supply units that have a high level of efficiency and very low standby losses (around 0.25 W).

Networking in private households could give rise to an average increase in electricity consumption of up to 1.3% p.a. in the next two decades and overcompensate the anticipated “autonomous” technological progress of 1% p.a. for all other electrical applications. Although the actual additional electricity consumption will probably be considerably lower, in order to support the declared energy and environmental policy objectives (EnergySwitzerland, Kyoto) it is nonetheless recommended to already introduce all those measures now that promise to lead to increased efficiency from the point of view of the overall economy. One of the most important of these is the reduction of electricity consumption in standby and off modes. Here international co-ordination is called for, since most of the decisive players operate on a global scale and corresponding structures and initiatives are already in place to some extent. This needs to be complemented at the national level with information (e.g. through the use of labels) and training programmes, and here trade and industry can be actively involved within the framework of personal commitments.

1 Introduction

The fact that technology influences and helps shape society is undisputed, and this applies especially today with the evolution of the Internet, the new economy, an information-based society and globalisation - a topic that is dealt with practically every day in the media. The converse question, i.e. "how much does society influence technology?", is one that is (currently) asked much less frequently. One way in which we can discuss the various related questions is to take a close look at how technologies are applied. By studying how, where, how much and for what purpose a given technology is used, we can gain an idea of its impacts, e.g. on the environment. With respect to the question of the impacts of (new) information technologies on energy consumption, Spreng and Hediger come to the conclusion that these will inevitably lead to a significant increase in the use of electricity unless they are used specifically for enhancing energy efficiency (Spr 1987). This method was quantified within the scope of the preparatory work on the Energy Act in the "communication society" scenario (Aeb 1988), (Lut 1988): despite average economic growth of 1.3% per annum, the consumption of fossil fuels and electricity in 2025 is lower than at the starting point in 1985. But today, information technologies are primarily used for increasing productivity, opening up new markets and for entertainment purposes. A significant increase in the consumption of electricity is foreseeable, but there is disagreement as to how great this will be. On 2 February 2000, the US House of Representatives Sub-Committee on National Economic Growth, Natural Resources, and Regulatory Affairs conducted a hearing around this topic - "Kyoto and the Internet: the Energy Implications of the Digital Economy“ - in which opposing views collided head-on (http://www.house.gov/reform/neg/hearings/index.htm). On the one hand, those of Mark Mills - author of the study, "The Internet Begins With Coal: A Preliminary Exploration of the Impact of the Internet on Electricity Consumption“ (Mil 1999)[1], a summary of which was published in Forbes Magazine (For 1999) and incorporated into an article in a German-speaking scientific journal, c’t (Gro 00) - whose pointed statements that the Internet was responsible for 8% of overall electricity consumption in the USA in 1999 and that in ten years time, 50% of electricity consumption would be Internet-related, triggered the whole debate. And on the other hand, the opposing views of those represented by Joseph Romm - the main author of the study, "The Internet Economy and Global Warming: A Scenario of the Impact of E-commerce on Energy and the Environment" (Rom 00), who argues that estimates concerning direct consumption of electricity for the use of the Internet are many times too high, and that the indirect impacts of the Internet (structural changes and improvements in energy efficiency) would compensate the direct additional consumption except in the private households sector (and perhaps the transport sector).

The debate on whether electricity consumption will increase as a result of use of the Internet is far from over. It is much more complex than the issue of how much electricity is consumed by computers or electronic entertainment equipment, for the motto of the information and communications industries is no longer "a computer on every desk and in every home", but rather "Internet anywhere, any time, from any device" (NZZ, 2000/3). The 85% of microprocessors that are not installed in computers and similar devices can no longer be overlooked.

[1] Cf. http://enduse.lbl.gov/Projects/InfoTech.html for a discussion of Mill's article.

2 Description of the issue at hand and our methodology

With the spread of the Internet into the private household, and in view of the numerous new application potentials in the area of multimedia, it is foreseeable that, in many households, various electronic devices that until now have been used separately will be networked before long, and/or that the various media will be used on a shared platform. It is also possible that the long-standing dream of an "intelligent house" could become reality within the scope of this development. The IT and telecommunications industries have been carrying out intensive development and marketing efforts towards this end for a number of years now, and an enormous amount of literature on this topic is meanwhile available. However, the question of the impacts on energy consumption has hardly been paid any attention to date. The purpose of this study is to look into this aspect with the aim of assessing whether there is a need for action at government level, and which measures it will be possible to introduce in order to promote efficient use of energy in the area of (and through) networking in the private household.

2.1 Subject matter

This study deals with the following issues (with the emphasis placed on points 1 and 2):

1 **Direct** impacts of the networking of devices, systems and functions on **electricity** consumption in private households, and measures aimed at promoting efficient energy use (key term: standby consumption)

2 **Indirect** impacts of the networking of devices, systems and functions on **energy** consumption in **private households**, and measures aimed at promoting efficient energy use (key terms: control, regulation, automation, remote control)

3 **Indirect** impacts of networking on energy consumption **outside the private household**, and measures aimed at promoting efficient energy use (keywords: e-commerce, teleworking)

2.2 Methodology

The project comprised 3 stages (with overlapping between stages 1 and 2):

1 Procurement of information (primary data)

Study of existing literature and consultation with a variety of experts (IT industry, white goods, heating and lighting industries, security/monitoring)

Measurement of electricity consumption resulting from networking in a private household (e.g. c/o Bodmer, President of HTS, Spillmann, employee of Federal Office of Energy) and collection of additional data on electricity consumption of networks (demonstration/pilot systems, components, control and regulation systems)

2 Processing of primary data (–> secondary data)

Analysis of measurements and data, formulation of measures to promote efficient energy use

Basic simulations of the impacts of networking on the electricity and energy consumption of single devices in a typical household (single-family dwelling/apartment block)

Calculation of scenarios for the impacts of networking in households on electricity and energy consumption in the private households and other sectors

3 Report for the attention of the Swiss Federal Office of Energy

3 Networking in private households: technology and market

Publicity text from a promoter of home automation:

"Imagine you are in your electric car on the way home. You are looking forward to being in your comfortable living-room and eating a nice hot meal that is ready and waiting for you - for you switched on the hotplate by telephone from your office. Since it is already late, you take out your handy and quickly programme your video recorder to record your favourite TV series. When you get home, you open the garage door using the electronic remote control, and at the same time the lights go on in the corridor and living-room, and the blinds close automatically.

While you are watching TV, a message appears on the screen that the washing machine has completed its cycle, and at the same time the dishwasher switches itself on in the kitchen.

Before you go to sleep, you set the alarm one hour later, since an early appointment has been cancelled. This means that, when you wake up an hour later than usual, the coffee machine, toaster and radio (i.e. the whole house) will also be switched on an hour later. Sounds like a dream - but it could soon become reality"

This is how the technical basis for realising this vision might look:

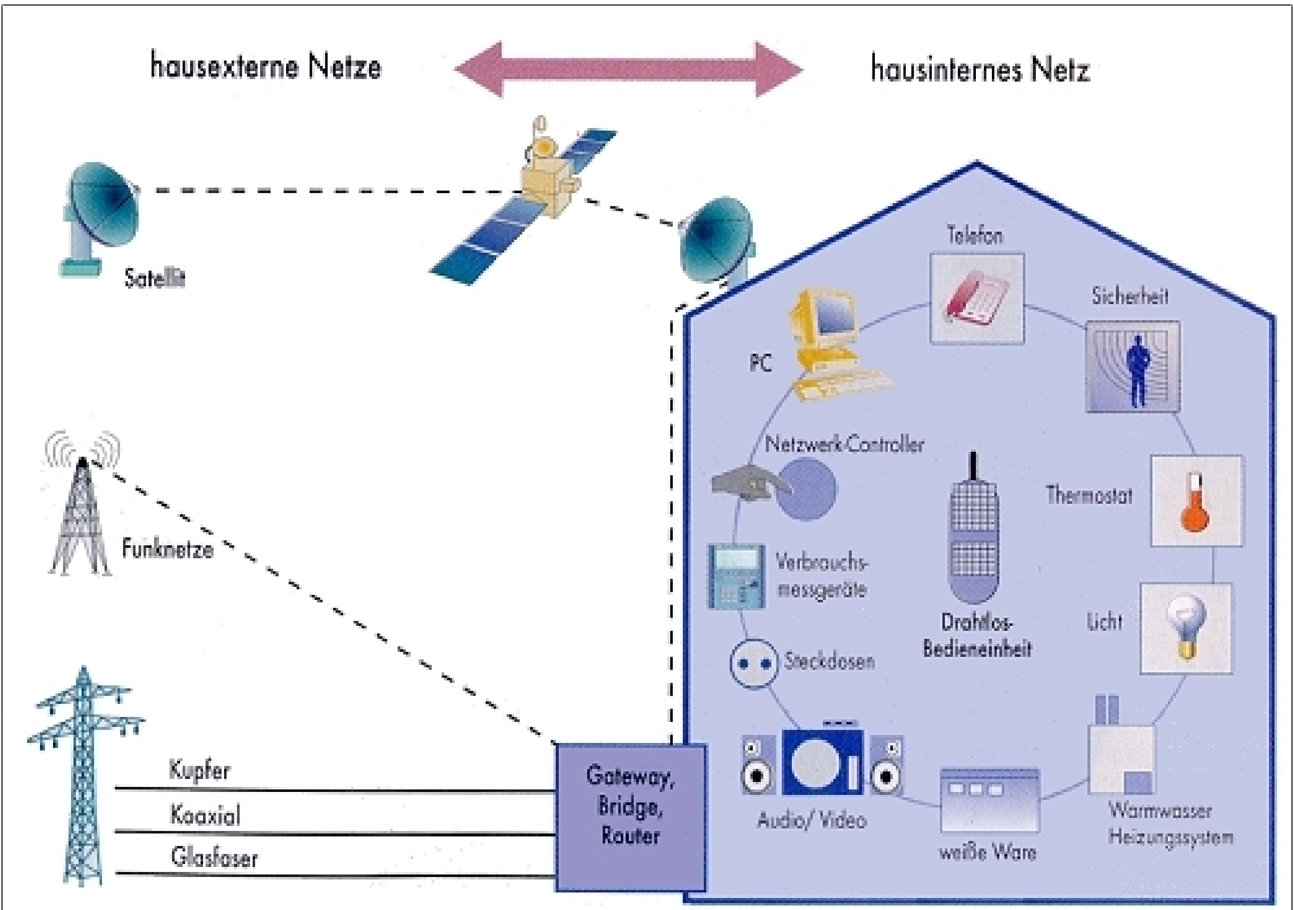


Fig. 2.1: House with external and internal networks (Source: Fraunhofer Institute – Project in a house in North-Rhine Westphalia; www.inhaus-nrw.de)

3.1 Networking today

Roughly speaking, the areas of application can be divided into three categories:

1. Process control technology: remote control, telemaintenance and automation of systems for basic requirements, i.e. heating, lighting and security.

2. White goods: remote control, telemaintenance and documentation (operating instructions)

3. Multimedia services: telephone, Internet, information technology, TV, video, audio

A large number of communication installations and services are already in use in **private households** today. These include:

- Intercom systems with door opening device
- Remote control of garage doors
- Telephone
- Internet
- Audio, TV: remote control, loudspeaker connections, cable connections, satellite receivers
- Control of heating systems: remote control, sensors
- Baby-monitoring devices
- Switchover of electricity tariffs
- Remote (load) control of electrical appliances (water heaters, washing machines)
- Security systems (sensors, e.g. motion detectors, glass-breakage alarms, etc.)

These applications currently take the form of separate, self-contained solutions. They are neither able to communicate with one another, nor can they use shared transmission systems.

Communication **outside the house** is based on a variety of systems:

- Telecommunications network (comprising central and connecting systems - copper cable, satellite systems, directional transmission, radio, etc.)
- TV cable network (coaxial cable)
- Wireless communication for radio and television (one-way communication)
- Electricity network (one-way communication)
- Satellite reception (one-way communication)

Various solutions exist for **connecting networks inside and outside the household** (last mile):

- Copper cable lines of the telephone network
- Radio (mobile communication)
- Television network (coaxial cable)
- Electricity network (PLC: power line carrier)

3.2 System limits

A network inside a household is connected to other networks in the building or to public networks outside the building. This raises the question of delimitation. As far as telecommunications providers are concerned, a network inside the household is the "end" of the public broadband network infrastructure. Here a distinction is made between the network inside the building (building network, or BN) and the network inside the dwelling itself (customer premises network, or CPN). These two systems combine to form an in-house network (IHN) - see Fig. 3.1. below.

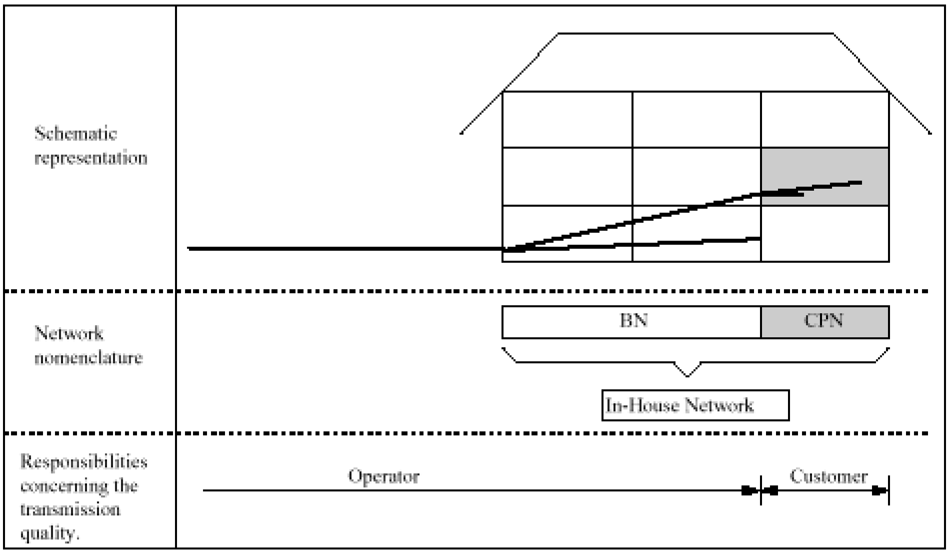


Fig. 3.1: Networks inside a building (source: [Eur 98])

3.3 Components of a network

For communication purposes, data are exchanged between a transmitter and a receiver via a given medium. This process calls for a physical carrier plus common standards for addressing and processing the connection. Within its "Open System Interconnection" (OSI) standardisation plans, the ISO (International Standards Organization) has created a generally accepted reference model for processing communication between systems from different manufacturers. Here, communication is divided into a number of function layers:

Layer 1:	Physical transmission of signals (hardware)
Layer 2:	Securing of transmitted signals between directly (physically) linked transmission devices
Layer 3:	Relaying
Layer 4:	Transport protocol between two (as a rule) indirectly linked components
Layer 5:	Session/connection control
Layer 6:	Data presentation
Layer 7:	Communications application

Layers 1 to 3 are generally referred to as the "network", layer 4 determines the transport protocol, and layers 5 to 7 are transport-related and regulate data exchange between the end-users.

A network inside a building consists of the following hardware components (Fig. 3.2):
- Sensors: devices that issue commands
- Actuators: devices that execute commands
- Controllers: linking of functions
- Man-machine interface (MMI): touch panels, handheld PCs, etc.
- Communication devices: couplers, gateways, etc.

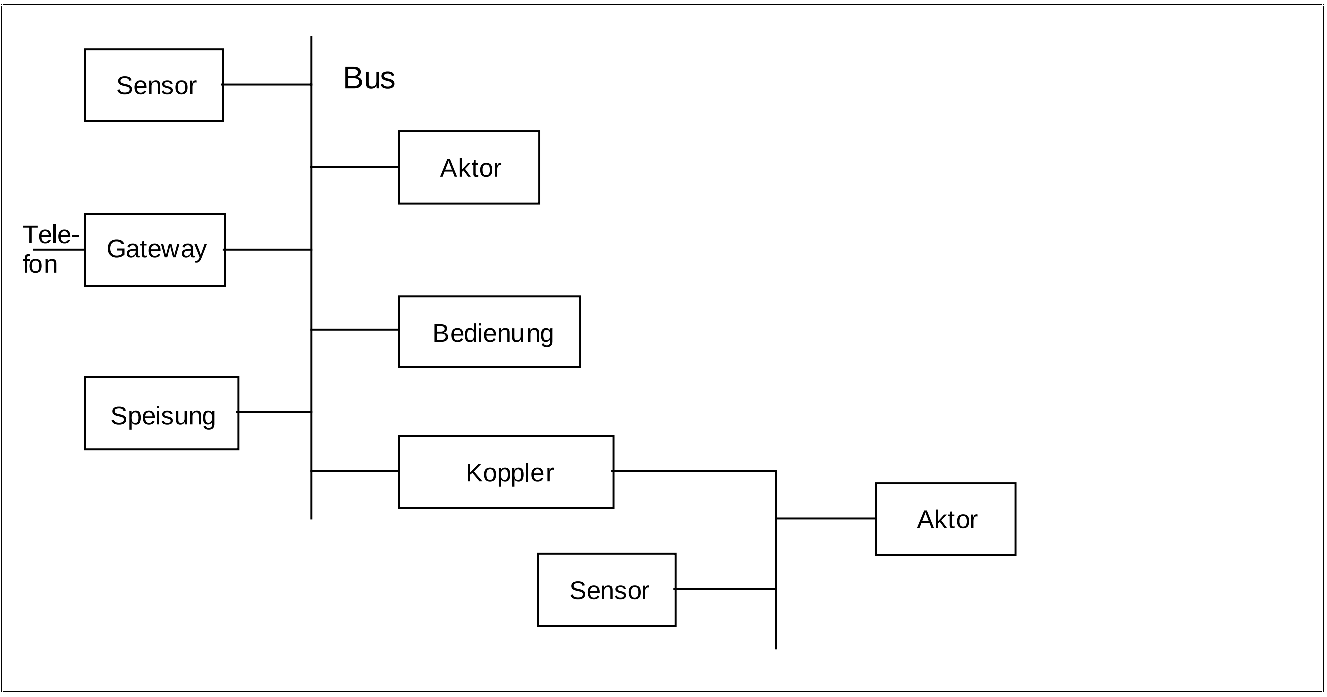


Fig. 3.2: Network components

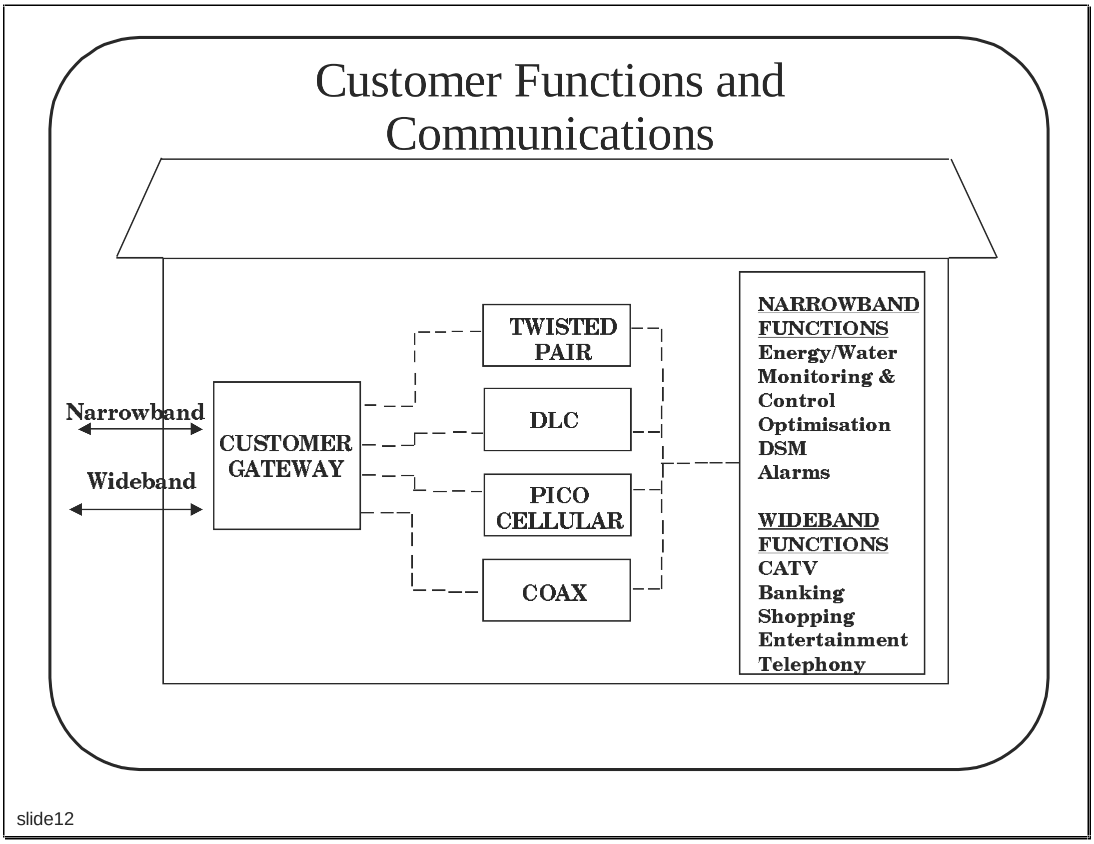
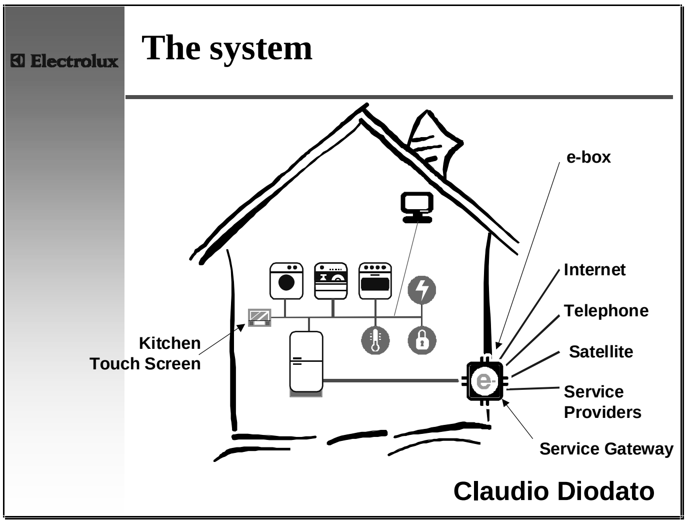


Fig. 3.3: Network in household with gateway as central intelligence (source: [Eur 98])



3.4: Network in household with gateway as interface to the exterior (source: [Ele 99])

Strategically speaking, it is the gateway (which has a variety of different designations, depending on the observer's viewpoint: residential gateway, customer gateway, service gateway, etc.) to the public network that is regarded as the most important component. A variety of companies in the computer and network products industry, as well as various telecommunications providers, are anxious to establish their own solutions in the central intelligence of networks in households (cf. Figs 3.3 and 3.4). Consequently this device has a fast, broadband data processing capacity. One example of such a gateway is Ericsson's "e-box": here, Ericsson is working together with Electrolux in the area of networking household appliances. Other manufacturers are also involved in the development of a gateway: IBM recently announced the establishment of a company called "Home Director", and Cisco has announced its intention to collaborate with Sun and the household appliances group, Whirlpool.

For transmission purposes, a number of different media can be considered:

- Telephone cable
- Twisted pair Cat. 5
- Coaxial cable
- Wireless: radio, infra-red
- Electricity network (power line)
- Optical fibre cable

The choice of transmission medium depends on the demands to be placed on it (cf. Table 3.1). Experts are of the opinion that all transmission media will continue to be used alongside one another for the time being.

The following transmission technologies are more widely used and are therefore of greater importance (cf. Table 3.1):

- X-10: primarily in the USA
- EIB (European Installation Bus) with HES (home electronic system) user interface: no. 1 in Europe
- LON (Local Operating Network) from Echelon: used throughout the world
- Batibus: widely used in France
- Ethernet, TCP/IP: widely used in the field of IT
- i-Link (fire wire, IEEE 1394): multimedia bus systems
- Bluetooth: currently in the expansion stage, but broadly supported short-range wireless technology

Systems	Application	Bandwidth	Physical carrier
X10, Lonworks, EIB, CEBus	Building technology	narrow	Copper cable
Ethernet 10/100, ATM 25/50, Firewire – IEEE1394	Data processing	broad	Copper cable, coaxial cable
DECT	Telecommunications	medium	Radio
Bluetooth, Hiperlan, IEEE 802.11, HRFWG, COMMEND	Data processing	broad	Radio
Power line	Building technology	narrow to medium	Power lines

Table 3.1 Characteristics of the most widely-used systems

	DECT	GSM	Bluetooth	UMTS
	Digital Enhanced Cordless Telecommunications	Global System for Mobile Communications		Universal Mobile Telecommunications System
Frequencies	1880-1900 MHz	890-915 MHz, 935-960 MHz	2400-2483.5 MHz	1900-1980 MHz, 2010-2025 MHz, 2110-2170 MHz
Range	300 metres	35 kilometres	10 metres	10 kilometres
Transmission rate	522 Kbps	9.6 kB/s	1000 kB/s	144-2000 kB/s
Availability	since 1992	since 1992	from 2000	from 2002

Table 3.2 Standards in wireless communication

3.4 Pilot projects

In a number of countries, houses have been networked for demonstration purposes using the most up-to-date technologies available. For example, a house in London's commuter belt has been equipped with a network that allows the occupants to "tap" data, video and audio via 72 connections and to control the household installations using a standard Internet browser (cf. Fig. 3.5).

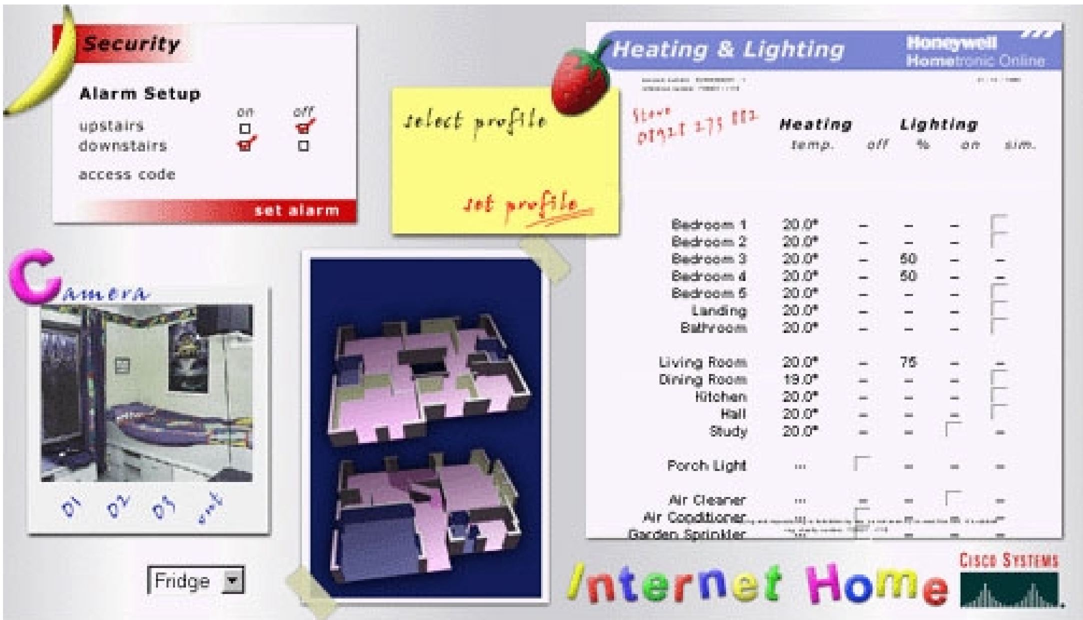


Fig. 3.5: Heating, lighting and other systems can be controlled via a browser window (source: www.cisco.com/go/ihome)

Two examples of (partially) networked dwellings in Switzerland are described in section 4.2. A fully-networked house in Huenenberg was scheduled to be put into operation in October 2000 (www.futurelife.ch).

Manufacturers of kitchen appliances have started offering consumers concepts for networked systems (Fig. 3.6). For example, Electrolux recently introduced a refrigerator with communication options and a monitor. This appliance is still in its pilot stage, and others only exist on paper at present and are currently undergoing studies to determine their feasibility and market acceptance.

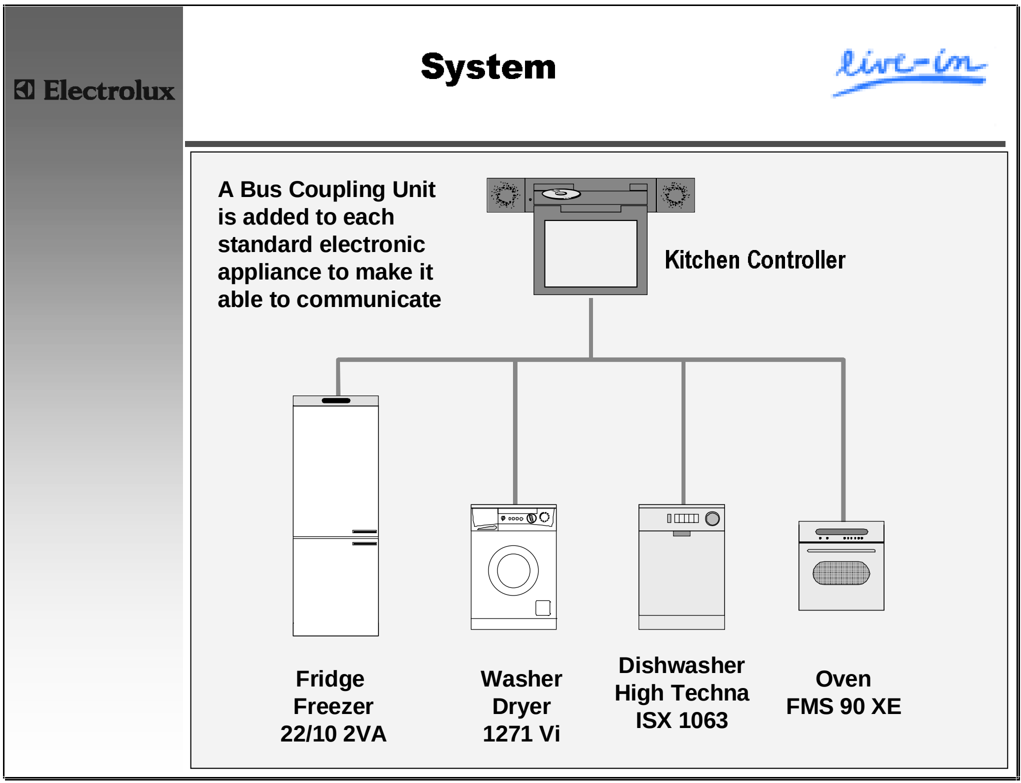


Fig. 3.6: Networking of white goods (source [Ele 99]).

3.5 Players

Networking in private households involves a broad variety of players:

- Manufacturers of electrical installation components: ABB, Feller, Legrand, Siemens, etc.
- Manufacturers of household appliances: Electrolux, Miele, etc.
- Manufacturers of computers and relevant software: Apple, Compaq, IBM, Microsoft, etc.
- The telecommunications sector: telephone companies, manufacturers of devices: Ascom, Ericsson, Nokia, etc.
- Manufacturers of electronic entertainment equipment: Philips, Sony, etc.
- Manufacturers of security and automation systems: ABB, Honeywell, Siemens, etc.
- Cable TV operators
- Power supply companies

3.6 Organisations for standardisation and promotion

Components intended for use in networks in private households need to be both inexpensive and compatible with a large number of other systems, and this is only possible if standards exist that are applicable throughout the world. Manufacturers are therefore endeavouring to agree on the definition and use of such standards. Nowadays there are organisations that deal with standards for each technology and which set out to secure their practical application. These include:

- OSGi: Open Service Gateway Initiative:
  A large number of companies in the telecommunications, computer, consumer electronics and household appliances industries
- Home Phoneline Networking Alliance:
  3Com, Advanced Micro Devices, AT&T, Wireless System Compaq, Hewlett-Packard, Intel, IBM, Lucent Technologies
- CEBus Industry Council
- IPCF International Powerline Communication Forum
- ETSI European Telecommunications Standards Institute
- Wireless telecommunications (DECT):
  DECT-MultiMediaConsortium (DECT-MMC): Ascom, Canon, Dosch&Amand, Ericsson Mobile Networks, Hagenuk, National Semiconductor, Screen Media
- Bluetooth Promoter Group: Ericsson, IBM, Intel, Nokia, Toshiba, 3Com, Lucent, Microsoft, Motorola
- Infrared Data Association (IrDA):
  Consortium of more than 160 leading US and Japanese manufacturers in the computer, semiconductors and communications industries working towards standardisation of infrared communications (Eur 98).

3.7 Networking in private households: current status and trends

In Switzerland, the penetration of households with IT applications (telecommunications, consumer electronics, office equipment) is already very high. Practically every household now has at least a telephone, a radio and a television set. According to a recent market survey, a total of 1.6 million PCs were installed in Swiss households in 1999 (Wei 00), and this can be regarded as an equivalent penetration rate of almost 50%. The percentage of households with an Internet connection has increased rapidly over the past few years: 2000 = 30%; 99 = 19.4%; 98 = 11.5%; 95 = 2%; 94 = 1.2% (Gas, 1999). Although the latest figure is relatively low in comparison with that for the USA (50% of households with Internet connection), it is considerably higher than in the EU (15%) (Tse, 2000). The increase in the frequency of use of the Internet is also impressive, for it more than doubled (combined total for use from workplace and home) between 1997 and 1999 (Lins, 2000). Today, the Internet is used more from home (average, 4.3 hours per week) than from the office (average, 3.7 hours per week). However, professional use of the Internet (from home, en route or from the office) is still slightly higher (4.2 hours per week) than private use (4.0 hours per week). (www.wemf.ch/de/produkte/comis.html, cited in [Bul 00]).

With very few exceptions, the various IT applications in private households are not linked together. Practically all the exceptions that do exist are attributable to owners of single-family houses who have invested in networking systems. For example, one company specialising in supplying home automation equipment, and which acts as both systems integrator and software supplier, reported that it installed networking systems in 45 single-family dwellings in 1999.

Those owners who have chosen to invest in home automation systems to date were driven by the following motivations:

1. Enthusiasm for advanced technology
2. Aesthetics (e.g. lighting effects, etc.)
3. Convenience, show of luxury (prestige)
4. Use of new services such as monitoring, control, regulation

In the opinion of experts, the use of home automation systems will only become more widespread if the degree of convenience, gain or enjoyment is sufficiently increased thanks to networking and if the necessary technical installations remain in the background. Here the automobile industry with its recent innovations such as GPS control systems, ABS, airbags, etc, is often cited as a comparison.

Promoters of home automation equipment are now taking note of these requirements and setting out to provide the following new services:

- Greater convenience with respect to remote control and monitoring of lighting and shading devices and household appliances
- Increased security in the form of alarm systems and remote monitoring of household appliances
- A higher degree of autonomy for elderly and handicapped people
- Reduction of costs by installing simpler systems and multiple-purpose sensors
- Efficient use of energy by controlling processes and appliances as required
- Better communication ("keeping the family together")
- Possibility to shop electronically
- Management of power consumption in the event of limited supply from the power company

Today, networking is clearly driven by multimedia applications, and in particular by the requirement to use the Internet from various locations within the home. The market is Internet or e-mail driven: "stay in contact everywhere at every moment". Computer games are part of the growing range of multimedia services: the console may be a PC, a set-top box or a television set. Here, too, the trend is moving in the direction of a fusion of the various functions and devices. In 1999, some 3 million computer games were sold in Switzerland.

In the foreseeable future, the introduction and distribution of networking in private households will not be clearly dominated by any one system, but rather we will see a large number of systems (different transmission media and technologies) and applications in use alongside one another (cf. section 3.3). Since many multimedia applications require a relatively high data transmission rate, some solutions for central transmission methods have to be taken out of the equation, at least given the present-day status of technology (Table 3.1). But in principle, for less demanding applications, all existing systems may be used, and in this case, the following aspects play an important part in the decision as to which system to use:

- First offer (lowest transaction costs)
- Costs (purchase and installation)
- Rent/purchase conditions (authorisation for installation modifications)

Since modifications of **in-house** cables or the installation of additional ones are associated with high costs, it is clear that the focus needs to be on wireless solutions. In Switzerland, there is another reason why wireless transmission is the preferred solution (assuming that other important criteria are met): only 31% of the population own their own house. Those who rent an apartment or house normally find that it only contains a rather rudimentary infrastructure. This means that networking has to be simple to install and remove, and should not give rise to unduly high costs. The fact that wireless transmission is also growing in importance in the field of building technology becomes apparent when we consider that it is now being offered by EIB alongside communication via twisted-pair lines and the 230-volt network (power line).

Sensors are an important component in any home automation system, and these are now being developed into adaptive intelligent devices. Developers envisage a scenario in which each room is equipped with a multiple-purpose sensor that communicates via radio. The electricity consumption of these devices needs to be low so that they function using a local power source and do not need to be connected to the mains (Bod 2000).

The exact level of importance of wireless technology for data transmission depends not only on technical (bandwidth, distance, etc.) and financial aspects, but also on other factors such as the degree of acceptance (harmful rays) and security considerations (preservation of privacy). However, it is extremely likely that wireless communication (e.g. mobile phones, etc.) will assume a dominant position when it comes to the control and operation of networked systems.

The benefits of networks in households are only fully realised once a **connection to the exterior** has been established, and this of course applies especially to telecommunications and multimedia applications. Access to telecommunications, TV and radio networks can take place via a broad variety of media. Until now, most of these connections have been made via telephone lines (phone, Internet), but it is likely that the cable-TV network will play a significant role in Switzerland in the near future for “bridging the last mile”. Here the transmission rate is around four times faster than an ISDN connection, and approximately the same as that of a phone line equipped with ASDL technology (NZZ, 2000/2). There is now a trend towards a convergence of services, i.e. telecommunications, information technology and entertainment equipment are evolving together and using the same carrier.

In the USA, networking in private households is already expected to experience rapid growth in the near future (Fig. 3.7).

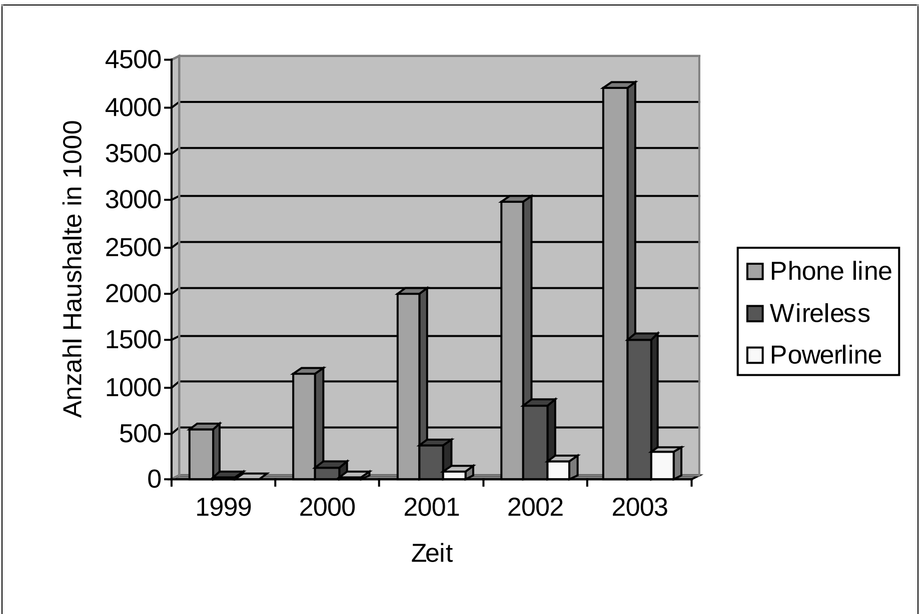


Fig. 3.7: No. of networked households in the USA (source: The Yankee Group, [Ami 99])

UK market researchers at Strategy Analytics in London anticipate that, by 2005, there will be wireless networks in around 15% of European households, linking a total of 88 million devices. According to this forecast, the average home will have networked 2.5 devices (Met 00).

According to the assessments of a variety of experts, networking in private households will develop more slowly in Switzerland than in other countries such as the USA, the UK or Italy. The main reasons for this are:

- Building substance has a longer life here, and this means that renovation and new-construction cycles are longer than in (for example) the USA
- Higher proportion of rented accommodation
- Higher proportion of institutional investors on the property market

4 Electricity consumption of networks in private households

4.1 Electricity consumption of components

Electronic components only require a small amount of electricity in the form of low direct voltage, with the exception of processors with a high capacity such as those used in broadband gateways. Electricity consumption is decisively determined by the type of power supply, and the latter also has an influence on the degree of fluctuation:

- Conventional power supply unit
- High-frequency switching power supply
- Battery (grey energy)
- Local power supply, e.g. solar cells, Peltier element, electromagnetic waves

Electricity consumption also depends on whether each component is powered separately or conversion from 230-volt alternating current to the adapted direct current is carried out centrally and distributed to the networked components via a bus.

The power consumption of bus systems in private households lies within the following ranges (the list below cites examples of a variety of devices, indicating the approximate electricity consumption in standby mode):

- Ericsson's gateway e-box 101: power consumption according to specifications: 15 W.
- Digital TV reception box (set-top box): manufacturer, Visionetics: 20 W, 30 VA (own measurement)
- NT device (ISDN connection): power consumption, 2 W (own measurement)
- "Step one" WebNode: switching device with 4 relays 4 opto-decoupled inputs that can be driven via a 10 MB Ethernet: power consumption, 2 W, 5 VA (own measurement)
- According to the developer of the IBM system "Arigo" (Wid 95), which is based on the LONWORKS concept from Echelon, the power consumption of its components is 0.1 W DC if everything is completely switched off, or 3-4 W during transmission.
- According to one leading developer, the coupling components for power-line transmission have a power consumption of well under one watt (verbal information).

In the USA, the following standby consumption figures have been recorded:

Components	El. consumption (range) [watts]	El. consumption (average) [watts]
Security systems	4-22	14
Digital modems	10-14	12
Analogue TV reception boxes	2-18	10.5
Digital TV reception boxes	19-24	23
Satellite receivers	10-19	13
Cordless phones	1-5	2.5

Table 4.1: Standby consumption of components in the USA (source: [Mei 99])

In its June 1999 issue, "Test" (a journal published by "Stiftung Warentest, 10785 Berlin", which carries out tests on a variety of goods), published figures for standby losses of satellite antennas and receivers:

Components	Range [watts]	Average consumption [watts]
Satellite antennas with one user	2 – 3.4	2.4
Satellite antennas with a number of users	10 - 15	12.5
Satellite receivers	0.5 – 13	6

Table 4.2: Standby consumption of satellite antennas and receivers

4.2 Analysis of standby consumption of networked households

4.2.1 New single-family house with EIB bus

The owner of a new single-family house has equipped it with the latest communication devices. Three communication networks have been installed in this very large house, which has two storeys (basement and ground floor) and six rooms:

- EIB bus for process control of lighting, shutters, windows, doors, exterior (security)
- Ethernet cat. 5 for data transmission
- Coaxial cable for transmission of video signals

External connections are via the telephone network, and TV reception is via a satellite receiver.

The heating has not yet been linked to the EIB bus, since there are as yet no acceptable regulation systems (i.e. that are comparable to conventional regulators) on the market. However, in addition to heating, the owner also wishes to control the windows and blinds with the aid of data collected from a meteorological station installed on the roof.

The EIB bus system consists of three communication lines with the following components:

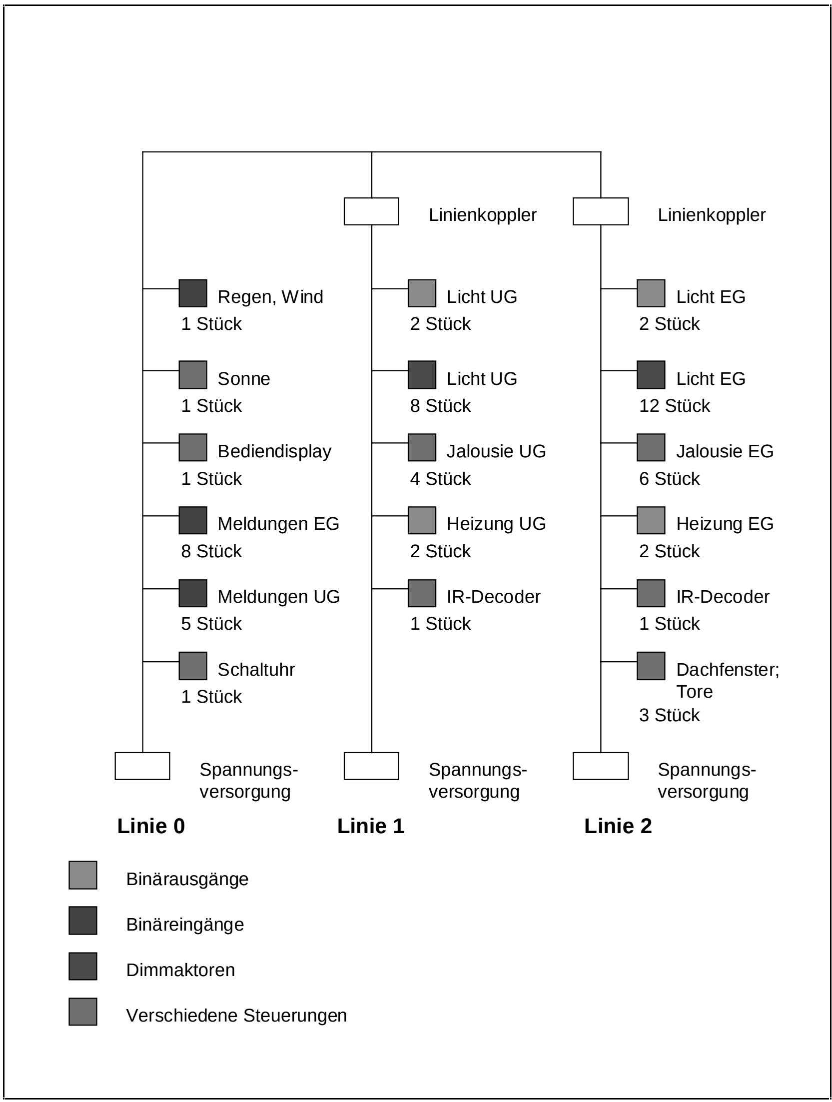


Fig. 4.1: Diagram of EIB bus in new single-family house

Line 0:

- Power supply with 12 V, 7.2 Ah accumulator
- 1 x automatic switch
- 1 x control display
- 1 x component with 5 binary inputs for rain detector and wind sensor
- 1 x component with 4 analogue inputs for sun sensors (N-S-E-W)
- 5 x component with 4 sensor inputs for basement
- 8 x component with 4 sensor inputs for ground floor
- Sensors: probes, infrared, etc.

Line 1:

- 1 x power supply assembly (230 V AC -> 29 V DC, In 640 mA)
- 1 x line coupler
- 2 x component with 6 binary outputs for lighting in basement
- 8 x dimmer actuators for lighting in basement
- 4 x shutter controls for basement
- 1 x IR decoder
- 2 x component with 6 binary outputs for heating valves in basement

Line 2:

- 1 x power supply assembly (230 V AC -> 29 V DC, In 640 mA)
- 1 x line coupler
- 2 x component with 6 binary outputs for lighting on ground floor
- 1 x component with 6 binary outputs for door lock and garage door
- 12 x dimmer actuators for lighting on ground floor
- 2 x control unit for skylights on ground floor
- 6 x shutter control unit for ground floor
- 1 x IR decoder
- 2 x component with 6 binary outputs for heating valves on ground floor

This means that 62 components with 183 data points are connected to the bus system, and these are used for the following functions:

1. Communication and bus services: 4 components (3 data points)
2. Lighting: 37 components (87 data points)
3. Heating: 4 components (10 data points)
4. Shutters: 10 components (20 shutters with a total of 60 data points)
5. Windows: 4 components (18 data points)
6. Security: 3 components (5 data points)

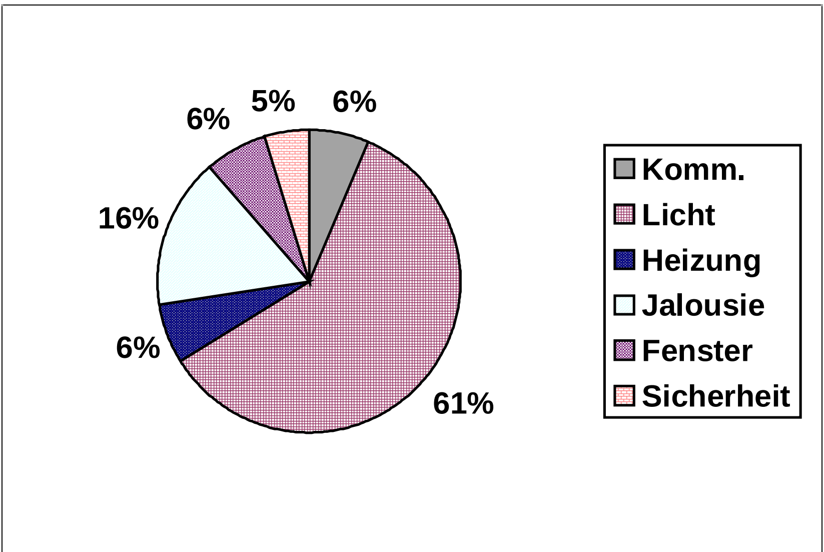


Fig. 4.2: Distribution of bus components among controlled objects in networked household

This EIB bus system requires an apparent power output of 34 VA (20 W, power factor, 0.6).

The communication systems via Ethernet and coaxial cable are not yet in operation. Below is a theoretical estimate of power consumption based on findings obtained from other tests:

Data communication via Ethernet:

- Server (PC or broadband gateway): approx. 20 to 50 W
- Hub for star-shaped distribution (8 ports): 12 W

Video and TV signal transmission:

- Satellite receiver: 13 W

For networking purposes, this house therefore requires the following standby consumption:

- EIB bus: 20 W
- Ethernet system: 42 W

- TV signal distribution 13 W
- Total 75 W

4.2.2 Ethernet network in renovated house

The dwelling here is an older farmhouse that has been renovated and equipped with twisted pair cat. 5 cable. The owner's objectives with respect to networking were as follows:

- Internet connection in all rooms
- Laptop in the kitchen (electronic cookery books)
- Longer-term objectives:
  - Control of front door from bedroom
  - Process control via handy
  - Use of multimedia with one device per room (TV set, Internet, video, games, PC)

This family places a strong emphasis on flexible use of multimedia. The television set has been replaced by a multimedia projector with screen. The power consumption data for a modern projector are as follows (own measurements):
in operation: 82 W/115 VA
in standby mode: 19 W/34 VA
Compared with a TV set (in operation, approx. 70 – 90 W, average standby consumption, 12 W), this means an increase in standby consumption. However, general conclusions cannot be drawn from this single example.

A total of 15 connection points have been installed in 9 rooms, and some rooms contain coaxial cable feeds for video signal transmission. The network is star-shaped and is wired around a hub on the ground floor. It uses the following components:

- PC as central control unit and fax
- USV system (Best Power 750)
- Hub, 16-port,
- ISDN NT connection
- ISDN Gigaset 2060 (cordless telephone)
- ISDN terminal adapter
- Printer/fax
- Laptop in kitchen
- PC, laptop in study

The intention is to add 2 to 3 Web cameras for external surveillance, and the heating system is also to be controlled via the network. This would be highly desirable, since a manually operated tiled stove needs to be optimally aligned with gas central heating. These two functions have not yet been installed, since at this time it is difficult to find control units for heating systems on the market that are equipped with open communication interfaces.

The standby consumption levels of the central communication devices are as follows:

- PC 30 W
- Hub 23 W (39 VA)
- ISDN NT connection 2 W
- ISDN Gigaset 3 W
- Total 58 W

This means that the standby consumption per device is around 4 W, which is roughly equivalent to the result obtained from a study conducted on the network in a high-school (Hus 99). But if we add 3 network connection cards, 3 Web cameras and 3 decentralised control devices, each with a standby consumption of approx. 2 W, as peripheral devices, this results in a total standby consumption of 75 W for the house in question.

Process control via this Ethernet network is more or less impossible at this time, since practically no devices with an Ethernet connection and Web server functionality are available on the market. All devices that communicate via Ethernet have to have their own power supply via separate mains units, and this greatly increases standby consumption. Other systems such as a household EIB bus or a USB bus for the computer industry supply power centrally via the bus.

4.3 Standby consumption of a model household with a process technology bus and alternative technologies

A single-family house with 5 rooms, plus kitchen, bathroom, toilet, hobby room, laundry, heating room, attic and garage, was used as a model for estimating the standby consumption of bus components for network devices. The house has a total of 14 rooms and all appliances are fully networked.

The system comprises the following components and data points:

Systems	No. of data points
White goods	8
TV, audio, data processing	10
Burglar alarms	15
Intercom	4
Ventilation, toilet/bathroom	4
Heating	17
Hot-water system	1
Shutters	24
Garage door	3
Lighting	84
Total	**169**

Table 4.3: No. of data points in EIB system of model networked household

If this system were to be installed using an EIB bus, at least three lines each with their own power supply would be required.

Components	Quantity	Power consumption [W]	Total power consumption [W]
Bus couplers (5 mA, 24 V)	169	0.12	20.3
Line couplers	3	0.12	0.4
Power supply lines	3	2	6
Visualisation	1	3	3
Total			**29.7**

Table 4.4: Power consumption in EIB system of model networked household

If LON technology were to be used instead of an EIB bus, it is decisive whether the power supply for the LON components is fed via the bus, a battery or separately via transformers or switched power supply units. A common power supply via the bus, as is the case with EIB technology, would undoubtedly give rise to the lowest standby losses.

If the entire in-house networking were to be effected using another system (Ethernet, radio, etc.), then here too the standby consumption would depend decisively on the type of power supply of the individual sensors/actuators. At present, standby consumption resulting from conversion of the 230-volt mains supply to electronic low-voltage in conventional supply units is around 2 W. If the components are powered by battery, this eliminates the standby consumption drawn from the mains. However, the “grey energy” supplied by the batteries would also have to be included in the overall calculation. In future we can expect sensors that do not require auxiliary energy to be available on the market (Bod 00).

These figures only include the power consumption of the in-house network for process control technology. Multimedia applications call for the transmission of large quantities of data, and an EIB bus is not suitable for this purpose. Additional networks are necessary here (Ethernet, coaxial cable, radio, etc.), which require additional electricity (cf. simulation estimates in Chapter 6 and findings in section 4.2).

An external connection is assumed to already exist. Other devices that could be added as a result of in-house networking have not been included (these perhaps decisive [inductive] secondary effects for an evaluation of the impacts on power consumption are dealt with in the simulation estimates in Chapter 6. See also section 4.2)

4.4 Summary of power consumption data

In sections 4.1. to 4.3 above we have dealt with the power requirements for networks in private households using a few examples. Table 4.5 below presents an overview. The various system delimitations have to be taken into account here.

Example	**Applications**	**Standby consumption [W]**
New single-family house with EIB bus	Process control technology, multimedia	20 for EIB 55 for multimedia
Ethernet in older house	Multimedia	75
Model household with EIB bus	Process control technology (lighting, shutters, security)	30

Table 4.5: Overview of power requirements for the various examples

From this overview it can be seen that the choice of technology and medium for an in-house network plays a significant role.

It is not possible to foresee which technology will prevail over the longer term, or the extent to which various technologies are likely to play a role over the short and medium terms. The financial interests of the various involved players are enormous. Here, arguments relating to energy efficiency are of secondary importance, and we do not see any realistic way of steering these, and this is the reason why this aspect is not dealt with further in our simulation and scenario calculations (Chapter 6).

It is interesting to make an international comparison of present-day power consumption levels without networking:

Within the scope of an initiative launched by the International Energy Agency (http://www.iea.org/standby/), standby consumption data in a private household were measured in five different countries, and the results obtained were as follows (http://eetd.lbl.gov/leaking/hometours.html):

- France: 70 W (including microwave oven, 3 W; garage door, 3 W)
- Sweden: 80 W (including games console, 8 W)
- USA: 74 W (including modem, 7 W)
- New Zealand: 125 W (including heating, 10 W; tumble-dryer, 2 W; washing machine, 6 W; security system, 22 W; combination fridge/freezer, 6 W; dishwasher, 3 W; electric heating, 5 W)
- Japan: 80 W (including closomat, 8 W; motion sensors (for lighting), 4 x 1.1 W; cable box, 6 W; air-conditioner, 8 W

5 Impacts of networking in private households on energy consumption

In our introduction to this report, we referred to the widely varying and conflicting estimates of the impacts of information technology in general, and the Internet in particular, on energy consumption. With its countless new potentials in the area of multimedia, the Internet is the principal driver behind networking in private households. In this sense, this study is also a small contribution to the discussion of the overlying question of the impacts of the Internet and information technology on energy consumption.

This chapter does not set out to present a comprehensive survey of the impacts of networking in the private household, but rather to present examples using selected applications. The areas of application have been chosen so that, on the one hand, they provide elements for answering the question whether there is a call for action at government level (aimed at keeping additional electricity consumption in check), and on the other hand, they provide us with an insight into the broad range of potential impacts on energy consumption both inside and outside the private household. We have not explicitly dealt with the question of the dependency of the impacts of the technologies and media on which the network is based. We have also excluded observations concerning the importance of grey energy. In the field of information technology this can certainly be just as important as direct energy, and with short operating times and short lifecycles it can even exceed direct energy consumption.

This chapter deals with the following three topics:

- Electricity consumption in the private household (5.1)
- Energy efficiency in buildings or apartments (5.2)
- Impacts on energy consumption outside the household (5.3)

Here we have only studied and quantified additional electricity consumption in the private household. With respect to potential ways of saving energy inside the house, we have referred to the results of an earlier study (Aeb 1995), but have gone on to supplement these with some more recent findings. The impacts on energy consumption outside the house are illustrated using the example of the frequently discussed topics of e-commerce and teleworking. Here we have drawn on the findings of a number of recently concluded studies and have likewise supplemented these results with some of our own considerations and calculations.

5.1 Additional electricity consumption in Switzerland as a result of networking in private households

In this section we have drawn up the criteria for answering the question whether there is a call for action from a point of view of energy management and energy/environmental policy in the form of taking measures aimed at keeping potential additional electricity consumption in check, and which strategic criteria can be recommended in this connection. Here it is necessary to carry out observations over the long term, since the potential impacts will only become apparent after an extended period of time, and a lengthy preparatory period is required for planning measures and subsequently implementing them. But even over a period of several years it is barely possible to obtain reasonably reliable findings regarding the spread of networks in private households. With the exception of those made by absolute sceptics, who do not envisage a market for this application over the longer term, all previous forecasts have subsequently turned out to be far too optimistic. So rather than attempting to define a precise scenario, we drew up a perspective that ranges from a **lower** (“networking in private households fails to take place”) to an **upper threshold** (maximum penetration in the area of multimedia applications within 20 years”). Although this means that the questions concerning a need for action and the introduction of measures are not answered comprehensively, it does allow a differentiated depiction of potential additional electricity consumption so that, on the one hand, political decision-makers themselves can assess whether intervention is called for, and on the other hand it will be possible to propose a strategy based on “no regret” measures.

The procedure for defining the **upper threshold** was as follows: the first step (**simulation**) involved calculating the additional electricity consumption in a networked private household (sections 5.1.1 to 5.1.4). Then in step 2 (**scenario**), this figure was projected to all households in Switzerland (section 5.1.5), and differentiated assessments were made concerning the distribution of networks in the various types of private households (single-family houses, duplexes and apartment blocks).

Simulation of additional electricity consumption was carried out separately for each of the three application categories: multimedia (5.1.1), white goods (5.1.2) and lighting (5.1.3) (as an example of process control technology) for the period from 2000 to 2020. Here we included two networking variants for each simulation: a typical networked house today (as far as such examples currently exist), and a vision of a future maximally networked household in each application category. These variants differ with respect to not only the number of networked objects, but also to their use. As has been observed for many years in association with various IT applications (Aeb 2000), it is to be assumed that the power requirements for networking will remain unchanged in both variants in the period from 2000 to 2020, i.e. the anticipated reduction as a result of technological improvements[2] will be offset by an increase in services. But what does change in both variants is the length of utilisation time, and thus the level of energy consumption.

The additional electricity consumption in a networked private household was measured against a **reference household** that corresponds to a present-day one that is equipped with all relevant appliances and applications, but is not internally networked. The trend with respect to additional electricity consumption in an **average networked house** over the period from 2000 to 2020 was simulated using the following basic assumptions:

- In 2000, the average networked private household is described using variant 1
- In 2020, the networking standard corresponds to the present-day vision of a fully-networked household (variant 2)
- The shift in market shares of the two variants between 2000 and 2020 is linear, i.e. the market share of variant 1 falls from 100% in 2000 to zero in 2020, while that of variant 2 climbs from zero in 2000 to 100% in 2020.

This trend reflects what is technically possible from the present-day point of view, but is hardly realistic in economic and sociological terms, for not every networked household will be able to afford the maximum variant, nor will they all pursue Bill Gates's vision. So the average networked household simulated here sets an upper limit for additional electricity consumption as a result of networking. A simulation of more realistic trends could be carried out in a follow-up project (cf. Chapter 6, Recommendations).

5.1.1 Multimedia/Internet

Multimedia and Internet applications are already in widespread use today (cf. section 4.3) and their use will continue to expand within a limited framework even without in-house networking. For the **reference household** (3 occupants, 5 rooms) used for comparison purposes for estimating the impacts of networking on energy consumption, it is assumed that the **degree of use** of the following equipment will remain **unchanged**:

- 1 PC, 1 modem
- 1 TV, 1 cable connection, 1 video recorder
- 2 hi-fi systems
- 1 fixed-line phone, 1 mobile phone.

We based the composition of the two variants for a networked household on the following assumptions:

- Multimedia and Internet applications are the most important factors for both external and in-house networking.
- As soon as there are two computers in a given household, users want to have them networked. And vice versa, if a household is internally networked, this gives rise to the desire for more than one PC (or similar device).
- PCs and TV sets are growing closer together: PCs are being used as television sets, and TVs are being used for surfing. It is conceivable that the same basic equipment can be used for both purposes, with added modules such as a large screen, plus additional software and processing capacity that can be called up from the house's central computer or via the network.
- Increasing use of the Internet does not give rise to less use of TV sets (NZZ, 2000), (Sti, 2000).

[2] To the extent that they are identifiable, technological advances are explicitly taken into account. LCD and related display technologies are regarded as standard. Due to the significantly higher costs involved, laptop technology (energy-optimised chips) is only expected to gain a foothold in association with mobile devices and applications.

- A high-capacity broadband gateway permits optimal external communication.

Variants 1 and 2 are characterised by the use of additional devices, their power consumption in standby and off modes, and their duration of active use (i.e. when they are switched on) in the period from 2000 to 2020 (with linear interpolation for the interim years - Table 5.1).

	Variant 1						Variant 2			
Device	PC		Tvdigi		Netw.		4MM		GA	
Status	On	SB/off	On	SB/off	On	SB/off	On	SB/off	On	SB/off
Capacity [W]	100	5	150	5	10	7	400	20	25	25
Duration of use, 2000 [%h]	5	95	10	90	20	80	10	90	20	80
Duration of use, 2020 [%h]	30	70	30	70	50	50	30	70	50	50

Table 5.1: Additional devices in variants 1 and 2 for networked households ,together with power consumption and duration of use

Explanations re variant 1:

- PC with LCD screen: 100 W
- The 5% duration of use in 2000, which is equivalent to 1.2 hrs a day, is slightly below the figure of 2 hrs a day obtained from a survey of frequent Internet users in the USA (NZZ, 2000), (Sti, 2000). In Switzerland, the present-day average use of the Internet from home is 4.6 hrs per week (Bul, 00). It is assumed that use of the Internet (by the three persons in the average household) will increase very rapidly to 4 hrs a day in 2000. From 2010 onwards, variant 1 will be rapidly pushed aside by variant 2.
- For digital TVs with an internal video recorder, it is also assumed that the duration of use will double during the cited period, from 2.4 to 4.8 hours a day (3 persons), and there will be an approximation to the present-day duration of use in the USA. This means that the simultaneous use of PCs and TV sets that has been observed in the USA (Sti, 2000) is taken into account.
- An overestimate of the duration of use gives rise to an overestimate of overall electricity consumption, but to an underestimate of electricity consumption in standby/off modes, and thus to an underestimate of the electricity savings potential through the reduction of standby consumption.
- An average power consumption of 2.5 W per device is estimated for the network connection.

Explanations re variant 2:

- A household with a multimedia device (PC/TV set/game console) in each room, in which a screen is used as decoration instead of a picture on the wall, may be interpreted as a depiction of Bill Gates's vision.
- The high-capacity broadband gateway (GA) has a high standby consumption. Broadband transmission capacity of the gateway has to be readily available at all times.
- The number of devices and accumulated duration of use are twice as high as in variant 1, and the power consumption in on mode (standby/off mode) is around 60% (160%) higher than in that variant.

The estimated annual electricity consumption in variant 1 is 323 kWh/household p.a. in 2000, and 811 kWh/household p.a. 2020, while the figures for variant 2 are 727 kWh/household p.a. in 2000 and 1,393 kWh/household p.a. in 2020. The proportion of electricity consumption in standby/off modes varies between 46% in 2000 for variant 2 and 12% in 2020 for variant 1 (Table 5.2).

	Variante 1			Variante 2		
		davon On-Verbrauch			davon On-Verbrauch	
	kWh/HH.a	kWh/HH.a	Anteil	kWh/HH.a	kWh/HH.a	Anteil
2000	323	193	60%	727	394	54%
2001	346	218	63%	760	433	57%
2002	370	244	66%	794	471	59%
2003	393	269	68%	827	509	62%
2004	417	294	71%	860	548	64%
2005	440	320	73%	894	586	66%
2006	464	345	74%	927	624	67%
2007	487	371	76%	960	662	69%
2008	511	396	78%	993	701	71%
2009	534	421	79%	1027	739	72%
2010	558	447	80%	1060	777	73%
2011	581	472	81%	1093	816	75%
2012	605	498	82%	1127	854	76%
2013	628	523	83%	1160	892	77%
2014	652	548	84%	1193	931	78%
2015	675	574	85%	1226	969	79%
2016	699	599	86%	1260	1007	80%
2017	722	625	86%	1293	1046	81%
2018	746	650	87%	1326	1084	82%
2019	769	675	88%	1360	1122	83%
2020	793	701	88%	1393	1161	83%

Table 5.2: Additional electricity consumption (overall and in on mode) per networked household and year as a result of networking in private households (multimedia/Internet applications) in variants 1 and 2

Figure 5.1 depicts the trend with respect to electricity consumption in the average networked household (based on the assumed transition from variant 1 to variant 2). The additional consumption for 2000 corresponds to the estimated 323 kWh/household p.a. for variant 1 (Table 5.2), and for 2020 it corresponds to the estimated 1,393 kWh/household p.a, for variant 2. The increase in additional consumption is attributable to the constantly growing number of networked devices and their higher degree of use. The increase in consumption in standby/off modes is clearly disproportionally lower.

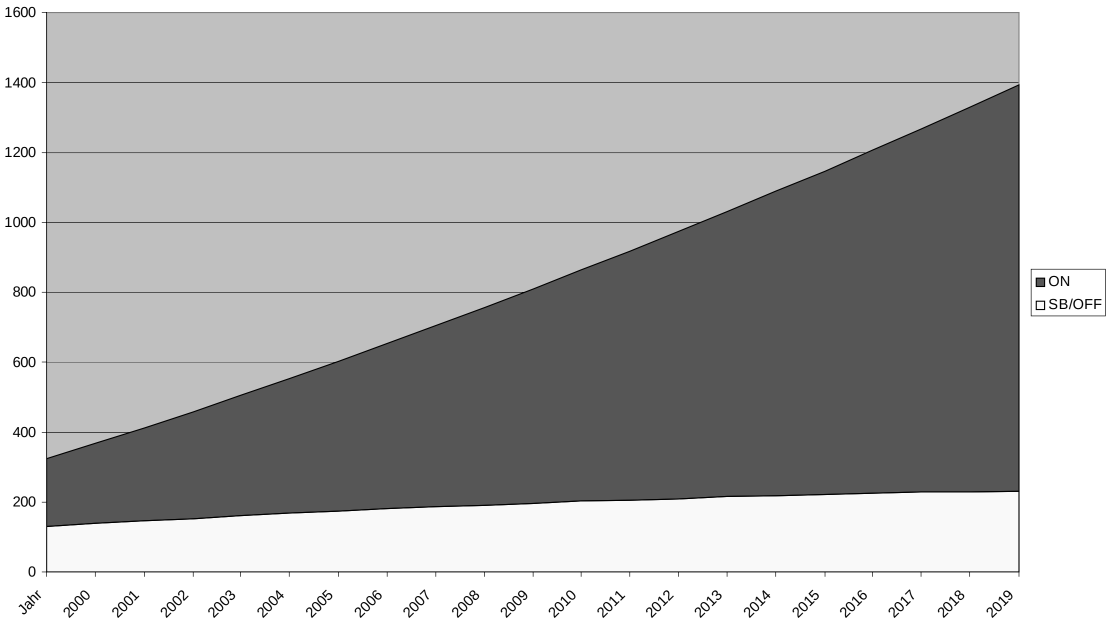


Fig. 5.1: Additional electricity consumption (divided into standby/off modes and on mode) per networked household and year resulting from networking in private households (multimedia/Internet applications only)

5.1.2 White goods

Here we assume a reference household with all the normal appliances: hotplates, oven, microwave; refrigerator and freezer; dishwasher, washing machine and dryer. These appliances are not networked. Some of them use a small amount of electricity in standby mode (e.g. washing machine that has not been switched off manually after completion of a washing cycle) or even in off mode (cf. section 5.4).

The principal considerations for networking are as follows:

- White goods are connected to communication modules that consume electricity in standby mode. According to (Mei 1999), this is already the case in Japan.
- The option of remote operation of devices (i.e. from outside the house) gives rise to longer operating times (e.g. pre-warming an oven).
- Other appliances that it would also be possible to network (e.g. coffee machines, toasters, etc.) have not been considered, since these cannot truly be classified as white goods.

Variants 1 and 2 differ in their external networking (gateway) - cf. Table 5.3.

	Variante 1									
Gerät	Kochen		Kühlen/Gefrieren		Waschen /Trocknen		Control.		Netz	
Zustand	On	SB/off	On	SB/off	On	SB/off	On	SB/off	On	SB/off
Leistung [W]	100	5	0	5	10	5	50	5	10	7
Nutzungsdauer im Jahr 2000 [%h]	4,17	200	0	200	20	200	20	80	20	80
Nutzungsdauer im Jahr 2020 [%h]	4,17	200	0	200	50	200	50	50	50	50

	Variante 2											
Gerät	Kochen		Kühlen/Gefrieren		Waschen/Trocknen		Control.		Netz		GA	
Zustand	On	SB/off	On	SB/off	On	SB/off	On	SB/off	On	SB/off	On	SB/off
Leistung [W]	100	5	0	5	0	5	50	5	10	7	25	25
Nutzungsdauer im Jahr 2000 [%h]	4,17	200	0	200	0	200	20	80	20	80	20	80
Nutzungsdauer im Jahr 2020 [%h]	4,17	200	0	200	0	200	50	50	50	50	50	50

Table 5.3: Additional equipment for variants 1 and 2 of a networked household, characterised by power consumption and duration of use. (200% duration of use = 2 devices with 100% duration)

Explanations re variant 1:

- Cooking: 2 networked appliances, plus facility for pre-warming or keeping dishes warm (100 W) for 4% of the time, i.e. 1 hour per week.
- Refrigeration/freezing: 2 networked appliances.
- Laundry/drying/dishwashing: 2 networked appliances.
- The assumed standby consumption of 5 W is an optimistic estimate in comparison with electronic devices.
- User interface/control device with monitor (touch screen), that is in operation 20% of the time in 2000 (5 hours), and 50% (12 hours) in 2020.
- Operation of network, cf. 5.1.1.

Explanations re variant 2:

- High-capacity broadband gateway as in 5.1.1

The resulting additional electricity consumption is approximately the same as in variant 1 for multimedia/Internet, but the proportion of consumption in standby/off modes is much higher, namely 70% today, and 50% in 2020.

	Variante 1			Variante 2		
		davon On-Verbrauch			davon On-Verbrauch	
	kWh/HH.a	kWh/HH.a	Anteil	kWh/HH.a	kWh/HH.a	Anteil
2000	489	142	29%	708	185	26%
2001	495	150	30%	714	197	28%
2002	501	157	31%	720	208	29%
2003	507	165	33%	726	219	30%
2004	514	173	34%	733	230	31%
2005	520	181	35%	739	241	33%
2006	526	189	36%	745	252	34%
2007	533	197	37%	752	264	35%
2008	539	205	38%	758	275	36%
2009	545	213	39%	764	286	37%
2010	552	220	40%	771	297	39%
2011	558	228	41%	777	308	40%
2012	564	236	42%	783	319	41%
2013	571	244	43%	790	331	42%
2014	577	252	44%	796	342	43%
2015	583	260	45%	802	353	44%
2016	589	268	45%	808	364	45%
2017	596	276	46%	815	375	46%
2018	602	284	47%	821	386	47%
2019	608	291	48%	827	398	48%
2020	615	299	49%	834	409	49%

Table 5.4: Additional power consumption (overall and in on mode) per networked household per year as a result of networking in private households (white goods) in variants 1 and 2

The assumed mix of variant 1 and variant 2 results in the average trend of additional electricity consumption as a result of networking white goods alone, as depicted in Fig. 5.5.

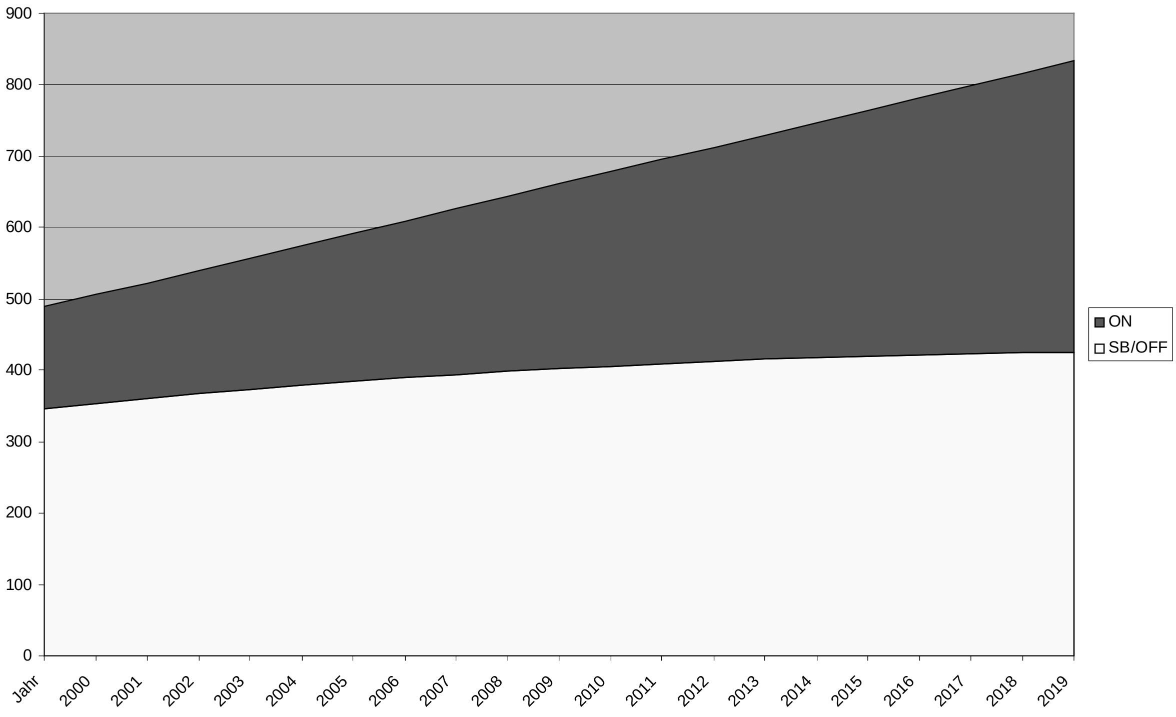


Fig. 5.5: Additional electricity consumption divided into standby/off and on modes per networked household per year as a result of networking in private households (white goods only)

5.1.3 Lighting control

For our reference household, we assumed an average consumption of 11.4 W per room for lighting (= annual consumption of household/8,760 hrs/no. of rooms). Lighting is only controlled via switches (with perhaps a dimmer in the living-room).

We based the principles for the design and fitting of variants 1 and 2 on the following assumptions:

- In order for the occupants to adjust the lighting effectively and create the desired ambience, a number of light sources are required.
- These options give rise to additional power consumption.
- The exterior (in the case of a single-family house, the garden) is artistically illuminated.
- External networking is less important than for other applications.

For lighting purposes, variants 1 and 2 are characterised by additional electricity consumption that depends on the variant concerned but is not time-related, plus standby consumption for process control and network operation (Table 5.5). Standby losses associated with the control of the individual light sources apply to a wired network, e.g. via an EIB bus. If networking is established via power line or radio, these losses may be considerably higher (section 4.3).

	Variant 1				Variant 2			
Device	Light		Netw		Light		Netw	
Mode	On	SB/off	On	SB/off	On	SB/off	On	SB/off
Consump. W]	2.28	0.12	3	3	11.42	0.12	20	20
Duration of use in 2000 [%h]	100	1000	20	80	100	5000	20	80
Duration of use in 2020 [%h]	100	1000	50	50	100	5000	50	50

Table 5.5: Additional equipment in networked households (variants 1 and 2) characterised by power consumption and duration of use (1,000% = 10 components with 100% duration of use)

Explanations re variant 1:

- Only the living-room is networked with a lighting control system.
- In this room, the additional electricity consumption is 20% (= 2.3 W average consumption).
- In this room: 10 * 0.12 W continuous (i.e. 100% of the time) standby consumption.
- Network and control devices require a standby consumption of 3 W.

Explanations re variant 2:

- All rooms and the exterior are equipped with a lighting control system that gives rise to additional consumption of 5 * 2.3 = 11.4 W for lighting.
- Continuous standby consumption is five times higher than in variant 1.
- Network operation and control devices are much more complex, with a standby consumption of 20 W.

This results in an additional annual electricity consumption that is significantly lower than the figures obtained for Internet/multimedia applications and for the networking of major household appliances. The proportion of consumption in standby/off modes is around 50%.

	Variant 1			Variant 2		
		of which in on mode			of which in on mode	
	kWh/HH.a	kWh/HH.a	Anteil	kWh/HH.a	kWh/HH.a	Anteil
2000	57	25	44%	328	135	41%
2001	57	26	45%	328	138	42%
2002	57	26	46%	328	140	43%
2003	57	26	47%	328	143	44%
2004	57	27	47%	328	146	44%
2005	57	27	48%	328	148	45%
2006	57	28	49%	328	151	46%
2007	57	28	49%	328	153	47%
2008	57	28	50%	328	156	48%
2009	57	29	51%	328	159	48%
2010	57	29	51%	328	161	49%
2011	57	30	52%	328	164	50%
2012	57	30	53%	328	167	51%
2013	57	30	53%	328	169	52%
2014	57	31	54%	328	172	52%
2015	57	31	55%	328	174	53%
2016	57	32	56%	328	177	54%
2017	57	32	56%	328	180	55%
2018	57	32	57%	328	182	56%
2019	57	33	58%	328	185	56%
2020	57	33	58%	328	188	57%

Table 5.6: Additional electricity consumption (overall and in on mode) per networked household and year as a result of networking (lighting control system) in variants 1 and 2

For the average networked household in which only the living-room lighting is programmable in 2000 (variant 1), then the lighting for the entire house is fully automated by 2020 (variant 2), the electricity consumption for lighting control is many times higher (Fig. 5.3). It is interesting to note here that, by contrast with multimedia /Internet applications and networking of major household appliances, the consumption in standby/off modes also increases sharply.

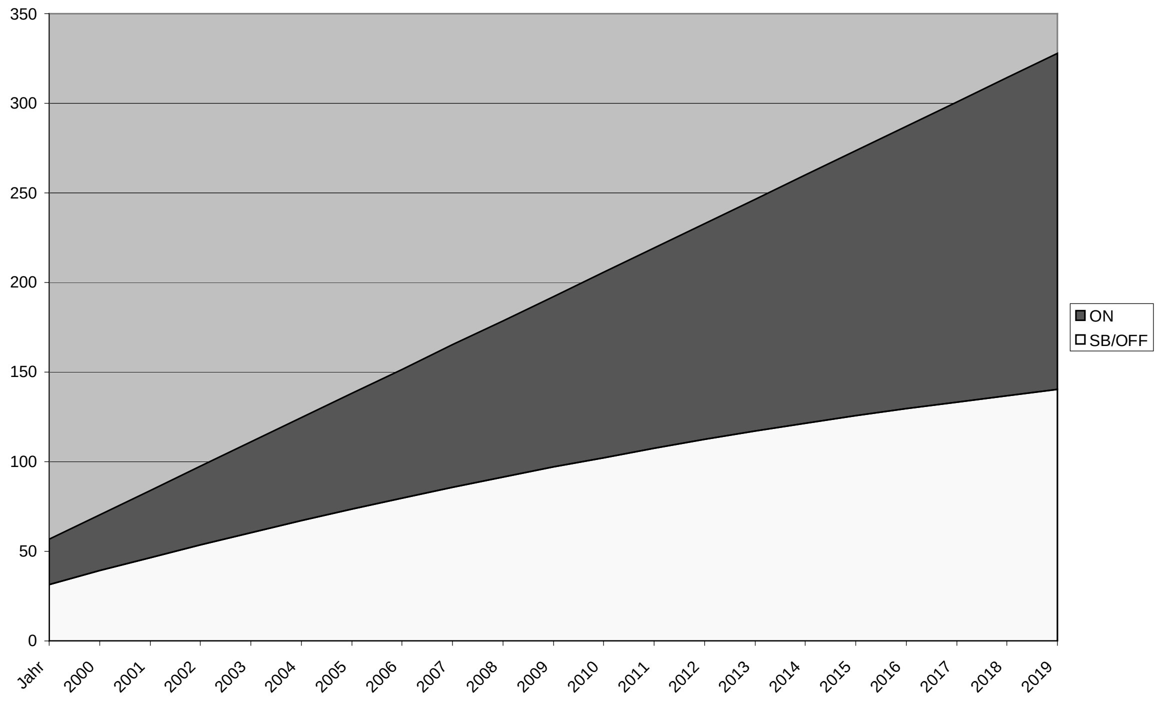


Fig. 5.3: Additional electricity consumption in standby/off modes and on mode per networked household and year as a result of networking in private households (lighting control system only)

5.1.4 Summary of results of the three applications

The upper threshold for additional electricity consumption in an average networked household with all three simulated applications is slightly lower than the total of electricity consumption for the three applications, since the use of certain network components (e.g. man-to-machine interface and gateway) is shared for various applications. Although we have only considered certain selected applications, the estimated upper threshold for additional electricity consumption in the average networked household in 2000 is almost 1,000 kWh p.a., or between 20% and 25% of the present-day level. By 2020, this additional consumption climbs to over 2,000 kWh p.a. (Table 5.7). This higher level of consumption is due to an increase in both the number of networked devices/components and their degree of use. This second point is responsible for the fact that the proportion of electricity consumption in on mode constantly increases. Nonetheless, even in 2020 more than 30% of additional electricity consumption – or 750 kWh p.a. – will be attributable to standby/off modes. If usage times were shorter, standby losses would of course be even higher.

This estimate of the upper threshold for additional electricity consumption cannot be regarded as absolute, since the following factors (among others) have not been taken into account:

- Other network applications (e.g. networking of smaller devices, surveillance/security, process control technology)
- Networking via power line or radio rather than wired systems
- Additional electricity consumption as a result of the use of mobile devices in networked households (cf. “The handy boom and networking in the private household” below).

		davon On-Verbrauch	
	kWh/HH.a	kWh/HH.a	Anteil
2000	926	342	37%
2001	989	387	39%
2002	1052	433	41%
2003	1116	480	43%
2004	1179	528	45%
2005	1242	577	46%
2006	1304	626	48%
2007	1367	677	50%
2008	1430	729	51%
2009	1493	782	52%
2010	1555	836	54%
2011	1617	891	55%
2012	1680	946	56%
2013	1742	1003	58%
2014	1804	1061	59%
2015	1866	1120	60%
2016	1928	1180	61%
2017	1990	1240	62%
2018	2052	1302	63%
2019	2113	1365	65%
2020	2175	1429	66%

Table 5.7: Additional electricity consumption (overall and in on mode) per networked household and year as a result of networking in households (multimedia, white goods and lighting control systems), incl. transition from variant 1 to variant 2

The handy boom and networking in private households

In just a few years, the number of mobile phones in Switzerland has rocketed from a few tens of thousands to around three million. This trend is an excellent example of how rapidly a product is able to establish itself on the market given the right background conditions and low starting costs, and how it can fundamentally change the behaviour of consumers.

The handy boom is the first practical manifestation of a new lifestyle – "always and everywhere online" – and will be the trigger for the networking of other devices, for example making it possible to control or monitor appliances in the household from another location. The development of radio networks (e.g. Bluetooth) will permit the realisation of small-scale mobile networks for personal use (personal area networks, or PANs) in the near future, and it is this technology that will probably be the main driving force behind the expansion of networking and which will supersede the other developments.

Experts believe that the development of mobile communication will be very rapid. It is likely that, in 2004, more bits will be used per handy for exchanging data than for making telephone calls (NZZ, 2000). And according to a Diebold study, by 2005 more users will be accessing the Internet via mobile phones or other mobile devices than via conventional computers.

5.1.5 Calculation of a scenario for additional electricity consumption in Switzerland

As with our simulation of additional electricity consumption in the average networked household, in this section too we have only established an upper threshold for additional consumption in our estimate for all households in Switzerland. The potential boundaries for the anticipated development have been staked out with this upper threshold and with zero growth. A delimitation by means of more detailed scenarios that take economic, social and cultural aspects into account, can be made in a follow-up study.

The distribution of average networked households among all homes in Switzerland is calculated using a simple logistics curve model as described in (Sch, 1996). These curves are characterised by the degree of distribution in the initial year, the degree of saturation and the diffusion time, i.e. the number of years until saturation level has been reached.

Our assumption is that the use of multimedia/Internet applications and the networking of white goods will be extremely widespread: with respect to multimedia/Internet applications, all households in single-family houses and duplexes will be fully networked in accordance with the vision of Bill Gates within 20 years; in view of the longer service life of white goods, market penetration will take twice as long. As far as households in apartment blocks are concerned, the degree of saturation will be slightly lower. For lighting control systems (as an example for the networking of all other household systems and services), no powerful lobby exists such as those for the networking of multimedia devices and white goods. Similarly, lighting control in bedrooms and kitchens is likely to be less attractive than in living-rooms. We have therefore assumed a significantly lower degree of saturation. For all areas it is the case that the assumed distribution only comes close to reality once networking is possible without the need for additional wiring, i.e. via radio and perhaps power lines.

	EFH			MFH		
	Multimed.	White G.	Lichtst.	Multimed.	White G.	Lichtst.
Startjahr	2000	2000	2000	2000	2000	2000
Diffusion im Startjahr	0%	0%	0%	0%	0%	0%
Sättigungsgrad	100%	100%	50%	80%	80%	20%
Diffusionszeit	20	40	40	20	40	40

Table 5.8: Parameters of the distribution curve for the three applications in single-family houses/ duplexes, and in apartment blocks

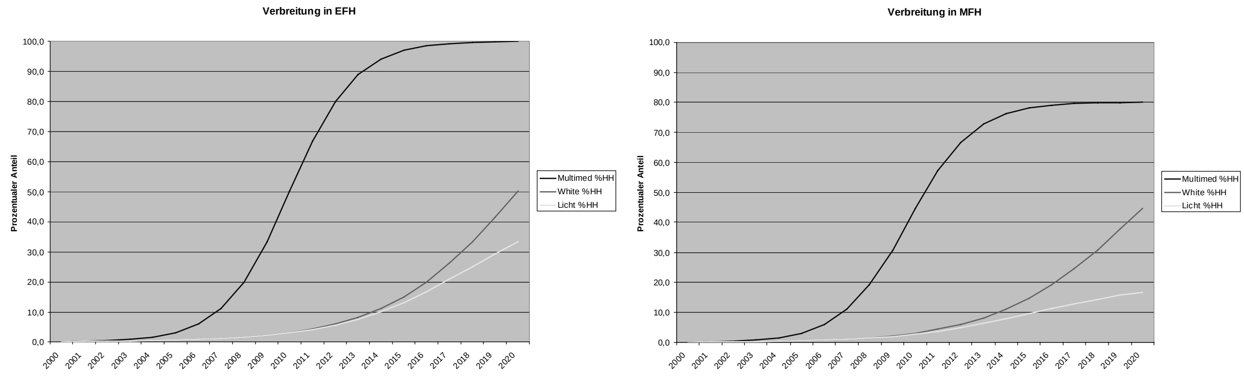


Fig. 5.4: Proportion of networked households in single-family houses/duplexes and apartment blocks

The resulting additional electricity consumption in private households in Switzerland (Fig. 5.5) is very low in the first few years, then it climbs sharply to 1,500 GWh p.a. by 2010 (approx. 10% of the present-day level of electricity consumption in private households) and reaches 5,000 GWh p.a. in 2020. The mean growth rate over the next 20 years – relative to present-day electricity consumption – is 1.3% p.a., and the proportion of consumption in standby and off modes is approx. ¼.

For the average household in Switzerland – whether networked or not – this additional electricity consumption is equivalent to 400 kWh p.a. in 2010, and to almost 1,500 kWh p.a. in 2020 (Fig. 5.6)

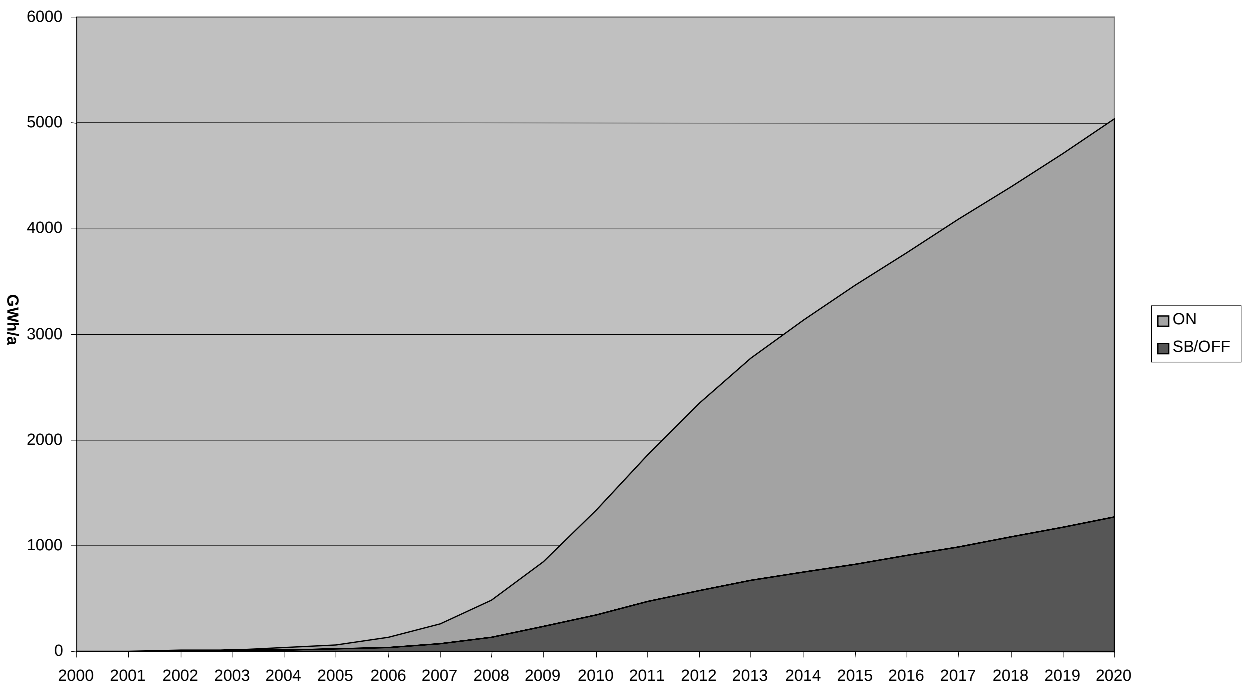


Fig. 5.5: Upper threshold for additional electricity consumption in Swiss households as a result of in-house networking

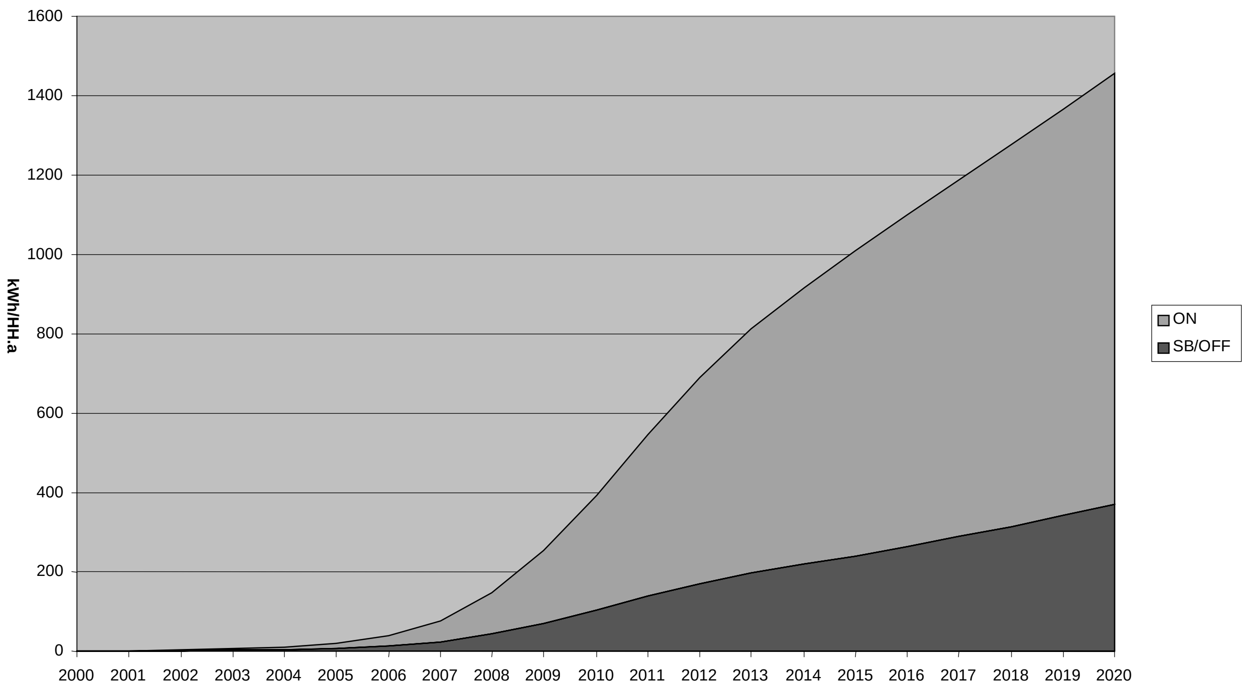


Fig. 5.6: Upper threshold for mean additional electricity consumption per household in Switzerland as a result of in-house networking

5.2 Networking in private households and energy efficiency in residential buildings

It is undisputed that, in an office complex, it is possible to significantly reduce energy consumption (electricity and heat) using intelligent control systems (Aeb 95, chapter 3.1.2). And in residential buildings, weather-related and time-dependent heating control systems are already in use today as a standardised means of cutting energy consumption. Motion sensors and automatic switches can lead to considerable savings in electricity, especially in the field of lighting. In new buildings with low energy requirements, shading and controlled room ventilation are new areas of application for intelligent control systems. Here the networking of such systems can have a positive influence on the energy consumption of a building, though at an already very low level of energy requirement. In order for the energy balance to be positive overall, the dedicated energy requirement of a network needs to be very low. In (Aeb 1995, page 45), the cited target level is 50 mW for the individual components.

On the other hand, networking in the private household is also hardly necessary for this purpose, for small self-contained systems already yield satisfactory results. In a study of the impacts of technology on energy – “Significance of LESIT technologies on energy consumption” (Aeb 95) – it was found that “Our energy supply structures with a simple central generator are clearly too primitive for an intelligent house. Only a very small proportion of the potentials to be found in an intelligent control system is in fact exploited. One could go so far as to say that it is already possible to achieve a great deal by optimising the individual components (e.g. improving building shells, using more efficient bulbs and electrical appliances); the intelligent interaction of these components is not necessary. However, the situation is quite different when competing energy sources or those that fluctuate periodically are used. As a rule, for the direct generation of energy (photovoltaics, solar collectors, biomass, etc.), a connection to, for example, the electricity network is still a necessity – in other words, drawing energy from an electricity network and a direct source is a process that has to be harmonised.“

However, positive effects of an intelligent control system are considered to exist in the form of the potential acceleration of the improvement of the efficiency of building systems and the lessening of the impacts of “bad” user behaviour (cf. box). But before it is possible to recommend an energy management system for single-family houses/duplexes, it is necessary to bring about a significant reduction in costs through standardisation and simplification of the various components and to simplify its operation.

Household automation as a measure for accelerating energy savings and promoting more energy-efficient behaviour on the part of consumers (Aeb 95, S. 45)

- *It will only be possible to reduce the level of energy consumption in new residential buildings very slowly as long as retrofitting measures are not made compulsory for existing buildings too, since the lifetime of a building is fifty years or more. Therefore in an interim period of around 30 years, household automation can certainly represent an attractive alternative to passive measures concerning building shells.*
- *Studies have revealed that the behaviour of consumers has a pronounced influence on the energy consumption of private households. In the "Landstuhl" demonstration project (Gruber E., Erhorn H., Reichert J.), measurements carried out on eight buildings with the same ground plan revealed that the behaviour of consumers can more than double the level of energy consumption for heating. Nonetheless, in this project it was also demonstrated that user influence in well-insulated buildings is lower (in absolute terms) than in those with less effective heating insulation (cf. Fig. 3.1-1). But by using intelligent control and regulation devices it is also possible to effectively limit the still significant energy losses even in well-insulated buildings. House automation therefore helps offset the behaviour of a non-energy-conscious consumer, though is not so helpful for energy-conscious users. For the latter it mainly increases the level of operating comfort. However, it is also important to recognise the risk here that when house automation does everything in the background, it is easy to forget about energy efficiency again. For this reason, the "education" aspect is particularly important, i.e. the possibility of constantly monitoring energy consumption (e.g. via a screen) so that consumers are able to see the effects of their behaviour immediately.*

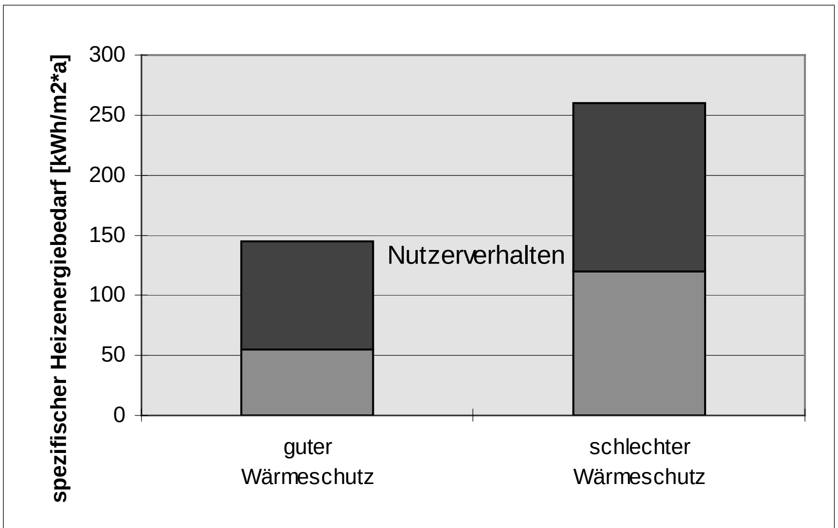


Fig. 3.1-1: Comparison of the degree of user influence on net energy consumption for heating in a well-insulated and a poorly-insulated building

5.3 Networking in private households and its impacts on energy consumption outside the house

In-house networking only yields a genuine value-added when it is connected to the outside world. This is now being carried out to an increasing extent via the Internet. Internet users are already experiencing radical changes here today with respect to daily activities such as communication, the procurement of information, payment transactions, etc., and the impacts of these changes are not limited to areas within the household, but also have an influence on the outside world. In this study we have taken e-commerce and teleworking – two areas of application that have been under discussion for some time and are still in their infancy – as examples for demonstrating the potential impacts on energy consumption outside the house. Here, our goal is to outline the diversity and complexity of the impacts and, if possible, to make qualitative findings concerning higher or lower energy consumption. These findings are mainly based on studies of existing literature and experts' reports. The study does not take the form of a comprehensive treatment of this topic, and certainly cannot be regarded as conclusive.

5.3.1 E-commerce

E-commerce, i.e. the processing of commercial transactions via electronic platforms such as the World Wide Web, is now a reality in Switzerland too. According to the Institute for Business Information Technology at the University of Berne, turnover in the private consumer (business-to-customer) segment amounted to more than a billion Swiss francs in 1999, or an average of CHF 1,600 per private Internet connection (Gas, 1999). To cite two examples from (Bus 2000, pp. 32/33), 2% of the sales of travel group Kuoni were realised via the Internet, and 2% of book purchases in Switzerland were carried out in electronic form.

The diverse impacts of electronic commerce, including those on energy consumption, have been examined in a variety of studies. In order to allow a critical interpretation of these findings, below we have outlined the "traditional" energy-relevant process of procurement/fulfilment of an item of merchandise/service (information, transaction) which in each case involves three steps: preliminary impacts, purchase/procurement and subsequent impacts:

1. Purchase of consumer goods

- Preliminary impacts: production, storage at factory, distribution, storage at retail outlet, packaging/presentation/display, sale
- Purchase by consumer: journey to point of sale, payment, return/onward journey
- Subsequent impacts: utilisation (e.g. deep-freezing/cooking of foodstuffs) of purchased product, disposal

2. Procurement of information, fulfilment of a transaction

- Preliminary impacts: provision of service (e.g. incoming/outgoing payments, investment consulting, procurement of information, etc.), counter service/advisory services infrastructure
- Visit to bank, post office or other institution: journey there, discussion/transaction, return/onward journey
- Subsequent impacts: follow-up enquiries, etc.

The most important potential impacts on energy consumption arising from e-commerce are discussed below for each of these three stages. We shall begin with purchase by consumer/visit to institution.

1. Purchase by consumer/visit to institution

The biggest consumer of energy – namely the journey to and from the point of sale – has to be compared with the consumption relating to delivery to the house. In Switzerland, shopping traffic is the biggest single contributor to energy consumption in the private transport segment, with a proportion of 13% (GVF, 96). Although the proportion covered on foot is 46%, 78% of the total distance is covered by car. These figures take account of the fact that some of the journeys are not only made for shopping purposes, but are combined with travel to and from work. The associated energy consumption has to be offset against that required for delivery, and this is sometimes higher and sometimes lower than for conventional shopping:

- The energy consumption associated with single deliveries, e.g. of a hot pizza, is certainly higher than that for the average shopping trip.
- For the delivery of goods to a number of customers (e.g. deliveries of foodstuffs within 24 hours, etc.), the energy requirements depend greatly on the customer density concerned, and of course on the distance to be covered. In extreme cases (e.g. milk deliveries), this is lower, but nowadays is probably higher on average than is the case with individual shopping.
- For postal deliveries, the energy consumption – perhaps with the exception of express and air-mail deliveries – is lower.
- The level of energy consumption is very low when deliveries are effected electronically.

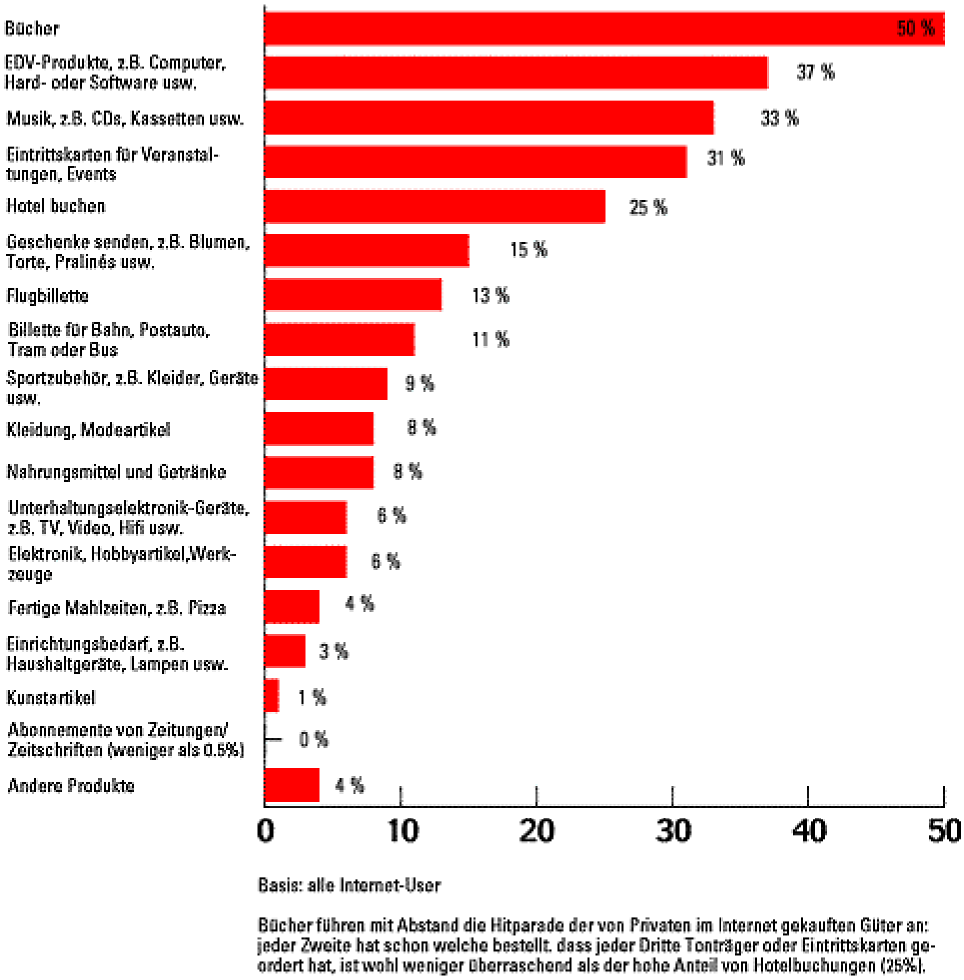


Fig. 5.8: Products that are already frequently purchased via the Internet (no. of Internet users who have already purchased such a product) (Bul 00)

The level of consumption therefore depends on how consumers make their purchases (e.g. journey to and from shop) and on the product concerned. Viewed overall, we would tend to predict lower consumption, given the present-day product mix (books, music and other items by post, plus a broad range of services and transactions). But this would probably only be the case if all purchases made via electronic means would also be carried out anyway. And this is very unlikely. The possibility of being able to make purchases from the comfort of one's own home, any time of day or night and any day of the year, effortlessly and without the transfer of cash, would significantly influence the behaviour of consumers and lead to increased buying, i.e. to higher energy consumption. (Ran, 2000, p. 17) cites the highly optimistic estimate by (Gas, 1994): "Thanks to e-commerce … it will be possible to reduce a certain proportion of shopping traffic ... but on the other hand, remote ordering of merchandise induces additional goods traffic. However, this could be optimally organised and co-ordinated so that it would not negate the benefits obtained from less shopping traffic". However, many authors today are less optimistic about this anticipated optimisation of goods traffic, including via information technology. In the view of (Zur, 2000), "... the ordering habits and altered expectations on the part of customers could lead to an individualisation of the distribution process, and this in turn would give rise to an increased number of journeys or to a lower capacity utilisation of goods vehicles".

2. Preliminary impacts

Generally speaking, e-commerce gives rise to a reduction in energy consumption within the retail trade, for consumers order directly from major distributors, or even from the manufacturer. This leads to the promotion of "just in time" production with reduced inventories at factories or distributors' warehouses, but above all it reduces the volume of deliveries to retailers as well as inventories and displays at retail outlets. This bypassing of retailers certainly gives rise to energy savings, as long as consumption for home deliveries is not included in the calculation of preliminary impacts, but rather – as we have done here – under the heading of "purchasing". It was not possible for us to make a quantification within the scope of this study, nor were we able to find any figures in existing literature.

Within the scope of an internal study published in (Zür 2000), the impacts on energy consumption of a reduction in floor space per employee were quantified at Switzerland's big banks. Approximately half of the anticipated reduction from $45m^2$ to $40m^2$ between 2000 and 2010 depends on increased use of e-commerce potentials, which would make it possible to significantly reduce the area required for teller and advisory services. Savings of several percent are anticipated by 2010.

3. Subsequent impacts

Subsequent impacts outside the private household particularly concern the removal of refuse. With the same range of products, the amount of packaging would probably be greater. Within the private household, we could probably anticipate a reduction in the quantity of frozen products and less energy consumption for cooking purposes (hot pizzas and other finished products). But here too, we do not have the necessary figures for drawing up a sufficiently accurate energy balance.

By way of summary, it can be expected that e-commerce will tend to give rise to energy savings in the retail sector, and, given the present-day (!) product mix, in the field of transport too. However, within the scope of this study we were not able to even broadly estimate how the overall energy balance might look.

5.3.2 Teleworking

The new information technologies, and particularly the networking potentials, are fundamentally changing the working environment. (Sch, 1996/2, S. 125) lists the following new trends from the point of view of one company:

- Teleworking/virtual office: employees are working part-time, or even full-time, outside the company's premises
- Delocalization: tasks are being carried out at external locations, e.g. in low-wage countries
- Self-employment: many employees are now working for themselves and offering their services to their former employer or operating as competitors.

Elsewhere in the same study (p. 177) we find the following definition: "*Teleworking is*

- *any job that is supported by information and telecommunications technologies ...,*
- *that is carried out outside the company's premises,*
- *that is linked to the company's central operations via electronic means of communication,*
- *as long as the activity concerned is not carried out on an occasional basis only."*

This somewhat restrictive definition explicitly excludes all self-employed people who are only able to carry out their activities outside of a largish company thanks to the possibilities opened up by information and telecommunications technologies. But it is generally applied in scientific studies, e.g. in (Bus 2000) too, in particular because it is compatible with official surveys of economic statistics.

The distribution of teleworking according to the restrictive definition cited above is a lot lower than assumed in earlier studies (Sch 2000). We have taken the following data from this study: the proportion of teleworkers in Switzerland is estimated at less than 1% (according to [Bus 2000], between 0.5% and 1%) of all gainfully employed people. Their distribution is among approx. 3% of companies in Switzerland. The potential for teleworking (as estimated by the companies questioned) is somewhere in the region of 20%.

For purposes of this study, we have considered teleworking in the broadest sense of the term: everyone who is able to work from home thanks to networking has been included. As stated above, no official statistics are available, and the figures cited below should be interpreted with a certain degree of caution.

According to an estimate by the European Commission, the proportion of teleworkers in the EU was already 6% at the end of 1998 (NZZ 99). National and regional differences are enormous: 18% in the Netherlands, 10% in Scandinavia, 5% in Germany and 3% in southern Europe. Teleworking is most widespread in the USA, with 15% of the workforce (Tag 00). It is precisely here that we find figures for the proportion of teleworkers in the narrower sense, who carry out a portion of their work at the office: 17% in the USA, 40% in Germany (according to a survey conducted by the Fraunhofer Institute for Labour and Organisation).

The following areas have to be included in an estimate of the impacts of teleworking on energy consumption:

- Energy consumption within the company: depending on how it is organised, teleworking gives rise to a decrease in the number of hours employees are present, perhaps in combination with a (partial) reduction in the number of workdesks (desk sharing), or to a total elimination of energy consumption within the company by the persons concerned.

- Energy consumption at teleworking locations: more hours spent at home (or elsewhere in the case of “nomads”), perhaps a larger house or apartment; electricity consumption of office equipment at the teleworking location
- Energy consumption for transport (mobility): reduction or elimination of travel to and from work (= substitution), additional journeys for other activities (shopping, visits, leisure-time) that were previously carried out on the way to and from work (= shift) and in general a reduction of overall distances covered (= contraction, greater emphasis on nearby locations).

Some of these topics are dealt with in closer detail below using case studies, empirical surveys and theoretical observations. The goal here was not to produce precise figures concerning additional or less energy consumption as a result of teleworking, but rather to obtain a broad idea of the potential impacts that can be compared with the estimated additional energy consumption in section 6.1 below.

5.3.2.1 Case study

For the purpose of our study on networking in private households, it is especially the potential additional energy consumption at home that is of interest. In the following case study, one of the authors of this report (AH) describes the changes he observed within his own household.

This case study is based on the electricity consumption of a household with two adults who work externally. In 1997, one of them then changed over to working at home. The table below shows the change in electricity consumption in this household (incl. water heating):

Year	Situation	Electricity consumption in kWh p.a.	Change in %
1992-1996	2 adults, both working externally	3,036	
1997	1 adult working externally 1 adult working at home (office work)	3,944	+30

Table 5.9: Electricity consumption p.a. in a private household before and after one occupant changed over to teleworking (actual measurement)

Here, the proportion of electronic workdesk appliances (PC, printer, fax, scanner and office lighting) to the additional electricity consumption is 54 percent:

Device	Capacity [W]	Usage time [hrs p.a.]	Electricity consumption [kWh p.a.]
PC (incl. monitor)	133	1,500	200
Printer	30	250	8
Fax	13	8,760	114
Scanner	15	500	8
Telephone	2	8,760	18
Office lighting	110	1,300	143
Total			**491**

Table 5.10: Electricity consumption p.a. for teleworking office (estimate)

The remaining additional electricity consumption of approx. 400 kWh p.a. is attributable to increased requirements for the following purposes:

- Hot water

- Food and beverages
- Lighting

Water consumption also increased to a similar extent alongside electricity consumption:

Year	Water consumption in m^3 p.a.	Change in %
1992-1996	66.5	
1997	83.9	+26

Table 5.11: Water consumption p.a. in a private household before and after one occupant changed over to teleworking (estimate)

The consumption of energy for heating purposes is likely to be more or less unchanged, since the area remains the same and the waste heat from the workdesk devices and lighting make a significant contribution towards the desired higher level of heating in the room used as an office.

As far as energy savings are concerned, the following aspects are of significance:

- Elimination of a workstation in the services sector (space requirements and energy consumption)
- Elimination of meals in a canteen or restaurant
- Elimination of journey to and from work amounting to 30 kilometres per working day = 7,200 kilometres p.a.

5.3.2.2 Empirical survey in Germany

In Germany a detailed study was conducted to analyse the travel behaviour of 80 teleworkers before and after the changeover. The final report was due to be published in the middle of 2000 – here we have used the preliminary report (Vog 2000). The substitution hypothesis, according to which commuter travel is simply substituted by telecommunication between the place of residence and the office, was basically confirmed. We are unable to make any conclusive statements as far as the level of representation of the results is concerned that might be put into question due to the interaction between travel behaviour and participation in the study by keeping a detailed log and in view of the short period during which travel behaviour was observed (the participants had only recently changed over to teleworking).

An average reduction in the total amount of travel by –9 kilometres per day (-24%) was observed per teleworker; the distances covered by car were 7.2 kilometres (-25%) per day lower (-25%). No significant change in behaviour was noted among other occupants of the households of the teleworkers involved in the study.

5.3.2.3 Comprehensive case study (semester study)

Within the framework of a semester study carried out at the Federal Institute of Technology (Sch 2000/2), the energy consumption of an office workstation was compared with that of an office in a private household, and the findings were then used for making a projection of the potential impacts on the region of Zurich. Quantification was achieved using a data-flow analysis that was based on detailed data from the Uetlihof office complex belonging to the Credit Suisse Group. This building has a very high level of automation and is therefore not representative for an average workplace. The authors use the restrictive definition of teleworking, i.e. some work is still carried out in the office complex. They assume that 4 teleworkers save the bank 3 workdesks, in other words that desk sharing takes place, and allow an (additional) area of 11 m^2 for each office at home.

The resulting energy balance (excluding transport) points to an increase in the consumption of fossil fuels (+1,650 kWh p.a.) at each office at home, and a change in electricity consumption that depends on the number of teleworking days (+115 kWh p.a. for 1 working day at home, -282 kWh p.a. for 4 working days at home).

5.3.2.4 Own (top-down) estimates

Our own estimates for the change in fuel and electricity consumption are based on average key energy statistics and energy intensities of office and residential buildings (Aeb 96), (Aeb 99), (Hof 96), (Web 99) and (Web 00), on measurements cited in section 5.3.2.3 above for the electricity consumption of an office at home (range, + 100%), on an average space requirement of 40 m^2 per employee in an office building (range 20-60), on an average space requirement of between 0 and 12 m^2 for a teleworking office at home, and on the assumption that a teleworking office substitutes at least 75% of a workplace in an office building.

For the purpose of estimating the potential changes in the area of transport, we used the results of the micro-census carried out in 1994 (GVF 96). 25% of overall passenger transport capacity (measured in passenger kilometres) is attributable to commuter traffic to and from work or educational institutions. The average distance covered is 17.9 kilometres per day (approx. 27 kilometres per working day). 69% of this distance is covered by car, 23% by public transport and the remaining 8% by bicycle (3%), motorbike or moped (2%), on foot (2%) and by other means (1%). The question concerning the changes in transport capacities that are to be anticipated with teleworking is a complex one. The usual practice is to take account of the following three hypotheses: substitution, shift and contraction, but in some cases (though perhaps also in general), other factors may also be of considerable significance. For example, teleworking can mean that the distance to customers is greater, and a reduction in commuter travel may lead to increased use of business travel. In towns in which parking spaces are very scarce, a spot that becomes free due to teleworking will be taken by a new commuter by car who previously used public transport in order to travel to work (this matter is discussed in [Sch 00/2]). The question of who is more likely to become a teleworker is also unclear: is it an employee who lives a long way from work and uses his/her car to get there, or is it someone who lives just round the corner and goes to work on foot? For the purpose of this study, our definition of a teleworker is someone who is an average employee and we assume that the ensuing reduction in travel is between 0% (total compensation) and 100% of the average distance.

5.3.2.5 Summary of findings and estimates of potentials for Switzerland

Quell	Elektrizit MWh/P.	Brennst MWh/P.	Treibsto MWh/P.
Fallbsp.	-2.4	-2.6	-5.2
(Vog, 00)			-1.2
(Sch 00/2)	-0.3	1.7	
min.	0.2	1.1	0.0
max.	-1.0	-0.7	-3.2

Table 5.12: Estimates for the energy consumption balance (negative figures = savings) within and outside the private household per teleworking location

Our estimate of potentials for Switzerland has been based on the assumption of 500,000 teleworkers. The savings in electricity consumption are a scale lower than the additional electricity consumption in private households as the result of networking.

Quelle	Elektrizität GWh/a	Brennstoff GWh/a	Treibstoff GWh/a
Fallbsp. 5.3.2.1	-1183	-1288	-2589
(Vog, 00) 5.3.2.2			-621
(Sch 00/2) 5.3.2.3	-150	850	
min. 5.3.2.4	100	540	0
max. 5.3.2.4	-500	-350	-1608

Table 5.13: Estimates of the energy consumption balance (negative figures = savings) inside and outside the private household with 500,000 teleworking offices

5.4 Summary of the impacts on energy demand

With the success of the Internet and mobile communication, it is now much more likely that we will see a significant distribution of “intelligent” houses in the near future. Of the various existing design and application potentials, it is the multimedia/Internet segment that will be the first to gain a foothold. The distribution of networking of white goods will depend partly on the development of innovative services and partly on the availability of inexpensive and user-friendly standard products that are able to communicate via radio or power lines. Of the many other potential applications, those devices intended for surveillance and access control have the best market chances in the near term, while in the field of process control technology it is primarily lighting control devices that will lead the way.

The impacts on energy consumption inside and outside the house are diverse and uncertain, but the probability is that there will be a significant increase in electricity consumption. The simulation and scenario calculations presented in chapter 5 yield an upper threshold for this increase of 1.3% p.a. over the next twenty years, but this could be considerably lower if:

- the number of networked devices/components and the degree of their utilisation in the average networked household should be lower than in the simulation presented in sections 5.1.1 – 5.1.3;
- the spread of networking in private households in Switzerland takes place at a slower pace and reaches a lower level of saturation than assumed in our scenario in section 5.1.5;
- the power consumption of devices/components in on and standby/off modes is lowered;
- an efficient power management system is used.

The significance of networking for efficient use of energy in private households is estimated as rather low. With relatively basic household technology and given the present-day energy supply, self-sufficient regulation systems in private households yield similarly good results to those from central energy management systems at much lower cost.

The impacts of networking in private households on energy consumption outside the house have been studied from a qualitative point of view using e-commerce and teleworking as examples. Both these applications should tend to give rise to energy savings in the services sector, and their impacts on energy consumption in the transport sector can also be assessed as positive, given the present-day system delimitation. However, within the scope of this project it is not possible to make statements of a general nature, since a large number of other applications – particularly in the area of entertainment/leisure-time – that influence energy consumption outside the house were not included.

6 Recommendations for efficient use of electricity

The potentially very high growth rates in electricity consumption in private households due to networking in the home are contradictory to the objectives of the EnergySwitzerland programme and make it more difficult to achieve the targeted reduction in CO_2-emissions. There is certainly a need for action here in that it essential to lessen the high degree of uncertainty with respect to the future trend by carrying out **more comprehensive studies** that take economic, social and cultural aspects into account. It is also necessary to take immediate measures aimed at **optimising future additional electricity consumption in standby and off modes**, and **support for research and development aimed at producing innovative solutions** would undoubtedly be beneficial too.

6.1 Comprehensive studies

Limitation of scope for potentials. Focus: economic, sociological and cultural observations.

Measurement of electricity consumption of networks under real conditions in a (completely) networked house, e.g. in the “house of the future” in Huenenberg (www.futurelife.ch), in which socio-cultural aspects have been taken into consideration in an exemplary manner.

Impacts of networking in the industry and services sectors on energy consumption. (Project outline: “New information and communications technologies and structural change in the services sector”).

Significance of different technological solutions for electricity consumption. (Keywords for networking in private households: copper cable, power line, radio; keywords for external networking: last mile, gateway, wire, cable, radio).

6.2 Optimisation of electricity consumption in standby and off modes

The proportion of electricity consumption in standby and off modes varies in the calculated scenario for the upper threshold of the potential range between 50% in the first few years and 25% from 2010 (Fig. 5.5). If the utilisation times of the various devices and systems are shorter, overall electricity consumption is lower, but consumption in standby and off modes increases. The assumptions for the power consumption of devices and appliances in these modes (cf. Tables 5.1, 5.3 and 5.5) are deliberately conservative, since experience has shown that many obstacles stand in the way of optimisation of losses in standby and off modes in a networked (non-proprietary) system. And the problems concerning efficient power management are likely to be very similar to those for a computer network (Sch 95), (Hus 97), (Hus 99). The technical measures are clear (section 6.2.1) and positive options already exist for implementation (section 6.2.2).

6.2.1 Technical measures

For multimedia/Internet applications, efficient power management as with computer networks is the principal measure. For networking white goods and for lighting control systems (and other areas of household technology), the power supply of components is particularly important: “A large fraction of total standby power is lost by the transformer (or power supply) converting the electricity from the mains voltage to a lower voltage“ (Mei 99). The following guidelines have to be observed here:

- Use of as few power supply units as possible: a central power supply lowers standby consumption (EIB bus, USB bus)
- For white goods and electronic entertainment equipment, use of separate and adapted power supply units that only supply the communication components which are responsible for networking
- Use of high-frequency automatic power supply units instead of conventional ones. Electronic automatic power supply units have a high level of efficiency and low standby losses (around 0.25 W).

Alongside the already cited measures, it is also possible to lower standby consumption by:

- Using power management for microprocessors (e.g. reducing pulse frequencies);

- Using energy-efficient chip technologies and a low supply voltage;
- Switching off components that are temporarily not in use.

6.2.2 Measures for implementation

The following guidelines apply with respect to implementation:

- The networking of private households is currently in its developmental stage, and this is precisely the right time to incorporate energy efficiency as a criterion. Action needs to be taken without delay.
- The new technologies, devices and systems are being developed by global players, so it is essential that measures are taken at the international level.
- For the majority of components and devices, principles have already been drawn up for formulating demands on energy consumption. For systems, however, this is generally not (yet) possible.
- It is essential to seek co-operation with developers and manufacturers.
- For specifying requirements and, above all, for implementing them it is important to ensure that all players are included in the various processes. A combination of different measures would help increase the degree of effectiveness.
- Accompanying measures such as information and training should be given consideration
- Priorities need to be defined.

6.2.2.1 Distribution of this study

This study has been translated into English in order to secure distribution to an international readership

Articles in international journals

Contributions for conferences (an abstract has been submitted for the 2001 ECEEE Conference)

6.2.2.2 Declaration, labelling of goods

It is essential that activities are harmonised on an international level in this market segment, in which products are developed and manufactured for the global market. Labelling programmes already exist in the international arena for related technologies, namely office equipment and electronic entertainment equipment. Technically speaking, there should be no difficulty in extending these activities to include devices and components that play a role in the networking of private households, but the involved governments and agencies first need to be convinced of the benefits of such a move. It is also essential that new players in the telecommunications and household appliances segments are included in this process and support the various activities.

It is interesting to note the latest requirements laid down by the EnergyStar programme for set-top boxes, in which a multi-function device is described in category 3 that could be regarded as closely approximating a gateway as required for networking in private households: "Multi-function device (i.e., a physically integrated device that has the core function of a satellite TV set-top box, digital cable TV set-top box, wireless TV set-top box, or personal video recorder plus one or more additional functionalities, such as an Internet access device or video game console)" (http://www.epa.gov/appdstar/home_electronics/stb_intro.html). The specified requirements for this device are a maximum standby consumption of 20 W (Tier 1), and 7 W (Tier 2). Over the longer term, a requirement of 1 W could well become exemplary for this device too (http://eetd.lbl.gov/leaking/Reducing/1Watt.html).

For household appliances it would be possible to record the standby consumption in the energy declaration. This would exert pressure on manufacturers to incorporate mains coupling components into their devices so as to avoid any unnecessary standby losses. From electronic entertainment and office equipment we already posses the know-how for recording standby consumption in a labelling scheme.

Labelling programmes include accompanying measures such as information and incentive campaigns and training modules, and it is essential that efficiency and effectiveness are constantly monitored. Combining labelling with the negotiation of target values, as tried out within the framework of the Energy 2000 programme, is attractive in theory, but in practice a number of additional prerequisites need to be met in order for this type of procedure to stand a chance of being successful:

- Realistic targets
- Authority to take action and scope for manoeuvre for the various partners concerned
- Regular monitoring and, if necessary, intensification of support measures and/or revision of specified targets
- Incentives for achieving targets (e.g. exemption from CO_2 tax[3])
- In the event of failure to achieve specified targets, possibility and readiness to take further measures, e.g. approval criteria.

6.2.2.3 Training

The fundamental technologies are in place, but at the moment there are not enough experts who can apply them to the benefit of end-users. Architects and household technology specialists face the challenge of acquainting themselves with the new technologies and applying them effectively. However, the know-how on the part of the players concerned is inadequate at present. It is almost impossible for a property owner wishing to build a networked household to find suppliers with the necessary integral know-how. But an all-round vision is essential for achieving optimal energy use. The topic of "energy and networking" needs to be incorporated into further education courses for architects and household technology specialists.

One of the main problem areas at this time is quality of systems integration and software, for there is a serious lack of adequately trained specialists here. The possibility needs to be studied of offering a training module that demonstrates how a home automation system should be designed and equipped in order to prevent an excessive increase in electricity consumption. The main goal here would be to avoid serious mistakes, and the module would be addressed to the installation industry.

Although the potential energy savings resulting from the use of an automatic energy management system are regarded as relatively low in most residential buildings today, the use of control systems for attaining more efficient energy use in complex buildings is an important issue. In future, this question will also become more important in residential buildings in which local energy sources are used in addition to a central power supply. Here, too, it is essential to find out how the level of know-how on the part of specialists can be improved.

6.3 Promotion of innovative solutions

Losses at various levels of conversion of the power supply will remain an important issue even with the application of more efficient technologies (section 6.1). The question also arises whether the use of a large number of electronic automated power supply units is the ideal (economical) solution, or whether an in-house DC distribution might also be a better solution for the supply of power to devices and components for multimedia/Internet applications and the networking of white goods. From the point of view of standby consumption, DC distribution is the most economical method, but this only applies if it possible to install DC distribution at the same time as, and parallel to, 230V AC distribution, and the connected devices only have a low power consumption (at low voltage, high-consumption devices require high currents and broad feed cross-sections).

Sensors/actuators are the central components of networking systems, and their quantity is going to grow enormously. It is likely that many will communicate and be controlled via radio. The question arises here whether a fixed connection will be necessary in future for the power supply. The power requirements of such components are growing constantly lower. A power source that is separate from the mains supply significantly cuts installation costs, but it is important that it requires relatively little maintenance (long service-life of storage elements), i.e. users should not need to carry out tasks such as changing batteries in the components. Certain questions remain open with respect to ecological evaluation of the various systems (ecological balance of power supply options such as mains, batteries, etc.). Research is currently being

[3] In a recently completed preliminary project (Zür 00) aimed at finding ways to oblige Swiss industry to assume responsibility for increasing energy efficiency and reducing CO_2 emissions, the possibility was considered that it is not only the success of measures introduced within individual sectors that should be evaluated, but also that impacts in other sectors, e.g. those in private households that result from the development of better appliances, should also be taken into consideration when assessing the degree to which specified targets are met.

carried out with the goal of developing sensor systems that draw their operating power from their immediate environment (temperature changes, incident light radiation) or from feed sources (electromagnet waves from radio connections).

7 Definitions

ADSL
Asymmetric Digital Subscriber Line: access technology for the provision of broadband services via the normal telephone line (standard copper cable). ADSL permits the transmission of up to 8 Mbps between provider and user (i.e. downstream). In the opposite direction (i.e. upstream), it is possible to transmit a data flow at speeds of up to 768 Kbps with ADSL. The actual achievable transmission speed depends on the corresponding technical specifications. Typical uses for ADSL include bit-rate asymmetrical services, video on demand (VoD), multimedia Internet applications.

ATM
Asynchronous Transfer Mode: standardised transmission and switching technology that encompasses bandwidths ranging from 2 Mbps to a planned 155 Mbps. It combines the advantages of connection-based transfer (each user has his own line) with those of package transfer. By splitting data into packages of uniform length with a code for the destination concerned, it is possible to transmit different signals (voice, data, images) almost simultaneously via a single line. Another advantage offered by ATM is that each user only pays for the data transmission rate that he actually uses in the network.

Backbone
Central connection in a network that normally consists of a number of nodes that are linked via transmission routes.

Bus
Transfer system that can be shared by a number of end devices, but which cannot be used simultaneously.

Business-to-Business applications
Applications in the business segment, e.g. point-to-multipoint distribution, tele-learning, teleworking, etc.

Carrier
Also referred to as network operator or provider. Organisation or company that operates telecommunications networks, i.e. carries out all network management activities. Carriers mainly provide (produce) low-layer transport-oriented transfer services, often to third-party users in return for a fee.

Carrier signal
A current that vibrates at a fixed frequency and is used for transmitting specific information between a transmitter and a receiver.

CATV
Abbreviation for cable TV.

Convergence
Convergence refers to the combined development of different networks (e.g. fixed telephone network, mobile phone network, Internet (= Fixed Mobile Internet Convergence, or FMIC) or services (e.g. voice and data services). From a user's point of view, full convergence means there is no longer any distinction between different networks and devices.

DECT
Digital Enhanced Cordless Telecommunications: digital transmission between a mobile phone and a base station.

EIB
European Installation Bus: uniform bus system for electrical installations that was introduced in 1990 by 15 leading European companies in the electrical installation technology sector.

Gateway
Hardware/software package that transfers data from one network into another non-compatible network.

GSM
Global System for Mobile Communication: GSM is an international standard for digital mobile wireless systems.

Home Electronic System (HES)
Management system developed jointly by Siemens and Bosch for use in private households with an EIB bus serving as network.

Intelligent network
An intelligent network is defined as follows (Aeb 95):
A network that is able to regulate communication between previously independent devices and systems for the purpose of integrating, controlling and steering the functions provided by the devices or systems concerned.
A microelectronic control for communication must be present either in decentralised (i.e. in the individual devices connected to the network) or centralised (i.e. via a central unit controlling all connected devices) form.
It must possess a software-based programming function that enables the user to program it according to his own specific requirements, and that is also designed in such a way that its control function is able to "learn".

ISDN
Integrated Service Digital Network: European standard for integrated digital networking via existing telephone lines based on 64 Kbps connections for public communication and local applications (narrowband ISDN). Used for transmitting both voice and data signals. ISDN offers (for example) two lines and at least three phone numbers via a single connection, plus a variety of other convenient features. May be used together with ADSL.

IT
Information technology in the broadest sense, including communication technologies. Often also abbreviated as ICT (Information and communication technologies). The term "New information and communication technologies" (abbreviation, NICT) is often used today.

LAN
Abbreviation for Local Area Network (= local computer network).

Last mile
Section between last network node and customer's connection.

LON
LonWorks is a network that is based on a low-cost micro-controller (neuron chip) that contains all the necessary protocols and services for communication purposes. Communication is possible via widely-differing media thanks to a joint protocol called LONTalk. Unlike EIB, LON tells us nothing about the system, but rather it merely indicates that a LON chip has been used. This product was developed by Echelon Inc. in Palo Alto, USA.

Multimedia
A trend word that does not have a widely-recognised uniform definition. Generally speaking, it refers to the combination of previously separate areas such as computer technology, telecommunications, consumer electronics and the media industry. In the field of telecommunications, multimedia is used in a broad sense to describe all applications that integrate voice, text, data and image communication, or parts thereof.

OSI
Open System Interconnection: an international standardisation project initiated by the ISO (International Standardization Organization) for defining communication protocols for connecting computer systems from different manufacturers.

PLC
Power line communication: narrow or broad band data transmission via the electricity network. Existing narrow-band systems up to 64 Kbps permit practical applications in the areas of building management and the control and remote call-up of systems to be monitored. With future developments it will be possible to achieve data transmission rates of up to 1 Mbps over distances of more than 300 metres via the local low-voltage network (= last mile via power network).

Protocol
Recording of data exchange processes between transmitter and receiver. Contains a description of formats used for data exchange, plus the amount of time required and the error correction process.

Set-top box

A decoder unit for participation in new digital (and interactive) video and TV programmes, including pay-TV. Set-top boxes are used for converting digital TV signals into standardised analogue picture and sound signals so that it will be possible to use conventional TV sets for receiving digital television.

UMTS
Universal Mobile Telecommunications System: new standard for mobile phone transmission that will have a greater bandwidth and will thus permit additional services.

Wiring closet
Unit in which communication lines are brought together.

WLL
Wireless Local Loop: wireless connections to the fixed networks of telecommunications providers via locally installed transmitters.

WPAN
Wireless Personal Area Network: Bluetooth technology provides wireless connection between devices within a radius of approx. 10 metres (Personal Operating Space, or POS). The goal of this development is "to define a wireless communications standard for a personal area network, focusing on low power consumption, small size and low cost." Bluetooth published its "Bluetooth 1.0" specification in July 1999 (further information is available at www.bluetooth.com).

xDSL
x Digital Subscriber Line: x stands for the various versions of DSL technology, e.g. ADSL, HDSL, RADSL, UADSL, UDSL, VDSL. These concern technical concepts for broadband digital data transmission via the conventional copper cable network. DSL concepts were developed because the bandwidths provided by symmetrical twin-wire copper cables were not being fully utilised. Only frequencies of up to 4 kHz are used for the transmission of voice signals by phone, but the installed cables are able to cover a frequency range of up to 1.1 MHz, and therefore provide scope for a bandwidth of around 250 times the size. DSL systems exploit these reserves by spectrally splitting up the available frequency range.

Abbreviations and English names (Source, [Eur 98])

ADSL	Asymmetric Digital Subscriber Line
AC	Alternating Current
AN	Access Network
AP	Access Points
ATM	Asynchronous Transfer Mode
ATMF	ATM Forum
ATS	Access Termination System
AV	Audio-Visual
BAU	Bus Access Unit
BB	Broadband
BN	Building Network
CDMA	Code Division Multiple Access
CEBus	Consumer Electronic Bus
CPN	Customer Premises Network
CPU	Computing and Processing Unit
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
CDCR	Collision Detection and Collision Resolution
DAVIC	Digital Audio-Visual Council
DBPSK	Differential Binary Phase Shift Keying
DCF	Distributed Coordination Function
DSSS	Direct Sequence Spread Spectrum
DVB	Digital Video Broadcasting
EHS	European Home System
EIA	Electronics Industry Association
EIB	European Installation Bus
EIBA	European Installation Bus Association
EMC	Electro-Magnetic Compatibility
ERO	European Radio communications Office

ETS	End Termination System
ETSI	European Telecommunications Standards Institute
EURESCOM	European Institute for Research and Strategic Studies in Telecommunications
FH	Frequency Hopping
FHSS	Frequency Hopping Spread Spectrum
FSAN	Full Service Access Network
FTTH	Fiber-To-The-Home
FTTB	Fiber-To-The-Building
FTTC	Fiber-To-The-Curb
FTTH	Fiber-To-The-Home
GFSK	Gaussian Frequency Shift Keying
GSM	Global System for Mobile Communication
GW	Gateway
HAN	Home Access Network
HAVi	Home Audio/Video Interoperability Architecture
HBES	Home and Building Electronic System
HIPERLAN	High Performance Radio Local Area Network
HLN	Home LAN
HN	Home Network
HRFWG	Home Radio Frequency Working Group
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IHN	In-House Network
IHDN	In-Home Digital Network
IR	Infra-Red
IrDA	Infra Red Data Association
ISDN	Integrated Services Digital Network
LAN	Local Area Network
MAC	Medium Access Protocol
MBS	Mobile Broadband System
MMI	Men Machine Interface
MMS	Multi Media Service
MP-MP	Multi Point to Multi Point
NT	Network Termination
PLC	Power Line Carrier
RBB	Residential BroadBand
RF	Radio Frequency
STB	Set Top Box
TA	Terminal Adapter
TC	Transmission Convergence
TE	Terminal Equipment
TP	Twisted Pair
UNI	User Network Interface
UMTS	Universal Mobile Telecommunications System
UPI	User Premises Interface
UTP	Unshielded Twisted Pair
VDSL	Very high Digital Subscriber Line
VESA	Video Electronics Standards Association
WDM	Wavelength-Division Multiplexing
WEP	Wired Equivalency Privacy
WLAN	Wireless LAN
WLI	Forum Wireless LAN Interoperability Forum

8 Consulted partners

- Berner, Jürg — Electrolux, Zurich
- Bodmer, James — HTS, High Technology System AG, Effretikon
- Demierre, Eric, Pythoud, Frédéric, Wyss, Markus — Swisscom AG, Corporate Technology, Bern
- Dersch, Ulrich — Ascom Systec AG, Mägenwil
- Spillmann, Stephan — Systems manager, BFE (owner and user of networked home)
- Staub, Richard — Bus House, Zurich
- Various international experts on the occasion of the "From Network to Services“ conference, Sigma Forum, held on 26 November 1999 in Paris
- Various experts on the occasion of a workshop held by the Gebäudenetzwerk-Institut (Building Network Institute) on 13 April 2000 in Zurich. Topic: “Home Automation: Utopia or Reality?”
- Various experts on the occasion of a meeting of NFP 41 held on 24 March 2000 in Berne. Topic: “Less traffic thanks to telecommunications”

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