Energy 2000

Energy efficiency in networks – made simple

Server and network components can be automatically switched off when not in use. Two installations are described below.

The PCs in company networks usually stay switched on from morning until evening. Central computers (servers) are normally in constant operation year in year out.

Two innovative projects conducted by the Swiss Federal Office of Energy (SFOE) have demonstrated that servers can be «powered down» by remote control during the night and over the weekend without restricting users in any appreciable way. This saves energy and costs.

1. Power consumption and networks

Until recently, the amount of power consumed by electronic data processing (EDP) devices was not regarded as important by either users or manufacturers, even though PCs, computer monitors and printers are big energy eaters and represent a major portion of the power consumed within the services sector.

A study ordered by the Swiss Federal Office of Energy investigated how much of the total electricity used in Switzerland is consumed by EDP networks. The proportions consumed by individual network components was also determined. The results showed that EDP networks account for about 1.6% of Switzerland's overall electricity consumption (equivalent to 780 GWh, or the annual electricity consumption of the city of Lausanne). Through systematic application of energy management in networks and the use of more energy-efficient end devices, a 52% reduction in electricity consumption could potentially be achieved.

According to the study, central units such as computers and servers use the largest share of electricity, at 62%. This is followed by devices at work desks, which consume 23%. However, the energy savings potential for individual devices (27%, or 560 GWh) is about the same as for central units (29%, or 550 GWh).

In local networks (excluding mainframe and departmental computers), devices at work desks account for about 60% of the electricity consumed, followed by servers (25%) and switching equipment (15%).

The simplest, cheapest and at the same time the most effective way to cut energy consumption at the level of **end devices** is to switch them off when they are not in use. If a device will not be needed for 15 minutes or more, it makes sense to turn it off. Studies by the Swiss Federal Institute of Technology in Zurich have shown that adhering to this guideline does not shorten the life span of computer equipment. Manufacturers of end devices have also come a long way in the last few years in minimising consumption in stand-by mode.

Table 1 shows the annual energy consumption and savings potential for the most important network components.

Category	Annual consumption [GWh]	Savings potential [%]
Mainframe computers	238.2	57
Departmental computers	161.8	45
Servers	82.2	44
Monitors	68.0	72
PCs/work stations	54.4	81
Terminals	53.8	20
UPS devices	28.3	45
Printers at work desks	27.7	65
Other	63.4	56

Table 1 *Energy consumption and savings potential of network components*

The energy consumed by **EDP networks,** on the other hand, is an issue which has received little attention so far.

The lack of initiative in the area of networks may be attributed to the growing complexity of the systems, plus operators' fear that their manipulations may cause malfunctions in the network or jeopardise the network's stability.

Another obstacle is the fact that in global network systems, some computers, such as the Webserver, Mail Server (electronic post office) and the FTP server (data archiving), need to be operational 24 hours a day.

Smaller networks or sub-networks of large networks may not need to be available outside of business hours or may not always need to be fully operational. In an effort to exploit this savings potential, the Swiss Federal Office of Energy has demonstrated with two different EDP networks that servers can be turned off at night and on weekends without inconveniencing users.

2. NOVELL pilot network

A Novell network with six work desks was installed at the engineering firm of R. Brüniger AG in Ottenbach, Canton of Zurich. The development and use of an «Energy Manager» has proven that it is possible to achieve substantial energy savings in this way, at an acceptable cost and without hampering productive operations.

It is not feasible to simply switch network components on and off using a timer, because for reasons of speed and quality, the network operating system stores directories of the data structure in RAM rather than on the hard disk. Disconnection or a power failure therefore results in partial or complete loss of the data structure. Consequently, before turning off a server's power supply, it is necessary to systematically «power down» the network operating system, which means that the data structure tables are stored on the hard disk, and the multi-tasking processes are brought to an end in a controlled manner.

Power consumption, «before»:	814 kWh/ year
Power consumption, «after»:	284 kWh/ year
Energy savings:	530 kWh/ year (≈65%)
Annual cost savings:	CHF 110.– (CHF 0.20.– per kWh)
Costs:	CHF 299.– per server

Table 2 *Costs and benefits of energy-saving measures in the NOVELL network (R. Brüniger AG)*

These limitations are overcome in the following way. Since power failures can have fatal consequences for servers, the latter are usually equipped with a separate small UPS device. Established network operating systems (such as Novell, Microsoft NT, etc.) therefore have standardised hard- and software interfaces, which, automatically «power down» the network operating system once a certain amount of time has elapsed after a power failure is detected.

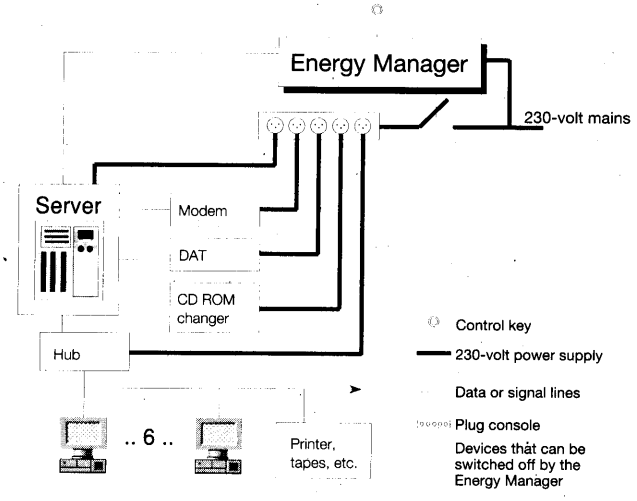

Figure 1 *EDP network (R. Brüniger AG)*

At the times indicated on the timer, the specially developed *Energy Manager* simulates a server power failure via a relay contact. The network operating system reacts by first alerting the users still logged onto the server. After a designated period of time, the network operating system is «powered down», and then the power supply to the server is shut off. At the same time, server-peripheral devices such as CD ROMs, DAT tape drivers and the hub are also turned off.

When necessary, the network can be kept operational longer than originally planned just by pressing a centrally installed control key. Operating time is thereby extended by three hours (adjustable). In the same manner, the network can be re-started after it has been switched off (on weekends, for example).

In addition, to assure that the network printer is only turned on when needed, an ECOMAN energy-saving switch was installed (see box). This switch turns the printer on when data is received, and automatically turns it off again if no further data arrives within a given period of time.

ECOMAN energy-saving switches
automatically turn off equipment to which they are connected, after it has not been in use for a given period of time. They run under Windows or Macintosh. The energy they consume themselves is negligible. ECOMAN energy-saving switches are available for computer monitors (price: CHF 42.–) and printers (price: CHF 68.–) as well as for other devices.

Energy Manager	
Manufacturer	Linard AG, 9506 Lommis
Dimensions	20 x 5 x 11 cm (breadth / depth / height)
Interfaces	1,3 or 5 server
Advantages	Simple installation, good value
Disadvantages	No remote control (planned for next model); simulated failure of UPS device is only possible if server is responding; programming of timer is complicated

Table 3 *The Energy Manager*

The more than two years of practical experience with this energy-saving technology in productive operations has been positive for all users concerned. Data have not been lost, nor has user comfort been affected.

3. Pilot network: UNIX/NT servers

The network of the Swiss Federal Office of Energy in Berne was spread out over three different buildings and represents part of the network serving the Swiss federal government's general administration. The servers run on UNIX and Windows NT operating systems. In one of the buildings, which comprises approximately 30 work desks, a pilot project was conducted to investigate the effects of switching off the network (partial network). Originally, four servers were installed in this network. Due to the increase in capacity, it was possible to replace these servers with two more powerful ones. In addition to the 29 work desks, several laser and ink-jet printers are connected to these servers.

The energy-saving measures in this case were implemented in three steps

- Since mid 1994, all printers have been equipped with ordinary timers, and computer monitors were automatically switched off by ECOMAN devices when not in use.

- In 1994, the UPS devices then in use were removed. To date, no failures or data losses of any significance have been noted.
- Since the middle of 1996, the Swiss Federal Office of Energy has been using the AC Manager (AC stands for «alternating current»). This control unit has six peripheral outlets (230 volts, 8 amperes). Various devices, such as servers, printers and scanners, can be hooked up to the AC Manager, according to the design of the network, and switched on and off by remote control (via a local network or modem). The servers, the central printer, the CD ROM changer and various modems are turned off at night via the local network. In the early morning, before regular office hours, the servers are turned on again so that data can be secured before work begins.
  A number of other devices, such as bridges, can also be controlled via the AC Manager. They were not included in this pilot project because the distance of the servers and these devices was too long.

Power consumption, «before»:	12'191 kWh/ year
Power consumption, «after»:	6'503 kWh/ year
Energy savings:	5'688 kWh/ year (≈47%)
Annual cost savings:	CHF 1'338.– (CHF 0.20.– per kWh)
Costs	AC Manager: The EMCT control unit costs CHF 2500.– (including Centronics interface); CHF 300.– for additional LAN interfaces (RJ 45 and BNC). The accompanying program costs CHF 1500.–

Table 4 Costs and benefits of energy-saving measures in the network of the SFOE

Times of operation are user-specified

A special program (scheduler), which runs on the central computer of the Swiss Federal Office of Energy network and which can be programmed at the discretion of the systems manager, issues the on/off commands to the AC Manager and orders the server to systematically conclude all processes. The scheduler allows the on/off times to be co-ordinated with **working hours.** Thus, **holidays** can be easily integrated into the switching schedule.

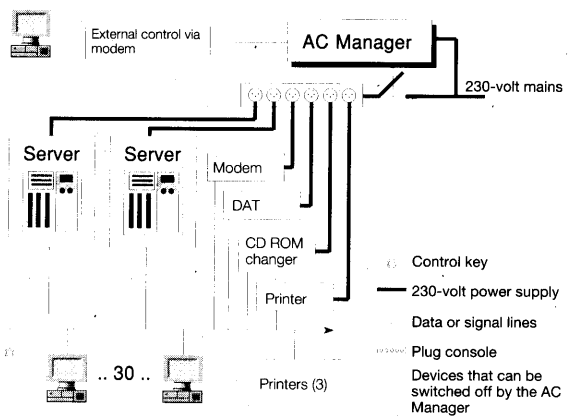

Figure 2 EDP network of the SFOE

Shortly before the network is to be powered down, a message appears on the screen informing users to this effect. If necessary, any user can **delay** the time at which the network is **turned off** by 1.5 hours (delay time can be re-programmed at the discretion of the systems manager) simply by pressing a central control key. This control key could be easily incorporated into the software at each individual work desk.

AC Manager	
Manufacturer	EMCT, 3322 Schönbühl-Urtenen
Dimensions	20 x 22 x 7 cm (breadth / depth / height)
Interfaces	6 (server)
Advantages	Remote control of any desired number of devices is possible via the local network or modem; flexible time planning via the control program
Disadvantages	Expensive; documentation is still inadequate; at present, can only be supplied by special order

Table 5 The AC Manager

If a user misses the warning message or wants to work on the **weekend,** the server can be re-started just by pressing the central control key (waiting time is 5 to 10 minutes); support from IT services is not required. The request from the central control key is relayed via the network to the central computer, which issues the switch-on command to the AC Manager.

Strong potential for saving energy

The Swiss Federal Office of Energy achieved major energy savings (Table 6) by implementing the energy-efficiency measures described above

- **Peripheral network printers: 71%**
  By consistently using timers on peripheral network printers (switched on only during working hours), electricity consumption was reduced by an impressive 71%.
- **Central devices: 54%**
  With central devices (servers), energy savings of 54% can be achieved by using the AC Manager.
- **Work stations: 30%**
  ECOMAN energy-saving switches installed on computer monitors cut the electricity consumption of work stations by 30%[1]. Modern monitors normally have an energy-saving switch already built in.

	Power consumption [kWh] «before»	«after»	Savings [%]
Server	3942	1805	54
Printer	2646	755	71
Work stations	5603	3943	30

Table 6 Energy savings achieved by the SFOE

[1] Turning off work stations whenever they are not in use is a simple way of cutting energy consumption: 85% less electricity is consumed than when work stations are left constantly turned on.

User friendliness and satisfaction

Both pilot networks proved to be practical solutions. Problems were rare and only minor. User acceptance of the energy-efficiency measures was always high.

Advantages for systems managers

The work for the systems managers was significantly reduced. In particular, if the status of a server becomes uncontrollable and cannot be corrected by simply powering down via the network, normal booting can usually be accomplished by completely disconnecting from the power supply. This can now be done either by remote control or via the network, whereas previously it was necessary for the systems manager to go on site.

4. Outlook

Several systems capable of switching off work stations by remote control are already available from leading manufacturers (e.g. Magic Packet by Advanced Micro Devices and Hewlett-Packard, Wake on LAN by IBM). Microsoft, Intel and others have announced a new energy management system (On Now). Their new approach still has to prove its feasibility in practice, however. Considering that the energy efficiency of networks is still not an issue for developers of operating systems, successful solutions will probably not be found in the near future.

An important step has been taken by the Swiss Federal Office of Energy in its pilot projects which have demonstrated that servers and network components can be fully powered down on a regular basis during non-working hours. Users can easily re-start the network themselves. The knowledge gleaned from these projects will be applied in a new federal administration building comprising 500 work desks.

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6. Explanations of key terms

- AC Manager: A newly developed programmable device for switching EDP networks or network components on and off (chapter 3).
- Bridge: A device which connects and filters the data transfer between different network segments, i.e. only that data is transmitted for which a recipient is present in the other segment. This makes segmenting of networks possible (higher efficiency), but slows down data transmission.
- ECOMAN: A device which is capable of switching off computer monitors or printers to which it is linked, if the equipment is not in use for a given period of time.
- EDP network: The collective of all EDP devices linked together in a network (server, clients, work stations, monitors, printers, communication devices, etc.).
- Energy Manager: A newly developed programmable device for switching EDP networks or network components on and off (chapter 2).
- End devices: Devices located at work desks, e.g. work stations and PCs.
- Hub: A multi-port amplifier allowing star-shaped branchings of network cables of different types (twisted pair, coaxial, fibre optics).
- Network components: Devices which are essential for the functioning of data transfer in an EDP network (communication servers, gateways, hubs, routers, bridges, etc.).
- Router: A device which connects a number of networks with one another and conveys data packets from a sender to a recipient by using various sub-networks. The sender needs to know the recipient's address, but not the path through the networks.
- Server: A central computer which provides services (data administration, calculations, communication, etc.) to other computers («clients»).
- Switch: A coupling device which connects data transfer between various network segments.
- Uninterruptible power supply (UPS): A device capable of providing power to the users connected to it for a limited period of time in case of failures or irregularities in the primary power source.
- Central devices: Devices which are shared by different users (e.g. servers, printers).

7. Literature

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Information sheet
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