1999 Report of the
"Electricity" Research Programme of the
Swiss Federal Office of Energy

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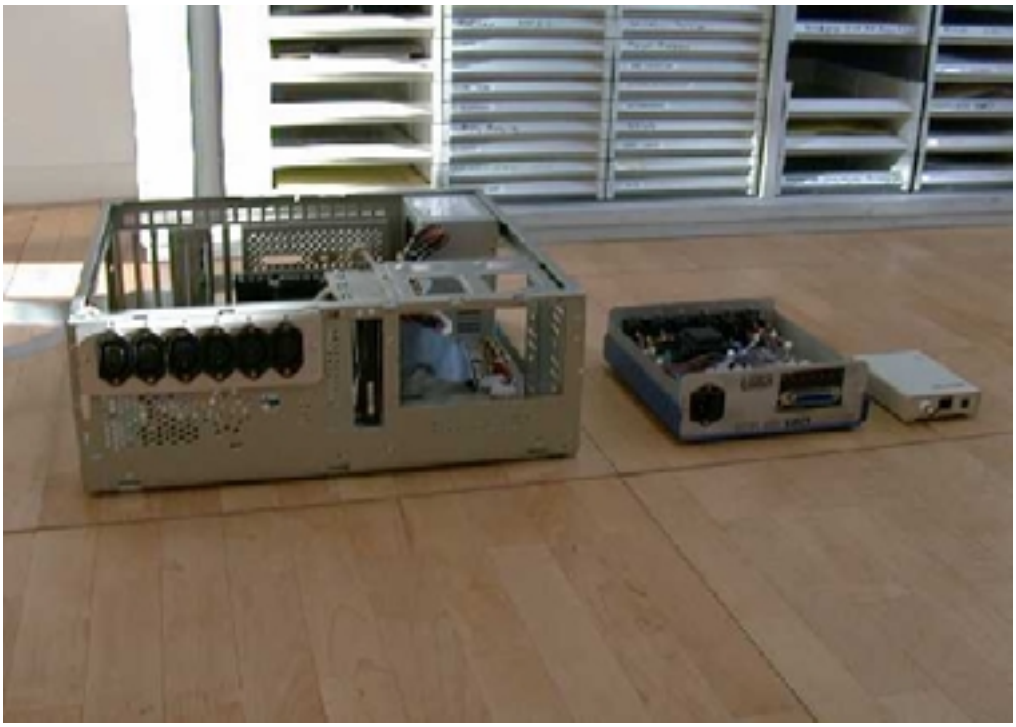


"Booting" is always helpful ... and saves 50% of Energy

With an AC manager it is possible to switch servers on and off at pre-set times, thus reducing their electricity consumption by around 50%. An additional benefit is that the degree of server stability can be enhanced as a result of daily booting.

Programme priorities and objectives for 1999

Through its various activities, the **Electricity** research programme sets out to promote the optimised use of electricity from the production and distribution stages through to its efficient use. The ultimate focus of all the programme's efforts is on *efficient and economical use of electricity*, despite – or precisely because of – the increasingly difficult environment of a liberalised market in which electricity is being sold using ever more sophisticated and aggressive marketing methods, and energy efficiency is not a high priority for either consumers or electricity companies.

A year ago the programme's activities focused on **four areas of priority**: *energy and information technology, electric drives and motors, distribution* and *high-temperature superconductivity*. In the year 1999 the main task was to proceed step by step with the implementation of the various measures within the scope of a revision of the overall concept, though it should be pointed out that, in view of the broad scope of the programme despite the above-mentioned focus on specific areas, a number of projects within the general field of *efficient use of electricity* needed to be positioned.

The **main objective for 1999** consisted in drawing up a harmonised concept for research activities and pilot & demonstration projects for the period from 2000 to 2003. The incorporation of four established trend-watching groups secured the necessary support from the electricity industry and universities.

In the priority area of **electricity distribution**, it was essential to draw up a suitable and carefully conceived concept with respect to research activities and pilot and demonstration projects despite the difficult environment of a market in the throes of liberalisation. Another task was to clarify whether the various universities were able to provide the necessary specialised know-how for implementing demanding projects in this field.

In the field of **high-temperature superconductivity in energy technology**, in addition to providing intensive support for projects already in progress the programme's main focus of attention was on acquiring fundamental background knowledge for determining the future direction to be taken, and on providing Swiss researchers with additional sources of information.

The main goals in the field of **energy and information technology** were the establishment of a recognised competence centre and the initiation of new projects.

Since the marketing of OPAL, a tool co-financed by the federal government, failed to progress as originally planned, it was decided to introduce more intensive efforts in the field of **drives/motors** in order to enhance the degree of awareness of this tool in Europe and to bring it into alignment with activities within the EU.

Tasks accomplished and results obtained

DISTRIBUTION

The ***declared goal*** in the field of *distribution* was to achieve or maintain the high level of network availability while securing the best possible quality and minimising transport losses. Priority here was given to the study of the technical impacts of the increased use of decentralised electricity production using renewable forms of energy, since this heightens the demands placed on the operational management of distribution networks. In addition, studies should be carried out to assess the technical impacts of the ongoing process of liberalisation of the electricity market in Switzerland.

The growing number of decentralised producers means that there is a greater likelihood of the undesirable formation of isolated networks. The goals of a project called **Reliability of safety switches to prevent the formation of isolated networks** [1] were to compile an overview and prepare an assessment of detection procedures used throughout the world. It also studied and compared the various measuring procedures on the basis of tests, simulations and findings published in various reports throughout the world. The results thus obtained demonstrated that, thanks to the limited number of decentralised production plants in Switzerland, the existing standards and regulations are adequate at this time. However, in the event of an increase in the number of decentralised producers it will be necessary to carry out a revision of the present-day regulations.

The project called **Development of system-oriented FACTS elements** (**FACTS** = ***F**lexible **AC T**ransmission **S**ystem)* focused on the construction of a 3 kVA trial plant for *transformerless reactive series compensation with a 2-point current converter* [2]. It also set out to speed up the implementation of a *circuit model* and at the same time it concerned itself with a broad range of viability considerations. The latter represent a major challenge. Making the use of FACTS components (more efficient control and utilisation of transmission networks) economically viable is a demanding and complex problem, precisely in an environment of on-

going market liberalisation. In addition, studies were conducted with respect to *practical concepts* for the optimal integration of FACTS elements into existing systems.

The goal of the **FlyWiP** (=***Fly****wheel Energy Storage for* ***Wi****nd* ***P****ower Generation*) project [3], which forms part of the European JOULE programme, encompassed the development of a flywheel energy storage system for stabilising networks for decentralised producers (e.g. using wind, photovoltaics) with an energy content of 15 kWh, a maximum capacity of 1 MW and a speed of 15,000 rpm. The main focus in 1999 was on developing and constructing system components so that it will be possible to assemble a complete system in 2000. The possibility of installing the pilot plant in Switzerland instead of in Holland is also currently under discussion.

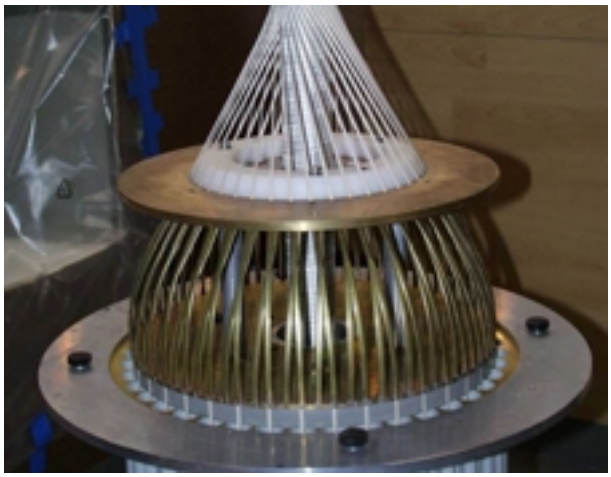
HIGH-TEMPERATURE SUPERCONDUCTIVITY

A study carried out under the heading of **High-temperature superconductivity in networks** [4] set out to identify the fundamental criteria for determining the benefits and obstacles for electricity generation, transmission and distribution that may arise as a result of the future use of high-temperature superconductivity. Here a great deal of attention was paid to the question of viability. The findings are to serve as the basis for the direction of future research and in particular for the definition of the concept for the period from 2000 to 2003.

In 1999, the project called **10 MVA high-temperature superconductivity transformers** [5] carried out numerous tests with respect to the resistive current limiting function. It also tested dielectric and mechanical models in order to determine the definitive transformer design, and drew up a new cryostat concept so that it would be possible to commence production of a high-temperature superconductivity transformer during 2000.

Production hall for high-temperature superconductivity transformer

One of the main activities in the **Developing a high-temperature superconductor cable for energy technology** project [6] involved the design, construction and testing of a prototype 5-metre single-phase superconductor cable. Earlier design studies had revealed that the ideal operating temperature for a hot dielectric conductor is close to 60 K, and this is why it was decided to use a new type of neon circuit for cooling. A special cable holder was developed at the same time, so that researchers also had a highly efficient testing device at their disposal.



Producing device for high-temperature superconductivity cables

The IEA programme, **Assessing the impacts of high temperature superconductivity on the electric power sector** [6], is about to finalise its report in the field of high-temperature superconductivity energy storage. In addition, within the scope of a study of the potential impacts on the CO2 effect, the team concluded that high-temperature superconductivity technology has the potential to reduce the CO2 level by between 3% and 4% over the long term. Finally, it is currently conducting preliminary studies with respect to the possibility of international co-operation in the field of hardware installation.

APPLICATION / EFFICIENT USE

a) Energy and information technology

The proportion of information technology to electricity consumption in Switzerland is currently around 10%, and indicates the highest growth rates among all electricity applications. In this segment, the main priorities concern the collection, processing and dissemination of data, the implementation of target values and labelling, and testing new technological solutions for efficient energy use.

As before, the *Energy and Information Technology support group* continues to function as a valuable information centre for researchers, the industry and users.

The focus of the tasks carried out by the **Energy and Information Technology Competence Centre** [7] is on the collection, processing and dissemination of relevant data in this field at both a national and an international level. In addition, a concise study conducted at

the Federal Institute of Technology in Zurich set out to analyse the power consumption of network components and found that the majority of communication centres are not air-conditioned and the room temperature is set at 26° as recommended in an earlier study.

The main aim of a project called **Networks in households** [7] is to study the impacts on electricity demand arising from the foreseeable networking of communications, household and building installations. It also aims to determine the possible measures for limiting an anticipated increase in consumption, and whether it is possible that *home automation* might even support efficient energy use.

As a result of the work carried out by the **Determination of the energy consumption of consumer electronics devices, office equipment and automatic dispensers in Switzerland** [8] project, up-to-date statistical material is now available on this topic

The aim of the project called **Study of the behaviour of end-users with respect to the switching on and off of PCs** is to examine the extent to which end-users turn off their PCs at the end of the day, and the degree to which the use of existing automatic devices for turning off PCs (e.g. Wake on LAN) leads to more efficient energy use. Unfortunately this project has been hampered by staffing problems, and its initiation has therefore had to be postponed. Attempts are currently being made to get this project off the ground again.

The **Refrigerated refreshment dispensers** project [9] set out to measure the electricity consumption and temperature levels of a cold drinks machine and a refrigerated foodstuffs dispenser.

Cold drinks machine

Here it was found that, contrary to expectation, the influence of the exposure of such machines to sunlight in Switzerland in a typical semi-shaded location is negligible, the proportion of electricity consumption for cooling is around 30% and the greatest potential lies in optimising the lighting of such machines.

b) Power and electric motors

Various assessments indicate that between 45% and 50% of electricity consumption in Switzerland is attributable to electric drives and motors, which means that there remains a great deal of efficiency potential in this area. A number of studies have confirmed this assessment, and have identified optimisation of the complete drive system as the main factor. This will therefore be the chief area of focus over the next few years, alongside activities in the field of cross-section technologies such as frequency converters, design tools, etc. Activities of a similar nature currently being carried out on an international scale – details of which were publicised on the occasion of an EU conference on this topic held in London [18] – underscore this priority.

With the completion of the *expansion of the OPAL program system with frequency converters*, the focus of attention in 1999 was switched to marketing activities. Unfortunately these have not been particularly successful to date, not least because the EU has meanwhile started distributing a similar tool free of charge. In view of this, intensive discussions were held with the EU and the German energy ministry in 1999 with the aim of seeking standardisation, but so far these have not led to the desired result.

From a point of view of energy consumption, drive systems (motors and regulating devices) cannot be directly compared with one another, but it would be possible for a testing centre to test these neutrally and in a uniform manner, thereby creating a greater degree of transparency on the market. A new project, **Market studies for a drive systems testing centre** [10], has been initiated for the purpose of clarifying which suppliers and users would be interested in the establishment of a suitable institution, and whether it would be possible for the latter to become financially independent at a later date.

Compressed air systems form a fundamental part of the infrastructure in trade and industry, and are responsible for between 1% and 20% of operational electricity consumption, depending on the sector concerned. A project called **Energy efficiency among compressed air systems in Switzerland** [10] will be seeking to draw up concrete sector-specific proposals for suitable measures for increasing the level of efficiency in the field of compressed air systems.

Following a lengthy interruption due to personnel problems, the ***Compresseur hydraulique-isothermique*** project [11] has now been completed. With the aid of a newly-defined compressor concept it is now possible to substantially increase the level of efficiency of compressed air generation based on measurements carried out on a practical model that has undergone a series of modifications. However, the question as to whether it will be possible to subsequently develop this system into a commercially marketable product still has to be clarified.

c) Miscellaneous

It is now possible to call up information concerning the European co-operation programme, *COST 244: Biomedical Impacts of Electromagnetic Fields*, on the Internet [20].

Furthermore, the *Medicine and Energy Forum*, which is supported by the Swiss Academy of Medical Sciences and the Swiss Academy of Technical Sciences, has compiled a report on the current status of knowledge in this field (e-mail address: fme@aget.ch).

National and international co-operation

The periodical meetings held by *trend-watching* and *support groups* contribute significantly towards the fact that co-ordination and co-operation between industry, universities and the Federal Office of Energy function smoothly and have since become institutionalised.

The electricity industry (which will ultimately be responsible for implementing the various research findings) and researchers from universities and scientific institutions, have been incorporated into almost all projects.

Special attention has also been paid to maintaining contacts with *other Swiss providers of funding in the field of electricity*, in particular PSEL (the *Electricity Industry Project and Study Fund*) and the *Commission recherche, développement, prospective de la Chambre romande d'énergie électrique* (RDP-CREE).

Participation in the *IEA high-temperature superconductivity programme* means that an exchange of information in this field continues to take place at an international level. Switzerland did participate in the international *Superconductivity Online Forum* last year – which functions as an international information centre Since the quality of content unfortunately failed to meet the expectations of Swiss users, an extension is now uncertain.

As in the past, a great deal of information has been exchanged at an international level in the field of e*nergy and information systems*, with the *Energy and Information Technology Competence Centre* making a considerable contribution. And as a member of the international *Group of Efficient Appliances*, which promotes efficient use of electricity in the fields of consumer electronics and office equipment, Switzerland has not only continued to make an active contribution, it also took over the chairmanship in 1999.

In the field of *electric drives and motors*, a great deal of time and effort was invested in drawing international attention to the Swiss design tool, OPAL, and seeking harmonisation with the EU, but these endeavours have unfortunately been unsuccessful to date.

Implementation of results, pilot and demonstration projects

TRANSMISSION / DISTRIBUTION HIGH-TEMPERATURE SUPERCONDUCTIVITY

The findings from a variety of Federal Office of Energy research projects were subsequently made available to a broad public in the form of articles and lectures.

Due to the ongoing liberalisation of the market, it is unfortunately very difficult at this time to implement project findings in collaboration with the relevant industry. This is also the reason why it has not been possible to continue the implementation of the **Electronic distribution transformers** project.

APPLICATION / EFFICIENT USE

a) Energy and information technology

The meetings of the *Energy management in networked systems* support group, which are held twice a year, always provide an opportunity for gathering valuable input for further activities as well as exchanging useful information.

The programme management prepared an article on *energy and information technology* in the middle of the year and published it in a variety of journals.

One of the programme's aims was to run a series of trials with a new *energy-efficient cash dispensing machine* in collaboration with an existing operator within the scope of a pilot and demonstration project, but this has not been possible to date since the manufacturer concerned originally belonged to a group of companies and was subsequently sold off. At this time it remains uncertain whether it will be possible to implement this project.

The purpose of a project called **AC managers: pilot and development project in the federal administration** [9] is to develop a control mechanism for the automatic switching of servers. A trial version is currently in use at in the Swiss Federal Office of Energy. It reduces the electricity consumption of servers by more

than 50%, and increases the stability of the system thanks to the fact that they are shut down each day. With this device it is also possible to perform a remote hardware *boot of the server*.

The **Switching of servers** project [9] pursues a similar objective, though unlike the AC managers referred to above, in terms of software the solution is based strictly on NT servers and is only intended for use with smaller networks. The resulting solution has been operating successfully in its installed environment, but bringing it onto the market is not a priority at this time, although it is planned to look into this possibility at a later date. Instead, the project is intended to serve the purpose of encouraging the industry to give consideration to this option and eventually integrate it into servers.

As a secondary finding from the above-mentioned project it was measured that the *offline USV system* indicated a standby consumption of 25 watts, which is much too high, so it was decided to deal with this aspect in a separate project in the near future.

b) Power / electric motors

The pilot and demonstration project called **Compressed air optimisation in the packaging industry** [12] has demonstrated that it is possible to save up to 30% electricity consumption through the professional renovation of existing compressed air systems. This finding was made following the renovation of an existing system by dividing it into a high-pressure and a low-pressure network, using an application-based control mechanism, efficiently sealing the networks and increasing the capacity of the compressors.

The pilot and demonstration project called **Field tests with a small-scale energy-efficient circulation pump** [13], which has now been completed, performed comprehensive tests in twenty apartments throughout Switzerland which resulted in the definition of technical prerequisites for further development towards series production. It is now up to the industry concerned to develop these pumps, which are up to three times more efficient than conventional ones, and to initiate their series production and bring them onto the market.

c) Miscellaneous

A statistical evaluation has shown that a great deal of use has been made of the Internet home page on the topic of electricity research [21] since it was first launched more than a year ago. This site provides a broad range of information about the electricity programme, including all annual reports. Updated material concerning the *energy label* is also available on the Internet [21].

The federal government initiated a variety of internal projects over the past few years in the fields of energy efficiency and ecology, including one called **Incorporation of the UKES project into an access database**, which set out to compile uniform checklists for all projects for the purpose of verifying the various implemented measures.

The findings of two related projects - **Preparation of a measurement procedure for airflow dryers** [13] and **Testing airflow dryers** [13] - were used as the basis for drawing up an energy declaration for airflow clothes dryers (with heat pumps). This step was necessary since, although the specific energy consumption of these devices is lower than that of conventional dryers, there was no standard in existence for making direct comparisons.

The **Heat-pump tumblers for commercial applications** project [14] was able to successfully demonstrate that it is possible to dry clothes with only half the energy consumption required by tumblers without a heat pump, *within the same period of time*.

Testing facility for heat-pump tumblers

As a result of the measurements carried out by the two closely related projects, **Energy efficiency in railway carriages** [15] and **Measurements on railway carriages in a climatic chamber in Olten** [16], it proved possible to demonstrate the effectiveness of the proposed efficiency measures. Swiss Federal Railways now plans to implement these measures in all railway carriages of the type used in the project.

Due to difficulties with the industrial partner concerned, it was not possible to successfully implement the **Ecological refrigerators** project, and as a result it has now been definitively abandoned.

Unfortunately it was not possible to implement the planned activities in the **Field testing of high-performance cooking systems** project [17] in 1999. It also proved necessary to seek another manufacturer of pans, since the one originally chosen was unable to supply the required products by the specified deadline. The completion of the definitive design and subsequent field test is now planned for 2000.

Summary for 1999 and outlook for 2000

The goal of *revising the concepts for the four main priorities* has been achieved, with the inclusion of the corresponding trend-watching and support groups. These concepts will now serve as the basis for drawing up the *overall electricity concept* during 2000.

The *high-temperature superconductivity* study also provides an excellent basis for defining the future direction to be taken in this field, and should serve a similar purpose as far as PSEL as co-financing institution is concerned.

The field of *transmission/distribution* is now heavily influenced by the ongoing liberalisation of the market, and this effectively makes things rather more difficult for the programme, since the electricity industry no longer regards tasks in the areas of research and pilot & demonstration projects as urgent, and is therefore also less likely to offer its support.

Efforts are also being intensified here, as well as in other segments, to integrate established universities and colleges of technology into research and pilot & demonstration projects.

An *energy and information technology competence centre* was established as planned in 1999, and it is now hoped that this development will provide the foundation for a long-term institutionalisation process.

Efforts aimed at marketing the Swiss tool, OPAL, in Europe failed to progress as hoped, and the EU's own efforts in turn have not yielded the desired results to date. It is to be hoped that renewed efforts in 2000 will prove more fruitful.

List of projects

[1] M. Real, R. Schmid, L. Tanner, ALPHA REAL, *Zürich*: ***Zuverlässigkeit von Sicherheitsschaltungen gegen Inselbildung*** (SB) / **Reliability of safety switches to prevent the formation of isolated networks**

[2] Ch. Schäfer, ABB HOCHSPANNUNGSTECHNIK, *Zürich*: ***Entwicklung neuer systemorientierter FACTS-Elemente*** (JB) / **Development of system-oriented FACTS elements**

[3] P. von Burg, ASPES, *Zürich*: ***Flywheel energy storage for wind power generation FlyWip*** (JB) http://www.flywip.com

[4] G. Schnyder, ABB SÉCHERON, *Genf*: ***Systemstudie "Hochtemperatur-Supraleitung im Netz"*** (SB) / **Study of high-temperature systems in networks**

[5] H. Züger, ABB SÉCHERON, *Genf*: ***10 MVA-HTSL-Transformator*** (JB) / **10 MVA high-temperature superconductivity transformers**

[6] G. Véscey, EPF-*Lausanne*: ***Entwicklung eines HTS-Kabels für die Energietechnik*** (SB) / **Development of a high-temperature superconductor cable for energy technology** • **Assessing the impacts of high temperature superconductivity on the electric power sector** (JB)

[7] B. Aebischer, ETH-*Zürich*: ***Betreuung des Kompetenzzentrums Energie- und Informationstechnik*** (JB) • ***Vernetzung im Haushalt*** (JB) http://www.cepe.ethz.ch / **Energy and Information Technology Competence Centre / Networks in households**

[8] B. Schaltegger, MEYER & SCHALTEGGER AG, St. Gallen: ***Bestimmung des Energieverbrauchs von Unterhaltungselektronikgeräten, Bürogeräten und Automaten in der Schweiz*** (SB) / **Determination of the energy consumption of consumer electronics devices, office equipment and automatic dispensers in Switzerland**

[9] A. Huser ENCONTROL, *Niederrohrdorf*: ***Gekühlte Verpflegungsautomaten*** (SB) / **Refrigerated refreshment dispensers** • ***AC Manager: P&D-Projekt in der Bundesverwaltung*** / **AC managers: pilot and demonstration project in the federal administration** (JB) • ***Schalten von Servern*** (SB) / **Switching of servers**

[10] R. Gloor, GLOOR ENGINEERING, Sufers: ***Marktuntersuchung für ein Prüfinstitut Antriebssysteme*** (JB) / **Market studies for a drive systems testing centre** • ***Energieeinsparungen bei Druckluftanlagen in der Schweiz*** (JB) / **Energy efficiency in compressed-air systems in Switzerland**

[11] L. Simon, Genf: ***Compresseur hydraulique-isothermique*** (SB)

[12] K. Frei, A-Z PLANUNG, *Diepoldsau:* ***Druckluftoptimierung in der Verpackungsindustrie*** (SB) / **Com-**

pressed air optimisation in the packaging industry

[13] J. Nipkow, ARENA, *Zürich*: ***Felderprobung einer Stromspar-Kleinumwälzpumpe*** (SB) / **Field tests with a small-scale energy-efficient circulation pump** ◆ ***Prüfung von Raumluft-Wäschetrocknern*** (SB) / **Testing airflow dryers** ◆ ***Ausarbeitung eines Messverfahrens für Raumluft-Wäschetrockner*** (SB) / **Preparation of a measurement procedure for airflow dryers**

[14] E. Schwarzwald, THERMODUL CONSULTING, Curio: ***Wärmepumpen-Tumbler für gewerbliche Anwendungen*** (SB) / **Heat-pump tumblers for commercial applications**

[15] C.U. BRUNNER, *Zürich*: ***Enper: Energiesparen bei Reisezugwagen*** (JB) / **Enper: energy efficiency in railway carriages**

[16] F. Thomi, SBB, Bern***: Messungen an Reisezugwagen in der Klimakammer Olten*** (JB) / **Measurements on railway carriages in a climatic chamber in Olten**

[17] M. Erb, ECOWATT, *Basel*: ***Feldtest von Hochleistungskochsystemen*** (JB) / **Field test with high-performance cooking systems**

(JB) = 1999 annual report available
(SB) = Final report available
All reports may be called up from the following address: http://www.electricity-research.ch.

References

[18] R. BRÜNIGER, *Ottenbach*: ***Report*** on the ***2nd International Conference of Energy Efficiency in Motor Driven Systems,*** held by the EU in September 1999

[19] http://www.psel.ch

[20] http://www.radio.fer.hr/cost244/

[21] http://www.electricity-research.ch / http://www.energielabel.ch