Excerpt from "ENERGY RESEARCH 1998". Editors: L. Dubal & C. Voirol
Swiss Federal Office of Energy http://www.admin.ch/bfe/

ELECTRICITY

Report on the 1998 research programme

Roland Brüniger
roland.brueniger@r-brueniger-ag.ch

New energy-saving cooker

According to a study by the EMPA (a Swiss Testing Institution), an additional saving of 15% is possible with the new generation of high-tech ceramic hotplates for cookers in comparison with the already energy-efficient induction hotplates.

Priorities and objectives of the 1998 research programme

With its various activities, the **Electricity** research programme contributes towards optimised handling of electrical energy, from its generation through to its distribution and efficient use.

The programme's **main objective in 1998** was the successive orientation of activities on four defined priorities, with all strategies focusing on the ultimate goal of *efficient and economical use of electricity*. In order to incorporate the industry and universities into this process in the best possible manner, one of the programme's goals was to establish professional trend-watching and support groups in all areas of priority in which these were not already present. A stronger emphasis was placed throughout on implementation and the distribution of information.

In addition to reinforcing the activities of support groups that have already been established, the focus in the field of **energy and information technology** was on the creation of a recognised competence centre and the initiation of promising new projects.

As before, projects in the field of **drives and motors** were supported with the aim of achieving a higher degree of energy efficiency.

With respect to **transmission and distribution**, the focus was on the organisation of a specialised seminar on the implementation and distribution of the results achieved to date, alongside the continuation of current activities.

In the field of **high-temperature super-conductivity for energy technology**, an information distribution centre was successfully set up last year to function as a kind of support group. Consequently the focus here was on intensifying efforts to find potential co-sponsors who would be prepared to fund the initiation of new and promising projects.

Tasks carried out and achieved results

GENERATION / PRODUCTION

The *generation / production* segment does not represent a priority in the present programme, and the private sector is providing significant funding for the various activities here. For this reason, the Federal Office of Energy did not support any corresponding projects.

The projects supported by the Federal Government in the field of **small-scale hydropower plants** are described in a separate programme.

The Project and Study Fund of the Electricity Industry supports tasks in the field of hydropower with contributions totalling around CHF 1 Million a year. Topics such as *energy losses at grates in hydropower plants situated on rivers, flow properties in the suction pipes of high-speed turbines*, etc., were dealt with primarily at universities.

STORAGE

In view of the greater extent of decentralised generation of electricity from renewable forms of energy (wind, biogas and photovoltaics) and fuel cells, the demand for storage capacities is likely to increase. The VDI conference on "energy storage units for electric networks", which was held in November 1998, provided a good overview of the potential areas of application of energy storage devices as well as the various storage technologies [18].

The "Electricity" programme is limited to mechanical and electromagnetic/electrostatic storage technologies.

The **FlyWip** (*Flywheel Energy Storage for Wind Power Generation*) project [1] supported by the Federal Government and carried out within the scope of the European JOULE programme deals with network regulation functions for decentral generators (wind) via a flywheel storage device with an energy load of 15 kWh and a maximum capacity of 1 MW. This project was launched in 1998, and to begin with it set out to compare the potentials of flywheel storage devices against competing technologies, within the scope of a market study. Next year it will be focusing on the development and manufacture of the various system components.

Until now, it has not been possible to identify any interest in the topic of *Electrical Energy Storage Technology for Utility Network Optimisation* in the IEA's *Energy Conservation through Energy Storage* programme, despite various enquiries. For this reason, Switzerland has decided not to participate in this programme for the time being.

TRANSMISSION / DISTRIBUTION

In the field of *high-temperature super-conductivity*, developments are making steady progress in the various segments. Since certain components of this technology (e.g. transformers, current limiters, cables) will be used in the electricity network, it is wished to draw attention here to the specific section concerning high-temperature superconductivity.

The **development of system-oriented FACTS (*F**lexible **AC** T**ransmission** S**ystems***) elements and their integration into network operation is the main objective of the project bearing the same name [2]. FACTS components can be used for controlling and optimized utilising existing transmission capacities. This primarily concerns *Universal Load-Flow Regulators* and *Advanced Series Compensation*, which can be integrated into the network without a transformer. A great deal of progress has already been made with simulation tasks, and the next step is to focus on optimisation of component concepts, operating procedures during interrupted and uninterrupted network operation and viability considerations.

With the completion of the **Electronic distribution transformers** feasibility study it was established that the development of this type of transformer with an efficiency of between 98.5% and 99% is in fact possible. Further-reaching studies of the possibilities of implementation of this type of transformer (from both a technological and an economic point of view) are planned for 1999.

The aim of the **Reliability of safety switches to prevent island effects** [3] project is to study the extent to which the mutual influence of detection switches is problematic, with the aid of both practical tests and theoretical simulations. At the same time it is drawing up proposals with respect to detection and safety switches. In 1998, various studies were carried out on selected networks, and with respect to modelling, a suitable simulation program was carefully evaluated.

APPLICATION / EFFICIENT USE

a) Electric motors

The objective for this priority was the establishment of a *trend-watching/support group*. The fact that high-level representatives from universities and the industrial sector were willing to participate here, and it was possible to officially launch the support group on the occasion of a *kick-off* meeting in the summer, was very pleasing. Thanks to the existence of this group it will be possible to intensify direct contact with the relevant industries and interested research organisations.

Preparations for a follow-up project in the field of *integral drive technology for lifts* were delayed for a variety of reasons, but the various obstacles have now been sufficiently overcome to allow the launch of this project at the beginning of 1999.

Significant savings in energy consumption and operating costs are possible with electric drive systems through the use of motors that have been adapted so that they ideally meet the requirements of the work process concerned, and frequency converters with a high degree of efficiency. With the **expansion of the OPAL programming system with frequency converters** [4], project staff in the field of drives now find themselves in a position in which they are able to choose from more than 1,800 types of motor for variable-speed drives that are optimal in terms of energy consumption and are made by a variety of manufacturers. The project was completed in the middle of the year, and efforts were then initiated to market the various products in Europe.

The electricity consumption of small ventilators in Switzerland represents 1% of the national total. Small ventilators (capacity less than 1,000 m^3/h) are always used as compact systems with an integrated motor for a variety of applications. It would be possible to greatly increase their efficiency, which is normally less than 10%. In the now completed preliminary study, **Principles for research and development priorities for small ventilators with a high degree of efficiency** [5], priorities have been identified in connection with additional tasks aimed at increasing the efficiency of these devices. From this study it evolved that the defined measures always concerned the buildings themselves, so the results of the preliminary study will now be processed in the "Efficient Energy Use in Buildings" programme.

The ***Compresseur hydraulique-isothermique*** project, which has been researching a new type of compressor, is now close to completion.

b) Energy and information technology

The *Energy and Information Technology support group*, which has been in existence for around two years now, provides valuable impulses and plays the role of an efficient information centre for researchers, the industry and users. It holds meetings every six months, thereby ensuring that it is able to keep pace with rapidly changing technologies.

The goal of the **Office for the promotion of efficient energy use in the fields of information technology and consumer electronics** [6] is to gather and process know-how, and then distribute it as widely as possible. Due to the fact that this office is now focusing on energy in data processing networks, it will probably be renamed *Energy and information technology competence centre*.

The purpose of the **Determination of energy consumption in the field of consumer electronics, office equipment and automatic machines in Switzerland** project is to update a variety of statistics.

Within the scope of the **Energy consumption and energy-savings potentials of automatic machines** [6] project, the first task was to examine and analyse existing international literature. Studies carried out in

the field of refrigerated refreshment dispensers showed that cold-drinks machines were by far the biggest consumers of energy among the various machines studied. The preparation of an overview of the electricity consumption of automatic machines in Switzerland showed that their proportion of the consumption of a given services building is between 1% and 4%. Finally, alternative activities for further research work were derived from this survey, and these are to be successively introduced within the scope of available funds.

The **Principles for research activities in the field of telephone systems (PABX)** [7] project gathered detailed data concerning the electricity consumption of telephone switchboards in Switzerland. Since this study showed that the total electricity consumption is only 80 GWh p.a., and many systems are ideally equipped from a point of view of energy consumption, it was decided that there was no call for any specific follow-up projects.

The development of *power-line carrier technology* [19] is of course being closely monitored, since it is expected to give rise to a significant increase in the distribution of communication end-devices, but given the existing competitive situation with respect to product development, it is only possible to introduce the topic of energy efficiency to the industry to a limited extent.

c) Miscellaneous

In the **Energy efficiency in buildings** project [8], proposals were drawn up aimed at minimising electricity consumption in construction-site containers. The annual savings potential here is estimated at around 20 GWh.

INTERDISCIPLINARY PROJECTS

a) High-capacity electronics

The two projects, **Comparison of component concepts for MOS-controlled high-voltage, high-capacity semiconductor switches with trench IGBT** [12] and **Analysis and optimisation of IGBT module packages** [12], concerned themselves with the energetical optimisation of high-capacity elements and were initiated as implementation projects for the results of LESIT. Studies showed that MOS-controlled thyristor structures do not need to be developed for high-voltage applications, and, like frequency converters, can be manufactured to be more compact, as well as lighter and more reliable. In addition, the static, dynamic and thermal behaviour of IGBT modules was studied, and it was found that heat is conducted statically and transiently in semiconductor modules.

With the involvement of the industry, universities and users, a basis was formed in the **Identification of parameters and testing procedures for uninterruptible power supply systems** project [13] for planners and operators of these systems to compare various models according to uniform criteria (quality/energy matrix). In addition, it is possible to inform manufacturers and planners about *energy-saving potentials in bypass mode* while taking the necessary quality demands into account, as well as to sensitise them to the benefits of its increased use.

b) Superconductors

The **10 MVA high-temperature superconductor transformer** project [9] is based on results of the earlier project which studied the 630 kVA high-temperature superconductor transformer, with the addition of a resistive current limiter. In 1998, the project focused on insulation, conductor specifications, the general design of the transformer and cryostatic temperature regulators.

The decision concerning design was taken in the **Development of a high-temperature superconductivity cable for use in the energy sector** project [10], taking account of the HTS material. Principles concerning cooling, safety and viability were also drawn up, so that it was possible to both finalise a trial cable as well as commence work on producing a prototype.

The IEA programme, ***Assessing the Impacts of High Temperature Superconductivity on the Electric Power Sector*** [10], was extended for a further period of two years. Once again a variety of HTS reports were prepared and placed at the disposal of interested specialists.

The aim of the **Systematic study on high-temperature superconductivity in networks** [11] is to form a basis for answering questions which will result in benefits in connection with the generation, transmission and distribution of electricity through the use of high-temperature superconductivity in the various components and their application. The intention here is to develop a platform for future research and development activities.

c) Low-frequency electromagnetic fields

The European co-operation programme, *COST 244: biomedical impacts of electromagnetic fields*, is to be prolonged until 2001. At the beginning of 1998, a survey was conducted in Switzerland concerning all projects associated with this topic, and the results plus other information can be called up on the Internet [21].

A *decree on protection against non-ionising radiation* is currently in the debate stage in Switzerland.

National and international co-operation

Thanks to the creation of the cited support groups it was possible to intensify and institutionalise co-operation between the industry, universities and the Federal Office of Energy in all areas of priority.

Furthermore, the industry - which after all will be implementing the various results of research activities - and researchers, universities and technical colleges, have now been brought into practically all current projects.

On top of this, close collaboration between Swiss providers of financial support (PSEL, Federal Office of Energy and *Commission recherche, développement, prospective de la Chambre romande d'énergie électrique (RDP-CREE*) has been achieved, particularly in the cost-intensive field of research into high-temperature superconductivity.

And the prolongation of the IEA's *high-temperature superconductivity* programme means that here, too, an international exchange of information will continue to take place in this segment. Switzerland will also be participating in the expansion of the existing international *Superconductivity* online forum.

As before, a large-scale exchange of information in the field of *energy and information systems* will continue to take place at an international level. The federal government is an active member of the *Group of Efficient Appliances*, which promotes efficient use of energy in the fields of consumer electronics and office equipment. And the goal of international harmonisation in the field of *labelling* is still being actively pursued.

Practical implementation, pilot and demonstration projects

TRANSMISSION / DISTRIBUTION

Together with the Swiss Federal Institute of Technology, Zurich and representatives of the industry concerned, in October 1998 the Federal Office of Energy organised a workshop called **Technology trends in electricity distribution**, which was based on the results obtained from research in the fields of transmission and distribution [19], and more than 100 participants attended this event.

For a variety of reasons, the implementation of the results of the **Load determination model for distributor transformers** project did not proceed as planned, despite the fact that a specialised company had been entrusted with this task. But now that the results of the project have been presented again at a special Federal Office of Energy conference and the company concerned has again been entrusted with the task of processing the market, there are good reasons for hoping that these results will begin to be put into practical application.

ELECTRIC MOTORS

The aim of a pilot and demonstration project called **Compressed air optimisation in the packaging industry** [14] is to demonstrate that considerable energy savings can be achieved through the improvement of compressed air systems by dividing them into high and low pressure networks, introducing the use of regulating devices where necessary and sealing networks more efficiently. The use of a load-dependent regulator during the pilot stage in 1998 led to savings of around 18%.

In the pilot and demonstration project called **Field trials with small energy-efficient circulation pumps** [5], 20 of these devices were installed in different types of heating systems in buildings in Switzerland ranging from single-family homes to medium-sized apartment blocks. The measurement modules attached to these trial pumps yielded extremely valuable findings, most of which appear to be very positive so far. It is now likely that this trial will be completed in spring 1999 after the 1998/99 heating period is over.

Thanks to the results obtained from the meanwhile completed **Integral drive** project, the Swiss company concerned has been able to find international companies that are prepared to invest in this technology. This means that a substantial contribution towards an increase in efficiency in the field of integral drives has been achieved.

Vacuum pump with integral drive technology

A number of follow-up projects have also been carried out in the EU zone (e.g. wind generators) using the same technology.

OFFICE EQUIPMENT / DATA PROCESSING NETWORKS

In spring 1998 a *list* of all publications released to date on the topic of *energy and information systems* was drawn up and sent out in a mass mailing to all potentially interested parties. The feedback was very positive, and it was possible to subsequently distribute information material to specific target groups.

Each of the meetings of the *Energy management in networked systems* support group held every six months resulted in valuable input for additional tasks, and provided an opportunity for the exchange of information.

A small-scale study has been initiated in order to discover how servers behave when a network is interrupted for a maximum of 20 ms. The aim here is to find out whether the more energy-efficient *offline* uninterruptible power supply systems are capable of securing servers. At the same time, work is currently in progress aimed at labelling loading stations and plug-in network components.

Within the scope of a recently launched pilot and demonstration project, operational tests are being carried out on a new *energy-efficient cash dispensing machine* in collaboration with an operator and representatives from the industry.

In two parallel pilot and demonstration projects, a new and user-friendly ***network manager for switching servers and network components*** is currently undergoing operational tests. These are based on a professional industrial program and the functions of an uninterruptible power supply system.

The findings obtained from the **Principles for research activities in the field of telephone systems (PABX)** [7] project have been released in a number of publications and placed at the disposal of the industry concerned.

MISCELLANEOUS

A comprehensive survey carried out at the beginning of 1998 among a variety of journals and other publications set out to identify the extent of their interest in research results in a variety of fields. As a result, the project manager now possesses a list of all interested publications.

In order to adequately respond to the demand for information, an Internet *homepage* [22] has been set up on the topic of electricity research. The goal here is to make all information available to all interested parties, including annual reports.

Ventilation clothes dryers (with heat pumps) indicate a favourable specific energy consumption in comparison with tumblers. Since the IEC's testing standard for clothes dryers only applies to tumblers, two pilot and demonstration projects were initiated (***Definition of a measurement procedure for ventilation clothes dryers*** [16] and ***Testing of ventilation clothes dryers*** [16]) in order to define measurement procedures and conduct various series of tests. As a result of the tasks carried out by these two projects, a *label* has now been produced which is based on the EU declaration for various household appliances and is now being used by the industry concerned.

Measurement equipment for ventilation hot-air dryers

The measures aimed at achieving **energy savings in passenger trains** [15] have been implemented by Swiss Federal Railways using a Bpm 20-70 carriage. By taking measurements in a climatic chamber it is hoped to provide evidence of the fact that it will be possible to reduce energy consumption by more than half by applying the proposed measures. Due to delays with respect to refitting requirements, this study will only be completed in 1999.

In the **ecological refrigerators** project it was unfortunately not possible to produce the 10 intended prototypes. The situation will be reviewed in the middle of 1999, at which time a decision will be taken as to whether this project is to be continued.

Based on the results of the *parameter identification and measurement procedures for uninterruptible power supply systems* project, the aim now is to produce a quality/energy label for these systems and prepare various tools that will serve as a planning basis with respect to dimensioning and choice of operating mode.

Following the invention of a new type of cooker, it is possible to exceed the high level of efficiency of induction cookers by a further 15%. After a lengthy and difficult preparatory stage, it has now been possible to construct a functional prototype in the **Field trials of a high-performance cooker** project [17]. Unfortunately there were delays with the production of the special utensils for this new system, which means

that tests had to be postponed until next year.

Finally, results and new findings arising from the *technology mediation centres in the energy sector* projects were passed on from time to time.

Evaluation of 1998 and outlook for 1999

The goal of establishing professional *trend-watching and support groups* in all defined areas of priority was achieved in full, and the next important step here will be to consolidate these groups in 1999.

The organisation of a conference on the topics of *transmission and distribution* led to the hoped-for transfer of know-how.

The initiation of new projects in the field of high-temperature superconductivity made it possible to bring together potential providers of funds and use the resulting resources for specific, promising projects.

For a variety of reasons, the planned initiation of new projects in the field of *efficient energy use* was delayed.

It was also not possible to create the desired competence centre in the field of *energy and information technology*, but preliminary discussions indicate that one can be optimistic for 1999.

The creation of an *own homepage* was a major step towards achieving the goal of increasing the distribution of information.

The focus of tasks in 1999 will be on revising the concept for the period from 2000 to 2003. Here it will also be important to bear in mind that the funds available for research purposes will unfortunately have to be used more sparingly.

List of projects

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

[2] D. Westermann, ABB HOCHSPANNUNGSTECHNIK, *Zurich*: ***Entwicklung neuer systemorientierter FACTS-Elemente*** (JB) / Development of new system-oriented FACTS elements

[3] M. Real, ALPHA REAL, *Zurich*: ***Zuverlässigkeit von Sicherheitsschaltungen gegen Inselbildung*** (JB) / Reliability of safety switches to prevent island effects

[4] R. Tanner, SEMAFOR, *Basle*: ***Erweiterung des Programmsystems OPAL mit Frequenzumrichtern*** (SB) / Extension of the OPAL programming system with frequency converters

[5] J. Nipkow, ARENA, *Zurich*: ***Grundlagen für Forschungs- und Entwicklungsschwerpunkte für Kleinventilatoren mit hohem Wirkungsgrad*** (SB) ⬩ ***Felderprobung einer Stromspar-Kleinumwälzpumpe*** (JB) / Principles for research and development for small ventilators with a high degree of efficiency / Field trials with small energy-efficient circulation pumps

[6] B. Aebischer, Federal Institute of Technology, *Zurich*: ***Förderung des rationellen Energieeinsatzes in der Informationsstechnik und Unterhaltungselektronik*** (JB) ⬩ ***Energieverbrauch und Energiesparmöglichkeiten von Automaten*** (SB)
http//:www.energieanalysen.ethz.ch / Promotion of efficient energy use in the fields of information technology and consumer electronics / Energy consumption and savings potentials of automatic machines

[7] A. Huser ENCONTROL, *Niederrohrdorf*: ***Grundlagen für Forschungsaktivitäten im Bereich TVA/PABX*** (SB) / Principles for research activities in the field of telephone switchboards/PABX

[8] M. Grueber, OECONSULT, *Zurich*: ***Energiesparen im Hochbau*** (SB) / Energy efficiency in buildings

[9] H. Züger, ABB SÉCHERON, *Geneva*: ***10 MVA HTSL transformers*** (JB)

[10] G. Véscey, Federal Institute of Technology, *Lausanne*: ***Entwicklung eines HTS-Kabels für die Energietechnik*** (JB) ⬩ ***Assessing the Impacts of High Temperature Superconductivity on the Electric Power Sector*** (JB) / Development of an HTS cable for the energy sector

[11] H. Züger, ABB SÉCHERON, *Geneva*: ***Systemstudie "Hochtemperatur-Supraleitung im Netz"*** (JB) / Systematic study, “High-temperature superconductivity in networks”

[12] W. Fichtner, ETH-*Zurich*: ***Analyse und Optimierung von IGBT Modul Packages*** (SB) ⬩ ***Vergleich von Bauelementkonzepten für MOS-kontrollierte Hochspannungs-Leistungshalbleiterschalter mit dem Trench-IGBT*** (SB) / Analysis and optimisation of IGBT module packages / Comparison of component concepts for MOS-controlled high-voltage high-performance semiconductor switches with trench IGBT

[13] P. Mauchle, SCHNYDER INGENIEURE, *Ottenbach*: ***Parameteridentifikation und Messverfahren für USV-Anlagen*** (JB) / Parameter identification and measurement procedures for uninterruptible power supply systems

[14] K. Frei, A-Z PLANUNG, *Diepoldsau:* ***Druckluftoptimierung in der Verpackungsindustrie*** (JB) / Compressed air optimisation in the packaging industry

[15] C.U. BRUNNER, *Zurich*: ***Enper: Energiesparen bei Reisezugwagen*** (JB) / Energy efficiency in passenger trains

[16] J. Nipkow, ARENA, *Zurich*: ***Prüfung von Raumluft-Wäschetrocknern*** (JB) ⬩ ***Ausarbeitung eines Messverfahrens für Raumluft-Wäschetrockner*** (JB) / Testing ventilation clothes dryers / Preparation of a measurement procedure for ventilation clothes dryers

[17] M. Erb, ECOWATT, *Basle*: ***Feldtest von Hochleistungskochsystemen*** (JB) / Field trials on a high-performance cooker

(JB) = annual report available

(SB) = final report available

All reports may be called up from http//www.electricity-research.ch

References

[18] R. BRÜNIGER, *Ottenbach*: ***Reisebericht*** über die VDI-Fachtagung ***Energiespeicher für elektrische Netze***, November 1998 / Report of visit to VDI conference on energy storage for electricity networks, November 1998

[19] R. BRÜNIGER, *Ottenbach*: ***Technologietrends bei der elektrischen Verteilung (Tagungsunterlagen zur gleichnamigen BFE-Fachtagung)*** / Technological trends in the field of electricity distribution (documentation from a conference organised by the Federal Office of Energy

[20] VSE, *Zurich*: **Tätigkeitsbericht 1997 des PSEL** / 1997 report on the activities of PSEL

[21] http://www.radio.fer.hr/cost244/main/npdbase/switz/switz.htm

[22] http://www.electricity-research.ch