Research Programme *Electricity*

Annual Report 2001

Research Programme „Electricity“
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worked out by
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ELECTRICITY

Report on the 2001 research programme

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Low-voltage motors at Lonza AG in Visp

Lonza consumes approximately 1% of all the electricity used in Switzerland. More than 90% of this is needed to operate motors. Studies have shown that a savings potential is present amounting to 45–50 GWh/year, which is equivalent to the power consumed annually by all the households in the city of Neuchâtel.

Programme priorities and objectives for 2001

Electricity represents about 20% of the total energy consumed in Switzerland and is also important in the efficient utilisation of other energy sources. The Electricity Programme strives to optimise our entire approach to electricity, from the point in time it is generated to its actual consumption, with the focus being on promoting efficient and economical use of electricity.

The Electricity Programme has **four priority areas:** *energy and information technology, electric drives and motors, electricity distribution* and *high-temperature superconductivity* [17].

In the area of **electricity distribution,** the goal for 2001 was to initiate viable projects in collaboration with the electricity industry and specialised institutes of technology, although the imminent market liberalisation will make this a particularly challenging task. The matter of primary concern here is understanding the various technical effects on the distribution network of a growing number of decentralised power generation facilities. We want to be able to establish the technical conditions that are necessary for the network to cope with a substantial increase in decentralised power generation. Another objective here was to implement findings from past and current research projects in an institutionalised manner together with the electricity industry.

The focus in the area of **high-temperature superconductors (HTSC) in energy technology** is on assuring information dissemination within Switzerland via national and international activities, and conducting appropriately scaled system-oriented studies. The goal in 2001 was to commence a joint project with the industry in Switzerland concerning the use of HTSC components in the electricity network.

Owing to the rapid progress and widespread use of **information and communications technology**, this area is of particular significance. The international marketing orientation of the industry makes it imperative to maintain close contact and engage in an active exchange of information with international bodies. By strengthening our network of international contacts and identifying concrete ways of improving efficiency, we endeavoured to effect a reduction in the electricity consumption of both current and future devices in "on" mode as well as in "standby". This represents a concrete step towards the realisation of the objectives defined as part of SwissEnergy.

In the area of **drives and motors** we also want to make a notable contribution towards the goals of SwissEnergy. Electric drive systems account for a share of nearly 45% of overall electricity consumption. Here the greatest savings potential may be achieved by optimising drive systems. Therefore, the goal defined for 2001 in this area was to initiate various pilot and research projects in a number of different industrial segments, in which not only the motor but also the entire drive system is examined for energy-saving potential which can then be implemented. Further research projects are to examine innovative drive systems offering better efficiency. The results of international research and declaration activities are also to be taken into consideration in Switzerland's own activities.

Tasks accomplished and results obtained

DISTRIBUTION

In the electricity sector, the issue of market liberalisation and the upcoming vote on the new electricity market law are still topics of major concern. The outcome of the vote is very uncertain, for which reason the industry is taking a wait-and-see attitude at the moment, which has the undesirable side effect that interest in long-term-oriented research projects is sparse.

One consequence of this is that the PSEL (Project and Study Fund of the Electricity Industry) has not yet been able to complete its reorganisation and reorientation process. Hopefully the PSEL will be able to continue its activities in future.

In the study on ***methods of cross-border transmission tariffication in the electricity market*** [1], which was jointly financed by the Swiss Federal Office of Energy and the European Commission for the Regulation of Electricity and Gas (CREG), different approaches were examined for establishing a non-discriminatory, user-pays tariffication based on physical energy flows. Simulations were carried out using a set of measurements from the European network for verification and to illustrate the effects of various parameters. The method which has been developed illustrates the various possibilities for applying an energy-flow-based concept of tariffication. It can be adjusted to fit the needs of regulators, network operators and network suppliers, and used accordingly.

The goals of the research project examining the ***increase in decentralised energy generation facilities in distribution networks*** [2] are to identify the special factors associated with the operation and development of distribution networks in a setting where decentralised energy generation is on the rise, and to determine the conceptual measures that are necessary to maintain control over those factors. Network operations are studied both under normal conditions and when in a state of malfunction. An important element of this project work also focuses on making conceptual modifications in centralised multi-service control systems, safety and protection systems, network configurations, etc. Following a fairly extensive preparatory phase during which the three different network operators and the PSEL took on a support role and the Biel School of Engineering and Architecture became an active participant in the project, work commenced at the end of 2001.

HIGH-TEMPERATURE SUPERCONDUCTIVITY (HTSC)

The system study on ***high-temperature superconductivity in networks*** [11] established important fundamentals for further research in the area of HTSC, laying the ground for joint projects to be initiated with partners from industry. Although ideas have been pursued along a variety of different lines, no projects have yet got under way, in part owing to the difficult economic situation at the moment. Industry has shown interest but currently prefers to remain in the role of observer. Development of the current limiter (Fig. 1), a network element which is considered to have major potential, is already quite advanced in Switzerland. A project proposal for furthering activities in this area has been drafted, and it is hoped that this work can be commenced in 2002.

Figure 1: *Prototype of a current limiter in a Swiss power plant (Source: ABB Research Centre)*

In July 2001 a new initiative was launched by the Swiss National Research Fund featuring ten *National Centres of Competence in Research*. One of these centres is responsible for the study and development of materials (Materials with Novel Electronic Properties, MANEP). This project involves 17 research groups located at different institutions, of which 8 are also participating in theoretical or experimental work on HTSC.

Participation in the *Implementing Agreement for a Cooperative Programme for Assessing the Impact of High Temperature Superconductivity on the Electric Power Sector* [3] of the International Energy Agency (IEA) provides an excellent means of sharing information about the current status of research, the state-of-the-art in technology, and international efforts planned in the area of HTSC in future. The programme allows the 14 member states to share technical reports with each other, and to visit laboratories, testing facilities and industrial complexes. It periodically publishes high-level technical reports. In 2001, the report *Today's Exploration Bearing upon the Private Sector's Future Use of Magnets Incorporating High Temperature Superconductors* was published. A summary report about international co-operation was published in the SEV/VSE bulletin [12].

APPLICATION / EFFICIENT USE

Energy and information technology

Information and communications technology currently accounts for about 10% of the energy consumed in Switzerland, and growth rates in this area are higher than in any other area of power consumption. Numerous studies are being conducted worldwide with the goal of making our use of electricity more efficient, especially in the areas of office equipment and electronic entertainment devices, and measures are also being taken to realise this savings potential. Our level of know-how and the range of products are changing rapidly, and there are many different players in the global market. International co-operation not only helps us to avoid redundancies and exploit synergies, it is also essential if we are to meaningfully exercise influence in this market segment.

The ***Energy and Information Technology Competence Centre*** [4a] works to achieve more economical use of energy in information technology and electronic entertainment equipment. It does this first by collecting relevant information in Switzerland and abroad, and then processing and distributing it. Furthermore this centre evaluates research topics with an orientation on practical implementation, and supports – and in some cases also carries out – research projects. Energy requirements associated with the Internet were a key issue in 2001. Discussion at the international level was driven in particular by the issue of power consumption in the home following networking of household appliances.

Another focus was on addressing energy issues in the training and ongoing education of IT specialists by offering lectures on the subject at a conference for network specialists and at the Zurich University of Applied Sciences, Winterthur, and by helping design a training concept for IT professionals. The goal of the project on ***energy issues in IT education*** [4b] is to promote the energy efficiency of devices and systems in information and communications technology by heightening awareness. For this reason, a close working relationship was established with I-CH, a Swiss services organisation which is working hand in hand with the Federal Office for Professional Education and Technology (BBT) to design and co-ordinate a flexible, future-oriented training programme for IT professionals. A pilot module has been selected as part of which a one-year pilot training course will be conducted next year.

The energy losses associated with power supply devices (network devices, power supply, cf. Fig. 2) in the area of information and communications represent a significant portion of overall energy losses. Efficiency is typically between 60 and 70%, but it varies greatly depending on the device (i.e. the point at which the power supply is operated), and in the case of redundant operation, for example, it can be as little as 20%. Producers do not make information of this kind (declarations) available. ***Energy efficiency in computer power supplies*** [4c] is a project that aims to better understand the energy losses that occur with individual devices and groups of devices (e.g. as used in data centres). At the Institute of Technology in Zurich, a test system was developed in 2001 for determining efficiency levels. Measurements began in 2002.

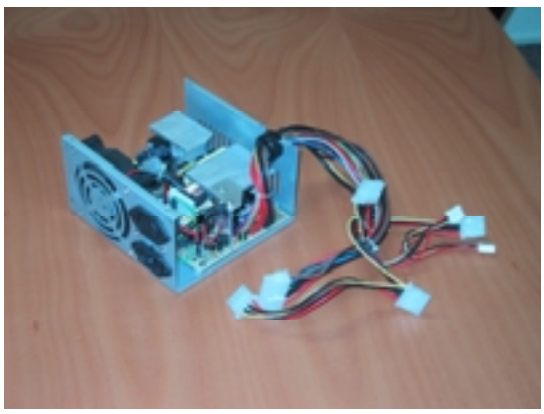

Figure 2: *PC network device with 250 W nominal capacity (Source: Encontrol GmbH)*

Data processing servers are in operation round the clock, even though in many cases server facilities are not needed during the night or on weekends. A representative market study in 2000 showed that the typical small or medium-sized company in German-speaking Switzerland would be in favour of automatic switching-off of servers during certain times if advanced, reliable systems for this purpose were available. The technical and organisational feasibility of server switching was demonstrated at four pilot facilities. Unfortunately, the pilot systems include components that are still in the prototype stage, and a large amount of investment will be required before they can be marketed. Although talks have been conducted with a number of interested companies, none is yet prepared to push ahead with the task of making these components commercially viable. In the project on the ***energy efficiency potential of servers*** [5], data is now being collected about the energy savings that are possible through sever switches. The issue is also being addressed of what measures are necessary in order to realise this potential, and which parties have a role to play in this process.

Drives / electric motors

The *European Commission* (DG Transport and Energy) intends to carry out a programme called the *Motor Driven Systems Challenge*, with the goal of implementing the currently available know-how concerning energy efficiency gains in the area of motors and electric drives on a broad basis within industry. To ensure that the programme is conducted efficiently, it is being preceded by a two-year pilot project examining the suitability and implementation potential of various features of the programme. Switzerland has committed itself as an active participant in the international ***pilot project*** *for the* ***Motor Driven Systems Challenge Programme*** [6a], and will join hands with a large group of other countries in implementing this know-how. The technical focus of the programme is on compressed-air systems, ventilators, and drives and control systems in different areas of application. Each participating country was first asked to summarise the results from national research projects and programmes and to compile a list of current national programmes and activities in this field. At present we are creating an index in the national languages plus English to enable efficient information searches. Drafts have already been produced for module documentation and for the Motor Challenge Guidelines and Endorser Guidelines (cf. Fig. 3). This material is currently being revised so as to fulfil official documentation requirements that have been established. Companies interested in participating in the programme are currently being sought in Switzerland.

Figure 3: *Label planned as part of the Motor Challenge Programme for energy-efficient industrial operations (Source: EU, Joint Research Center)*

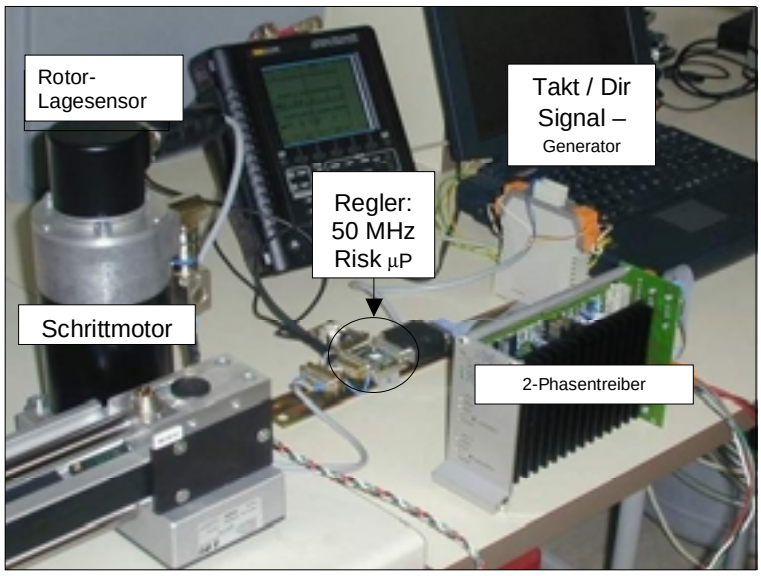

Figure 4: *Energy-saving stepping motor drive, test construction (Source: LEAG Antriebstechnik AG)*

Stepping motors are used in large numbers in the automation process. The magnetic circuit is designed so that in controlled operations the motor can assume defined positions that allow it to operate with little effort. If the mechanical load on such a stepping motor is too great during operation or at standstill there is a risk that it may *tip*. When this happens, the installations have to be re-started, which means production has to be interrupted and a production loss is suffered. To prevent this, the motor is *operated at full power*. A project on ***energy-saving stepping motor drives*** [7] was recently initiated to develop a means of powering these motors in such a manner that they only consume the electricity they actually need for any given position. This would drastically increase their cycle efficiency. A prototype has been developed (cf. Fig. 4) which will be used to study the economic aspects of *energy-saving stepping motors*.

Preparations are now under way for new projects devoted to electric drive systems. One of these projects will pursue an idea for a new type of high-efficiency compressor employing a synchronous motor, and another will focus on publishing an independent test series for server drive systems.

Miscellaneous

Electric band heaters (cf. Fig. 5) consume a surprisingly large amount of power. It is estimated that over 10,000

kilometres of heater band is installed, which consumes around 270 GWh annually. This is about the same amount of power consumed by all the television sets in Switzerland in a year. Many of these heat bands are not operated properly or may not be subject to any kind of operation controls at all, and in some cases people do not even know that heat bands are installed. Hence, there is major potential to save on electricity in this area. Heater bands are found in frost protection and outdoor heating devices (some of which are prohibited) as well as in trace heating for warm water distribution systems in industry.

Figure 5: *Construction of an electric band heater (Source: Raychem, J. Haag, HausTech 5/2001)*

The research project on ***electric band heaters*** [6b] is seeking to improve our knowledge about applications, usage and energy-saving potential in this area. Implementation projects for collecting data and action plans (e.g. information campaigns, educational measures) will follow. Comprehensive information was provided to our project partners in 2001.

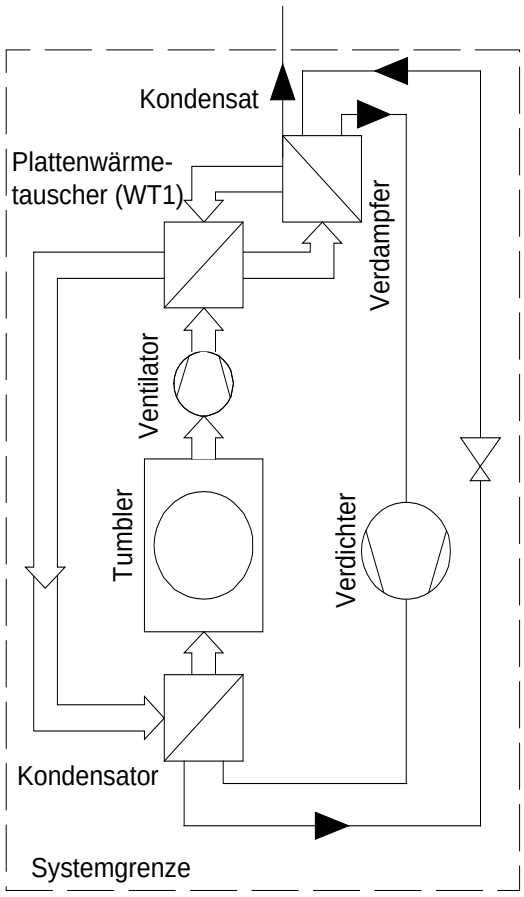

Figure 6: *How heat-pump dryers function (Source: Zurich University of Applied Sciences, Winterthur)*

In the project on ***heat-pump dryers for multi-family dwellings*** [8] two prototypes were built (cf. Fig. 6) and evaluated. The goal here is to develop a product that is extremely energy-efficient in handling 6-kilogram loads and that also dries the laundry significantly faster than comparable products. New know-how concerning device construction and technical design was gained from the measurements conducted and study of the prototype constructions. Miele, a major manufacturer of household appliances, has committed itself to pursuing this development work further with the intention of introducing a new heat-pump dryer to the market. Next year 8 further prototypes are scheduled for production and testing in multi-family dwellings at selected locations.

The focus of the public debate on the issue of *electromagnetic fields and their influence on the human body* has moved away from energy technology in general and for some time now has been clearly on mobile communication devices. This change is reflected in an alteration in the COST Programme 244 on ***biomedical effects of electromagnetic fields*** [13]. These activities will be further pursued in COST Programme 281 with an emphasis on the ***potential health effects of emerging wireless communication systems*** [14]. Switzerland will also be an active participant in the new COST Programme 281.

Co-operation at the national level

For each of the priority areas of the programme, *trend-watching/support groups* comprising representatives from industry, universities, institutes of technology and other research organisations have been well established by the programme's management at the Swiss Federal Office of Energy, and these groups convene regularly to share information and ideas. These meetings have proven to be extremely fruitful, which in some instances resulted in a marked ***increase in parties interested in participating in these groups*** *in 2001*. Good contact is maintained with other Swiss sponsors in the area of electricity, most notably the *PSEL* (*Projects and Studies Fund of the Electricity Industry*), the *Commission recherche, développement, prospective de la Chambre romande d'énergie électrique* (RDP-CREE) and the *Electricity Savings Fund of the* EWZ. Contact is also established with the cantonal energy offices when issues arise that are of common interest.

Several projects are being conducted in close collaboration with the Federal Institute of Technology in Zurich, and co-operation with schools of applied sciences is being increased. At present, projects are in progress with the universities of applied sciences at Valais, Biel and Zurich/Winterthur, and preparations for a **competence centre for compressed-air technology** are being made with the university at Yverdon.

We co-operate closely with the **energy agencies** [15] on a number of projects and for the purpose of medium- and long-term planning. Joint projects have already been launched with the Energy Agency for Industry (EnaW) and the Energy Agency for Electrical Appliances (eae). Close contact is also maintained with the Swiss Agency for Energy Efficiency (S.A.F.E.).

In virtually every project we also try to involve the major **business and industry associations**. For instance, the project examining *electric band heaters* relies on the participation of the Swiss association of plumbers and installation contractors (*Schweiz. Spenglermeister- und Installateur-Verband, SSIV)* and the Swiss association of electrical contractors (*Verband Schweizerischer Elektro-Installationsfirmen, VSEI*).

In the field of **high-temperature superconductivity** we are actively participating in projects being conducted by the Institute of Technology at Lausanne in connection with energy applications for ABB and the cable manufacturer Kabelwerke Brugg. Two other companies are pursuing activities in the field of superconductivity, but only for low-temperature applications (Bruker Biospin in connection with intense-field magnets for NMR and Swissmetal Dornach in connection with superconductive Nb3Sn wires). All of these companies are involved in joint research projects in the field of superconductivity with Swiss universities and institutes, particularly the Paul Scherrer Institute, the Federal Institute of Technology Zurich, the Federal Institute of Technology Lausanne and the University of Geneva.

Co-operation at the international level

International contacts are actively maintained in all priority areas, and in addition to sharing information with our international partners, we strive to pursue projects jointly with them and/or meaningfully co-ordinate our respective project work.

The ***Implementing Agreement for a Co-operative Programme for Assessing the Impact of High Temperature Superconductivity on the Electric Power Sector,*** an IEA programme in which we participate, gives us the opportunity to observe international activities in this field and share research results. In addition to participating in this IEA programme, the University of Geneva and the Federal Institute of Technology Lausanne are participating in the ***BIG POWA*** project as part of the **5th EU Framework Programme**. Both groups are working on the problem of AC losses. The goal of this project is to construct a small-scale transformer and a model coil at 77 K with round Bi,Pb(2223) wires that has minimal AC losses. Switzerland is also a member of the ***Superconducting European Network*** (SCENET) in which we are represented by two groups. SCENET comprises 73 different European groups from the university and industrial sectors and works to optimise the flow of information within Europe.

In recent years, Switzerland has played an important role worldwide in the area of *efficient energy use in information and communications technology,* and has had a decisive influence on the formulation of international and global energy declarations and labels. Maintaining contacts with many different international agencies and research organisations has been important in this respect, and especially so the participation of the programme head at the 2-day IEA conference in Tokyo [16]. At this workshop conference, the last in a series of three, which the IEA organised with the theme of

Standby as its focus, the motto was ***Towards a Harmonised Solution***. The Energy and Information Technology Competence Centre also makes a substantial contribution in the area of international networking. It maintains relationships with numerous institutions, including long-term partners such as the LBNL (Lawrence Berkeley National Laboratory) and the EPA (Environmental Protection Agency) in the USA, and the SNEA (Swedish National Energy Administration) and the ADEME (Agence de l'environnement et de la maîtrise de l'énergie) in France. Co-operation was also established with the ISI of the Fraunhofer Society in Karlsruhe.

In the area of motors and drive systems Switzerland is participating in the ***SAVE Project: Pilot Project for the Motor Challenge Programme***. In addition, regular contact is maintained with the European Commission. As a result, the programme head was invited to be a member of the International Programme Committee of the ***3rd International Conference on Energy Efficiency in Motor Driven Systems*** (EEMODS 02) which is taking place in autumn of 2002. Unfortunately, no progress was made in the negotiations with the European Commission concerning the motor design software *OPAL* and the integration foreseen with the European motor tool *EURODEEM*. The negotiations, which were well under way in spring of 2001, were interrupted when the European Commission decided to launch a SAVE Project in this area in which Switzerland would be included, and all efforts were focused on this move. Unfortunately the project failed to be approved the following autumn by the presiding committee. This issue will be re-addressed in 2002.

Pilot and demonstration projects

The current P+D projects are concentrated exclusively in the area of *drive systems/motors.*

Lonza AG in Visp is one of the biggest electricity customers in Switzerland, consuming about 1% of the electricity used in Switzerland. Around 94% of this goes to power electric motors, the majority of which drive pumps (cf. Fig. 7) and compressors. A detailed study is being conducted on the ***savings potential for electricity used to power motors and drive systems at Lonza AG*** [9]. Through the process of collecting the basic material for the study it is hoped that awareness concerning energy consumption will be significantly heightened. Subsequently, concrete, economically attractive measures will be formulated on the basis of the analysis results. We anticipate a technical savings potential of about 25% on average, which could be realised by employing variable-speed drives. By optimising the overall systems, the estimated savings potential would be between 25 and 80% depending on the area. On the basis of a conservative estimate, it may be assumed that an average savings potential of around 10% exists, which is equivalent to a huge 45–50 GWh/year.

Figure 7: *HS network water pump at Lonza (Source: Lonza AG, Visp)*

Potential for economically attractive energy savings is also present in the area of compressed-air installations. A project looking for means of **optimising compressed-air processes in weaving operations** *[10]* measured the passage of a load through a weaving mill and found that the compressor consumed between 27 and 31 kW during both day and night-time operation. A systematic search was made to identify sour-

ces of power loss in the compressor system, and leaks in one room were discovered that accounted for 75% of the approximate 200 MWh/a in electricity consumed by the compressor. At many connections in the compressed-air system there is an audible loss of air which can be detected when the machinery is not running in the weaving hall. Following repair of the leaky connections, another measurement will be conducted with a test load to determine the degree of success of the action. This example clearly demonstrates that optimising compressed-air installations begins at the consumer level.

For small and medium-sized companies, the savings in electricity costs achieved through efficiency-enhancement measures usually do not offset the costs of a systems optimisation by external specialists.
A project on ***optimising compressed-air processes in a joiner's workshop*** [10b] is concentrating on developing a practical guide based on simple examples of how to effectively achieve energy savings in the area of compressed-air systems. The project tested various measures *at each point at which compressed air is used* and calculated the cost/benefit ratio of each step in the optimisation procedure. The guide will only include the measures that are judged to be particularly effective in optimising compressed-air operations in joiners' workshops.

Summary for 2001 and outlook for 2002

In January 2001, the Energy Research Commission of the federal government evaluated the programme concept for 2000 – 2003 and gave its official approval of the programme's content framework for this period.

In the priority area ***electricity distribution***, the project that had been planned for some time concerning the increase in decentralised power generation was finally initiated towards the end of the year. This work will proceed and be intensified in 2002. We are anxiously awaiting the outcome of the upcoming general vote on the electricity market law, as it will decisively influence how the electricity industry functions in future. The joint efforts of the Association of Swiss electricity companies *(Verband Schweizerischer Elektrizitätsunternehmen,* VSE) and the Federal Office of Energy to create an integrated educational platform are well advanced.

We were unsuccessful at launching a project in the area of ***high-temperature superconductivity*** (HTSC) as planned, despite intensive efforts and active negotiations with industry. Discussions are continuing, however, and the HTSC issue may be re-addressed in 2002 in connection with the topic of current limiters. Activities in the area of HTSC information dissemination are proceeding very satisfactorily.

No end is yet in sight to the rapid developments in ***information and communications technology***. It is therefore particularly pleasing that several projects were started in this area to eliminate gaps in our current knowledge. At the IEA Conference in Tokyo, Switzerland presented its latest research results, which met with great interest from the other participants. An IEA Conference is planned for 2002 in Paris at which the topic of consideration will be the *Impact of Information and Communications Technology on Energy Systems*. At this event, the programme head plans to present the activities and ideas currently being pursued by Switzerland. A common goal of further projects will be to identify energy savings potential. It is hoped that the new study on savings potential in connection with servers will motivate the private sector to get involved. We plan to continue our activities focusing on *networking in private households* and to address the topic of *standby mode and household appliances*.

We were able to start a number of pilot projects in the area of ***drive systems/motors***, thanks to thorough preparatory work done the year before. In the area of compressed-air technology and systems optimisation we were particularly successful in involving various companies in energy-related projects. Further projects of this nature are planned for 2002. Research to identify new potential for greater technical efficiency will continue. Major efforts with this objective were planned for 2001 in connection with *gearless drives* but had to be postponed due to scheduling problems encountered by our partners in industry. Unfortunately, it was not possible for the integration of the design tools *OPAL* and *EURODEEM* to be realised. Establishment of a competence centre for compressed-air technology at the university of applied sciences at Yverdon was also delayed. The rich network of international contacts Switzerland has established in this field is yielding rewards, one of which is the invitation received by the programme head to join the Programme Committee of *EEMODS'02,* the EU Conference on Motor Driven Systems.

List of R+D projects

(AR) 2001 annual report (available)

(FR) Final report (available)

ENET: report's ENET order number

The reports can be downloaded from the Internet addresses indicated:

[1] H. Glavitsch, G. Andersson, (haglav@bluewin.ch, andersson@eeh.ee.ethz.ch), FIT, ZURICH: ***A new methodology for establishing a system for cross-border transmission tariffication in the internal electricity market*** (FB) ENET 210004

[2] G. Schnyder, (gilbert.schnyder@sing.ch), SCHNYDER INGENIEURE AG, *Hünenberg:* ***Zunahme der dezentralen Energieerzeugungsanlagen in Verteilnetzen / Increase in decentralised power generation facilities in distribution networks*** (AR)

[3] R. Flükiger, (rene.flukiger@physics.unige.ch), University of Geneva: ***Implementing Agreement for a Cooperative Programme for Assessing the Impact of High Temperature Superconductivity on the Electric Power Sector*** (AR)

[4] B. Aebischer, (bernard.aebischer@cepe.mavt.ethz.ch), CEPE, FIT, ZURICH: ***a) Betreuung des Kompetenzzentrums Energie und Informationstechnik / Administering the Energy and Information Technology Competence Centre*** (AR) • ***b) Energieaspekte in der IT-Ausbildung / Energy issues in IT education*** (AR) • ***c) Energy efficiency in computer power supplies*** (AR)

[5] A. Huser, (alois.huser@encontrol.ch), ENCONTROL GMBH, *Niederrohrdorf:* ***Stromeffizienzpotential bei Servern / Energy efficiency potential of servers*** (AR)

[6] J. Nipkow, (juergnipkow@swissonline.ch), ARENA ARBEITSGEMEINSCHAFT ENERGIE-ALTERNATIVEN, *Zurich:* ***a) Schweizer Vertretung am SAVE-Programm: Pilot Actions for the Motor Challenge Programme / Swiss representation in the SAVE Programme: Pilot Actions for the Motor Challenge Programme*** (AR) • ***b) Elektrische Heizbänder / Electric band heaters***

[7] S. Berchten, (bn@leag.com), LEAG ANTRIEBSTECHNIK AG, *Schaffhausen:* ***Energiesparender Schrittmotorenantrieb / Energy-saving stepping motor drives*** (AR)

[8] E. Schwarzwald, THERMODUL CONSULTING, *Curio:* ***Wärmepumpentumbler für Mehrfamilienhaus / Heat-pump dryers for multi-family dwellings*** (AR)

List of P+D projects

[9] S. Troger, G. Schnyder, V. Bregy, et al., (stefan.troger@lonzagroup.com) LONZA AG, *Visp:* ***Einsparpotential an elektrischer Energie bei Motoren und Antrieben in der Lonza / Potential electricity savings with motors and drive systems at Lonza*** (AR)

[10] R. Gloor, (gloor@energie.ch), GLOOR ENGINEERING, *Sufers:* ***a) Druckluftoptimierung in einer Weberei / Optimising compressed-air processes in weaving operations*** (AR) • ***b) Druckluftoptimierung in einer Schreinerei / Optimising compressed-air processes in a joiner's workshop*** (AR) www.energie.ch

References

[11] G. Schnyder, ABB Secheron, *Geneva:* ***Hochtemperatursupraleitung im Netz / High-temperature superconductivity in networks***, Study by the Swiss Federal Office of Energy, 2000, www.electricity-research.ch.

[12] R. Flükiger, R. Brüniger**:** ***Die internationale Zusammenarbeit bei der Hochtemperatur-Supraleitung im Energiebereich / International co-operation on superconductivity in the area of energy,*** SEV/VSE Bulletin, vol. 25/2001, pp. 23 - 25, 2001.

[13] Arne Wennberg: ***COST Actions 244BIS, 1996 – 2000, Biomedical effects of electromagnetic fields,*** Final Report, ISBN 91-7045-592-9

[14] ***Home page of the COST 281 Programme*** www.cost281.org

[15] ***Home page of energy agency*** www.energieagentur.ch and www.energie-agentur.ch

[16] R. Brüniger: ***Reisebericht: 3rd International Workshop: Standby-power towards a harmonised solution / Report from 3rd International Workshop: Standby-power – towards a harmonised solution, 7/8 February 2001 in Tokyo,*** www.electricity-research.ch.

[17] ***Research programme web site:*** www.electricity-research.ch.