



Needs of Education and Research in the Electricity Supply Industry and Manufacturing Industry

Main Findings of the EPEE Panel of 30th August 2004

Preamble

Electricity has an important position in energy supply business worldwide. Efficiency in production, transmission, distribution and consumption is a prerequisite in a quest for higher standards of living as well as decreased environmental impacts. Increased knowledge and continuous development of new technologies in the electricity sector are crucial for success.

The long-standing involvement of CIGRE in Electric Power Engineering Education, as part of its mission of development and diffusion of technical information, took a special turn with the organisation of a workshop “Links Universities-CIGRE” (LUC) held during the 1998 Session.

This strengthened involvement in Education was subsequently integrated in the Action Plan of the Technical Committee, as one of the Key Actions, under the title of “ELECTRIC POWER ENGINEERING EDUCATION (EPPE). This includes initiatives such as the setting up of Tutorials, specific actions towards students... and the preparation of an event centred around Education, and scheduled during CIGRE Sessions.

Panels on EPEE were held during the 2000, 2002 and 2004 Sessions; generally speaking they focused on the need of the Electric Power Industry to recruit educated and skilled people, taking into account the present challenges of the Electricity Sector. They brought together representatives from Universities, from the Industry and from Public Authorities. Views were exchanged on the needs experienced in the areas of education and research, as well as on ways and means of drawing young people to the Industry.

EPEE Panel 2004

The topic of discussion for the 2004 panel was the “Needs of Education and Research in the Electricity Supply Industry and Manufacturing Industry” after experiencing more than ten years of liberalisation (restructuring) of the industry. This process has changed not only the electricity supply industry itself, but has also influenced the manufacturing industry, and the educational programs of the universities.

Nils Flatabø, SINTEF Energy Research, Norway chaired the EPEE Panel 2004.

The invited speakers were:

Mr. Pierre Bornard, Managing Director Power System Division, RTE, France

Mr. Jon Haaheim, Vice President Production, Statkraft, Norway

Dr. Ashok Manglick, Manager/Project Development, TransGrid, Australia

Prof. Jose Sidnei Colombo Martini, Chief Executive Officer, Companhia de Transmissão de Energia Elétrica Paulista- CTEEP, São Paulo, Brazil

Dr. Bruno Meyer, Director of Power Systems Technology and Economics, EDF R&D, France

Dr. Prabha Kundur, President & CEO PowerTech Labs Inc., Canada

Prof. Michael Dureau, Executive Director, The Warren Centre for Advanced Engineering, Sydney University, Australia.

Mr. Robert Mahler, President FRANCE ALSTOM, France

Prof. Vijay Vittal, Iowa State University, USA

Prof. Ferdinand Gubina, University of Ljubljana, Slovenia

Prof. Johan J. Smit, Delft University of Technology, The Netherlands

CIGRÉ-TC Chairman Aldo Bolza, Italy

Topics of discussion for the EPEE Panel

A. Challenges for the Energy Supply Industry in the next decade and beyond

Many countries are now in a rapid process of restructuring its energy supply industry. The move from shielded monopolies to a truly competitive energy market within a country or a region is not an easy one. The whole structure of how to run the business is changing, and its players have to adapt to new roles and attitudes.

- What are the foreseeable challenges of the ESI in the next decade and beyond?

B. Competencies and skills of a good power engineer in the next decade and beyond

- What range of subjects will be of importance (Technology, Economy, Market issues, Information and Communication Technologies, System issues, Environment, Social questions, Others)?
- What kind of professional skill will be needed (Comprehensive competence, specialists, technological, market economy)?
- What professional education, or combinations of, should the personnel possess?

C. An effective EPEE program for meeting the manpower requirements of the restructured Electric Power Industry

- How can the Electricity Supply Industry and Manufacturing Industry appear as attractive career paths for young people?
- What has to be done in a long-term educational perspective, to recruit the required personnel to the energy business and manufacturing industry sectors?

- How may increased outsourcing in the electric power industry affect the required skills of manpower both in the power industry and the manufacturing industry?

D. Role of the universities in training and continuous education of engineers/economists

- What kind of competencies have to be established in universities and colleges to manage to deliver the persons the energy business and the manufacturing industry require?
- How strong interaction is needed (or wanted) with the energy supply and manufacturing industries?
- How can research collaboration between industry and universities become a means of strengthening the power engineering education?

E. The role of CIGRÉ in facilitating the formation of good EPEE programs

- What is the role of CIGRE in the formation of the future engineers?
- How can CIGRE, through its organization, promote the recruitment of young people to the electric power and manufacturing industries?
- Have CIGRE a role to play towards public authorities concerning the educational process?
- Will CIGRE establish own activities (other than the EPEE panel) that promote exchange of information or exchange of personnel/students between educational bodies and the power and manufacturing industries?

Table A. Challenges for the Energy Supply Industry in the next decade and beyond (1 of 2)

| The new framework of the ESI | |
|--|---|
| <ul style="list-style-type: none"> • Many countries are now in a rapid process of restructuring its energy supply industry. • The move from shielded monopolies to a truly competitive energy market within a country or a region is not an easy one • The whole structure of how to run the business is changing, and its players have to adapt to new roles and attitudes | |
| Questions | Indications from panellists |
| <p>What are the foreseeable challenges of the ESI in the next decade and beyond?</p> | <p>The restructuring of the electric power industry – a shift from monopolistic to a competitive structure – has introduced new financial and social pressures. The challenge for the industry will be to:</p> <ul style="list-style-type: none"> • Reduce costs by improving business practices and operating efficiency • Enhance service quality by improving power system reliability, security, and power quality, and • Produce, transmit and utilize energy in an environmentally responsible manner <p>All this will require:</p> <ul style="list-style-type: none"> • A highly skilled, well-informed and empowered workforce • More importantly, a wide range of new technologies will be required <p>It is no longer a slow, overly conservative industry. On the contrary, it is a large dynamic industry in need of talented people to run it and new technologies to operate it more efficiently</p> <ul style="list-style-type: none"> • The challenge will be to attract good students into this field • The industry and the universities will have to work together to develop successful Power Engineering programs <p>The Main Challenge for the Electricity Supply Industry in the next decade:</p> <ul style="list-style-type: none"> • Avoiding misconception of the new market arrangements • Keeping anticipation capabilities to adapt and correct policies and processes (avoiding myopia and sheep behaviour) • Saving minimum core business competency at decision-making level • The environment laws will increase the restrictions to electric engineering • The automation and smart instrumentation presence will be increased • New materials and processes will force a permanent knowledge update • The demand of technical and financial management will increase • The professional competition will increase • The legal aspects will increase in professional activities |



EPEE Panel 2004 Findings

Table A. Challenges for the Energy Supply Industry in the next decade and beyond (2 of 2)

| The new framework of the ESI | |
|--|---|
| <ul style="list-style-type: none"> • Many countries are now in a rapid process of restructuring its energy supply industry. • The move from shielded monopolies to a truly competitive energy market within a country or a region is not an easy one • The whole structure of how to run the business is changing, and its players have to adapt to new roles and attitudes | |
| Questions | Indications from panellists |
| <p>What are the foreseeable challenges of the ESI in the next decade and beyond?</p> | <p>The future power/market manager of the electricity industry is likely to face three main kind of challenges while exercising his profession:</p> <ul style="list-style-type: none"> • Legal and regulatory issues in relation to the domestic and interstate frameworks • Economical and financial problems related to the development of the market, pricing, tariffs and infrastructure investments • Being able to address complexity and multi-disciplinary problems is the main key to master market and power systems issues <p>Challenges and opportunities coming up:</p> <ul style="list-style-type: none"> • Design and implementation of new market tools, new interfaces • Customer services • Innovation in trading techniques, risk management methods, contractual arrangements • International development • Environment handling <p>The actual number of academics in power area and their age profile are such that their sustainability is in question. Power schools are under threat</p> <ul style="list-style-type: none"> • Low student numbers plus reduction in university resources • No obvious replacement for imminent loss of experienced academics <p>Difficulties in hiring trained engineers in power systems</p> <ul style="list-style-type: none"> • Diminishing number of students in the field • Power engineers are attracted to other areas • How to preserve the existing expertise <p>Growing concerns about the gap between industry requirements & graduate abilities</p> <ul style="list-style-type: none"> • Reduced interest in maths & science at high schools (for a variety of reasons) reduces the pool from which science & technology students are drawn |

**Table B. Competencies and skills of a good power engineer in the next decade and beyond
(1 of 2)**

| Questions | Indications from panellists |
|---|---|
| <p>What range of subjects will be of importance? <i>(Technology, Economy, Market issues, Information ad Communication Technologies, System issues, Environment, Social questions, Others)</i></p> | <p>For market development</p> <ul style="list-style-type: none"> • A deep understanding of Kirchhoff laws and their environment is more than ever necessary: urgent competency problem for the whole Industry <p>The power industry will require:</p> <ul style="list-style-type: none"> • A wide range of new technologies • A highly skilled, well-informed and empowered workforce <p>The Power Engineer for the next decade and beyond needs to be skilled in different fields:</p> <ul style="list-style-type: none"> • Institutional: To know the electric sector environment, laws, ethics and scenarios • Technological: To know new materials, equipment, methods and processes • Management: To plan, control, motivate, reward the customers, the shareholders, and the employees • Information technology: To do the best use of communication and information integrated systems <p>The Power Engineer shall:</p> <ul style="list-style-type: none"> • Have competence in human relationship and communication • Have ethic bearing, cultural and social engagement with his country • Assure the environment, anthropologic, labour and ethic sustainability • Be able to express and communicate in several languages |

**Table B. Competencies and skills of a good power engineer in the next decade and beyond
(2 of 2)**

| Questions | Indications from panellists |
|---|---|
| <p>What kind of professional skill will be needed? <i>(Comprehensive competence, specialists, technological, market economy)</i></p> | <ul style="list-style-type: none"> • Power Engineers should be trained for future versatility and future access to top management positions, not for narrow specialized engineering: This paradox must be addressed by Company practices in engineer careers: steady technical positions at the beginning, open opportunities towards management and business after 7-8 years • Future engineers will need to graduate with general skills and may need further ongoing training in specialised areas of industry needs <p>Concern:</p> <ul style="list-style-type: none"> • The power systems study involve a high level of expertise • Power systems have become increasingly large and complex <p>Diversified and complementary skills will be needed:</p> <ul style="list-style-type: none"> • Academic and engineering sciences: power systems, mechanics, fluid mechanics, thermo-hydraulics, neutronics, materials, chemistry, water quality, etc • Skills related to industrial activities: Operation & Management in generation, transmission, distribution; processes at customers, etc • Integration skills: scientific information systems, software engineering, economics, sociology and human behaviour |
| <p>What professional education, or combinations of, should the personnel posses?</p> | <p>The power engineer for the future (2015):</p> <ul style="list-style-type: none"> • He shall have comprehensive education both systemic and analytic, based on solid knowledge of engineering basic science, with an ever learning attitude |

Table C. An effective EPEE program for meeting the manpower requirements of the restructured Electric Power Industry (1 of 2)

| Questions | Indications from panellists |
|--|--|
| <p>How can the Electricity Supply Industry and Manufacturing Industry appear as attractive career paths for young people?</p> | <p>The Industry is in general not very attractive and needs to “spice up” the marketing towards future students</p> <ul style="list-style-type: none"> • Emphasize opportunities, career options, and international possibilities <p>Socialize the image of EPI</p> <ul style="list-style-type: none"> • Stimulate innovative developments • Improve business exposure by <ul style="list-style-type: none"> • Educational section on internet site • Making expertise attractive for young engineers • Utilising worldwide expert contacts |
| <p>What has to be done in a long-term educational perspective, to recruit the required personnel to the energy business and manufacturing industry sectors?</p> | <ul style="list-style-type: none"> • There is indeed a great need for having EPEE programs with focus on <u>education</u> as well as <u>research</u> • The industry and universities will have to work together to develop successful EPEE programs • Government program to increase students with mathematics and physics at Upper secondary school. • Marketing activity directed towards students at Upper secondary school (age 16-19) <p>The existing university capabilities in teaching and research in power engineering are, at best, very limited with future prospects even bleaker (Australia).</p> <ul style="list-style-type: none"> • The solution to this issue lies in a holistic approach, involving industry, academia and government in a focused partnership. <p>The development of AEPI (Australia) is a significant recognition by industry of the need for much greater involvement in the education area in order to ensure a sustainable intellectual resource into the future. At the same time it is perceived by government as a positive contribution to a rationalisation of university resources in this area</p> <p>To be well equipped to address the new challenges of the restructured electric power industry, students (in France) are offered the benefit of a win-win strategy to which grid operators, manufacturers, regulators, Supelec (Ecole Supérieure d'Electricité) and Faculté Jean-Monnet (specialised in Economy) are contributing through a fruitful co-operation:</p> <ul style="list-style-type: none"> • The approach of putting new challenges, and of revising the teaching program, has proven to be attractive, and the number of students choosing courses relevant for the CIGRE related industry has doubled within the last 3 years |



EPEE Panel 2004 Findings

Table C. An effective EPEE program for meeting the manpower requirements of the restructured Electric Power Industry (2 of 2)

| Questions | Indications from panellists |
|---|--|
| How may increased outsourcing in the electric power industry affect the required skills of manpower both in the power industry and the manufacturing industry? | <ul style="list-style-type: none">• More and more companies hire these skills from other types of businesses, such as Financial services, Insurance companies, Commodities trading, Logistics• In a general context this is a staff reduction• Fewer and fewer people with competences in Power Engineering at decision-making level |

Table D. Role of the universities in training and continuous education of engineers/economists (1 of 3)

| Questions | Indications from panellists |
|--|--|
| <p>What kind of competencies have to be established in universities and colleges to manage to deliver the persons the energy business and the manufacturing industry require?</p> | <p>Introduction of energy markets brought about the notion that electric power engineers do not get an appropriate curriculum at the universities. Variety of missing subjects has been suggested which are needed in the electrical energy market operation and power system control.</p> <p>It is generally true that universities cannot deliver engineers with all the needed practical knowledge in each company. However, power engineers should attain a minimum amount of basic knowledge of sufficient quality to understand the process of producing, transporting, delivering of electric energy and controlling quality of its supply.</p> <p>In addition to that, they should achieve some training to be able to communicate with the business and public efficiently. Due to globalization, the language abilities are also required.</p> <p>In practice, all power engineers are aware of the needs for economics, management communication, and language skills, but the universities are slow in adopting this knowledge in their curricula.</p> <p>Engineering won't be the dominating factor anymore, but:</p> <ul style="list-style-type: none"> • It is the basis upon which the students have to learn how more complicated but even more challenging solutions for technology applications have to be founded. <p>If the universities want to prepare the students well on their near future, this implies:</p> <ul style="list-style-type: none"> • The curriculum has to take into account the <u>changing driving forces over the next two decades</u>, which are: • Engineering → Economics → Environment |



EPEE Panel 2004 Findings

Table D. Role of the universities in training and continuous education of engineers/economists (2 of 3)

| Questions | Indications from panellists |
|---|--|
| <p>How strong interaction is needed (or wanted) with the energy supply and manufacturing industries?</p> | <p>A co-operation between utilities and universities can be fundamental in establishing a new generation of KM (Knowledge Management) systems.</p> <p>Universities could:</p> <ul style="list-style-type: none"> • Act as a major source in relevant literature • Bring some illustrative test cases that could be run on the simulation software. <p>Utilities could:</p> <ul style="list-style-type: none"> • Provide universities with new problems or situations, that could be interesting for the university syllabus <p>A balance is needed between fundamental or basic research and applied research for the industry</p> <ul style="list-style-type: none"> • In fact, the one helps the other <p>Ideally, part of the research work for Ph.D. should be carried out in the industry, thus:</p> <ul style="list-style-type: none"> • Exposing the students to current industry practices • Providing necessary practical knowledge and appreciation for business implications of problem being solved • Building technical confidence <p>The Power Program at Iowa State University (ISU) has a long tradition of continuing education interaction with industry that started in the 1960s</p> <ul style="list-style-type: none"> • ISU provides several options for continuing education to the practicing engineer • The options have a range of flexibility from tailored short courses to a formal degree program • Quite a bit of the material is video streamed as a result of which the user has complete freedom and choice to view the material whenever possible |



EPEE Panel 2004 Findings

Table D. Role of the universities in training and continuous education of engineers/economists (3 of 3)

| Questions | Indications from panellists |
|---|---|
| <p>How can research collaboration between industry and universities become a means of strengthening the power engineering education?</p> | <p>Collaborative research will have a major impact on forming good post-graduate programs:</p> <ul style="list-style-type: none"> • Leads to good practically oriented research projects • Increases the profile of the field, and helps attract good students <p>It is not a matter of just providing research funds to universities. Industry's active involvement is necessary:</p> <ul style="list-style-type: none"> • Industrial partner defines the problem, and provides the basic tools, data and information about existing knowledge • Academic research can focus on experimentation with different new ideas and advancing the state-of-the-art <p>An example of cooperation between industry and universities is the Power System Engineering Research Center (PSERC) Seminar</p> <ul style="list-style-type: none"> • Iowa State University (ISU) is a member of a 13 university U.S. National Science Foundation sponsored Industry University Research Center that has 40 industrial members • The participants in this centre conduct state of the art research on a number of relevant topics to power engineering • As a part of the research dissemination process regular research seminars are held once a month during the academic year • Continuing education credits are also provided for the seminar |



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Table E. The role of CIGRE in facilitating the formation of good EPEE programs (1 of 2)

| Questions | Indications from panellists |
|--|---|
| <p>What is the role of CIGRE in the formation of the future engineers?</p> | <p>Since the energy and power will remain the problem of concern of the modern society, CIGRE as an international power engineering organization should address this problem and enable a fruitful communication between educators and practicing engineers regarding the power engineering curricula, as it is happening within the IEEE. The experience gathered within the CIGRE experts could assess this problem adequately</p> |
| <p>How can CIGRE, through its organization, promote the recruitment of young people to the electric power and manufacturing industries?</p> | <p>Contributions by CIGRE members to Electric Power Engineering and Education (EPEE) might be:</p> <ul style="list-style-type: none"> • Establish programs which integrate academic teaching and research focusing towards new challenges of the Industry • Shape up the education, offering a more favourable regulatory environment for continuous education • Promotion campaign made through companies and professional organisation of a country, like MEDEF (Mouvement Des Entreprises de France), to motivate new generations to embrace scientific studies in view of an industrial career <p>Establish a CIGRE website for young people</p> <ul style="list-style-type: none"> • A good possibility for CIGRE to reach young people • Information on the newest findings and revolutionary developments coming up in the electrical power industry in all its multidisciplinary aspects could be found • The website should look very professional, kept well maintained, and up-to-date, so that educational institutes will recommend its use to the students • Each study committee should submit to the editor of this website their revolutionary developments • This website should have a high quality in accessibility and modern presentations like games and movies, downloadable pictures and so on |

Table E. The role of CIGRE in facilitating the formation of good EPEE programs (2 of 2)

| Questions | Indications from panellists |
|---|---|
| <p>Have CIGRE a role to play towards public authorities concerning the educational process?</p> | <p>CIGRE, as worldwide power engineering organization, could</p> <ul style="list-style-type: none"> • Contribute in forming an adequate Catalogue of the required power engineering knowledge • The Catalogue could be presented as a <u>CIGRE White Book on Power Engineering Education</u> <p>CIGRE could coordinate R&D and Educational efforts</p> <ul style="list-style-type: none"> • With universities, companies, institutes • Funding sources • Internally SC's |
| <p>Will CIGRE establish own activities (other than the EPEE panel) that promote exchange of information or exchange of personnel/students between educational bodies and the power and manufacturing industries?</p> | <p>Knowledge Management (KM) is a major issue now, considering the evolution of electrical companies</p> <ul style="list-style-type: none"> • If a KM approach is used, it is suggested that different cases be presented, in particular within the EPEE Workshops (or on the CIGRE Website) • There could possibly be a joint, multi-utility KM initiative, with the backing of universities • CIGRE could offer a platform for exchange of experience between utilities, and between utilities and universities • A special KM forum could be set up on the CIGRE Website <p>A task force, or a working group, could be established to form a Catalogue of required power engineering knowledge</p> <p>Development of an electronic CIGRE Power Engineering Forum</p> <ul style="list-style-type: none"> • Web access to the Catalogue of EPE knowledge • Access to information of CIGRE activities • Help with the practical problems • Dissemination of tools and standardised test systems |