

CIGRÉ' 42nd Biennial Session (24th – 29th August 2008)

International Experts from around the Globe meet to discuss

'Large High Voltage Electric Systems'

CIGRE's 42nd General Session is an International Conference on Large High Voltage Electric Systems that provides a unique forum for delegates and Exhibitors from around the world which is always held in the beautiful city of Paris. It is probably one of the world's largest Conferences which together with an Exhibition is a 'must attend' event for the transmission and distribution industry professionals. This year the Conference was attended by some 3,000 delegates from 82 countries, a new attendance record and the ever increasing popularity of this event resulted in the Technical Programme being supported by the largest ever Exhibition.

Opening Ceremony

CIGRE 2008 opened with a short address by Yves Filion (CIGRE President) who welcomed the delegates and companions who packed the large auditorium for the Opening Address. A special and very warm welcome was given to the three previous CIGRE Presidents in attendance, namely Jerzy Lepecki (Brazil), Michel Chamia (Sweden) and David Croft (Australia).

The Opening Address was delivered by Andris Piebalgs, Energy Commissioner for the European Union since 2004 who outlined the recently adopted new Energy Policy for Europe as follows:-

“In March 2007 the European Union (EU) became the first region in the world to agree ambitious energy and climate targets. The 27 Heads of State and Government agreed binding targets to reduce greenhouse gas emissions by 20% by 2020, rising to 30% with an international agreement, and to increase the share of renewable energy to 20% of the energy demand over the same period. This was followed in January 2008 when the European Commission (EC) produced an integrated proposal for Energy & Climate Action that included the creation of a European –wide single energy market allowing cross-border competition.

The programme of change in European energy policy established three objectives: -

- An open European gas and electricity market,
- New rules to expand the EU Emissions Trading System, and a
- Directive to enforce the 20% renewable target and agreement with the sustainability standards for biofuels.

The Internal Energy Market (IEM) not only offers competitive energy costs for all citizens it is vital in order to satisfy the environmental aims as electricity companies will no longer be able to increase costs to reflect the carbon price. The lack of competition has allowed

companies to benefit from windfall profits. Electricity markets need policies if the renewable energy commitment of 20% is to be met and also to combat the dual challenges of climate change and energy security. To achieve these objectives the EU need to invest an estimated €900 billion on the electricity infrastructure and €220 billion on the gas infrastructure in the next 25 years.

The IEM package promotes investments to ensure improved coordination between the unbundled Transmission System Operators and the formation of a European Network of Transmission System Operators. This new organisation will be responsible for all operational rules, system security and planning, updating a ten-year development plan for the European network every two years. Consideration is being given to the idea of 'regional system operators' having full responsibility for the operation of transmission systems in four or five Member States but this may not materialize. However, the EC has taken some steps in this direction with the appointment of European co-ordinators for essential projects and later the EC plan to publish a Green Paper on Trans-European networks to determine needs on a Community basis.

Further changes are being sought to ensure that the Internal Energy Market succeeds and this will be achieved by seeking the removal of existing trade barriers. The proposed Community 'Agency for Co-operation of Energy Regulators' often referred to as the 'European Energy Regulator' will address cross-border regulatory issues leaving national Regulators to continue exercising their current range of responsibilities. Standardization of national Regulatory power is required in order to strengthen the co-operation between these national bodies.

In Europe the search continues to strike the right balance between regulation and competition. Electricity, gas and water networks are now regarded as 'essential facilities and natural monopolies'. Therefore the regulator is an unavoidable partner for network companies making decisions that equivocally safeguards the interest of the companies and their customers.

Regulation extends to include Emissions Trading and Renewable packages and whilst the former is easily traded, renewables are more challenging with respect to achieving the 20% target by 2020. These projects will require major subsidies and rules that will allow integration of renewable, grid connection and energy trading. To harness all renewable electricity all the administrative and regulatory barriers linked to its integration must be removed to achieve the energy policy goals.

The reforms in Europe are designed so that electricity systems meet the climate change and energy security challenges by 2020. As the EU has accepted that greenhouse gas emissions will be reduced by 50% by 2050 this means that the electricity system will be carbon neutral by 2050. Further challenges will have to be met by 2050 as the increasing demand for oil will deplete or exhaust this resource. Both in the EU and USA this has led to rapid development of the electric car. These challenges have resulted in the EU forming a group of experts to produce a 'European Road Map' towards a carbon-free electricity system in Europe by 2050.

Finally, attention was drawn to the fact that 1.6 billion people or one-third of the world's population have no access to an electricity supply. Some 67% live in rural areas where this low-income group have no alternative but to use environmentally damaging energy resources like wood and charcoal. Energy helps eradicate poverty and the provision of clean electricity offers the opportunity for greater agricultural productivity, development of small enterprises and increases the chance for education. Hence these are the objectives included in the Millennium Development Goals and the Africa –EU Partnership agreed in December 2007. Infrastructures to promote regional electricity networks are included in the EU-Africa Infrastructure Partnership.”

Yves Filion thanked the Commissioner before giving CIGRE members a brief review of the activities undertaken since 2006. This two-year period has seen the membership increase to over 10,000 and the number of National Committees to 58 with the new Committees in Cyprus and Montenegro. In recognition of their significant contributions to Power Engineering and services on behalf of CIGRE, the CIGRE Medal a new award, was presented to Aldo Bolza (Italy) and João Batista Guimarães Ferreira Da Silva (Brazil).

Before declaring CIGRE 2008 open, Yves concluded his term as President by saying “I am very proud to be part of the CIGRE family. This is a tremendous organisation powered by highly motivated members who are helping to make a difference in society, ending with the Mission Statement that:-

‘CIGRE stands for cooperation, exchange of knowledge and promotion of expertise’

General Session

The Session started with the Opening Panel “Integrating large shares of fluctuating power sources in electric power systems” held on the morning of Monday 25th August. It was given to a series of presentations by speakers from RTE (France), ENEL (Italy) and Vattenfall (Europe) who addressed ‘Sustainability Issues’ as applied to existing transmission systems and distribution networks. The impact of renewable sources of generation and the accessibility to liberalised markets is presenting Transmission System Operators (TSO’s) and Distribution Network Operators (DNO) with major challenges on system operation and security in order to ensure 100% integration. The State-owned Swedish utility Vattenfall who are now the third largest network operator in Germany have some 40% of the country’s installed wind power capacity (9,000 MW) connected to their networks. Many of these wind farms are installed many kilometres off-shore in areas remote from load centres and with a further 14 wind farm applications (4,300 MW) for the Baltic Sea being processed it is proving necessary to construct new transmission lines.

Improvements in the form of the ISET tool have been made that enable day-a-head and short-term forecasts to be made of wind farm output but even so market related measures have to be taken to balance shortfalls in the predicted output. Although Germany has the largest wind farm capacity (23,000 MW) in the world there are no standard rules applicable for the connection of existing and new wind farms.

The latest forecasts from EPRI suggest that the Capacity Factor applicable to wind farms is increasing to values in excess of 40% but 'Wind Power still needs a Dancing Partner'. The role and issues of 'Energy Storage Systems' was reviewed by Professor Geza Roos (McGill University, Canada) who outlined the existing applications of electric and magnetic means of energy storage together with pumped storage and compressed air storage systems. At present case studies are being conducted in the USA and Scandinavian countries using hydro or pumped storage plants to back-up wind power but these schemes need to be cost-effective and satisfy environmental issues. It seems that the 'jury is still out' on a number of possible solutions currently being considered.

The '**Large Disturbances Workshop**' held in the afternoon of Monday 25th August is now becoming a regular feature at the Conference and as in previous year's this key Meeting was very well attended by delegates keen to benefit from shared experiences. Six major system outages formed the basis of the Meeting that was coordinated by Study Committee C2 'Systems Operations and Control'.

The European incident was linked to a major problem in November 2006 on the UCTE interconnected transmission system operated by 29 - TSO's that links 24 countries supplying some 450 million customers. A 380 kV circuit outage coincided with a planned double-circuit outage which resulted in cascade tripping. The UCTE split into three unbalanced and the resulting drop in frequency caused the disconnection of some 15 million customers. This proved to be the most severe disturbance in the history of the UCTE but all supplies were restored within two hours. Subsequent investigation confirmed N-1 security standards were not available, a lack of planned countermeasures and insufficient regional inter-TSO co-ordination.

The presentation from Japan was linked to the shutdown of a Nuclear Power Plant following a severe earthquake (Richter Scale 6.8) although all off-site power supplies were maintained during and after the event. The reactor shutdown and cooling was in accordance with the design specification and there was no environmental impact. Since the incident in July 2007, seismic design standards have been harmonized.

In May 2008, the UK's National Grid was subject to low voltage and low frequency disconnections following the loss of generation totalling 1582 MW as a result of the loss of generating capacity at two power plants occurring within a space of two minutes. Frequency levels were restored in 11 minutes and all customers were re-connected in 40 minutes.

The unprecedented snow and ice storms in January 2008 were featured in the presentation given by the State Grid Corporation of China. This event resulted in transmission line failures in two regional and ten provincial grid systems, damage to 884 overhead lines in the voltage range of 35kV and above and the loss of supplies to some 27 million customers. Due to the determination and ingenuity of the Grid Companies and the mobilisation of some 300,000 staff over six months work was completed within six weeks. Subsequently, action has been taken to upgrade the design standards of all transmission circuits, 110 kV and above with circuit undergrounding at strategic points in key urban areas.

The large disturbance in February 2008 in Florida that resulted in the loss of 4,000 MW was presented on behalf of the utilities involved, Florida Light & Power, Progress Energy and Tampa Electric as the post-fault Report has not yet been published. Initial findings indicate that the primary cause was the removal of two levels of system protection prior to undertaking maintenance hence it was suggested there was a need to renew relay practices and Control Centre co-ordination.

This Workshop concluded with some background information on the decline in reserve generating capacity that resulted in Eskom introducing regional load shedding in 2006 and national load shedding in 2007. Since deregulation in Eskom has seen a steady decline from 25% in 2000 to 5% in 2007 in the reserve margin whilst the annual growth in demand has continued to increase and Eskom lack interconnections with neighbouring countries. Furthermore, reserve coal stocks have also declined from 20 days to 11 days supply. Faced with these escalating problems Eskom with the support of the Regulator deemed it prudent on 24th January 2008 to inform the Government that the entire power system was in danger of complete collapse. The situation is likely to continue with a load growth of 4% per annum and the need for an additional 40 GW generating capacity in the next 20-25 years. This incident highlights a number of issues linked to regulatory regimes, restrictions on new power plants and long-term economic and load growth projections.

Technical Programme

The four-track programme of Technical Meetings started on Tuesday 26th August 2008 allowing the delegates the opportunity to select the Specialist Subjects – “Preferential Subjects” of their choice from the 16 - Discussion Group Meetings. These Meetings discuss the Papers submitted for each of the Preferential Subjects considered by CIGRE’s Study Committees. From the some 650 Papers received by the CIGRE Technical Committee from authors around the world 422 Papers were selected for discussion. In advance of the Technical Meetings, the Study Committee’s Special Reporter identifies a number of common key issues that the authors and contributors are invited to address at each Technical Meeting.

The following Table shows the timetable for the Technical Meetings during the four-track programme that runs from the 26th to 29th August 2008

Date	Special Subject (No. of Technical Papers submitted to the Study Committee for each Session)
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Tuesday 26 th August	A2 - Transformers	(30 Papers)
	B2 - Overhead lines	(25 Papers)
	C5 - Electricity Markets & Regulation	(30 Papers)
	D2 - Information Systems and Telecommunication	(26 Papers)
Wednesday 27 th August	A1 - Rotating Electrical Machines	(18 Papers)
	B1 - Insulated Cables	(24 Papers)
	B5 - Protection and Automation	(23 Papers)
	C1 - System Development and Economics	(27 Papers)
Thursday 28 th August	B3 - Substations	(24 Papers)
	C2 - System Operation and Control	(32 Papers)
	C3 - System Environmental Performance	(23 Papers)
	D1 - Materials and Emerging Technologies	(24 Papers)
Friday 29 th August	A3 - High Voltage Equipment	(31 Papers)
	B4 - HVDC and Power Electronics	(30 Papers)
	C4 - System Technical Performance	(28 Papers)
	C6 - Distribution Systems and Dispersed Generation	(27 Papers)

Tuesday 26th August

A2 – Transformers – This Discussion group meeting which was attended by some 350 delegates attracted 30 Papers which were presented in three Preferential Subjects as follows:

1 – Performance in Service of New Insulation Systems – The need for an environmentally acceptable alternative to mineral oil was stressed and resulted in discussions of the characteristics and performance of ester fluids used for transformer insulation and cooling. It was reported that ester fluids are less tolerable to oxidation and moisture than mineral oil and the higher viscosity is a factor to be considered in the design of the cooling system. The higher dielectric withstand capability of SF₆ insulation systems is an economic solution for HV switchgear; and large rated transformers were included in contributions from authors in Korea and Japan and a further contributor outlined the merits of silicone immersed transformers. Finally, a Paper by authors from Pauwels (Belgium) and Du Pont (USA) detailed the merits of using a hybrid insulation system to produce a compact transformer for substations to be installed in dense urban areas.

2. Reliability and Risk Assessment of Transformers in Service – A total of 19 papers prepared by authors from 18 countries were selected for this topic linked to transformer maintenance refurbishment, repair (on and off-site) and life expectancy. The advantages of standardisation in terms of ratings were presented by RTE (France) and REE (Spain) while

Hydro-Quebec outlined their condition assessment methods used to produce a health index. A number of the contributions recorded the methods and analysis used following diagnostic testing linked to dissolved gas analysis (DGA), paper degradation and oil corrosion. Although transformers in general are reliable power system components monitoring techniques are widely used to assess remaining life in view of the high replacement cost and long delivery time for new units.

3. Reactors (shunt, shunt with regulation, series, neutral) and related items – Although only six Papers were selected this topic attracted more contributions and discussions the reports indicating that the in-service failure rate of reactors is somewhat higher than for transformers. In summarising this part of the Meeting the Special Reporter concluded there was an urgent need to establish methods to determine reactor condition and life expectancy as many large reactors fail to reach their expected life-span.

B2 – Overhead Lines -There was a large audience for this group meeting for which 25 Papers were accepted. This discussion was held by considering two Preferential Subjects.

1. Increasing the Capacity of Overhead Lines – The number of contributions and the general discussion in this Session reflected the industry's keen interest to optimise the load transfer capacity of overhead lines. The value and extensive use of ambient temperature monitoring techniques to provide real-time ratings together with the increasing interest in AC to DC line conversions were the two topics that created most interest. Surprisingly, interest, references to and applications of the now widely available high temperature low sag conductors was low key.

2. Solutions to improve the availability of overhead lines - The contributions to this Session represented the global interest in diagnostic methods and testing of towers, conductors and transmission line components. Among the more interesting contributions was the de-icing system used by Hydro-Quebec, the tower structure grading system developed for the UK's National Grid which was similar to the system recommended by KEMA for extending the service life of overhead line towers using a system based on 10-year spans,

C5 – Electricity Markets and Regulation – This group meeting was attended by some 200 delegates keen to benefit from the variety of prepared and spontaneous contributions. This Session covered the subject under three Preferential headings. Topic 1 being held in conjunction with D2 (Information Systems and Telecommunications)

1. Information & Communication Systems in the Deregulation of the Electric Sector – This Session gave delegates an overview of the information systems that have been developed by a number of vendors for the energy markets around the world. Systems vary considerably as the size of energy markets vary and there is a lack of standardisation. The customer option adopted by the Nordic Market namely the 'Fixed Price Return Option' appears to be successful as there has been a 24% reduction in demand at times of peak energy costs.

2. Incentives for investing in Generation and Transmission in an Electricity Market environment – The contributions related to this topic covered a wide range of issues from a lack of reserve generating capacity in Israel, a call for improved coordination between generation and transmission system operators in Norway to a plea for greater scrutiny of the market rules by Regulators in Australia and New Zealand. Italy, a net importer of energy from the UCTE has a vested interest in the incentives for more investment in interconnections and in India, where there are massive investment programmes in generation and transmission there are problems in allocating network and loss costs.

3. Interactions between System Security Rules and Market Rules – Contributors from Japan, Norway, and France together with commentary on the Europe market shared their experience of the IT systems in place to aid the development and operation of the established energy markets. Three companies PJM, AREVA T & D and ABB each contributed expressing their different systems and software together with drawing attention to a number of concerns. For example, PJM outlined the Advance Control Centre Architecture, AREVA referred to the standardization that is taking place enabling software providers to integrate system using components from different vendors while ABB expressed the need for data exchange between existing SCADA/EMS systems and Marketing Management System (MMS).

D2- Information Systems and Telecommunications – There is some overlap in the presentations linked to Study Committees C2 and D2 but almost 200 delegates were present for the discussion period that was arranged around one Preferential Subject..

1. Frameworks for the governance and the management of the information and communication systems in the Electric Power Utilities. – This subject was addressed by excellent contributions on the IT systems used by utilities in Mexico, France, Thailand, Russia, Spain, Croatia, Malaysia and Korea. Information security, a subject being addressed by Working Group D2.22 with a membership from Sweden, Norway, Italy and France was also presented. EDF gave delegates a review of their ‘survival kit’ on cyber security an issue of increasing concern for utilities.

Wednesday 27th August

A1 – Rotating Electrical Machines – The A1 Discussion attracted over 150 delegates to benefit from the two consecutive sessions the first addressing the Papers selected and the second a Panel Session on Giga-Watt Generators.

1. Developments in electrical machine design and experience in service – There were 26 contributions to this period although the number of Papers (16) for this Session was the lowest. Nevertheless, the Papers from utilities and manufacturers in 12 countries addressed new developments and service experience. Design changes included the introduction of generator stator core teeth ventilation which allows increased output without exceeding design temperature limits. Improved design tools and diagnostic test equipment has resulted in a measure of de-skilling, giving specialist staff more time to analyse test results and

undertake post-fault investigations. Partial Discharge equipment has reached the maturity stage and is now used in monitoring and inspection programmes.

2. Giga-Watt Generators – This Session gave the manufacturers of turbo-generators and hydro-generators the opportunity to outline their current design philosophies at a time when the demand for nuclear, thermal and hydro power plants is rapidly increasing. The maximum turbo-generator plant ratings currently available from manufacturers are Mitsubishi (1600 MVA), Alstom (2000 MVA), Toshiba (1000MVA), Doosan (1100 MVA), GE (1560 MVA), Hitachi (1570 MVA) and Electrosila –Russia (1500 MVA). The maximum ratings for hydro-generators are Alstom (800 MVA), VA Tech Andriz (300 MVA), Electrosila (720 MVA) and Voith Siemens (840 MVA). The main feature of this interchange of design standards was that manufacturers are continuing to use basic technologies and there is no indication that generators designed with super conductors are in the market place.

B1 – Insulated Cables - This subject which attracted a large number of contributions was attended by between 250 and 300 delegates in a Discussion meeting with three Preferential topics.

1. Technical challenges overcome in newly installed underground and submarine transmission systems. - There were two contributions on superconducting cables installations but reservations still exist on the factory testing and the procedures linked to the liquid nitrogen coolant. Installation of cable systems is a time-consuming procedure and more efficient methods are being sought in terms of greater cable drum lengths and reducing the number of joints per circuit. Interest in submarine cables with XLPE insulation was limited but it was reported that the first 245 kV and 420 kV XLPE insulated cable systems are already in operation.

2. Current and future methods supporting efficient operation, maintenance and upgrading/replacement decisions of cable systems. - Online Partial Discharge (PD) was discussed at length in view of the problems of distinguishing noise from internal discharge acceptance levels, sensitivity and standardized test procedures, Concerns still remain on XLPE cable and the accessories and there was a call for improved quality control during cable manufacture and jointing work

3. Future technical solutions of underground and submarine transmission systems addressing environmental and economical considerations. - Different methods of reducing the EMF from cable circuits by incorporating integrated magnetic shielding, using a self cancelling three-phase six core cable configuration. It was also interesting to note coordinated efforts being presented by the three cable manufacturers, Nexans, Silec and Prysmian. There was only one example from Argentina that addressed the environmental issues of installing cables in dense urban areas.

B5 – Protection and Automation – This group meeting was arranged in two parts and during the course of the day the peak attendance was between 350 and 400 delegates.

1. Impact of IEC 61850 -9-2 process bus on protection and system automation.- The application of IEC 61850 9-2 was the focus of attention and in addition to the six Papers accepted for this session from authors in Europe, USA, Canada and the Middle East this discussion period attracted 39 prepared contributions. As yet there were no reports to confirm that a fully bus-based architecture had been commissioned but there has been progress towards this goal. Interoperability remains a problem and the integration of software modules from different vendors may require more standardization.

2. Life cycle management of protection and control systems- Utilities and manufacturers authored the 17 papers selected for this session that also had 48 prepared contributions. The current trends result in the application of more software in P & C systems and there is greater standardisation in the hardware used. However, utilities lack tools for managing P & C system problems that vendors need to address together with facilities for automated testing and greater security. It should be noted that there was evidence to confirm that utilities and manufacturers are already working together to develop the tools to monitor and manage these key operational and control system assets.

C1 – System Development and Economics – This Study Committee accepted 27 Papers which formed the core to the discussion which was arranged in three Preferential Subjects

1. Development and justification of transmission investment. – Reports were presented that there is increased cooperation between TSO's within and outside national boundaries which is considered necessary for the long-term planning of large interconnected transmission systems. The impact of new technologies and the reliability of systems were discussed and RTE (France) are just one of the many utilities who have installed Phase Shifting Transformers in order to optimise load transfer capacity. Utilities from the USA, Germany, Portugal and Denmark all reported on their strategies with regard to short, medium and long-term development plans.

2. Design Strategies to make power systems resilient to failure including tools to enable effective planning. - The increasing use of underground cables is giving TSO's the need to source reactive power and network operators in Brazil, France USA and Canada reported that they have contracts with hydro power plants to allow the plant to be switched from generators to synchronous condensers at times when additional reactive power is required. Voltage instability is a problem experienced by a number of TSO's and in Brazil voltage control issues are inherent in a country larger in area than Europe and the USA combined, having a peak demand comparable to the RTE in France. In Korea where the capital city Seoul consumes 43% of the peak demand KEPCO have overcome voltage and fault current issues by installing FACTS devices.

3. Adequacy and security in generation and transmission in the context of the future generation mix and location. – The role of wind energy was the key issue in this discussion period and there is a need to develop new methods to evaluate and report on reliability. European utilities proved to be the main contributors to this session and in France research indicates that wind output is 25% during winter but this drops to 10% in the summer. France

expects to invest 1 billion euros in network development by 2020 to facilitate wind penetration. This prompted discussion on network investment on transmission system development that should be used for conventional generation unless the output from the source of renewable energy is significant.

Thursday 28th August

B3 – Substations – A total of 24 Papers addressing two Preferential Subjects which were selected for this well attended meeting.

1. Lessons learned on substation asset use optimisation. – In this changing environment, an increasing number of ageing assets still require maintenance, are retrofitted or replaced. Some 40% of minimum oil circuit breakers in the voltage range 72.5 kV to 100 kV are still in service 30 years to 45 years after commissioning. Asset management on ageing components is required to maintain reliability and reduce maintenance costs. Modern HV equipment is reliable and requires less maintenance and this has resulted in time-based maintenance being replaced by condition-based or reliability-centred maintenance policies.

2. New Challenges in Substations – The majority of the Papers and contributions received addressed this subject. Australian and Japanese utilities are reportedly in phase and both have standardized substation design while a Spanish contribution outlined a means of improving the visual appearance of substations. The demand for Gas Insulated Lines (GIL) is increasing with reported applications in Germany and China linked to a windfarm application and a hydro power plant transmission tunnel respectively. Connecting renewable energy generation projects particularly for on and off-shore windfarms require substations and the design of off-shore substations to withstand the harsh operational environment is particularly challenging. These have to accommodate considerations linked to construction, testing, fault repairs and maintenance of the primary and secondary equipment.

C2 – Power System Operation and Control – For this subject the largest number of Papers were selected (32) and the discussion which attracted over 150 delegates was divided into three Preferential Subject parts.

1. New applications in system operation and control for detection and mitigation of system conditions. - It is now acknowledged that Wide Area Measurement Systems (WAMS) are an accepted technology to increase power system transfer capacity without jeopardizing system security. Examples were presented by contributors from Russia, Korea, Finland and India. Brazilian utilities are using ORGANON software for operational planning, steady state and security assessment which is able to construct security regions for every area at 15 minute intervals. A US contributor presented a vision of a conceptual design to realise a self-healing power grid via a smart-wide distributed IT infrastructure

2. Evolution of operational reliability standards in the context of open markets and reduced security margins. - This meeting discussed nine Papers and these generated many questions

linked to the challenge facing system operators during normal and disturbance situations due to the distributed generation and wind power production. Operator training is an industry need and there is increasing evidence to confirm that this is now a coordinated exercise between TSO's, DNO's and generating companies (GENCO's).

3. Impact on system operation and control of the integration of large wind generation – Contributors from various utilities outlined the wind forecasting or power production procedures. Apparently in the USA real-time data is not available whilst in Japan's Tohoku area forecasting is 70% accurate in winter and 90% in summer, values being within a $\pm 10\%$ accuracy. In Ireland, wind farm output totalling 602 MW from the 977 MW generators installed is subject to controls as all wind farms with an installed capacity of 10 MW are required to fulfil Grid Code requirements. Finally, in Japan, limited wind power output is now being combined with energy storage in NAS batteries.

C3 – System Environmental Performance – This meeting proved to be the least popular with delegates the attendance being less than 100, although the selected contributions were addressed in three Preferential Subjects.

1. Implications of climate change on the electric power system – The contributions accepted lacked a common theme with utilities from Japan, France, Italy, China, Switzerland, Portugal and Russia presenting a diverse range of topics linked to keeping the CO₂ concentration below the level of 450 ppm which currently is considered a 'safe limit'. For example, Japan is taking action in the form of education, carbon sequestration and fuel mix changes, China is increasing the use of renewable and nuclear generation and Brazil is using bio-electricity from their sugar-cane process.

2. Strategic environmental assessment methodologies in the planning of system expansion- This session gave utilities an opportunity to discuss their policies and reporting disciplines with respect to environmental assessments. Eskom in South Africa started preparing Strategic Environmental Assessments in 1969 and by 1990 this was an established practice in Italy (TERNA), Canada (Hydro-Quebec), Sweden (Vattenfall) and Brazil (EPE). In the UK, National Grid prepare a Lifecycle Economic and Environmental assessment of the Transmission System (LEETS). Work in this field has been extended to include Assessment studies for HVDC submarine cable circuits.

3. Power system and large urban area environments. – This part of the meeting presented three different approaches to the environment with RTE (France) evaluating the environmental benefits associated with undergrounding 225 kV cables and stating a commitment to consider further undergrounding projects. Similarly, a combined theoretical study by EOS (Switzerland) and TERNA (Italy) was reported on the design of a new transmission system interconnector via an HVDC/HVAC overhead line and XLPE insulated cable. An innovative study in Japan has considered using the high ambient temperatures for

heat-pump applications which among other benefits would reduce the number of deaths due to heat stroke.

D1 – Materials and Emerging Technologies – This broad-based subject attracted 24 Papers from authors around the world each addressing a variety of topics. The subject was presented in three Preferential sections each of which was very well attended.

1. Status of emerging technologies for power systems. – This session was dominated by contributions on superconducting technologies and American Superconductors addressed the value of superconducting wires to limit short-circuit currents. Papers from China and Japan presented the development work undertaken on MV cables (35 kV) and on superconducting fault current limiters rated at (90 MVA and 100 MVA respectively). To reinforce the UES in Russia consideration is now being given to a high-capacity tidal plant (800 – 1200 MW) which in combination with a pumped-storage plant could supply the UES via a $\pm 500/750$ kV connection. The potential for landfill gas power generation was discussed by authors from Brazil.

2. Diagnostic of material properties in power equipment: Development and practical experiences. – The presentations addressed the diagnostic testing practices associated with cables, transmission line components, switchgear and transformers. Papers submitted on behalf of all utilities in Spain and Australia reported on the merits of partial discharge testing used on XLPE cables up to 150 kV while the Netherland utilities reported on the techniques used for condition assessment of aged HV cables (150 kV). The utilities from Japan outlined their on-site monitoring and diagnostic techniques applied to gas insulated switchgear. The diagnostic equipment and tests applied to power transformers was covered by contributions that addressed, dissolved gas analysis (DGA), the measurement of furans in mineral insulating oil and the use of Ultra Wide Band PD sensors installed within the transformer.

3. Challenges for materials in future power systems. – This different topics raised in three Papers from authors in Japan, Australia and South Africa were discussed. Development work in Japan is linked to the development of MgO/LDPE nanocomposite and electrical insulating material for use in DC high field electrical insulation. In general, transmission line components are designed and operate in temperate climates, but Powerlink Queensland reported their concern with the reliability of polymeric composite insulators installed in a tropical environment. Eskom (South Africa) due attention to the adverse performance of silicone rubber composite insulators installed in conditions of harsh marine pollution suggesting there may be a need to consider changes to the dimensions of insulators.

Friday 29th August

A3 – High Voltage Equipment – This subject addresses all aspects of high voltage equipment therefore the Papers selected for this meeting covered a wide spectrum and so the discussion addressed three Preferential Subjects.

1. Managing an ageing high voltage asset population. – Asset management attracts considerable interest in view of the capital involved in the replacement of HV equipment. The first discussion centred on the replacement of HV switchgear and it appears that many of the major utilities are seeking ways to extend the useful life of switchgear. The utilities in Germany are establishing strategies for end of life assessment, the UK's National Grid are following the same path in respect of the air-blast switchgear that has been in operation since the 1950's/1960's. In Russia, the utilities face a similar problem with 40% of the HV switchgear population having been in commission for 25/30 years. The Brazilian utilities now have a problem with HV switchgear that has been operated over and above the design capabilities as a result of the excessive growth in demand. RTE reported on their work to identify diagnostic testing for 400 kV VT's and CT's to overcome in-service failures while in Japan similar investigatory work on test procedures is in progress with respect to gas leakage on GIS.

2. Developments in testing and verification of HV substation equipment. - Included in this part were reports from three Working Groups on their work in support of the Study Committee and nine Papers were in accord with this topic. In view of the increasing use of UHV systems the testing procedures of 1100 kV GIS switchgear was presented by ABB and Areva and authors from Siemens discussed dielectric testing of UHV metal-oxide surge arresters. Powerlink Queensland who stated installing hybrid GIS units some seven years ago presented the background to their decision to opt for on-line monitoring of this equipment.

3. Acceptance and experience of new substation equipment and techniques. - A total of ten Papers were selected including two Reports from Working Groups on specialist topics. There was no common theme to the remaining contributions that covered optical voltage and current transformers for HV, EHV and UHV applications, non-conventional new generation electronic current transformers (ECT's) presented by Coopers (USA) to the experience of using efficient anti-resonant 220-550 kV voltage transformers reported by authors from Russian utilities.

B4 – HVDC and Power Electronics – The current escalation in the number of major HVDC projects planned or currently under construction around the world prompted huge delegate interest, these technologies being discussed in three Preferential Subject periods.

1. HVDC transmission projects including applications at 800 kV. - The international interest in HVDC prompted teams of authors from some ten countries to submit Papers plus the Study Committee's Report on the Reliability of HVDC systems throughout the world for 2005-2006. Knowledge and experience on the operation of HVDC systems that have been in operation for up to four decades were exchanged, the maintenance strategies adopted plus reports on the feasibility studies linked to new major interconnections. With the need for increased power transfer capacity the design and testing of equipment for voltages of 800 kV HVDC and above were also discussed.

2. FACTS applications and new developments. – Two of the four Papers reported on the advantages and benefits of installing Static VAR Compensators that Powerlink Queensland

and TransGrid in Australia have been installing since the 1970's and RTE in France who more recently installed SVC's to overcome poor voltage conditions in Brittany. Russian utilities outlined their research into the merits of FACTS devices to overcome a number of the existing transmission system operational problems. For the future delegates were given a presentation by ABB who have developed a Statcom SVC light device combined with a high performance battery storage unit.

3. New power electronic equipment development and applications. - Contributions came from the leading manufacturers Areva and Siemens outlining the HVDC systems designed for the interconnection and integration of large windfarms to existing transmission systems. Spanish utilities took the opportunity to report on a new active earthing system for distribution networks using a new electronic device based on a multi-frequency power converter combined with the protection and control systems.

C4 – System Technical Performance – The number of Papers (27) submitted for to this Study Group for presentation and discussion were discussed under a single Preferential topic held in three periods as reported below.

1. How can system technical performance be specified, evaluated and improved? - In addition to Reports for a Working Group and a Joint Working Group (CIGRE/CIREN/UIE) a further 25 contributions covered topics including insulator selection for polluted areas, lightning surge phenomena on 300 kV GIS substation equipment and the value of improved weather data on the lightning performance on the Romanian transmission system.

EDF/RTE reported on their theoretical and field studies on grounding electrodes for transmission towers while TERN (Italy) reviewed their technical/economic studies linked to the optimising and positioning shunt reactors on the transmission system to improve power system restoration and voltage regulation. Chinese utilities can now benefit from a recently completed statistical analysis of power system component reliability based on the information available from a five-year period.

C6 – Distribution Systems and Dispersed Generation – The global interest in renewable forms of power generation resulted in 26 Papers being selected by the Study Committee who managed this discussion period in three Preferential subject sessions.

1. Development and operation of power systems incorporating Dispersed and Renewable Energy Resources (DER/RES).- The majority of the contributions were reports on theoretical studies funded by the European Community and Governments which covered every aspect of the technical issues created by dispersed generation. Authors from Greece presented the problems of connecting 870 MW of wind power on island and mainland networks while in New Zealand a proposed windfarm having a capacity of 200 MW had to be scaled down to 58 MW to enable connection to the extremity of a weak rural network.

2. Concepts and technologies for active distribution networks. – The Study Committee allocated five Papers for this session and all proved to be reports on the theoretical studies

undertaken by Universities and Government funded utility research projects. Long-term the results of these investigatory studies will prove invaluable to utilities faced with wide-scale dispersed generation.

3. Storage to support DER and RES integration in distribution grids and stand-alone systems. University research teams from Germany and Norway contributed to this session the latter reporting on a wind-hydrogen-diesel energy system. CESI from Italy are currently developing a hydrogen-storage system but the only utility-scale storage system fully developed was presented by Japan's Tokyo Electric Power Company (TEPCO). This exciting Hybrid Sodium-Sulfur (NAS) storage battery system to be installed at Rokkasho Village in Northern Japan will comprise 51MW Wind Power (34 units rated at 1.5MW) and a 34 MW NAS Battery Storage (17 units rated at 2 MW).

CIGRE 2008 Technical Exhibition

The CIGRE 2008 Technical Exhibition conveniently accommodated in close proximity of the Conference Auditoria attracted a record number of exhibitors (128) from 20 countries with particularly a large presence of companies from Germany, France, Canada and the USA. In addition to the leading plant and equipment manufacturers of transmission equipment, namely, ABB, AREVA, Siemens and Toshiba all the major manufacturers of underground cables were represented. Therefore, delegates had the opportunity to update their knowledge on all leading technologies in every topic associated with their professional business activities. The list of Exhibitors present is appended to this Report but an approximate breakdown of these exhibitors indicates that over 50 companies were linked to Test Equipment and Services, Protection Control and IT products and services and Diagnostic Monitoring Equipment and Services.

This year the Exhibitors were keen to display the equipment and technologies that have been developed to address the global interest in sustainable energy systems. For example, Areva chose the slogan 'Smart Technology for a Greener Future' for their booth that included smart automation solutions, a demonstration of their dynamic stability system using phasor measurement and their low mass F-35 170 kV GIS. ABB addressed substation automation with a new product that links network management to market management, HVDC light power cables while taking the opportunity to report on the ELK 5 – 1100 kV switchyard commissioned in China this year that includes the most compact 1100 kV GIS. GE Energy featured 'Smart Grid' technologies via a suite of integrated solutions specifically designed to optimise the performance and capability of the existing transmission system or 'Unleash the Grid's Potential Performance'. Toshiba prominently promoted their gas-insulated transformers which addressed their booth's slogan 'Engineering in harmony with the Environment' together with the latest protection, control and automation products. Among many first-time exhibitors American Superconductors were able to give delegates an insight into this cable technology. This was supported by details of the world's first HTS

transmission cable manufactured by Nexans that is the 138 kV interconnector between the Long Island Power Authority and Holbrook Substation.

Siemens presented ‘Answers for Energy’ with the HVDC Plus Power Module designed specifically for off-shore windfarms together with the range of gas insulated switchgear available from 72.5 kV to 550 kV. Also featured was the Gas Insulated Line (GIL) a major Siemens development that is now receiving contracts from utilities seeking to underground key transmission lines in city areas and in close proximity to Civil Airports. With increasing interest in optimising system capacity, cable manufacturers chose this Exhibition to display their monitoring systems with NKT Cable featuring the ‘VALCAP Grid Monitoring’ system for overhead line and underground cable applications and the Nexans the CAT – 1 Transmission Line Monitoring System. The Japanese consortium of manufacturers, Japan AE Power Systems Corporation displayed product information for power plant and transmission system stability, details of the compact high performance GIS and their vacuum monitoring device all linked to their ‘Environment and Reliability’ slogan.

Among the new developments identified was the Jarylec[®] GA and Jarylec[®] GT two additives to optimize the performance of mineral oils in power transformers marketed by ARKEMA, the Hexaformer from Sweden and the Distributed Temperature Sensing Systems offered by LIOS Technology used recently on HV cable system that supplied the Olympic City in Beijing. The international interest in this event is increasing and manufacturers from China at CIGRE for the first time and keen to increase their export market included Kangxing Cables, Nanjing NARI – Relays Electric Company and Nantong Shenma Electric Technology.

Finally, the Norwegian utility, Statnett one of five utility exhibitors presented comprehensive details of their largest ever project, the world’s longest submarine cable electricity interconnector. The NorNed 580 km (360 miles) cable having a load transfer capacity of 700 MW recently commissioned between Norway and The Netherlands will link Norway to the European electricity market.

Summary

CIGRE has an increasing membership that continues to play a major role supporting electricity industry professionals around the world by sharing knowledge, experience and developing the industry’s engineering design, construction operation and control standards. Although the CIGRE General Sessions attract an increasing number of technical contributions, includes a large comprehensive Technical Conference Programme and Exhibition, it still retains a unique atmosphere among the international attendees from all sectors of the industry from universities to the utility end user.

This experience is encapsulated in the following sentence expressed by a Russian delegate at CIGRE 2008 -

“The spiritual component at CIGRE is stronger than the commercial component”

CIGRE 2008 brought to an end Yves Filion's term in Office as CIGRE President and whilst acknowledging his tremendous contribution to CIGRE during the past four years, all members will now wish the incoming CIGRE President, André Merlin, (Past-Chairman of CIGRE's Technical Committee) every success for the future.

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For more information on CIGRE visit www.cigre.org

Schedule of Exhibitors

ABB	SWITZERLAND
ALBATROZ ENGINEERING	PORTUGAL
ALROC SAS	FRANCE
AMA – SYSTEMS	GERMANY
AMERICAN SUPERCONDUCTORS	USA
AREVA T & D	FRANCE
ARGILLON	GERMANY
ARKEMA FRANCE	FRANCE
ARTECHE	SPAIN
B21 GROUP VIVERES	FRANCE
BARCO NV	BELGIUM
BAUR PRUF-UND MESSTECHNIK GMBH	AUSTRIA
BCP BUSARELLO + COTT + PARTNER AG	SWITZERLAND
BPL GLOBAL EMEA	FRANCE
BRUGG CABLES	SWITZERLAND
CABLECURE OF UTILX LTD	GERMANY
CEDRAT	FRANCE
CESI SPA	ITALY
CHAUVIN ARNOUX	FRANCE
CIGRE (UK) NEXT GENERATION NETWORK	UNITED KINGDOM
CIREN	BELGIUM
CYME INTERNATIONAL T&D INC	CANADA
DALEKOVOD	CROATIA
DIGSILENT GMBH	GERMANY
DILO ARMATUREN UND ANLAGEN GMBH	GERMANY
DM SYSTEMS	UNITED KINGDOM
DOBLE ENGINEERING COMPANY	NORWAY
DOW WIRE & CABLE	SWITZERLAND
DYNAMIC RATINGS PTY LTD	AUSTRALIA
EDF	FRANCE
EFACEC	PORTUGAL
ELCON	SWEDEN
ELECTRIC ENERGY T & D MAGAZINE	CANADA
ELECTROCON INTERNATIONAL	USA
ELEKROINSTITUT MILAN VIDMAR	SLOVENIA
ELEKTRO MOTOREN UND GERATEBAU BARLEBEN GMBH	GERMANY
ELPROS D.O.D.	SLOVENIA
ENERGY SUPPORT	GERMANY

ETNA INDISTRIE	FRANCE
EURO SMC S.A.	SPAIN
FCI COMPOSITE INSULATORS	SPAIN
FISO TECHNOLOGIES	CANADA
FUGRO GEOID SAS	FRANCE
G.A.S. GMBH	GERMANY
GE ENERGY	UNITED KINGDOM
GLOBAL INSULATOR GROUP	RUSSIA
HAEFELY TEST AG	SWITZERLAND
HAPAM B. V.	NETHERLANDS
HEXAFORMER	NETHERLANDS
HIGHVOLT	GERMANY
HSP HOCH SPANNUNGS GERAETE	GERMANY
HYDRO QUEBEC / IREQ	CANADA
IBERDROLA INGENIEWRIA	SPAIN
ICMET CRAIOVA	ROMANIA
IEEE PES	USA
INGETEA TRANSMISSION & DISTRIBUTION	SPAIN
IPEC HIGH VOLTAGE LTD	UNITED KINGDOM
IPH	GERMANY
IPS	NETHERLANDS
IRIS POWER LP	CANADA
ISA EUROPA SARL	FRANCE
ISKRA	SLOVENIA
JAPAN AE POWER SYSTEMS CORPORATION	JAPAN
JST TRANFORMATEURS	FRANCE
KANGXING CABLE LTD	CHINA
KELMAN LTD	GERMANY
KEMA	NETHERLANDS
KINELECTRICS INC	CANADA
KOCOS MESSTECHNIK AG	GERMANY
KONCAR ELECTRICAL INDUSTRY INC	CROATIA
KSANDR	NETHERLANDS
LAPP INSULATOR GMBH & CO KG	GERMANY
LIOS TECHNOLOGY GMBH	GERMANY
LORUNSER AUSTRIA GMBH	AUSTRIA
LUMPI-BERNHOF DRAHT –UND SEILWERK GMBH	AUSTRIA

MANITOBA HYDRO RESEARCH CENTRE	CANADA
MASCHINENFABRIK REINHAUSEN GMBH	GERMANY
MAXWELL TECHNOLOGIES SA	SWITZERLAND
METAL DEPLOYE RESISTOR	FRANCE
MIDTRONICS	USA
MOMENTIVE PERFORMANCE MATERIOALS	GERMANY
MORGAN SCHAFFER INC	CANADA
MOSDORFER GMBH – LORUNSER AUSTRIA	AUSTRIA
MTE METER TEST EQUIPMENT	SWITZERLAND
NANJING NARI – RELAYS ELECTRIC CO LTD	CHINA
NANTONG SHENMA ELECTRIC TECHNOLOGY	CHINA
NAREC NEW AND RENEWABLE ENERGY CENTRE	UNITED KINGDOM
NEOPTIX FIBER OPTIC SENSORS INC	CANADA
NEXANS	FRANCE
NKT CABLES GMBH	GERMANY
OMICRON	AUSTRIA
OPAL – RT TECHNOLOGIES INC	CANADA
OPSENS	CANADA
OPTEN GROUP OF COMPANIES	RUSSIA
PB POWER (BPI)	UNITED KINGDOM
PFISTERER	FRANCE
PHENIX TECHNOLOGIES	USA
PMV SYSTEMS BV / DECISION SUPPORT ASSOCIATES	NETHERLANDS
POWER DIAGNOSTIX SYSTEMS GMBH	GERMANY
POWER LINE SYSTEMS INC	USA
POWERTECH LABS INC	CANADA
PPC INSULATORS	AUSTRIA
PROSOFT – SYSTEMS	RUSSIA
PRYSMIAN ENERGIES CABLES	ITALY
PSYMETRIX LIMITED	UNITED KINGDOM
QUINTAS & QUINTAS	PORTUGAL
RIBE AND LDIC GROUP	GERMANY
RTDS TECHNOLOGIES INC	CANADA
RTE – RÉSEAU DE TRANSPORT D'ELECTRICITE	FRANCE
RUGGEDCOM INC	USA
SAMTECH S.A.	BELGIUM
SBB TOWERS	CANADA
SCHNEIDER ELECTRIC	CANADA
SCHNIEWINDT GMBH & CO. KG	GERMANY
SCHWEITZER ENGINEERING LABORATORIES	NETHERLANDS
SDCEM	FRANCE
SEBAKT	GERMANY
SECUCONTROL GMBH	GERMANY

SEDIVER	FRANCE
SEE – REE	FRANCE
SELTA	ITALY
SERGI FRANCE	FRANCE
SEVERON	USA
SIEMENS AG	GERMANY
SILEC CABLE	FRANCE
SOLVAY FLUOR GMBH	GERMANY
STATNETT SF	NORWAY
STRI	SWEDEN
TGS	CANADA
TOSHIBA INTERNATIONAL	UNITED KINGDOM
TRACTEBEL ENGINEERING	BELGIUM
TRANSMISSION & DISTRIBUTION WORLD MAGAZINE	USA
TRENCH FRANCE SA	FRANCE
TYCO ELECTRONICS SIMEL S.A.S.	FRANCE
UCA INTERNATIONAL USERS GROUP	USA
UNITRONICS ELECTRIC	SPAIN
VOGEL; GMBH & CO, KG HEDRICH	SWITZERLAND
WACKER CHEME AG	GERMANY
ZENSOL AUTOMATION	CANADA
ZIV	SPAIN
3M COMPOSITE CONDUCTORS	UNITED KINGDOM

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