

June 27, 2006

**IEEE POWER ENGINEERING SOCIETY
ENERGY DEVELOPMENT AND POWER GENERATION COMMITTEE**

**PANEL SESSION: AFRICA---INTEGRATED GAS AND ELECTRICITY TRANSMISSION PLANNING IN POWER
GENERATION AND ENERGY DEVELOPMENT BENEFITS, AND DEVELOPMENTS IN HVDC ENGINEERING
TECHNOLOGY IN HARNESSING LARGE-SCALE HYDROELECTRIC SITES FOR INTERCONNECTED REGIONAL
POWER SYSTEMS**

Tom Hammons, Pat Naidoo and Bai Blyden

IEEE 2006 General Meeting, Montreal, Canada, 18-22 June 2006

Wednesday June 21, Room 512e 9:00 a.m.-1:00 p.m. and 2:00 p.m-5:00 p.m.

Sponsored by: International Practices for Energy Development and Power Generation[#]

Chairs: Tom Hammons, University of Glasgow, Scotland, UK.
Pat Naidoo, ESKOM, South Africa

Topic: Integrating New Sources of Energy in Power Systems

INTRODUCTION

On behalf of the Energy Development and Power Generation Committee, welcome to this Panel Session on African Integrated Gas and Electricity Transmission Planning in Power Generation and Energy Development.

The Panel Session focuses on integrated gas and electricity planning, the present status and future prospect of electricity infrastructure from the viewpoint of generation and transmission development, policies and lessons from global deregulation, advances in global research, and development (R&D) and strategies to influence Africa's integration into the Global transition to knowledge-based economies.

It will consider regional power pools as an economic development paradigm that leads to improving economical, ecological and technological efficiencies by joint operation of the power systems. The examination of these models remains core to the strategies presented under these series of panel sessions because of the focus they can provide to influence wider institutional integration and in particular academia where core mathematical and technical skill sets necessary for building knowledge-based economies are developed.

[#] Introduction prepared and edited by T J Hammons

Active projects such as the Westcor project representing an initial phase of the large regional South African Power Pool will showcase new milestones in HVDC technology used to harness the large hydro potential contributing to the pool.

Panelists and Titles of their presentations are:

1. Ahmed F. Zobaa, Cairo University, Egypt and Pat Naidoo, Senior General Manager of Transmission Company, ESKOM, Johannesburg, South Africa. Electric Power Development and Trade, and Power Sector Reform in Africa (paper 06GM 0043).
2. Lawrence Musaba, Coordination Centre Manager, Southern African Power Pool, Harare, Zimbabwe; Pat Naidoo, Senior General Manager of Transmission Company, ESKOM, South Africa; and Alison Chikova, System Studies Supervisor, Southern African Power Pool, Harare, Zimbabwe. The Southern Africa Power Pool Plan Development. (paper 06GM1330).
3. Abedalgany Athamney, Research Associate, and Wei-Jen Lee, Director, Energy Systems Research Center, The University of Texas at Arlington. Benefits of Facts Devices for Power Exchange among Jordanian Interconnection with other Countries (paper 06GM0352).
4. Frederick T. Sparrow and Brian H. Bowen. The Impact of West Africa's Natural Gas Prices on Energy Trade and Capacity Expansion (Invited Discussion).
5. Bai K. Blyden, Engineering Consultant, BRM Group LLC, Elk Grove, USA and Wei-Jen Lee, Director, Energy Systems Research Center, University of Texas at Arlington, USA. Modified Microgrid Concept for Rural Electrification in Africa (paper 06GM1159).
6. Neville S. Arachchige Don, President/CEO, International Research Foundation for Development, Inc., Cambridge, USA. Energy Crisis and Development Issues in Africa: A Critical Need of Strategic (Diagonal and Convergent) Approach to Integrate Africa into Global Economy (paper 06GM0682).
7. Arezki Merkhouf, Electromagnetic Team Leader, and Sonjoy Upadhyay, GE Energy, Peterborough, Canada. Variable Frequency Transformer—An Overview (paper 06GM1333).
- 8.. Pat Naidoo, Senior General Manager of Transmission Company, ESKOM, South Africa, D Muftic and R Vajeth, Corporate Transmission Line Design Consultants, Trans Africa Projects, South Africa, I Ijumba, Dean of Engineering, University of Kwa Zulu, Natal, South Africa, P Pillay, Visiting Professor of Machines, University of Cape Town, South Africa and University of Clarkson, Canada and A. F. Zobaa, Assistant Professor, Cairo University, Egypt. Human Resources Developments in HVDC Engineering for Continental Grid Application (Invited Discussion).
9. Pat Naidoo, Senior General Manager of Transmission Company, ESKOM, South Africa; L Musaba, W. Balet, and A Chicova. Southern African Power Pool, Harare, Zimbabwe. Feedback Report on the Short Term Energy Market of the Southern African Power Pool as presented to the 2004 General Meeting (paper 06GM0614).
10. Pat Naidoo, Senior General Manager of Transmission Company, ESKOM, Johannesburg, South Africa. *The Western Power Corridor Project – Status and Feedback Report* (paper 06GM0620).
11. Adnan Al-Mohaisen, General Manager, GCC Interconnection Authority, Saudi Arabia and Satish Sud, Vice President, Power Systems Energy Division, SNC-Lavalin Inc., Montreal, Quebec, Canada. Update on the Gulf Cooperation Council (GCC) Electricity Grid System Interconnection (paper 06GM0385).
12. Invited Discussers.

Each Panelist will speak for approximately 20 minutes. Each presentation will be discussed immediately following the respective presentation. There will be a further opportunity for discussion of the presentations following the final presentation.

The Panel Session has been organized by Tom Hammons (Chair of International Practices for Energy Development and Power Generation, University of Glasgow, UK), Pat Naidoo (Senior General Manager of Transmission, ESKOM, South Africa), and Bai Blyden (Engineering Consultant, BBRM Investments, LLC, USA).

Tom Hammons and Pat Naidoo will moderate the Panel Session.

The first presentation is on Electric Power Development, Trade, and Power Sector Reform in Africa and will be given by A. F. Zobaa and P. Naidoo. Africa, as a continent, possesses adequate energy resources for her development, but energy distribution across the continent is highly uneven. Africa has only begun to reap the benefits potentially available from integrated energy development. Full integration of energy systems is a very long-term task. Many factors have helped or hindered energy cooperation and integration: the existence of markets which will permit payback for investors, international development policy, economic social and environmental pressures, geography and demography, safety and security, governance, human and institutional capacity and the establishment of collaborative forums and regional and pan-African standards. If future progress is to be optimized, it is vital that the lessons of past experience in all these and other, as yet unexplored, areas are learnt. This presentation gives an overview of energy power development and trade and power sector reform in Africa.

Ahmed Faheem Zobaa is an Assistant Professor, Cairo University. He was an Instructor in the Department of Electrical Power & Machines from 1992 to 1997 and Teaching Assistant from 1997 to 2002. He is an Editorial Board member for the Journal *Electric Power Components & Systems*, *International Journal of Emerging Electric Power Systems*, and *International Journal of Computational Intelligence*. He is an Editor for *IEEE Power Engineering Letters* and *IEEE Transactions on Energy Conversion*, and others.

Pathmanathan (Pat) Naidoo is a registered professional engineer, a member of SAIEE and IEEE, a graduate in Electrical Engineering from the University of Durban Westville in South Africa and a postgraduate with an MBA from Samford University in the USA. Presently, Mr. Naidoo is an engineering doctorate student with the Da Vinci Institute for Technology Management.

With twenty-one years of in service experience with Eskom, South Africa, Pat Naidoo is currently the Senior General Manager for Eskom, a member of the Transmission Board and of the Operations Committee of Eskom. In 1994, he received the South African Institute of Electrical Engineers young achievers award. He is married, has two sons and when not at work he enjoys sports, gym and participating in cultural music and drama.

The second presentation is on the Southern African Power Pool Development Plan and has been prepared by L. Musaba, P Naidoo, and A Chikova, SAPP Coordination Centre, Harare, Zimbabwe. The Southern African Development Community (SADC) region is endured with a

lot of power generation potential. Integrated generation and transmission expansion is the objective of this and other power pools. This leads to economic and efficient use of energy resources. Utilities should benefit from the diversity of energy resources in terms of the use of different technology for power generation be it hydro, gas, coal or renewable energy. This is examined. Pat Naidoo will present it.

Lawrence Musaba is the Co-ordination Centre Manager for the Southern African Power Pool in Zimbabwe. He is an IEE Member and Chartered Engineer.

Pat Naidoo is the Senior General Manager for Eskom Transmission, South Africa.

Alison Chikova is with the Southern African Power Pool Coordination Centre, Zimbabwe. He is the SAPP Supervisor for System Studies. He is a Chartered Engineer and a Member of IEEE and IEE.

The third presentation has been prepared by Abedalgany Abedallah Athamneh and Wei-Jen Lee, Energy Systems Research Center, University of Texas at Arlington. It is entitled: Benefits of FACTS Devices for Power Exchange among Jordanian Interconnection with Other Countries.

The transmission system is the backbone of the electrical power delivery system. It is essential to maintain safety and efficient operations of the transmission system on both steady state and transient conditions using different methods to improve overall performance of the power system. Flexible AC Transmission System (FACTS) are effective devices to increase the transfer capacity, improve different stability aspects, and control the power flow especially for the interconnected systems.

The Mediterranean Ring plans to connect electric power transmission grids among the countries that encircle the Mediterranean Sea. Jordan reigns over a strategic location among the middle-east countries. It is bordered with Iraq, Syria, Saudi Arabia, Israel, and the Palestinian Authority Territory. Power transfer capabilities between Jordan and its neighboring countries play an important role in effectiveness of the Mediterranean Ring.

This presentation studies the impact of FACTS on the performance of Jordanian transmission system under different levels of power exchange with Egyptian and Syrian power systems. This will help to determine the appropriate types and locations for FACTS devices to be installed to improve these limits.

Abedalgany Athamneh worked as Protection Engineer at National Electric Power Co. (NEPCO / JORDAN) for 18 months, and at Yaromouk University as Lab and Tutorial Instructor for four years. Currently, he is a PhD student at University of Texas at Arlington. He is looking forward to having more achievements in research at the different fields of the electrical power engineering.

Wei-Jen Lee joined the University of Texas at Arlington, where he is currently a professor, Electrical Engineering Department and Director of the Energy Systems research Center. He has been involved in research on power flow analysis, transient and dynamic stability analysis,

voltage stability study, short circuits calculation, relay coordination, power quality analysis, renewable energy, load forecasting, and deregulation for utility companies. He is also involved in research on the design of integrated microcomputer-based monitoring, measurement, control, and protection equipment for electric power systems.

The fourth presentation is an invited discussion. It has been prepared by Frederick T. Sparrow and Brian H. Bowen. It is entitled: The Impact of West Africa's Natural Gas Prices on Energy Trade and Capacity Expansion. The Authors are with the Power Pool Development Group, Purdue University, West Lafayette, USA.

F.T. Sparrow has been professor of industrial engineering and economics at Purdue University since 1978. He has a Ph.D. in economics and operations research from the University of Michigan. He is director of the Purdue Power Pool Development Group (PPDG) and the Center for Coal Technology Research (CCTR). His interdisciplinary interests focus on energy modeling and analysis.

Brian H. Bowen is associate director of the Power Pool Development Group at Purdue University from where he received his Ph.D. in industrial engineering. He has been at Purdue for twelve years and prior to this he lectured in engineering schools in Africa for 17 years. His research interests are in economic development, and energy planning.

The fifth presentation is entitled: Modified Microgrid Concept for Rural Electrification in Africa and has been prepared by Bai K. Blyden, Engineering Consultant, BRM Group LLC, Elk Grove, USA and Wei-Jen Lee, Director, Energy Systems Research Center, University of Texas at Arlington, USA. Bai Blyden and Wei-Jen Lee will present it.

With 13.4% of the world's population and a land area of 15%, Africa has only 2% of the world's industrial capacity. Its per capita income is only 15% of the world average and consumes only 3% of world energy. A Survey of Energy Resources conducted by the World Energy Council (WEC) in 2004 shows that Africa has more than enough to satisfy all its energy requirements. These include 7.1% of the world's known oil reserves, 7.5% of the gas, 10.6% of the coal and 13% of the hydro. Due to high cost for the construction of UHV/EHV transmission lines, there are needs to develop a balanced Distributed Generation strategy which takes into account future integration with small, midsize and large regional projects. This presentation recommends a bottom up approach through an evaluation of an autonomous or non-autonomous modified MicroGrids concept to provide electricity to local residents and which serve as basic building blocks for future system expansion. Issues regarding to control associated with the integration of MicroGrids to larger systems will be addressed.

Bay K Bladen is currently a Project Manager with the Cummins Power Generation Group responsible for Distributed Generation projects in California where he resides. He most recently served as a Project Manager on the Calpine California Emergency Peaker Program which planned and managed the construction of eleven (45 MW) gas turbine Peaker units around Silicon Valley during the 2001 CA Energy Crisis. He has authored several papers on African

Energy Development (1983-2004). Mr. Blyden presented a technical analysis for a centralized African Power pool with links to North Africa at the first IEEE Region 8 conference held in Nairobi, Kenya, December 1983.

Wei-Jen Lee is with the University of Texas at Arlington and currently is Director of the Energy Systems Research Center and a Professor with the Electrical Engineering Department. He has been involved in research on power flow, transient and dynamic stability, voltage stability, short circuit, relay coordination, power quality analysis, and deregulation of utility industries. He is also involved in research on the design of integrated microcomputer-based monitoring, measurement, control, and protection equipment for electric power systems.

The sixth presentation concerns energy crisis and development issues in Africa and considers a critical Need of strategic (diagonal and convergent) approach to integrate Africa into a global economy. Dr. Neville S. Arachchige Don, President/CEO, International Research Foundation for Development has prepared and will present it.

In face of globalization, Africa cannot advance in the 21st century without integrating its economy into a global production and trading system. Africa integration requires a comprehensive approach which will ignite rapid structural transformation, thereby alleviating poverty and other societal illness. It requires advancement in human development, capacity building and institutional development, thereby reducing social and spatial conflicts and disparities, community empowerment, and attainment of sustainable societies.

Energy security can be achieved through a diagonal and convergent approach, which integrate four critical resource factors: water-energy-technology-knowledge. Integration of these critical factors provides the foundation for African development and transformation. Energy security is closely linked with economy, environment, and society.

This presentation will focus on the followings: overview of the current status of Africa development issues in the light of the energy intensity in terms of production and consumption; examination of energy convergence potentials; and an emphasise of importance of a comprehensive (diagonal and convergent) approach linking water-energy-technology. Such a comprehensive approach is a must to transform Africa towards a knowledge-based continent and integration into the global economy.

Neville S. Arachchige Don is the founder and the president of the International Research Foundation for Development. He is also a professor of Sociology and World Politics at the Cambridge Campus, Minnesota Universities and Colleges, U.S.A. In his early career, he has worked for a number of research organizations, taught at Universities both in Sri Lanka and the United States, and worked as a consultant at the Sri Lanka Institute of Development Administration under the Ministry of Public Administration. He has participated in and contributed to numerous international conferences and forums. Under his initiative, he has organized several world forums in view of the UN World Summits on Social Development, Urbanizing World and Human Habitat, Economy, Environment and Society, and Digital Divide, global Development and the Information Society

The seventh presentation is on a variable frequency transformer and gives an overview. It has been prepared by Arezki Merkhoul, Sanjoy Upadhyay, and Pierre Doyon. The authors are with GE Energy, Peterborough, Ontario, Canada.

The variable frequency transformer is a controllable bi-directional transmission device that can transfer power between asynchronous networks. The construction is similar to conventional asynchronous machines. Electrical power is exchanged between the two networks by magnetic coupling through the air gap of the VFT. This presentation gives an overview .

Arezki Merkhouf joined GE Energy (Hydro), where he is a member of the R&D team. His research activities include analytical and numerical simulation of large rotating electrical machines, numerical and analytical computation of electromagnetic fields, variable frequency transformers, power electronic, and drives. He has a Bachelor Degree from Algeria (1990), a Master Degree from Pierre and Marie Curie (1991), and PhD from Sherbrooke University, all in electrical engineering.

Sanjoy Upadhyay joined GE Energy in 2000 as a member of the hydro generator design team. He is presently involved in system design as relating to hydro power plants. Prior to joining GE he worked for DCL, a consultancy firm in Kolkata, India. His research interests include electrical machines, power electronics, variable frequency transformers, power system dynamics and hydro system dynamics.

Pierre Doyon graduated from L'Université Laval, Quebec City, Canada (1987) and joined GE Energy (Hydro) in 1988. He later obtained a master's degree from University of Toronto, Canada. His fields of interest include hydro generators, variable frequency transformers and optimization techniques.

The next presentation is an invited discussion on human resources developments in HVDC Engineering for Continental Grid Applications. It has been prepared by Pat Naidoo, D Muftic, R Vajeth, I Ijumba, P Pillay and Ahmed F. Zobaa.. The authors are Pat Naidoo (Senior General Manager of Transmission Company, ESKOM, South Africa), D Muftic and R Vajeth (Corporate Transmission Line Design Consultants, Trans Africa Projects, South Africa), I Ijumba, (Dean of Engineering, University of Kwa Zulu, Natal, South Africa), P Pillay (Visiting Professor of Machines, University of Cape Town, South Africa and University of Clarkson, Canada) and Ahmed. F. Zobaa, Assistant Professor, Cairo University, Egypt..

The power transmission grid from the Cape to Cairo has been modeled in power system forward planning studies. With large-scale distributed generation sources, it has been shown that HVDC transmission technology provides the bulk point-to-point power transfers over long distances.

However, HVDC technology requires detailed knowledge of the physics of transmission line engineering, high voltage power equipment dielectric insulation, presence of high currents and importance of the cooling for the power electronics. It also requires the need for control systems engineering for both scheme protection and power control, and an integrated power system operations strategy for areas of weak and strong HVAC optional power flow paths. This will be evaluated in the presentation.

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Naidoo is an engineering doctorate student with the Da Vinci Institute for Technology Management.

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Ahmed F. Zobaa is an Assistant Professor in the Department of Electrical Power & Machines, Faculty of Engineering, Cairo University, Giza, Egypt. He is an Editorial Board member for *Electric Power Components & Systems Journal*, *International Journal of Emerging Electric Power Systems*, *International Journal of Computational Intelligence*, and *WSEAS Transactions on Power Systems*. He is an Editor for *IEEE Power Engineering Letters* and *IEEE Transactions on Energy Conversion*. Also, he is an Associate Editor for *IEEE Transactions on Industrial Electronics*, *Electrical Power Quality and Utilization Journal*, *International Journal of Power and Energy Systems*, *International Journal on Modelling and Simulation*, *International Journal of Energy Technology and Policy*, and *Neurocomputing Journal*.

Dr. Zobaa is a Senior Member of the IEEE Power Engineering / Industry Applications / Industrial Electronics / Power Electronics Societies. Also, he is a member of the Institution of Electrical Engineers, the International Association of Science and Technology for Development, and the International Solar Energy Society

The ninth presentation is a Feedback Report on the Short Term Energy Market of the Southern African Power Pool as presented to the 2004 PES General Meeting . It has been prepared by P Naidoo, L. Musaba, W Balet and A Chikova.

At the 2004 General Meeting in Denver, the Southern African Power Pool shared innovative developments in the establishment of a short-term energy market for members of the Southern African Development Community. With few participating members, the initial trading results were encouraging and impressive. With continued trading to date, an update is provided on results achieved, the challenges and experiences encountered and the plans for enhancement. With technical support from Nordpool, a new spot market platform is under construction.

The Southern African Power Pool clearly demonstrates maturity of the participating countries in sharing and protecting natural resources beyond just the needs and requirements of individual countries. This has a positive contribution to the accelerating impacts from climate change and global warming. The co-operative pool model with competitive trading platforms offers a new arrangement for the electricity supply industry and contributes to lower cost of energy delivered to customers. This will be evaluated.

Pat Naidoo is the Senior General Manager for Eskom in South Africa. He is a Member of the IEEE, the SAIEE and a registered professional engineer.

Lawrence Musaba is the Co-ordination Centre Manager for the Southern African Power Pool. He is an IEE Member and Chartered Engineer.

William Balet is the past Executive Director of the New York Power Pool and currently the USAID Senior Advisor to SAPP.

Alison Chikova is the Senior Engineer at SAPP in charge of Power System Studies. He is an IEE Member and Chartered Engineer.

The tenth presentation discusses the Western Power Corridor Project Report-- Status and Feedback and will be made by Pat Naidoo.

At the 2005 General Meeting in San Francisco, the Southern African Power Pool and NEPAD flagship project, the Western Power Corridor, was presented. This presentation updates the project diary of events, presents the next steps for the pre-feasibility studies and records closure of the first pass planning studies to yield the proposal of extra high voltage DC transmission coupled with run of the river hydro generation.

Pat Naidoo is the Senior General Manager for Eskom in South Africa. He is a Member of the IEEE, the SAIEE and a registered professional engineer.

The final presentation is an update on the Gulf Cooperation Council (GCC) Electricity Grid System Interconnection and has been prepared by Adnan Al-Mohaisen (GCC Interconnection Authority), and Satish Sud.(Energy Division of SNC-Lavalin).

The presentation describes development of the interconnection between the Gulf States (Kuwait, Saudi Arabia, Bahrain, Qatar, UAE and Oman). The interconnection was justified based on reserve sharing between the systems but once built will provide the opportunity for trading electricity between the member countries. This presentation also describes the principal components of the interconnection as well as some of issues which had to be addressed such as creation of the GCC Interconnection Authority, cost sharing and financing before the project could proceed towards implementation.

Adnan Al-Mohaisen has worked in various positions and in the 29 years that he was with the Royal Commission for Jubail & Yanbu, Adnan held 3 senior positions of Deputy Director General in the Planning & Projects, Community Services and Public Services areas. In late 2004, Adnan was nominated to become General Manager for the GCC Interconnection Authority in which he took the position in January 2005. Adnan also headed and participated in various committees in the Royal Commission and other public organizations.

Satish Sud is Vice President of Power Systems in the Energy Division of SNC-Lavalin. He is an electrical engineer with over 36 years of experience and is responsible for the development and

management of the Power Systems Group that undertakes electrical transmission and distribution projects, electrical system and energy studies, master plans, power sector reform and restructuring studies, and economic and financial studies. He has directed numerous electrical generation, transmission planning and system design studies, both in Canada and overseas. He was the project manager for the planning studies to determine the techno-economic feasibility of various interconnection projects where both AC and DC alternatives were considered.

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12. Invited Discussers

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