

Classical and Renewable Power Systems and Electricity Policy

Facing the current energy crisis and environmental issues, better solution for power supply and usage has never been more important. This topic covers a broad area that ranges from classical power flow management and dispatching, generating unit maintenance and reserve margin optimisation, to modern solutions to power supply such as electricity market, smart grids, renewable energy systems and micro-grids.

Generation, distribution and consumption of power all play vital roles in the road to energy efficiency improvement and better resource utilisation. In this research group, research activities under this theme are arranged around these three pillars. Generation dispatching and maintenance scheduling have been and are still being actively investigated.

Power distribution control, rural area electrification and intentional islanding are being studied. Hybrid renewable power generation systems as well as electricity market related researches are also on-going in parallel.

There are several post-doctoral fellows, PhDs and master students working in this area. Future research focus will be the renewable system efficiency and the integration of renewables to the main grid.



Postgraduate studies and bursaries

Opportunities for postgraduate studies and bursaries exist in all aspects of energy efficiency and demand-side management for prospective candidates from various engineering backgrounds. The admission requirements can be found at: www.ee.up.ac.za/main/en/postgrad/admission_requirements.

Excellent skills in English, written and spoken, are required, likewise an ability to communicate research results. Detailed information on this research group and the EEDSM Hub can be found at <http://eehub.up.ac.za>.

This research group strives for a more even gender balance and women are specially invited to apply for postgraduate studies. Information about the formal application procedures can be found on the website of the Department and the EEDSM Hub. Applicants are also welcome to contact this research group for detailed topics and other academic information.

Postdoctoral positions are always available within this group and applicants with research interest in energy efficiency are welcome.

General enquiries can be made to

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Energy Systems Group

Department of Electrical, Electronic
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www.up.ac.za/eece



The Energy Systems Group in the **Department of Electrical, Electronic and Computer Engineering**, University of Pretoria, is an active research group from the Centre of New Energy Systems (CNES) and the National Hub for Postgraduate Programme in Energy Efficiency and Demand Side Management (EEDSM Hub).

The group leader is Professor X Xia (Fellow IEEE, NRF A rated). The centre hosts a large number of postgraduate students at BEng (Hon), MEng and PhD levels working on various energy projects and topics under supervision of senior researchers, staff members, postdoctoral fellows and visitors.

Research themes

Industrial Energy Optimisation

Existing studies in this topic include the development of energy modelling, optimisation and control system approaches and their application to industrial systems and processes. Examples range from research on model predictive control methods and its application to energy optimisation problems related to colliery, conveyor belts, winders, ventilation systems, water pumping systems, coal beneficiation processes and co-generation systems to new ideas such as optimal control and load management.

The group is actively collaborating with industrial partners, such as Exxaro, to identify and solve problems that are of essential importance to the society. One of the group's goals is to seek real world application of its research outputs through collaboration with the industry.



Energy Efficiency and Management in Buildings

Research in this area covers building energy consumption analysis, building retrofitting, maintenance planning and green building concepts. The key research methodologies are energy management and optimisation and control system approaches. Existing studies cover the research on home appliances scheduling, hot water stratification phenomenon in electric geysers, heat pumps, HVAC system control and optimisation, building retrofitting and maintenance planning.

This field is being investigated by several post-doctoral fellows, PhD students, master students, as well as honours students. For instance, two PhD students are working on the air conditioning system temperature and humidity control and optimal home appliances scheduling, respectively. Two other PhD students are working on building retrofitting and maintenance planning and there are master's students working on the ice storage system and grid integration of zero energy buildings.

Transport Efficiency

The modelling and optimal control of heavy-haul trains have been studied extensively. One student has obtained his PhD in this topic in 2007. Moving forward, an integrated approach to improve energy efficiency of the railway systems in terms of a multi-layer energy system has been proposed and discussed with Transnet and under investigation. Future research on this topic will cover integrated energy approach for railway systems and other types of transport systems, such as mining trucks and conveyor belts.

New Methodologies in Energy Optimisation

Model predictive control (MPC) approach for a class of resource allocation problem has been introduced as one of the priority tools in energy optimisation. The convergence, robustness and integer solutions are obtained. This work brings the birth of new classes of problems which will have far-reaching impact on the research of control theory and energy optimisation.

Besides the MPC methodology, observer design techniques and geometric steady states are investigated and their application in motor efficiency is under investigation. General classification of energy efficiency in terms of the performance, operation, equipment and technology (POET) are also studied, applications in building energy management and general energy audit are found. This POET approach has also been taken by Exxaro in developing energy efficiency specifications for its conveyor belts and other facilities. Further study of this topic for possible improvement and applications are currently being sought.

Energy System Performance Evaluation

This is a relatively new topic driven by the need of energy conservation and environmental pollution mitigation. Main contents of this topic include the mathematical modelling of energy system measurement and verification, optimal measurement and verification plan, collective behaviour in mass roll out energy efficiency programmes, Clean Development Mechanism (CDM) related modelling and optimisation, optimal sampling, socio-economical evaluation of energy systems, demand response modelling, standard offer and standard product programmes.

Case studies include lighting system renovation and heat pump roll out programme. This research group runs more than 300 industrial and commercial energy efficiency projects which provide ample opportunities for postgraduates to practice energy efficiency principles, build industrial connections and gain extra financial support.

