THE ELECTRICAL ENERGY AND POWER SYSTEMS GROUP

The Electrical Energy and Power Systems Group carry out research driven by a number of specific areas including global warming, ageing infrastructure, poverty, liberalisation of markets and energy supply security.

Long term research areas include:

- Low Carbon Future Energy Systems
- Power Systems Analysis, Operation and Economics
- Local and Wide Area Monitoring, Protection and Control
- Smart Distribution Networks
- HVDC Systems
- Energy storage - devices, lifetime management and integration
- High Voltage Engineering and Sustainable Power Systems Plant
- Transformer Research

The Centre has a number of mechanisms to enable collaboration and access to unique facilities

- Projects of a few weeks to a few months are supported by a dedicated Knowledge Transfer Fellow
- Longer term research requirements can be approached via a number of mechanisms.
  - Dedicated research projects funded by an industry partner.
  - Collaborative research to leverage additional research funding support. The Centre has experience of working on Technology Strategy Board, EPSRC collaborative and EU collaborative projects
  - Support for PhD students,
  - Membership of the Centre for Doctoral Training in Power Networks

Contact details

The Power Systems Research Centre is housed within the School of Electrical and Electronic Engineering at the University of Manchester.

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OUR BACKGROUND

For more than 50 years The University of Manchester has provided internationally excellent research and teaching in power systems and high voltage engineering. In 2002 National Grid established a strategic alliance with The University of Manchester. The vision was to strengthen their combined research capabilities and ensure Great Britain leads the world in transmission network related research. The alliance helps National Grid deliver its research initiatives whilst enhancing the capabilities of Manchester in both research and the education of the next generation of electric power engineers and scientists.

Manchester is, therefore, proud of its research, the strength of its industrial collaboration and its teaching. The National Grid Power Systems Research Centre (NGP SRC) will continue to be a leading centre of excellence, which in addition to delivering solutions to the problems experienced by National Grid, undertakes pure and applied research of international significance. The Research Centre is currently used by 15 full-time permanent academics, over 40 researchers, 50 MSc Students and has a research portfolio of over £10m.

HV TEST FACILITIES

The National Grid Power Systems Research Centre contains a suite of HV test facilities. The largest HV lab has a floor area of 500m2 and includes a 32kV impulse generator, a 60kV AC cascade resonance test set, a 600kV DC test set, a 300kV AC test set and the latest numerical control instrumentation and monitoring system with facilities for off-loading equipment using an overhead crane. The laboratory, which is the largest of any UK University, is capable of testing equipment that is intended for use on the 400kV power system. The laboratory also contains a 10kA high current source that can be used for the evaluation of thermal performance, wet spray facilities and a large acoustic chamber allowing testing in a noise free environment.

Smaller HV laboratories also exist within the facility and these have capability which includes a 300kV DC test set, 50kV AC test set and a range of advanced measurement equipment including partial discharge detectors capable of measuring less than 5pC. Environmental chambers and a salt fog chamber allow the assessment of power system equipment under a wide variety of conditions.

HV TEST NETWORK

The University owns its own 6.6kV network which is fed from a primary substation. The range of loads on the network is diverse and includes cultural assets, offices, student residences and industrial type loads used within research facilities. The University is now offering this network as a Living Lab to enhance the performance of the University estate while providing ways in which new approaches to energy systems in an urban environment can be tested and demonstrated at a scale that is relevant to real world experience. In this context the University is small enough to control but large enough to matter.

Unlike most private networks and purpose build "smart grid" demonstrator facilities the private network at the University of Manchester is a small version of a real network with assets of different ages and technologies, and a variety of load types ranging from the residential to industrial type loads along with a small amount of distributed generation making it typical of public networks.

ENERGY STORAGE RESEARCH FACILITIES

We have a suite of facilities for the development of energy storage systems that range from the atomic level required for the study of electrode interfaces through to those required for full scale testing of complete systems for use on the electricity supply system. Recent investments include in-situ electrode characterisation, raman spectroscopy, a high current potentiostat and a pendant drop analyser.

Lifetime Management & Converter Test: We have a high power (400W 400V) electrical energy storage testing facility that has the capability to exercise individual cells and large-scale storage banks over a wide range of representative operating duties and environmental conditions. Environmental chamber (650 litre, -70°C to 180°C, 10 - 95% RH) enables the impact of environmental factors on battery lifetime to be examined. A 1 Ml/30 kW super-capacitor-based energy storage system enables advanced controllers to be demonstrated over a wide range of operating scenarios.

Energy Storage System integration and control: A fully-instrumented, programmable high-power (200 kW 250 kVA 100 kW) AC grid connected energy storage systems linked into the campus low voltage system enables control algorithms for grid services to be examined. Alternative or hybrid energy storage elements can be connected to the energy storage system to assess their impact on the power network. The AC grid energy storage system can also be interfaced with the real-time hardware-in-the-loop power network simulator to enable local distribution network and wider power network studies to be undertaken.

The Intelligent Electric Power Network Evaluation Facility (IEPNEF) is a state-of-the-art 100 kW DC aircraft-electrical systems demonstrator test rig. IEPNEF forms part of the Rolls-Royce University Technology Centre in Electrical Systems, and was funded by Rolls-Royce through the Systems Engineering for Autonomous Systems (SEAS) Defence Technology Centre (DTC) which was established by the UK Ministry of Defence and is central to their intelligent integrated energy management strategic priority.

REAL TIME DIGITAL SIMULATION

The hardware in the loop test facility allows hardware to be tested in a realistic manner by connecting actual storage, control and protection equipment in a closed loop with the simulator in the same manner that they are connected to the real power system. A variety of operating scenarios including fault, load rejection and islanded operation can be simulated in order to study the performance of this hardware under varying normal and abnormal operating conditions.

The Real Time Digital Simulator in Manchester allows us to run detailed switching models of power converters and integrated models of distribution and transmission networks with hundreds of three-phase buses to fully explore the optimal integration and coordination of energy storage systems.

www.energy.manchester.ac.uk/research/energy-networks