Power & Energy Systems
School of Information Technology & Electrical Engineering
UQ Power and Energy Systems

Academic Staff

Professor Tapan Saha
BSc Eng., M Tech., PhD, Grad. Cert. (HE), FIEAUST, CEng, SMIEEE, RPEQ
Leader, UQ Solar & Director of Australasian Transformer Innovation Centre, Tapan's research interests include condition monitoring of electrical equipment and integration of renewable energy to the national grid.

Assoc. Professor Mithulananthan Nadarajah
B Sc. (Eng.), M.Eng, Ph.D, Grad. Cert. (HE), SMIEEE
Mithulan's research interests are grid integration of renewable energy, battery energy storage and electric vehicle charging stations.

Dr Chandima Ekanayake
BSc Eng, Tech. Lic., PhD, SWIEE
Senior Lecturer
Chandima's research interests are condition monitoring of power apparatus, alternatives for insulating oil, performance studies of HV insulators, high voltage engineering and impact of renewables on grid assets.

Dr Dan Martin
B.Eng. (Honours), PhD, MIEEE
Lecturer
Dan's work surrounds determining the life remaining of power transformer insulation, and has worked with Energex, Ergon Energy, Powerlink Qld and TransGrid to deploy his technology into their network.

Dr Hui Ma
B Eng, M Eng, M Eng (research), PhD, MIEEE
Lecturer
Hui's research interests include signal processing & machine learning application in power system, high voltage engineering and electrical insulation, and wireless sensor networks.

Dr Sijia Hu
B.Eng, PhD, MIEEE
Postdoctoral Research Fellow
Sijia's research interests include power flow control, system modelling in high-speed railway power system, new topology converters and control of multi-converter interactive systems.

Dr Wayes Tushar
B Sc, PhD, MIEEE
Advanced Queensland Research Fellow
Wayes' main research interests include energy and storage management, peer-to-peer energy trading, renewable energy, smart grid, design thinking, and game theory.

Professor Firuz Zare
B. Eng, M.Sc, PhD, SMIEEE
ARC Future Fellow
As the ARC Future Fellow, Firuz's main research fields are power electronics applications and control, renewable energy systems, harmonics in distribution networks, Electromagnetic Interfaces (EMI) and pulsed power systems.

Dr Rahul Sharma
B.Tech, Master of Engineering Science, PhD, MIEEE
Senior Lecturer
Rahul's research interests include control systems, system modelling, fault diagnosis, real-time optimisation and applications to power systems and vehicle electrification.

Dr Olav Krause
Dipl.-Ing. (M.Sc Eng.), Dr.-Ing. (D.Eng.), MIEEE
Lecturer
Olav's main research activities are in monitoring and autonomous management of electrical power distribution networks with major contributions to the determination of network loadability limits, state and network parameter estimation.

Dr Ruifeng Yan
BEng, MEng, PhD, MIEEE
ARC DECRA Fellow & Lecturer
Ruifeng's research areas are solar PV and wind technology, power transmission and distribution system analysis, and network operation and control.

Dr Negareh Ghasemi
B.Eng., M.Eng.,PhD, MIEEE
Lecturer
Negareh's research interests include Power Electronics and Control, Pulsed Power and Ultrasound Systems and their applications.

Dr Feifei Bai
B.Eng., PhD, MIEEE
Postdoctoral Research Fellow
Feifei's research interests include power system wide-area monitoring and analysis, power system dynamics and inter-area oscillation damping.

Dr Seyyed Ali Pourmousavi Kani
B.Eng., M Eng, PhD, MIEEE
Postdoctoral Research Fellow
Seyyed's research interests include large- and small-scale storage optimal sizing and operation, aggregation of flexibility resources for market participation, and microgrid autonomous operation and interoperability.
Mr Lakshitha Naranpanawe  
BSc Eng., Student Member MIEEE  
Lakshitha's research interests include condition monitoring of power transformers, generators and other power system assets, developing vibro-acoustic condition monitoring techniques and applying FEM-based simulation techniques in condition monitoring of power system equipment.

Dr Hansika Rathnayake  
BSc Eng., PhD, MIEEE  
Postdoctoral Research Fellow  
Hansika's research interests include control of active front end systems in renewable energy systems, power quality research and electric machine drives.

Dr Phillip Wild  
B.Econ, B.Econ Hon, PhD  
Postdoctoral Research Fellow  
Phillip's research interests include wholesale electricity market modelling, integrating high penetrations of intermittent renewables, yield analysis of variable renewable energy systems, financial viability analysis and energy policy.

Dr Jalil Yaghoobi  
B.Eng., M.Eng.,PhD, MIEEE  
Postdoctoral Research Fellow  
Jalil's research interests include power quality of LV networks, power electronics, renewable energy integration in power systems, and power system voltage stability.

Mr Ray Holzheimer  
B.Eng, RPEQ  
Manager - Australasian Transformer Centre  
Ray has over 40 years experience in the electrical industry, including power transformer design, manufacture and test, mining, water resources, transmission substation design, procurement and maintenance.

Friska (Dendi) Pambudi  
Friska is working as a software developer for the Australian Renewable Energy Agency (ARENA)-funded Solar Enablement Initiative (SEI) project.

Jack Terry  
B.Eng (Honours)  
Jack is seconded from TasNetworks to UQ’s Solar Enablement Initiative project. Jack’s interests lie in the opportunities and applications of state estimation in distribution networks.

Gian-Marco Morosini  
Gian-Marco is part of the research team working on the Solar Enablement Initiative. The focus of his work is network development of and modelling for the State Estimation (SE) Algorithm at the core of the project as well as analysis of SE results.

Andre Gebers  
Andre is working as a systems developer for the Australian Renewable Energy Agency (ARENA)-funded Solar Enablement Initiative (SEI) project. His interests lie in software development and Unix server administration.

Dr Phillip Wild  
B.Econ, B.Econ Hon, PhD  
Postdoctoral Research Fellow  
Phillip's research interests include wholesale electricity market modelling, integrating high penetrations of intermittent renewables, yield analysis of variable renewable energy systems, financial viability analysis and energy policy.
Power and Energy Systems research activities are centred on dynamic analysis of renewable energy integration and condition assessment of critical electricity infrastructure. Power Systems are generally large, non-linear, interconnected and complex. There is a significant need for an improvement in the planning and operation of such power systems, in particular with high proliferation of distributed renewable energy sources in the Australian national electricity grid. The School’s research is specifically directed at the analysis and prediction of the dynamic behaviour of power systems for reliable and secure operations. Amongst the many options in this area, power system stability analysis tools and power systems control methodologies are the most important foci.

A significant proportion of the electricity infrastructure in Australia and other countries is aged and requires special attention. The focus is thus industry orientated research and aims to deliver next generation condition assessment techniques that comprise accurate modelling and interpretative tools for power transformers, underground cables and other plant assets. Australasian Transformer Innovation Centre has been established within the School of Information Technology and Electrical Engineering, which focuses on the asset management of power transformers in the modern electrical network. In this center, we apply innovative research and industry experience together with professional training to help members operate their transformer fleets sustainably and efficiently. Researchers in this area includes industry experts in transformer asset management, as well as researchers and educators from leading Australian universities.

Another major research focus area for the group is to study the visibility of low voltage and medium voltage electricity distribution network that determines the operational state of the network and forms the basis for automated management of the network using the state estimation algorithm. This algorithm would provide a platform for automated network management applications including the coordination of solar PV generation, demand side management, energy storage, electric vehicles and network loading during critical times to help reduce the need for capital-intensive network augmentations and associated electricity price increases.

The Power & Energy Systems Research group is actively involved with industry oriented challenges and enjoys strong industry collaboration in research both nationally and internationally. The area is also a major partner of the Australian Power Institute and Energy Networks Australia.

Solar Research at UQ

University of Queensland has the largest university solar PV facilities in the world. In 2011 UQ has installed 1.3 MW rooftop PV stations across several buildings at the Universities St. Lucia Campus with more than 5000 polycrystalline silicon solar panels, covering a space equivalent to one-and-a-half rugby fields. Since then, UQ St. Lucia campus Solar PV installations have significantly grown in many other building roofs and totaled around 2.5 MW.

In 2015 UQ has installed 3.3 MW Solar Research Facility comprises more than 37,000 thin-film photovoltaic panels, mounted on 10ha former airstrip at the university’s Gatton Campus. This 3.3MW system comprises of 5 arrays: - a dual tracking array, a single axis tracking array and 3 fixed tilt panel arrays. Multiple PV mounting technologies including fixed-tilt, single-axis and dual-axis tracker technologies are in operation side-by-side in the same field to investigate their performance. PV panels mounted on a single axis tilts from east to west throughout the day to maximise energy output. Dual Axis Tracking Array trackers are capable of a 340° slewing motion and 180° tilt that allow the panels to directly face the sun at all times and thus, maximize output power. A 600 kW, 760 kWh Battery Energy Storage System (BESS) has been integrated with the Gatton Solar Research Facility.

These facilities are providing a unique research opportunity to Power and Energy Systems research to understand the challenges and opportunities of solar PV integration to the electricity grid. UQ is working with local distribution utilities in Australia to solve some of the major integration challenges.

UQ has recently announced a 65MW Solar PV Plant to be in operation in 2020 at Warwick. This PV Plant will be connected to the grid and will offset UQ’s carbon footprint, which will make UQ a carbon neutral energy user.
Research and Discovery

Power and Energy Systems research has long been a strength of The University of Queensland.

The strong research output has continued in recent years and the productiveness of the group’s research activities can be attributed to the close links and generous support provided by the group’s industrial and academic research partners.

The group has two primary areas of focus in research. A number of academics are working on condition monitoring of ageing assets of electricity industry. This includes transformer, cables, overhead transmission/distribution conductors and other assets. The other is focused on renewable energy integration to the transmission and distribution grid. This includes power system analysis tools for solar PV, wind and other renewable energy integration into the national electricity.

Significant research is in progress to address the challenges of rooftop distributed solar PV and commercial/industrial solar PV integration to the distribution low voltage grid. The group has obtained significant financial support from both the Australian Research Council and national and international research partners.

Preventing transformer failures caused by silver sulphide (2017–2020)

This project will investigate mechanisms leading to the loss of effective silver surface protection and the corrosion of OLTC silver contacts. The primary objectives of the project are:

- Investigate how to measure the barrier formed by a passivator on the surface of a metal and why this chemical attack occurs, the factors determining its rate, and how to limit the rate of degradation.
- Perform an investigation to understand why passivator is not effective in preventing damage to silver contact and why certain chemical components of mineral oil attack the silver.
- Produce a technique that the utilities can use to determine OLTCs which are at high risk of silver sulphide, and failure.

Researchers
- Professor Tapan Saha
- Dr Dan Martin
- Dr Hui Ma
- Mr Sameera Samarasinghe

Industry Partner
Energy Networks Association Limited

Sustainable operation of transformers with better understanding of technical and economic constraints (ARC Linkage Project 2014–2018)

This project aims to develop new methodologies that industry can apply to maximize the usage of transformers. Through the innovative use of fiber optic sensing, new leakage current detection methods and use of advanced pattern recognition techniques, coupled with the research to understand the ageing processes of biodegradable oils, transformer lifespan can be accurately determined. The expected outcomes are new monitoring techniques and improved life-cycle costing for various transformers.

Researchers
- Professor Tapan Saha
- Dr Chandima Ekanayake
- Dr Dan Martin
- Dr Hui Ma
- Mr Md Abdul Hafeez Ansari
- Mr Lakshitha Wanisekara Naranpanawe
- Mr Junhyuck Seo

Industry Partner
Energy Networks Association Limited

The project aims to monitor and analyse power quality of grids within the frequency ranges of 0-2 kHz (existing regulations) and 2-150 kHz (new regulations). Power quality of grids deteriorate due to high penetrations of inverter based renewable energy systems. To estimate power quality of grids, a multi-domain simulation model based on grid configurations and operating conditions will be developed in this project. Developed methodologies will assist network service providers to better analyse harmonics and resonances within low and high voltage power systems and further support them to develop new planning guidelines and regulations to address power quality of grid connected solar inverters and wind turbines.

Researchers
• Professor Firuz Zare
• Professor Tapan Saha
• Dr Daniel Eghbal
• Mr Tayyab Rahman

Industry Partners
Energy Queensland
Powerlink Queensland

Addressing Challenges for the Future Grids - Harmonics Standardization, ARC Future Fellowships (2016-2020)

Due to the global demand for energy saving and reduction of greenhouse gas emissions, utilization of renewable energy sources and efficient loads based on power electronics technology is increased in electricity networks. The negative aspects of this technology are very complex and not well known which affect reliability and robustness of the grids. The main aims of this project are to: a) develop advanced tools for a better understanding of power quality issues of the residential, commercial and industrial distribution networks in Australia b) investigate and develop novel techniques to improve power quality and reliability of the grids c) develop harmonics emission and immunity levels and modify the Australian standards accordingly.

Researchers
• Professor Firuz Zare
Increasing Visibility of Distribution Networks to Maximise PV Penetration Levels, ARENA Funded (2017-2020)

The Solar Enablement Initiative will provide improved visibility and understanding of electricity network performance and avoid undue restrictions being placed on the capacity of new Solar PV installations and their export into the Australian grid, thereby enabling an increase in the percentage of renewable energy connected to the grid.

Researchers
- Dr Olav Krause
- Project Director Simon Bartlett
- Jack Terry
- Friska (Dendi) Pambudi
- Andre Gebers
- Gian-Marco Morosini
- Ms Xiang Li

Industry Partners
Australian Renewable Energy Agency (ARENA)
Energy Networks Australia (ENA)
Australian Power Institute (API)
Energex
UnitedEnergy
TasNetworks
Springfield Land Corporation
Redback
Aurecon

Conductor Condition Monitoring
API-ENA Innovation Project (2018-2019)

This project will investigate how to effectively monitor and assess the condition of overhead conductor for an improved asset management of conductors in Australian networks. A comprehensive study will be performed to understand the conductor degradation mechanism and parameters that affects each types of degradation mechanism with the focus on the root causes of Australian conductor deterioration. A ‘health index’ method will be developed for conductor condition assessment improving the ability to predict the likelihood of conductor failure. A number of state-of-the-art conductor condition monitoring techniques will be evaluated for their suitability for Australian networks. With assistance from the industry partners, the ‘health index’ methodology and the new smart sensor based condition monitoring technique will be tested on a representative type of conductor.

Researchers
- Professor Tapan Saha
- Dr Hui Ma
- Mr Lakshitha Naranpanawe

Industry Partners
Energy Networks Australia (ENA)
API Partners

Australian Strategic Technology Program - Network Sensing Project (Energy Networks Australia)

Operators of electricity networks are faced with tremendous change to the power industry they support and to the way their networks will be used in the near future. This requires them to pro-actively plan and take investment decisions that will affect their network performance and operation for decades to come. This project looks into network sensing schemes to support future network optimisation functions in the most general sense. These optimisation functions range from long-term investment planning based on insights obtained from collected data to optimal short-term allocation of identified network capacity to energy system participants to participation in various existing and evolving markets. After the first phase, identifying and prioritising the most likely and relevant network optimisation functions operators of electricity network will have to implement, alternative sensing schemes will be developed and investigated for their technical efficacy, but also their economic viability, taking into consideration the current situation of the network operators, including past investment and legacy systems. The project will deliver assessments of a range of alternative sensing schemes to support the identified and priorities network optimisation functions, as well as demonstrations of their technical efficacy and the economic implications of the required transitions from the status quo.

Researchers
- Dr Olav Krause
- Dr Chris Hazzard
- Mr Mike Griffin
- Mr John Theunissen
- Mr Murray Chandler
- Mr John Haddow
- Mr Simon English
- Mr Richar Tatnall

Industry Partners
Energy Networks Australia (ENA)
Australian Power Institute (API)
Ausnet Services
AusGrid
ElectraNet
Energy Queensland
Western Power
Enabling high photovoltaic penetration in power distribution networks (2018-2020)

The rapid uptake of residential solar systems has resulted in extensive voltage management issues for power distribution grids. This project aims to develop a novel hybrid control method for network voltage regulation with high photovoltaic penetration. Without such technology, the further integration of solar photovoltaic into the power grid will become increasingly difficult. The outcome of this project will enable power utilities to cost-effectively regulate network voltage and ultimately remove barriers for future photovoltaic deployment. This will deliver significant economic benefits for both the wider community and utility providers, along with substantial environmental outcomes through increased use of sustainable energy sources. This project greatly aligns with one of Australian Science and Research Priorities – Energy, and will advance power industries towards a more sustainable and resilient future.

Funding body: ARC DECRA Scheme
Researcher: Dr Ruifeng Yan (DECRA Fellow)

Peer-to-Peer Energy Trading Schemes for Sustainable Cities, Advance Queensland Research Fellowship (2017-2020)

This project aims to address these issues by empowering individual users to participate in energy trading with each other and with the central energy supplier and increasing the flow of clean energy within the grid system. This fellowship aims to explore the technique of peer-to-peer (P2P) energy trading by managing storage devices at the different levels of the grid system and will propose scheduling mechanisms for individual users with distributed energy resources. This project will explore the potential of game theory, auction theory, and data science in designing suitable energy trading schemes with practical impacts, and propose a P2P energy trading scheme across various heterogeneous energy entities, through the novel integration of different approaches, which will also consider diverse practical constraints.

Researchers
- Dr Ways Tushar
- Professor Tapan Saha

Industry Partner
Redback Technologies

International Collaborators
Princeton University, USA
Singapore University of Technology and Design (SUTD), Singapore

Recently completed projects and their funding sources

- Development of Smart Power Transformers with Intelligent Monitoring, Diagnostic and Life Management Systems (ARC Linkage Project)
- Investigation of Stability and Power Quality Issues from the Wide Spread Photovoltaic Integration into Electricity Distribution Networks, (ARC Linkage Project)
- Queensland Geothermal Energy Centre of Excellence (Queensland Government)
- Evaluation of the Impact of Demand Response Program on Transmission Network Planning (TransGrid)
- Optimum Location of FACTS Devices with Advanced Control Scheme for Improving the Security of Complex Power Grid (ARC Linkage Project)
- Control Methodologies of Distributed Generation for Enhanced Network Stability and Control (CSIRO Intelligent Grid Cluster Project)
- Investigation of Key Factors Affecting Advanced Planning Tools for the Prevention of System-Wide Blackouts of Large Power Systems (ARC Discovery project)
Synchrophasor Measurement Data Applications for Distributed Energy Resource Connection and Distribution System Management (ARENA Project)

The aim of this project is to investigate and develop possible synchrophasor data applications to actively manage distribution networks and release more capacity for connecting renewables. This project will study the impact of renewables on the distribution grid, investigate the benefit of Synchrophasor Measurement Data for renewable integration, and develop load and DER models.

Researchers
- Professor Tapan Saha
- Dr Ruifeng Yan
- 2 PhD students

Industry Partners
- Noja Power
- Energy Queensland

Recently completed projects and their funding sources

- Emergency Control of Power Systems (ARC Discovery Project)
- Condition Assessment of Medium-Voltage XLPE-Insulated Cables Degraded by Water Treeing (ARC Linkage project)
- Innovation in Power System Asset Management (UQ VC’s strategic fund)
- Investigation of Demand Diversity and New Generation Entry into Electricity Market Simulation Tools (ARC Linkage Project)
- The Polarisation Based Diagnostics of Power Transformers (ARC Linkage Project)
Current Competitive Fellowships

ARC Future Fellow: Dr Firuz Zare

Addressing challenges for the future grids: Harmonics standardisation. The main aim of this project is to deliver appropriate frequency standardisation to protect electricity grids and support the use of renewable energy sources. Globally, there is no harmonic standardisation within the frequency range of 2–150 kHz, which can significantly affect the reliability of electricity networks and smart grids. Electricity networks are increasingly using renewable energy sources and an efficient loads approach based on power electronics technology. However, this can affect grid reliability and robustness. The project aims to develop advanced tools to better understand the power quality issues of Australian residential, commercial and industrial distribution networks. It also aims to develop novel techniques to improve power quality and reliability of the grids, and to develop harmonics emission and immunity levels to modify the Australian standards accordingly.

ARC Discovery Early Career Researcher Award (DECRA) Fellow: Dr Ruifeng Yan

Enabling high photovoltaic penetration in power distribution networks. This project aims to develop a novel hybrid control method for power distribution grid network voltage regulation with high photovoltaic penetration. The outcome of this project will enable power utilities to cost-effectively regulate network voltage and ultimately remove barriers for future photovoltaic deployment. This will deliver significant economic benefits for both the wider community and utility providers, along with substantial environmental outcomes through increased use of sustainable energy sources.

Advance Queensland Early Career Fellow: Dr Ways Tushar

Present electricity supply models are based on centralized and fossil-fuel-based supply, with very high cost and poor environmental sustainability. This project aims to address these issues by empowering individual users to participate in energy trading with each other and with the central energy supplier, and increasing the flow of clean energy within the grid system. This fellowship closely works with Redback Operations Pty Ltd to explore the technique of peer-to-peer (P2P) energy trading by managing storage devices at the different levels of the grid system and will propose scheduling mechanisms for individual users with distributed energy resources. However, P2P trading involves energy management across various heterogeneous entities with different properties and energy objectives. Hence, this project will explore the potential of game theory, auction theory, and data science in designing suitable energy trading schemes with practical impacts, and propose a P2P energy trading scheme across various heterogeneous energy entities, through novel integration of different approaches, which will also consider diverse practical constraints.

Honorary/Adjunct Professors

Emeritus Professor Mat Darveniza
Professor Ian Hiskens
Dr David Allan
Dr Ross Baldick
Dr David Birtwhistle
Dr Deb Chattopadhyay
Dr Richard Harris
Dr Christian Rehtanz

Honorary/Adjunct Research Fellows

Dr Md Jan E Alam
Dr Daniel Eghbal
Dr Sebastian Lehnhoff
Dr Yong Li
Dr Jim Lyall
Dr Nilesh Modi
Dr Gangning Wu
Dr Nahid-Al Masood
The Australasian Transformer Innovation Centre
http://www.itee.uq.edu.au/tic

Australia's Leading Transformer Research Centre: Filling Australia's critical need for Transformer Innovation and Education. Collaborative initiative by Australia’s Transformer experts from research and industry. Over ~$1 million jointly committed and being invested to establish the centre including:

- Wilson Transformer Company donated natural ester oil filled research transformer
- Dynamic Ratings state-of-the-art on-line condition monitoring system
- Reinhausen’s latest generation tap changers and education
- University of Queensland new Long Pocket Transformer Laboratory with state of the art research equipment
- Collaborative effort by UQ, QUT, UNSW and Griffith researchers

The research programme is designed to create innovations that meet the evolving needs of industry including:

- Decreasing the risk of transformer failure during normal and contingency events
- Reducing maintenance costs and extending life with improved condition monitoring.
- Investigating improved operation, performance and risks with natural esters oil
- Increasing transformer utilisation and working transformers smarter
- Investigating effects of renewable generation on transformer life and cyclic rating

Some examples of currently conducted R&D projects including:

- Optimizing network ratings for power transformers retrofilled with vegetable oil
- Development of PD Analytic Tools for Ester Fluid Filled Transformers
- Criteria for Retro filling Transformers with Ester Fluids
- Asset Management of Network Power Transformers in the Presence of High Penetrations of Solar and Wind Generation

The Centre houses:

- Research-grade power transformer donated by Wilson Transformer Company
- Sensory technology, provided by Dynamic Ratings

Other commercial grade equipment to carry out testing and research include:

- Omicron DIRANA (FDS and PDC combined)
- Frequency response analysis equipment
- Partial discharge monitoring
- Ageing facilities
- Polarisation/depolarisation currents and return voltage measurement
- Frequency domain spectroscopy
- Vaisala water activity measurement probes
- Fibre optic equipment to measure temperature and water content of insulation
- Thermal infrared camera for studying heating and temperature rise
The Centre offers innovation and CPD programmes purpose built for the industry's future needs and delivered by acclaimed transformer experts. The programmes bring a total focus on best practice asset management and high performance. Member organisations will reap the benefits of this focus through reduced costs, increased asset performance, reliability and asset management breakthroughs.

Basic transformer courses will include transformer theory and applications, procurement, design, operation, maintenance and condition monitoring techniques. Advanced courses will include transformer ageing, failure analysis, specifying for requirements, dynamic loading, and condition based maintenance. Courses will be delivered by transformer experts from universities, transformer manufacturers and transmission and distribution companies.

In these 2 day intensive courses the delegates will be given an overview on how to make the best use of their transformer assets. The course has been set up to be delivered jointly by industry and academic staff, where the delegates enjoy the best of both worlds in course relevance, depth and structure. In general, academic staff will discuss the fundamental background to the various concepts while industry staff show how to apply these concepts to real-life situations.

Some examples of delivered CPD courses including:

• Managing the Life Cycle of Power Transformer (28th - 29th September 2017)
  - Specifications
  - What to look for in a factory audit & design review
  - Application of design techniques for windings, tank, core and system parameters
  - AAV Formulas and design considerations
  - Design requirements for selecting transformer components – OLTC, Bushings, temperature instruments etc
  - Transformer Design and Considerations
  - Factory and Site Testing
  - Maintenance and Condition Monitoring
  - Live cross to TIC for real-time condition monitoring
  - Whole of Life Costing
  - Condition & Risk based maintenance & Risk mitigation techniques (end of life)

Course was delivered by:

Gary Russell (Powerlink Queensland), Dr. Dan Martin (UQ), Craig Adams (TRAFOIX Pty Ltd), Amra Alibegovic-Memisevic (Powerlink Queensland), Dr. Hui Ma (UQ), Kerry Williams (K-BIK Power Pty Ltd), Michael O’Brien (GE Grid Solutions), Ray Holzheimer (TIC)
• Power Transformer HV Bushings- Design, Maintenance & Risk Mitigation (12th - 13th February 2018)

- Basic principles of design of HV Bushings.
- Differences in technology for SRBP, OIP, RIP, RIS bushings.
- Be informed of the latest Australian HV bushing failure statistics.
- Understand the mechanisms of HV bushing failure.
- Learn how to detect bushing failures using offline techniques.
- Learn practical methods to improve your bushing testing methodology.
- Understand online bushing monitoring techniques, what they measure, and diagnostic tools in common use.
- Learn what other electrical utilities are doing in bushing life cycle management, testing, replacement practices.

Course was delivered by a unique mix of nine industry and academic experts:

Rob Milledge (ABB Australia), Gary Russell (Powerlink Queensland), Dr. Dan Martin (UQ), Dr. Wenyu Guo (OMICRON Australia), Karl Haubner (Doble Australia), Brian D. Sparling (Dynamic Ratings), Dr. Thomas Smolka (Reinhausen Australia), Emmanuel Santos (Western Power), Ross Kempnich (Essential Energy).

• Power Transformer Tap Changers- Design, Maintenance & Retrofit (27th - 28th June 2018)

- Understand the basic principles of tap changers, including oil, vacuum.
- Learn the basic arrangement of regulating windings, benefits and issues of oil and vacuum diverters.
- Understand tap changer designs and applications, differences between diverter and selector type, Loading capability.
- Become familiar with OLTC maintenance for oil and vacuum types.
- Witness live of diverter maintenance, steps to take for high diverter moisture content.
- Participate in a forum for OLTC fault investigation and supply restoration.
- Understand MR & ABB retrofit options where oil diverters are replaced by vacuum.
- Understand the benefits of dynamic resistance tests.
- Be exposed to how some utilities are implementing life cycle oriented maintenance of tap changers.
- Moisture tolerance, Life extension.
- Learn about OLTC failures due to silver sulphide formation.

Course was delivered by:

Dr. Thomas Smolka (Reinhausen Australia), Anders Hakansson (ABB Singapore), Rob Milledge (ABB Australia), Dr. Wenyu Guo (OMICRON), Dr. Hui Ma (UQ), Dr. Dan Russell (Energy Queensland), Mike Elms (Western Power), Ross Kempnich (Essential Energy), Ray Holzheimer (TIC)
Researchers

- Professor Tapan Saha
- Dr Dan Martin
- Dr Hui Ma
- Dr Chandima Ekanayake
- Dr David Allan
- Dr Shawn Nielsen
- Mr Ray Holzheimer

Contact: transformer@itee.uq.edu.au
National and International Collaborations

The Power and Energy Systems research group has strong links with the local electricity industry and active research collaborations with a number of national and international universities.

Professional activities (IEEE, Engineers Australia & CIGRE)

The Power and Energy Systems group is an active contributor to the world’s leading technical forums for the electric power industry. This includes:

- CIGRE, the world’s leading technical association for large electric power systems, covering 90 countries.
- IEEE and IEEE Power & Energy Systems Society – with more than 426,000 IEEE members in more than 160 countries
- Engineers Australia- national forum for the advancement of engineering and the professional development of members.

Professor Saha is an Australian CIGRE Panel member of A2 Transformer and D1 Materials and Emerging Test Techniques. PES research group academics regularly publish papers at the CIGRE biennial Paris Sessions. Dr. Olav Krause is a member of C6.

The group is a strong supporter of the Queensland Chapter of IEEE-PES with a number of members serving on the Queensland Committee and many technical papers published at IEEE-PES international conferences. Professor Saha is the current Chair of IEEE PEs Chapter and has served the IEEE Queensland Section as Chair for two terms.

Group members are also active contributors to Engineers Australia. Professor Saha is the current Board Member of Electrical College of Engineers Australia and has been serving the Queensland Electrical Branch for many years. He is also an Editorial Board Member of AJEEE Journal published by Engineers Australia.

Redback Technologies

One of the UQ Power and Energy System group’s latest industry partner is Redback Technologies Pty Ltd, a new Start-Up company that is developing and supplying innovative and intelligent inverters “with a difference” for household PV systems. Redback System provides intelligent technology that gives the power to store, monitor and manage home’s solar energy. We have been working with Redback and other Industry partners to Plan a Ground breaking development that will enable householders to compete with traditional higher cost Supply-side solutions to power system Security needs and wholesale Markets. Our group is working with Redback in a $4 million Advance Queensland Platform Technology Program project that will lead to the development of a smart energy monitoring platform that will give customers the ability to instantly analyse and control energy consumption. Redback managing director Philip Livingston said the smart power monitoring platform would enable home owners and businesses to understand and control their energy usage and will help networks to more efficiently manage the grid, allowing for increased penetration of renewables. The UQ research team is working on the project in collaboration with industry partners including Redback Technologies, Energy Queensland and Springfield City Group.

UQ Power and Energy Systems Group Leader Professor Tapan Saha said the platform would bring enormous benefit to customers managing their own energy consumption. “This will help to increase penetration of renewables in to the grid and tackle some of the key energy challenges the industry is facing.”
Transformers

The power transformer condition monitoring group has been supported by the Australasian Transformer Innovation Centre. The Centre is supported by many utilities, national and international manufacturers and universities. Current centre members include Wilson Transformer, The Australian Power Institute, CIGRE Australia, Reinhausen, United Energy, Dynamic Ratings, SA Power Networks, Powerlink, TasNetworks, Essential Energy, MAXIVAR, K-BIK Power, Energy Queensland, NYNAS, WEIDMANN, ABB, Transmission & Distribution Publisher, Budin-Philipp Partners, ACTewAGL, & ETEL Transformers. Current ARC research projects are supported by utilities AusGrid, Energey, Ergon Energy, Powerlink Queensland and TransGrid, and by the Wilson Transformer Company.

The group focusses on developing the technologies required by the industry to optimise the management of their transformer fleet. This is becoming even more important since the industry is under pressure to reduce costs.

The recent successes of the group include: delivering software to the utilities which estimate the life remaining of transformer insulation (and therefore of the whole transformer), and providing a holistic monitoring system which uses algorithms developed from the research. So far, the group's software is currently in use with the utilities, where their feedback is invaluable in determining future direction.

UQ Supporting the Australian Power Institute (API)

The API is an Australian National Organisation, strongly supported by the Australian Power Industry and committed to working collaboratively with Australian Power Engineering Universities to ensure that the Power industry has access to the required quantities of power engineering graduates with the necessary engineering skills to meet industry’s needs now and into the future.

The API, together with the University of Queensland and Powerlink Queensland, established the API/Powerlink Australian Chair in Electricity Transmission at the University of Queensland, which ended in 2017.

UQ’s Power Energy Systems group has been selected as one of the most qualified and experienced universities in Australia to support API and the power industry in the development of research projects nominated by API and industry.

Industry Collaborations (Present & Past)

Energy Queensland
Australian Energy Market Operator (AEMO)
Powerlink Queensland
TransGrid
AusGrid
CS Energy
Stanwell Corporation
Ergon Energy
Energey
The Australian Power Institute
CIGRE Australia
Maschinenfabrik Reinhausen
TasNetworks
Nynas
Weidmann
ActewAGL
Wilson Transformer Company
Aurecon
Hydro Tasmania
AGL Energy Ltd
Clean Energy Council Limited,
Suzlon Energy Australia Pty Ltd
TRUenergy Pty Ltd
Vestas International Wind Technology A/S
Hydro Tasmania
United Energy
ABB
Essential Energy
Maxivar
K-Bik Power Pty. Ltd.
Budin - Philipp Partners
Dynamic Ratings
Teaching and Learning

The Power and Energy Systems group is actively involved in teaching in undergraduate and postgraduate engineering programs.

Coursework

Academics contribute specialist courses in power systems and broad power engineering areas of electrical engineering based specialisations.

ELEC3300 Energy Conversion & Utilisation
ELEC4300 Power Systems Analysis
ELEC4302 Power Systems Protection
ELEC4400 Power Electronics
ELEC4320 Asset Management & Condition Monitoring
ELEC7309 Power System Planning and Reliability
ELEC7310 Electricity Market Operation and Security
ELEC7313 Renewable Energy Integration: Technologies to Technical Challenges
ELEC7051 Transformer Technology Design & Operation

Further information can be obtained from www.itee.uq.edu.au/future-students

Scholarships

API Bursaries

The UQ Power and Energy Systems group is one of the founding university partners of the API’s Undergraduate Bursary Awards Program. This is a collaborative program between the API, universities and industry that has supported hundreds of outstanding power engineering undergraduates during their university course encouraging them to study and pursue subjects to pursue a career in the power engineering industry. http://api.edu.au/bursary/

ES Cornwall Scholarships

The UQ Power and Energy group is also proud to fund and manage the ES Cornwall Memorial Scholarship, which for more than 55 years has underpinned the early career development of aspiring industry engineers though supporting and mentoring their overseas employment in the electric power industry. $3,500 per month for up to 18 months. http://escornwall.com.au/

Engineers Australia Queensland Electrical Branch Medal

This is awarded annually to a UQ student with a medal and $500 from the EESA. Recipients are assessed based on GPA, involvement in Power Engineering courses and thesis submission. https://www.engineersaustralia.org.au/

UQ Graduate School Postgraduate Scholarships for Higher Degree Research

The UQ Graduate School offers a number of scholarship opportunities that provide financial support for tuition fees, living costs and travel to enable research candidates to focus on their research and achieve the best results. Further details about the scholarships can be viewed at www.uq.edu.au/grad-school

UQ PhD and MPhil Scholarship information can be obtained from the link https://graduate-school.uq.edu.au/scholarships

University Collaborations

University of New South Wales, Sydney Australia
QUT, Brisbane, Australia
Jadavpur University, India
IIT Kharagpur, India
IIT Bombay, India
Xi’an Jiaotong University, Xi’an, China
South West Jiao Tong University, China
Hunan University, China
TU Dortmund University, Germany
University of Texas at Austin, USA
AIT, Bangkok
University of Michigan, USA
Griffith University, Brisbane, Australia
Facilities

The teaching and research in power and energy systems is supported by sophisticated laboratory facilities.

Renewable Energy Laboratory

The Power and Energy Systems group has developed a state of the art renewable energy laboratory with funding from AGL Solar Flagship Education Infrastructure Fund.

The lab is equipped with modern renewable energy research facilities including:

1. Two Real Time Digital Simulator racks
2. Power Amplifiers
3. Solar Emulator
4. STATCOM
5. Battery Storage
6. Battery simulator
7. Wind turbine control setup (With dSPACE)
8. Most commercial power systems analytical tools

Power Systems & Power Quality Laboratory

The power system simulation laboratory has analytical software tools to simulate, plan, design and control complex interconnected power systems with state of the art solutions.

The analytical tools available at PSS-L can solve power system problems in wide range of time frames, from micro seconds to steady state and study impact of renewable energy integration, Custom Power devices, etc. Some of the software tools available at the PSS-L are listed below.

Apart from the above tools, the powerful sever located at the PSS-L carries a number of test power systems, both at transmission and distribution level typically used for research in power and energy system research.

1. PSS/E
2. DSAT tools
3. PowerWorld
4. DigSILENT Power Factory
5. PSCAD/EMTDC
6. SINCAL
Machines Laboratory

UQ has developed the Machines Laboratory as an online laboratory – in which real laboratory experiments can be accessed through the Internet using the MIT’s iLab environment.

This laboratory has a number of conventional laboratory experiments (Transformer & AC circuits) and a number of online machines experiments (AC, DC and Synchronous machines) using iLabs, which can be shared across university or across the world.

The iLabs vision is to share expensive equipment and educational materials associated with lab experiments as broadly as possible within higher education and beyond.

This is the only online machines laboratory in the country and is jointly funded by the Australian Power Institute and the University of Queensland.

Intelligent Plant Diagnostics Laboratory

A well-equipped insulation diagnostics laboratory, which is very actively used for insulation degradation and over-stress measurements.

This lab includes a lightning impulse voltage generator, single and multiple impulse current generators, 300kV AC transformer system, Recovery Voltage and Polarisation / Depolarisation current measurement system, frequency domain dielectric spectroscopy equipment with HV variable frequency power supply, Partial Discharge Measurement System, thermal imaging camera and Frequency Response Analyser.

Intelligent Plant Diagnostic laboratory has a special accelerated ageing experimental facility at Long Pocket. This laboratory is suitable for long term ageing experiments under controlled moisture and temperature for transformers and other insulation materials.

Solar PV demonstration system

A PV demonstration setup consists of PV array and troubleshooting system. The system provides hands-on skills and troubleshooting ability across the types of PV systems commonly used such as standalone and grid-connected. It is used for teaching connection, operation, programming, and troubleshooting of AC/DC and grid-connected PV systems. The PV array has capability of connecting PV panels in series and parallel.

This system contains a mobile workstation, component panels with breakers, combiner box, MPPT charge controller, lamps, batteries, meters, grid-connected inverter, a fault insertion system. The system can be used to show the different effects (shading, angle tracking, heating and cooling of panels) on the PV power output.

The PV demo system is used for teaching and demonstrating the connections, operation and troubleshooting. Specially, students or researchers can gain practical knowledge to get the further exposure in PV system.
Recent Awards

Power and Energy Systems - Academics

- Prof Tapan Saha won ACPE-CIGRE award of Outstanding Academic for 2017
- Prof Tapan Saha participated in the Indian Government’s Global Initiative of Academic Networks (GIAN) program
- IEEE Outstanding Engineer Award 2015, Queensland Section Power and Energy Society Chapter - Professor Simon Bartlett
- Two PES papers won the best papers awards at IEEE APPEEC 2015
- UQ Early Career Researcher Grant 2015: Dr Rahul Sharma
- Xi’an Jiaotong University and Hunan University in China for 2015-2017 - Professor Tapan Saha appointed as an Adjunct Professor
- UQ Award for Excellence in RHD Supervision 2014 - Professor Tapan Saha for his outstanding contribution in the supervision, mentoring and training of research higher degree students over a sustained period of time.
- EAIT - 2013 Teaching Excellence Awards - A/Prof. Nadarajah Mithulananthan and Dr Chandima Ekanayake
- IEEE Outstanding Engineer Award 2012, Queensland Section Power and Energy Society Chapter - Professor Tapan Saha
Current Research Higher Degree Students (Full Time)

Mr Ahmad Abdullah
Mr Mohsen Ahmadi
Mr Abdulrahman Alduraibi
Mr Davood Solati Alkaran
Mr Saeed Alzahrani
Mr Md Abdul Hafeez Ansari
Mr Imran Azim
Mr Amit Dhoke
Mr Huajie Gu
Mr Mohammad Habibullah
Mr Mehedi Hasan
Mr Md Monirul Islam
Mr Md Naz Niamul Islam
Mr Kiarash Gharani Khajeh
Mr Jaroslaw Krata
Mr Awan Krismanto
Ms Xiang Li
Mr Yu Luo
Mr Muhammad Muneer
Mr Lakshitha Wanisekara Naranpanawe
Ms Juliana Babosa Nunes
Ms Erin Oliver
Mr Muhammad Qamar Raza
Mr Sameera Samarasinghe
Mr Junhyuck Seo
Mr Herlambang Setiadi
Mr Ebby Thomas
Mr Sohel Uddin
Mr Licheng Wang
Mr Ruiyuan Zhang
Mr Aobo Zhou

Current Research Higher Degree Students (Part Time)

Mr Hashemi Ford
Mr Shanker Lamichhane
Mr Saeid Veysi Raygani

Recent Awards

Power and Energy Systems - RHD students

- IEEE PES QLD chapter travel prize 2018: Huajie Gu, Junhyuck Seo
- UQ Graduate School Candidature Travel Award 2018: Md Monirul Islam
- EAIT Postgraduate Engineering Conference 2018: Aobo Zhou
- Best Poster Award in ECON 2018: Amit Dhoke
- IEEE International Conference on Applied System Innovation held on May 13-17, 2017: Herlambang Setiadi
- Best Poster Award in ISGT Asia 2017: Amit Dhoke
- IEEE Student Travel Award for ISGT 2017: Amit Dhoke
- 3rd Best Paper Award in AUPEC 2017: Ebby Thomas, Rahul Sharma and Yoni Nazarathy
- IEEE Power & Energy Society General Meeting 2017 Travel Award: Md Qamar Raza
- CSIRO Top-up Scholarship: Md Qamar Raza
- Dean's Award for Outstanding Higher Degree by Research Theses - Dr. Yi Cui
- EAIT Postgraduate Engineering Conference 2017: Md Hafeez Ansari, Lakshitha Wanisekara Naranpanawe, Junainah Sardi, Juliana Nunes, Asif Islam
- IEEE Innovative Smart Grid Technologies - Asia (ISGT-Asia) Travel Award: Md Qamar Raza
- Australasian Universities Power Engineering Conference (AUPEC) 2016: Amit Dhoke, Md Qamar Raza, Huajie Gu, Md Monirul Islam
- Graduate School International Travel Award (GSITA): Amit Dhoke, Shohana Deeba, Lakshitha Wanisekara Naranpanawe
- Westpac Future Leaders Scholarship: Gemma Calyton has won one of the 17 Westpac Future Leaders Scholarships
- Asia-Pacific Solar Research Conference 2015 Conference in Brisbane: Amit Dhoke has won the first prize in the Poster Paper Competition
- IEEE-PESGM 2015 Conference in Denver, USA: Nahid-Al Masood has won the first prize in the Poster Paper Competition
- EAIT Postgraduate Engineering Conference 2015: Lakshitha Wanisekara Naranpanawe; Jeffery Chan, Jalil Yaghoobi, Shohana Deeba
- IEEE Queensland Section (PES Chapter) Student Travel Prize-2015: Sohel Uddin and Nahid-Al-Masood
Research Higher Degree Students and their Projects

Mr. Mohsen Ahmadi
Design of an Intelligent Charging Station for Electric Vehicles and Evaluating its Effects on Maintaining the Stability, Voltage Profile and Power Quality of the Distribution Network

Mr. Amit Dhoke
Development of Solar Micro-Grids and its Control Strategy

Mr. Imran Azim
100% Renewable Powered Autonomous Microgrids Integrated with Battery Storage

Mr. Huajie Gu
Optimal energy management in smart grids with renewables

Mr. Mohammad Habibullah
DC Microgrid: Stability, Power Quality & Fault Analysis

Mr. Mehedi Hasan
Control of Battery Energy Storage System (BESS) for Effective Utilisation of Large Scale Solar PV Plant

Mr. Md. Monirul Islam
Power system stability assessment with high penetration of PV generation integrated with transformerless inverter

Mr. Md Abul Kalam Chowdhury
Hierarchical Capacity Constrained State Optimization of Distribution System

Mr. Davood Solati Alkaran
Optimal Operation and Control of Active Front End systems, Smart Microgrids and Grids

Mr. Md. Abdul Hafeez Ansari
Fibre Optics Based Condition Monitoring of Transformer Insulation

Mr. Marwan Al-Dhaheri
Optimal energy management in smart grids with renewables

Mr. Saeed Alzahrani
Stability Performance of Power System In Present of Large-Scale Photovoltaic Power Plants

Mr. Md. Naz Niamul Islam
Hierarchical Capacity Constrained State Optimization of Distribution System

Mr. Kiarash Gharani Khajeh
Stability analysis of grid-connected inverters to mitigate the high frequency harmonics in the range of 2 to 9 KHz due grid impedance variation

Mr. Jaroslaw Krata
The centralized control method for power distribution grids penetrated by renewable energy sources

Mr. Ahmad Abdullah
Harmonics and Power Quality Analysis, Modelling and Measuring of Low Voltage Grids

Mr. Huajie Gu
Optimal energy management in smart grids with renewables

Mr. Mohammad Habibullah
DC Microgrid: Stability, Power Quality & Fault Analysis

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Control of Battery Energy Storage System (BESS) for Effective Utilisation of Large Scale Solar PV Plant

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Mr. Ahmad Abdullah
Harmonics and Power Quality Analysis, Modelling and Measuring of Low Voltage Grids
Ms Xiang Li
Load Modeling in State Estimation for Distribution System

Mr Yu Luo
Wind farm integration via VSC-HVDC

Mr Muhammad Muneer
Transformer condition Monitoring using vibration patterns

Mr Lakshitha Wanisekara Naranpanawe
Numerical Modelling of Thermally Driven Moisture Distribution in Transformer Insulation System

Ms Juliana Barbosa Nunes
Integrated planning of electricity and natural gas networks considering renewable energy and electric vehicle penetration

Ms Erin Oliver
Measurement based methods for distributed optimisation and control of distribution networks

Mr Md Qamar Raza
Demand response management of smart grids using electrical load forecasting by artificial neural network

Mr Sameera Samarasinghe
Preventing transformer failures by silver sulphide

Mr Junhyuck Seo
Intelligent Monitoring and Diagnosis of On-Load Tap-Changer (OLTC) and Bushing of Power Transformer

Mr Hermalbang Setiadi
Coordinated Control of BES and PSS for Small Signal Stability Enhancement in Power System with High Penetration of RE

Mr Ebby Thomas
Stochastic optimisation of demand side management

Mr Licheng Wang
Renewable Energy Integration into Power Grid

Mr Ruiyuan Zhang
Energy Smart Management based on Advanced Data Analysis

Mr Aobo Zhou
Comprehensive analysis on renewable energy management and Demand Response (DR) in the micro-grid

Mr Shanker Lamichhane
Towards “100 percent” Renewable Energy Penetration in Australian Grids: Stability Challenges and Countermeasures