One-Day Workshop For Professionals in Energy Sector

Title: Workshop on Renewable Energy Integration Challenges and Applied Industrial Solutions

Presenters (*Please see Annex 1 for the presenter biographies*):

This workshop will be delivered by a joint team from CQUniversity and Belash Pty Ltd, who offer innovative dSTATCOM solutions for overcoming several challenges in grid integration of renewable energy resources.

CQUniversity

- Dr. Umme Mumtahina,
- A/Professor Sanath Alahakoon

Belash Pty Ltd

- Mr. Mark Hibbert
- Mr. Shane Goodwin
- Mr. Edward Burstinghaus

Date: 3rd October 2025

Venue (with free parking): Belash Pty Ltd, 160 Samford Rd, Enoggera QLD 4051

Abstract

Overview

Energy production plays a vital role in enhancing the quality of modern life, supporting economic activity, public services, and social well-being. However, reliance on fossil fuels has led to serious environmental consequences, particularly in the form of greenhouse gas emissions and climate change. In response, the Australian Federal Government has committed to an ambitious decarbonization strategy. This strategy focuses on a national transition toward renewable energy sources that aim to deliver long-term electricity price stability, energy security, and environmental sustainability.

One of the major technical challenges facing the transition to a renewable-powered grid is the management of voltage variability caused by high penetration of decentralized energy sources, particularly rooftop solar photovoltaic (PV) systems. Traditional electricity distribution networks, originally designed for one-way power flows and centralized generation, are now facing issues such as voltage imbalance, over-voltage, and power quality degradation.

This workshop investigates the use of distributed static synchronous compensators (dSTATCOMs) to regulate voltage and improve power quality in distribution networks with high levels of renewable energy. Two control strategies are compared: independent phase reactive power control and sequence-based control. The analysis shows that sequence-based control provides significantly improved voltage balancing, reduced negative and zero sequence voltages, and the ability to redistribute real power among phases.

Furthermore, the workshop addresses the optimal placement of dSTATCOMs within the network. Strategic siting maximizes the effectiveness of these devices by targeting voltage-weak or heavily loaded nodes, enhancing overall system stability while minimizing installation and operational costs. Optimization algorithms are used to determine a placement that delivers the highest technical and economic benefits.

Learning Objectives

Upon attendance of this workshop, participants will be able to:

1. **Recognize Renewable Integration Challenges**: Explain the impact of decentralized generation, especially solar PV, on voltage profiles and power quality in modern distribution systems.
2. **Understand Voltage Regulation Requirements**: Identify the necessity for voltage regulation in maintaining system reliability, equipment protection, and compliance with standards.
3. **Explore dSTATCOM Operation and Capabilities**: Describe how dSTATCOMs inject reactive power to manage voltage levels, balance phase voltages, and enhance distribution network performance.
4. **Compare Control Strategies**: Differentiate between independent phase reactive power control and sequence-based control, highlighting how the latter offers superior voltage regulation by managing sequence components and enabling real power redistribution.
5. **Assess Technical and Economic Benefits**: Analyse how sequence-based control leads to better phase balancing, reduced system losses, and improved power quality compared to conventional approaches.
6. **Apply Optimal Placement Techniques**: Understand the principles of optimal dSTATCOM placement in a network, considering load profiles, voltage sensitivity, and economic constraints. Use optimization methods (e.g., sensitivity analysis, heuristic algorithms) to determine where dSTATCOMs should be installed for maximum impact.
7. **Develop Practical Implementation Skills**: Apply knowledge of dSTATCOM technologies, control strategies, and placement methodologies to propose effective voltage regulation solutions in the context of Australia's energy transition.

By achieving these objectives, learners will be equipped to contribute to the design and operation of future-ready distribution networks that support a resilient, low-carbon energy future.

Proposed Outline

Session structure and key topics (tentative)

Time	Program Highlights
8:00 – 8:30	**Registration**
8:30 – 10:00	**1. Renewable Energy Resources Data** • NEM • AEMO • Weather Data Scrapping for accurate forecasting **2. Distribution Network Challenges**
10:00 – 10:30	***Morning Tea Break***
10:30 – 12:00	**1. STATCOM Design** • Parallel STATCOM Design • Optimal dSTATCOM placement • Results (EDP, RACE 2030) **2. PLL** 3. **Protection Framework**
12:00 – 13:00	***Lunch Break***
13:00 -14:00	**1. Energy Storage** • NEM Data • Optimal Placement of Energy Storage • Energy Storage Management

- Co-ordination of Energy Storages to mitigate network challenges

2. **Ticking the boxes of network challenges through STATCOM and Battery**

14:00 – 14:15 ***Afternoon Tea Break***

14:15 – 16:00 **Performance Demonstration of Advanced dSTATCOMs in Modern Power Networks**

- Unbalance
- Voltage Management
- Harmonics
- Live Demo of EDP

Format

This will be delivered as a full-day workshop. A combination of presentations, demonstrations through simulations, and demonstration of real-time performance of systems through remote access is proposed.

The proponents would also like to arrange a laboratory demonstration using dSTATCOM hardware, provided that the workshop venue is capable of hosting such hardware. Alternatively, it could also be delivered in a split-session format where presentations, demonstrations through simulations, and demonstration of real-time performance of systems through remote access will be in a typical studio environment, while the hardware demonstrations will take place in the workshops of Belash Pty Ltd in the same location as the workshop - 160 Samford Rd, Enoggera QLD 4051.

Demonstrations will be using following hardware:

1. Regatron TC.ACS.50.528.4WR.S.LC - Programmable Bidirectional Regenerative (4-quadrant, 50 kVA 72 A) Liquid Cooled AC Power Source. This will act as a grid simulator.
2. Regatron LAE.5.4WR - Liquid/Air Heat Exchanger, 19", 4U, 5kW, 400VAC for cooling grid simulator
3. Elexsys 30kVA dSTATCOM as device under test (DUT)
4. Two PCs or laptops and fixed wired networking equipment to interface with the dSTATCOM and grid simulator.

Annex 1: Presenter Biographies

Dr. Umme Mumtahina, CQUniversity

Dr. Umme Mumtahina is a Senior Post-Doctoral Research Fellow at CQUniversity, specialising in power systems, renewable energy integration, and electrical infrastructure planning. In 2024, Dr. Mumtahina was awarded the prestigious Advance Queensland Industry Research Fellowship to lead a collaborative research initiative with Belash Pty Ltd, focusing on enhancing the resilience and hosting capacity of Queensland's distribution networks. With a strong background in distribution system modelling, inverter-based resource integration, and optimal energy storage strategies, Dr. Mumtahina has made significant contributions to improving the technical and economic feasibility of clean energy technologies in rural and regional communities. Her work supports the development of smarter, more sustainable grids through advanced simulation, stakeholder engagement, and data-driven decision-making. Dr. Mumtahina's ongoing research not only informs policy and infrastructure investment but also strengthens partnerships between academia, government, and industry to drive Queensland's transition to a low-emissions energy future.

A/Prof. Sanath Alahakoon, CQUniversity

Associate Professor Sanath Alahakoon, received B.Sc. Eng (Honours) degree in Electrical and Electronics Engineering from the University of Peradeniya, Sri Lanka in 1994. He received his Ph.D. in Digital Motion Control from the Electrical Machines and Power Electronic Group of the Royal Institute of Technology (KTH), Sweden, in 2000. Currently, he is in the School of Engineering and Technology (SET) at CQUniversity Gladstone campus. Sanath leads the SMART Grid Research Group of the School of Engineering and Technology. He is also a research lead within the electrification theme of the Centre for Hydrogen and Renewable Energy of CQUniversity. His research interests and expertise are in renewable energy & microgrids, electrical machines and drives, hybrid electric systems, condition monitoring, Instrumentation, and control.

Mr. Mark Hibbert, Belash Pty Ltd

Mark has a master's degree in electrical engineering and 40 years of experience specialising in power system analysis, power system planning, and substation design, including specialist knowledge in earthing, EMTP transient analysis, and harmonics. Mark has wide experience in all aspects of transmission and distribution network planning and design, and HV power. Mark worked for Energex for 20 years and for Aurecon for 19 years before joining Elexsys Energy. Mark has undertaken or supervised significant projects for transmission and distribution utilities around Australia and now focuses his efforts on renewable energy integration, battery storage, and microgrid applications.

Mr. Shane Goodwin, Belash Pty Ltd

Experienced engineer specialising in D-STATCOM technology and BESS integration. Expertise in hardware design and firmware development. Proven ability to architect and program intelligent control systems for D-STATCOMs, contributing to the full lifecycle. Deep understanding of power systems and power electronics, coupled with experience in embedded systems programming. Background includes research management, focusing on renewable energy integration and condition assessment of aging electrical infrastructure. Holds a Master of Engineering (Radio Frequency and Microwave Communications) from UQ and Bachelor of Engineering (Computer and Electrical) from QUT.

Mr. Edward Burstinghaus, Belash Pty Ltd

Edward is an electrical engineer with over six years of work experience in the power industry and has a PhD in electrical engineering focusing on power electronics control. His experience includes load flow studies investigating the effectiveness of dSTATCOMs in Brisbane distribution networks using DIgSILENT PowerFactory, generator connection due diligence studies in PSCAD, PSCAD-PSSE benchmarking studies, R2 testing, protection studies in distribution networks, transformer inrush studies in PSCAD, and substation earth grid design in CDEGS. He is also experienced in interpreting and applying the NER in assessing compliance with generator performance standards.