



TRAINING SEMINAR

Harmonic Assessment and Filters for Renewable Energy Systems

Practical knowledge and technical expertise on harmonic assessment and filter application for renewable energy systems

Presented by **Dr Tuan Vu**
Volt-Var and Control Power Systems Consultants Pty Ltd



Introduction

As Australia transitions towards clean, renewable energy, power-electronic-based generation sources such as solar, wind, and battery energy storage systems (BESS) are gradually replacing the aging fleet of coal-fired power stations. While these technologies provide significant benefits to network operators and consumers, they also introduce new challenges, particularly in managing harmonic distortions in the power system.

Harmonics can adversely affect grid stability, equipment performance, and compliance with regulatory standards. Network operators and plant owners must navigate complex harmonic compliance requirements and implement suitable filter solutions to ensure reliable and efficient operation. However, understanding and addressing harmonic issues can be a technically challenging task, requiring a deep knowledge of power system behaviour, modelling techniques, and mitigation strategies.

Seminar Overview

This comprehensive 3-day training course is designed to provide practical knowledge and technical expertise on harmonic assessment and filter application for renewable energy systems. Participants will gain insights into power quality fundamentals, harmonic modelling, compliance assessment methodologies, and the practical application of passive and active harmonic filters. The course will also cover relevant industry standards and guidelines, along with real-world case studies to enhance practical understanding. By the end of the course, attendees will be equipped with the essential tools to assess harmonic impacts, design effective mitigation strategies, and ensure compliance with transmission and distribution network requirements.

Seminar Presenter | Dr Tuan Vu

Dr. Tuan Vu

PhD, FIEAust, CPEng, RPEQ, APEC Engineer, IntPE(Aus)

Manager Power Systems / Principal Consultant

Volt-Var and Control Power Systems Consultants Pty Ltd

Dr. Tuan Vu is a highly experienced Power Systems Engineer with over 30 years of expertise in the electricity supply industry and energy consulting across Australia and internationally. His expertise spans high-voltage (HV) and extra-high-voltage (EHV) projects, generator and large load (including data centre) connections, power quality (harmonics), network planning, Renewable Energy Zones (REZs), system strength, voltage stability, reactive power control, wind, solar and battery energy storage system (BESS) integration, substation design, National Electricity Market (NEM) connections, power system studies, fault investigations, and FACTS technologies (SVCs and STATCOMs).

Dr. Vu has successfully led multidisciplinary teams in the delivery of high-voltage capital projects valued at over **AUD \$300 million**. He is also an active representative of Standards Australia, contributing to IEC standards development and participating in several CIGRE Working Groups.



Learning Outcomes

By the end of this course, participants will be able to:

- Understand the fundamentals of harmonics, including sources, phase sequences, and their impact on power systems.
- Apply harmonic modelling techniques for sources, transformers, reactors, filters, and network components.
- Interpret key industry standards like IEC 61000-3-6 (AS/NZS IEC/TR 61000-3-6:2012) and the Australian National Electricity Rules (NER).
- Perform harmonic compliance assessments and evaluate network scenarios against grid codes.
- Understand harmonic filter solutions, including passive and active filters, configurations, and integration strategies.
- Analyse case studies on harmonic challenges, filter failures, and mitigation in transmission and distribution networks.
- Understand harmonic measurement techniques, instrument selection, data analysis, and reporting for compliance.

This course will equip participants with the skills to handle harmonic assessments and filter solutions for renewable energy systems.

Course Content

Day 1

Fundamentals	▪ Power quality and its significance ▪ Why harmonics are a concern ▪ Current and voltage harmonics ▪ Thevenin and Norton equivalent circuits ▪ Total Harmonic Distortion (THD) ▪ Power factor and power factor correction ▪ Linear vs. non-linear loads ▪ Sources of harmonic distortion ▪ Harmonic phase sequences ▪ Triplen harmonics ▪ Impact of harmonics on power factor
Harmonic Filters	▪ Active and passive harmonic filters ▪ Single-tuned and double-tuned passive filters ▪ Short-circuit power and harmonic impedance ▪ Voltage support capacitor bank; detuned and non-detuned capacitor banks; harmonic filters ▪ RLC filters, C-Type filters and Mechanically Switched Capacitor with Damping Network (MSCDN)
Harmonic Modelling	▪ Modelling of transmission lines/cables, motors, loads, transformers and reactors ▪ SVCs ▪ Parallel resonance and series resonance ▪ Harmonic amplification effects ▪ Harmonic impedances ▪ Load damping considerations ▪ Harmonic frequency scans



Day 2

Harmonic Standards and Guidelines

- AS/NZS IEC/TR 61000.3.6:2012
- Australian Energy Network Association (AUS ENA) guideline for harmonics
- UK Energy Network Association (UK ENA) Engineering Recommendation G5
- Comparison of harmonic assessment requirements across Australian TNSPs

Australian TNSP Harmonic Compliance Assessment Guidelines

- Network scenario considerations
- Harmonic allocation (emission limits)
- Point of Connection (POC) impedance polygons
- Application of Thevenin and Norton equivalent models for harmonic assessment
- Norton equivalent current source and impedance model
- POC impedance amplification factors
- Aggregation of harmonic sources within inverter-based generation (solar, wind, and BESS)
- Pre-connection assessment requirements
- 95th percentile value of total harmonic voltage; post-connection assessment requirements



Day 3

Passive Harmonic Filters	▪ Filter configuration and optimal placement ▪ Component ratings – currents and voltage stresses ▪ Tuning/detuning frequency considerations
Practical Exercises	▪ Transmission Case Study 1: Harmonic allocation and pre-connection assessment for solar/wind/BESS connected to a transmission network ▪ Distribution Case Study 2: Harmonic allocation and pre-connection assessment for loads/solar/BESS connected to a distribution network
Practical Harmonic Case Studies	▪ Analysis of harmonic filter failures ▪ Transformer saturation impacts
Harmonic Measurements	▪ Current and voltage transformers for harmonic measurements ▪ Additional harmonic measurement circuits in voltage transformers ▪ Current and voltage harmonic measurements ▪ Placement of harmonic meters ▪ RC voltage dividers and their applications ▪ Data storage, analysis software and reports



VOLT-VAR AND CONTROL POWER SYSTEMS CONSULTANTS PTY LTD
ABN 43 622 622 664

Registration Fees and Details

Registration Contact	Dr Tuan Vu <i>Manager Power Systems / Principal Consultant</i> M: +61 407 372 483 E: admin@vvcpowersystems.com.au
Venue	Course to be conducted at Client's Office
Fees	\$1,500 per person (minimum 10 participants), or \$20,000 per course for 15 participants
Duration	3-day training seminar
Course Materials	Soft copies (PDF)



Volt-Var and Control Power Systems Consultants Pty Ltd

ABN 43 622 622 664 | Brisbane, Australia

admin@vvcpowersystems.com.au | vvcpowersystems.com.au