

Introduction to power system VOLT-VAR Optimisation (VVO)



Who Should Attend



This course will assist utilities' personnel with the application knowledge of VVO technologies in the electricity supply networks. This course will be beneficial to:

- **Asset Strategy Engineers and Managers**
- **Procurement Specialists and Managers**
- **Network Planning Engineers**
- **Design Engineers**
- **Field Engineers and Technicians**
- **Technical Officers**
- **Commissioning Engineers**
- **Construction and Project Managers**
- **Power System O&M Engineers**
- **Power System Consultants**

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Volt-VAR Optimisation (VVO) is a process of optimally managing voltage levels and reactive power to achieve more efficient grid operation by reducing system losses, peak demand or energy consumption or a combination of the three as well as improving voltage stability. The concept of Volt-VAR management or control is essential to electrical utilities' ability to deliver power within appropriate voltage limits so that consumers' equipment operates properly, and to deliver power at an optimal power factor to minimize losses. Traditional Volt-VAR management technologies have been used by the power industry for over 30 years to reduce line losses and increase grid efficiency. Today those technologies have advanced to include Volt-VAR Optimization (VVO) sensors, equipment and software capable of reducing overall distribution line losses by 2%–5% through tight control of voltage and current fluctuations.

Advanced VVO techniques with coordinated control schemes using capbanks, reactors, voltage regulators, STATCOMs or SVCs can help improve voltage stability, reduce line losses, peak load demand and energy consumption. Successful implementation of Advanced VVO systems depends on a wide range of factors throughout the power system network including: Load types, feeder and substation automation, SCADA, communication infrastructure, sensors, metering, feeder and bus voltages, transformers, capbanks, reactors, feeder conductor type size and length, location and size of distributed energy resources (solar, wind and battery).

Advanced VVO solutions provide a higher level of visibility into system operating parameters and a greater degree of automated control to maintain and improve voltage stability, optimize energy efficiency and deliver reliable electricity supply. Utilities are facing a dynamic operating landscape, a landscape that wasn't envisioned when most electrical networks were designed. The increasing penetration of intermittent renewable generation sources, the increasing diversity and variability of loads are driving this volatility. Utilities are also running closer to the operating limits of these systems than ever before, making the ability to optimize within operating parameters extremely important. Successful implementation of advanced VVO schemes requires good knowledge of the technical requirements, technical and financial challenges, benefits and risks.

Seminar Overview & Learning Outcome

The main focus of this seminar is to provide course attendees with the essential knowledge to:

- Understand applications of VVO technologies and benefits,
- Assess the network readiness and plan for VVO pilot project and network wide deployment,
- Implement feeder and substation automation, SCADA, Communication Infrastructures, VVO equipment, sensors
- Operate and maintain VVO Schemes that deliver technical and financial benefit

At the end of this course, attendees should

- ◆ Be familiar with the roles and functions of Advanced VVO in Active Smart Grids
- ◆ Understand the principles of Volt-VAR control in power systems
- ◆ Understand the technological advantages and disadvantages of different types Voltage and Reactive Power (VAR) systems and equipment
- ◆ Be familiar with the best practices of VVO from other utilities
- ◆ Be familiar with and applications of Volt-VAR Systems and equipment to improve voltage stability, minimise energy losses and manage peak demand in power systems.

Seminar Presenter

Tuan Vu, *B.E (Elec. Hons), M.E (Systems), FIEAust, CPEng, RPEQ*

Tuan has over 21 years of experience in the electricity supply industry. He is currently an Asset Strategies Engineer at Powerlink Queensland and has extensive knowledge and practical experience in Voltage Control and Reactive Power Plants (SVC and STATCOM), SCADA and Automation Systems, and covering a wide range of disciplines including technical specification, design, contract and project management, construction, commissioning, investigation and training.

Tuan was the Technical Project Manager, Technical Superintendent Representative and SVC Subject Matter Expert for 16 SVC projects with total project budget in excess of \$145M. He successfully led a number of major technical investigation tasks identifying the major contributing factors to a wide range of equipment and power system faults associated with SVCs and STATCOMs

Tuan Vu is a Fellow Member of the Institute of Engineers Australia, a Chartered Professional Engineer, a Registered Professional Engineer of Queensland and an International Professional Engineer, Australia. He holds a Bachelor of Electrical Engineering (Honours), Master of Systems Engineering – Specialised in Large and Complex Electrical Systems, and is currently undertaking PhD research in the field of Power System Harmonics and Power System Network Modelling.

Tuan is a member of Standards Australia committees and Joint Standards Australia/New Zealand committees, and a member of IEC TC 57 / WG 10 (Australian Delegate). He presented a number of papers on the subjects of SCADA, Automation Systems, Power Systems Harmonics, Voltage and Reactive Power Control and SVC projects at CIGRE and CIRED conferences. Tuan currently delivers training courses and provides consultant services to utilities and industrial customers.



DAY 1

1. Introduction to Volt-VAR Optimization (VVO)

- What is VVO, Why VVO, What does VVO offer?
- How to Implement VVO?
- Traditional Volt-VAr Control Versus Advanced VVO
- Volt-Var Control Systems – Stand-Alone, SCADA and Advanced Distribution Management System (ADMS)
- Principles of Volt-VAr Control in Power Systems
- Harmonics Distortion, Voltage Unbalance and Power Factor Issues
- Energy Consumption, Peak Demand and Losses
- Voltage constraints, Current constraints
- Challenges – Manual versus Intelligent Automatic Control Schemes and Variation of Load Types

2. Practical Application of Voltage Control, Reactive Power (VAr) Management in Smart Grid Systems

- Feeder and Substation Automation
- Power System Improvements with Volt-VAr Control
- Improve Feeder Voltage Profile using Coordinated Control Schemes
- Load Balancing – Negative Phase Sequence Control
- Power Factor Correction
- Peak Demand Reduction
- Energy Loss Minimisation
- Volt/VAr Dynamic Support for Solar and Wind Generation Sources using STATCOM or SVC.
- Solutions for Power System Voltage Issues using STATCOMs and SVCs

3. Volt-VAR Systems, Equipment and Control Schemes

- VVO Systems – Distributed versus Centralised
- Transformer On Load Tap Changers (OLTCs)
- Line Voltage Regulators
- Capbanks and Reactors
- Control and Communication Equipment
- STATCOM versus SVC
- Volt-VAr Control Schemes:
 - Conservation Voltage Reduction (CVR)
 - Automatic Voltage Regulation (AVR) / Transformer Tap Control
 - Circulating Current Minimisation
 - Line Drop Compensation
 - Capbank Control Schemes for Power Factor Correction and Voltage Support.
 - Coordinated Volt-VAr Control Schemes

DAY 2

4. SCADA, AMI and Communication Infrastructure

- SCADA, AMI, Monitoring and Control Requirements
- Data and Communication Requirements – Equipment, DNP3, MODBUS Protocol and IEC 61850 Standard.
- VVO Measurement Requirements – Voltage, Current, Active and Reactive Power, Power Factor, Harmonic Quantities (V,I, THD)

5. Electrical Load Types, Load Model and VVO Effect

- Voltage Sensitive and Voltage Non-Sensitive Loads
- Constant-Resistance Loads With & Without Feedback
- Constant-Energy, Constant-Current & Constant-Power Loads
- Characteristic of Motor Loads - High or Low Voltages
- ZIP Load Model and Thermostatic Control Load Model
- Effect of CVR on Different Load Types

6. VVO Benefits and Challenges

- VVO Benefits and Challenges
 - Technical and Financial Challenges
 - Cost Benefits and Risks
- System Challenges
- Decision Making Guidelines for VVO
- VVO Feasibility Assessment
 - Technical Considerations
 - Financial and Benefits Considerations
- VVO in Advanced Distribution Management System (ADMS)

7. System Integration Plan, Testing, Deployment and Evaluations of VVOs

- System Design
- Load Measurement and Model Verification
- Equipment and Control Scheme Testing
- System Testing

8. VVO Use Cases and Guidelines

- Use Cases from Other Utilities
- Smart Grid Initiative Projects – Analysis and Results
- Smart Grid Model and Guidelines

9. VVO Roadmap and Asset Management

- VVO Roadmap and Business Case
- Spare parts and Inventory Management