

United Energy Information and Consultation Low-Voltage Regulators

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Why

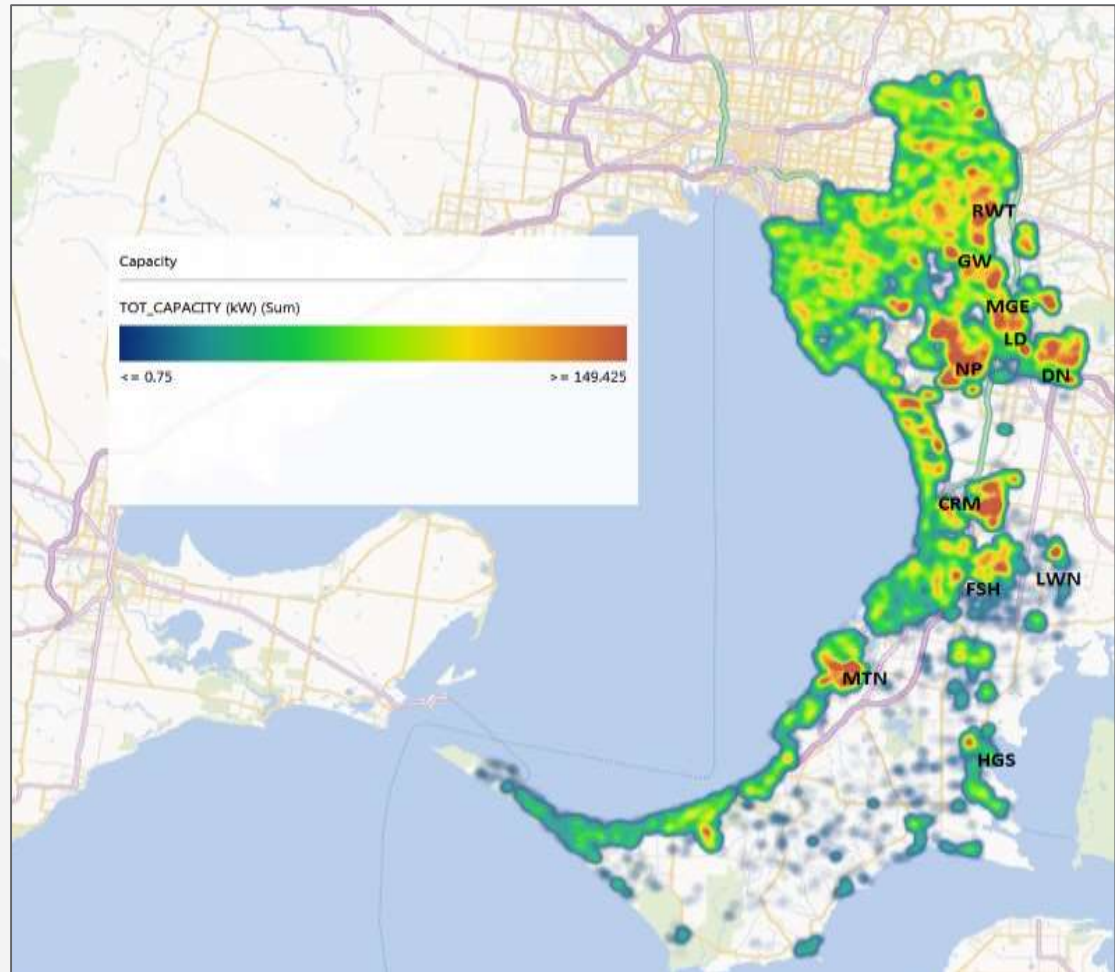
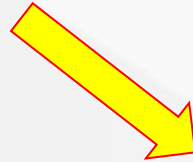
United Energy (UE) is exploring economic ways to facilitate a greater uptake of solar PV on our network by removing the technical barriers to connection of new distributed embedded generation:

- Connection of solar PV pushes up voltages on the low-voltage (LV) networks especially during light load in the middle of the day;
- When solar PV penetration levels are high, UE has difficulty maintaining voltages within Regulatory limits;
- Main cause of voltage regulation issues are long LV overhead circuits;
- One technology possibly able to resolve this issue is the LV Regulator.

HEAT MAP OF SOLAR PV SYSTEMS



UE Installed Solar PV
System Capacity per
Distribution Substation





Findings

- 39% of the AMI meters installed on the UE network recorded LV steady state voltage excursions over 2012
- 80% of the voltage excursions were over-voltage and 20% were only under-voltage
- Most of the under-voltage issues were experienced under hot weather, high demand conditions
- The over-voltage issues were experienced during light load and high solar PV penetration conditions
- Over the last five years there is a notable increase in the installation of solar PV roof top generation by the customers



Solutions

- Distribution Transformer Tap Change
- Zone Substation On-Load Tap Change (OLTC) Voltage Set Point Change
- Installation of Pole-Mount Capacitor Banks
- LV Network Augmentation (LV Feeder or Distribution Substation)
- HV Network Augmentation (HV Feeder)
- HV or LV Open-Point Changes or Phase Balancing
- HV Voltage Regulators
- Installation of Load Drop Compensation
- **LV Voltage Regulators**



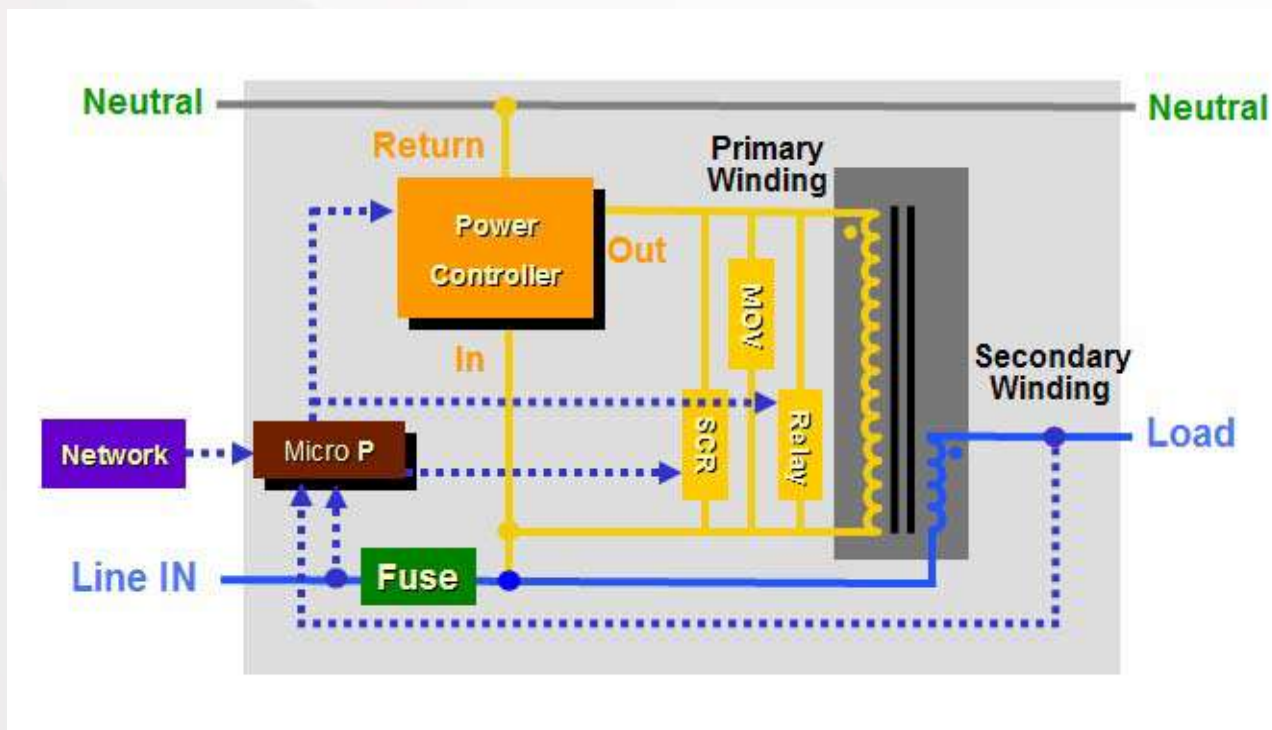
The LV Regulator Trial

UE is trialing LV Regulator technology (manufactured by MicroPlanet - LVR-C) over a period of at least 12 months in order to:

- Evaluate the performance of the LV Regulators at regulating the voltage within the Regulatory limits;
- Evaluate the total cost to supply and install the LV Regulators for any possible future rollout programme;
- Evaluate the LVR-C product (build quality, reliability, standard adherence, etc.); and
- Determine the benefits of using LV regulators on the UE network (for use in future cost-benefit analysis).

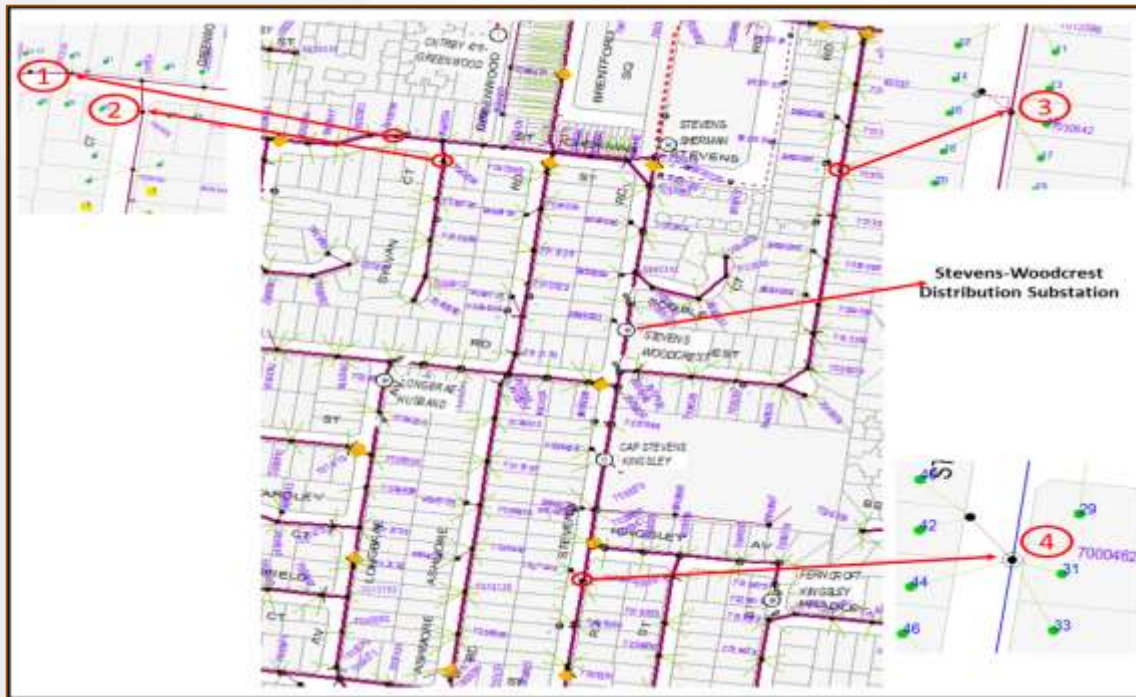
What is an LV Regulator

- An AC-to-AC converter produces a voltage with a varying magnitude
- AC-to-AC converter drives the primary of a high-efficiency toroidal buck/boost transformer



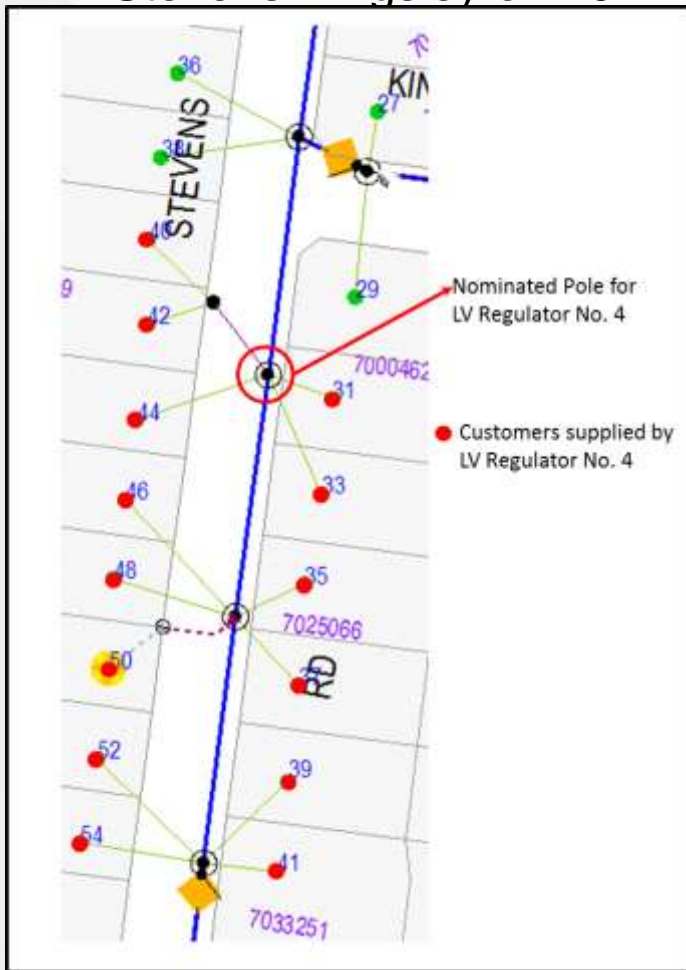
Location of the Trial Sites

Four sets of LV regulators are being trialled at “Stevens Woodcrest” 22/.4kV substation which is a pole-mount 300kVA transformer (ex NW33 – Vermont South) with each LV Regulator set consisting of 3 single-phase 20kVA LVR-C units, connected to form a three-phase installation.



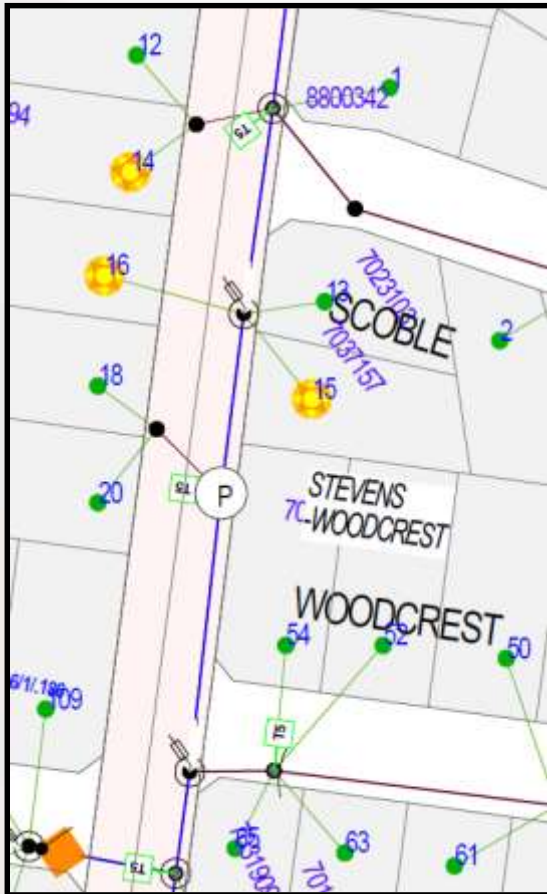
Site 1

- LVR Stevens-Kingsley on 19th March 2014

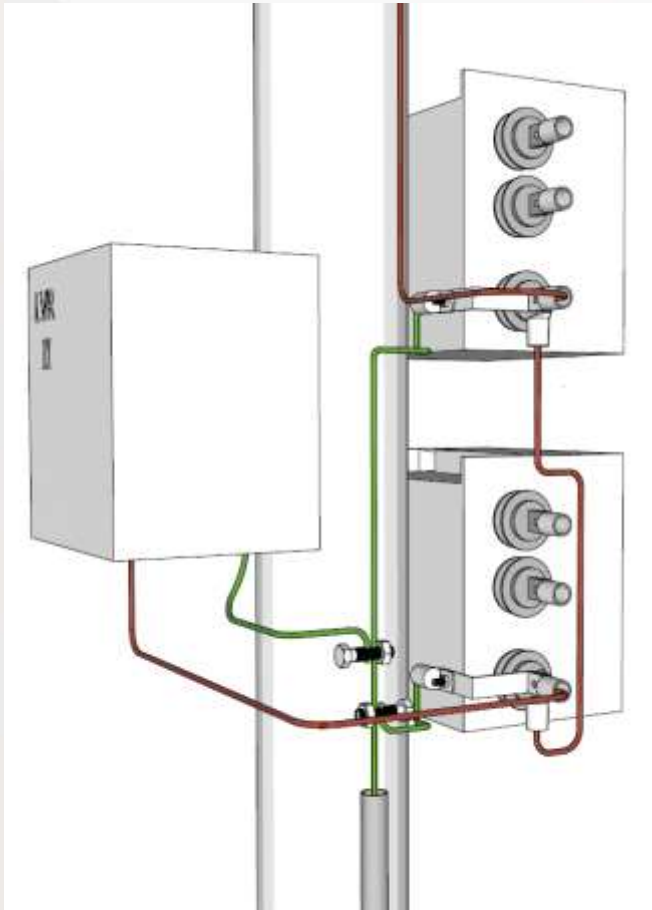


Substation Tap Change

- Stevens-Woodcrest Substation Tap Change on 21st June 2014

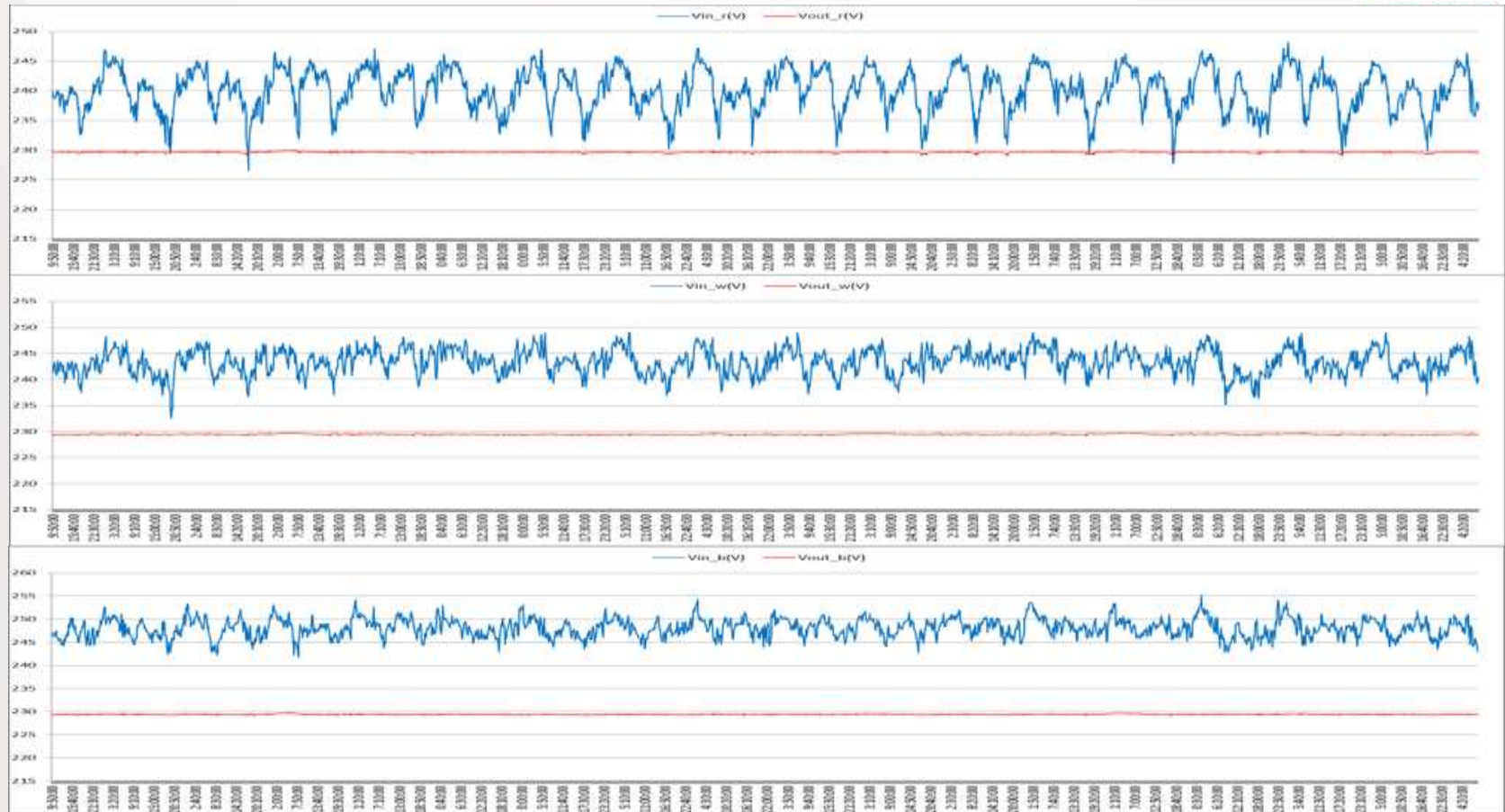


LV Regulator Installation





Steady State Voltage (Before & After)



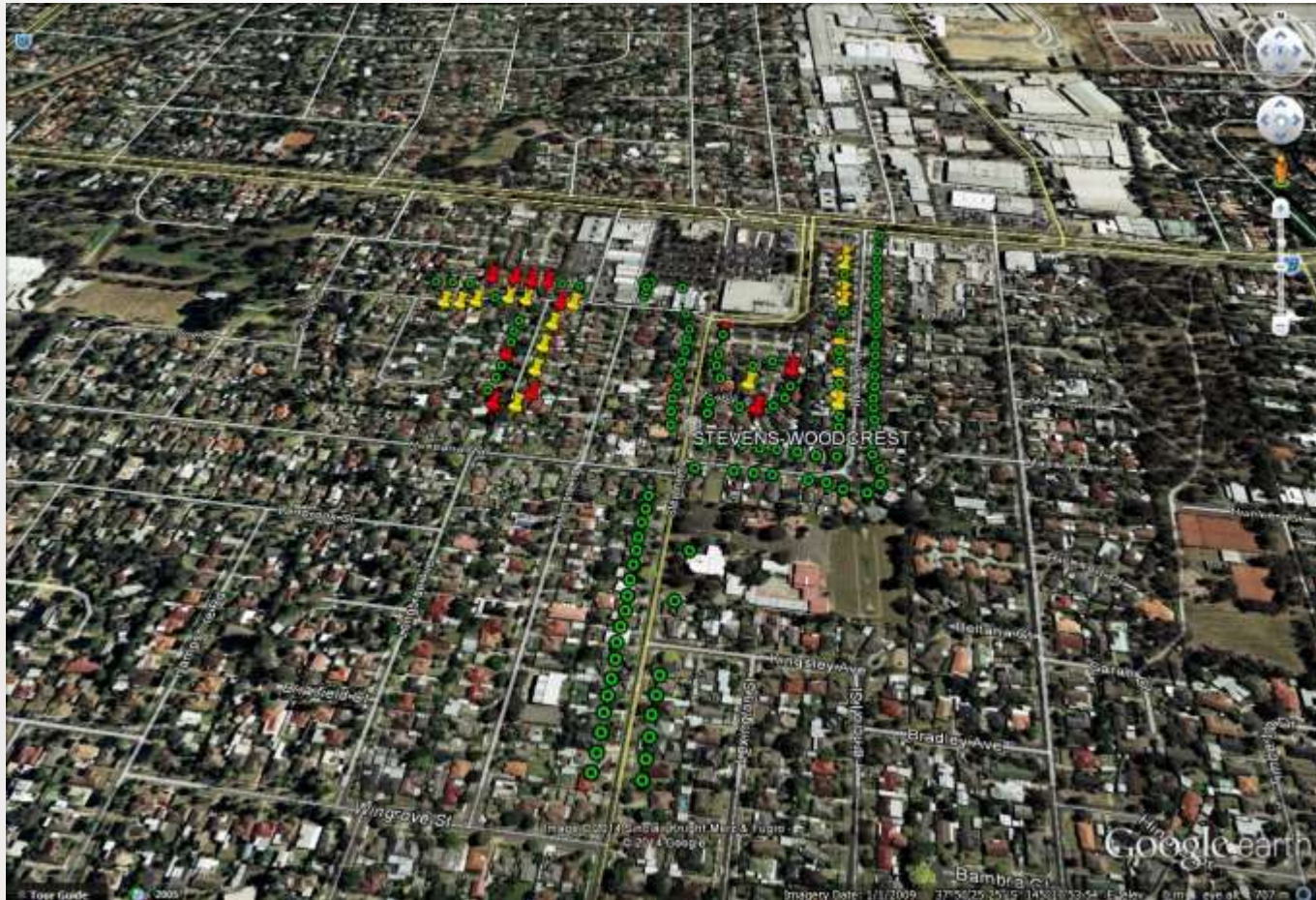
Measured Input and Output 10min Average Voltages (V_{rms} (V))

LVR Stevens-Kingsley – Red / White / Blue Phases

Voltage Excursions-AMI Meters 2012 (Before)



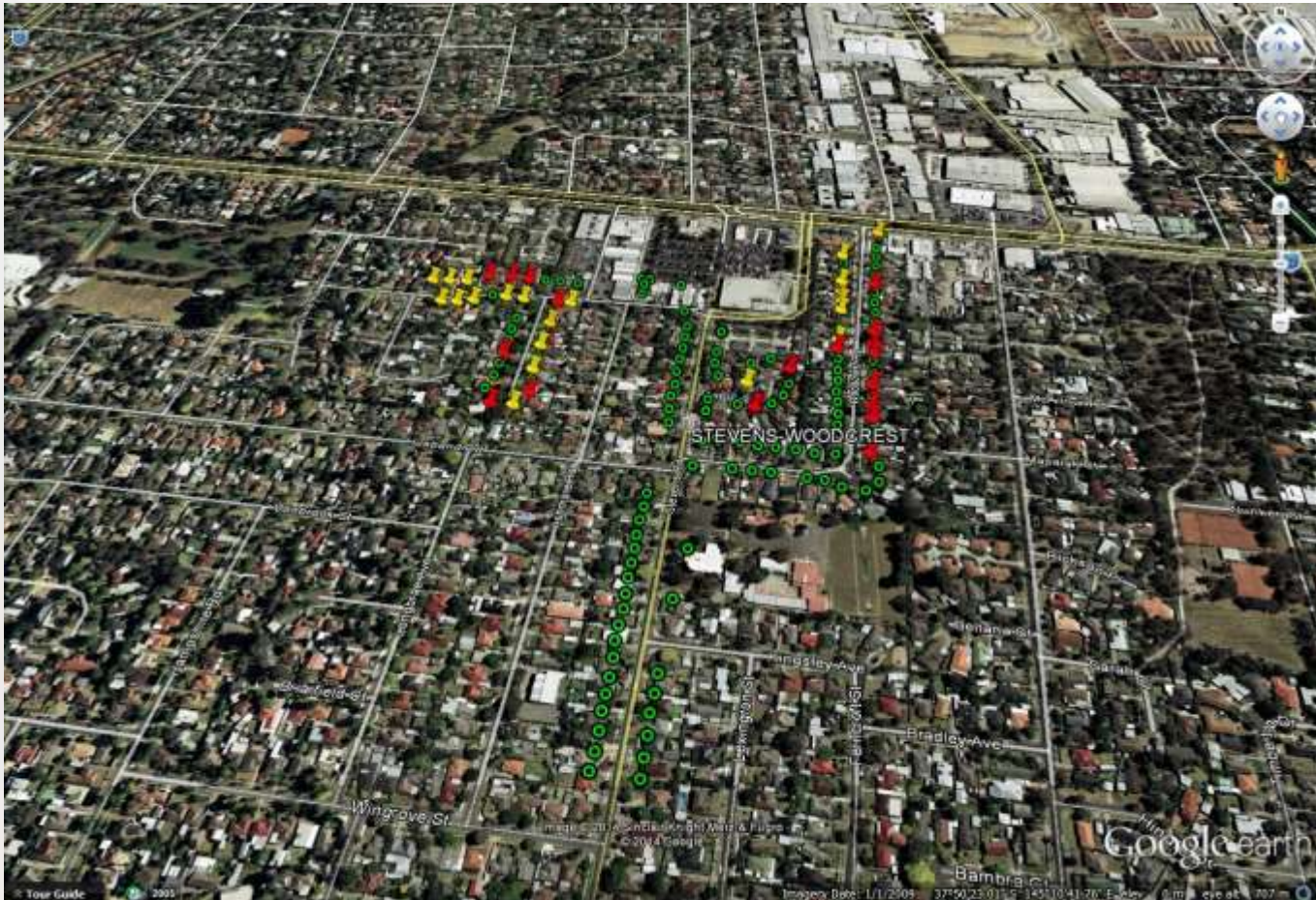
Over/Under-Voltages and Sags/Swells Captured by the AMI Meters for Distribution Transformer Steven-Woodcrest from 14/09/2012-15/09/2012



Voltage Excursion-AMI Meters 2013 (Before)



Over/Under-Voltages and Sags/Swells Captured by the AMI Meters for Distribution Transformer Steven-Woodcrest from 14/09/2013-15/09/2013



Voltage Excursion-AMI Meters 2014 (After)



Over/Under-Voltages and Sags/Swells Captured by the AMI Meters for Distribution Transformer Steven-Woodcrest from 14/09/2014-15/09/2014





CONCLUSION

- UE's Long-Term Strategic Objective is to Address the Emerging Challenges of Solar PV Systems to Provide Supply Voltages to All Customers that Comply with Stipulated Regulatory Quality of Supply Limits
- The Solar PV Penetration Strategy is to Propose a Proactive Plan to Address the Challenges and to Adopt Initiatives in:
 - Facilitating the Development of Solar PV System Standards and Connection Requirements
 - Improving Measurement, Analysis, and Simulation Techniques to Locate and Understand the Issues Related to Solar PV Systems
 - Trialing of New Technologies, Research, and Education Targeting Specific Voltage Regulation Challenges
 - Undertaking Proactive Programs to Rectify Identified Relevant Issues and Accommodate Further Increases in Distributed Solar PV Generation