United Energy Demand Response Project Performance Report - Milestone 6

17.12.19

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Contents

1. Summary

This document is the United Energy Demand Response Project Performance Report for the ARENA Advancing Renewables Programme – Demand Response programme (RB006). It fulfils an obligation under the Knowledge Sharing Plan to provide an update on the status of the delivery of the Dynamic Voltage Management System (DVMS) rollout project including sharing of results and lessons learnt.

This report documents the major achievements of the project since the release of the last milestone report. These achievements include completion of:-

1) AEMO tests to confirm United Energy's demand response reserve capability for the last period;
2) Post-implementation review of the DVMS performance in relation to steady-state voltage regulation compliance; and
3) Knowledge sharing activities relating to the findings of the project during the period.

To minimise duplication of content, this report should be read as a continuation of the milestone 1, 2, 3, 4 and 5 reports.

Any parties interested in discussing the contents of this report directly with United Energy are encouraged to contact United Energy at planning@ue.com.au.

The milestone reports are available on United Energy's website.

2. Testing Demand Response Reserve Capability

United Energy (UE) undertook a winter 2019 period demand response test with AEMO. The objectives of the tests were to i) confirm UE's demand response reserve capability achieves the required 30MW for RERT, and ii) ensure the ITT (Invitation to Tender) and activation communication channels were operating correctly and acted on within the required period of time of 30 minutes and 10 minutes respectively.

2.1. Sixth Test – 23rd May 2019

AEMO called a sixth test with UE on 23rd May 2019 for a 2-hour period starting 1300 market time for a capability of 30MW.

The following chart shows the high frequency sampling rate measurements of the total demand included in UE's demand response portfolio, before, during and after the test.

Activation of the demand response by way of voltage reduction is evident in the time before the event start date (1300 market time) with demand falling from 845MW at 1250 to around 818MW at 1310. With underlying demand at the time just prior to activation decreasing at 0.17MW/minute, the coincident time demand reduction achieved in the first interval is 845MW – 818MW + 0.17MW/minute x 20 minutes = 30MW. Subsequent intervals also achieved demand reductions of at least 30MW.

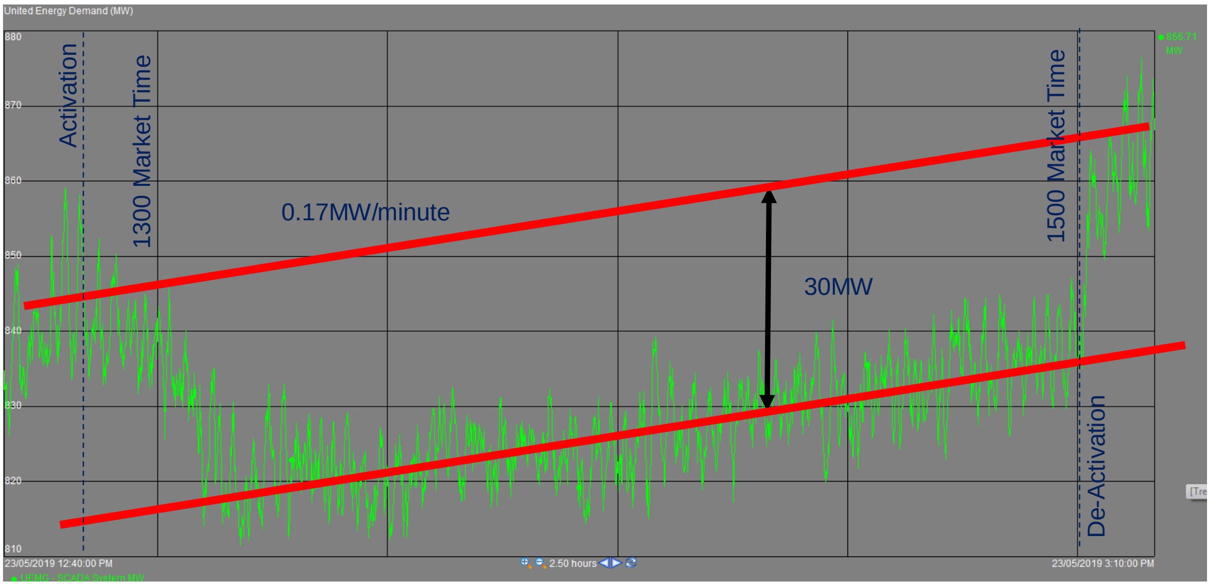


Figure 1 Test on 23rd May 2019 showing demand response due to voltage reduction (2.5 hour window)

Deactivating the demand response was undertaken by restoring network voltages which occurred from 1500 market time with demand rising from 837MW at 1500 to around 868MW at 1510. With underlying demand at the time decreasing at 0.17MW/minute, the coincident time demand reduction in the final period is 868MW – 837MW + 0.17MW/min x 10 min = 32MW.

In summary, high-speed SCADA measurements (presented above) provide evidence that UE delivered at least the required 30MW of demand response capability for all half-hour periods and that the communication process to receive and accept the ITT, and the subsequent activation of the demand response reserve capability have been successfully demonstrated.

The chart below illustrates the relativity of the demand response performance to the total demand levels on the UE network during the entire day on which the test was conductor.

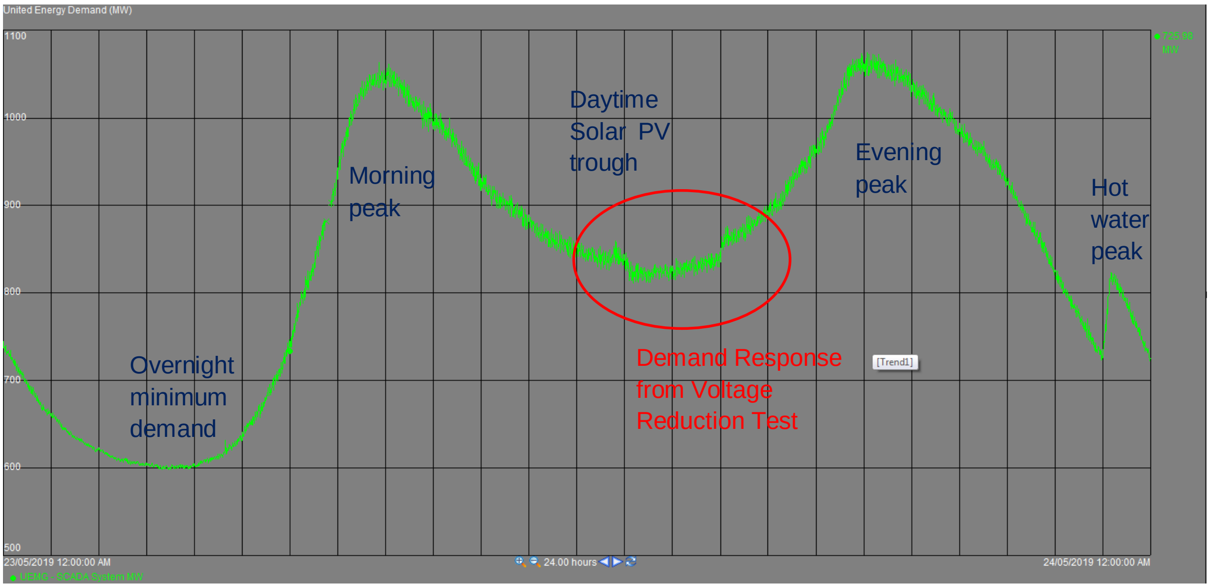


Figure 2 Test on 23rd May 2019 showing demand response due to voltage reduction (24 hour window)

3. Benefit of DVMS on Customer Voltages

Dynamic Voltage Management System (DVMS) and smart-meter technology provides distributors the opportunity to achieve the following outcomes:

- Deliver demand response services for RERT using voltage reduction to increase supply-demand reserve levels in the NEM to help avoid load shedding – as demonstrated in our Milestone 5 report;
- Deliver step-change improvements in steady-state voltage compliance by dynamically adjusting voltages at zone substations using customer voltage feedback from smart meters in response to changing load and generation patterns on the network – the subject of this Milestone 6 report;
- Allow for higher penetrations of customer solar PV systems to be connected to the network (and at increased export levels) without adverse impacts on network performance (i.e. increased solar hosting capacity), while reducing customer voltage complaints – this will be the subject of upcoming Milestone reports.

UE through this ARENA-funded project, has been able to demonstrate the benefits and share the learnings of this technology with the broader industry.

With the DVMS technology fully rolled-out across the UE electricity distribution network and in operation now for a year, UE has been able to monitor and demonstrate the positive impact DVMS has had on customer steady-state voltages. This section shares the learnings of this investigation.

3.1. DVMS design objective for voltage compliance

DVMS has been developed with the intent of facilitating steady state voltage compliance against AS61000.3.100. This Australian Standard allows for customer steady-stage voltages to exceed 230V + 10% (253V) or fall below 230V – 6% (216V) for no more than 1% of the time.

DVMS helps to achieve this compliance at a population scale by selecting an appropriate voltage setpoint at each zone substation that facilitates at least 99% of our customers at any instant in time remaining within the 253/216V limits, with the view that residual outliers could be addressed on a site-by-site basis with localised remedial actions. This approach allows UE to strike an appropriate balance between population-based voltage regulation versus individual site-based remedial actions, while maximising the level of demand response provided for RERT. Outliers are likely to be sites that have a localised issue such as loose connections (for under-voltage) or large export of solar through long service lines (for over-voltage) and these are best suited to a localised remedial action. As such the two operating modes for DVMS ensure that for normal operation no more than 1% of customers operate above 253V and for demand response mode, no more than 1% of customers operate below 216V.

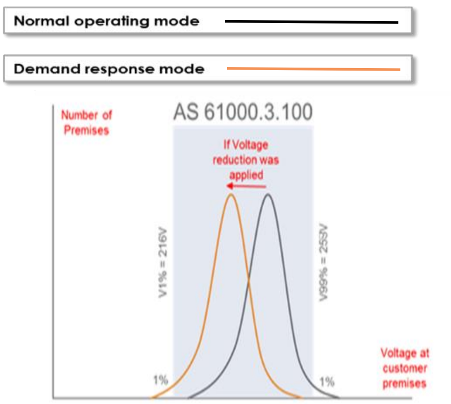


Figure 3 DVMS operating modes to maximise both demand response and voltage compliance

3.2. Voltage performance by zone substation

A daily report is produced on the performance of DVMS for each zone substation across the UE network documenting the results of the previous day. The report includes the:-

- percentage of customers experiencing steady state voltages less than 216V (i.e. 230V – 6%);
- percentage of customers experiencing steady state voltages greater than 253V (i.e. 230V + 10%);
- percentage of customers within the range 216V to 253V (i.e. 230V + 10% / – 6%);
- actual V1% and V99% voltages relative to the AS61000.100.3 limits of 216V and 253V respectively; and
- average zone substation transformer tap position compared to the available tap range.

A sample report is presented below for a typical mild day during 2019.

Table 1: Steady State Voltage Performance by Zone Substation on a typical mild day

Zone Sub	Percent of Customers < 216V (6% Under Voltage)	Percent of Customers > 253V (10% Over Voltage)	Percent of Customers in 230V +10% / -6%	V1% Volts	V99% Volts	Avg Tap Position	No. Taps
BH	0.00	0.03	99.97	231	250	6.0	17
BR	0.01	0.51	99.48	230	252	6.5	17
BT	0.00	0.11	99.89	233	250	7.5	17
BU	0.00	0.47	99.53	234	252	5.0	17
BW	0.01	0.26	99.73	229	250	2.0	11
CDA	0.02	0.20	99.79	230	251	4.0	17
CFD	0.01	0.22	99.77	231	251	7.0	17
CM	0.00	0.01	99.99	233	249	7.5	17
CRM Bus12	0.01	0.06	99.93	230	250	8.7	17
CRM Bus 3	0.00	0.00	100.00	230	248	8.7	17
DC	0.00	0.40	99.60	231	251	5.0	17
DMA	0.01	0.90	99.09	232	253	16.0	17
DN Bus 13	0.01	0.03	99.96	230	250	4.5	13
DN Bus 2	0.00	0.11	99.89	233	251	4.5	13
DSH Bus 1	0.00	0.31	99.69	238	252	7.0	17
DSH Bus 23	0.00	0.11	99.89	231	252	7.0	17
DVY	0.00	0.26	99.74	231	251	6.0	17
EB	0.01	0.40	99.59	232	252	6.0	17
EL	0.00	0.09	99.91	232	251	6.0	17
EM	0.00	1.26	98.74	233	253	7.0	17
EW	0.01	0.04	99.95	231	250	4.5	17
FSH	0.01	1.10	98.89	233	253	10.8	17
FTN	0.00	0.02	99.98	230	249	14.0	17
GW	0.00	0.10	99.90	231	250	5.0	17

Zone Sub	% Customers less than 216V (6% Under Voltage)	% Customers greater than 253V (10% Over Voltage)	% Customers within 230V +10%, -6%	V1%	V99%	Avg Tap Position	No. Taps
HGS	0.02	0.42	99.56	229	252	4.5	17
HT	0.00	0.70	99.30	235	253	6.5	17
K	0.00	0.03	99.97	232	250	4.0	17
KBH	0.00	0.31	99.69	232	252	4.5	17
LD	0.00	0.06	99.94	231	250	4.0	17
LWN	0.01	0.26	99.73	232	251	4.0	17
M	0.00	0.25	99.74	230	250	3.5	17
MC	0.00	0.06	99.93	229	249	3.5	17
MGE	0.00	0.11	99.89	232	251	14.0	17
MR	0.00	0.10	99.90	229	250	5.5	17
MTN	0.00	0.21	99.78	230	252	3.5	17
NB	0.00	0.45	99.54	233	253	7.5	17
NO	0.00	0.73	99.27	231	253	3.0	17
NP	0.00	0.71	99.28	232	252	6.6	17
NW	0.00	0.63	99.37	233	252	6.0	17
OAK	0.00	0.00	100.00	230	248	5.0	17
OR	0.00	0.34	99.66	233	252	7.0	17
RBD	0.01	0.22	99.77	229	251	15.0	17
SH	0.00	0.01	99.98	231	250	7.0	13
SR Bus 2	0.00	0.52	99.48	232	252	7.5	17
SR Bus 3	0.00	0.50	99.50	233	252	7.5	17
SS	0.00	0.17	99.83	232	251	2.0	17
STO	0.05	0.43	99.53	227	251	15.5	17
SV	0.00	1.00	99.00	233	253	13.0	17
SVW	0.00	0.15	99.85	229	249	15.0	17
WD	0.03	0.00	99.97	229	249	5.5	17
TOTAL	0.005	0.31	99.69	231	251		

In summary the table above is showing that, with DVMS in service:-

- V99% voltage is being regulated at all sites within the 253V limit;
- V1% voltage is being regulated at all sites within the 216V limit;
- 0.005% of customers are at times operating below 216V and 0.31% of customers above 253V;
- V1% is 231V and V99% is 251V, a spread of 20V and a demand response margin down to 216V of 15V.

The results of this report are represented in graphical form below with DVMS operating in normal mode.

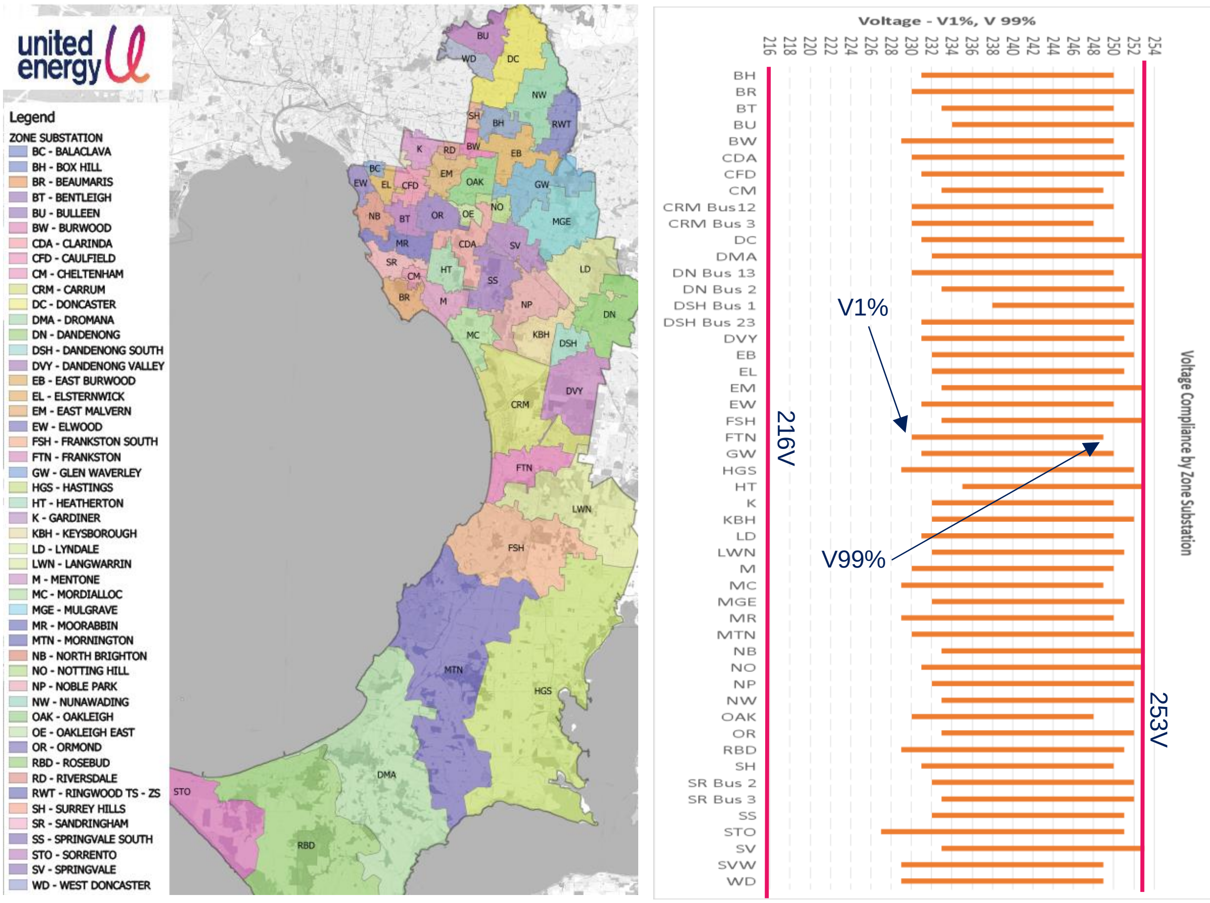


Figure 4 Typical day V1% and V99% voltages by zone substation against limits 253V and 216V

The voltage spread shown for each zone substation is consistent with the type of area being supplied. HGS (Hastings) zone substation for example supplies a semi-rural area and has a wider voltage spread than an urban industrial area such as HT (Heatherton). The margin between V1% and 216V also shows the opportunity for demand response using voltage reduction.

Appendix A shows the distribution of voltages at each zone substation on a typical day.

For voltage outliers beyond V1% and V99%, the percentage of customers over and under 253V and 216V respectively is shown below.

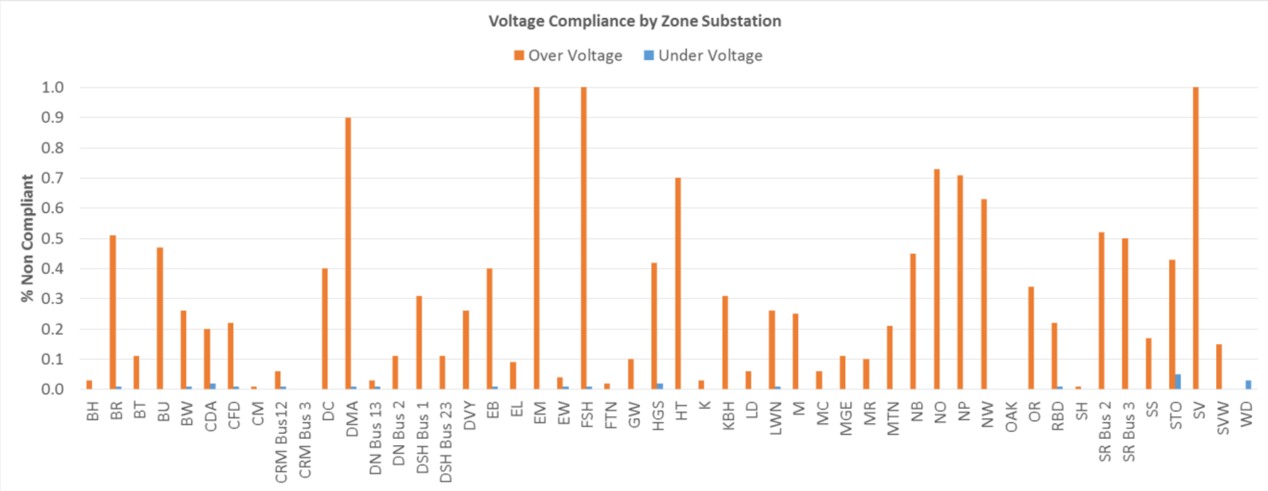


Figure 5 Typical day Voltage outlier results by zone substation against hard limits 253V and 216V

The discrete nature of the voltage setpoint recommendations available to DVMS means that levels fluctuate on a day-by-day basis across different zone substations between 0% and 1%, with an average of 0.31% for over-voltages. Overall, the performance remains consistent across the population on typical mild days.

3.3. Managing tapping range to maintain voltage compliance

The following figure highlights the ability of each zone substation to adequately regulate the voltage upward or downward when DVMS is in normal voltage mode, and the tapping margin available to provide a reduced voltage demand response. Each tap position represents a voltage change of 1.25%.

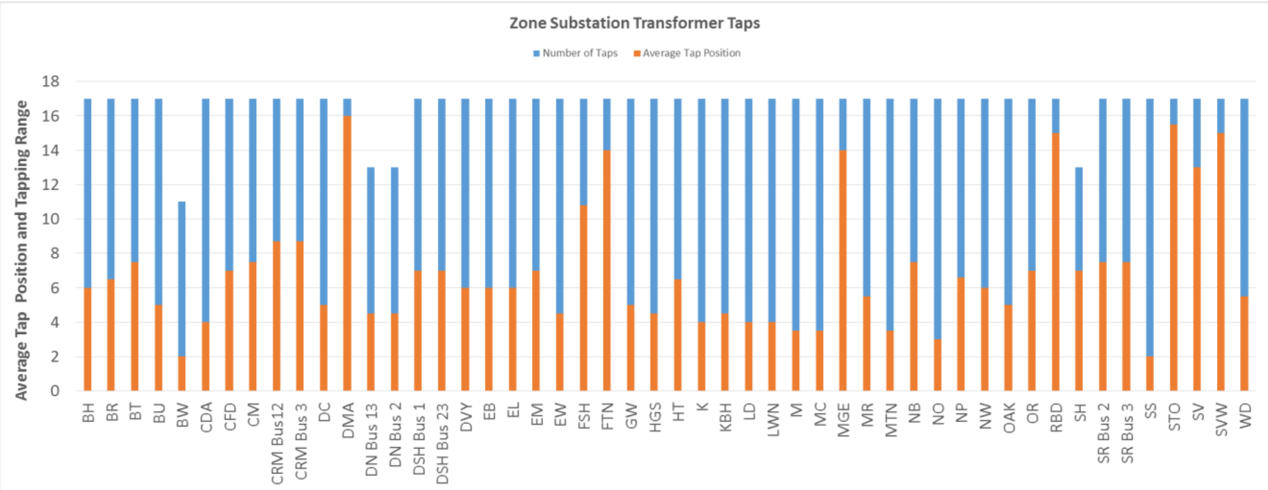


Figure 6 Typical (low demand) day's remaining tapping range by zone substation

DMA (Dromana) zone substation operates close to its end tap on most days, and the margin available for it to provide demand response (or absorb additional solar PV export) on low demand days is limited. Recently, voltage levels at the supplying Tyabb terminal station have been reduced to provide more margin for DMA, however ultimately a higher reactive power draw is needed through the transformers at DMA to provide a larger available tapping range. This could be achieved in future by switching off capacitor banks or installing reactors at the zone substation. There are a number of other zone substations similar to DMA with limited tapping range at low demand periods, but on the whole, most zone substation have a wide tapping range available.

3.4. Voltage performance on low demand days

Below is a summary of daily performance across the whole UE network (all zone substations) during a mild-weather week in 2019 when conditions are such that demand on the network is low and solar generation is high.

Table 2: Steady State Voltage Performance across UE Network on a recent low demand days

Date	% Customers less than 216V (6% Under Voltage)	% Customers greater than 253V (10% Over Voltage)	% Customers within 230V +10%, - 6%	V1%	V99%	Voltage Reduction Capability (V%) (based on available taps constraint)	Voltage Reduction Capability (V%) (based on voltage spread constraint)	Overall Voltage Reduction Limitation
Wednesday, 4 December 2019	0.002	0.30	99.70	232	251	5.5	6.8	Tap range
Tuesday, 3 December 2019	0.003	0.35	99.65	232	251	5.6	6.7	Tap range
Monday, 2 December 2019	0.006	0.37	99.62	231	251	5.2	6.4	Tap range
Sunday, 1 December 2019	0.005	0.31	99.68	232	251	4.8	6.6	Tap range
Saturday, 30 November 2019	0.003	0.36	99.64	233	251	4.4	7.0	Tap range
Friday, 29 November 2019	0.003	0.56	99.44	233	252	5.6	6.9	Tap range
Thursday, 28 November 2019	0.002	0.66	99.34	233	252	5.7	6.9	Tap range

The table illustrates that lower demands on Saturdays and Sundays generally see a smaller available tapping range (and hence a smaller voltage reduction) for demand response, and on all mild-weather days, the voltage reduction available for demand response is limited by the available tap range on the zone substation transformers.

3.5. Voltage performance on high demand days

For high demand days, the constraint on the size of the demand reduction available shifts from the available tapping range to voltage spread. Below is a summary of daily performance across the network during the highest monthly demand days in 2019[1].

Table 3: Steady State Voltage Performance across UE Network on a recent high-demand days

Date	UE maximum demand MW	% Customers less than 216V (6% Under Voltage)	% Customers greater than 253V (10% Over Voltage)	% Customers within 230V +10%, - 6%	V1%	V99%	Voltage Reduction Capability (V%) (based on available taps constraint)	Voltage Reduction Capability (V%) (based on voltage spread constraint)	Overall Voltage Reduction Limitation
Thursday, 31 October 2019	1363	0.02	0.80	99.18	230	252	6.2	5.8	Voltage spread
Monday, 9 September 2019	1361	0.03	0.46	99.52	229	251	6.1	5.6	Voltage spread
Friday, 9 August 2019	1456	0.06	0.41	99.53	228	251	5.7	4.9	Voltage spread
Wednesday, 31 July 2019	1404	0.03	0.44	99.53	229	251	5.6	5.4	Voltage spread
Thursday, 20 June 2019	1458	0.04	0.34	99.62	228	251	5.9	5.1	Voltage spread
Wednesday, 29 May 2019	1468	0.05	0.35	99.60	228	251	5.5	4.9	Voltage spread
Friday, 1 March 2019	1974	0.37	0.53	99.09	223	251	6.4	2.9	Voltage spread

[1] No high demand days in April 2019. January 2019 excluded due to abnormal load shedding day on 25/1/2019.

Thursday, 28 February 2019	1856	0.23	0.52	99.24	225	251	6.8	3.6	Voltage spread

The table illustrates that high demands (on days of extreme heat or cold) generally see a larger voltage spread between V1% and V99% which limits the size of the voltage reduction available for demand response. For example the voltage-reduction demand response capability on 1/3/2019 was limited by the voltage spread to 2.9%, compared to an available tapping range of 6.4%. This limits the size of the demand reduction to 2.9% x 1974 MW x 0.7%/% = 40MW (based on the 0.7%/% elasticity of UE demand to voltage). This is illustrated in the chart below with DVMS in normal operating mode where the increased voltage spread on 1/3/2019 was due to high loads through network impedances creating voltage drops within the network.

3.6. Managing voltage spread to maintain voltage compliance

The 99th percentile voltage (V99%) provides an indication of the light-load voltage at a site. The limit for V99% is 253V for low-voltage sites. The 1st percentile voltage (V1%) provides an indication of the peak-load voltage at a site. The limit for V1% is 216V for low-voltage sites.

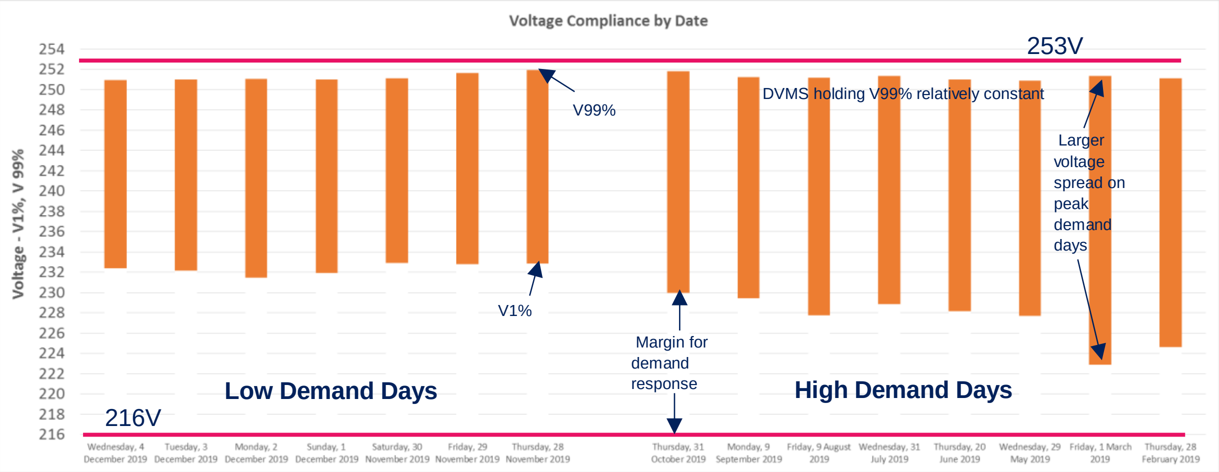


Figure 7 Comparison of voltage-spread for low-demand and high-demand days

The chart above also illustrates the effectiveness of DVMS to hold V99% as close to 253V during normal operating mode as possible, regardless of the demand on the system, to maintain voltage compliance and maximise the opportunity for demand reduction when needed.

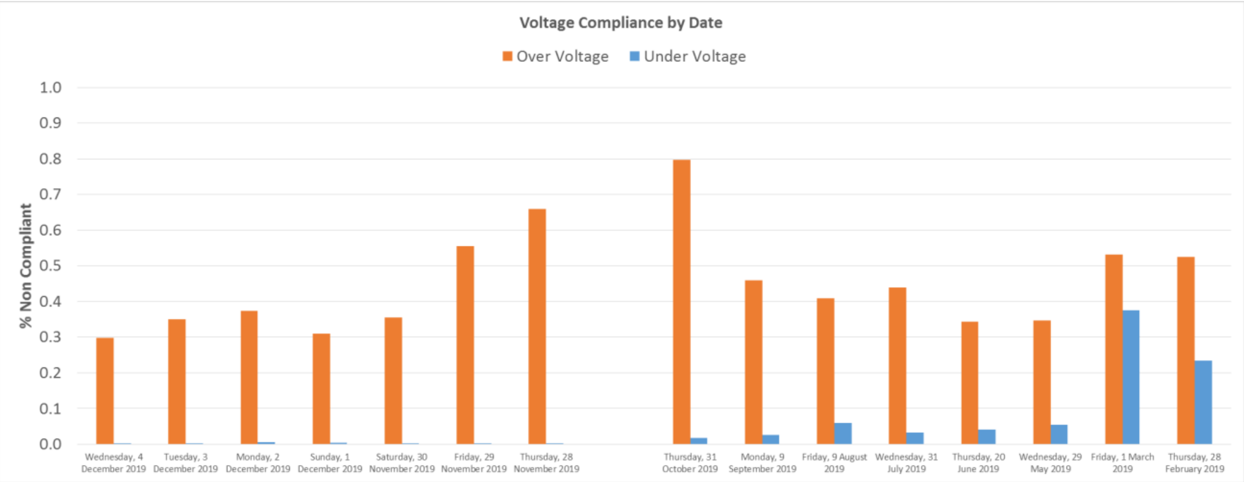


Figure 8 Voltage outliers for low-demand and high-demand days

With DVMS holding V99% close to 253V, most of the voltage outliers are localised over-voltage issues. However, on days of high demand, as the voltage-spread increases on each zone substation, there are some localised under-voltage issues which highlight the need for some local remedial solutions.

UE has calculated voltage spread as the difference between the 99th percentile value and the 1st percentile value. As part of this project, UE has undertaken a large number localised remedial works on its low-voltage distribution network to tighten up the voltage spread and maximise the opportunity for achieving coincident voltage compliance and demand response capability. These works have involved tap changes on distribution transformers, rectification of loose connections, phase balancing and transferring customers across low-voltage open points. Figure 9 demonstrates the average values of voltage spread for each UE's zone substation prior to and post implementation of the low-voltage remedial works.

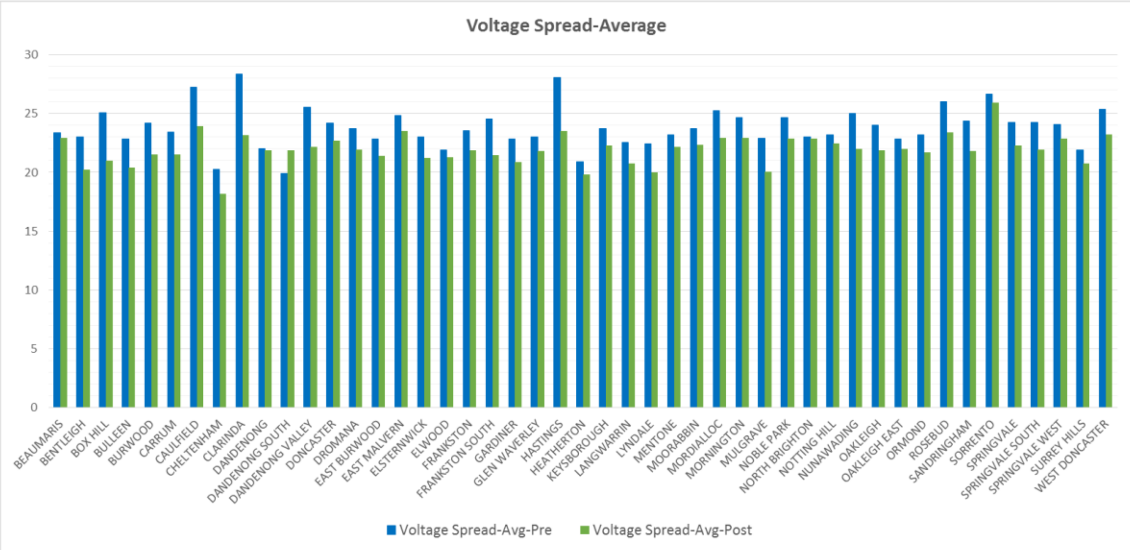


Figure 9 Average Voltage Spread (V) on each zone substation Pre and Post LV Remedial works

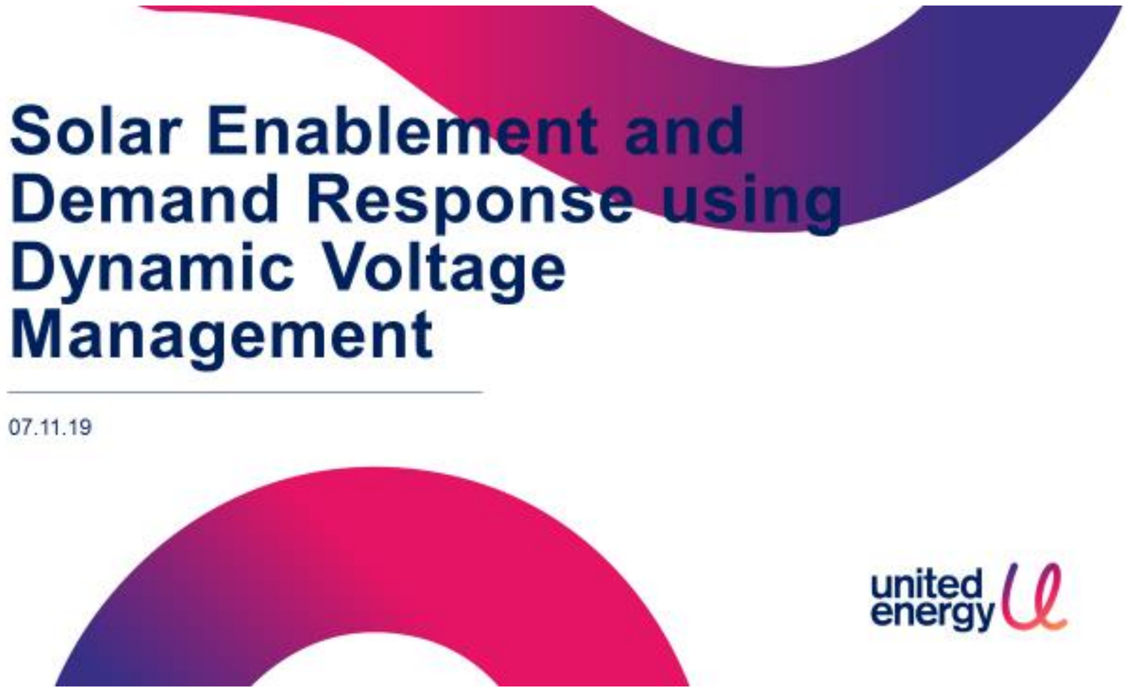
As this figure shows, low-voltage remedial works under the DVMS rollout project have reduced the voltage spread at all zone substations and consequently, increased the level of demand response capacity for RERT services. The remedial works undertaken have provided an additional 1% voltage reduction margin for demand response across the network.

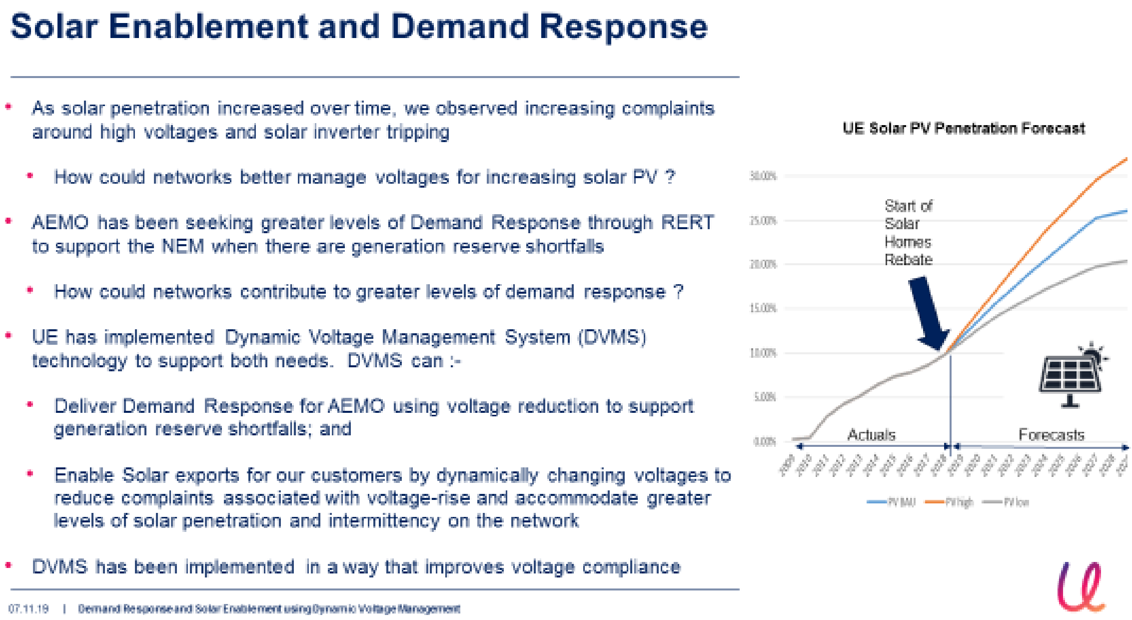
4. Knowledge Sharing Activities

Since the last milestone report, UE has participated in the following events and shared the learnings of this project with the broader industry:

- UE and SA Power Networks Knowledge Sharing Workshop on 1st July 2019.
- UE and AusNet Services Knowledge Sharing Workshop on 5th August 2019.
- Annual meeting of CIGRE Australia Panel C6 Active Distribution Systems and Distributed Energy Resources on 19th August 2019.
- CIGRE Australia Conference on Integration of Distributed Energy Resources Asia Pacific 2019 presentation on 20th-21st August 2019.
- UE and Power Asset Holdings Knowledge Sharing Workshop on 3rd September 2019.
- 3rd Australian Distribution Future Network Forum presentation in Brisbane on 14th-15th October 2019.
- RMIT Industry Forum on Energy Profiling and Demand presentation on 7th November 2019.
- UE and AEMO Knowledge Sharing Workshop on 25th November 2019.
- Updated the knowledge sharing webpage on the UE website for the purposes of sharing our project performance reports and provided input into the ARENA knowledge sharing insights website content.

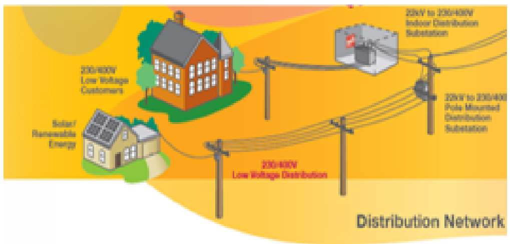
4.1. RMIT Industry Forum on Energy Profiling and Demand

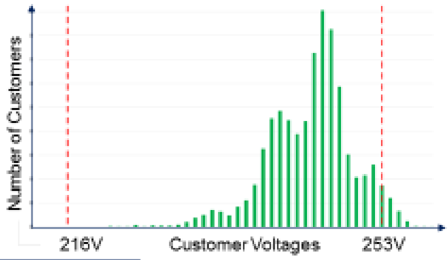




Steady State Over-Voltage Challenge

- Historically, voltages on distribution substations were set at the high end of regulatory voltage limits to allow for voltage drop at peak demand.
- Peak demand only occurs for a small proportion of the year (hottest summer days < 1%), so most of the time, customer voltages are on the high side.
- Solar PV export can cause voltages to rise above the regulatory voltage limit, resulting in growing compliance issues and solar inverter tripping.
- All UE smart meters provide voltage readings at customer premises, revealing whether customer voltages are rising above the regulatory voltage limit.
- This information can be used by DVMS to dynamically adjust zone substation voltages at MV downward to bring voltages back to compliance.





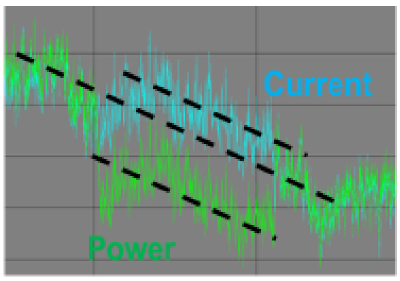
07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

Demand Response Voltages Reduction Challenge

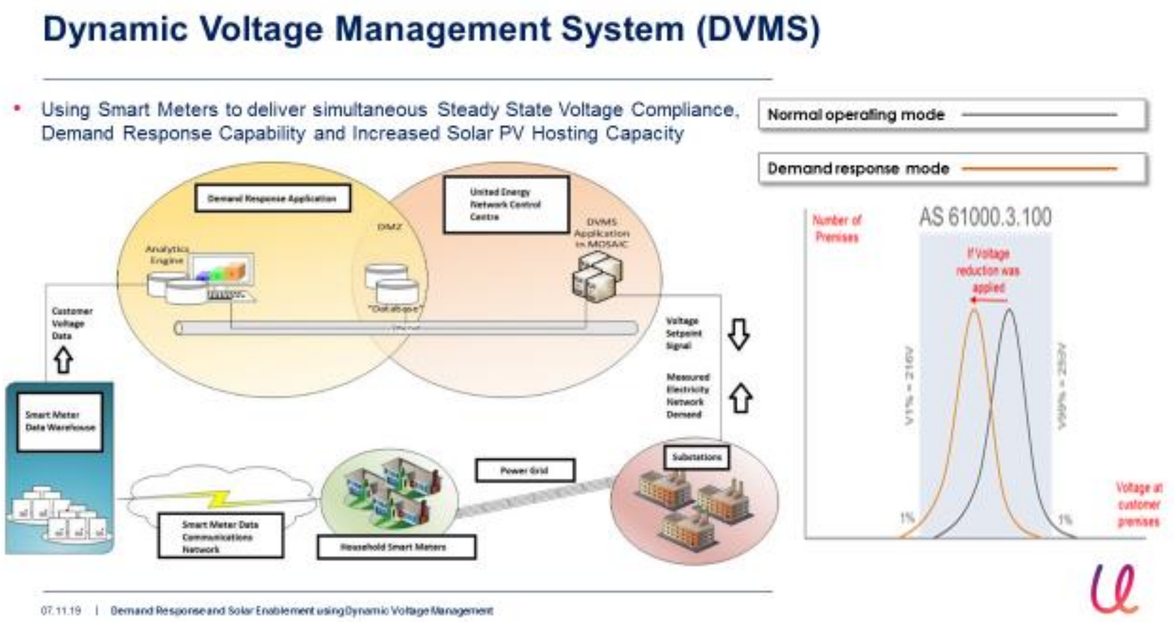
- It is well known that reducing voltage at zone substations reduces active power demand on the network.
- Historically, it is limited in use because of its unknown impact on customer voltages, relative to regulatory voltage limits.
- Weighted average test results on United Energy Network give

  $\Delta P\% / \Delta V\% = 0.7 \qquad \Delta I\% / \Delta V\% = -0.1$

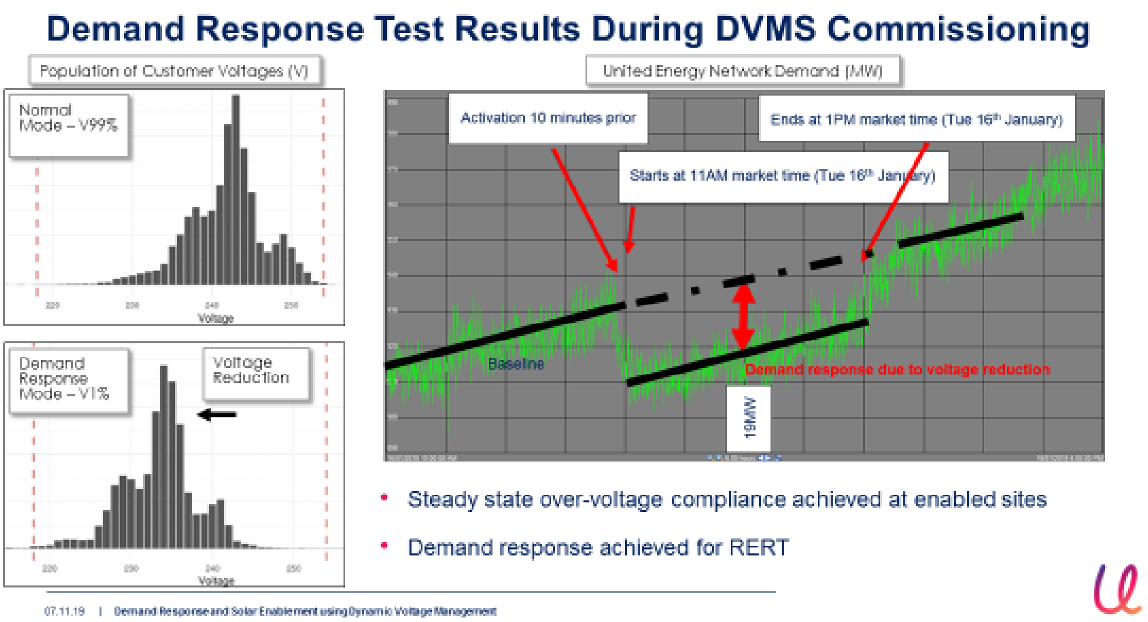
- Negative current behaviour means voltage reduction is only useful for upstream network constraints and generation shortfalls.
- All UE smart meters provide voltage readings at customer premises, revealing whether customer voltages are falling below the lower regulatory voltage limit.
- This information can be used by DVMS to dynamically adjust voltages at MV upward to bring voltages back to compliance.



07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

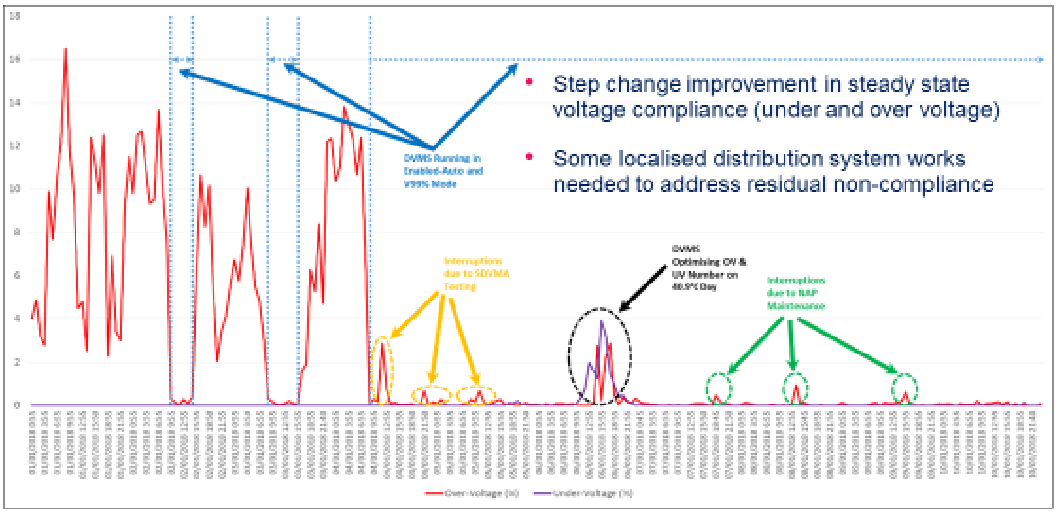


Dynamic Voltage Management System (DVMS)
Using Smart Meters to deliver simultaneous Steady State Voltage Compliance, Demand Response Capability and Increased Solar PV Hosting Capacity
Normal operating mode
Demand response mode
AS 61000.3.100
Demand Response Application
United Energy Network Control Centre
DVMS Application in MOSAIC
Analytics Engine
Customer Voltage Data
Voltage Setpoint Signal
Measured Electricity Network Demand
Smart Meter Data Warehouse
Smart Meter Data Communications Network
Household Smart Meters
Power Grid
Substations
07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management



Demand Response Test Results During DVMS Commissioning
Population of Customer Voltages (V)
Normal Mode – V99%
Demand Response Mode – V1%
Voltage Reduction
Voltage
United Energy Network Demand (MW)
Activation 10 minutes prior
Ends at 1PM market time (Tue 16th January)
Starts at 11AM market time (Tue 16th January)
Baseline
Demand response due to voltage reduction
19MW
Steady state over-voltage compliance achieved at enabled sites
Demand response achieved for RERT
07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

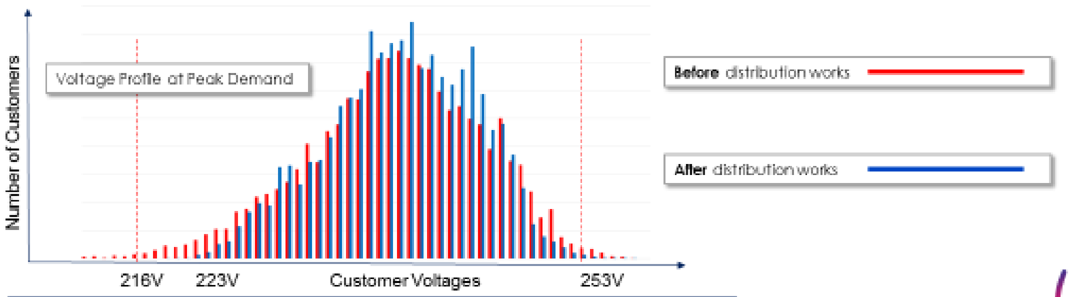
Voltage Compliance Test Results During DVMS Commissioning



07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

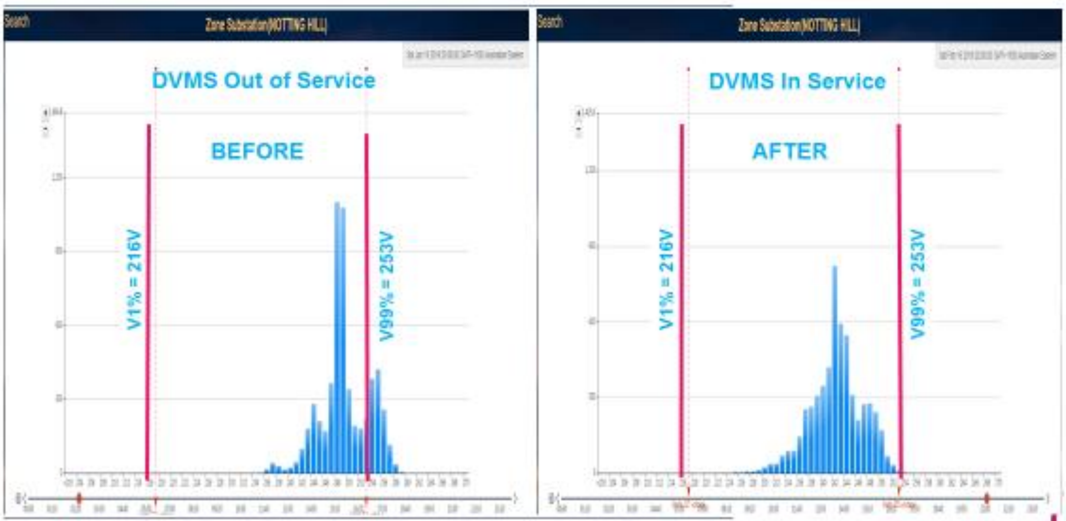
Distribution Works to Achieve Demand Response at Peak Demand

- Voltage spread increases on peak demand days can lead to power quality non-compliance (both over and under-voltage) and/or dilutes demand response effectiveness
- Some localised distribution system works needed to tighten the voltage distribution
- Scope includes local tap changes, phase balancing, open point changes and connection checks.
- Achieves compliance plus a 3% margin for voltage reduction



07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

DVMS Demo – Steady State Voltage Compliance



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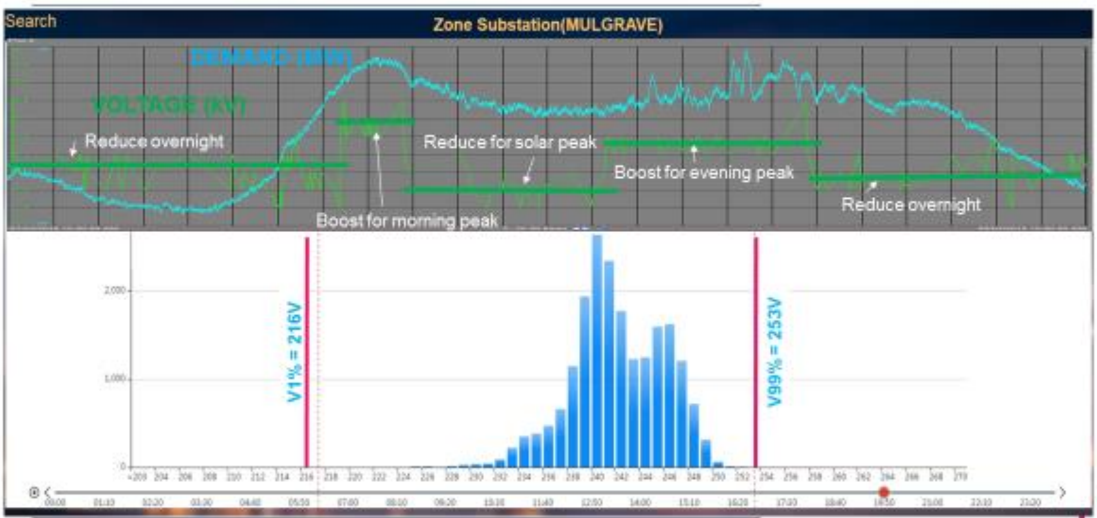
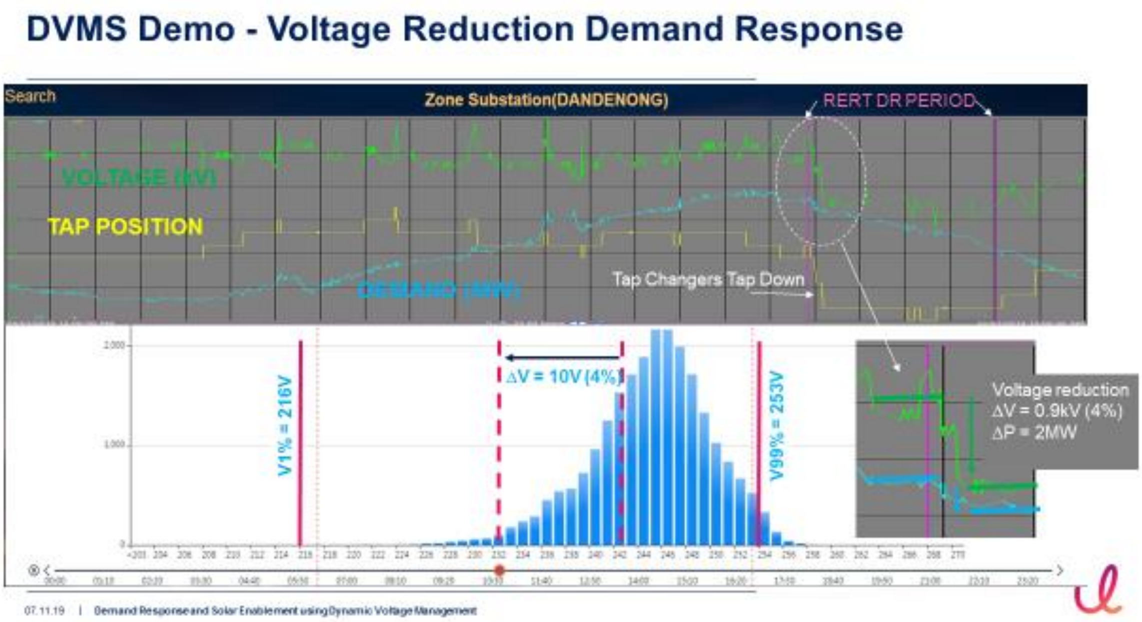
DVMS Demo - Solar Hosting Improvement



07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management


DVMS Demo - Voltage Reduction Demand Response
Search
Zone Substation(DANDENONG)
RERT DR PERIOD
VOLTAGE (kV)
TAP POSITION
DEMAND (MW)
Tap Changers Tap Down
V1% = 216V
ΔV = 10V (4%)
V99% = 253V
Voltage reduction
ΔV = 0.9kV (4%)
ΔP = 2MW
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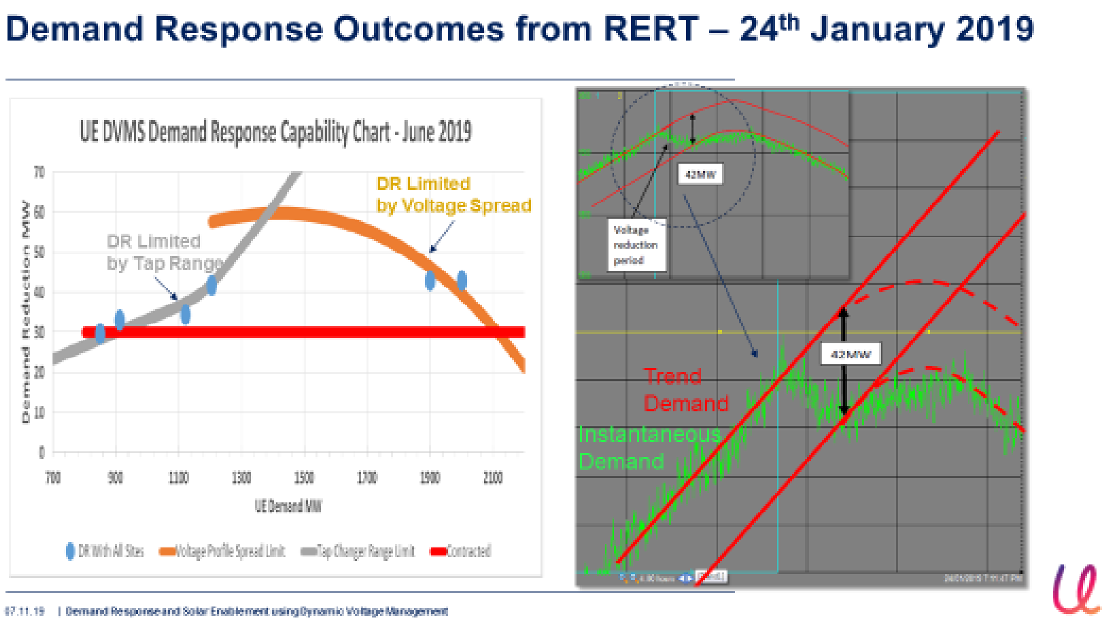
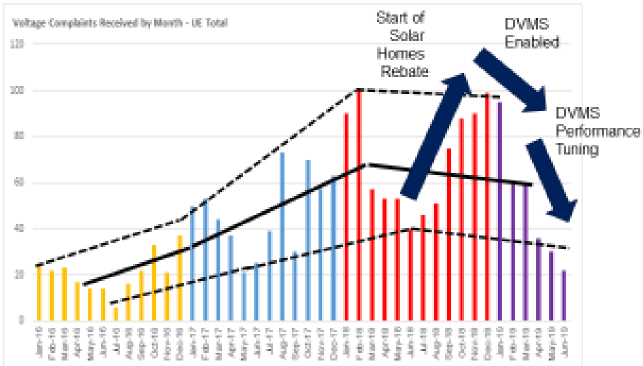

Demand Response Outcomes from RERT – 24th January 2019
UE DVMS Demand Response Capability Chart - June 2019
DR Limited by Voltage Spread
DR Limited by Tap Range
Demand Reduction MW
UE Demand MW
DR With All Sites
Voltage Profile Spread Limit
Tap Changer Range Limit
Contracted
42MW
Voltage reduction period
Trend Demand
Instantaneous Demand
07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

Voltage Rise Complaint Outcomes from Solar Export

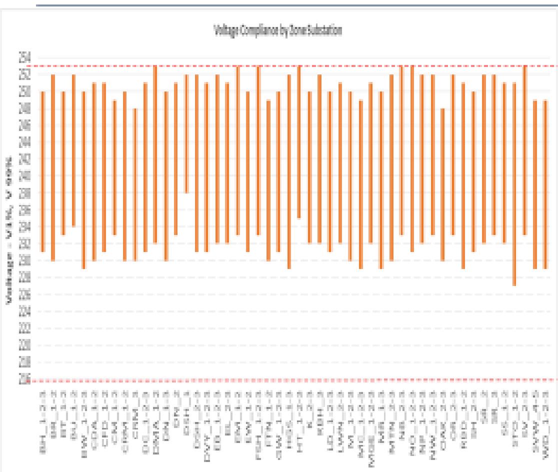
- DVMS was implemented as part ARENA's-funded Demand Response Program.
- Voltage complaints volumes were trending up each year due to growth in solar PV exports
- Vic. Govt. Solar Homes program in late 2018 accelerated the solar PV uptake. Number of voltage complaints accelerated at this time
- Implementation of DVMS in summer 2018/19 arrested the increases in complaints
- Since performance tuning of DVMS in early 2019, we now have lowest complaint volumes in 2 years, despite a doubling of rate of solar PV connections
- This outcome has allowed us to maintain our 10kW per phase export limit for basic residential solar PV systems

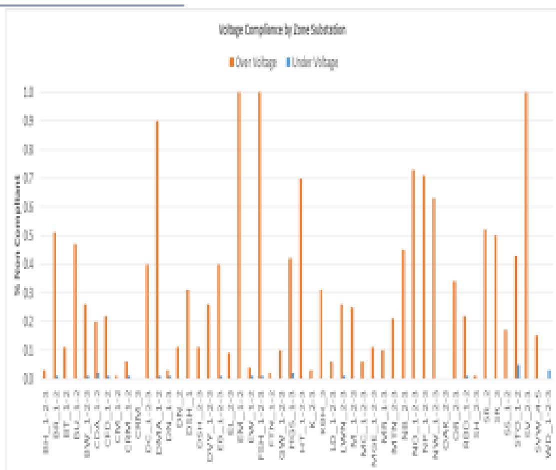


UE Monthly Voltage Complaints

07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

Voltage Compliance Outcomes on a typical day





- Voltage compliance > 99% now achieved.

07.11.19 | Demand Response and Solar Enablement using Dynamic Voltage Management

Conclusions

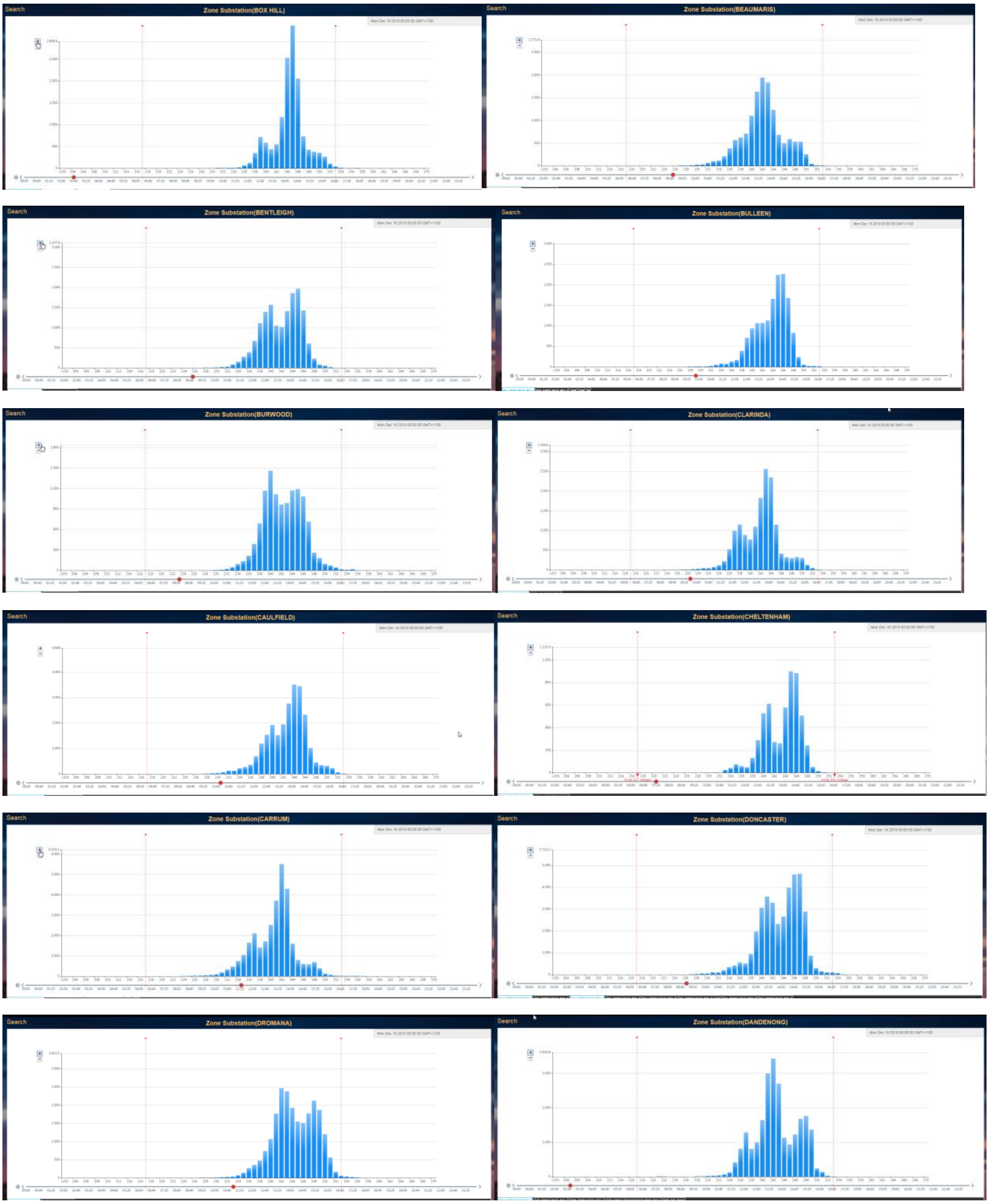
- Smart meter analytics coupled with voltage regulation has enabled us to deliver Dynamic Voltage Management capability.
- We have DVMS implemented and operating 24 x 7 across all zone substations.
- Benefits include
  - Quality of supply compliance achievable (steady state over-voltage and under-voltage).
  - Apply voltage reduction with 10 minutes notice to deliver large-scale demand response capability for AEMO, minimising the risk of violating regulatory voltage limits.
  - Allows for higher penetration of solar PV by automatically adapting (on a population basis) to new solar PV connections and variable solar PV output.

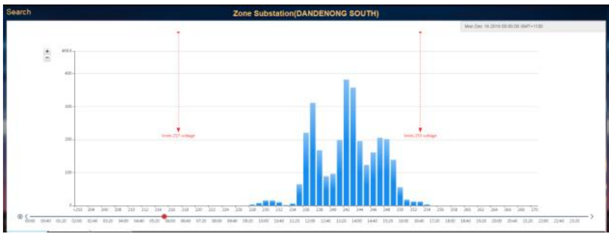
5. Glossary of Terms

The following terms are referenced within this document:

Term	Description
AEMO	Australian Energy Market Operator
AMI	Advanced Metering Infrastructure (Smart Meters)
ARENA	Australian Renewable Energy Agency
DR	Demand Response
DVMS	Dynamic Voltage Management System
HV	High Voltage
LV	Low Voltage
MW	Mega Watt
NAP	Network Analytics Platform
NCC	Network Control Centre
NEM	National Electricity Market
OLTC	On-Load Tap Changer
PV	Photo-voltaic
RERT	Reliability and Emergency Reserve Trader
RMIT	Royal Melbourne Institute of Technology
SCADA	Supervisory Control and Data Acquisition
UE	United Energy
VRR	Voltage Regulating Relay

6. Appendix A – Samples of Voltage Distribution by Zone Substation on a Typical Day

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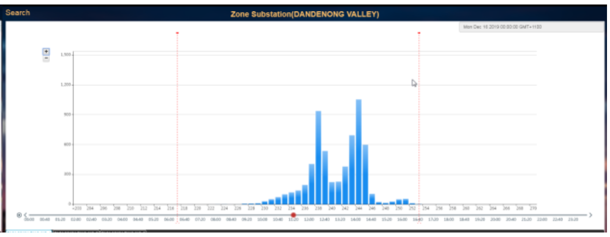
Zone Substation(DANDENONG SOUTH)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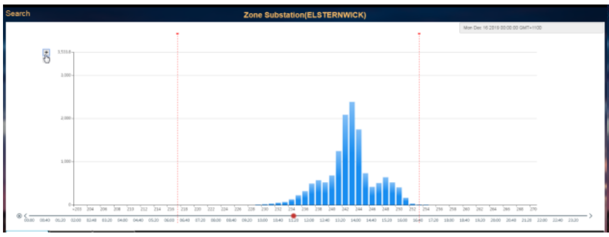
Zone Substation(DANDENONG VALLEY)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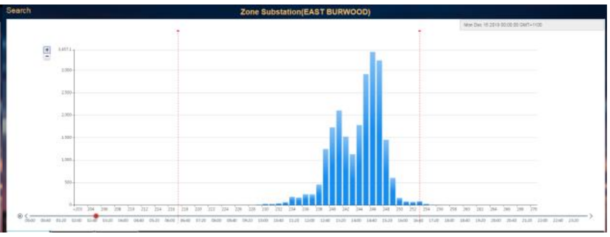
Zone Substation(ELSTERNWICK)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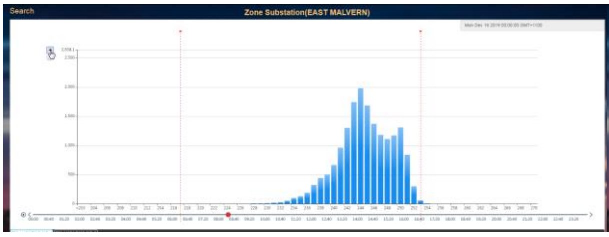
Zone Substation(EAST BURWOOD)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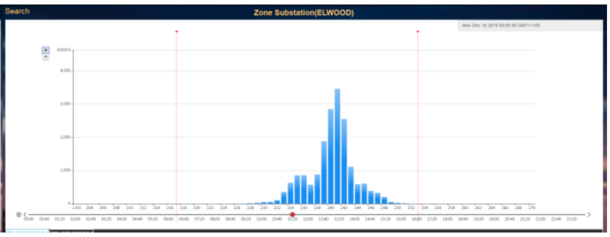
Zone Substation(EAST MALVERN)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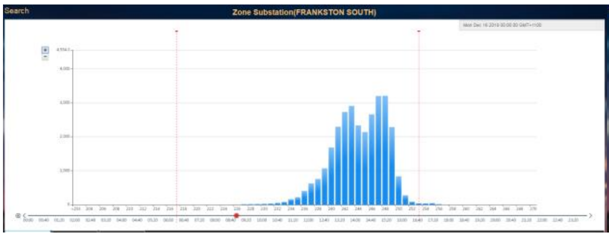
Zone Substation(ELWOOD)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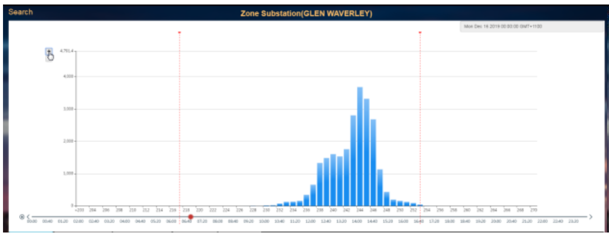
Zone Substation(FRANKSTON SOUTH)


Search
Zone Substation(FRANKSTON)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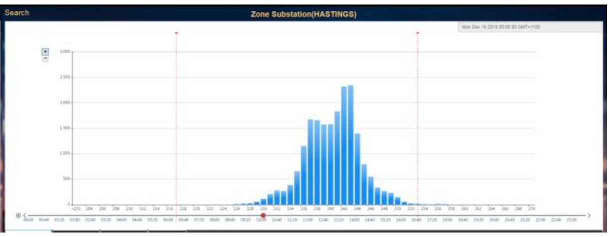
Zone Substation(GLEN WAVERLEY)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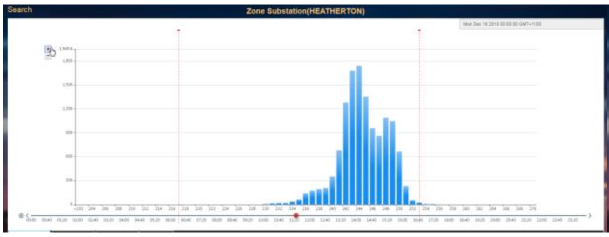
Zone Substation(HASTINGS)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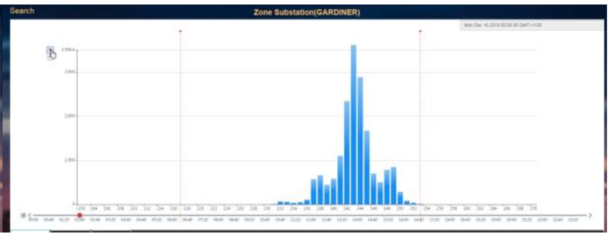
Zone Substation(HEATHERTON)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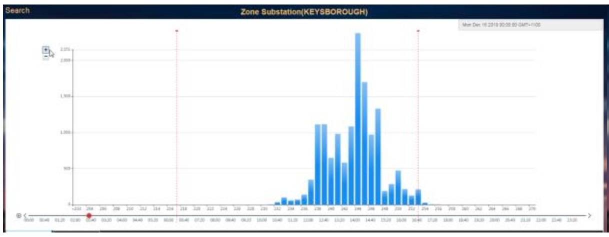
Zone Substation(GARDINER)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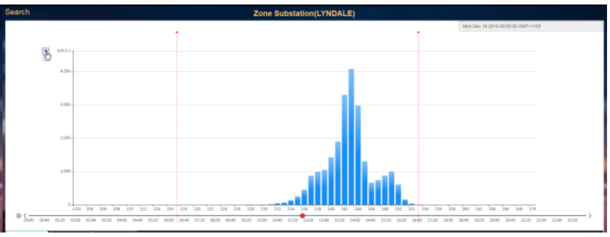
Zone Substation(KEYSBOROUGH)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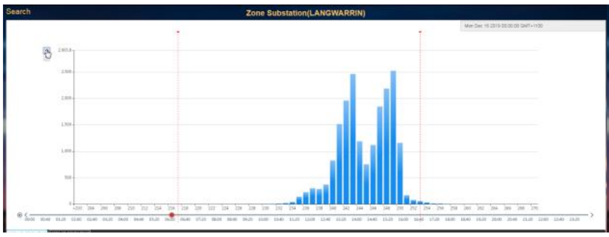
Zone Substation(LYNDALE)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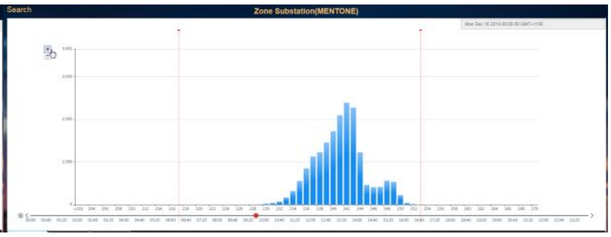
Zone Substation(LANGWARRIN)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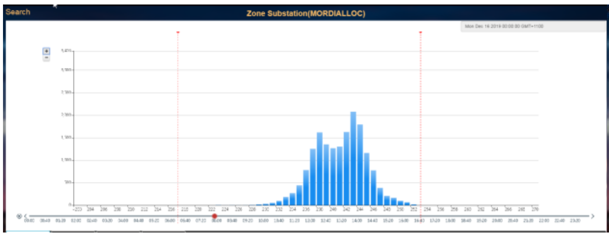
Zone Substation(MENTONE)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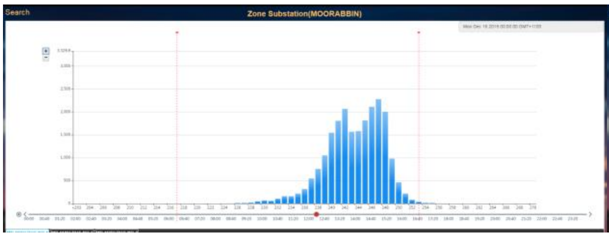
Zone Substation(MORDIALLOC)


Search
Zone Substation(MULGRAVE)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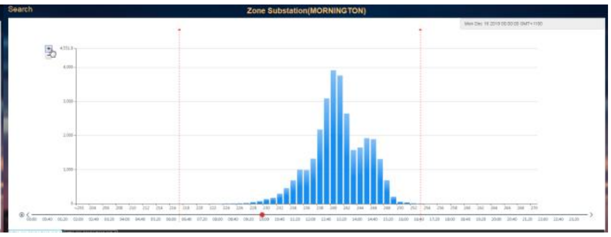
Zone Substation(MOORABBIN)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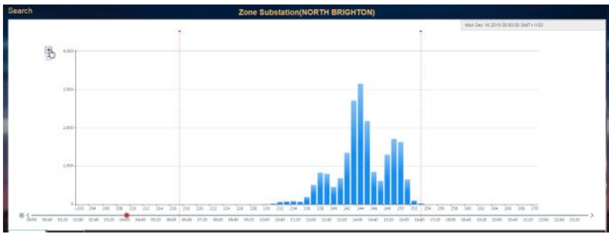
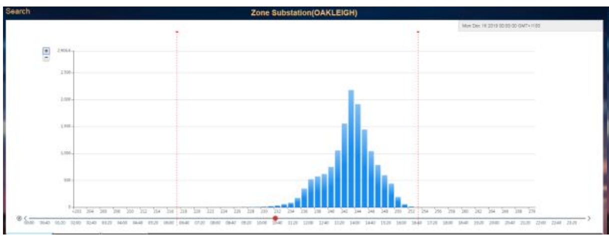
Zone Substation(MORNINGTON)


Search
Zone Substation(NORTH BRIGHTON)


Search
Zone Substation(NOTTING HILL)


Search
Zone Substation(NOBLE PARK)


Search
Zone Substation(NUNAWADING)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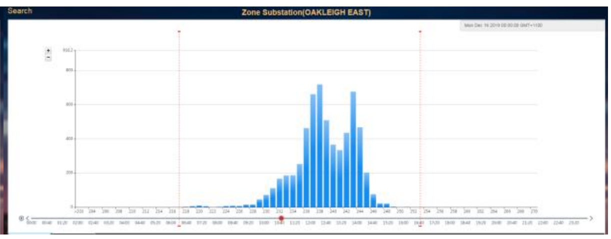
Zone Substation(OAKLEIGH)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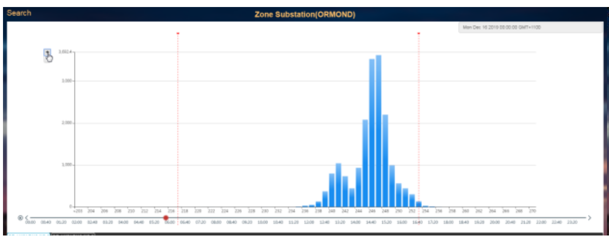
Zone Substation(OAKLEIGH EAST)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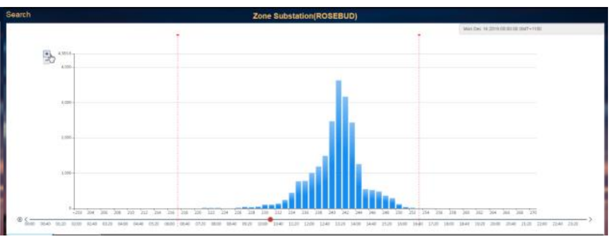
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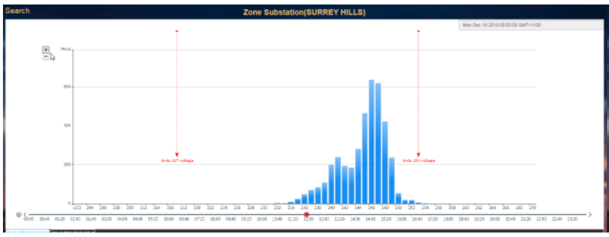
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Zone Substation(SURREY HILLS)


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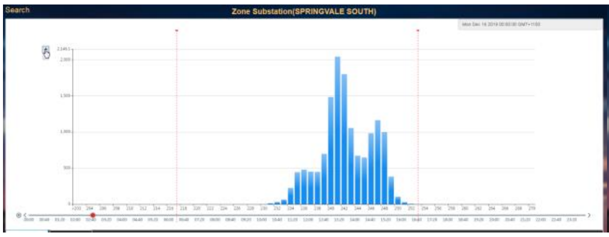
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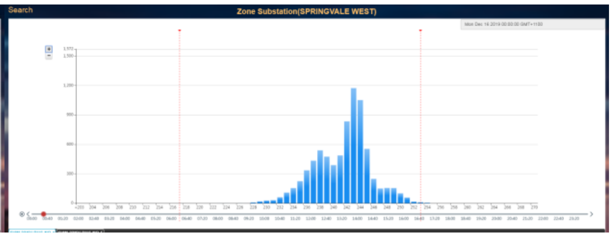
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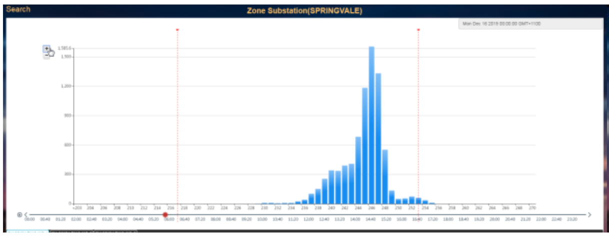
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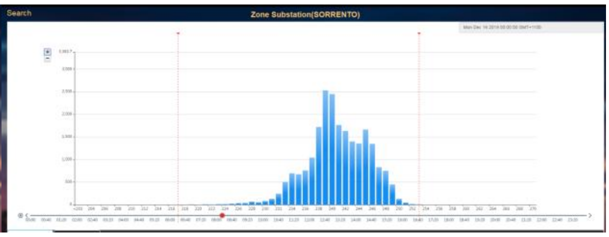
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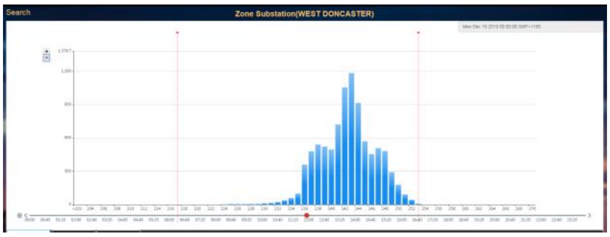
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