United Energy Demand Response Project Performance Report - Milestone 3

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1. Summary

This document is the United Energy (UE) 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's testing of United Energy's demand response reserve capability during the non-summer period;
2) an algorithm to identify distribution substation locations to perform low voltage remedial works. These works are contemplated to tighten up outlier site voltage profiles to provide sufficient voltage margins within regulatory voltage limits to deliver the required demand response capability;
3) quantifying changes in the sensitivity of demand to voltage on UE's distribution network during the non-summer months of the year; and
4) 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 and 2 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. AEMO's testing of UE's demand response reserve capability

United Energy undertook a non-summer period demand response test with AEMO.

The objectives of the test undertaken on 17th May 2018 were to :-

1. confirm UE's demand response reserve capability achieves the required 12MW; and
2. 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.

In summary, while the results of the test were skewed by baseline methodology inaccuracies (as currently being investigated by Oakley Greenwood), high speed SCADA measurements (presented below) provide evidence that United Energy has delivered at least the required 12MW of demand response capability, 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.

2.1. Third Test – 17th May 2018

AEMO called the third test with UE on 17th May 2018 for a 2 hour period starting 1700 market time. This test was an example of a non-summer condition, with the maximum temperature on the day being only 15 degrees Celsius.

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

Activation of the demand response by way of voltage reduction is clearly evident in the minutes before the event start date at 1700 market time with demand falling from 1005MW at 1648 to around 992MW at 1703. With underlying demand at the time increasing at 1.3MW/minute, the coincident time demand reduction is 1005MW – 993MW + 1.3MW/minute x 15 minutes = 32MW.

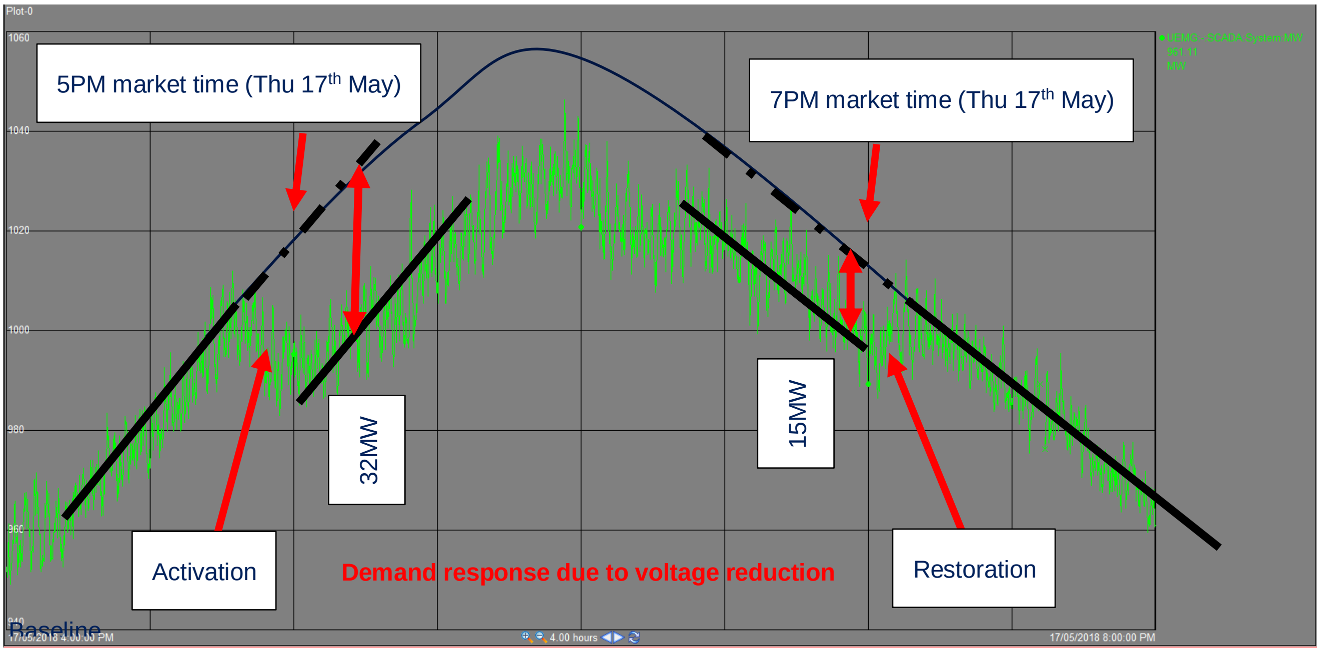


Figure 1 Test showing demand response due to voltage reduction

The demand response was held for the entire two hours which fully encapsulated the peak of the day which occurred just before 1800.

Removing the demand response was undertaken by restoring network voltages which occurred from 1900 market time with demand rising from 996MW at 1900 to around 1005MW at 1908. With demand at the time decreasing at 0.7MW/minute, the coincident time demand reduction is 1005MW – 996MW + 0.7MW/minute x 8 minutes = 15MW.

There appears to be some deterioration in the performance during the last half hour of the period from 32MW down to 15MW. This may be a result of heating-related load, where customer appliances performing at a lower output with reduced voltage will tend to stay on for longer periods over time (thermostat action) to maintain ambient temperature levels. This deterioration in performance seems to be more significant on the cooler day, when compared to the previous summer season tests.

Contributions from each zone substation participating in the demand response were measured using high speed SCADA metering, and the load sensitivity to voltage calculated for each site (i.e. **VSol** = **∆P% / ∆V%)**. The network weighted VSol during this test was approximately 0.75%/%. This appears to be slightly higher than the summer testing results of 0.69%/%. This is likely to be reflective of the greater amounts of resistive load on the network during the cooler weather.

Table 1: Zone Substation Contributions and Load Sensitivity Indices

Zone Substation	Test Date 17 May 2018			
	17 00		19 00	
	∆P (MW)	VSoL (%/%)	∆P (MW)	VSoL (%/%)
BR	0.50	81%	0.50	71%
BT	NA	NA	NA	NA
BW	0.33	110%	NA	NA
CDA	1.69	132%	1.09	125%
CM	0.38	51%	0.71	82%
CFD	0.62	80%	0.50	86%
CRM	0.77	45%	0.39	25%
DC	1.11	64%	1.15	67%
DMA	0.54	103%	0.32	114%
DN	1.87	125%	1.00	77%
DVY	2.00	101%	1.40	84%
EB	1.60	140%	1.00	86%
EM	0.29	44%	0.26	35%
EW	0.53	110%	0.23	37%

FSH	NA	NA	NA	NA
GW	1.50	79%	0.69	39%
HT	0.85	81%	0.87	92%
K	1.00	98%	0.96	91%
KBH	0.89	99%	0.31	51%
LD	1.20	81%	0.96	85%
LWN	0.45	55%	0.23	38%
M	0.44	60%	NA	NA
MC	1.70	95%	1.70	105%
MR	0.81	88%	0.46	48%
MTN	0.56	44%	0.55	42%
NB	0.82	105%	0.85	105%
NO	0.56	55%	0.28	33%
NW	0.52	62%	0.50	66%
OR	0.57	88%	0.75	82%
RBD	0.19	41%	0.55	114%
SH	0.15	129%	0.06	65%
SR	0.46	81%	0.50	83%
SS	NA	NA	NA	NA
STO	0.36	55%	0.53	108%
SV	1.31	90%	2.23	172%
SVW	0.33	16%	0.17	12%
WD	1.00	77%	0.86	66%
Total Demand Response (MW) and VSol	***27.9***	***79%***	***22.6***	***72%***

The results of the assessment of this test event are summarised below, including the assessment by AEMO.

Table 2: Assessment of Demand Response Delivered by UE (12MW required)

Half Hour Period	AEMO/UE Agreed Baseline Method (dates used by AEMO)	AEMO/UE Agreed Baseline Method (dates used by UE)	UE High Frequency SCADA Data (UE Service Area)	UE High Frequency SCADA Data (Zone Substation Aggregate)
1	-22MW	16MW	32MW	28MW
2	0MW	40MW	27MW	-
3	22MW	49MW	29MW	-
4	28MW	47MW	15MW	23MW
Average	**7MW**	**38MW**	**26MW**	**25MW**

While the baseline method used by AEMO and UE in the table above are identical, the baselining reference dates selected were different in 3 out of the 10 dates considered.

The AEMO baseline reference dates were sourced from the days closest to the event day with the maximum temperatures closest to that of the event day within the range ±4 degrees. Three of those baseline reference days had temperatures 3 to 4 degrees warmer than the event day and there were no other cooler days to select that were close to the event day.

The UE baseline reference dates were similarly sourced from the days closest to the event day with the maximum temperatures closest to that of the event day. However, the three baseline reference days that had temperatures 3 to 4 degrees warmer than the event day were substituted with like-temperature days from the same month in the prior year.

With such variability in the magnitude of the estimated delivered demand response (particularly skewed by the increase in demand suggested by AEMO in period 1), clearly the results of the baselining remain heavily dependent on the baseline reference dates selected and the temperature on those particular days. To achieve greater accuracy, baseline reference days **balanced** within ±2 degrees of the event day may need to be considered rather than the wider unbalanced ±4 degrees currently being used, however this means looking backward further in time for similar like-days.

These learnings could be useful input for ARENA's Oakley Greenwood baselining method review that is currently underway.

3. Identification of distribution substations for low voltage remedial works

Figure 30 in the Milestone 2 report (reproduced below) identified that during days of extreme heat when the demand is high, the voltage profiles at some zone substations can coincidentally exceed both the upper and lower regulatory voltage limits even when the Dynamic Voltage Management System (DVMS) is active in Enabled-Auto V99% (normal) mode.

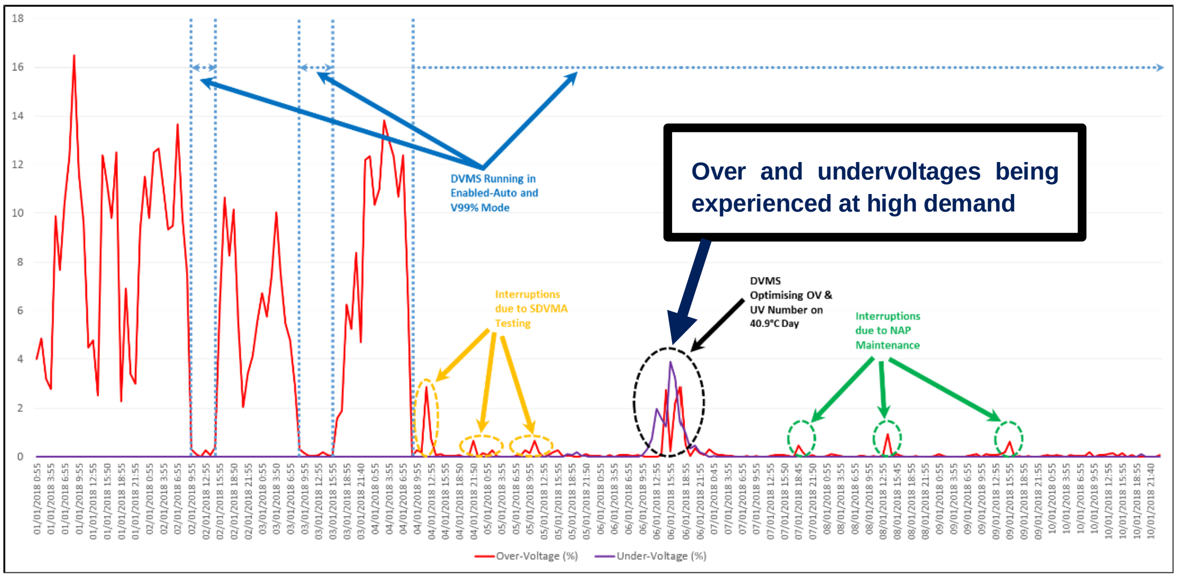


Figure 30 Impact of DVMS on Over-Voltages and Under-Voltages Received by CDA Zone Substation's Customers from Monday, 01/01/2018 to Wednesday, 10/01/2018

Under this condition, the algorithms deployed in the Network Analytics Platform (NAP) optimise to minimise the number of customers experiencing over and under-voltages by equalising the number of customers over and the number of customers under. This means there no opportunity, when this condition arises, to undertake demand response without going beyond regulatory voltage limits.

When the condition occurs, it is not a widespread issues across all parts of the network. Rather it tends to be localised issues triggered by parts of the low voltage network that have

a) distribution tap settings set sub-optimally (~6% of distribution substations);
b) circuits with high phase unbalance (~5% of low voltage circuits); and/or
c) excessively long LV circuits or loaded assets (less than 1% of low voltage circuits).

Part of the ARENA funding provided to United Energy is being used to address these localised issues and tighten up outlier site voltage profiles to provide sufficient voltage margins within regulatory voltage limits to deliver the required demand response capability.

In order to reduce the voltage spread of the zone substation during peak demand periods and consequently, ensure V1% (demand response) mode can be operated effectively to provide a demand response, low-voltage network remedial works are being undertaken during 2018 to deliver the contracted 30MW of demand response for summer 2018/19.

Figure 2 demonstrates how the low-voltage remedial works would improve the voltage profile of a zone substation and provide higher opportunity for demand reduction under high demand conditions.

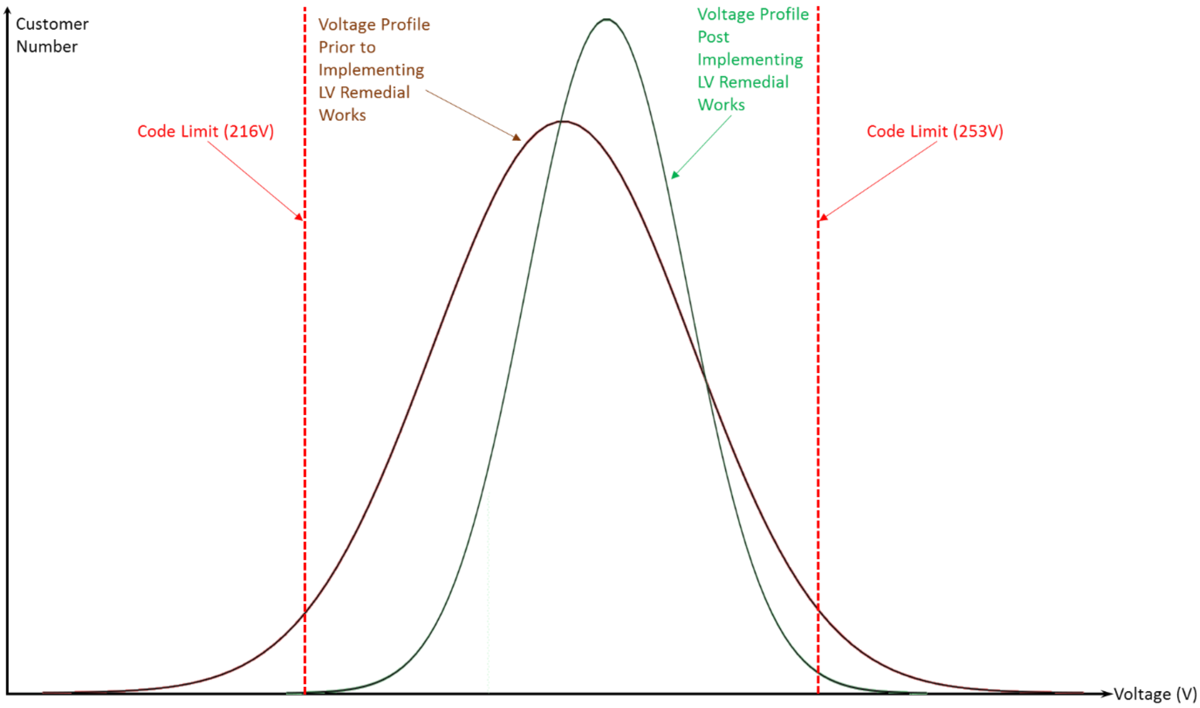


Figure 2 Estimated Impact of Low-Voltage Remedial Works on Zone Substation Voltage Profile

United Energy has developed an algorithm that can be used to optimally identify the minimum number sites required for low-voltage remediation to achieve voltage compliance with a 3% voltage margin reserved for demand response at times of peak demand. This algorithm is documented below.

3.1. Deployed algorithm

In order to implement the LV remedial works, a holistic programme has been put in place to identify the distribution substations, which when reducing their voltage spreads, will have the maximum improvement on the voltage spread profile of the entire zone substation for which DVMS is applied. The flowchart shown in Figure 3 is deployed to identify these distribution substations.

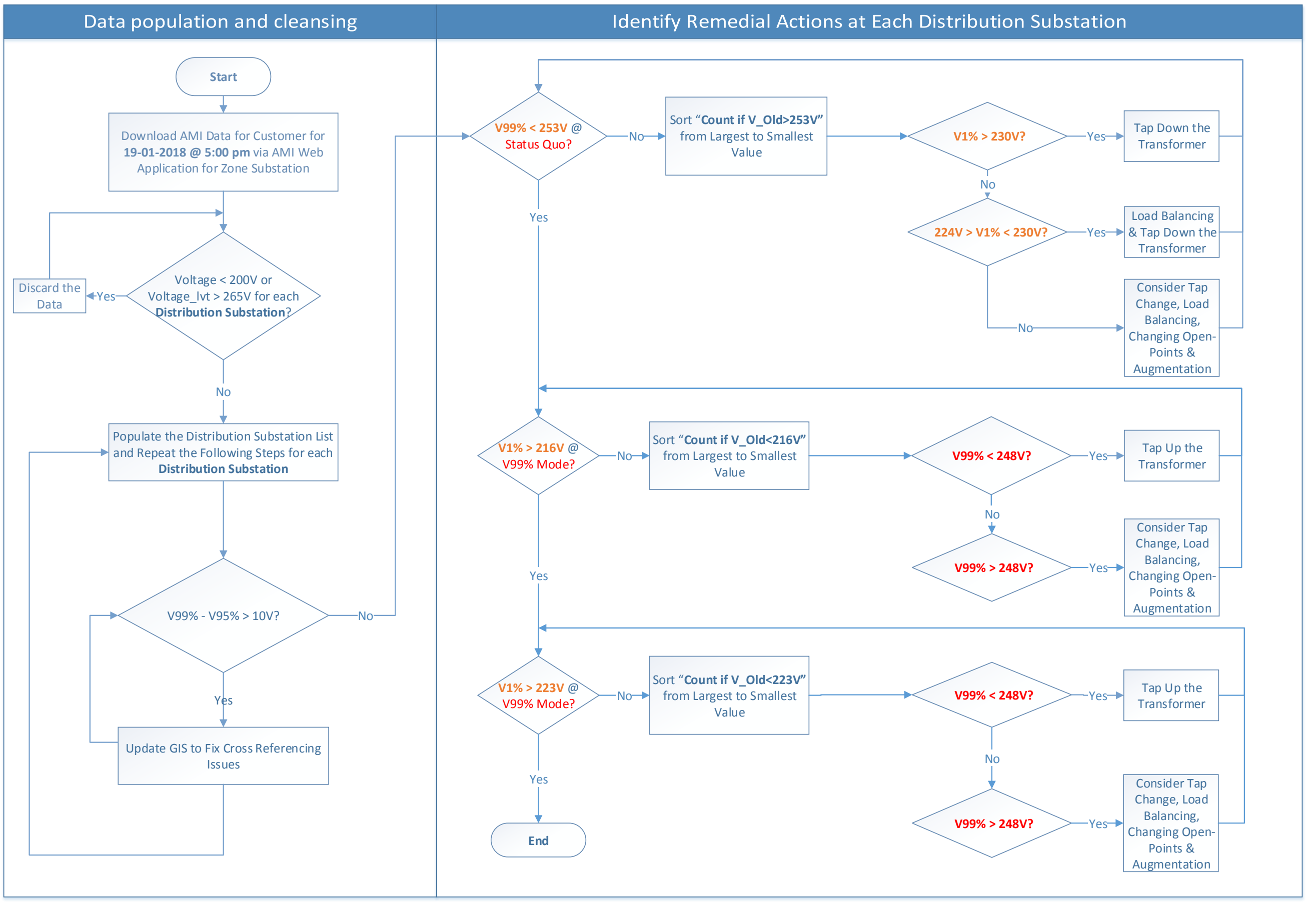


Figure 3 Algorithm Deployed to Identify Distribution Substations for Low-Voltage Remedial Works

This algorithm takes the below scenarios into consideration to ensure the appropriate remedial actions will be taken on the identified distribution substations:

- Status quo (DVMS is not operational); and
- DVMS is operating in V99% (normal) mode.

This algorithm also explains the appropriate remedial actions required for the identified distribution substations. The corrective works on the LV network can be categorised into the below groups:

- Adjusting the tap settings of distribution transformers
- Balancing the load along the LV circuits
- Checking and correcting the loose connections
- Investigating and relocating the LV open points
- Augmenting the constrained distribution substations and LV circuits (only if required)

According to this flowchart, AMI (smart-meter) data for all of the customers supplied by a zone substation is populated into the model. The populated data includes the voltage delivered to each customer at the peak demand time for the United Energy distribution network.

To ensure the data considered for identifying the non-compliant distribution substations does not include the data associated with outages, brownouts or network switching activities, any values above 265V and below 200V are discarded here.

As the next step, the V1% and V99% values for each distribution substation are calculated. If the difference between V1% and V99% is higher than 10V, then the potential discrepancies between the network connections recorded in Geographical Information System (GIS) and the connections in the field will be investigated and the customers who might be supplied by adjacent transformers but are incorrectly recorded in GIS will be identified. The connections for the identified customers will be corrected in GIS to prevent any inappropriate decisions being made by DVMS. This step is effectively a data cleansing exercise to ensure the customer connection data is mapped to the correct distribution substation.

3.1.1. Status Quo Scenario

First, the distribution substations are ranked according to the numbers of customers with non-compliant voltages and therefore, the substations with the highest numbers are taken into account first.

If V99% of a distribution substation is higher than the Victorian Electricity Distribution Code limit of 253V and V1% of the substation is above 230V, the distribution substation can be tapped down at least one tap to improve the voltage profile of the customers.

In case V99% is above 253V and V1% possesses a value between 224V and 230V, the option of balancing the load will be also be taken into consideration before tapping down the distribution substation to ensure the customers located at the end of the circuits will not receive under-voltages during peak demand periods.

If V99% is higher than 253V and V1% is lower than 223V, other remedial actions will be required in case load balancing does not deliver the required outcome. For example, the open point of the LV circuit might need to be relocated or the supplying transformer or the LV circuits may need to be augmented (as a last resort).

223V is a key parameter in the model as it provides a 7V margin above 216V to allow a 3% voltage reduction for demand response at peak demand. This voltage margin is expected to be larger at lower levels of demand. Hence the level of demand response capability in MW is likely to be relatively consistent across a range of demand conditions.

3.1.2. V99% Mode of DVMS

The purpose of checking the voltage profiles of distribution substations when DVMS is operating in V99% mode is to ensure this scheme delivers a sufficient level of demand response when it operates in V1% mode without compromising the quality of supply. To do this, the values of V1% and V99% for all of the distribution substations are calculated for the DVMS operating condition of V99%. Similar to the status quo scenario, distribution substations are ranked according to the number of customers with non-compliant voltages and the substations with the highest numbers are served first.

If V1% of the distribution substation is below the Victorian Electricity Distribution Code limit of 216V and V99% is less than 248V, then the supplying transformer will be tapped up.

But, if V99% for this scenario is above 248V, to ensure no over-voltages will be created as a result of tapping up the distribution transformer, balancing the load, changing the LV open points and augmenting the supplying transformer or LV circuits might be required too.

If the required level of demand response cannot be achieved after completing the above step (V1% for the zone substation is still below 223V), the distribution substations with V1% above 223V are taken into consideration. If V99% is less than 248V then, the supplying transformer will be tapped up.

But, if V99% for this scenario is above 248V, to ensure no over-voltages will be created as a result of tapping up the distribution transformer, balancing the load, changing the LV open points and augmenting the supplying transformer or LV circuits might be required too.

3.2. Remedial actions

3.2.1. Distribution Transformer Tap Change

This method is the simplest solution to address either the under-voltages or over-voltages experienced by all of the customers connected to a particular distribution substation. This method can be the first step to centre the operating bounds within the regulatory limits.

Figure 4 shows the voltages and currents of a distribution substation supplied by CDA zone substation (the trial DVMS site) that needs to be tapped up for performance improvement of DVMS. This distribution substation has

been identified for this tap change due to a high risk of receiving under-voltages by the customers during peak demand times when a demand response using voltage reduction is performed.

By tapping up the transformer, the voltage received by each customer will be slightly higher during normal operation days but still within the stipulated regulatory limits. As a result of this action, during peak demand times when called upon for a demand response event, DVMS can reduce the voltages of all customers supplied by this distribution substation to deliver the required demand response without compromising the quality of supply.

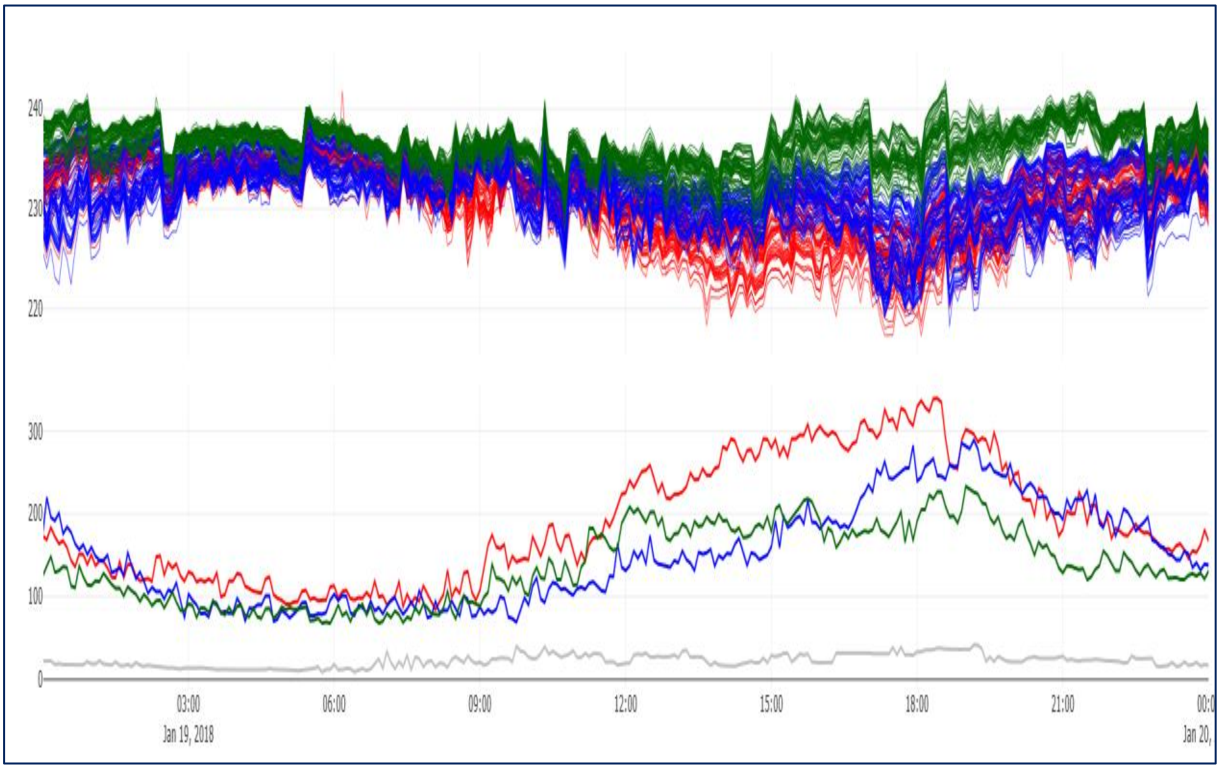


Figure 4 Voltages and Currents of a Typical Distribution Substation that needs to be tapped up[1]

In comparison, when the majority of customers receive over-voltages, the supplying transformer needs to be tapped down. Figure 5 illustrates the voltages and currents of a typical distribution substation supplied by CDA zone substation that requires a tap down. According to this figure, many of the customers received over-voltages even during peak demand times.

As aforementioned, DVMS possesses two operating modes of V99% (normal) and V1% (demand response) and when the V99% value for the zone substation is above 253V, DVMS will select a lower voltage set-point to place customers within the regulatory limits. Tapping down this transformer locally will prevent DVMS reducing the voltage at the zone substation. As a result, sufficient voltage margin will be available during peak demand times when a demand response is required.

It should be noted that by reducing the voltages via tapping down the supplying transformers, more solar PV systems can be connected to the distribution network and DVMS will be able to facilitate new solar PV systems even further.

[1] Some customers are displaced in grey colour as the phasing of these customers has not been finalised yet.

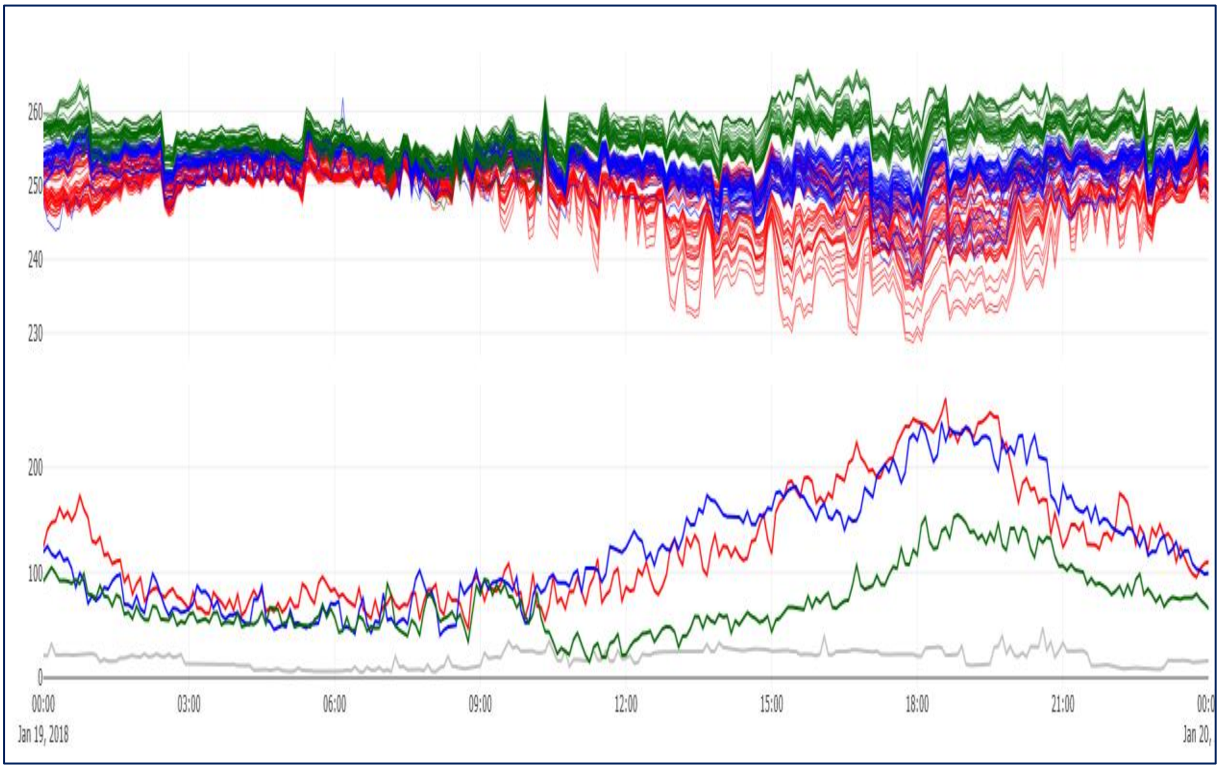


Figure 5 Voltages and Currents of a Typical Distribution Substation that needs to be tapped down

3.2.2. Load balancing

Due to the dynamic nature of a residential distribution network load, it is not possible to achieve a completely balanced load in an LV circuit. This is because the residential customer usage pattern varies at different times of the day. System designers and engineers calculate optimum load across the three phases during transformer installation. However, due to network augmentations and changes in customer usage patterns, the LV balance may drift over time.

Unbalance requires more attention to be taken when the distribution transformer has long overhead lines due to higher level of voltage drop and consequently, unbalance which causes more customers to be impacted by the associated detrimental impacts. Therefore, United Energy needs to rectify voltage unbalance operating conditions via load balancing which are identified by using AMI meter data.

In order to perform load balancing, first the current phases of the customers supplied by the distribution transformer are identified using an AMI-based technique and then, the customers whose phases need to be changed are selected by taking into account their peak demands and average energy consumptions.

Figure 6 displays the voltages and currents of a distribution substation that has been identified for load balancing to improve the performance of DVMS on CDA zone substation. According to this figure, the current of the red phase is by far higher than the other phases. As a result of this current unbalance, the customers connected to the red phase received under-voltages during the peak demand time.

Since DVMS considers the voltage for all customers and unbalance circuits cause wider voltage spread, DVMS would not be able to improve the quality of supply if there are significant numbers of unbalance circuits for the zone substation. Thus, the severe current unbalance issues need to be rectified first.

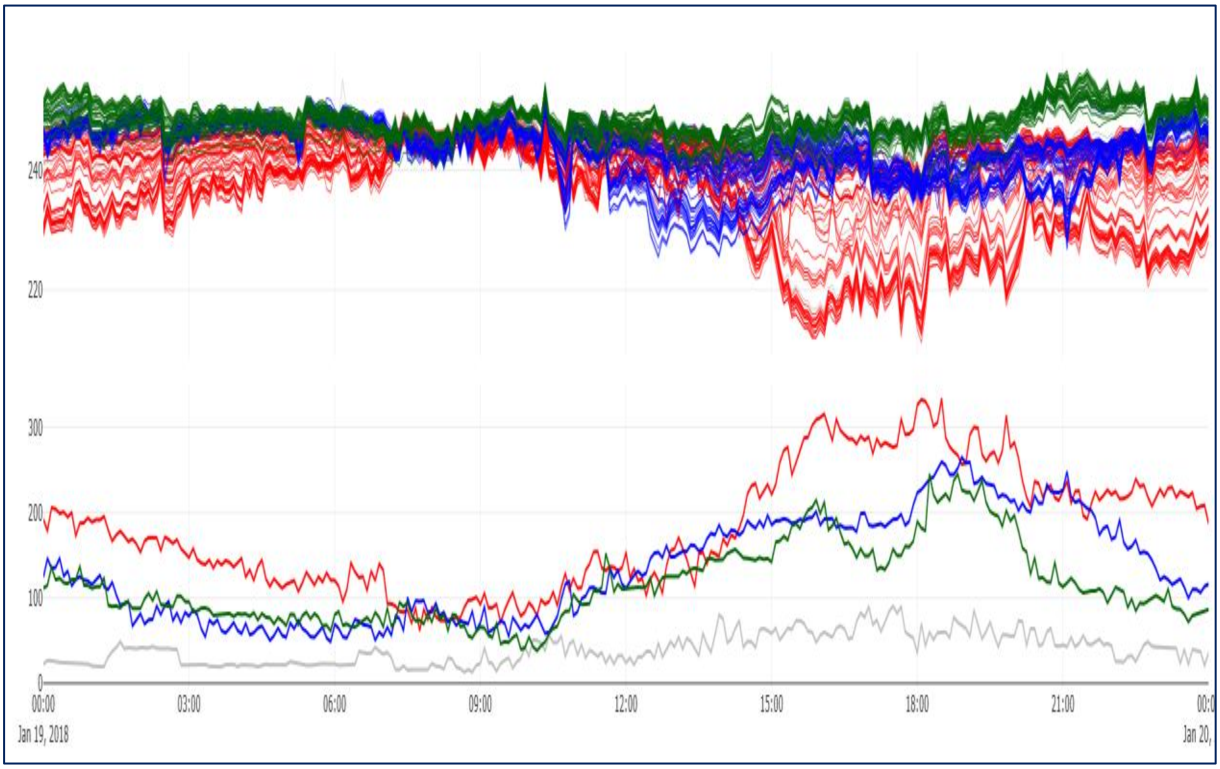


Figure 6 Voltages and Currents of a Typical Distribution Substation that needs to be Load Balanced

Figure 7 demonstrates the principles of load balancing for the distribution substations with high level of voltage unbalance. As shown in this figure, load balancing aims to reduce the voltage spread which would result in improvement of DVMS and consequently, supply quality.

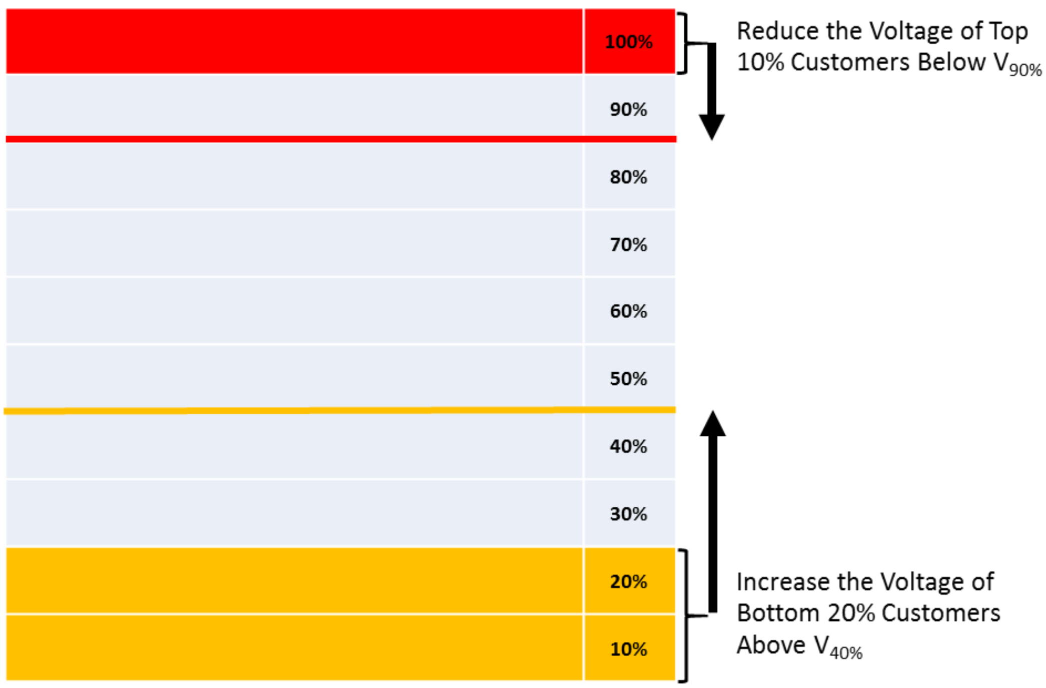


Figure 7 Principles of Load Balancing to Improve the DVMS Performance

3.2.3. Correction of loose connections

A common cause of over/under-voltages in distribution networks is loose connections. Correcting loose connections will reduce line resistance and losses. In addition, failing to fix a loose connection is potentially costly as it may lead to a fault in the network and thus to a power outage.

Therefore, United Energy investigates and rectifies the potential loose connections using the AMI data analytics. Similar to load balancing, this option will improve the performance of DVMS.

Figure 8 shows the minimum voltages received by customers, during peak demand period, who are supplied by a distribution substation of CDA zone substation whose connections need to be checked. As this figure shows, the customers with blue icons would be the ones whose connections are either loose or faulty and need investigation.

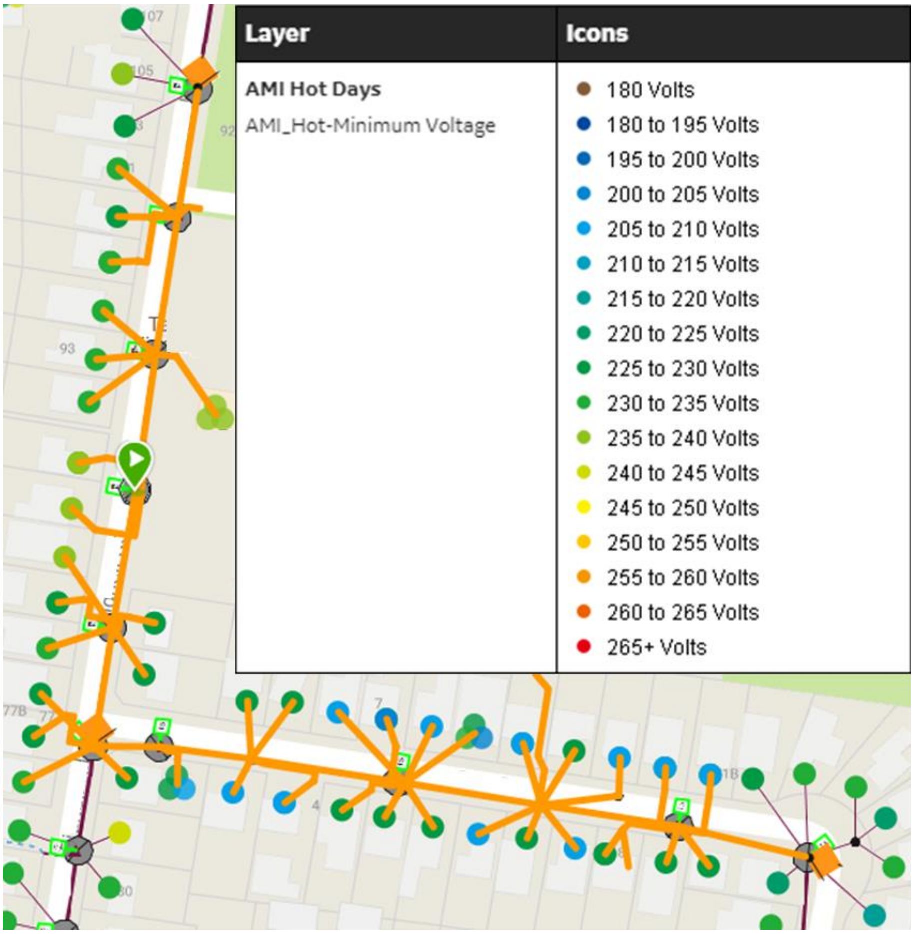


Figure 8 Minimum Voltage Levels Received by Customers supplied by a Distribution Substation whose Connections need to be checked

Figure 9 also shows the voltages and currents of this distribution substation. To identify the distribution substations with loose connections, the voltages during peak demand times should be taken into consideration. As Figure 9 demonstrates, by dropping the voltage for blue phase, the voltage for red phase increased which indicates there are some loose/bad connections for the customers connected to these phases.

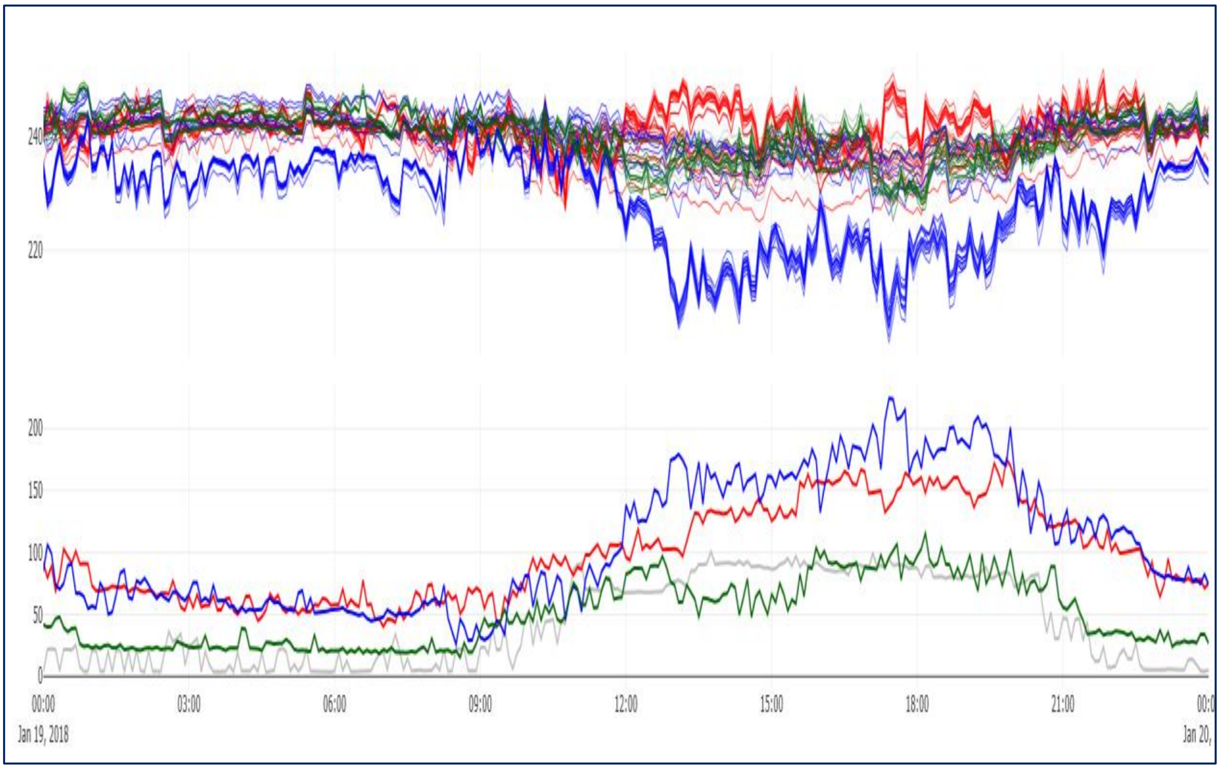


Figure 9 Voltages and Currents of a Typical Distribution Substation that Connections of its Customers need to be checked

3.2.4. Open Point Change

Changing the open points at LV level can be taken into account to balance out under-voltages occurring on the system and can be implemented if adjacent transformers have heathy voltage profiles.

After analysis of AMI meters of all customers who are supplied by CDA zone substation, a number of distribution substations have been identified whose open points can be changed to improve the voltage profiles of those distribution substations. Figure 10 shows the voltage and current profiles of a distribution substation which is supplied by CDA zone substation. This distribution substation experienced under-voltages during heat waves due to high level of currents. After reviewing the current configuration of this substation, some of the LV open points can be relocated which consequently, will reduce the currents drawn by the supplying transformer. This action will improve the quality of supply for this transformer without causing any over-loading operating conditions for the adjacent transformers due to adding more customers to their circuits.

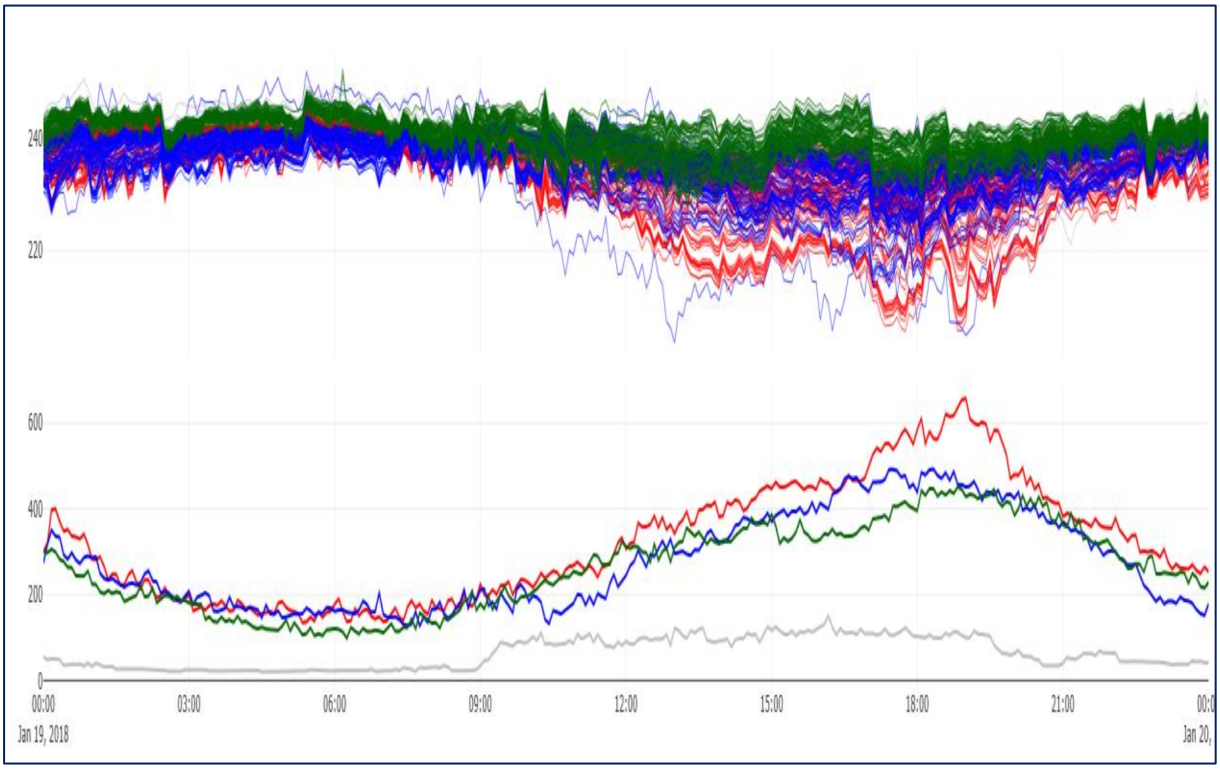


Figure 10 Voltages and Currents of a Typical Distribution Substation that its Open Opens need to be relocated

As a result of this action, the distribution substation will possess a narrower voltage spread during peak demand days and DVMS can deliver higher level of demand response for CDA zone substation.

3.3. Expected improvement on DVMS performance

After analysis of AMI meters supplied by CDA zone substation, a number of distribution substations have been identified for LV remedial works. To improve the voltage profiles of these distribution substations, one or a combination of the below actions will be taken. It should be noted that the least-cost lifecycle option will be considered to improve the performance of DVMS on CDA zone substation.

- Adjusting the tap settings of distribution transformers
- Balancing the load along the LV circuits
- Checking and correcting the loose connections
- Investigating and relocating the LV open points
- Augmenting the constrained distribution substations and LV circuits

The expected improvement on the performance of DVMS can be seen in Figure 11. This figure shows how effectively rectification actions would improve the voltage profile of this zone substation.

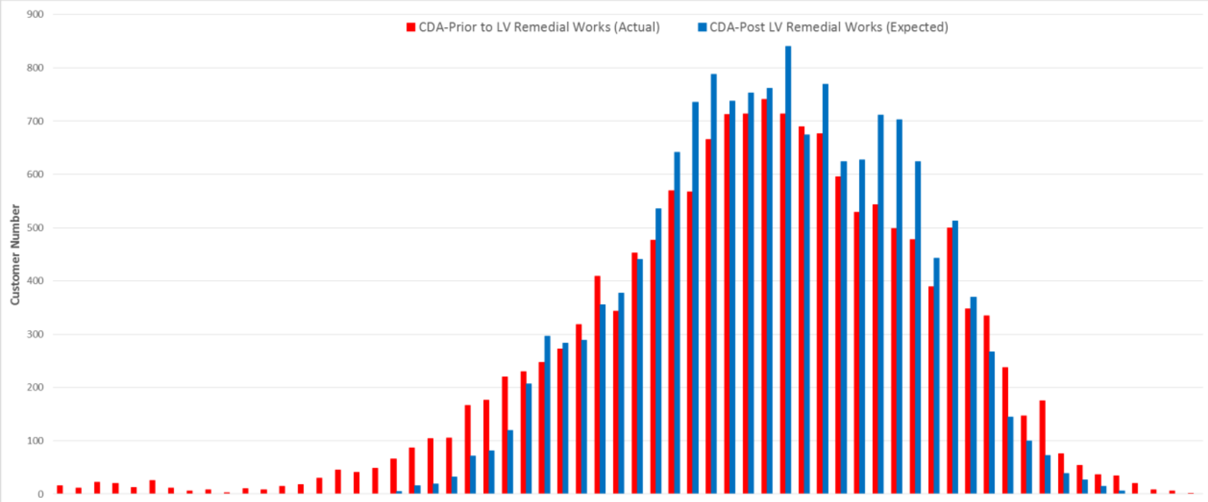


Figure 11 Voltage Profile of CDA Zone Substation Prior to (Actual) and Post (Expected) Implementing LV Remedial Works to Improve DVMS Performance at Peak Demand

The target of the aforementioned rectification actions is to make the voltage profile of CDA zone substation narrower during peak demand periods. Table 3 demonstrates the expected values for V1% and V99% for status quo when DVMS is not operational as well as DVMS V99% and V1% modes.

Table 3: Impact of Low-Voltage Remedial Works on Voltage Profile of CDA Zone Substation

Voltage Parameter	Status Quo		V99% Mode		V1% Mode	
	Prior	Post	Prior	Post	Prior	Post
V1%	211V	226V	205	223	216	216
V99%	259V	256V	253	253	264	246
Voltage Spread	48V	30V	48	30	48	30

As this table shows, for status quo scenario (DVMS out of service) both V1% and V99% possess values outside the regulatory limits due to a wide voltage profiles of the zone substation. Even after implementing the LV remedial works, it is expected that some customers supplied by this zone substation would receive over-voltages.

In comparison, with DVMS in service, both DVMS operating modes of V1% and V99% would cause under-voltages and over-voltages, prior to implementing any LV remedial works. However, following LV remedial works, it is expected that all customers would receive a voltage between the regulatory limits after completion of the LV remedial works with the DVMS operational. Furthermore, in this scenario DVMS would be able to provide a 3% voltage reduction to support demand response without compromising the quality of supply.

4. Knowledge Sharing Activities

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

- ARENA Demand Response Participant Workshop held by ARENA on 8th March 2018 in Melbourne.
- Oakley-Greenwood interview on Baseline learnings on 11th April 2018 for investigation into revised Baselining methodologies.
- United Energy visit to AGL on 12th April 2018 and presentation to AGL on United Energy's DVMS technology and learnings from the programme.
- Tokyo Electric Power Company (TEPCO) visit to United Energy on 24th May 2018 and presentation to TEPCO on United Energy's DVMS technology and learnings from the programme.
- Energy Networks 2018 Conference 7th June 2018 Sydney – Large-Scale Smart Meter Demand Response Program. Presented by Rodney Bray, Manager Network Planning and Strategy, United Energy.
- Established a knowledge sharing webpage on the United Energy website for the purposes of sharing our project performance reports.

4.1. Energy Networks Conference Slides

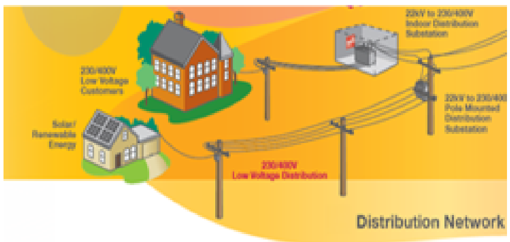
Large-Scale Smart Meter Demand Response Program

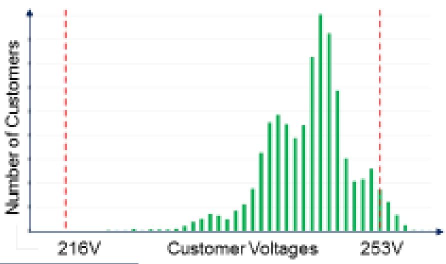
07.06.18

united energy

Power Quality Steady State Over-Voltages Challenge

- Historically, voltages on distribution substations set at high end of regulatory voltage limits to allow for voltage drop.
- Fixed tap needs to cater for minimum and maximum demand conditions with no reverse power flow.
- Maximum demand only occurs for small proportion of the year (hottest summer days < 1%), so most of the time, customer voltages are on high side.
- Now, two-way flows from solar PV is increasing customer voltages, resulting in growing compliance issues for steady stage over-voltages.
- All UE smart meters now provide voltage readings at customer premises revealing whether customer voltages rise above the upper regulatory voltage limit.





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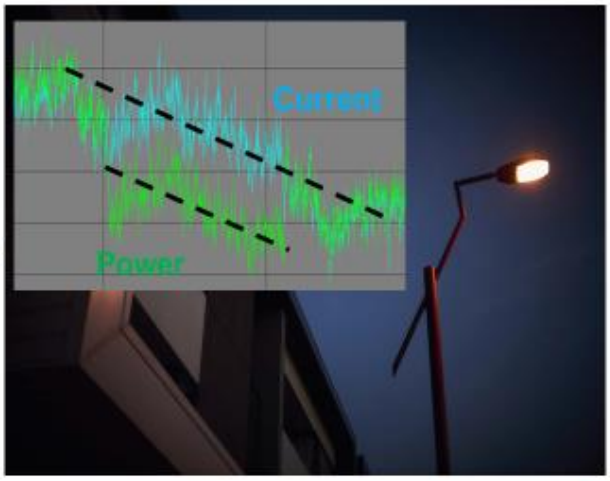
Demand Response Voltages Reduction Challenge

- Reducing voltage reduces active power demand.
- Weighted average test results on United Energy Network give

  $P\% / \Delta V\% = 0.7 \quad \Delta I\% / \Delta V\% = 0.0$

- Constant current behaviour is useful for upstream network constraints and generation shortfalls.
- Historically, limited in use because of its unknown impact on customer voltages relative to regulatory voltage limits.
- All UE smart meters now provide voltage readings at customer premises revealing whether customer voltages fall below the lower regulatory voltage limit.



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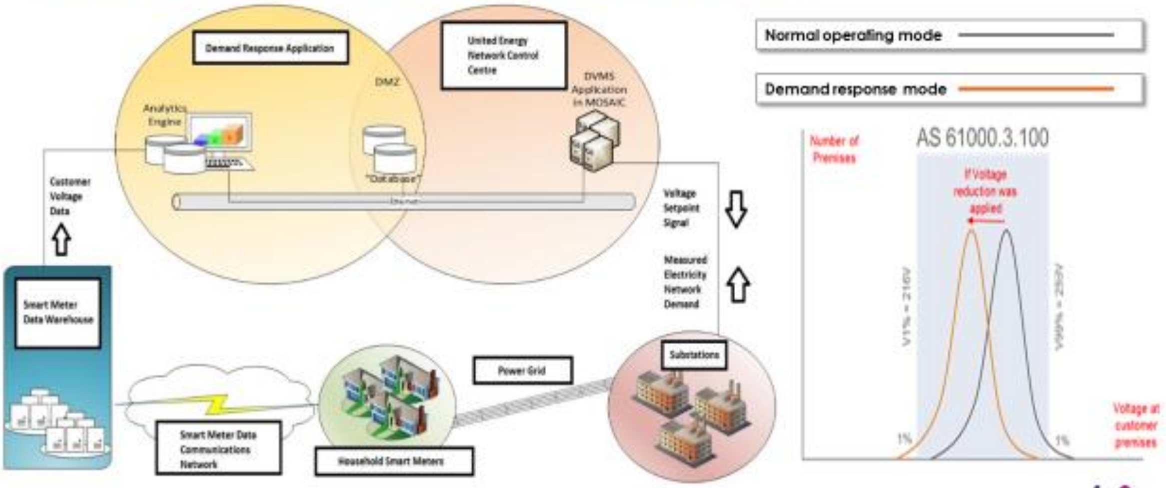
Using Smart Meters to deliver simultaneous Steady State Voltage Compliance and Demand Response capability



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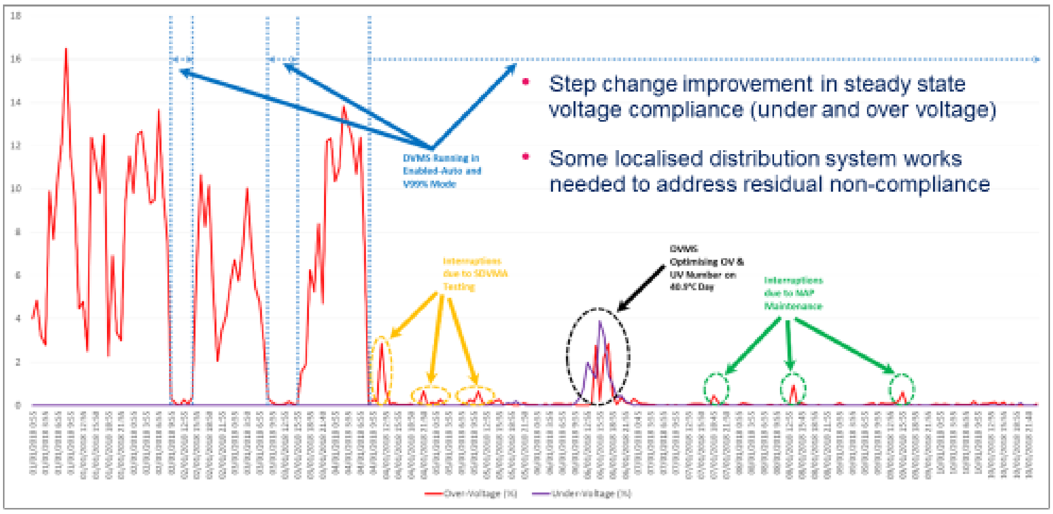
Power Quality Compliance During Commissioning



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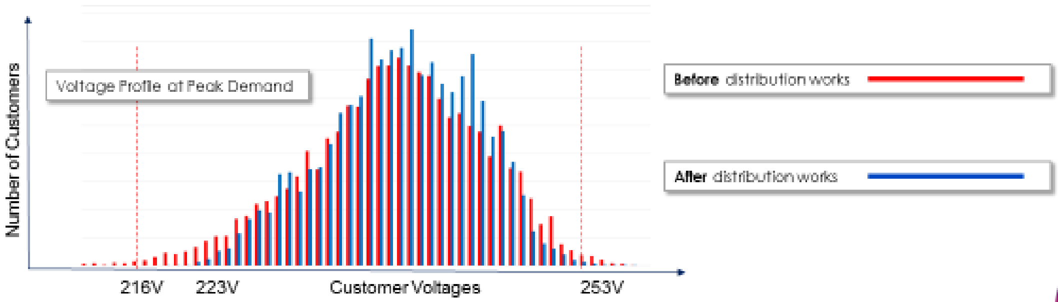
Localised Distribution System Works for Peak Demand Day

- Voltage spread increase 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



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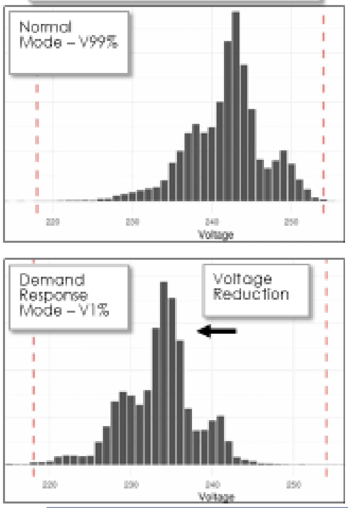
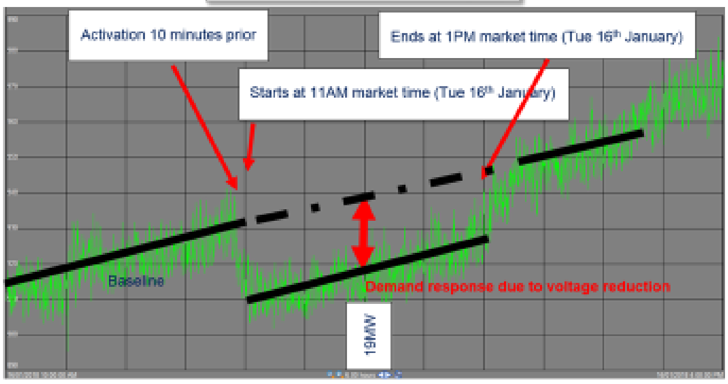
Power Quality Compliance and Demand Response Test Results

Population of Customer Voltages (V)



United Energy Network Demand (MW)



- Steady state over-voltage compliance achieved at enabled sites
- Demand response of 19MW last summer -> more than 30MW next summer

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Conclusions

- Smart meters have provided an opportunity for UE to apply conservation voltage reduction to deliver large-scale demand response capability without the risk of violating regulatory voltage limits.
- UE has successfully tested this capability and is now deploying to all zone substations during 2018 funded through ARENA's Demand Response Program.
- Demand response service delivery for AEMO's SN RERT with 10-minute activation time.
- Quality of supply compliance achievable (steady state over-voltage and under-voltage) including during periods of light load or high solar PV generation and high demand.
- Allows for higher penetration of solar PV by automatically adapting to new solar PV connections and variable solar PV output.

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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
CDA	Clarinda Zone Substation
DVMS	Dynamic Voltage Management System
GIS	Geographical Information System
HV	High Voltage
I/O	Input and Output
IU	Interface Unit
LV	Low Voltage
NAP	Network Analytics Platform
NCC	Network Control Centre
OLTC	On-Load Tap Changer
OT	Operating Technology
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SDVMA	SCADA Dynamic Voltage Management Application
UE	United Energy
VRR	Voltage Regulating Relay