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New Settings Analysis Report

Evaluation of the New EAVC Settings Applied at Trafford Park North Primary Substation

Part 1

Fundamentals Reference F9183 V1.1

16/04/2018

Confidential

Electricity North West LTD

Enhanced Voltage Control

ENWL011

About this report

Version Information

Rev	Date	Purpose of Issue / Changes	Authored	Checked	Approved
1.0	15/01/18	Issued to Customer	J. Gault	H. Shishtaw	H. Shishtawi
1.1	16/04/18	Updated as per customer's comments	J.Gault	H. Shishtaiw	H. Shishtawi

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Abbreviations

EAVC	Enhanced Automatic Voltage Control
DG	Distributed Generation
LDC	Load Drop Compensation

1 Introduction

New EAVC settings have been applied at Trafford Park North Primary Substation since May 2017. The performance of the EAVC and the tapchangers has been monitored since then and all monitoring data has been captured and recorded. The purpose of this report is to show the effects of the applied new settings.

1.1 Settings Design

Considerations for settings

- Site specific information from surveying; such as transformer information, tapchanger information, feeder loads, DG levels, etc.
- Site history and previous commissioning details; such as historical load trends.
- Analysis of the recorded monitoring data.

2 Proposed Settings

The main EAVC settings proposed (and applied) for the trial purposes are:

Table 1 EAVC settings

Setting Name	Setting Value
Basic Voltage Target	99.5 %
Load Drop Compensation (LDC)	3.5 %
Gen Bias	3.0 %
Measured Feeders	Generator (with the relevant parameters set up correctly; such as generator ratings)
Reverse LDC	0.0 %

2.1 Settings Design process

The design process follows this order:

1. Site information and preliminary site settings
2. iHost Data
3. Settings Proposal

2.1.1 Site information

Table 2 Site and assets information

Trafford Park North: 2 Transformers site with 33/6.6kV nominal transformation ratio	
Nominal Voltage	6.6 kV
Tx Winding LDC Rating	1225 A
LDC CT Ratio	1225:1 A
Tx Winding Impedance	13.8 %
Target Voltage	99.5 %
Bandwidth	1.5 %
Generation	15.2 MW

Trafford Park North has a high amount of local distributed generation, 14MW (Cerestar) connected across 4 feeders. Another 1.2MW of DG is also directly connected to Trafford Park North's busbars. This 1.2MW generator is not monitored because:

1. Its maximum generation output is insignificant compared to the monitored 14MW.

2. There are not enough freely assignable CTs within the hardware on the installed SuperTAPP SG relays on site. This can be mitigated by upgrading the hardware.

The 14MW feeders are monitored using the SuperTAPP SG relays installed on site. This is to allow us to gather information about the generator characteristics, as well as general site load trends and voltages.

2.1.2 Online Data

The combined local DG output (Cerestar) at Trafford Park North and T11 transformer load have been plotted in Figure 1 to show how it is affecting the power flow through T11 transformer. The DG output level is more than the site load and is pushing the transformers into reverse power flow mode.

This can vary throughout the day depending on the activity at Cerestar. The power factor has been plotted for the site and for the DG in Figure 2. The DG in this case is at a constant fixed power factor of -0.945 leading (generating real power and consuming reactive power).

2.1.3 Settings Proposal

The settings used have been deduced by:

1. Calculating the maximum voltage drop on the load feeders connected to Trafford Park North using the simulation results from the first stage in the previous report.
2. Calculating the maximum voltage rise caused by the generation connected at Trafford Park North using the simulation results from the first stage in the previous report.

A comment on the correlation between the simulation voltage drops and the real network voltage drops is provided in the next section.

3 Impact of New Settings

3.1 Recorded Data

Site loads, voltage levels, tap positions, generation output and other data was gathered and used for analysis. We also have access to the LV voltage data from Tenax Road. This allows us to plot real voltage drops across the longest line of the Trafford Park North network.

3.2 Analysis & Observations

In Figure 3, 24 hours of load flow from the recorded data is plotted. You will notice the T12 tap position is fixed in position 5. Unfortunately due to a tap changer fault that occurred in May 2017 T12 is unable to tap around with T11 for full automatic voltage control operation.

When the transformers are not on the same tap (Trafford Park North transformers are identical), a circulating current voltage bias is introduced by the SuperTAPP SG relays to keep the two transformers from running away from each other. This means we only see T11 respond to its effective target by one or two taps before its target is restricted too much by the circulating current between the transformers.

In Figure 4 voltage drop is plotted, using the measured voltage at Trafford Park North and the measured voltage at Tenax Road. This is a remote part of the Trafford Park North network. Voltage drop is around 1-2% in normal conditions with the new settings applied.

The above confirms that the chosen settings are working very well; where the interaction between the generator bias setting (dropping down the voltage of the busbars directly proportional to the generation output) and the LDC setting (increasing the voltage of the busbars directly proportional to the load level). The voltage drop between Trafford Park and Tenax Road (the furthest point electrically from Trafford Park North) is 1.5% on average.

4 Future settings

For future settings suggestions it would be sensible to study the data again with both tap changers in service. At the moment the restriction in tapping is not allowing us to see the full effect of the settings applied. It would be interesting to compare the data with the same settings files to see how much the Tenax Road voltage has been affected.

Future settings plan:

- Reanalyse data with full AVC with T12 tap changer in service
- Suggest new levels of generation bias
- Gather data with the Mosley Road interconnection closed

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Figure 1 Transformer & Gen Current vs Time

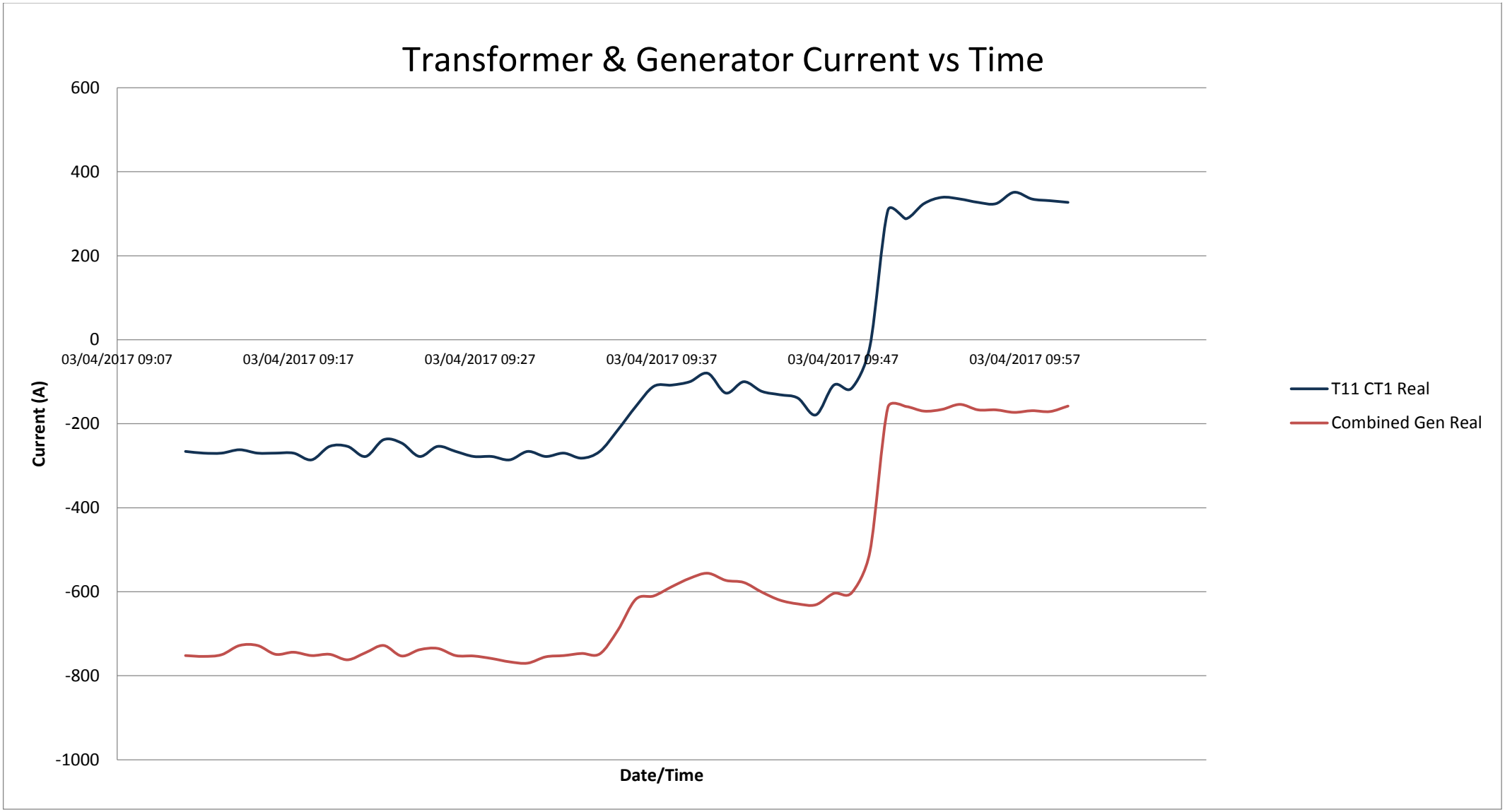

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Figure 2 Site & Generation Power Factor vs Time

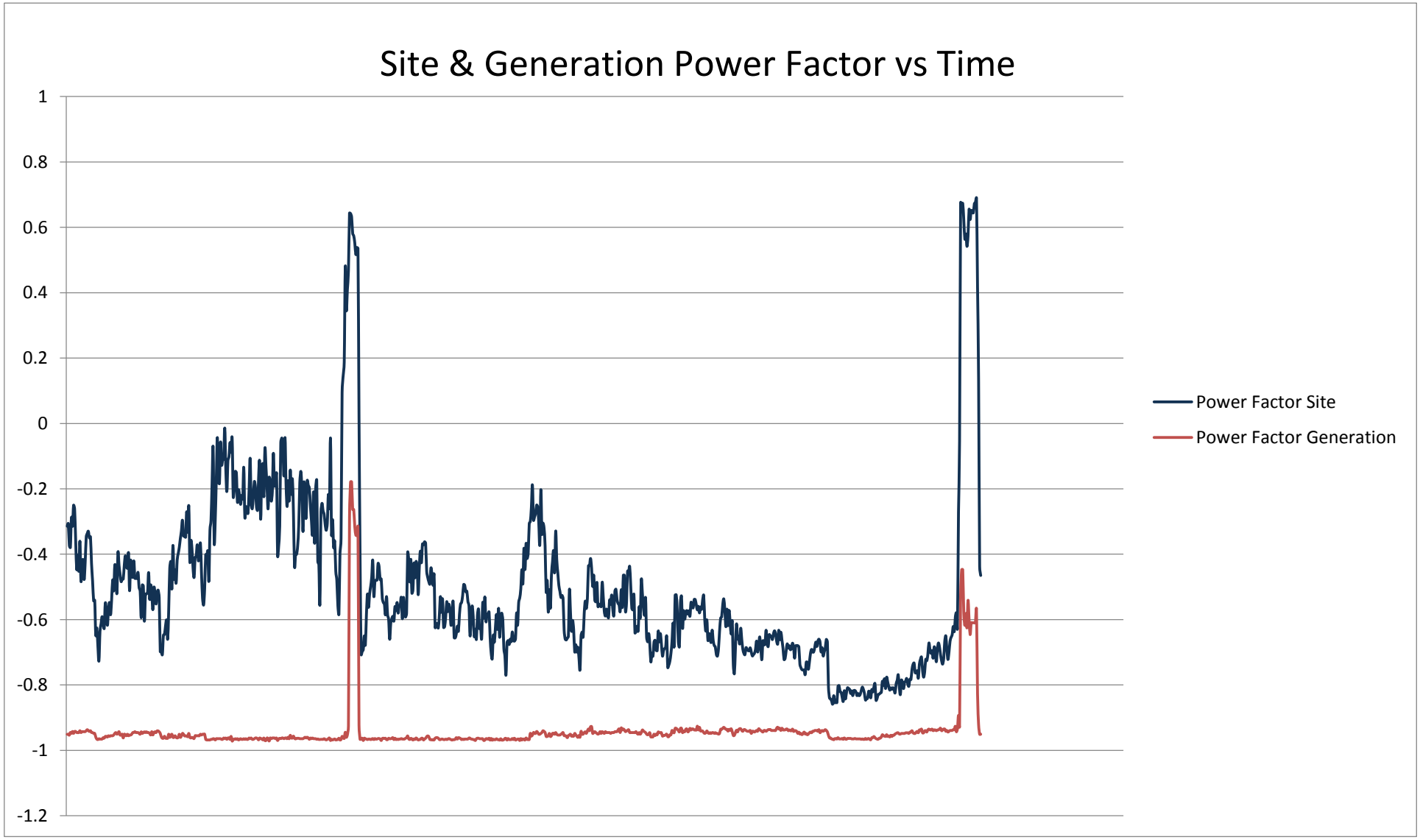

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Figure 3 Voltage Target vs Generation

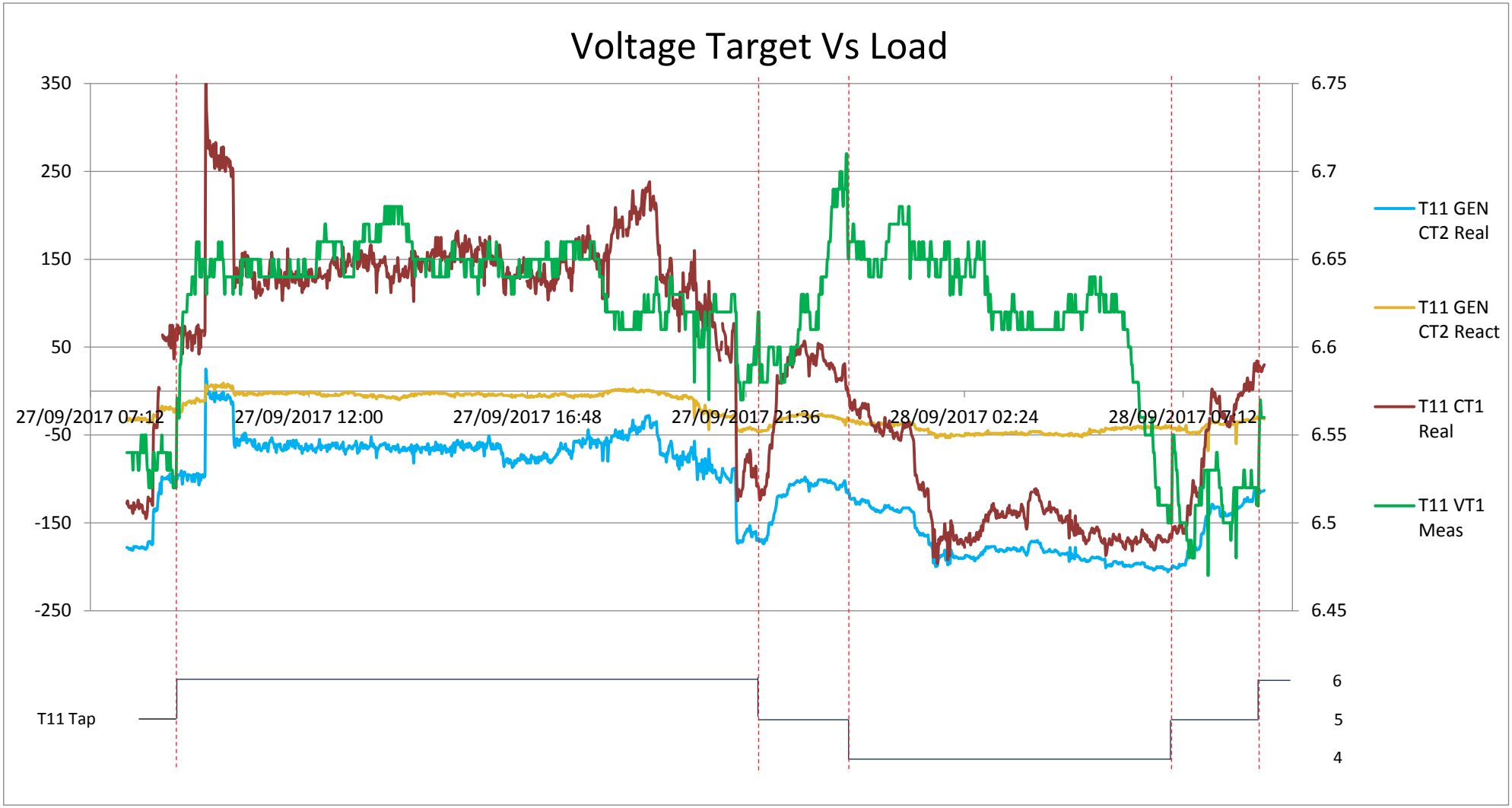

Figure 4 Voltage Analysis vs Time