Scottish and Southern Energy Power Distribution

New Thames Valley Vision

SSET203

LCNF Tier 2 SDRC 9.2(a) Evidence Report
250 End Point Monitors Installed

Prepared By

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Employment Manual Version Control

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1.0	31 01 2013	Gideon Evans	Version 1.0 submitted to Ofgem

Bracknell Forest Council ea technology KEMA DNV GE Honeywell University of Reading

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Contents

1 Summary

1.1 Criteria 9.2(a)

Successful Delivery Reward Criteria 9.2 (a)

250 in house end point monitors installed and learnings presented

SSEPD confirms that this criterion has been met.

This document provides details of the completion of the installation of the 250 end point monitors, and presents the findings identified in line with the evidence criteria specified for the Successful Delivery Reward Criteria (SDRC).

It is confirmed that:

- 250 customers have been engaged and confirmed their acceptance for an end point monitor to be fitted at their property, and for the half hourly data from this monitor to be stored, transferred, and processed by Project Partners (specifically the University of Reading) as appropriate;
- End point monitors have been installed and commissioned at each of these properties;
- A sample of data has been captured and transferred to the University of Reading for their assessment
- The end point monitors and associated systems are active
- Unit costs have been identified;
- The reliability of the end point monitors since installation has been assessed;
- Photographs of installed end point monitors have been taken(1);

(1) Ofgem representative(s) are invited to visit one or more properties with the customer's permission where end point monitors have been installed (by appointment).

1.2 Background

The NTVV project requires half hourly energy data to be captured from end points on the low voltage network so that energy usage patterns can be identified, categorised and forecast and aggregated to network level. With this information it is expected that meaningful forecasts can be made regarding the future loading of the low voltage network.

Had the smart meter roll out programme progressed to an advanced level (during 2012), data could have been obtained directly from energy suppliers. It was recognised at the conception of the project that availability of real smart meter data was at best uncertain, and realistically likely to be limited. The availability of alternative devices that could be fitted as part of the project would give considerably enhanced certainty of data availability. The end point monitors installed to date provide this data.

SDRC 9.2 (a) was established to ensure that a clear focus was given to the fitting of end point monitors so that data is captured at the earliest possible stage and made available to our Project Partner the University of Reading. All subsequent stages of data analysis depend upon this data and hence the high priority given to this task.

The data being collected is personal data as defined in the Data Protection Act 1998 and to ensure compliance considerable attention has been given to aspects of consent, data storage and data transmission. This document identifies the serial numbers of the devices fitted, and provides samples of the data collected to ensure that appropriate evidence of compliance with the SDRC is available. To maintain privacy, this document cannot link the devices or data to individual properties or their occupiers. The link between devices and properties is held securely by SSEPD(1),

(1) Ofgem representative(s) are invited to visit one or more properties with the customer's permission where end point monitors have been installed (by appointment).

1.2 Link to Methods and Learning Outcomes

Method 3 as defined for NTVV (see SET203 New Thames Valley Vision bid submission) proposes the development of mathematical techniques to reduce the need for new and extensive low voltage network monitoring that might be required to manage and design low voltage networks to meet the needs of the new low carbon technologies. Mathematical models are to be developed by the University of Reading using data from end point monitors now installed in customer's premises, and subsequently from devices measuring the energy profiles of low voltage feeder cables from distribution substations. The substation monitors are being installed in line with SDRC 9.2 (b).

To meet SDRC 9.2 (a) 250 end point monitors have been installed at domestic customer's properties, commissioned and data collection established. The end-point monitors are EDMI Mk 7c Atlas devices, which were originally designed as "smart" meters. These have been configured for use as end point monitors and installed in series with the customer's meter. They have been connected between the SSEPD main "cut out" fuse and the existing meter in order that no operating energy consumption is charged to the volunteer customers.

The end point monitors have been connected via the Vodafone network to GE's Smart Metering Operating System (SMOS). From SMOS the data is available for storage in SSEPD's PI system, for sharing with the University of Reading. The personal data collected by the end point monitors has been handled in accordance with the Data Protection Act 1998 and the NTVV Data Protection Strategy agreed with OFGEM.

Successful completion of Learning Outcome 1 requires an understanding of energy usage behaviour of customers in order to optimise network investment. The selection of the 250 end point monitor locations was made with guidance from the University of Reading and in line with the NTVV Customer Engagement Plan agreed with Ofgem. The University of Reading require a mix of customer types to develop a model of customer behaviour in terms of domestic energy consumption. This will be used to predict future demand and better inform investment decisions relating to the low voltage network.

Successful completion of Learning Outcome 2 requires improved modelling to enhance network operation procedures and to provide a management tool for planning and investment on the low voltage distribution network. The University of Reading are using the data from the 250 end point monitors to develop the model.

2 End Point Monitor Installations

2.1 Customer Selection Process

To be able to install 250 end point monitors, consent had first to be obtained from no fewer than 250 customers. These customers were selected in consultation with the University of Reading to achieve, so far as reasonably practical, a good statistical mix of property types with good coverage of feeders with various numbers of network connections and various network homogeneity properties while maintaining coincidence with the substation monitoring being carried out in line with SDRC 9.2 (b).

A more detailed description of the criteria is found in **Appendix 9 UoR Selection Procedure for End Point Monitor Locations.**

2.2 Customer Engagement

515 customers have registered their involvement in the project and consent has been obtained from over 320 customers, initially by direct mailing, and subsequently by telephone or personal visit to :

- Confirm permission
- Agree access arrangements
- Agree short supply interruption
- Advise communications arrangements.

All customer engagement has been carried out in accordance with the NTVV Customer Engagement Plan.

The details of the customer engagement process, outcomes and lessons learnt will be reported on separately in line with SDRC 9.3 (c)

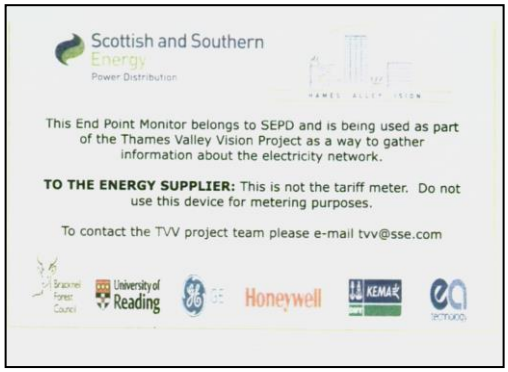
2.3 Installation of End Point Monitors by SSEPD

The installation of the end point monitors work was carried out by SSEPD staff. For each End Point Monitor installation electrical phase tracing equipment had to be installed on "live" equipment at the distribution substation feeding the end point; for this the operatives worked in pairs to comply with SSEPD safety rules. Cable jointing teams based at Slough Depot carried out this work on behalf of the NTVV project team. The Depot team benefitted from this involvement by becoming much more aware of the NTVV project, its goals and the future benefits to their business-as-usual.

An appointment was individually made to fit the monitor with each customer in the period October 2012 to January 2013. On arrival the SSEPD operative confirmed and took a copy of signed consent from the customer as well as additional information about the customer's household. To achieve the number of monitor installations required in the available time it was necessary to work during evenings and weekends.

The installation process included the following tasks:

- Check LV plans to identify feeding substation
- Before attending site the signal injection part of the phase tracing equipment had to be installed at the local substation in readiness for the phase identification at the house.
- The phase that the service was connected to was determined using the receiving part of the phase tracing equipment.
- Where necessary, the existing tariff meter was relocated to the "check meter" position (this was dependent on space being available on the meter board)
- The end point monitor was installed in the original tariff meter position above the cutout
- The sticker (shown below) was fixed across the digital display and optical port of the end point monitor to indicate to any meter reader that the device is NOT a tariff meter. This has been designed to avoid potential confusion by supply company or meter operator staff, and to allow them to contact the NTVV team if necessary:



- The end point installation check list was completed by the installer

The following information was then forwarded to the TVV Team:

- Customer name
- Customer address
- MPAN number
- End Point monitor serial number
- IMEI number linked to the internal modem

The information has been captured by the NTVV team; it will be shared with the University of Reading and stored, in accordance with the NTVV Data Protection Strategy.

A complete schedule of the 250 end point monitors installed can be seen in **Appendix 8 Schedule of 250 Installed End Point Monitors.**

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Power Distribution

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End Point Monitor – Installation Check List

Name										
Date of Visit			Time of Visit							
Address										
Customer Reference										
MK7C Serial Number										
Exsiting Meter Position	Outside Box				Lounge					
	Garage				Communal Area					
	Kitchen				Looped Service					
	Under Stairs				Other					
Electricity Supplier	British Gas				Scottish Power					
	EDF				Scottish & Southern					
	E.ON				Other					
	N.Power									
Heating Type	Gas		Electric		Oil					
MPAN Number										
Electrical Phase	Red/Brown/L1									
	Yellow/Black/L2									
	Blue/Gray/L3									
MK7C Device Communicating at time of visit	Yes				No					
Cut Out	Lucy		Henley		Compound		Other			
Cable Type	35 sq mm single Phase		35 sq mm 3 Phase		Conventional single phase		Conventional 3 phase			
MK7C fitted to	Existing Board				New/Additional Board					
Isolator Fitted	Yes				No					
How many Occupants	Adults				Children					
Customer Reaction	Lack of Interest			Interested					Very Enthusiastic	
	1	2	3	4	5	6	7	8	9	10
Comments										

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2. 4 End Point Monitor Configuration

SSEPD specified that the end point monitors to be supplied and installed were required to comply with requirements in the areas of electrical safety, measurement capability and data security. Electrical safety and measurement capability are aspects that are readily confirmed for existing tariff meters and high confidence can easily be obtained by virtue of Measuring Instrument Directive (MID) certification and CE marking. Data security is particularly important for meters that can transmit data (i.e. smart meters), and expectations and standards in this aspect have grown significantly in recent years. SSEPD decided that for the NTVV project a metering device of no less than the Smart Meter Equipment Technical Standard (SMETS 2) should be deployed.

As product partner for monitoring hardware and integration, GE Digital Energy offered SSEPD the use of EDMI Mk7C devices. SSEPD accepted the use of these devices for the following reasons:

- MID Certification obtained (See **Appendix 2**)
- CE Marking achieved
- Known compatibility with GE Digital Energy's head end system (SMOS)
- Previous usage on another LCNF project
- Commitment by EDMI that the MK7C device would be configured to meet SMETS2 in time to meet the NTVV project plan commitments
- Smaller dimensions than some comparable devices

260 EDMI Mk7C end point monitors were delivered to SSEPD on the 5 October 2012. This included 250 for installation at customer properties, 2 for testing, 1 for demonstration at the Your Energy Matters facility in Bracknell, and 7 as spares in lieu of extended warranty. See **Appendix 3 GE Digital Energy Delivery Note**.

A data security risk assessment was carried out on the Mk7C device and control measures identified. The loss of any customer data or any compromise to the end point monitor security during the NTVV project life cycle is unacceptable with significant adverse consequences to customers, SSEPD and all parties linked to the project. The risk assessment included a thorough review of the technical specifications for the EDMI device by SSEPD technical and legal representatives. This led to a number of weaknesses being identified in relation to the data transport mechanism and the physical

security of the device that could not be tolerated without resolution. These were as follows:

- **Physical device (end point monitor) security risks.**

The standard monitor has the ability to locally update or upload additional firmware and had a disconnect switch that, if used, would cause loss of supply. In order to mitigate this EDMI removed the disconnect capability thereby addressing this risk. The device also has a tamper detection alarm that alerts SMOS. The local password policy is set to lock the device for one hour after two incorrect password entry attempts. Each user password is encrypted internally to each device and is unique. Authentication of the login with encrypted password is achieved using 128 bit key valid for 30 seconds. The monitor logs both the successful and unsuccessful access attempts.

- **The security of the transmitted data.**

The original lack of encryption of the data sent from the end point monitors to SMOS would have meant that sensitive personal information, as defined by the Data Protection Act, would be transmitted across a weakly secured private Access Point Network in plain text. Mobile data network communication (GSM) has a level of encryption that prevents trivial eavesdropping, but this has been compromised in laboratory conditions and is unlikely to satisfy the Information Commissioner. To overcome this problem EDMI has created a firmware update, which was released in December 2012. This addresses data encryption by implementing the DLMS HLS Protocol between the end point monitors and SMOS.

2. 5 End Point Monitor Communications

NTVV partners GE Digital Energy in association with EDMI designed the data collection process to transfer the data from the customer's premises to SSEPD. This process will be fully integrated with the data from the substation monitors through the GE PowerOn Fusion system and stored in the SSEPD Pi Historian database for immediate use and sharing with the University of Reading.

The data is being sent in an encrypted format from the end point monitors via the Vodafone network to the GE Digital Energy data centre in Livingstone. Here the data is processed by the GE Smart Meter Operating Suite (SMOS). When fully operational the data will then automatically be transferred to the SSEPD data centre in Havant via a virtual private network (see **Appendix 10 Data Flow Diagrams**).

The data sent from the end point monitors is half hour energy consumption - both positive and negative flows (import and export). Note that the location to which the data relates is not transmitted with the data or recorded in SMOS. The address is known only by SSEPD and shared with the University of Reading The serial number of the device is used by SSEPD to link the data to the location.

A sample of data has been downloaded from one of the monitors on site The data output is shown below:

```
[LoadSurvey]
LastRecord=0000000077
StartTime=16/01/2013 20:30:00

Record No  Date/Time  Imp Wh Total     Exp Wh Total     Status
           (0x00003413)     (0x00003423)
0     16/01/2013 20:30:00   516   0     .IP..U.
1     16/01/2013 21:00:00   509   0     .......
2     16/01/2013 21:30:00   481   0     .......
3     16/01/2013 22:00:00   504   0     .......
4     16/01/2013 22:30:00   480   0     .......
5     16/01/2013 23:00:00   484   0     .......
6     16/01/2013 23:30:00   513   0     .......
7     17/01/2013 00:00:00   445   0     .......
8     17/01/2013 00:30:00   512   0     .......
9     17/01/2013 01:00:00   471   0     .......
10    17/01/2013 01:30:00   504   0     .......
11    17/01/2013 02:00:00   470   0     .......
12    17/01/2013 02:30:00   542   0     .......
```

Note that “wh” is “watt hours” and that, for example, “516” is 0.516 kWh.

Data is now being gathered by all 250 end point monitors.

2.6 Photographs of Installations at Customer Premises

End Point Monitor Tariff Meter

End Point Monitor

Additional photographs of end point monitors installed on site are shown in **Appendix 12 NTVV Photographs of End Point Monitor Installations.**

2.7 Site installation Issues

During the Installation stage it was not possible to install the EDMI Mk7C end point monitor at all locations as requested by the University of Reading. At 22% of the locations where access arrangements had been made, instances were found where there was insufficient space to install the end point monitors. Typically this was due to time switches associated with the off peak tariff as arranged between the customer and the supplier, and occasionally due to very small existing meter boards, meter boards located in very tight or inaccessible spaces, or due obstructions from customer equipment. Two such situations are shown in the photos below.

3 Active Operation of Systems

3.1 SMOS Development and Commissioning

The IT and communications architecture for the transfer of data from end point monitors to SSEPD is centred on GE Digital Energy's Smart Meter Operations Suite (SMOS). GE Digital Energy were responsible for the integration of the communications into SMOS and all aspects of the configuration of the system components to ensure that the level of encryption required is achieved. The systems have been built in conjunction with Vodafone (communications) and EDMI (end point monitor supplier) and are now able to handle the data captured by 250 end point monitors.

See **Appendix 4 – GE Digital Energy Implementation Report for End Point Monitors**

3.2 PI Historian

SSEPD uses Pi Historian extensively for the storage of operational data and it was decided very early at the project conception stage that this was an appropriate database for the storage of end point data that is linked the low voltage network.

Appropriate licences have been purchased for Pi Historian to be deployed for NTVV and software has been configured to receive the end point monitor data that is now available.

A full description of the commissioning of Pi Historian is given in **Appendix 5 NTVV Pi Commissioning Report.**

4 Data Capture

4.1 Sample Data

Data has been obtained from a number of end point monitors and transferred to the University of Reading. End point monitors have been installed to suit customer access preferences and resource availability, starting in October 2012 and running into January 2013. The volume of data captured reflects this programme.

Sample data can be seen in **Appendix 6 NTVV Sample of Data**.

4.2 Review of Data

The University of Reading have received data and made initial observations. These are included in **Appendix 7 UoR Review of Data**

5 Review of Unit Costs

5.1 Installation Costs

To achieve an efficient installation success rate the installation team made arrangements for access to best suit the customers. This typically required working on evenings and weekends for households where the customers themselves were at work during the week and during the day for customers that are not at work or are retired.

On a typical working day 4 or 5 appointments were made for each of the fitting teams to work during the working day with 2 or 3 evening (after 16-30hrs) appointments. Four monitors were typically fitted on a Saturday morning. Occasionally it was necessary to fit the monitors on Sundays (up to 5 could be fitted). One or two teams were programmed on each working day dependent on the number of appointments that could be successfully booked.

The average time spent to fit a single device was 1.72 hours. This included travel to and from site and temporarily fitting the phase indication device at the distribution substation. Note that two operatives were required therefore each device took 3.44 man hours to fit. To best match the availability of operational staff and customer preference 55% of installations were carried out after normal working hours (42% evenings, 14% Saturdays and 1% Sundays), this has had the effect of increasing the average unit installation cost. If the process were to be scaled up, with a preference to achieve more installations during the working day, additional resource would be required to maintain business as usual commitments.

5.2 Cost of End Point Monitors

The end point monitors are off-the-shelf components (in large use by energy suppliers as tariff meters) supplied to NTVV by EDMI via GE Digital Energy. The total cost of the devices includes reconfiguration by EDMI and GE Digital Energy to achieve the very high (equivalent to SMETS 2) standards for data security, as this required significant additional man hours for configuration compared to the standard configuration required for off-the-shelf monitors. The end point monitors were supplied to the NTVV project by GE Digital Energy as part of their overall package of work and it is difficult to breakout individual costs; for a quantity of 250 monitors, which is small compared to the large

volumes supplied to others for tariff purposes, a relatively high cost is expected, and this would clearly not be representative if scaled up for a larger deployment.

5.3 Cost of Communications and Systems

The provision of communications to individual end point monitors has been provided by GE Digital Energy as part of their overall package of work. The arrangements have been made by GE Digital Energy with Vodafone for the use of GPRS data SIM cards using standard commercially available services. Iindividual data charges have not been released to SSEPD.

The licence and operational costs for the operation of the existing SMOS system and Pi Historian are subject to further analysis linked to the volume of data. This will be reviewed in the Learning Outcome reports to be drafted in line with SDRC 9.8 (a).

6 Review of Reliability

6.1 Reliability of End Point Monitors

There have been no reliability issues with the EDMI Mk7 end point monitors in the period of operation to date.

6.2 Reliability of Communications and Systems

During the commissioning phase close inspection of data on the Vodafone system have resulted in concerns being raised regarding unexplained data flows. This issues remains under investigation and the outcome will be reported in subsequent learning outcome reports.

A total of 4 end point monitors have been installed where their SIM cards have failed to connect on the vodafone system. The reaasons for this are currently under investigation, the outcome of which will influence the proposed solution.

There have been no reliability issues with GE Digital Energy's SMOS system in the period of operation to date. SMOS as a pre-existing system is of proven reliability, and some modifications to the configuration established for NTVV are to be expected over the next few months.

6.3 Reliability of Pi Historian

There have been no reliability issues with the Pi Historian database in the period of operation to date. Pi Historian as a pre-existing system is of proven reliability, and some modifications to the configuration established for NTVV are to be expected over the next few months.

6.4 Data Received by the University of Reading

The University of Reading will review the quality of data received in terms of completeness and error checking on an ongoing basis. To date, as more end point

monitors have been commissioned on a daily basis it has not been practicable to establish meaningful information about the reliability of the data. The University of Reading have not reported any concerns to date.

7 Appendices

Appendix 1 EDMI Mk7c Brochure

See separate document attached.

Appendix 2 MID Certificate SGS0035 EDMI Mk7A Issue 1

See separate document attached.

Appendix 3 GE Digital Energy Delivery Note – 260 off EDMI Mk7C

See separate document attached.

Appendix 4 GE Digital Energy Implentation Report End point

See separate document attached.

Appendix 5 NTVV PI Commissioning Report

See separate document attached.

Appendix 6 NTVV Sample of Data

See separate document attached.

Appendix 7 UoR Review of Data

See separate document attached.

Appendix 8 Schedule of 250 Installed End Point Monitors

See separate document attached.

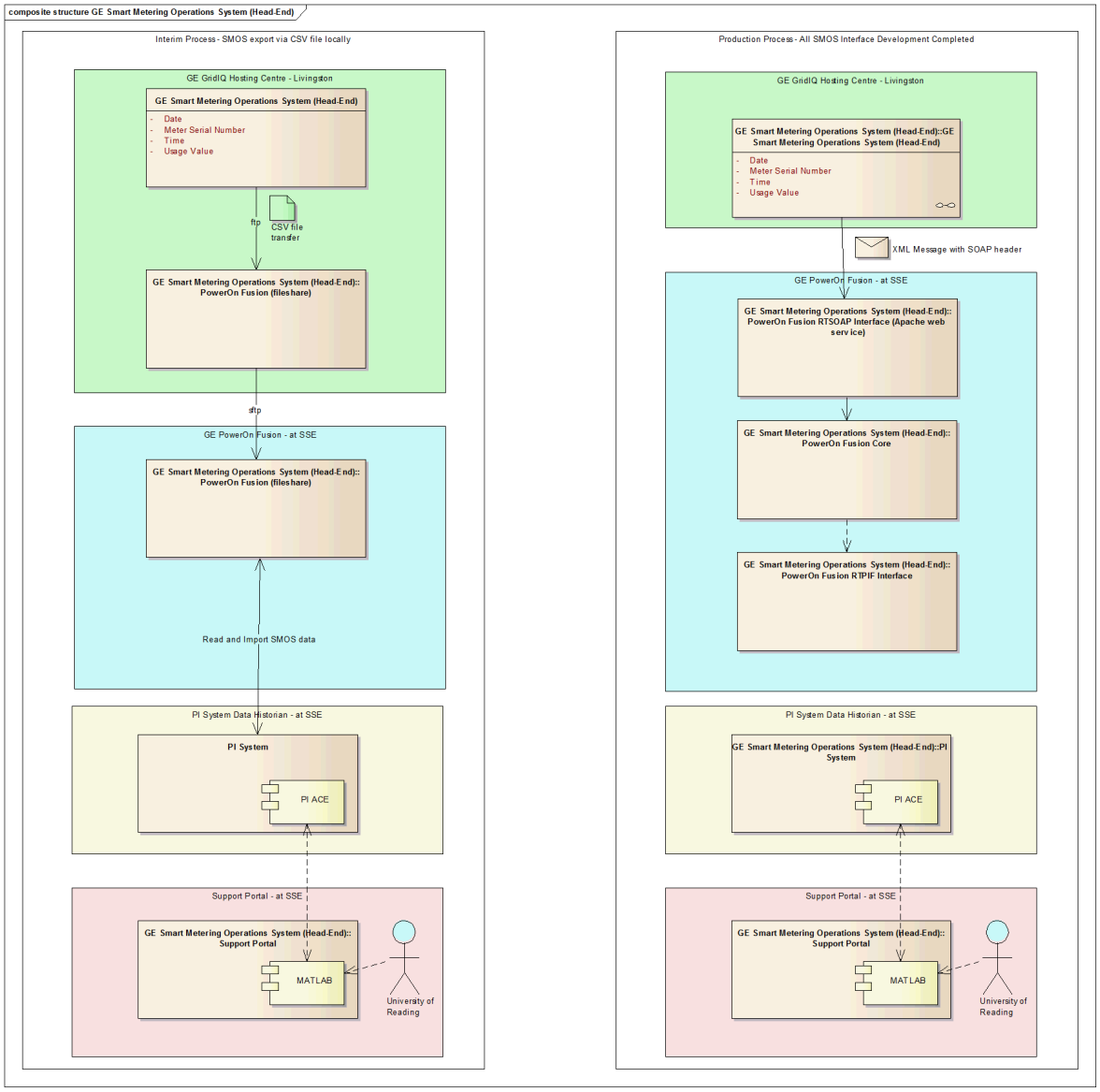
Appendix 9 UoR Customer Selection Considerations

See separate document attached.

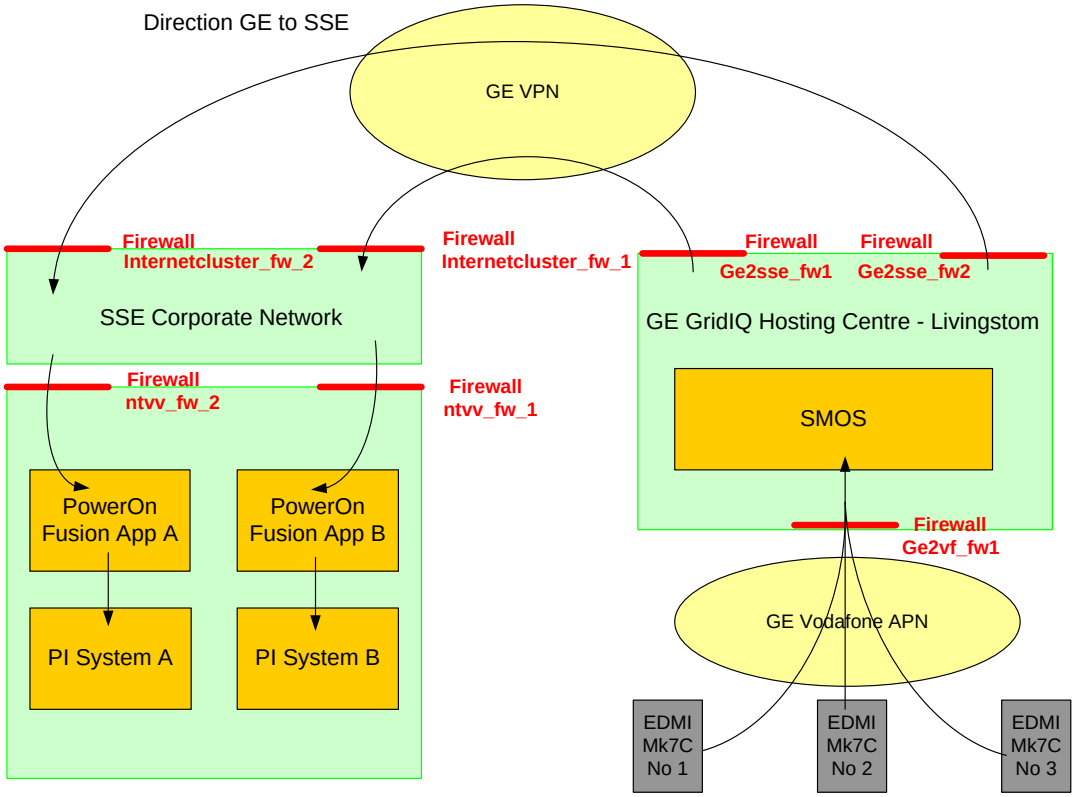
Appendix 10 Data Flow Diagrams

Interim Process

Production Process



Appendix 11 Security Diagram



Appendix 12 NTVV Photographs of End Point Monitor Installations

See separate document attached.