New Thames Valley Vision

SSET203

LCNF Tier 2 SDRC 9.4(b) Evidence Report
Install 30 thermal energy storage devices (as defined in (a))

Prepared By

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Employment Manual Version Control

Version	Date	Author	Change Description
1.0	20 03 2014	Mark Coulthard	Release

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Scottish and Southern Energy Power Distribution

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1 Summary

1.1 Criteria 9.4(b)

Successful Delivery Reward Criteria 9.4 (b)

Install 30 thermal energy storage devices as defined in (a)[1] –

SSEPD confirms that this criterion has been met through the installation of 30 energy storage devices (EMMAs) within domestic properties around Bracknell.

This document provides details of the completion of the installation of 30 EMMAs, and presents the findings identified in line with the evidence criteria specified for the Successful Delivery Reward Criteria (SDRC).

It is confirmed that:

- 30 domestic customers have had an EMMA device fitted at their property after an engagement process in which 57 domestic customers took up initial enquiries and completed a process of site inspection and consultation.
- EMMAs have been installed and commissioned at each of these properties.
- A sample of performance data has been captured and has been processed by the NTVV Project Team.
- The EMMAs and associated systems are actively storing peak solar energy as hot water for use by the customer.
- Photographs of installed EMMAs have been taken[2], examples are provided in this report and the photographs of all installations are available upon request to Interested parties.

[1] Definition (a) can be found in Appendix 6

[2] Ofgem representatives are invited to visit one or more properties with the customer's permission where EMMA's have been installed (by appointment)

1.2 Background

The NTVV project requires, under SDRC 9.4b, the installation of 30 thermal energy storage devices (known as EMMA devices), to include photographic evidence and where required an arranged site visit.

The installation of these devices will help Scottish and Southern Energy Power Distribution (SSEPD) and all other GB DNOs understand the benefits to network operation that these units could bring and also quantify the installation rates, data needs and method of analysis. Under this project, EMMA units are being installed to limit the peak export of Photo Voltaic (PV) Micro Generation on to the low voltage (LV) network whilst allowing customers to consistently store and benefit from the energy their PV systems have produced by using it to heat hot water for normal use in their properties.

The EMMA units configured for this project adjust the amount of PV energy exported onto the network by diverting excess amounts to a conventional hot water storage tank via the customer's existing immersion heater. The EMMA units, adjusted for this project:

- use a learning model of the maximum output from the PV system to calculate a generation profile for the site. The control algorithm takes into account the time of year, the size of the PV system and the time of peak output.
- consider the customer's expected thermal storage needs (hot water tank), which are expected to be between 3kwh to 6kwh per day, subject to PV generation and daily usage.

Based upon the above criteria, the EMMA unit calculates how much energy can be diverted off the peak export to the supply, typically for a household with a PV capacity of 5kWh this has been found to be 1kW. Therefore when PV production meets expectations, the customer will receive a regular, expected, amount of hot water, whilst simultaneously diverting the peak export power to the LV network.

Note: For the purpose of this analysis the EMMA units that have been deployed collect energy usage information, which is considered personal data as defined in the Data Protection Act 1998. To protect this data considerable attention has been given to all aspects of consent, data storage and data transmission. Whilst this document identifies the serial numbers of the devices fitted and provides samples of the data collected to ensure appropriate evidence of SDRC compliance, to maintain privacy, this document does not link the devices or data to individual properties or their occupiers.

1.3 Link to Methods and Learning Outcomes

Method 2 as defined for NTVV (see SSET203 New Thames Valley Vision full bid submission), proposes the 'learning's from thermal energy storage, in the form of domestic water and storage heating will be used to expand the controllable load for the demand response'. SSEPD is actively collecting performance data from the 30 installed EMMA units and using it to confirm the potential customer and network benefits..

As per SDRC 9.4 (b) 30 EMMAs have been installed at domestic customers properties, commissioned and interim data collection established. The units are Coolpower EMMA 3G devices, which were originally designed to divert excess energy generation to a variety of different storage solutions. Coolpower and SSEPD have further enhanced the standard model to provide controllable energy storage to a customer's hot water storage tank, whilst managing peak export.

The EMMA is connected in series with the immersion heater and the customer's distribution board (immersion heater circuit), and is located near to the distribution board.

The EMMA is a standalone unit, not connected to any form of external/remote communications. This has made the unit more cost effective, easier to operate and install. However, this has also mean that data collection for research purposes can only be performed by pre-arranged visit with the customer. At the visit, data is collected via an RJ45 connector installed on the top of the unit. To access this data, bespoke software installed on a dedicated Netbook is used to communicate with the EMMA and download the required data. All personal data is handled in accordance with the project Data Protection Strategy to ensure the requirements of the Data Protection Act are met.

Successful completion of Learning Outcome 1 , see Appendix 6, requires an understanding of energy usage behaviour of customers in order to optimise network investment. The data retrieved from the 30 installed EMMAs, will be used to predict the effects of micro generation and usage to better inform investment decisions relating to the LV network.

Successful completion of Learning Outcome 4 , see Appendix 6, requires the implementation of technologies to support the transition to a Low Carbon Economy. Data sourced from the 30 installed EMMAs and analysis by the manufacturer and SSEPD, will result in an optimised energy management unit.

2 EMMA Installations

2.1 Customer Selection Process

In order to install 30 EMMAs, customers in Bracknell needed to be engaged to gain enough interest from sufficient participants in the borough. These customers were selected in consultation with Bracknell Forest Council, and based upon best selection profile, both from a DNO LV feeder cluster perspective, and from prior knowledge of micro generation installation(s).

The data from Bracknell Forest Council identified 269 solar installations in the borough and this list formed the basis of our targeting. The next stage was to sort the addresses by location in order to identify the highest densities of installations. Higher density of installations has the potential to provide greater learning as the key reason for installing EMMA devices on the network is to limit voltage issues due to reverse power flow caused by PV generation exporting power onto the network.

A more detailed description of the criteria is found within Full Submission Pro-forma SSET203.

2.2 Customer Engagement

The approach taken to engage with customers for the hot thermal storage trial was informed not only by our end point monitoring deployment on the TVV but also via various customer engagement learning sessions organised by DNV GL for DNOs.

The key engagement for this work was formed of a number of stages;

1. Dropped an information leaflet through the door of the target addresses along with details of how they can get in touch
2. Revisited addresses for a one-to-one conversation with the customer
    a. This was an opportunity to answer any questions that the customer had and/or give them the material again as they may not have read in any detail, if at all.

   b. On many occasions, customers were not at home therefore, a number of properties were revisited on a number of occasions. No information was left at this stage.
3. During this process, the customers that expressed an interest (and those that appeared to meet the eligibility criteria), see Figure 1, were invited to have a site survey.
   a. This site survey was the opportunity for the customer to ask our engineer any technical questions and the time that we deduce whether an installation was feasible , see Figure 1, at the address.
4. If this stage proved that an installation was possible, a time was booked by the engineer at the survey time.
   a. Customers were invited to read through the customer consent forms and ensured that they were clear of expectations from the project team with regards to data collection and future engagements etc.
   b. This was the point where customers agreed any access arrangements, short term supply interruptions and advised future communication arrangements.

2.2.1 Customer Engagement Statistics

Between the months of December 2013 - February 2014 the following figures were recorded.

- 174 Houses where EMMA promotional material was dropped
- 156 - Properties revisited
- 57 - Surveys booked
- 30 - Installations

Other Statistics

- 5 - Already have EMMA equivalent
- 36 - Have no hot water tank/ have solar thermal for hot water needs
- 1 - Moving house
- 15 - Spoke to but not interested

Full details of the customer engagement outcomes and lessons learnt will be reported on separately in line with SDRC 9.8 (a). As an aside to this evidence report, the TVV team will compile a customer engagement lessons learnt report specifically for the Hot Thermal Storage trial. This report will provide more details as to the conversations with customers and go into greater detail regarding the time it took to engage with customers.

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

2.3 Installation of EMMAs by SSEPD

The installation of 30 EMMAs was carried out by a domestic electrical contractor, with customer management, project management, and technical support by SSEPD staff. Prior to the installation of the EMMAs, the electrical contractor's staff underwent in house EMMA training, with periodic onsite reviews.

All of the EMMA installations involved working with domestic LV distribution boards and circuits, hence the trained operatives worked in pairs with no lone working, to comply with SSEPD safety rules. The domestic electrical contractor based in Thatcham carried out this work on behalf of the NTVV project team.

As described above, two appointments were made with each customer in the period December 2013 to February 2014. The first appointment was an in depth survey to identify key areas within the customer's property and give an overview of the EMMA, its purpose and the customer's role in this research. The second appointment was to confirm customer consent, complete installation and commissioning of the EMMA and give a full demonstration of the EMMA.

The survey process included the following tasks:

- Record the customer's full name, address, contact details, number in the household and future availability
- Identify the location and suitability of the domestic distribution board and required circuits

- Establish the location and suitability of the micro generation (PV) system, required isolators and circuits
- Confirm the location and suitability of the hot water storage tank, immersion heater, and location and settings of the customers boiler
- Ensure that the customer understood the principles of the EMMA and the future installation process
- Determine customer's hot water usage?

A sample survey form is shown on the next page:

SSE NTVV - Thermal Storage

Survey Form - 001	Revision B	Date of Survey	
Customer's Full Name			
Customer's Full Address (include full post code) (include tel' No.)			
Customer Available Dates/Times over next 2-6 weeks for install			
Number in Household		Hot Water Useage (High/Medium/Low)	
location of Fuse/Breaker Box (include type/no. of ways/ease of access) (Does it conform to BS7671, inc' earth bonding?) (Are PV&Immersion Htr Fuse/Breakers Identified)			
Confirm Kw Rating of Customer's P.V. Installation		Loc' of P.V. AC Isolator	
		Loc' of P.V. DC Isolator	
location of Water Tank and size in Litres (include Kw rating of Immersion Heater/setting) (is the immersion heater vertical or horizontal?) (include tank thermostat location/type/setting) (does the immersion htr' cable run parallel to telephone circuits used for broad band?)			
where possible include photo's of immersion heater/tank thermostat settings			
location of Boiler (include type/model/ease of access)			
Confirm with Customer current boiler hot water Temperature setting		Celsius	
Confirm with Customer current boiler hot water Time to ON/OFF setting			
Confirm with Customer if Hot Water/Heating Controls are separate		Yes/No	
Can the boiler Hot water Control be switched OFF, without effecting the heating?		Yes/No	
Can the EMMA unit be installed next to the Fuse/Breaker Box at this property?		Yes/No	
Approx' dimensions will be required - L 480 x D 200 x H 350 mm			
Confirm that the customer will have access to the EMMA at the proposed location		Yes/No	
Has customer been briefed with EMMA interaction/will proceed with installation?		Yes/No	
Attending SSE (Contracting) Engineer details/contact(s)			

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Figure 1 – Survey Form

The installation process included the following tasks:

- Discussing the installation methodology with the customer, agreeing a convenient location and receiving written consent to proceed
- Using the survey form, the domestic electrical contractor's operatives quickly identified all relevant areas within the customer's property to be accessed during the installation works
- The domestic electrical contractor's operatives, using an agreed Safe System of Work, proceeded to perform relevant property specific Risk Assessments, and make the relevant work areas safe, by barriers or equivalent
- The EMMA and associated components, were installed in the agreed location both mechanically and electrically, paying specific attention to the customers property. The customer was engaged throughout the installation process, and advised when the power would be interrupted/re-instated, with disruption kept to a minimum
- Post installation, the work areas were cleaned and left as found, with all waste materials removed to the domestic electrical contractor's vehicle, for eventual recycling, where possible.
- The EMMA was then fully commissioned using a comprehensive commissioning form, detailed below, and installation photograph(s) taken for SSEPD records.
- The customer was then given a full demonstration of the EMMA and encouraged to operate and understand the unit. The customer was also supplied with a bespoke operating manual, further detailing the operations of the EMMA
- After a time period, typically no later than 60 days, the domestic electrical contractor revisited the 30 installed EMMA's to confirm that all were full functional and that they met the customers expectations

The following information was then forwarded to the NTVV Team:

- Customer name and address
- Contact details
- EMMA serial number
- Survey date
- Installation date
- Revisit date

A complete schedule of the 30 installed EMMAs can be seen in **Appendix 1 Schedule of 30 Installed EMMAs.** A sample of the commissioning form is shown below:

NTVV Thermal Storage – Commissioning Form

SSE

Project Title	NTVV Thermal Storage (EMMA – Commissioning)	**Job No.**	3555
Client	SSE Power Distribution (Future Networks)	**Contact**	37070
Prepared By	Mark Coulthard	**Date**	

1 - Scope of Works	EMMA module Commissioning (ref' Method Statement 003 Rev' B)
2.1 – Serial Number **2.2 – Location of Unit**	
3 – Site Address (*to include postcode*)	

4 – Mechanical Tests			
4.1 – EMMA secured to the wall	Secured with 4 fixings and washers	YES	NO
4.2 – EMMA Cover secured (Stuffing Glands tight)	Secured with 4 unit fixings	YES	NO
4.3 – Consumer Unit Cover secured	Secured with manufacturer fixings	YES	NO
4.4 – Consumer Unit Extension/Gland box secured to the wall (Stuffing Glands tight)	Secured with 2 fixings	YES	NO
4.5 – Consumer Unit Extension/Gland box cover secured	Secured with manufacturer fixings	YES	NO
4.6 – Boost Button Back box secured to the wall (Stuffing Gland tight)	Secured with 2 fixings	YES	NO
4.7 – Boost Button switch assembled to the Back box (Labelled correctly)	Secured with manufacturer fixings Suitable label attached	YES YES	NO NO
4.8 – Cable Containment secured to the wall and suitably assembled	Self adhesive manufacturer fixing	YES	NO
4.9 – Inverter A.C. Isolator Unit Cover secured	Secured with manufacturer fixings	YES	NO
4.10 – Inverter D.C. Isolator Unit Cover secured	Secured with manufacturer fixings	YES	NO
4.11 – Immersion Heater Connections Cover secured	Secured with manufacturer fixings	YES	NO
4.12 – Boiler Tank Thermostat Connections Cover secured	Secured with manufacturer fixings	YES	NO
4.13 – Photograph of Installation taken for SSE/Ofgem records		YES	NO
Engineer Notes/Recommendations			
5 – Electrical Tests			
5.1 – Confirm Consumer unit main switch is ON		YES	NO
5.2 – Confirm Inverter D.C. switch is ON		YES	NO
5.3 – Confirm Inverter A.C. switch is ON		YES	NO
5.4 – Confirm Immersion Heater Isolation switch is ON		YES	NO
5.5 – Confirm Immersion Heater Thermostat is set to 70deg C		YES	NO
5.6 – Confirm Boiler Tank Thermostat is set to 55deg C		YES	NO
5.7 – Confirm EMMA Blue/Grey plugs are secure and locked in situ		YES	NO

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NTVV Thermal Storage – Commissioning Form

5.8 – Confirm Boost Button functionality – 1 press (30m), 2 press (60m), 3 press (90m), 4 press (120m) & 5 press (0m), as detailed on the EMMA screen	YES NO
5.9 – Confirm 'Heater' parameter is set within System Settings	Kw rating of Immersion Heater -
5.10 – Confirm 'PV' parameter is set within System Settings	PV Kw rating of PV Installation -
5.11 – Confirm 'KWH' parameter is set within System Settings	KWH perceived energy requirement -
5.11 – Confirm 'Orientation' parameter is set within System Settings	Orientation +/- South (180deg) -
5.12 – THINK were the CT's fitted to the correct cables, and connected correctly to the PLC (polarity sensitive)?	YES NO
5.13 – Confirmation of CT connection/operation – Switch ON kettle and note change in Demand (W) figure	Demand figure increased/decreased during kettle switching ON/OFF YES NO
5.14 – Confirmation of CT connection/operation – Press BOOST button and note change in Demand (W) figure	Demand figure increased/decreased during boost switching ON/OFF YES NO
6 – Customer Interaction	
6.1 – Has the Customer been briefed, and supplied with overview sheet(s)	YES NO
6.2 – Any Customer suggestions or confirmation Signature of Installation	Suggestions - Customer Signature -
6.3 – SSE Engineer Signature	Comments - SSE Signature -

Figure 2 – Commissioning Form

2. 4 EMMA Configuration and Data Handling

Under NTVV, the EMMA has a dual role to perform which required the correct configuration of the EMMA during the commissioning activity. The EMMA has been configured to provide the following:

- To maximise the value of PV output by providing the customer with as much ‘free’ hot water as possible without exceeding their normal daily requirement
- To perform an algorithm based limitation of PV energy export to the LV network

To accurately achieve the above, on a case by case basis, the domestic electrical contractor’s operative had to configure the EMMA and record within the commissioning form the following parameters:-

Capacity of the PV array [W_p] – This is used together with a set of hard-coded tables to calculate the maximum daily output from the system. This is used for internal control purposes

Orientation of the PV array – This is used to calculate when the PV array should start and stop generating power. This is also used for internal control purposes

Size of the electric immersion heater [W] – The EMMA uses this together with percentage power being supplied (which it controls) to calculate the amount of energy sent to the immersion heater

Daily hot water energy requirement [kWh] – The EMMA unit needs to know how much energy to divert to the hot water cylinder each day, which is based upon the customer’s determined usage (low, medium or high) and recorded within the original survey form.

The settings are password protected to prevent accidental changes. The full EMMA Installation and Operating Manual fully details levels of accessibility to the unit and is included under Appendix 2 EMMA Installation and Operating Manual.

The key pad and display screen is shown below:

Keypad and display screen

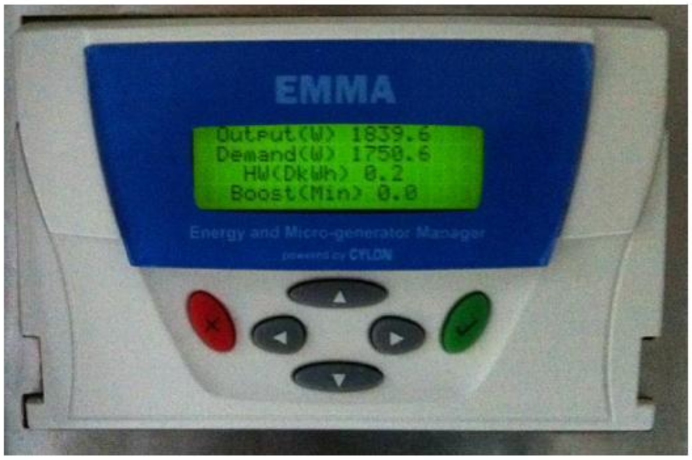

Figure 3 – EMMA Display Screen

The EMMA is a stand alone unit and not connected to any form of external/remote communications system, which as detailed, should ensure a relatively deployable system. Therefore data handling collection and communications with the EMMA is by pre-arranged appointment with the customer, and via an RJ45 connector installed on top of the unit.

All of the installed EMMA's, were re-visited by the domestic electrical contractor during February/March 2014. The purpose of the visit was twofold, firstly to ensure that the units met the customers expectations, and secondly that all were functioning safely and correctly.

The EMMA was accessed, only by trained domestic electrical contractor personnel, via serial connection from a dedicated Netbook to the RJ45 connector. The Netbook contains proprietary software, which enables an authorised user to communicate with the EMMA's controller, to download historical system data and hence confirm operation. Any personal data has been handled in accordance with the Data Protection Act 1998 and the NTVV Data Protection Strategy agreed with Ofgem.

The following photos detail the EMMA with RJ45 connector and a sample of downloaded data:

An EMMA with RJ45 connector is shown below:-

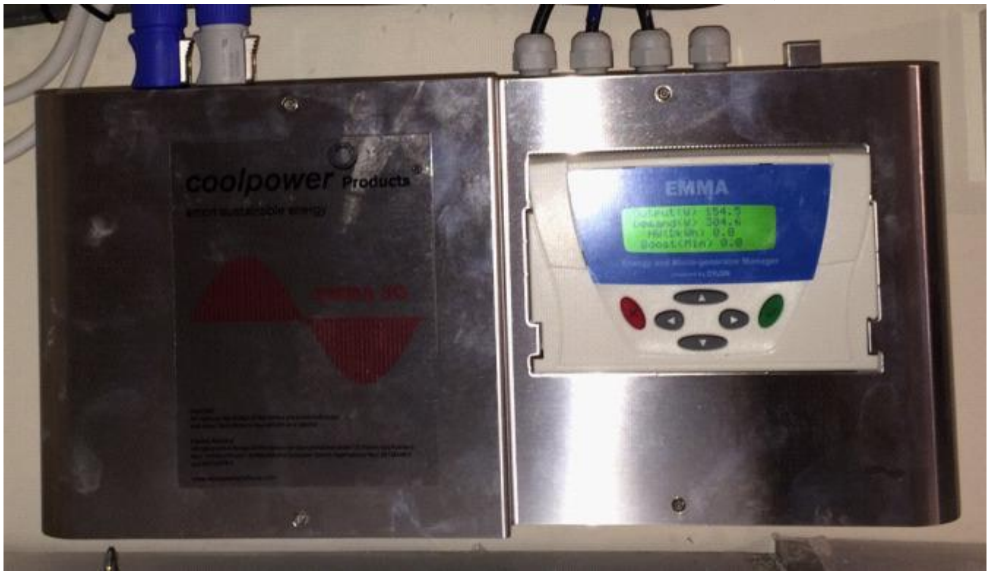

Figure 4 – EMMA RJ45 Connection point

A sample of downloaded EMMA data is shown below:-

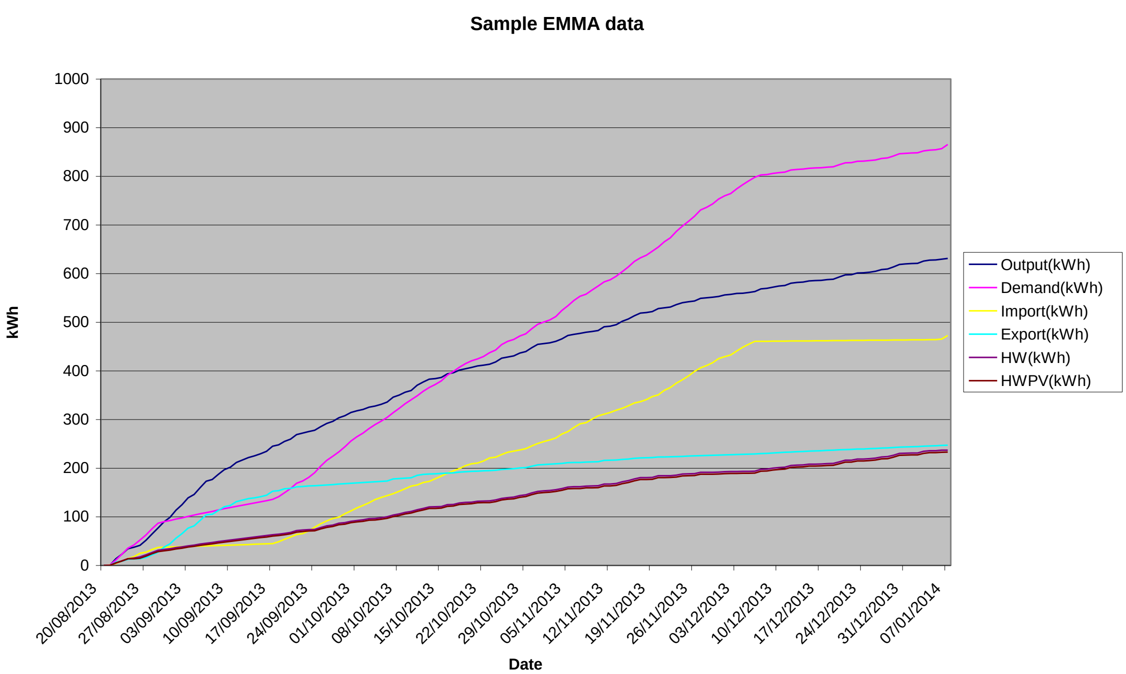

Figure 5 – Sample EMMA data – Summation of kWh's

2.5 Photographs of Installations at Customer Premises

Figure 6, 7, 8, 9 – Installed EMMAs

Additional photographs are available to interested parties and Ofgem representatives are invited to visit one or more properties with the customer's permission where EMMAs have been installed (by prior appointment).

2.6 Site survey and installation findings

Throughout both visits (survey and installation), all of the customers which the domestic electrical contractor and SSEPD engaged with, were found to be very supportive of the NTVV project, its goals, and the purpose of the EMMA units.

During the survey stage, it was found that not all of the properties visited would be suitable for an EMMA installation. The main reasons why the properties did not qualify for installation are listed below:

- The micro generation system (PV system) was too small (less than 1.5Kw)
- The water tank did not contain an immersion heater
- The property did not have an immersion heater circuit
- The EMMA could not be located in a safe/suitable place (typically next to the distribution board, protection from mechanical damage and other ingress)

Below are a couple of photographs detailing an unsuitable location and a water storage tank without an immersion heater.

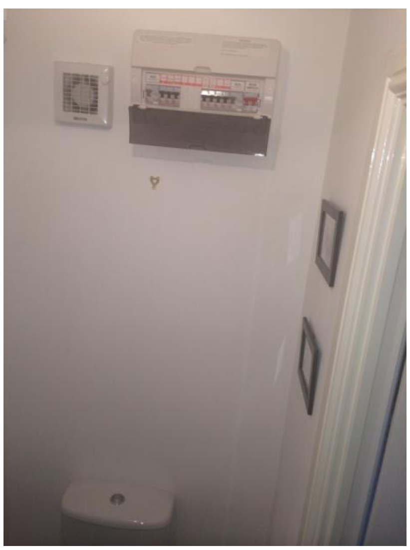

Figure 10 - Inappropriate location (customer toilet)

Figure 11 – No Immersion Heater

During the installation stage, the domestic electrical contractor experienced very few property related installation issues. Where necessary, minor works included rewiring immersion heater circuits, re-positioning electrical accessories (e.g.switches) and installing electrical accessories. The contractor did, however, encounter an issue with three EMMAs failing to power up correctly and some minor issues with current sensing transducers.

The units which did not power up correctly were replaced during the installation phase, and returned to the manufacturer for analysis. SSEPD is currently awaiting the outcome of a full Failure Mode and Evaluation Analysis (FMEA) for these units. With regards to the current sensing transducers, again these were replaced during the installation and returned to the manufacturer for analysis. SSEPD is currently awaiting a report of findings.

Figure 12 - Current Sensing Transducer

3 Active Operation of Systems

3.1 EMMA Standalone operation

For ease of installation and use, the EMMA has been designed as a Standalone unit, with benefits detailed previously. The EMMA is not connected to any form of external/remote communications, and does not require any regular calibration(s) or maintenance.

The EMMA is a compact solid state unit, designed to be installed as close to a customer's distribution board as possible. During an installation, the immersion heater circuit within the customer's distribution board is reconfigured so that the circuit breaker/fuse provides a mains supply to the EMMA, and the output from the EMMA is connected to the immersion heater cable. Using two current sensing transducers, clipped around the mains incoming cable and the micro generation (PV) incoming cable, the EMMA will accurately 'pulse' electrical energy to the immersion heater, thus generating hot water within the customer's storage tank, whilst reducing peak generation to the LV network.

The EMMA uses a Programmable Logic Circuit (PLC) controller incorporating proprietary software algorithms, to switch energy on and off to the immersion heater through solid state switching components. The adaptive algorithm 'learns' micro generation (PV) output versus changing customer demands, and continuously varies the amount of energy supplied to the immersion heater during the day, to ensure that the required stored kWh of energy is achieved.

The EMMA has largely been designed to operate 'out of the box', with minimal setting up being required. The domestic electrical contracting operative is only required to set four parameters, as detailed in depth on page 16 of this report. Once these parameters have been set, then the EMMA will operate without further technical interaction.

Appendix 3 EMMA Drawings, details connection of an EMMA to a customer's distribution board, including current sensing transducers.

3.2 Customer interaction with the EMMA

Customer interaction with the EMMA, is important for a successful Thermal Storage trial under NTVV. As detailed within earlier sections of this report, the customer is engaged at the point of survey and the point of installation, with an overview and demonstration being provided, respectively. The customer is encouraged to understand the below parameters and understand their usage versus generation and storage.

As detailed above within section 3.1, the EMMA is a standalone unit although the customer is able and encouraged to interact with the EMMA through the controller (screen and buttons). Critical system settings are password protected, although it is possible for the customer to access various sub menu's in addition to the EMMA display screen as detailed below:

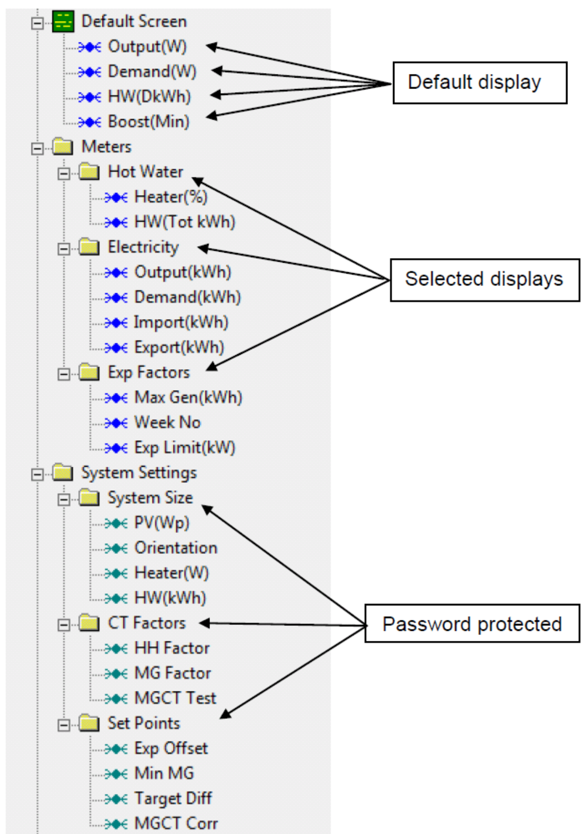

Figure 13 – EMMA Menu Structure

The above sub menus will enable the customer to access various parameters, which are detailed in more depth within Appendix 4 EMMA 3G SSE unit User Leaflet – 141213.

4 Data Capture

4.1 Sample Data

Interim data has been obtained from all of the 30 installed EMMAs. This data, where relevant, has been supplied to the SSEPD NTVV Project Team, to confirm that the EMMAs are functioning correctly and as a start point for data analysis for SDRC 9.8 (a) later this year. A sample of the data can be seen on page 18, with further data available upon request to all interested parties

4.2 Review of Data

Specific review of the above data is not required for this SDRC report, although the data was used as a confirmation of correct operation of all of the EMMA's, and archived accordingly. Review of the data with trending analysis will be provided under SDRC report 9.8 (a) later this year.

5 Review of Installation Method

5.1 Installation Rates

To achieve an efficient installation success rate the installation team made arrangements for access to best suit the customers. On a typical working day, two appointments were made for the installation team, typically one installation in the morning and one in the afternoon.

The average time spent to fit a single device was approximately 3.5 hours dependent upon ease of installation, and includes travel to and from site. Note that two operatives were required therefore each device took 7.0 operative hours to install. With the customer's prior agreement, all of the EMMA installations were carried out during normal working hours (09:00 to 17:00 hours), which enabled a consistent installation unit rate throughout.

6 Review of Reliability

6.1 Reliability of EMMA's

There have been no reported reliability issues with the EMMA 3G SSE units commissioned into service during the period of operation to date.

7 Lessons Learnt – application to subsequent trials

The process of deploying the 30 EMMA units was very successful, and was aided greatly by customers with a keen interest in the purposes of the NTVV project. At an early stage in the process SSEPD spent quite some time with the individual customers, both by telephone and by home visits/surveys which were found to be beneficial to the customers, the electrical contracting company and SSEPD for later installation.

The installation/commissioning and revisits to the 30 EMMA units were largely without issues, although some properties required minor electrical works to enable connection of the EMMA to the property, the immersion heater circuit and subsequent electrical accessory relocation and connection. All of the EMMAs were retrofitted to existing properties, although a future approach may be to install any subsequent EMMA's to 'in/new build' properties, where the installation should be simplified greatly.

Under the next stages of the project, EMMA 4G models will be used. This newer unit has improved power quality characteristics and splits the unit into two smaller units rather than one unit. This will have similar functionality to the EMMA 3G SSE unit, although should be simpler to install which will benefit all parties. This simplicity should make the new 4G model even more deployable, should a DNO identify a network constraint issue due to PV output, or require a relatively timely LV network trial of this solution.

8 Appendices

Appendix 1 Schedule of 30 Installed EMMA's

See separate document attached.

Appendix 2 EMMA Installation and Operating Manual

See separate document attached.

Appendix 3 EMMA Drawings

See separate document attached.

Appendix 4 EMMA 3G SSE Unit User Leaflet - 141213

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