3 Components

3.1 Introduction

1 This section outlines the various components, or constituent parts, that will be brought together, in combination, in a test cell in order to prove a given Learning Outcome or Outcomes. Each component represents an entity that will have been subject to development in its own right. Throughout the trial we aim to use components that are available on the market (i.e. not in the early stages of R&D as defined by their Technology Readiness Level).

2 In this context, components include:

- **Monitoring Systems** – the various physical devices that will be used to measure changes on the electrical network. Delivery of the planned tests will require monitoring of voltage, current and other load characteristics experienced by elements of the network operated by the DNO through to customers' mains supply and specific installed Consumer Equipment.

- **Consumer Equipment** – the novel electrical items located within a customer premises; be they industrial, commercial or domestic. For example in a domestic property the equipment could be a type of load (e.g. an electric vehicle, smart fridge-freezer, heat pump, etc) or a form of generation (microCHP, PV, wind, etc).

- **Commercial Solutions** – the market mechanism by which a commercial solution is embodied (e.g. a tariff, etc).

- **Network Equipment** – a physical engineering technology or system that will sit on the electricity network in order to manage assets or conditions (e.g. Enhanced Voltage Control, Real Time Thermal Rating, Energy Storage, etc).

- **Control Systems** – the systems employed to manage and monitor dynamic network response to loads (whether actual or simulated). It encompasses the control system that sits on the DNO side and the interface with the customer side solution.

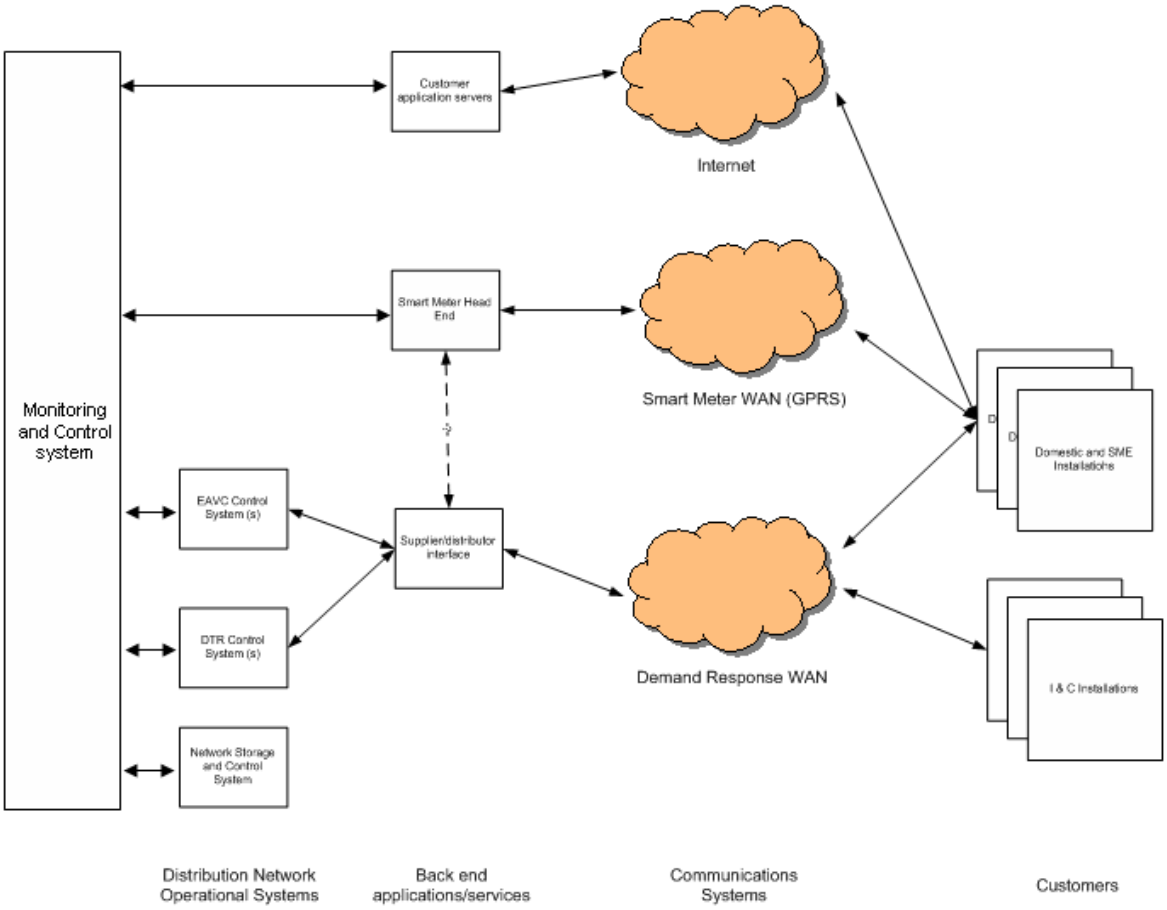

Figure 1. System Overview

3 Figure 1 shows an overview of the overall system comprising:

- Distribution Network Operational Systems
    - These are the link to the upstream DNO network and call upon the active network functions e.g. voltage control / thermal control / energy storage.
- Back end applications/services
    - **Meter system head end**: Manages the installed meter base
    - **Customer application servers**: Provides web and data collection services

- **Supplier / distribution interface**: Manages the transmission of real time distribution demand state to customer response systems. This may ultimately be included in the metering system but is impractical to integrate at this stage as requirements are not yet established

- Communications Systems
  - These provide the interface between network / supplier systems and customer systems. It is anticipated that there will be three main interfaces:
    - **Metering**: (read data, set tariffs etc)
    - **Demand control**: transmit real time demand status to demand response systems
    - **Information**: non critical communications to customers or data retrieval from customer equipment via broadband or related means

- Customers
  - **Domestic / SME:** It is anticipated that these two customer groups will select from the same range of services and components.
  - **I & C:** These will be larger scale customers with different 'appliance' and control requirements as well as different meter types to domestic / SME. However it is anticipated that the same demand transmission means would be used for all customers. I & C installations will not be generic and so will be dealt with on a case by case basis

4 The specific types and groups of components required are derived from the test cell matrix (see methodology, section 8.7 'Summary of Customer Numbers').

3.2 Monitoring

3.2.1 Where monitoring is likely to be applied

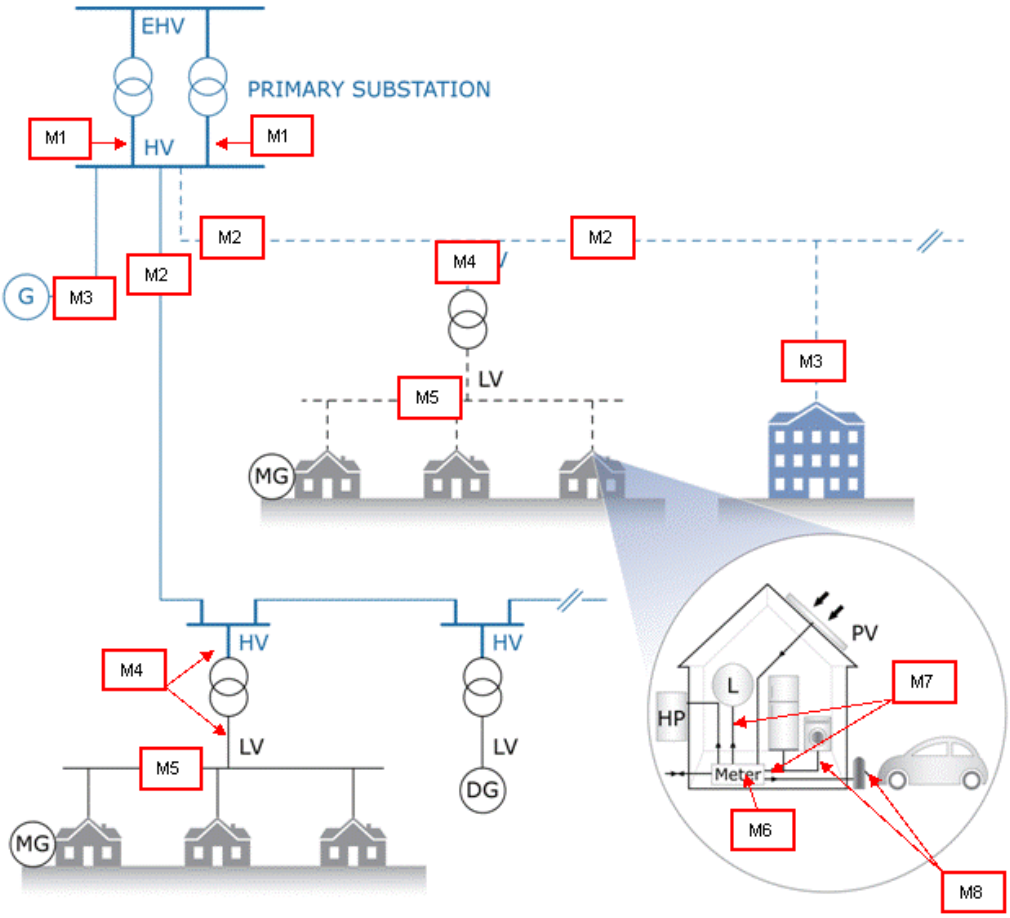

Figure 2. Monitoring topology

5 Overview of monitoring in a conventional system (pre-smart metering roll-out):

- **Primary transformer**: Monitored in real time and presented in the DNOs SCADA system. Half-hourly data extracted into a DNO planning database.
- **11kV (HV) feeder**: As Primary transformer.
- **HV customer**: Generally metered on a half-hourly basis, using metering class CTs.
- **Secondary transformer**: Not typically monitored. Possibly some limited visibility where automation / telecontrol equipment is located.

- **LV feeder**: No monitoring
- **LV cut-out**: No monitoring from the DNO, meter readings taken from Supplier on quarterly basis.

- **LV ring-main**: No monitoring from DNO nor Supplier.

- **Appliances and other consumer equipment**: As LV ring-main

3.2.2 What to monitor

6 Time stamped / synchronised analogue information:
- Current: Amps
- Voltage: Volts
- Power: kW, kVA, kVAr (calculated from Amps and Volts)
- Power Quality:
    - Power frequency
    - Magntiude of Supply Voltage
    - Flicker
    - Supply Dips/Swells
    - Voltage Interruptions
    - Unbalance
    - Harmonics

3.2.3 Types of monitors available

7 Measurement systems that are used to observe and validate the LCNF trial should be developed to conform to IEC 61000-4-30 (Power quality measurement methods). The purpose of the standard is to define measurement methods that are able to deliver reproducible and comparable measurements across different organisations and with different instruments. Measurements that conform to this standard can be described by 3 classes.

Class A - when connected to the same signals, these devices will produce the same results. Class A instruments must meet the highest performance and accuracy requirements in the standard.

Class S - performance requirements are useful for statistical surveys and contractual applications where there are no disputes. Accuracy and performance requirements for Class S are less stringent than Class A.

Class B - requirements are useful for qualitative surveys, troubleshooting applications and other applications where low uncertainty is not required. Class B instruments will produce useful, but not necessarily accurate, results.

8 In context of the trail, statistical data must be collected using either a class A or S system this will be referred to as high spec.

9 In addition to power quality measurements customer load data is also required to quantify changing customer load/generation profiles and how these will be influenced by the trail. These devices will be referred to as low spec.

Table 1. Overview of monitoring components

MONITORING OVERVIEW		A - High Spec	Estimated Deployed Cost (£k)	B - Low Spec	Estimated Deployed Cost (£k)
M1	Primary transformer	UNIPOWER - UP-2210 Dewetron - Dewe-821/820 Dranetz - Encore Fluke 1760 Large multi channel devices designed for direct integration into SCADA systems.	15-20	Existing DNO Monitoring and SCADA	-
M2	HV (e.g. 11kV) feeder				
M3	HV customer (I&C)		10-15		
M4	Secondary transformer	PSL - PQube Elspec - G4000 Compact multi channel devices. Data can be stored locally or integrated into SCADA networks through an RTU	5	Clamp on Line monitor equipment and RTU	2
M5	LV feeder				
M6	LV cut-out			L&G E470 (or later version) Smart Electricity Meter. Measurements : power, voltage and power quality. AlertMe Energy. Measurements : Power monitoring via current clamp.	0.5 .25
M7	LV ring-main			Clamp on Line monitor equipment and RTU	2
M8	LV appliance			Alert Me Smart Plugs. Measurements : Power monitoring and logging for individual appliances	.25

10 Estimated deployed costs used in the above table have been based on known unit costs of monitoring equipment and estimated installation costs but do not include ongoing cost associated data gathering.

3.2.4 Monitoring Equipment

3.2.4.1 M1 – Primary Transformer

Description

11 Amps: Typically monitored using metering class Current Transformers (CTs) transferred in, near to, real time and presented in the DNOs SCADA system. Half-hourly data is typically extracted into a DNO database and used in for network design / planning purposes.

12 Volts: Busbar voltage (secondary winding side of the transformer – i.e. HV network) monitored using metering class Voltage Transformers (VTs) transferred in, near to, real time and presented in the DNOs SCADA system. Half-hourly data is typically extracted into a DNO database and used in for network design / planning purposes.

13 Power quality: Fault recorders are becoming increasing common in UK distribution substations.

3.2.4.2 M2 – HV Feeder

Description

14 HV Feeders are typically monitored at the Primary substation in a similar manner as the Primary Transformer. Feeder current is generally measured using CTs located in the HV switchgear – these are generally the same CTs that are used for the feeder protection, and hence a slightly lower grade of monitoring class to metering CTs (eg. Class X). It is typical for each feeder to be monitored at this point and for the information to be presented to the DNOs SCADA system. Again, half-hourly data is typically extracted into a DNO database and used in for network design / planning purposes.

15 Typically few measurements are taken along the length of a HV feeder. Exceptions may include: locations where automation / telecontrol are installed, or through the use of conductor mounted transducers (e.g. embedded in Fault Passage Indicators) on key sections of HV overhead line.

16 The numbers and exact locations of monitoring equipment deployed in the project will be dependent on the specific network topology, e.g. load / generation distribution along a feeder. For the purposes of the trial, it is reasonable to assume a minimum of 2x measurements along a feeder.

17 It is not usual for power quality monitoring to be deployed to HV feeders.

3.2.4.3 M3 – HV Customer

Description

18 Metering class CTs and VTs are used to measure volts and amps for HV connected customers (with metering class accuracy dependent on the size of

the load). It is typical for HV customers to be metered on a half-hourly basis, with the information provided to both the Energy Supplier and DNO.

19 Half-hourly data is typically extracted into a DNO database and used in for network design / planning purposes.

3.2.4.4 M4 – Secondary Transformer

Description

20 The vast majority of secondary transformers are not closely monitored. It is typical for ground mounted substations to include a basic maximum demand indicator (analogue dial with a manually reset high-set needle), but these are not taken back to the DNO control room in real-time. Readings will typically be taken when the substation undergoes its legal and licence inspection (e.g. once per year).

21 It is not typical for pole mounted substations to be monitored.

3.2.4.5 M5 – LV Feeder

Description

22 Not typically monitored.

3.2.4.6 M6 – LV Cut-Out Metering

Description

23 The metering system incorporates separate electricity and gas meter and in home display to provide fiscal metering of customer energy use. The meter system uses GPRS for WAN communications to the utility head end and ZigBee SEP for communications between meters and with the in home display.

24 The electricity meter supports time based tariffs enabling a sophisticated tariff profile to be set if required. It provides a profiling function to capture detailed overall demand data.

25 The capabilities of the meter for any demand based response during this trial are likely to be limited until this becomes part of the 'standard' meter functionality and so it is anticipated that alternative systems will be required to provide active demand management.

26 The standard in home display will give the consumer basic energy use, cost and CO2 information. More advanced displays will be optional, providing additional information and services.

3.2.4.7 M7 – LV Ring Main (Log Volts, power, power quality, etc)

Description

27 A data logging system that will be used to capture voltage and power quality parameters. This will be used to assess network impacts of new load and microgen equipment and would be used to determine aggregate effect of harmonics from loads with significant harmonic content and 'flicker' due to power cycling of high loads such as heat pumps

3.2.4.8 M8 – LV Appliance (Log high & low power)

Description

28 A data logging system that will be used to capture demand profiles (power) for individual loads/generation in order to develop a detailed statistical model of demand for different load, customer and building types.

Requirements

29 Measurement units: Average power over logging interval (Watts)

30 Current range:

- o High power version (hard wired devices): 30A Max (heat pumps, EVs etc)
  - ▪ Note – may be OK with lower power version for EV and heat pumps if these are below 3KW. Heat pumps may have high starting peak though
- o Low power version (plug in devices): 13A Max

31 Logging interval: configurable in multiples of 1 minute, typical interval 6 minutes

32 Accuracy: 5% suggested, high accuracy not critical

33 Resolution: 0.1 Watts

34 Data storage:

- o If stand alone version : 6 Months (up to 300K samples)
- o Web downloadable : 2 Weeks (up to 6K samples)

3.2.4.9 Consumer Equipment

35 Figure 3 shows view of the main components that could be included in a domestic or SME installation. Note that this shows all of the potential component types for illustration purposes and installations will normally include only a subset of these.

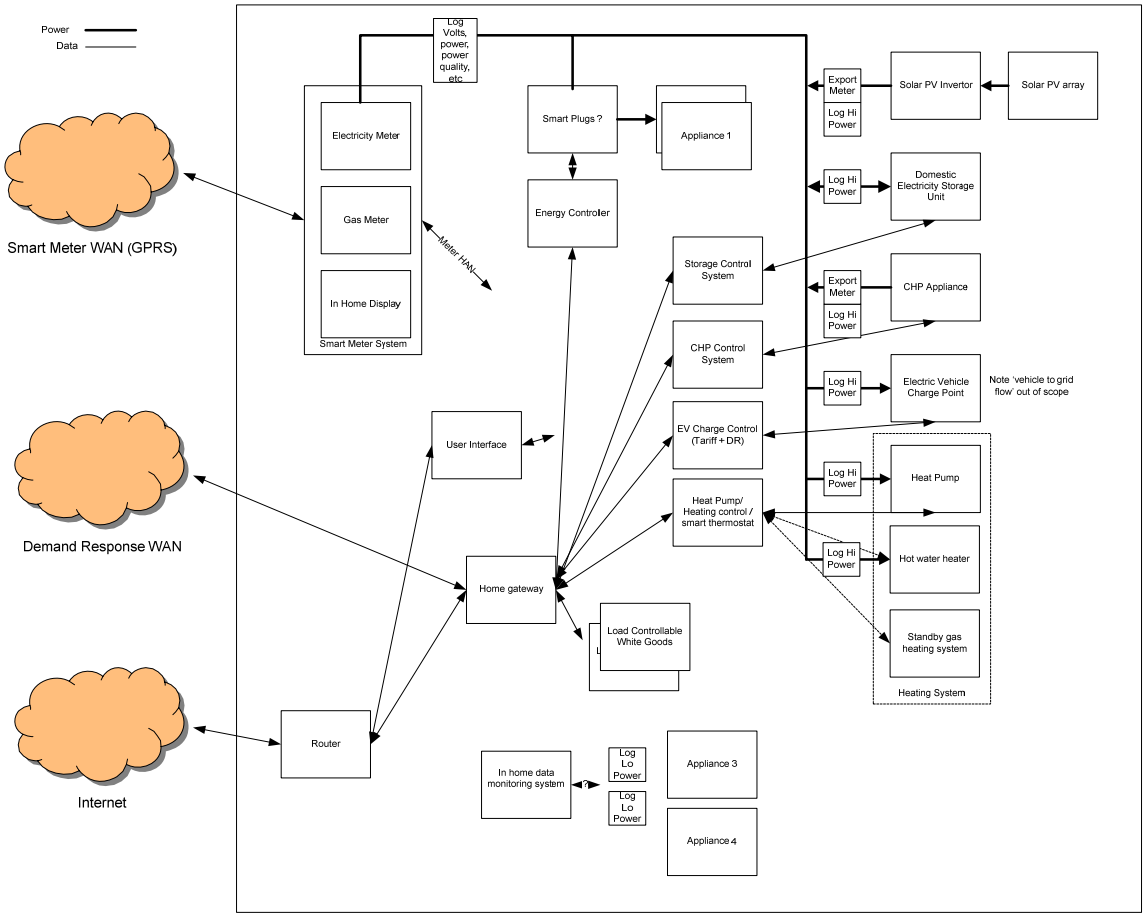

Figure 3. Domestic/SME Installation

36 The components are detailed in sections 3.6.3 onwards. For each component an overall description is given along with details of suppliers and an outline of critical parameters. The components are grouped into functionally similar areas

3.2.5 Home/SME Comms

3.2.5.1 Home Gateway

Description

37 This will provide the interface between the supplier and various installed appliances and controls (where this interface cannot be provided through the smart metering system). A number of the appliances and controls may include their own gateway functionality and so a gateway may not be needed for all or there may be more than one gateway. The intention in the project is to take a pragmatic approach and use what is available – future developments would aim for a single common gateway unit. At this stage it would be anticipated that there is a gateway requirement at least for white goods and requirements for others will become clearer in exploring the offerings of each potential supplier.

Requirements

38 WAN interface:

- Demand response (SMS, possible GPRS)
- IP connection for information services and management

39 HAN interface:

- ZigBee 1.0 or later. Smart Energy Profile and / or Home Automation Profile
- Others TBD depending on control/appliance suppliers

3.2.6 Home/SME Appliances and Controls

3.2.6.1 Energy Controller + Smart Plugs

Description

40 There are a number of systems that can be used by consumers to automatically manage energy use, often providing integration across a number of load types. These will control electrical appliances through smart plugs and can also potentially include control of other loads such as heating. Systems of this type, using X10 mains signalling, have been around for a number of years and readily available. Alternatives using ZigBee, Home Plug and other means of communications are also available.

41 This capability could be incorporated into the trial to provide the user with some means to respond to 'static' time of use type tariffs that we may want to test in connection with distribution network operation. The key areas of interest for energy control in this trial will be heating, electric vehicles, microgeneration with white goods as an additional likely option and these are considered separately in the relevant sections of this document. Therefore the

only additional function that a generic energy controller could provide would be through smart plug based control of electrical loads.

3.2.6.2 Domestic Electricity Storage Unit and Control System

Description

42 Domestic electricity storage systems are expected to be available in the near future, Panasonic have plans to market such systems in 2011 with capacity for homes to store up to a weeks worth of electricity. This would enable customers to store grid or micro-generated energy at times of surplus (or low imported costs) and use at peak times within the home and so would be expected to provide some significant load profile modification capability. Time of use and peak tariffs shaped for the DNO would be expected to encourage customers to use storage in ways that would benefit the distribution network.

Requirements

43 The storage system controls should allow (as a minimum) the user (or service provider) to program the storage system to store and provide energy in line with time based tariffs provided to the customer.

44 Ideally it should be able to respond to energy tariff information automatically transmitted via the metering system (ZigBee SEP interface).

45 The storage system should be able to respond to a demand signal (direct demand reduction/increase or price based) that will cause it to go into a %storage or % output mode such that utility or service provider could access the unit for demand response (for both voltage and thermal control purposes).

3.2.6.3 Solar PV array and Inverter

Description

46 With present solar PV technology a 10-15 square metre array on a roof will generate around 1.5KW Peak (the average is much less) and provide about a third of the annual energy required by the home. In the UK an ideally positioned system would typically generate 750KWh per KWp per year i.e. 1KWp corresponds to 85W average continuous power if the energy could be stored and provided at a constant rate.

47 Solar PV is of importance to this project in determining voltage impact on the distribution network.

48 Section 3.2.6.5 covers solar PV canopies for vehicle charging.

Requirements

49 There are no particular requirements on the solar PV array as far as this project is concerned. The main requirements are around the inverter and control capability for this so as to provide a means where utility or service

provider could (ideally) reduce or shut off power generation under certain conditions.

50 It is not believed that power reduction is presently available but turning off/disconnecting could be possible as microgen systems have to provide shut off in case of power outage anyhow so is potentially extending this capability.

51 Ideally any energy not delivered to the network would be diverted for other purposes. A possible option here is provided by Cool Power Products. Their 'EMMA' product range comprises various control units that can be used to manage diversion of PV (or other microgeneration energy) to storage (e.g. hot water storage). The system can be used either to balance local generation and demand so as to minimise energy export, or can be used for grid voltage stabilisation where the unit will modify the level of energy exported depending on the network voltage so that export is minimised when network voltage is high. This is likely to be a better control strategy than sending control signals to customer equipment as the communications response times need to be quite fast (2 minutes – see section 3.6.4). Incentives may have to be provided to customers to encourage use of this approach so that the customer will benefit from using energy locally rather than export under defined conditions.

52 The ideal arrangement would be a ZigBee SEP or other interface with means to receive power shut off signal from a home gateway.

3.2.6.4 Combined Heat and Power Appliance and Control System

Description

53 CHP appliances provide space and hot water heating plus electrical power outputs from a natural gas input. Two main technologies exist for this type of product:

- Stirling Engine/generator combination
    - Established products exist for domestic installation (e.g. Whispergen). These have a high heat to electric output ratio (5:1-10:1) and generally suit only large high heat load premises
- Fuel cell
    - Products are under development and trial. These have a heat to electric output ratio around 1:1 and suit a much wider range of building types than the Stirling engine type.

54 It is proposed that the trial consider only fuel cell based appliances as the Stirling engine technology seems unlikely to gain significant penetration. The proposed appliance has a peak output of 1KW and uses an electrical demand following approach to match the customers real time demand as far as possible. Appliances are expected to be available for customer trials mid-2012.

55 Fuel cell CHP appliances are designed to generate all of the heating and hot water and the majority of the electricity needed by a typical UK home, matching daily and seasonal energy demands all year round and substantially reducing the need to buy electricity from the network. The appliance is a direct replacement for a normal boiler, using the same connections and with similar installation and maintenance requirements

56 The appliance provides overall a much more efficient use of energy than central generation as there is no waste heat and transmission/distribution losses are avoided. Such appliances can save the consumer around 25% of total energy costs, and reduce each home's CO2 emissions by up to 2.5 tonnes per annum in the UK.

57 This is an innovative technology and must be considered that there is some risk of delays around its availability.

Requirements

58 The system should provide an interface that can respond to:

- Respond to network demand signals so that generation could be increased to alleviate the impact of high demand
- Respond to network voltage signals so that generation could be reduced to reduce effects of over voltage through microgeneration
- Allow specifying a particular demand profile for the appliance that will optimise its operation for both customer and network operation

3.2.6.5 Electric Vehicle Charge Point and Controls

Description

59 Niche electric vehicles have been around for a few years (e.g. Reva G-Wiz ; 50 mile range and full charge of 10KWh in 8 hours). Most major vehicle manufacturers will be bringing out various electric vehicles in the next few years ranging from hybrid through plug in varieties. An example is the Nissan Leaf which roughly doubles the above range of the Reva (and hence double the charge required) and includes fast charge drawing 10's of amps.

60 Time of use and peak tariffs shaped for the DNO and applied to EVs are of particular interest in this project so as to discourage significant peaks through simultaneous vehicle charging.

61 It is not anticipated that this project will include vehicle-to-grid discharge so EVs will be purely load and demand response based

Requirements

62 While many vehicles can be plugged in to a 13 Amp socket, these sockets are not recommended for new installations. Industry guidelines (www.ev-

network.org.uk) indicate that IEC 60309-2 single-phase, 230 Volt, 16 Amp socket, BS4343 or CEE17 should be used. The splash-proof IP44 is adequate; the water-proof IP67 affords greater protection. These connectors are already widely used in outdoor locations such as caravan parks and marinas, since they are more robust than a domestic plug and are designed for outdoor use. They are available from a wide range of manufacturers and suppliers.

63 There are no particular requirements on the electric vehicle itself other than it is a plug in type. A range of different vehicle types would enable understanding the profile variations from different change levels. Both slow and fast charge systems would be desirable so as to understand the range of network impacts from these.

64 The charge control system should allow (as a minimum) the user (or service provider) to program the charge system to charge the vehicle in line with time-based tariffs provided to the customer

65 Ideally, it should be able to respond to energy tariff information automatically transmitted via the metering system.

66 The charge control system should be able to respond to a demand signal (direct demand reduction or price based) such that utility or service provider could access the unit for demand response for thermal control purposes. This may be done via a simple signal that enables charging at times determined by tariffs below a set threshold or may be more sophisticated including setting maximum charge power levels available under different tariff conditions as well

67 A further option for vehicle charging would be the use of 'solar canopies' (Romag PowerPark) which provide a charge source for vehicles in public or business parking locations. Surplus electricity can be fed into the grid and so these are potentially also a source of additional network voltage control issues but these may be offset by reduced loading on the grid for charging. Pricing strategies could be used to encourage charging at times best for grid optimisation. A typical panel produces 1.7kW peak and can provide 1100 to 1400 KWh per annum depending on UK location (100+ full charges for a small EV)

3.2.6.6 Heat Pump

Description

68 Impacts of electric heating on the distribution network and capabilities to modify the impact of these appliances are key areas of interest for the project. There are three main types of heat pump system and their relevance to this project is outlined below.

- Ground source
    - Likely to be a small proportion of the trial installations as significant installation costs and will likely be on new build where distribution network can be designed for expected loads.

- Air to water
    - Would be expected to be the main impact as can be retrofitted to wet CH systems so would be prevalent in existing build where impacts on distribution network are more significant
- Air to air
    - More likely on new (and smaller) build as not easy to retrofit air ducting to existing properties. As with ground source this enables the distribution network to be sized appropriately.

69 Heat pumps are only suitable for buildings with low to medium heat loss, say below 10KW heating requirement so are unlikely to be found in housing developments with large or old properties. Input power ranges generally 1.5-3KW for 5-10KW out.

Requirements

70 There are no particular requirements on the heat pump itself other than the possibility of providing some form of demand response and this can be achieved through a 'smart thermostat' used as part of the heating control system, external to the appliance itself. However, to achieve demand response requires reducing the input to the appliance there are benefits in the appliance installation design allowing for this through (for example) some thermal storage and reducing heat losses for the building itself.

71 In future there will be appliances with variable speed compressors that could become part of the demand control regime.

72 It will be beneficial in the project to work, preferably with BGs heat pump supplier to address the points discussed here.

3.2.6.7 Heat Pump/Heating control/smart thermostat

Description

73 A key component around electric heating load management is a control system that will enable the operation of the heating system to be adjusted to respond to distribution network requirements and provide demand response. The main purpose of the controls will be to control electrical (heat pump) based heating systems but secondary areas would be to transfer heating demand to gas appliances (if air sourced heating was retrofitted to a gas system and the gas appliance is left in place).

74 Control capabilities for electric water heating will be an additional area where meaningful demand response and profile shaping could be achieved.

Requirements

75 As a minimum the system will provide standard room and water temperature sensors and heating / hot water demand outputs for the heating appliance.

76 It should provide a more complex time profile to be set up than traditional controls such that a series of operating time bands and temperatures can be coordinated with tariff profiles set to optimise distribution network performance.

77 It should include demand response capability where external network demand (or price) signals will reduce the target temperatures to effectively reduce the appliance demand.

78 The user should be able to override any demand response if required but this will be recorded and may incur some penalty.

79 A simpler version of the control with a single load control output will be used to control electric water heating in the same way.

3.2.6.8 Standby gas heating system

80 This would simply be an existing heating system with additional controls to allow gas / electric options.

3.2.6.9 Hot water heater

81 This will simply be an existing electric hot water system with additional controls fitted.

3.2.6.10 Load Controllable White Goods

Description

82 A number of manufacturers are developing appliances with capabilities for energy management functionality and load control via home area network interface to the appliance. These are typically washing and refrigeration appliances. HAN based communications enables optimising the energy profile of the appliance to suit external drivers such as energy price or demand signals. White goods are responsible for about a third of domestic electricity consumption and significant numbers of appliances could provide meaningful demand response.

83 This approach is being trialled at present in the UK using refrigeration to provide frequency response to central generation. Frequency response is not distribution driven and so implementation of a response at the distribution level requires a specific response request, or profile shaping, to be addressed to appliances in selected parts of the distribution network.

Requirements

84 White goods appliances with HAN interface (ZigBee SEP preferred).

85 One or more of the following capabilities:

- Functionality to provide real time demand response through HAN signals reducing/increasing load
- Functionality to optimise the appliance operation against tariff signals
- Functionality to provide a 'shaped' profile over the day, for example to match distribution network demand limits.

3.2.7 Customer Systems Supply and Costs

86 The consumer equipment section so far has described the various components that would comprise a customer installation. This section outlines the potential suppliers of these components and gives some indication of pricing.

87 In a significant number of cases the components will be provided by a supplier as part of a system. The document has described the individual components to give some idea of the content and structure of the customer installations, but where these are delivered as part of a system then this is provided in the 'Smart Home' Energy System table following the component implementation table below.

Component Implementation		
Component	**Unit cost**	**Comments**
Gateway	See smart home sys. Table	Integral component of 'smart' home energy system
Energy controller / Smart plugs	See smart home sys. Table	Integral component of 'smart' home energy system
Domestic Energy Storage	NA	Not implemented in this proposal
Solar PV	£11K	Fully installed cost
PV Controls	£1364	Equipment cost including comms for monitoring
CHP and control system	£12K	Specific appliance and control from OEM. 2012 Installed cost. Will reduce to £6K 2013
EV Charge point and controls	£1,000	Estimate
Heat Pump	£7K	ASHP fully installed cost
Heat Pump/Heating control/smart thermostat	See smart home sys. Table	Integral component of 'smart' home energy system
Load Controllable White Goods	£660	Per appliance, assuming fridge and washing machine are installed This cost includes gateway and appliance comms costs too
Customer application servers	See smart home sys. Table	Integral component of 'smart' home energy system
Meter Head End Systen and Smart Meter WAN	NA	BG Specific system, part of BG Smart Meter Implementation
Supplier / distributor interface	See smart home sys. Table	Integral in the energy management systems discussed
Demand Response WAN	See smart home sys. Table	Integral component of 'smart' home energy system

88 The following table summarises costs provided by suppliers for the 'smart home' system and these are used in the overall project costings.

Smart Home Energy System		
Item	**Cost, per customer (£)**	**Comments**
Hardware	649	Includes any configuration and test, per unit
Installation	225	
Maintenance/update visit	75	
Decommissioning	225	
Service costs (help desk, tech support)	555	Note this is 3 years

3.3 Commercial Components

89 This section describes the structure of the commercial components required to underpin the integrated trials described in Section 8.0 – Methodology. They will be used either individually or in combination with other commercial and technical components to develop new customer propositions designed to encourage customers to actively participate in the transition to the low carbon economy.

3.3.1 Energy Supply Tariffs

90 It is envisaged that a range of energy supply tariffs will be utilised within the project either on their own, or in combination with other commercial and technical components, that will provide customers an incentive to reduce peak demand and alleviate constraints on the distribution network. Typical examples are:

3.3.1.1 Static Time of Use (e.g. Economy 7)

91 These are designed for customers who can change their consumption patterns to make use of a fixed period of "off peak" electricity, normally 7 hours overnight. Typically they are designed for use with electric storage heating and/or electric water heating (and increasingly in the future EV charging, heat pump operation) however they will also benefit customers who can move a significant portion of their discretionary load such as washing machines, dishwashers to the off peak period. The differential in unit price between normal and off peak is typically 2.5:1.

3.3.1.2 Dynamic Time of Use (e.g. Economy 10)

92 These tariffs offer greater flexibility as to when, and for how long, the controlled circuits are energised throughout the day, week and time of the year using dynamic radio teleswiching. Typical tariffs would include an off peak period of 7 hours overnight with a 3 hour off peak boost in the mid afternoon. Currently around 1 million customers have a dynamically switched

supply tariff using this communication technology, but the ubiquitous deployment of smart metering could enable them to be introduced in the wider domestic sector. They more closely align the unit price to the generation and network costs/constraints of providing electricity to the customer at the particular time they wish to consume, and again would include normal and off peak differentials of around 2.5:1

93 A further development of Time of Use pricing introduces additional price bands e.g. peak, normal and off peak, where typically the unit price during the peak period would be 70% higher than the normal rate and about twice that of the off peak rate[1]. They can therefore be used to provide sharper price signals, closely linked to the costs associated with operating the electricity system, that provide incentives for customers to reduce demand in higher cost periods.

3.3.1.3 Critical Peak

94 These are a further evolution where the aim is to shift consumption away from particularly expensive or high load periods of the day, week and time of year by applying significantly larger differentials between the costs of peak, normal and off peak periods during identified periods. The differentials could typically rise to around 5 times the normal rate1. They can either be scheduled e.g. day ahead, or be more dynamic; in both cases messaging and/or alerts are normally deployed to inform customers of a current and/or impending critical peak period thereby allowing customers the option to move or reduce their consumption accordingly.

95 In addition to tariffs that are designed to reduce peak demand, tariffs can also be used to incentivise a reduction in overall consumption levels. Typical examples are:

[1] Quantifying Customer Response to Dynamic Pricing (California's State Wide Pricing Pilot), A Faruqui and S George, Charles River Associates (May 2005)

3.3.1.4 Multi Tier or Rising Block

96 These are used today to primarily recover supplier fixed costs, both operational and network driven, over an initial block of units consumed. The cost of consumption then falls for consumption of units over the initial block.

97 It is possible to use this in reverse by introducing a rising block tariff that dis-incentivises customers from higher consumption by increasing the unit price as their consumption goes over the initial block. This concept is not currently popular with customer's, however this may change in the future if customers can perceive it as being analogous to a contract mobile phone rather than a mechanism to ration energy use.

98 In addition to tariffs designed specifically to manage demand, the profiling element of the project will also include customers who are on Un-restricted tariffs. These tariffs are primarily for customers who use electricity for general purposes, and use fuels other than electricity as their main form of heating and hot water.

3.3.1.5 Direct Control

99 In the US, Australia and other markets, customers are offered a tariff rebate in exchange for submitting their air-conditioning load (which dominates the need for generation capacity) to direct control by the local utility. Typically, a pager-like signal increases the thermostat setting and hence reduces the duty cycle.

100 There is scope to apply this kind of approach in GB, offering to share with customers the benefit of subjecting some responsive load (or generation) to external direct control. In the Project, our base premise is that suppliers will contract with customers to establish this resource, and use it for energy balancing; distributors will then contract with suppliers for an additional level of this resource for local network balancing.

3.3.2 Demand Response

101 Demand response tariffs are usually designed to support the deployment and control of specific technologies (white goods, air conditioning etc.) in the active management of the grid. The technologies are used depending on what they are required for. Typical examples are:

3.3.2.1 Frequency Response – rapid (<10s)

102 In order to keep the system frequency between statutory limits it is necessary to ensure that the overall supply and demand for electricity remains in balance. Industry level mechanisms exist for providing a service to National Grid, however new technology is being developed which can provide distributed frequency response by monitoring the mains frequency and automatically triggering local action in a customer's premise e.g. switch off refrigeration equipment for short periods. The provision of this service will provide an additional value stream (potentially through a reduced unit rate or via a direct credit on their account) that would be integrated into the overall energy product offering.

3.3.2.2 System Energy Balancing – fast reserve (5 min)

103 In order to reduce the requirement for expensive peak generation capacity and offset the variability from renewable generation (particularly wind), demand response provides a valuable resource. This would involve a directly controlled response at a national and/or local level to either switch on or off load (EV charging, heat pumps, water heating, storage etc.) to balance supply and demand as required. Customer's participation would again deliver a value stream that would be integrated into their overall energy product offering.

3.3.2.3 Network Balancing – fast reserve (5 min)

104 In order to avoid the need for unnecessary and inefficient network reinforcement to overcome short term network constraints, demand response also provides a valuable resource. This would involve a directly controlled response at a local level to either switch on or off load or distributed generation (PV, CHP etc.) to alleviate short term thermal and voltage constraints on the network. Utilising customer side resources to manage this would allow the value of avoided reinforcement costs for the network operator to be shared with the customer as part of the overall energy product offering.

Table 1 – Tariff Mapping

	Tariff					
Category	Un-restricted	Static Time of Use	Dynamic Time of Use	Critical Peak	Multi Tier /Block	Demand Response
Profiling	√	√	√	√	√	√
Smoothing (Planned)		√	√		√	
Responsive (Active)				√		√

105 It is envisaged that the energy and demand tariff structures used within the trials will require to be subsidised in order to provide a sufficient level of incentive for customers to participate in actively managing their demand.

3.3.3 Equipment Subsidy and Financing

106 In addition to energy supply and demand response tariffs, the subsidisation and financing of equipment in customer's premises is expected to be central to ensuring engagement and take up of low carbon alternatives.

3.3.3.1 Consumer Self Financing

107 This is where a consumer, or a non commercial body (local energy partnership etc.), finances the provision of low carbon technology such as PV micro-generation or air/ground source heat pumps. The payback periods for these types of technology do not justify the expense of equipment purchase and installation, meaning take up remains low and so the per unit cost remains high. In order to encourage their take up, government have introduced both direct subsidies in the form of up-front payments and through longer term subsidies e.g. Feed in Tariffs (FiT's).

108 The opportunity exists to incorporate the revenue streams generated from FiT's etc. into an overall energy supply package which also recognises the additional value of demand response to suppliers and network operators, allowing greater financial benefits to customers and encouraging the development of innovative commercial structures.

3.3.3.2 Equipment Financing

109 This is where a third party finances the provision of low carbon technology to customers on a commercial basis. These financing arrangements can take into account the long term income streams provided by both FiT's and by demand response tariffs. They may also be used to anticipate further sources of value which may become available as a result of rising levels of controllable load being available for system balancing. To customers this will generally translate as a simpler integrated energy proposition with lower (or no) up-front costs and dependable long term savings or income streams.

3.3.4 Tariff Subsidies

110 The various customer trials planned for this project will offer customers various tariffs to test their response to price signals, with the intention of modifying the customer's energy profile through these tariffs. The types of tariffs and their purpose are discussed in detail in the methodology appendix. The conditions of the proposed trial are 'artificial' in that they are not passing on real network costs and benefits to customers and so it is considered necessary to provide customer with some form of additional incentive in order to motivate the customer to participate in the trial with some modification of their energy usage.

111 BG experience is that customers will generally not change behaviour below an incentive threshold of about £50 per year and so to achieve a reasonable level of response it is believed that customers will need to be enticed by a multiple of this incentive. For domestic customers an incentive of £150 has been proposed. For non domestic customers a value of £500 has been proposed to reflect the proportionally higher energy costs of these customers and hence the need for more significant incentives. These tariff subsidies are included in the costing for each customer tariff trial group.

112 The tariff subsidies have been proposed set at a level we believe will be required to engage customers with the project. The project will test the customer response to different pricing levels and it may be that the full subsidy is not required.

113 It is currently believed that a much lower level of tariff differential would be possible in the long term once mass rollout of the technology and commercial arrangements are established. The trial will endeavour to establish what this level could be through this testing on customer price sensitivity.

3.4 Conventional Network Solutions

114 The distribution network can of course be reinforced by entirely conventional methods to cope with the new disruptive loads and intermittent generation sources presented to it. Such methods have been devised and implemented for essentially passive networks with typically unidirectional power flows and are well established, proven and cost-effective for traditional networks.

115 These conventional solutions can be summarised essentially as providing heavier duty infrastructure to provide greater capacity headroom to cope with all eventualities that the passive network could face with the new loads and generation encountered. They would be achieved by increasing cable sizes and transformer ratings, possibly combined with elements of network reconfiguration where suitable opportunities presented themselves.

116 In some circumstances, such solutions may still be entirely adequate for the range of new loads and intermittent generation that can be predicted for certain parts of the existing distribution networks. In others however, trigger thresholds for expensive upgrades to infrastructure may be incurred by using such conventional approaches, and more sophisticated approaches could be pursued. In such circumstances, application of network solutions already used at higher voltage levels can be contemplated.

Table 2. Excerpt from DPCR5 – Unit costs of conventional distribution reinforcement components

Asset	Units	Cost £k
Services		
OHL - Service Replacement	#	0.40
OHL - Cut-out Replacement	#	0.20
UG - Service Replacement	#	1.01
UG - Cut-out Replacement	#	0.16
Cables		
LV Main (UG Plastic)	per km	98.4
6.6/HV UG Cable	per km	82.9
20kV UG Cable	per km	82.9
Transformers		
6.6/HV Transformer (PM)	#	2.9
6.6/HV Transformer (GM)	#	13.2
20 kV Transformer (PM)	#	0.5
20 kV Transformer (GM)	#	14.4
33 kV Transformer (PM)	#	7.9

Overhead Lines	Units	Poles/km	Per pole	Conductor only	Total Cost £k
Reconductoring and Rebuilding					
LV Main – ABC reconductoring	per km	11.6	0	0.6	16.4
LV Main – ABC Full Rebuild	per km	20	0.6	16.4	28.4
LV Undergrounding (excluding services)	per km	-	-	-	67.2
HV - Reconductoring	per km	11.6	0	0.9	23.6
HV - Rebuild	per km	11	0.9	23.6	33.5

Source: Ofgem - Electricity Distribution Price Control Review Final Proposals - Allowed revenue - Cost assessment appendix

3.5 Novel Network Solutions

117 Although the alternative network solutions considered for this project are novel at distribution voltages, many of these technologies are not new to the industry. In general, many of the elements of the solutions proposed for this project have already been developed and applied satisfactorily at higher voltage levels where loading and power flows have been more complex than has been the case at traditionally distribution levels. The principles and the functionality of these solutions is thus not in question. What is novel, is application at the distribution level, where the case for use of such devices has been less robust in the past, and where network topologies are more complex than at transmission level..

118 Now that distribution networks are beginning to experience some of the problems encountered previously only within transmission networks, thought is now turning to whether such solutions can be applied economically at the distribution levels. Application would clearly entail the provision of smaller, lower cost devices with similar functionality but tailored in capabilities to distribution network requirements. The challenge for manufacturers is to see

this requirement developing and to meet the market with suitable devices that can be produced in adequate volumes at prices which are cost-effective. A significant number are already aware of this and have products which they expect to be at a suitable level of development by 2011.

3.5.1 EAVC Components

Descriptions

119 Impacts on network voltage due to new loads and generators will vary depending on the location, season and even time of day. DNOs are tasked with managing customer voltage within limits at all times, network solutions are available to:

1. Improve the control of primary substation tap changers and other existing active voltage control components to include actual network conditions and distributed generation (EAVC1);
2. Introduce LV automatic/controlled tap changing into secondary transformers (EAVC2);
3. Further use of HV inline voltage regulators (EAVC3)
4. Maximise power transfer on LV and HV feeders by actively managing reactive power flows (EAVC4), and
5. Further use of LV inline voltage regulators that could be adjacent to secondary transformers, on the feeder or at individual customer connections (EAVC5)

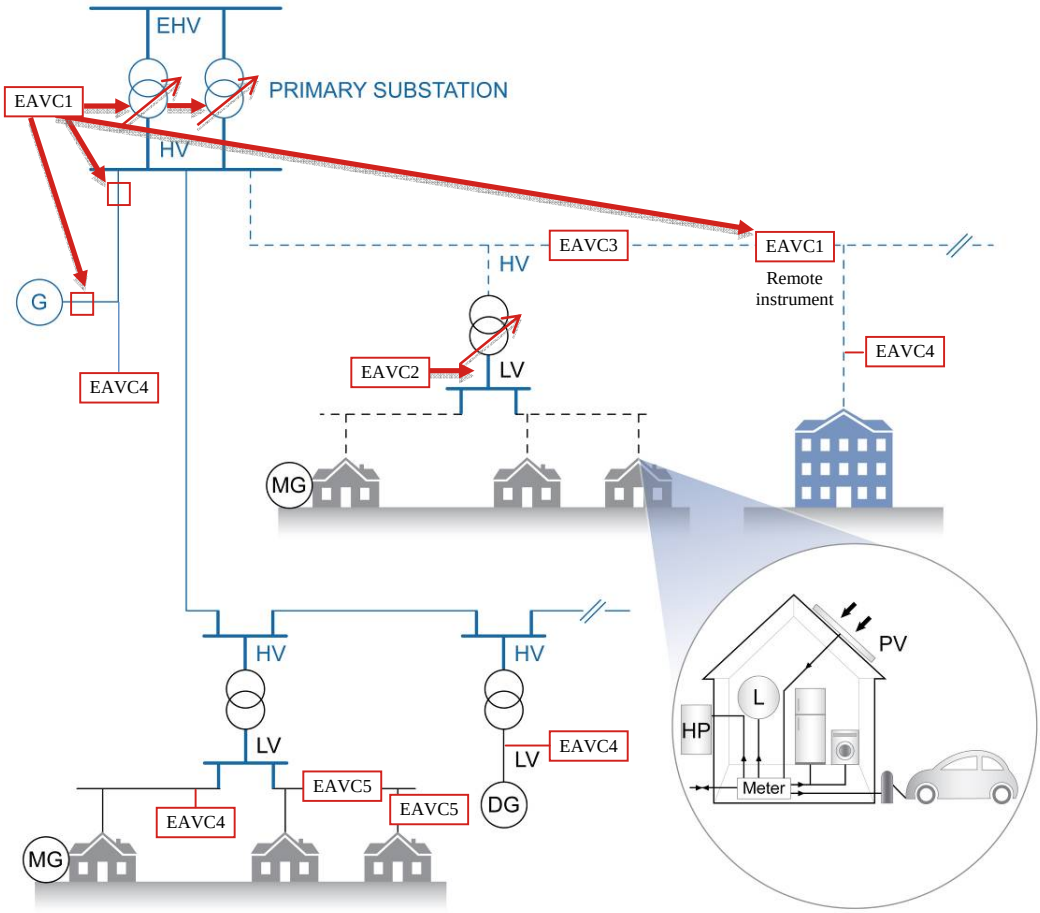

Figure 4. EAVC Topology

Budget Prices and Suppliers

120 In order to obtain best estimates of budget prices and lead times from potential candidate suppliers of EAVC equipment, a seven page high level Request For Information (RFI) was issued to nine companies whose equipment was considered potentially useful to the aims of this project. In the absence of a specification for the candidate suppliers to respond to, the background to the LCNF Tier 2 funding was explained and the sphere of interest was set out in general terms, emphasising that interest at this stage was in gaining general awareness of products available and their approximate costs.

Table 3. Budget Prices of EAVC Technologies

Available Technologies	Suppliers	Component Cost (£k)		Deployment Cost (£k)	Footprint (m^2)	RFI or Estimate
		Low	high			
Advanced control of transformer tap changers	*SuperTapp (Siemens),*	£5	£10	£28		RFI
	Gen AVC,	£30	£50	£200		RFI
	ABB NMS, GE ENMAC					unknown
On-line automatic control of 400V 'bar voltage	*AREVA*	£8	£5	£10		Estimate
LV Regulators	*MicroPlanet 1Ø*	£2	£2	£2		RFI
	MicroPlanet 3Ø	£6	£7	£10		RFI
	Powerperfector, PowerSave, Claude Lyons, AREVA	£20	£50	£72		Estimate
HV Inline Voltage Regulation	*Coopers*	£15	£20	£30		Estimate
Reactive power management	*AMSC - 2MVar*	£275	£300	£362		RFI
	AMSC - 4MVar	£465	£500	£557		RFI
	ABB, GE, AREVA, S&C Electric Company					unknown

3.5.2 RTTR Systems/Components

Descriptions

121 A real time thermal rating[1] tool essentially provides an estimate of the difference, at a given point in time, between the current that is being carried by an asset and the maximum current that can safely be carried by that asset. This estimate can then be acted upon by implementing a control strategy to limit or reduce the current, i.e. to constrain the use by customers of that asset. The application of RTTR with passive customers will enable higher asset utilisation through better knowledge of thermal response. RTTR also has potential with active customers, providing a higher level of confidence in the capacity of an asset at a specific point in time which will allows distributors/suppliers to implement a control strategy to limit or reduce loading of the asset. RTTR solutions yield benefits in two ways:

3.6.1

[1] This is similar to dynamic thermal rating (DTR). Here, we consider DTR to be a process that considers the dynamic nature of the load curve and, to some degree, predicts how much load can be carried before the asset overheats. Here, we consider only RTTR, without the predictive capability.

1. In planning timescales, providing better knowledge of the firm and interruptible capacity that can be secured by a given asset, allowing more focussed reinforcement; and
2. In operational timescales, confirming the amount of interruptible capacity that can be released (or, on the flip side, the interruptible contract volume that needs to be called)

122 RTTR systems consist of four main components

1. Thermal models (i.e. IEC 61597, IEE 738, CIGRE WR 22.12)
2. Measurement system (sag, tension, temperature, current, wind speed)
3. Controller to integrate measurement data, perform model calculations and output information.
4. Forecasting/analysis tools to allow RTTR to be incorporated into normal planning processes.

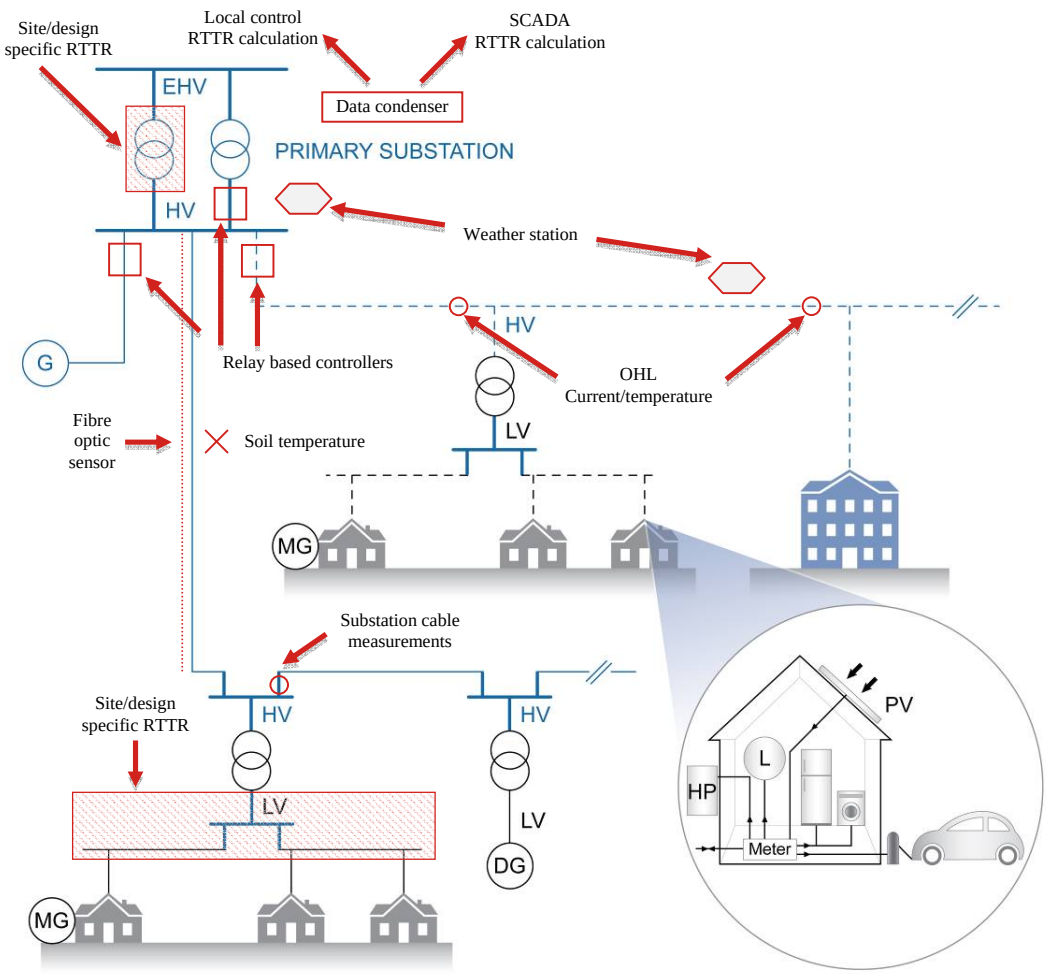

Figure 5. RTTR topology

Budget Prices and Suppliers

123 In order to obtain best estimates of budget prices and lead times from potential candidate suppliers of RTTR equipment, a seven page high level Request For Information (RFI) was issued to eight companies whose equipment was considered potentially useful to the aims of this project. In the absence of a specification for the candidate suppliers to respond to, the background to the LCNF Tier 2 funding was explained and the sphere of interest was set out in general terms, emphasising that interest at this stage was in gaining general awareness of products available and their approximate costs.

Table 4. Budget Prices of RTTR Components and Technologies

	Group	Product	Suppliers	Units	Component Cost (£k)		Deployed Cost (£k)	RFI or Estimate
					Low	high		
Measurement Systems	Environment	Weather monitors	*Various*	per measurement	0.5	0.8	1.8	RFI
	OHL	3Ø power measurements with local controller	*FMC-Tech, Gridsense,*	per measurement	1.5	2.5	4	RFI
		Thermal monitor units	*LIOS*	per feeder				
	UG	3Ø power measurements with local controller		per measurement	1.5	2.5	4	Estimate
		Soil Temperature		per measurement point	0.2	0.5	1	Estimate
		Fibre optic sensor in duct/conduit	*LIOS*	per km	1	2	2.5	RFI
		Thermal monitor units	*LIOS*	per feeder	25	30	37.5	RFI
Controllers	OHL	T-NET Server	*FMC-Tech*					unknown
	OHL / UG	Real Time Thermal rating controller	*LIOS*	Per Substation	65	125	125	RFI
	OHL / UG / Tx	Micom Relay (per feeder/Tx)	*AREVA*		5	20	22.5	RFI
Combined Systems	OHL / UG / Tx	ENMAC	*GE*					unknown
		Valcap	*NKT*					unknown
			AREVA					unknown
Bespoke Thermal Models	OHL	OHRAT	*EATL*	Per feeder	-	-	5	internal cost
	UG	CRATER	*EATL*	Per feeder	-	-	5	internal cost
	Transformer	Advanced transformer rating	*EATL*	per Transformer	4	10	22	RFI

3.5.3 EES Components

Descriptions

124 Electrical Energy Storage has the potential to provide a range of functionalities in multiple applications. The overall financial viability of any electrical energy storage system is determined by its ability to extract value (revenue) from one or more value/revenue streams.

125 Here, we consider "pure" bidirectional electricity storage, i.e. a device that accumulates electrical energy from, and later release it back to, the distribution network. Other forms of energy storage exist, but will be considered within this programme as responsive load.

126 Energy storage technology can be classified into the following categories:

1. **Transient storage** can be used to improve power quality by smoothing transient network events such as voltage dips and spikes. This storage can equally be considered as enhanced automatic voltage control.
2. **Short term storage** maintains energy reserves sufficient to provide the rated power from less than one second up to several minutes. The main applications are for use in uninterruptible power supplies and for power system stabilisation.
3. **Medium term storage** where the stored energy is used for a period of several minutes up to a few hours. Applications for this type of storage include renewable energy management and deferral of network reinforcements.
4. **Long term storage** is able to hold energy for durations ranging from a few hours up to weeks or months. This is commonly used to smooth output fluctuations from intermittent renewables and also to decouple generation and consumption to take advantage of low electricity prices to charge the storage device and periods of high prices to utilise the stored energy.

127 Application as part of CE Medium term electrical energy storage solutions. Specifically the discussion develops a small series of outline functional specifications, for the application and uptake of complete EES systems in CE Electric's power distribution network, based on the following proposed reference applications:

1. Primary sub-station applications (33kV/11kV) (EES1)
2. Secondary sub-station applications (11kV/LV (400 V) (EES2)
3. LV applications (400 V) (EES3)

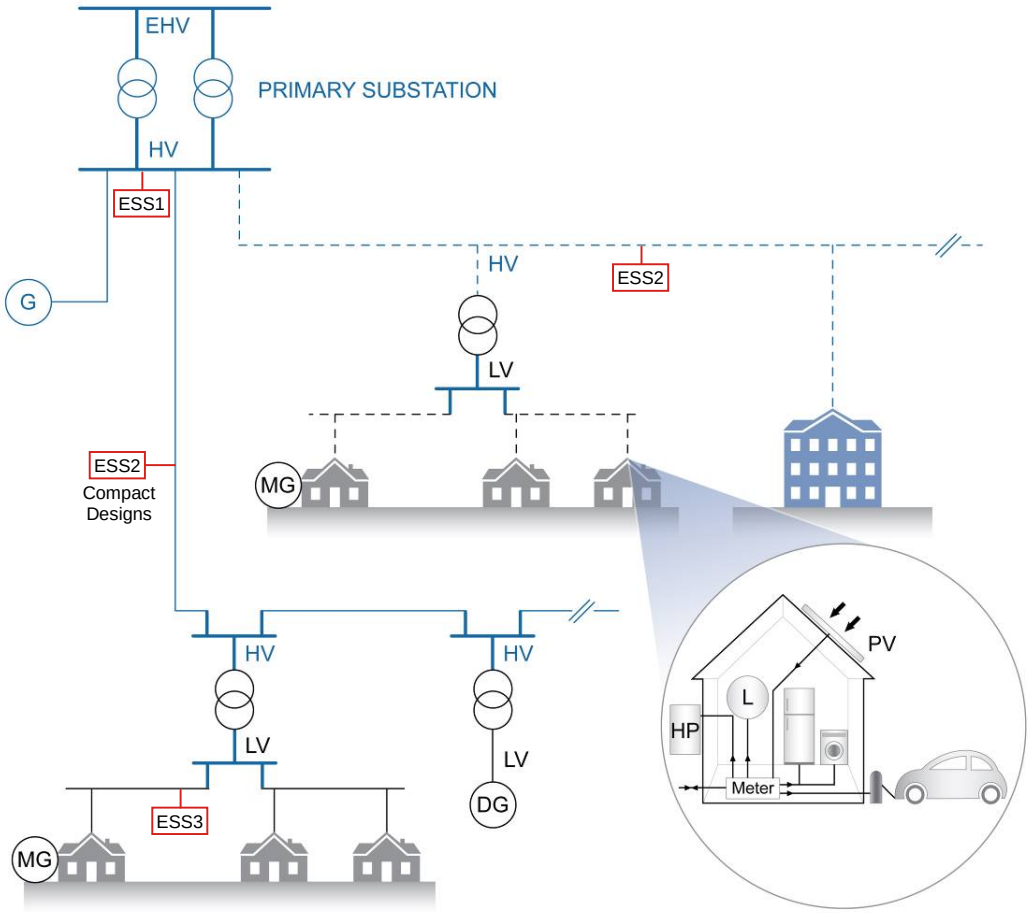

Figure 6. EES Topology

Budget Prices and Suppliers

128 In order to obtain best estimates of budget prices and lead times from potential candidate suppliers of EES equipment, a seven page high level Request For Information (RFI) was issued to fourteen companies whose equipment was considered potentially useful to the aims of this project. In the absence of a specification for the candidate suppliers to respond to, the background to the LCNF Tier 2 funding was explained and the sphere of interest was set out in general terms, emphasising that interest at this stage was in gaining general awareness of products available and their approximate costs.

Table 5. Budget Prices for 2.5MW / 5MWhr EES applications (EES1)

	Suppliers	Component Cost (£k)		Deployed Cost (£k)	Footprint (m^2)	RFI or Estimate
		Low	high			
Lead Acid (Pb-acid)	*Exide*	£2,278	£2,637	£2,840	293*	Estimate
Nickel Cadmium (NiCd)	*SAFT*	£4,555	£5,275	£5,201	146	RFI
Sodium Sulphur (NaS)	*NKT*	£3,416	£3,956	£3,922	146*	Estimate
Sodium Metal Halide	*GE*					Unknown
Lithium Ion	*ABB, A123*	£4,194	£4,516	£4,490	46	RFI
Flow Cells	*Premium Power, ZBB*	£2,742	£3,065	£3,209	432	RFI

Table 6. Budget Prices for 100kW / 200kWhr EES applications (EES2)

	Suppliers	Component Cost (£k)		Deployed Cost (£k)	Footprint (m^2)	RFI or Estimate
		Low	high			
Lead Acid (Pb-acid)	*Exide*	£117	£135	£168	2*	Estimate
Nickel Cadmium (NiCd)	*SAFT*	£234	£270	£298	1	RFI
Sodium Sulphur (NaS)	*NKT*	£175	£203	£230	1*	Estimate
Sodium Metal Halide	*GE*					Unknown
Lithium Ion	*A123*	£184	£213	£241	2*	RFI
Flow Cells	*Premium Power, ZBB*	£184	£145	£208	26	RFI

Table 7. Budget Prices for 50kW / 100kWhr EES applications (EES3)

	Suppliers	Component Cost (£k)		Deployed Cost (£k)	Footprint (m^2)	RFI or Estimate
		Low	high			
Lead Acid (Pb-acid)	*Exide*	£58	£68	£84	1*	Estimate
Nickel Cadmium (NiCd)	*SAFT*	£117	£135	£149	1	RFI
Sodium Sulphur (NaS)	*NKT*	£88	£101	£115	1*	Estimate
Sodium Metal Halide	*GE*					Unknown
Lithium Ion	*A123*	£92	£106	£121	2*	RFI
Flow Cells	*Premium Power, ZBB*	£31	£94	£91	18	RFI

Note * designates that the footprint has been estimated.

3.6 Control Systems

3.6.1 Introduction

129 The role of the control system is in acting as the architectural glue between the various components in each trial cell. Ultimately this is the link from measurement, to decision making, to actioning device. The systems employed to manage and monitor dynamic network response to loads (whether actual or simulated).

130 Functional requirements of the control system to be deployed to support our proposed project:

- real-time monitoring and logging of network conditions experienced by equipment deployed across all test cells
- simulation of high load events on the distribution grid
- management of response to real or simulated high load events through triggering of the components deployed in each test cell
  - multiple events may be triggered on any given day across different test cells
  - over time a given household or piece of network equipment may be deployed as part of different test cells or in order to test different inputs/outcomes with in an individual cell
- response tracking to ensure that triggered equipment has not been over-ridden by consumers, and to allow incentive or penalty payments to be

registered (where consumers over-ride the system and re-enable disabled equipment)

- monitoring and logging of network conditions to confirm the extent to which real or simulated high load events have been managed within assigned parameters

3.6.2 DNO Control system

Description

131 The DNO control system can be deployed in one of two fundamental ways:
- Centralised
- Decentralised

132 Various R&D projects have been undertaken in recent years detailing the pros and cons in terms of cost, risk and timeliness. Broadly, they group into the following:

	Centralised	**Decentralised**
Overview	Central architecture with all inputs connecting at a single (or dual headed) node point. Software algorithms located in a central server.	Locally deployed control architecture. By definition it consists of many multiple node points, and algorithms located in many parts of the network.
Applications	Control systems, e.g. SCADA	Automatic Voltage Control, Protection relays, etc
Computational power	High(er)	Low(er)
Availability	Single point of failure, though typically backed up with live standby units	Multiple units, therefore
Software models	One central connectivity model • Ease of updating • Notionally simpler	Potentially multiple connectivity models • Can be more complex to manage • Can be expensive if manual update is required • Requires ways to remotely update
Security	Can be sophisticated, as it is cost effective to apply robust local security around the host and standby platforms	Arguably less secure, as more physical (unmanned) locations – only as good as the lock on the gate and local measures.
Communications requirements	High capacity (typical) High speed (depending on function) Generally more expensive per channel	Lower capacity Lower speed Generally cheaper per channel

133 A key factor on whether a centralised Vs decentralised architecture is selected is the functions being undertaken, and the associated speed requirement of that function. This will be determined as a part of the LCNF project.

Requirements

134 The control system for this project is to be performed by a system that is installed and operated separately to CE Electric's core SCADA platform. Where identified, key analogue measurements and digital status indications will be presented to the control room using conventional techniques.

135 The exact control architecture will be identified in the trial, but will be optimised around the speed, security and cost requirements needed for the control functions.

136 The communications for these functions are assumed to be in addition to CE Electric's (core) operational communications system. Whilst generic solutions will be strived for, it is likely that the communications solutions will vary between locations depending on topology.

137 The control system should communicate using the DNP3 protocol in line with CE Electric policy and practice.

3.6.3 Energy Supplier - Back end servers and communications systems

3.6.3.1 Customer application servers

Description

138 It is expected that there will be one or more web-based or remote services that customers will access to provide management and information for their in home system. One example of this would be the Alert Me system which provides web based management and display for its in home energy and security devices.

139 There are no specific requirements for application servers of this type in the project and the inclusion of these will be dependent on specific appliance or control systems being chosen that require web or remote services.

3.6.3.2 Smart Meter Head End

Description

140 This is a BG operated system that will allow reading of electricity and gas meter data including profiling and alerts. It will also allow targeting specific customer groups with time of use tariffs.

3.6.3.3 Smart Meter WAN (GPRS)

Description

141 GPRS network used by BG for meter communications. Details not important to this project

3.6.4 Supplier / Distributor Interface

Description

142 This system manages the interface between the distribution real time systems and the customer response systems, as follows:

- EAVC
  - Receives voltage alerts (over or under volts) from smart meters indicating network voltage limits have been reached at one or more locations. Note that for EAVC the response times need to be fast as are dependent on the rate of change of voltage. Tap changers have a 2 minute response time so this would be the ideal target detection-to-response window. A maximum of up to a 5 minute response time would be allowable.
  - Transmits microgen reduction/shut off signals to customer generation systems to reduce network over-voltage excursions
- RTTR
  - Transmits demand reduction signals to demand response enabled loads

143 The system will need to provide a means of address mapping and aggregation such that the location of a voltage alert in the network can be identified from the location of a customer equipment generated event. Conversely, outbound network responses must be able to be directed to an appropriate group of customers. This would be done by mapping a group of customers to each active network node through the supplier/distributor interface.

144 It will likely be problematic to interface this system to BGs head end to receive meter voltage alerts so these may have to be captured by other customer systems.

3.6.5 Demand Response WAN

Description

145 A communications network is required to support transmission of real time demand information from the supplier/distributor Interface to customer equipment. Potential options include:

- SMS (most likely option)

- PMR (UHF) etc

Requirements

146 Response time:

- For **EAVC**: 2 minutes ideally, 5 minutes maximum (see section 3.6.4)
- For **RTTR**: typical time constants are :
  - 20 minutes for overhead line
  - 1-2 hours for underground line
  - So detection to response activation times around 10 minutes will be adequate for RTTR

147 Data rates:

- Data volume to individual customers will be quite low, in the order of a fraction of a KByte. These signals can be broadcast and do not need a secure bidirectional channel. The absolute maximum number of target customers on the project would be likely be in the order 10,000 but this will include a mixture of monitored, volt and RTTR types so possible less than 10% would need simultaneous comms. If non broadcast means are used this will require in the order of 1000 customer X 1Kbyte in 5-10 minutes from the back end system. This is around 30KBits/Sec – quite a low rate so unlikely to be problematic.