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# CONSUMER ACCESS DEVICES

## APPLICATIONS FOR DATA IN THE CONSUMER HOME AREA NETWORK (C HAN) AND WIDER MARKET CONSIDERATIONS

A BEAMA
practical guide

# COMPANIES INVOLVED IN THE PREPARATION OF THIS PAPER












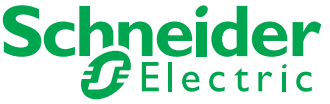













# ABOUT BEAMA

BEAMA is a trade association for the electrotechnical industry, representing over 200 companies in the power, electrical and building services sectors. Our members, who range from multinationals to SMEs manufacture the wide range of equipment required for end–to-end electrical systems.

The BEAMA Consumer Access Device Working Group (CAD WG) has developed this document as a guide to the basic architecture of a CAD. The members of the CAD WG have considerable expertise in the connected homes and smart grid sector, and range from smart meter, in home display, CAD, and low carbon technology manufactures, including heating and hot water systems and controls.

The CAD WG is part of BEAMA Emerging Markets where dedicated resource is applied to develop supply chains in the UK for smart technologies and systems. Through Emerging Markets members have oversight and input into the standards being developed in the sector and provide expertise to inform the scope and content of international and European standards.

Details of other BEAMA activity can be found on the BEAMA website www.beama.org.uk

For more information about CADs and Connected Homes please contact smartgrid@beama.org.uk

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# ACRONYMS

| | |
|---|---|
| ALCS | Auxiliary Load Control Switch |
| API | Application Platform Interface |
| CAD | Consumer Access Device |
| CEM | Consumer energy manager |
| C HAN | Consumer Home Area Network |
| DCC | Data Communications Company |
| DNO | Distribution Network Operator |
| DSR | Demand Side Response |
| E-meter | Electricity Meter |
| ESME | Electricity Smart Metering Equipment |
| G-meter | Gas Meter |
| HCALCS | HAN Controlled Auxiliary Load Control Switch |
| HHIC | Heating and Hot-water Industry Council |
| IHD | In Home Display |
| LCNF | Low Carbon Networks Fund |
| RF | Radio Frequency |
| RHI | Renewable Heat Incentive |
| SE | Smart Energy |
| SMETS | Smart Metering Equipment Technical Specifications |
| SM HAN | Smart Metering Home Area Network |
| SoC | System on Chip |
| TOU | Time Of Use |
| WAN | Wide Area Network |

# DEFINITIONS

| | |
|---|---|
| API | Application Platform Interfaces – communication platforms for connected homes and energy management |
| C HAN | The Consumer Home Area Network is the consumers world, and represents anything in the building or data stored in the cloud. |
| Dynamic TOU | This is a time of use tariff that will change throughout the day. Not consistent day to day, with different triggers. Price changes at times that are not pre-set for the consumer. A dynamic tariff can be relatively simple or complex (e.g. limited annual critical peak response to more complex retail price offers which may be more directly linked to wholesale price, low carbon generation and demand, and which could change many times in one day or a year). |
| Microgeneration | Small scale heat and electricity generation by individuals at a smaller scale to national generation. |
| Static TOU | This is a time of use tariff that remains constant with the same triggers. Consumers know in advance what time of day each price will change. |

# EXECUTIVE SUMMARY

The UK smart metering rollout places a strong emphasis on consumer benefits and the pace of market demand for consumer engagement solutions in the UK is greater than anywhere else in the world.  BEAMA expects to see significant innovations in consumer energy management systems following the rollout of smart meters.

The key to the development of this market and the more advanced functionality is the availability of real time consumption and energy price data. It is through the Consumer Access Device (CAD) that this data will be made available into the Consumer Home Area Network (C HAN).

This paper outlines a blueprint for the CAD and use cases for the application of data from the Smart Meter Home Area Network (SM HAN). We also consider the routes to market for CADs and what this means for consumers and progressive innovation in the connected homes sector. This paper has been developed by BEAMA members, manufacturing connected home products and systems. It is aimed at policy makers, regulators and the industry and aims to provide clarity on the architecture of the CAD, its likely implementation and, importantly, what this means for the consumer.

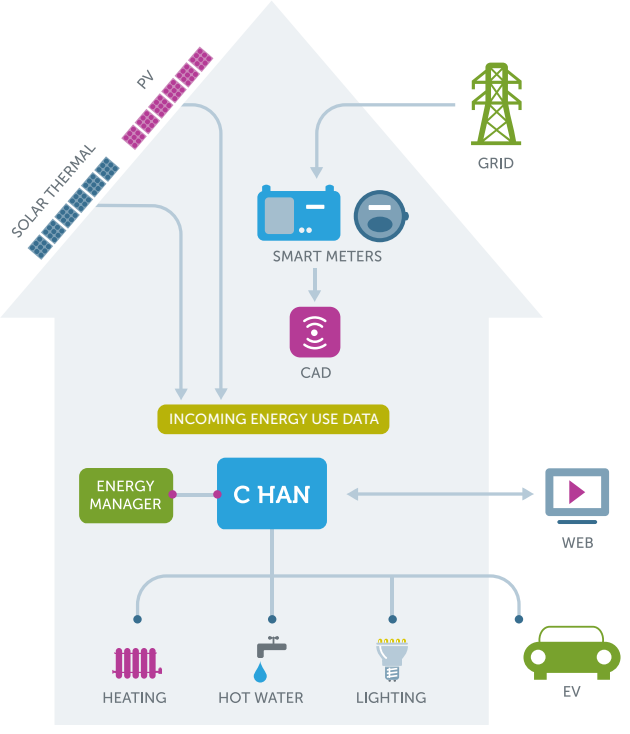
## What is a Consumer Access Device (CAD)?

A CAD is a physical or logical device that links the SM HAN and the C HAN which is linked to a wide range of fixed and portable building service technologies. The CAD is permitted to pair with the SM HAN and extract real time data that can be utilised by the consumer e.g. for increased efficiency and cost effective use of their heating and hot water systems. Energy management systems in the home can utilise data from the SM HAN, in addition to other data sources to make the best decisions for the consumer:

- Onsite micro-generation
- Consumer needs
- Weather
- Inside and outside air temperature

From the perspective of Utilities and the Grid, the great benefit of the CAD is that it clearly delineates between “things that are the Utility’s responsibility” and “things that are the Consumer’s responsibility”. The lifespan, rate of evolution and potential complexity of consumer devices goes way beyond most Utilities’ abilities or interests in managing them, so it is right that consumers manage these for themselves. It is important that innovation in energy services can evolve at the pace of consumer technology. The CAD is the key to allowing that.

The CAD allows a user to make separate decisions about their energy supply and their energy services provider. By separating the data via the CAD, users can make independent supply decisions based on what is best for them, creating a vibrant open market.




THE CONNECTED HOME

# EXECUTIVE SUMMARY (CONT'D)

## Routes to Market

The CAD is a consumer device with multiple routes to market. The growth trajectory for the CAD market is inextricably linked to the timely rollout of smart meters and an effective local CAD pairing process. When CADs become widespread it is expected that the innovations in home energy management that follow are likely to be significant, and will add value to the connected homes platforms consumers are already buying into on today's market.

There are some major steps ahead before we can establish a market for CADs and extract the true value of some of these applications in the C HAN, these include:

- Timely Smart Meter rollout
- Local CAD Pairing
- A clear commercial framework for service providers and an understanding of the role different service providers may have (DNOs, utilities, 3rd parties etc)
- Reform of existing tariff structures and the introduction of dynamic Time Of Use (TOU) tariffs
- Additional data will need to be made available through the SM HAN to allow for more advanced demand side response (DSR) functionality
- Development of International and European standards will affect market development and requires strong UK input
- Further behavioural research is required to establish the impact of such devices on demand side response

We should not limit the data made available through the CAD as in doing so we will limit the applications consumers can access for whatever their needs are, whether that is for energy, assisted living or just improved lifestyle and comfort.

WE SHOULD NOT LIMIT THE DATA MADE AVAILABLE THROUGH THE CAD AS IN DOING SO WE WILL LIMIT THE APPLICATIONS CONSUMERS CAN ACCESS FOR WHATEVER THEIR NEEDS ARE.

# 1 INTRODUCTION

**This document outlines a blueprint for applications of data through the Smart Metering system and Consumer Access Device (CAD) gateway into the Consumer Home Area Network (C HAN) (Fig 1). This is a working paper and, while the overall blueprint and principle of the work will remain, we appreciate that the market for smart energy data platforms is rapidly emerging. Therefore the use cases and applications will develop over time and BEAMA will maintain this work to keep track of market developments.**

THERE IS SIGNIFICANT OPPORTUNITY FOR THE UK MARKET TO INNOVATE IN AND AROUND THIS SECTOR, AND THE MARKET IS ALREADY DEMONSTRATING THIS.

There has been a lot of discussion about the types of data that utilities require through the Smart Meter HAN (SM HAN) to support the provision of energy data to the householder. However, there has been less discussion about the data consumers require to engage in more advanced demand side services and further increase the benefit they can gain from energy management in the connected home.

This paper looks at the type of data that could be applied through the SM HAN and how:

1) CAD data will allow consumers to engage with market solutions to reduce energy waste identified in their own consumption

2) In the advent of a well-structured and open demand management utility market with signal triggers or tariff pricing, consumers will be able to tune and automate their Home Energy Management systems to optimise consumption vs cost vs lifestyle

This paper focuses on the CAD interface between the GB Smart Metering system and the consumer, as defined in SMETS, which will provide consumers with better access to their energy data. We have therefore not gone into great detail about third-party smart data platforms and Application Platform Interfaces (APIs), but we recognise the existence of these and their likely interaction with the mandated system. The BEAMA Connected Homes Group is working on wider market development issues and can provide further input on this in future papers and on request from government and industry.

For the purposes of this paper we focus on applications for domestic consumers, but we recognise that there is a significant market opportunity for similar applications for small to large commercial premises. In most cases the technology and communication architecture will not differ, but this is more likely to be from a third party aggregator or supplier contracted to provide Demand Side Response (DSR) services.

There is significant opportunity for the UK market to innovate in and around this sector, and the market is already demonstrating this. The applications outlined have multiple benefits for the whole energy system upstream of the meter as well as for the end consumer.

This paper outlines a broad roadmap for the market development of CADs and corresponding applications for connected homes. This provides a basis to inform discussions on the policy and regulatory framework that will support the rollout of demand side services, both on the grid and in the commercial and domestic built environment.

The use cases outlined in this paper are not exhaustive but provide an example of the benefits for consumers with access to data in the C HAN and the range of applications for this. The priority is to ensure that market options and use cases for data in the C HAN are not blocked, so that they provide benefits to consumers managing their energy consumption.

# 1 INTRODUCTION (CONT'D)

## 1.1. Key observations from previous BEAMA studies

BEAMA has over the past two years published a series of industry papers[1] that outline the role of CADs and In Home Displays (IHDs), more broadly in line with the government's smart meter rollout. BEAMA is strongly aware of the need to develop the market for consumer products that allow consumers to engage with their energy consumption and participate in the wider energy market. This market development depends on energy products being interoperable, allowing for the communication of data across platform interfaces.

Previous BEAMA publications have made the key observations that:

- A significant number of consumers want their energy information online, for example through the Smarter Phone app or the web
- When given IHDs that store data, a significant number of consumers choose to upload this data online in order to access online services
- With more dynamic TOU (Time of Use) tariffs, which require more advanced applications for data, consumers will save more on their energy bills
- Consumer access to meaningful data leads to behavioural change

## 1.2. Demand Side Response

We consider in this paper basic use cases for static tariffs as well as potential applications for data with the availability of dynamic TOU pricing.

There are still a number of key unmet market conditions to facilitate the development of a more sophisticated Demand Side Response market for both commercial and residential loads. These include half-hourly settlement and appropriate wholesale market arrangements to facilitate the extraction of value from associated market services. Most importantly the tariff structures to allow for more dynamic (TOU) pricing, reflective of supply (renewable and fossil fuel), are not yet developed. The ability to provide a price signal reflective of generation capacity and local peak demand will be the key market incentive for connected home applications. This will be the mechanism to empower consumers to manage their energy use effectively, utilising automation and control systems, and ultimately save on their energy bills.

THE ABILITY TO PROVIDE A PRICE SIGNAL REFLECTIVE OF GENERATION CAPACITY AND LOCAL PEAK DEMAND WILL BE THE KEY MARKET INCENTIVE FOR CONNECTED HOME APPLICATIONS.

CONSUMER ACCESS TO MEANINGFUL DATA LEADS TO BEHAVIOURAL CHANGE.

[1] October 2012, The Benefits of Energy Visibility, A BEAMA White Paper. 2014, BEAMA and Vasset, Assessing the Use and Value of Energy Monitors in Great Britain

# 2
# WHAT IS A CONSUMER ACCESS DEVICE?

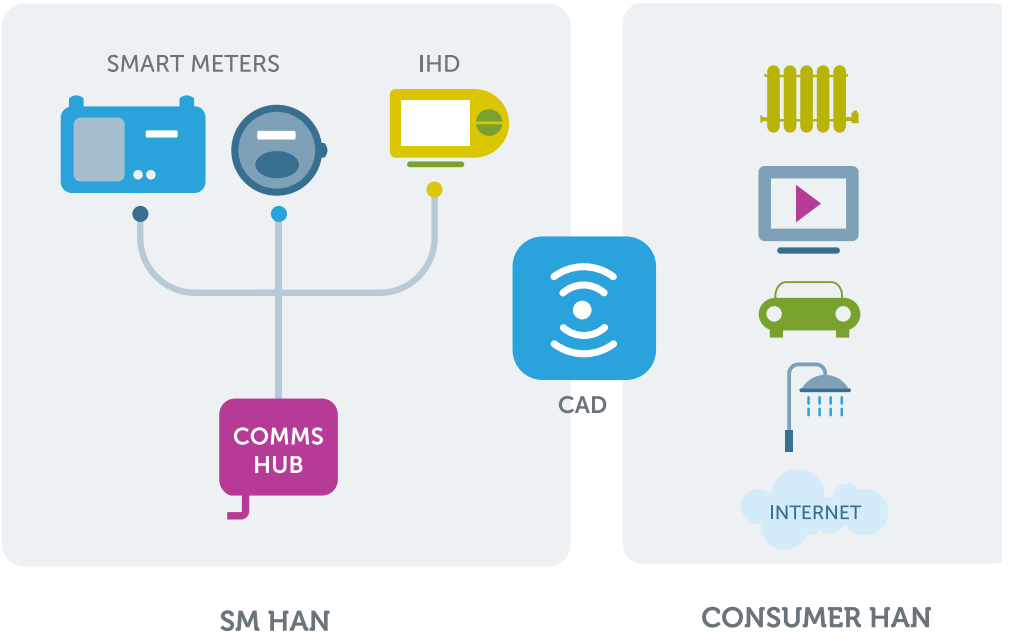



FIGURE 1: SYSTEM DIAGRAM – SM HAN AND C HAN

**The Consumer Access Device (CAD) provides a link between a Smart Meter installation and the consumer's world, helping to provide for more interactive smart homes in the future. It is a logical or physical device that will be the bridge for real time energy and pricing data from the SM HAN to the consumer HAN or other domains, with no loss of data granularity. A CAD could therefore be an embedded device in other equipment (e.g. heat pump control, a centralised home energy manager), or other stand-alone devices[2].**

CADs may securely bridge the Smart Meter messaging protocol within the home to the home area network, or to individual consumer devices and to possible external services by speaking multiple protocols. This ability is defined in SMETS2 as specific to a type 2 device, with one-way communication from the smart meter.

The CAD connects to the SM HAN in much the same way as the IHD does, as this is also a type 2 device. It is complementary to the IHD and is typically used in conjunction with it. It may even in some cases be integrated into the IHD. It takes the same live energy data feed from the Smart Meters in the home and typically uses it in two ways:

1) Uses it locally to help manage appliances in the home (e.g. running appliances when energy is cheap)

2) Is connected via the consumer's broadband connection into the Cloud, where multiple online services can turn it into value to the consumer in different ways, making that data available in the place where the consumer wants it

[2] Market options for the CAD will be dependent on limitations on the number of type 2 devices permitted to pair with the SM HAN.

# 3
# THE CAD AND OTHER METHODS OF COMMUNICATION IN THE CONNECTED HOME

There are currently a number of communication methods in the domestic property identified on the market today. Obviously none of the connected home energy systems installed on the market today include a CAD linked to a smart metering system. The mandated role out of smart meters and corresponding specification outlines the CAD and the allowance for its connection to the SM ZigBee HAN. We can therefore expect this route of communication to be utilised, as outlined in this paper. But we must consider how this may sit alongside other methods of communication. The development of new API platforms on today's market, with large multinational companies driving their rollout, will push the market considerably. This paper is focused on the use cases for the CAD, but here we outline the other likely communication routes into the home and the interfaces these may have with the SM HAN[3].

## 3.1. Current approaches to communication in the connected home

- **One way communication**
  - Radio teleswitch
- **Two-way wireless communication**
  - 'Point to Point' wirelessly connected equipment or appliances, (M2M – Machine to Machine) communication via a mobile signal direct to the appliance (e.g. GPRS), or increasingly, via a broadband internet connection which thereafter communicates wirelessly in the home (e.g. Bluetooth, ZigBee or Wi-Fi) or via a wired connection (e.g. Powerline). This connection might be direct to the appliance to be controlled, or to an in-home controller with connectivity to the appliance via compatible in-home wireless communications. The information may for instance relate to price, credit level or another trigger/ signal (system stress). The appliance or control can also transmit data back about its operation. This is a well-established form of control for communication for DSR services provided by consumers in the industrial and commercial sector. In the domestic sector the most rapidly developing market for 'point to point' is for heating controls / programmable thermostats

Todays automated control for electrical heating systems lack accurate consumption and pricing data and instead rely on data entered or updated by the user. With the availability of smart data the market opportunities are broadened. The potential value a consumer can extract from a smart system in their home is significantly increased, for example by enabling domestic primary services (heating, hot water, lighting etc.) to utilise the most cost effective management option (low tariffs). With the development of TOU tariff structure and dynamic TOU for DSR this value can be increased further.

## 3.2. Auxiliary Load Control Switches

With the rollout of smart metering the supplier will have access to the Auxiliary Load Control Switch (ALCS) and SM HAN-connected ALCS (HCALCS). This access will allow the supplier to remotely control subsections of a consumer's electrical supply. ALCS and HCALCS are only accessible if a consumer has signed a contract with the supplier for a service. They are designed for buildings with large demand loads, including those servicing electric vehicles and heat pumps. In this instance consumers would not be able to change or configure their own switching roles using this method. With the addition of the CAD the gap between the two systems can be bridged, allowing industry to utilise already developed systems to control a home, and also augment and improve the efficiencies by utilising the data provided by the SM HAN.

BEAMA therefore maintains that the CAD is vital to enabling optimum efficiency from a home energy management system, whether for an entire building or for individual services.

## 3.3. Smart Meter communication approaches for in-home automated appliance control

- **Via Auxiliary Load control switches (ALCS)**
  - A variant SMETS2 smart meter – where the ALCS is integrated into the meter
  - Smart Meter Home Area Network-Connected Auxiliary Load Control Switches (HCALCS)
- **Via the Consumer Home Area Network & CAD**

[3] This is also noted in 2014 Sustainability First, Electricity Demand Project, Paper 11 – How could electricity demand-side innovations serve the electricity consumer in the longer term?. BEAMA were sponsors of this work and it provides a comprehensive look at the longer term options for consumers.

# 4
# THE CAD GATEWAY ARCHITECTURE

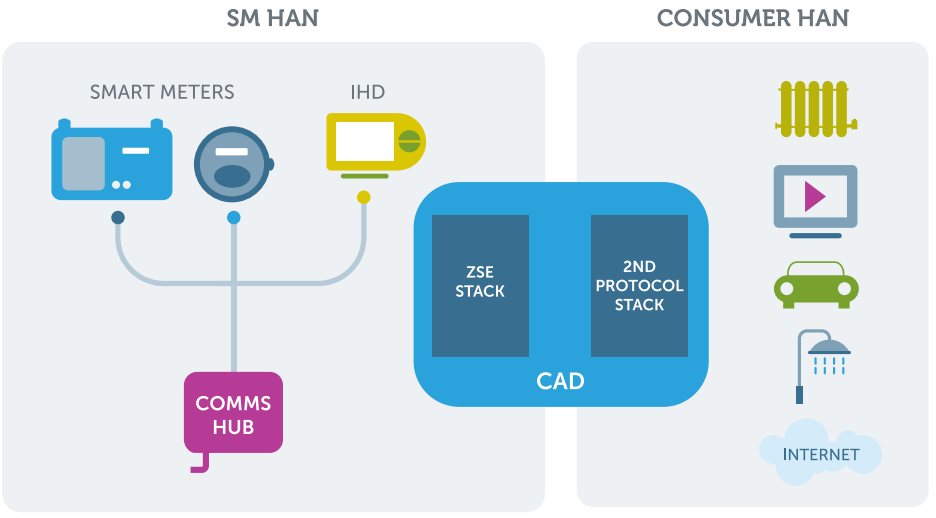



FIGURE 2: THE CAD GATEWAY ARCHITECTURE

The Government's Smart Metering Implementation Programme's technical specifications[4] allows for three type-2 devices to be connected to the SM HAN. The CAD will occupy one of these slots, connecting to the SM HAN and providing SM HAN data on another interface. This interface may be a standard Application Platform Interface (API) or it may be proprietary (bespoke).

The following sections outline the building blocks for the CAD, including information abstraction from the SM HAN and information export and use in the C HAN.

## 4.1 Smart Energy Information Abstraction – through the ZSE Stack

A CAD requires a connection to the SM HAN. This requires the CAD to contain a ZigBee Smart Energy (SE)[4] module (ZSE Stack in Fig 2), typically realised as a 'System on Chip' (SoC) device. This module contains dedicated hardware to support the lower layers of the ZigBee protocol stack and a processor to handle the higher layers of the ZigBee SE application. Combined with the Radio Frequency (RF) circuitry on the module a communication link to the SM HAN can be provided.

The ZigBee device will communicate with the other parts of the SM HAN using a ZigBee SE. Communication can be direct, as in the case of the Electricity meters, or indirect as in the case of Gas meters, which are bridged and read from the Communications Hub. The connection is established by pairing the CAD with the Communications Hub; this interaction is handled by the ZigBee device in the CAD. Once paired, the ZigBee device establishes what meters are used in the SM HAN by using the ZigBee SE service discovery process.

It is proposed that the software stack within the ZigBee device has a high-level Smart Metering API that contains data items that are available to the CAD on the SM HAN. The ZigBee device (software) manages the collection of these items and all of the ZigBee/ZigBee SE aspects, so that external devices that use the information on the SM API do not need to deal with the ZigBee SE and SM HAN aspects.

This half of the CAD is always there in any CAD.

4 2014, Communications Hub Technical Specifications (CHTS), Smart Metering Equipment Specifications (SMETS)

5 It is feasible that alternatives to ZigBee may be used for the minority of consumers who will not have access to ZigBee

# 4
# THE CAD GATEWAY ARCHITECTURE
(CONT'D)

THE CASE FOR CADS IS STRONG AND CLEARLY OUTLINED IN THIS PAPER, THEREFORE THE PROCESS BY WHICH A CONSUMER PAIRS A CAD ENABLED DEVICE TO THE SM HAN IS VITAL.

## 4.2 Smart Energy Information Export and Use – via the 2nd Protocol Stack

The second half of the CAD is typically used to enable the SE information to be used by other systems or devices. This interface could be proprietary or through a standard API.

In the simplest case, data may be used within the same device. For example, an appliance that connects to the SM HAN to obtain dynamic pricing information would be defined as a CAD. (Note that any non-metering device that connects to the communications hub will use up one of the three available slots for CADs, so where many devices are connected it is not possible for each device to get its own information.)

In all other cases the CAD bridges the information to other devices or systems. The other devices or systems may be connected directly in the home or connected externally via the internet or phone networks. Examples of such connectivity include wired Ethernet, wireless Ethernet (typically via Wi-Fi), or a mobile connection (GPRS 2G, 3G or 4G). Data rate requirements are low so this does not impose on the choice of Wi-Fi variant.

To support external connection, the CAD implements a second protocol stack (Fig 2). This implements the bridge to and from the SM API and the outside world. The hardware and software to support the bridge will depend on the type of connection. If for instance the connection were Wi-Fi then an IEEE802.11 SoC and associated radio circuitry would be required.

In a similar way the CAD could bridge to other domains within the home. In this case hardware and associated software would be required to support connection with the other domain.

Examples of this might include:

- Bluetooth
- Z-Wave
- Wi-Fi (internal)
- ZigBee
- Powerline
- Thread (runs on IEEE 802.15.4)
- 6 LowPAN (runs on IEEE 802.15.4)

## 4.3 CAD pairing with the SM HAN

BEAMA agree that the CAD pairing process with the SM HAN is crucial to the market rollout of CADs. The process has now been agreed and will be implemented in two stages as part of the rollout of smart metering in Great Britain.

The case for CADs is strong and clearly outlined in this paper, therefore the process by which a consumer pairs a CAD enabled device to the SM HAN is vital. This should be made as straightforward as possible, if it is too arduous and complex, it could lead to market failure.

A consumer should have the means to check which devices are connected to the SM HAN and if necessary be able to remove them. This need could arise in a number of situations:

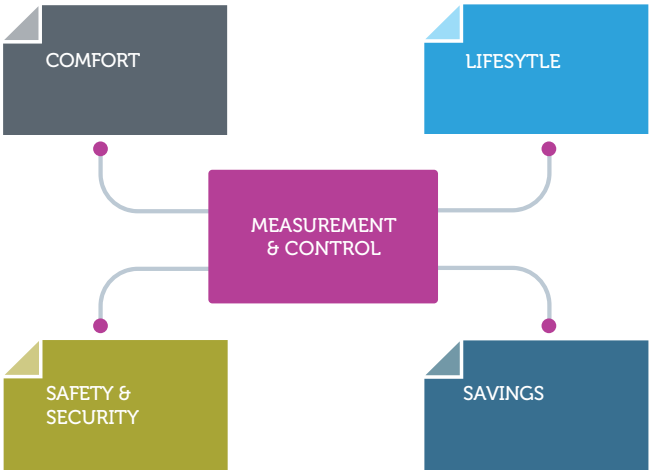
- Change of tenancy (including change of property owner)
- Defective Units
- End of service agreement with CAD supplier

# 5
# THE CONNECTED HOME

A connected home system enables a consumer to have full control of their primary services, through the application of simple controls. The architecture of a connected home system includes devices, sensors and controls all linked and managed centrally, using common communication channels (wired, wireless, or over the mains) to deliver 4 key benefits (comfort, lifestyle, safety and security and savings).

There are significant interrelationships between the necessary actions involved to deliver each of the broad categories in terms of benefits, outcomes and the technologies involved (Fig 3). Here you can see how the connected home can have multiple benefits not just for energy management, but assisted living and security, all met through the same or similar configurations of the system.

The architecture of a C HAN in the connected home is dependent on what roles it has been designed for. These are generally grouped into four objective categories:



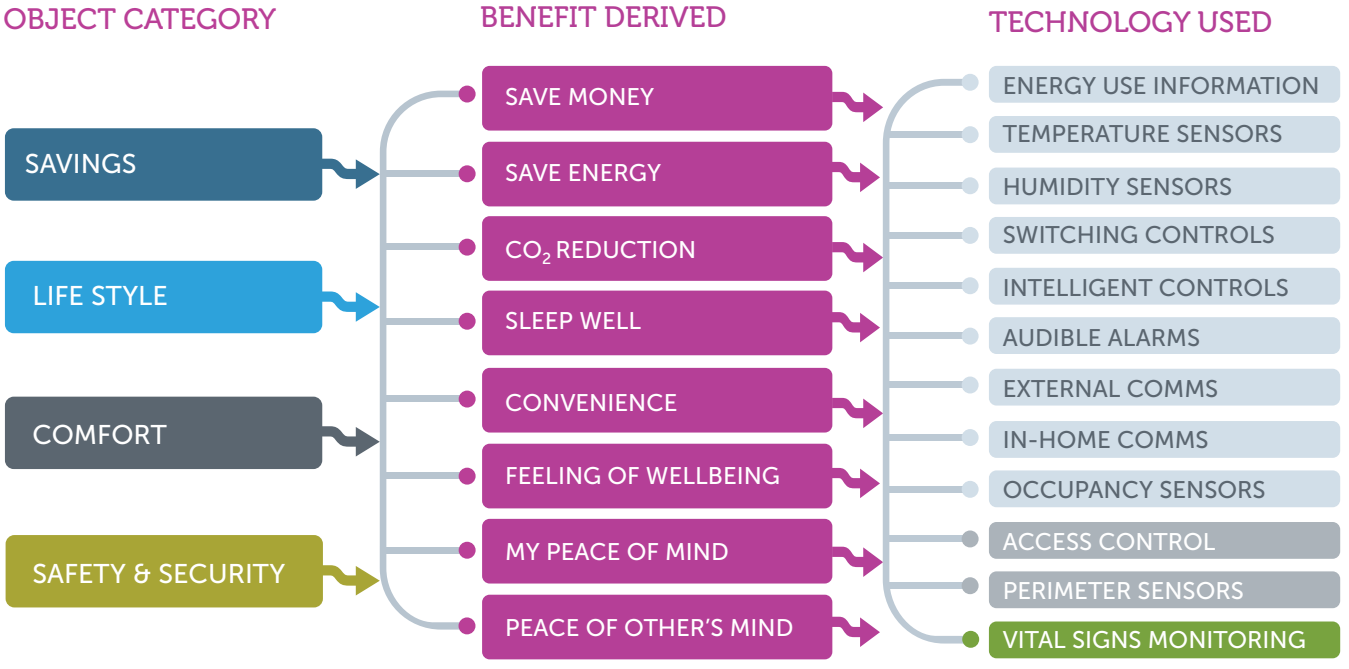




FIGURE 3: ROLES OF THE C HAN AND BENEFITS DERIVED

# 5
# THE CONNECTED HOME
## (CONT'D)

The C HAN enables the various actions and technologies to be initiated together to deliver these different aspirational benefits to the consumer by linking controls, sensors, data, devices and appliances both manually and automatically. The modular architecture of the majority of C HAN systems that exist today enables them to be tailored to the specification requirements of an installation including that outlined below for energy.

Figure 4 outlines the overall connected home system and the link between the SM HAN, C HAN and the overall energy management of the home. The CAD is an integral device for providing access to consumption and tariff data for the efficient running of primary services (hot water, lighting, heating and transport).

THE CAD IS AN INTEGRAL DEVICE FOR PROVIDING ACCESS TO CONSUMPTION AND TARIFF DATA FOR THE EFFICIENT RUNNING OF PRIMARY SERVICES

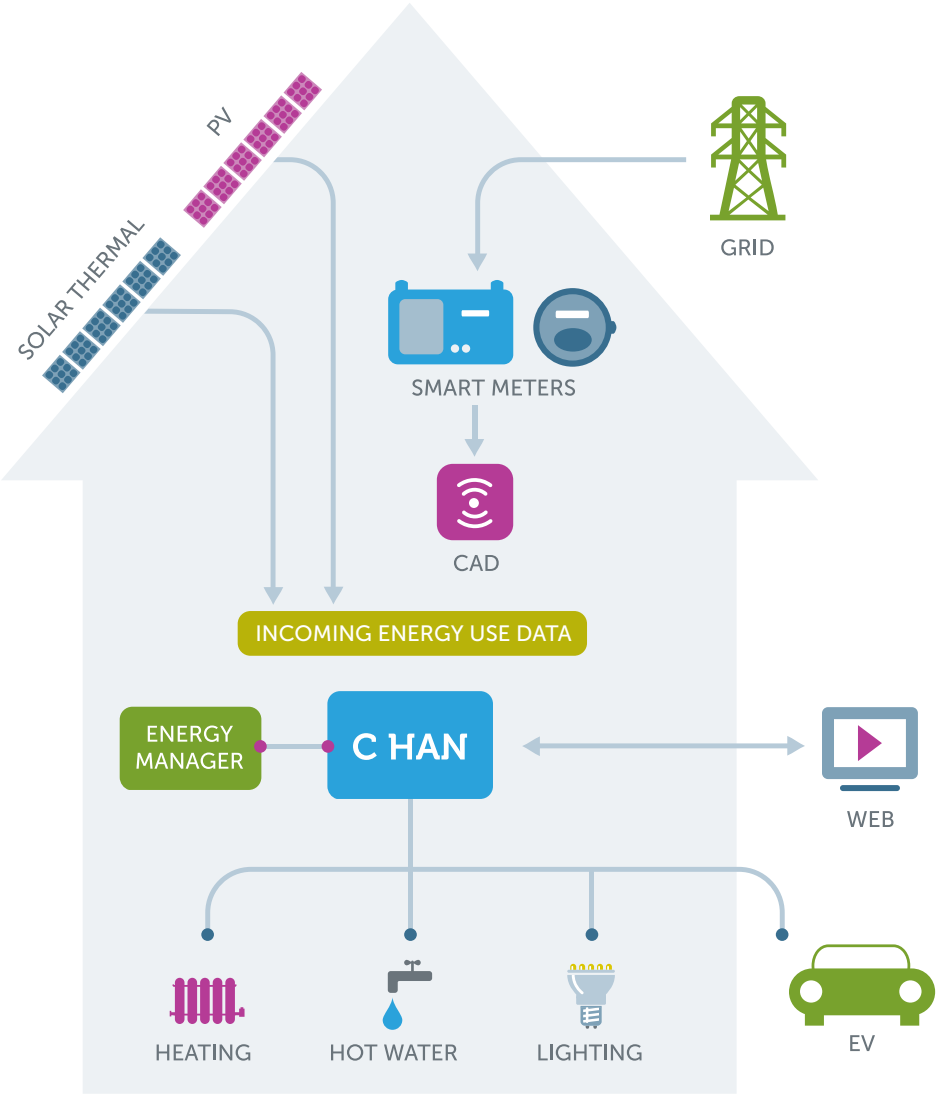



FIGURE 4: THE CONNECTED HOME

# 5
# THE CONNECTED HOME
(CONT'D)

## 5.1 'Energy Management' and the Connected Home

Managing energy in the home becomes increasingly key as a balance has to be made between central and onsite generated power, and this is where on site storage becomes a crucial factor. Further to this are the additional external signals including tariffs and potential weather forecasting.

If you consider the decision making process for any smart appliance, or whole house energy management system (Fig 5), the input of external data is very important in order to optimise the efficiency of the system, whether that be cost, comfort or lifestyle. It is therefore important that we do not limit the data available to the CAD and restrict the future, currently un-tapped, functionality in the connected home.

IT IS THEREFORE IMPORTANT THAT WE DO NOT LIMIT THE DATA AVAILABLE TO THE CAD AND RESTRICT THE FUTURE, CURRENTLY UN-TAPPED, FUNCTIONALITY IN THE CONNECTED HOME.

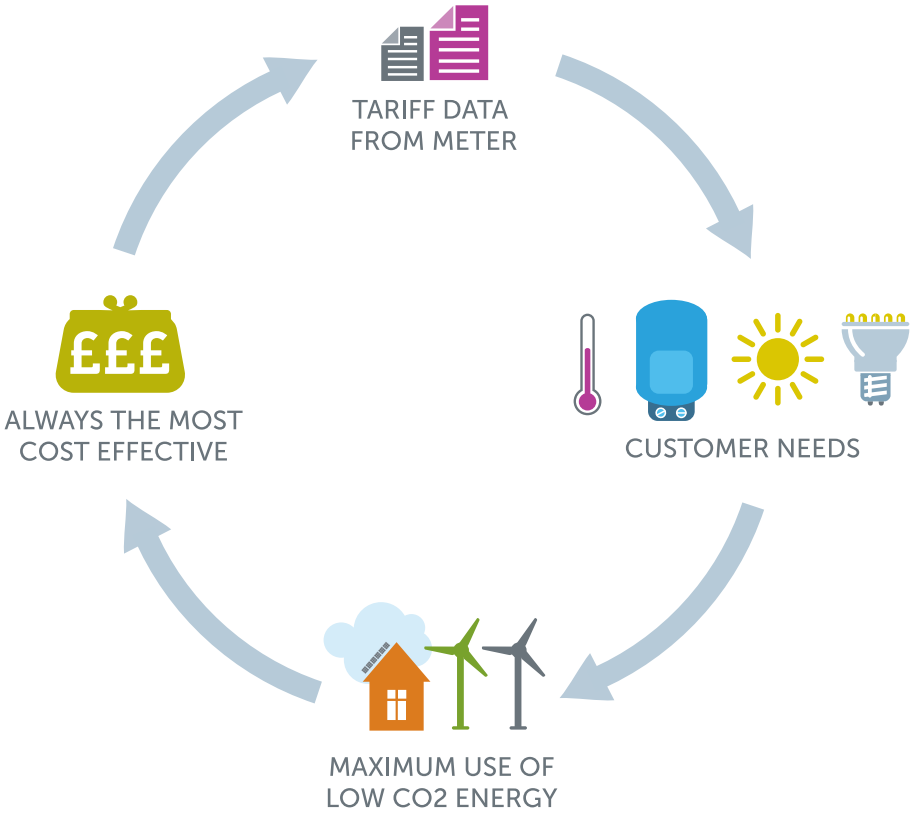



FIGURE 5: CONNECTED HOME DECISION MAKING PROCESS

# 5
# THE CONNECTED HOME
## (CONT'D)

**Work is taking place in standardisation organisations across Europe to consider how the home and its infrastructure interfaces with the grid and other external sources. The standards work covers many aspects, however, the work centres around the concept of a consumer energy manager (CEM) and the data sets that are needed to provide interoperability.**

THE ESTABLISHMENT OF A SUSTAINABLE MARKET REQUIRES THAT INNOVATION IN ENERGY SERVICES CAN EVOLVE AT THE PACE OF CONSUMER TECHNOLOGY. THE CAD IS THE KEY TO ALLOWING THAT.

In the case of a C HAN where a key focus is on controlling energy use, a form of energy manager module covering the role of a CEM is incorporated. Key elements of the design normally includes:

- methods of measuring the primary energy input to the home (today by use of pulse and toroid type sensed meters)
- meters for the key energy using circuits (power and lighting), and sensors (zone thermostats and as required presence and lux sensors)
- controls (switches, dimmers, remote valve controls and circuit breakers)
- a programmable energy manager module within the C HAN

In addition to analysing the user's incoming energy use (both primary energy from the grid and energy from onsite such as PV) it also measures the consumer's energy by use type (heating, lighting etc) and manages energy use by:

- Using sensors: temperature, light levels, absence etc coupled to programmed rules and controls
- Using programmed rules to ensure energy use remains within consumer's maximum load target by implementing load shedding types of measures
- Where some form of TOU tariff is being used, applying limited load shifting by maximising appropriate energy use at low tariff periods

All of the functionality mentioned here happens outside of the SM HAN once the metering data is delivered across the CAD. The link to the availability of the CAD will significantly enhance the effectiveness of the energy manager module of a C HAN as:

- Real time energy use and cost will be available to the C HAN enabling consumers to monitor accurately their energy inputs with that of their energy use and cost by application in the home. This will enable them to take necessary action including making adjustments to certain programmed events
- Up to date and future TOU tariff data will be available to the C HAN to enable and provide users with cost optimised measures for their key energy uses. Potential real-time peak shifting based for major energy uses where TOU tariffs justify this

From the perspective of Utilities and the Grid, the great benefit of the CAD is that it clearly delineates between "things that are the Utility's responsibility" and "things that are the Consumer's responsibility". The lifespan, rate of evolution and potential complexity of consumer devices goes way beyond most Utilities' abilities or interests in managing them, so it is right that consumers manage these for themselves. It is important to remember that about 25% of meters in UK homes today were installed before the advent of the World Wide Web, and less than 10% since the first iPhone. The establishment of a sustainable market requires that innovation in energy services can evolve at the pace of consumer technology. The CAD is the key to allowing that.

The CAD allows a user to make separate decisions about their energy supplier and their energy services provider. By separating the data via the CAD, users can make independent supply decisions based on what is best for them, creating a vibrant open market.

# 6
# USE CASES FOR CAD DATA

**In this section we consider use cases for the CAD and data from the ZigBee SE SMHAN, as currently defined in SMETS2, and also considering future applications for DSR.**

**To note we do not look at what data is sent back by the appliance. The CAD link to the ZigBee SE SMHAN is one way and therefore data cannot be transmitted back to the DCC but we do expect some low carbon technologies and smart appliances to send some signal back to the connected home management system. Lists of the type of data is available, but this will also vary by type of appliance.**

## 6.1. Smart heating controls – hot water/heat storage

Smart heating systems that know when the user requires hot water and heating can determine when best to use energy and still meet the householder's requirements. Smart heating control systems with knowledge of energy tariffs, user requirements, heating system and building characteristics and weather conditions could calculate when to take power, timing energy use appropriately and providing optimum start.

Data required:

- Active Tariff Price
- Tariff Block Counter Matrix
- Tariff Block Price Matrix
- Tariff Switching Table
- Tariff Threshold Matrix
- Tariff TOU Price Matrix
- Tariff TOU Register Matrix
- Tariff TOU Block Register Matrix

This is required for each of the two fuels (if supplied).

Use of a twin element meter gives visibility of the usage of a second circuit thereby enabling bills to be sub-divided into usage types. This second circuit is typically used for heating systems, for instance storage heaters. In this case the heating control system will also need to know the tariffs that apply to the second circuit.

To support twin electricity element meters the following additional data is required:

- Tariff switching table
- Secondary Tariff TOU Price Matrix
- Secondary Active Tariff Price
- Secondary Tariff TOU Register Matrix

In some homes heating systems are on an Auxiliary Load Control. The auxiliary Load control switch (ALCS) gives the utility the ability to turn off or limit usage on a circuit and would typically be used for high load items. In cases where these are deployed then the heating system would need to know of their presence so that it can work out how best to operate the heating system with any restriction they may be imposing. For instance the fact that part of the heating system has been turned off externally may alter how the remainder of the home heating system is managed.

To support electricity systems where auxiliary load control is present the following is required:-

- Auxiliary Load Control Switch – Calendar
- Auxiliary Load Control Switch – Description
- HAN Connected Auxiliary Load Control Switch – State

### 6.1.1 The evolution of heating and hot water systems – hybrid heat pumps

Combinations of renewable and fossil fuel heating systems have been around for many years. These systems are known as bivalent. Bivalent system controls are simple and are based on an outside temperature to switch between appliances of different fuel types. The motivation for installing bivalent systems is typically that the householder wishes to reduce high running cost and reduce their dependency on fossil fuels such as LPG and oil. The reduction in CO2 emissions has rarely been considered or measured so far. In recent years, policy makers such as DECC, and the energy providers have shown an increasing interest and realisation in the potential fuel and carbon savings of bivalent systems. During the same period manufacturers have developed and delivered the next generation of bivalent systems to market. These systems are collectively called hybrid systems and are tariff and temperature controlled (i.e. their operation is informed by a balance of electricity, gas/ oil price, outside and inside air temperature and the needs of the consumer).

The additional carbon savings of hybrid systems has been widely recognised and they received formal acceptance by DECC[6] with their inclusion in the domestic RHI and LCNF program. Hybrids are formally recognised by HHIC, BEAMA and SEA as providing a solution to reducing fuel bills, reducing carbon emissions, and most importantly as a solution to managing the increasing demands on the electricity grid with its low spare capacity.

[6] March 2013, DECC, Future of heating: Meeting the Challenge

# 6 USE CASES FOR CAD DATA (CONT'D)

Hybrids can be seen as none-disruptive technology as they require no modification to or additional 'in home' infrastructure, and will provide the majority of carbon emission savings in the transition to air source and ground source heat pumps over the next 20-30 years.

Hybrid systems are currently available and being installed in the UK. With current hybrid systems the energy tariff or static TOU is updated during the annual service. A hybrid system is also capable of responding to dynamic TOU, with the availability of data as outlined in section 6.1. to smart heating controls. The system will then decide on the most cost effective product to heat the home, accounting for air temperature and consumer's needs. While dynamic TOU is not commercially available today for domestic consumers, heating manufactures are able to provide CAD enabled controls. In the case of hybrid technologies data on gas price is also required and this is important in the decision making process of the system.

## 6.2. Home appliances and the SM HAN

Consumers can get best value by programming their appliances to operate according to applicable tariff rates.
An appliance connected to the SM HAN, typically via a CAD and some form of C HAN, will be able to determine the optimum times to undertake the requested service. For instance, the consumer can load a dishwasher and set a finish-by time, and the dishwasher will then choose the optimum time to operate, for example by waiting till a low TOU tariff applies and then operating in that period.

To determine when best to operate, the appliance would need access to the following data, available to the CAD from the Smart Metering System:-

- Active Tariff price
- Tariff Block Counter Matrix
- Tariff Block Price Matrix
- Tariff Switching Table
- Tariff Threshold Matrix
- Tariff TOU Price Matrix
- Tariff TOU Register Matrix
- Tariff TOU Block register Matrix

Using this information then the appliance can determine the most cost optimal operation for the tariff set applicable in the household; it can calculate the optimum time to use the appliance in both TOU and block tariff situations.

In most cases because of the potential complexity involved in managing this at the appliance level, the function will be more likely carried out centrally in the C HAN through some form of energy manager module. The tariff and the consumption data available through the CAD will allow a consumer and for example, a utility, to agree and implement appropriate load shedding measures where desired.

It should be noted that in all of the use cases described in this document, the data may also be shared by the appliance with other platforms in the C HAN. This data might include appliance status (on/off/current energy usage/ current cost of usage), alerts such as washing finished and historical information such as cost of operation (per operation or over time).

## 6.3. Cloud Services

The CAD can send data gathered from the SM HAN and the C HAN to the cloud to enable the provision of energy management applications to consumers, such as:

- 'IHD like' live high-time-resolution energy consumption data (eg. energy dashboard)
- Additional energy services (eg. tariff advice, energy saving advice, switching services, energy audits, appliance information, appliance disaggregation, etc)
- Energy consumption and cost comparisons with social norms or with other consumers or groups of consumers (eg. energy saving competitions and campaigns)
- Integrating with other data and platforms that may not be connected to the SM HAN or C HAN (eg. weather forecast)

This information can be delivered in many ways to suit the needs of individual consumers, and many of these application are already in place today, these include:

- Offline (email or paper)
- Online (web portal)
- SmartPhone App
- iGoogle gadget (search home page), or yahoo software (computer desktop)
- Facebook page
- Text message
- Smart TV

# 7 ROUTES TO MARKET

**The CAD is a consumer device and there will be multiple routes to market (e.g. through the energy supplier, CAD manufactures, other services providers). The CAD is complimentary to the IHD and will exist in market alongside IHDs and other consumer HAN devices. BEAMA expect significant market innovation in this sector which is already evident today.**

The key driver for the CAD is the rollout of smart meters and arrangements for local CAD pairing. Any delay in this rollout and the development of a sound local CAD pairing platform would hold back market developments for CADs and corresponding data applications as referenced in this paper. Further to this the CAD market requires some clarity on the future role of DNOs, utilities and 3rd parties in providing services to consumers and applications for their energy use data.

The market will drive the development of common protocols on the 2nd Protocol Stack (Fig 2) and BEAMA is working with manufacturers across the Connected Homes sector to develop standards for data gateways and establish interoperable platforms. Manufacturers today can already demonstrate various forms of functionality from the CAD.

Only 3 Type 2 devices are permitted to pair with the SM HAN, this includes the mandated IHD, so the consumer is limited to 2 additional CADs. This would quickly be taken up if CADs are embedded in appliances directly / or separate controls. It is our understanding that the number of type 2 devices are not to be increased, we therefore anticipate that one CAD may provide a simple gateway into the home, the secondary stacks provide a link to distribute data to multiple appliances or the cloud.

The CAD can have a number of physical implementations and this will depend on the manufacturer and the service the consumer is signing up to. It is expected more options will evolve through innovation in the sector. These currently include:

- Standalone box connected wirelessly to the router (typically via Wi-Fi)
- Standalone box connected via Powerline
- Co-located box connected via Ethernet to the router
- Embedded with router
- Embedded within IHD
- Embedded with Home Energy Management System or Consumer HAN

## 7.1. Application Platform Interfaces – UK market growth and compatibility

BEAMA is aware of the multiple Application Platform Interfaces and cloud services developing on the market today for domestic consumesr to manage their energy use in real time. These include Nest, The Thread and Hive.

Market projections for this sector vary considerably but expectations are that up to 27% of UK households will have at least one smart system, including smart thermostats and management platforms by 2020 (Strategy Analytics). Market growth in this sector is significant as 3.1 million homes will have smart control, which could also be connected to their security and assisted living systems. We can therefore expect the opportunity for CO2 reduction and energy savings for individual consumers to be extensive if they can take full advantage of appropriate TOU tariffs.

Concern has been raised to BEAMA over the compatibility of these systems with the UK Smart Metering system. The 2014 DCC development plan provides for a Second General Objective that will 'support programs that will enable a transformation in the supply of energy and operation of networks for the benefit of the consumer' and ' deliver value for money for the consumer and the energy industry by maximising the utility DCC service'. It is therefore realistic to expect that the DCC communication infrastructure will evolve to accommodate a variety of value adding services, some of which these platforms may provide.

With multiple communication platforms emerging onto the market, and in order to ensure compatibility in the UK, we must focus our attention on dependable system integration. The design of this will be critical to ensuring that we can pass a standardised message between devices and organisations, and thereby develop a trusted and sustainable market for products and services in the UK.

Multiple 3rd party systems will evolve under their own business drivers and will continue to do so. The UK's market ability to integrate and maintain multiple ever-changing systems will determine its success in this sector. This work is heavily dependent on international standards.

# 8
# CONCLUSION

## A competitive market for the supply of smart metering consumer products and services is emerging to support the smart meter rollout and the CAD is an integral part of this.

**In conclusion BEAMA agree that a strong uptake of CADs will empower consumers, and allow them access to their real time data and therefore more advanced energy management. This is a key market step to ensure the adoption of demand side response.**

The UK Smart Metering rollout places a strong emphasis on consumer benefits and the potential for energy efficiency savings, evident in their allowance for CADs, compared to the primary focus of many other countries, on the management of supply, reducing losses and administrative costs. As a result, the extent and pace of the market demand for consumer engagement solutions in other markets is not yet as clear as the UK providing a market edge and opportunity to take a lead and develop export opportunities.

With the key step being the smart meter rollout we expect it will be some time before consumers have wide spread access to CADs, but as soon as they do, and real time data is then made available in the C HAN, we can expect significant innovations in the efficiency and smart functionality of consumer services, including heating and hot water.

It is evident that there is already a considerable level of innovation with many new APIs developing on today's market, but these lack real time data. Consumers will be able to extract more value from these innovations with access to their data and the ability to store this.

**WE WILL BE CONTINUING WORK ON MANY OF THE AREAS RAISED IN THIS PAPER.**

There are some major steps to go through before we can establish a market for CADs and extract the true value of some of these applications in the C HAN, these include:

- Timely Smart Meter rollout
- Local CAD Pairing
- A clear commercial framework for service providers and an understanding of the role different service providers may have (DNOs, utilities, 3rd parties etc)
- Reform of existing tariff structures and the introductions of dynamic TOU
- For more advanced demand side response and specifically if we consider dynamic TOU, additional data will need to be made available through the SM HAN
- International and European standards are being written today and this may affect how the market develops so we need strong UK input on this work
- Further behavioural research on the impact of such devices on demand side response

We are entering into an exciting time with many consumer innovations for home energy management, and other services (assisted living), and consumers will increasingly have access to a range of functions and means to visualise, store and apply their data, depending on their needs and priorities.

BEAMA invite readers of this document to engage with us and our members to help drive this market forward and importantly empower consumers to extract value from this. We will be continuing work on many of the areas raised in this paper.

# ANNEX

## Data available to an authorised CAD

The following sub-sections describe what data is available to a CAD from the Smart Metering HAN. This data can then be accessed and made available to other devices.

### A. Gas

Accumulated Debt Register;
Active Tariff Price;
Calorific Value;
Consumption Register;
Contact Details (of supplier);
Conversion Factor;
Cumulative and Historical Value Store (consumption and cost of consumption data);
Consumer Identification Number;
Daily Gas Consumption Log
Debt Recovery per Payment;
Debt Recovery Rates [1 ... 2];
Debt Recovery Rate Cap;
Debt to Clear (amount consumer needs to add to get credit back to zero);
Disablement Threshold;
Emergency Credit Balance;
Emergency Credit Limit;
Emergency Credit Threshold;
Low Credit Threshold;
Meter Balance;
Meter Point Reference Number (MPRN);
Non-Disablement Calendar;
Payment Debt Register;
Payment Mode;
Profile Data Log (13 months of half hourly consumption data);
Standing Charge;
Supplier Message;
Supply State;
Tariff Block Counter Matrix;
Tariff Block Price Matrix;
Tariff Switching Table;
Tariff Threshold Matrix;
Tariff TOU Price Matrix;
Tariff TOU Register Matrix;
Tariff Type; and
Time Debt Registers [1 ... 2].

### B. Electricity

Meter Variant (type of meter – e.g. single/twin element)
Auxiliary Load Control Switch – Description
Contact Details (of Supplier)
Consumer Identification Number
Debt Recovery per Payment
Debt Recovery Rates [1 ... 2]
Debt Recovery Rate Cap
Disablement Threshold
Emergency Credit Limit
Emergency Credit Threshold
Low Credit Threshold
Low Medium Power Threshold
Meter Point Administration Numbers (MPAN)
Medium High Power Threshold
Non-Disablement Calendar
Payment Mode
Standing Charge
Supplier Message
Tariff Block Price Matrix
Tariff Switching Table
Tariff Threshold Matrix
Tariff TOU Price Matrix
Tariff Type
Accumulated Debt Register
Active Export Register
Active Import Register
Active Power Import
Active Tariff Price
Cost of Instantaneous Active Power Import
Cumulative and Historical Value Store (consumption and cost of consumption data)
Daily Consumption Log
Debt to Clear (amount consumer needs to add to get credit back to zero)
Emergency Credit Balance
Meter Balance
Payment Debt Register
Power Threshold Status
Profile Data Log (13 months of half hourly active and reactive import and 3 months of active and reactive export data)
Randomised Offset
Supply State
Tariff Block Counter Matrix
Tariff TOU Register Matrix
Tariff TOU Block Register Matrix
Time Debt Registers [1 ... 2]
Also available where the ESME installed is Twin element metering equipment:
Secondary Tariff TOU Price Matrix
Primary Active Power Import
Primary Active Tariff Price
Secondary Active Power Import
Secondary Active Tariff Price
Secondary Tariff TOU Register Matrix
Secondary Active Import Register
Profile Data Log will also include data for second element.

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