The Benefits of Energy Visibility

A BEAMA white paper

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Issued by BEAMA's Consumer Energy Display Industry Group (CEDIG) which represents the majority of the UK's manufacturers and service providers of in-home displays (IHDs) and online energy services. For further information please see:

http://www.beama.org.uk/en/energy/consumer-energy-displays/

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CEDIG Members are:

- 2 Save Energy Ltd (Owl)
- AlertMe.com Limited
- Chameleon Technology (uk) ltd
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1. About this document

We are at the start of an energy revolution. Whilst we have focussed to date on moving to renewable generation, we must recognise that it is equally vital to also change how energy is *consumed*. We need to reduce consumption to the point where renewables will suffice, and we need to adapt our consumption to their variable supply. About one third of all energy consumption occurs within our homes, so engaging and empowering householders is vital to deliver energy change at the necessary scale and speed. This document articulates the key tools and technologies which are already starting to make that happen.

Here we introduce the broad category of Consumer Energy Displays and explain their different types, then describe the many ways in which they can transform complex energy data into simple, actionable consumer information, to the benefit of consumers, generators and the planet.

Written by CEDIG members in the UK, the contents of this document are informed by – and indeed have informed – our own government's plans for Smart Meter rollout. However the topics covered here are of relevance to all geographies, because consumer empowerment through Energy Feedback is an essential component of achieving energy transition.

Acronyms are explained in the Glossary on the last page.

2. Executive Summary

Consumer energy surveys regularly report that consumers are not engaged with their energy use. Consumers have limited or no understanding of terms such as kWh and Tariff. CEDIG members recognise this and produce solutions to help educate consumers about energy usage. This means using energy data to empower consumers and move them past their only current form of engagement – the quarterly bill.

The European energy market is changing in ways that would never have been considered a decade ago. Generation is becoming more democratised with many more forms of generation that need to be accommodated, even down to individual micro-generation. For the first time, many households are able to supply energy to the grid, possibly even being a net exporter. In the next decade we will see ownership of electric vehicles increase, introducing new peak demands, and possibly starting an era of distributed storage.

All of this means that home consumption patterns are changing rapidly, as a new range of energy devices appear in our homes, including Solar PV, Solar Thermal, Electric Vehicles, Heat Pumps, Smart White Goods, microCHP, Intelligent Heating and Online devices.

The effective management of these devices represents a real opportunity to achieve our goals of reducing carbon emissions and dependence on energy imports, bringing benefits to society, the grid and the consumer. They also pose a major challenge for existing distribution and management models. To survive this change, we need to enable new services from new suppliers who can innovate at the same rate as these potentially disruptive technologies appear. To achieve this, and to mediate between the needs of the Grid (e.g. adapting household demand to cope with variable supply from renewables) and the needs of the Consumer (e.g. ensuring that the washing-machine finishes on time at the lowest possible cost) they need access to data.

These new technologies bring significant challenges:

1. Consumer appliances evolve much faster than Utility technology. Smart Meters and their associated technology must work as-is for decades, whereas Consumer technology evolves year-to-year. We cannot today accurately anticipate what consumer devices and services will be popular in 10 years time.
2. Consumer appliances use a variety of physical standards which are themselves rapidly evolving. It is highly unlikely that all manufacturers will suddenly support a single physical interface or speak a single language.
3. It is simply not practical for utilities to assume responsibility for managing all of these consumer devices in the home – even if consumers wanted them to (which they don't).

All of these rely on energy data being "open", that is, accessible to the consumer and third-party products and services that they choose to apply to it.

Energy visibility helps governments achieve their goals regarding climate change and energy security, and helps consumers manage and reduce their bills. Energy retailers can use it to deliver their obligations, establish a presence in the lives of their customers, and (in competitive energy markets) differentiate themselves from their competitors, driving further competition and therefore consumer choice.

This is not a description of some possible future. All the products and services described here already exist and are in use by UK consumers, with utilities and others supporting mass-scale deployments ahead of the installation of Smart Meters. This paper therefore proposes that the Smart Metering program in all geographies recognise these benefits and ensure that they included within national deployments of Smart Meters.

Four key factors for Smart Meter success

Having analysed the successes and failures of earlier Smart Meter rollouts, and also of consumer-facing energy products and services which are independent of Smart Meters, we have concluded that successfully delivering benefits from Smart Meter roll-out depends on the following four key factors:

1. Supplying Energy Displays to every home by Government mandate.
2. Allowing consumers access to their energy data, in the home and online, live and historical. This means:
   - Enabling home owners to easily connect products and services to their Smart Meters; and
   - Open standards with a consumer-friendly security model
3. Marketing of the consumer benefits of Smart Meters by Utilities, Government and, other trusted bodies, through co-ordinated publicity programs and outreach.
4. Promotion of new markets for energy services which Smart Meters support enabled by Government and Regulators.

3. Energy Feedback

At present the vast majority of UK energy customers receive a single figure for their energy consumption, at very infrequent intervals – and even this is often an estimate. The traditional meter (gas and electricity) simply shows the current cumulative consumption value in cryptic units and is seldom conveniently located for consumer use.

The basic principle of energy feedback is to make much higher resolution consumption data available in near real-time via convenient products and platforms, presented in a way that allows the customer to make informed decisions on their energy use. By "high resolution" we mean that the information is much more frequently updated than at present, for example an in-home display may update its display every few seconds. For the first time, this makes it possible for consumers to start to understand the consequences of their actions – turn on the kettle and see the display immediately go into the red.

This section sets out the principles of energy feedback, how it can benefit consumers and the key requirements to ensure that smart meter roll outs deliver the consumer benefits expected of them.

Evidence of Benefits

A comprehensive study in 2011 by ESMIG/VaasaETT of global Smart Meter rollouts and scale trials, named the 'Empower Demand' study, showed that those which included In-Home Displays (IHDs), giving consumers real-time energy feedback, achieved substantially greater sustained energy reduction.

The study examined all of the Smart Meter rollouts to date worldwide. It supports the view that it is both important for an energy consumer to be able to interrogate consumption data in a way that is relevant to them; and additionally that greater energy savings can be made if some automation of appliances is included in the energy efficiency proposition (16 – 31% energy savings with automation versus 8% using an IHD alone)[1].

CEDIG members have observed several interesting points from studies of their customers and of the general UK population:

1. A significant number of consumers desire their energy information online, for example through a Smart Phone app or the web.
2. When consumers are given IHDs which store data, a significant number of consumers choose to upload this data online, in order to benefit from the online services.
3. Owning an IHD increases the desire for online services. So an IHD is the initial step in customer engagement, not the final one.

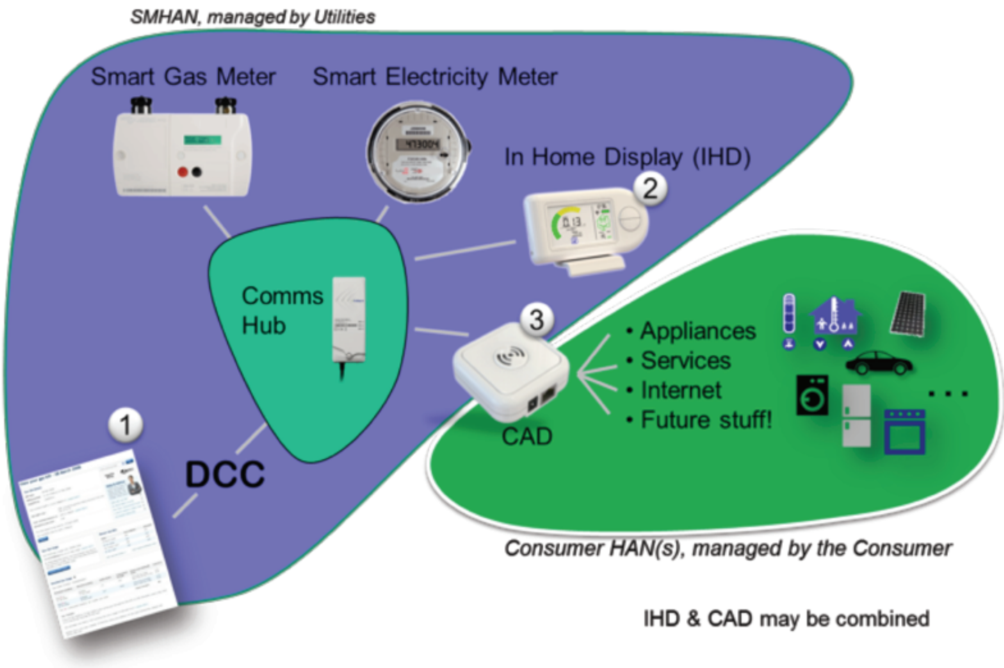
[1] VaassaETT Empower Demand, section 4.10 http://www.esmig.eu/press/filestor/empower-demand-report.pdf

4. Three types of Consumer Energy Display

There are three broad types of Consumer Energy Display. The numbering refers to the diagram below:

1. Offline
2. In-Home Display (IHD)
3. Consumer Access Device (CAD)

Note: this diagram portrays a UK architecture. The DCC and Comms Hub are not required to the enablement of consumer benefits for example similar interfaces enabling IHD/CAD and therefore consumer benefits are specified in the European M/441 mandate.



1. Offline (historic data)

Consumer behavioural change happens when consumers get access to a meaningful level of data. Even historic data can provide interesting and useful insights regarding their consumption pattern, and is usually delivered via the household bill (either paper, email or online). Historic data lets consumers compare their behaviour to similar households and track the effect of changes they make, which is key to showing how they can benefit by changing their behaviour. This requires a store of data which may have been manually submitted (e.g. monthly or weekly), or which consists of half-hourly readings automatically collected from Smart Meters over the metering Wide Area Network (WAN). Currently, and even once Smart Meters are ubiquitous, this data is not truly live, so cannot give immediate feedback to changes in usage pattern, which makes it harder for consumers to connect their actions to the resulting change in their energy spend. Even in the future, the UK specifications only envisage that this data will be sent from the meter once per day. In addition, a lot of potentially useful information cannot be shown because of the low-time-resolution nature of the data.

Typical benefits of offline (historic) data include:

- Seeing how you compare with others
- Predicting your next bill, annual spend etc.
- Checking you are on the best tariff for your consumption levels and patterns
- Receiving tips on your best ways to save. These are based on your data so are specific not generic, e.g. "You use 35% more gas than your neighbours, probably because your insulation needs upgrading. For a £200 investment you would save an estimated £300/year."
- Taking part in competitions or other "gamification" to increase engagement

This can be either a website, or an App for a Smart Phone, Tablet, online TV etc.

Utility database – Smart Meters also have a Wide Area Network (WAN) connection, through which basic consumption information is uploaded. This is low data resolution (30min), with an hourly, half hourly or daily update, and is sufficient for billing purposes.

Integrated platforms – Some platforms integrate data coming from the Consumer Access Device (CAD) with billing information (integrated with utility's management system – such as SAP). Some other applications take data directly from smart meters via the Utility's database (without the use of a CAD – although this will not the case in the UK).

Energy bills and reports – While now quite "old fashioned" (even when delivered by email), the good old utility bill is a regular point of engagement with consumers, and can be a good place to put simple contextual, personal messaging to help consumers understand what actions they can take to reduce their bill.

2. IHD (live data)

Millions of UK consumers have had their first real engagement with energy usage via an IHD that is wirelessly connected to a current transformer clamp on the cable to their meter. According to numerous focus group reports, most consumers think that this is a Smart Meter. In the near future when Smart Meters are installed similar IHDs will be connected, securely and wirelessly, to the Smart Meter Home Area Network (purple SMHAN area in above diagram) receiving data directly from the meters.

It will also be possible for more engaged users to buy and connect enhanced IHDs if they want to access additional features, with the assumption that there will be a competitive market for these displays. This will only succeed if it is easy for consumers to attach a new IHD to their SMHAN, replacing or augmenting the one given to them by their energy retailer during the Smart Meter installation.

The great benefit of the IHD is that it makes the invisible visible: it displays the instantaneous live power consumption of the house, updating every few seconds for electricity and every 30 minutes for gas. The IHD has been mandated as part of the UK Smart Meter rollout, and so for the first time every consumer will be able to see how much energy they are consuming. Most IHDs also provide additional information to help engage the user, typically being able to:

- Translate energy consumption into more meaningful units for consumers such as £/day.
- Cumulative summary of consumption, e.g. how much consumed today / last week etc.
- For a Time of Use or Demand Response tariff, show the current and future price of electricity.
- Provide behaviour-change triggers, such as showing progress against targets.

However, while a basic IHD educates and provides a real time view of energy usage, it can't then answer some of the questions that arise as a result, such as "what's using energy at any specific time?" and "what can I do to reduce my bill?"

Documented benefits of IHDs are:

- Increased level of customer education and engagement.
- Reduction of overall consumption and cost saving.

3. CAD (live and open data)

The Consumer Access Device (CAD[2]) provides the link between the Smart Grid and the rest of the consumer's world, opening the door to the future of the Smart Home. It speaks one messaging protocol to the metering network within the home, whilst potentially speaking multiple protocols to individual consumer devices and external services.

The CAD connects to the SMHAN in the same way that the IHD does. 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:

- Uses it locally to help manage appliances in the home (e.g. running appliances when energy is cheap).
- Streams it via the consumer's broadband connection into the Cloud, where a multiplicity of online services can turn it into value to the consumer in many different ways, making that data available in the places where the consumer wants it.

[2] Terminology: In this paper we adopt the term "Consumer Access Device" first used in DECC's Electricity Meter DDS issued in Feb 2012. Note that this same device has been variously referred to in earlier documents from industry and government by a variety of names including "Trusted Bridge", "Trusted Gateway Interface", "Consumer Access Portal", "Consumer Gateway" or simply "Hub". The key feature of all of these devices is that they enable the transfer of smart meter data streams beyond the smart meter system into other consumer devices and/or services.

Again, this is not a future vision. These Cloud services are already bringing new energy management applications to consumers:

- Delivering 'IHD like' live high-time-resolution energy consumption data anywhere, anytime e.g. via a Web browser or Smart Phone app.
- Delivering all the same information as the Low Resolution service, but within an interactive environment and in much greater detail (e.g. tariff advice and switching services, based on real consumption patterns).
- Detecting the usage pattern of individual appliances using disaggregation, as a step towards itemised energy bills.
- Offering specific energy-saving tips, based on a consumer's actual usage, e.g:
  - "If you always ran your washing machine at 30°C you would save £65/year"
  - "By boiling only a cupful of water you could save £25/year"
  - "Your dishwasher is costing you £45/year to run."
  - "Your fridge is behaving as if it has an E-class rating – or perhaps the seals have failed or it needs defrosting. Click here for tips or coupons towards a new A++ fridge."
- Drawing a user's attention to malfunctions in real time, such as:
  - "Your fridge is running continuously – have you left the door open?"
  - "Your iron is still on but you seem to have left home"
- Offering other advice, e.g.:
  - "It looks like you typically leave home at 8:30am and return home at 6:30pm, but your heating is still on for an extra hour after you leave. By changing your heating settings you could save an estimated £85/year (click for help)."

The CAD takes the consumer's data and makes it available to them as useful information, and does so wherever they spend their attention – which increasingly means online, although information can be delivered in many ways to suit the needs of individual consumers including:

- Offline (email or paper)
- Online (web portal)
- SmartPhone App
- iGoogle gadget (search home page), or Yahoo widget (computer desktop)
- Facebook page
- Text message (e.g. "Warning: You are going to exceed your target by 35%").

The CAD allows information to be presented in a more friendly way than with an IHD, because of the increased and more flexible real-estate available on a Web page or Smart Phone app.

But CADs don't just provide additional information; they also enable Control and Automation. The CAD can react to events in the home, working with other devices to automatically turn off appliances and turn down heating when the home is unoccupied. The CAD can be controlled remotely via the user's broadband link, so that the consumer can "act" in their home even when they aren't there. It can react to events both live and predicted, such as pricing signals or weather forecasts.

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 sobering 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. 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 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.

Unlike a fixed IHD product, the services delivered by a CAD can continue to evolve in response to the needs of the consumer and the changing energy landscape, keeping it engaging and useful. It is the obvious next evolutionary step in user energy engagement.

The IHD and CAD are not distinct

From the point of view of the SMHAN, the IHD (2) and CAD (3) are identical – they are authenticated in the same way and have access to the same SMHAN data.

It's also important to appreciate that if one takes an IHD and gradually augments it through making increasingly sophisticated use of energy data, and starting to interact with other household or online products and services, then it gradually turns into a CAD. There is no magic point where one becomes the other. Therefore combined devices will exist, which have a local display and also reach out to other services

5. Energy Data

Many types of data flow through the SMHAN. There has been much discussion about which data Utilities require in order to deliver accurate bills. Far less attention has been paid to which data Consumers require in order to empower them to act to reduce their consumption and this document addresses this question.

A key success criterion for the UK Smart Meter rollout is that the Consumer can benefit from using their data. This means that SMHAN data must be accessible to the Consumer and, with their permission, to third-parties acting on their behalf. Third party products and services (such as those from CEDIG members) convert this SMHAN data into "actionable information" for the consumer.

So in this section we outline the various sources of consumer energy data, describe how they differ, and introduce a set of applications for that data.

Energy Data Sources

Domestic consumption information today comes from several difference sources.

Existing "dumb" meters

Regular manual reading of the existing dumb meter and manually converting the reading to an actual cost, although very inconvenient, has proven surprisingly popular amongst a segment of the population, for example with the British Gas "Energy Smart" program. It's most immediate benefit is a reduction in bill shock.

"Clip-on" Current Transducer (CT) installed on the meter cable

This is a simple technology which a consumer can fit themselves to existing meters. The current transducer sends regular readings, typically to an in-home display, which then shows the consumer instantaneous power consumption ("kW") and cumulative totals (e.g. "kWh today" or "£ today"). It thus provides the consumer with high resolution real time data for electricity (although not gas because no easy retrofit solution is available). CT transducers are generally somewhat inaccurate (e.g. +/- 5% or so) due to voltage fluctuation. This means that any numbers on the display may not exactly match the bill, but that does not prevent it being a very useful means of increasing energy awareness and driving down consumption (which is after all a relative activity). Millions of current-clamp IHDs have been given out to UK consumers as part of the government's CERT scheme. Current clamps typically can only be retrofitted in countries where meter tails are accessible (UK, Australia).

Pulsed output meters (optical or wired connection)

Some more recent meters offer an alternative to current clamps. These allow the use of an optical detector to sense an optical pulse directly on the meter, and then send live consumption information to an IHD in the same way as a CT clamp. They are as accurate as the meter itself and can be used for electricity, water and gas, and provide reasonably high-resolution data (although less so than a CT clamp at low consumptions, due to the long intervals between pulses).

Smart meters

These provide relatively high-resolution, accurate, real-time data for electricity and gas. Many so-called smart meters in the world are really not that smart. They just communicate readings back periodically to the Utility, saving the cost of manual reads. These are called AMR/AMI meters. Modern Smart Meters, of the type about to be deployed in the UK and elsewhere, are considerably smarter, and exist on a local Smart Meter Home Area Network (SMHAN) to which other devices can be connected, including IHDs and CADs.

Energy Data Resolution

Data can be provided by the above means to consumers at various time-resolutions. Historically paper billing provides very low resolution data and because this data refers to a period of time way in the past (often 2-3 months ago) it is difficult for energy consumers to relate their energy consumption to their behaviour.

With higher **resolution** data (i.e. more frequent reads) it becomes easier for consumers to make the connection between their behaviour (use of heating, ventilation, appliances, lighting and other actions such as leaving doors and windows open) and the resulting changes in consumption of electricity and/or gas.

It is not only the resolution of data but the **promptness** of delivering the data that will help engage consumers with energy consumption. So, for example, with CTs delivering data to a real time display, a consumer can switch on an electrical appliance and within a few seconds see the resulting increase in energy consumption. If this information is delivered in terms of a cost then the consumer is very likely to realise that they should use this appliance more efficiently in order to reduce consumption because that change in behaviour will reduce their spend on energy. This same resolution of data (i.e. updated every 2 seconds) could be logged and delivered to the consumer one hour/day/month later but it would be of far less use because the consumer cannot relate exactly what energy consuming behaviour was undertaken at the time of use. So optimal understanding of how a user's behaviour relates to their energy consumption is achieved when they are given high resolution, real time data. This leads to an overall better understanding of energy consumption and a general change in behaviour amongst consumers to more efficient usage of energy.

High resolution real time data is useful in helping consumers understand individual appliance energy consumption and in making the direct connection between their behaviour and consumption of energy. High-resolution data also contains information about individual appliances which (if it's "crunched" automatically by computer) can help consumers better engage in energy reduction.

Lower resolution delayed delivery of data (e.g. logged at 5 minute intervals or more) can be very useful in helping consumers understand their daily consumption profile of energy. If data is shown graphically then it's easy for a consumer to see the peaks and troughs of usage throughout the day. This can help identify periods of the day when, for example, heating is being used but nobody is in the house, or it might help a consumer to notice that they have a very inefficient fridge that consumes a lot of energy 24hrs a day.

Low resolution data (e.g. hourly or daily) can help consumers understand their consumption profile over longer periods of time. This is useful in monitoring changes in consumption due to efficiency measures (e.g. installation of insulation or solar panels).

Very low resolution data (e.g. weekly, monthly) can help users understand seasonal effects on energy consumption and to understand the results of implementing changes to behaviour or installing efficiency measures such as insulation.

Energy Data Applications

Live Energy Visibility

Literally making energy visible, at-a-glance on a real-time display typically in a living space such as a kitchen or lounge. This draws consumers' attention to unexpected events, alerts and notifications such as an imminent change in tariff. This is absolutely vital if complex Time of Use (ToU) tariffs are ever to be introduced. It allows the consumer to correlate their behaviour (using an appliance) with the result (consuming energy, therefore increasing their energy bill). "Live" means every few seconds for electricity and every half-an-hour for gas (due to limitations of the battery in the gas meter). As well as showing instantaneous values (power) this can show cumulative values so far this day/week/month (energy) and comparisons with past intervals too.

Live and historical energy use is much more meaningful to most consumers if translated into £/p. This can be short-term (e.g. current power translated into £/hour), or cover the current billing period in which case it is an indicative bill.

It is also possible to translate energy use into carbon-footprint terms, so that particularly environmentally-conscious consumers can minimise their footprint, although CEDIG members have found that this is not something that most consumers relate to.

Energy Context and Time of Use

As our supply becomes increasingly based on renewables, we will need to move from a world where energy supply has to follow demand, to one where demand has to adapt to supply. Energy prices will therefore become more variable, changing according to time of day and generation capacity. That means that the industry needs to try to incentivise consumers to reduce peak grid loading. If this is to happen, it's important that consumers can see and understand both the current and future price of energy, i.e. the current and upcoming tariff rate. That's because consumers need to understand whether now is a good (cheap) time to be doing discretionary time-shiftable activities such as washing, drying, using the dishwasher etc.

To permit this, it is vital that IHDs should show consumption in cost terms (e.g. £/hour). Opportunities also exist to use this signal to manage the storage of local energy (e.g. today as heat in space and water heating, and perhaps in the future in batteries), or the costs of borrowing it (e.g. from an EV) which might include taking into account parallel (non-utility) tariffs.

Energy is a very abstract concept, and even when turned into pounds and pence it's just a number which is hard for most consumers to interpret – are they getting good value for money? Providing some context around their consumption is shown to affect behaviour (so-called "behaviour change"). This can take the form of:

- Comparison with yourself. Are you using more energy than you were yesterday, this time last week, this time last year?
- Descriptive Norms. People don't like to stray outside of mainstream behaviour. So "most people in similar homes are consuming 20% less than you" is a powerful message.
- Injunctive Norms (culturally approved/disapproved behaviour). "Well done, your savings last year are equivalent to planting 100 trees".
- Comparison with others. "You use 35% more gas than your neighbours, probably because your insulation needs upgrading. For a £200 investment you would save an estimated £300/year".

It is also helpful to consumers to predict their energy usage, helping them to budget, or to hit a reduction target.

In our competitive energy market, consumers also need information about the benefits they could receive from switching supplier. For example how much would switching to a new supplier or tariff save them, based on their actual consumption patterns?

Prepayment

Smart Meters will allow the energy account to be run either in credit mode where the consumer pays in arrears for example by monthly variable direct debit, or in prepay mode where the consumer has to pay-as-they-go. These two models will be familiar from the mobile phone market, and it is expected that the prepay energy market will grow substantially, as prepay helps consumers to budget and utilities avoid the costs of debt-collection

Analytics

Frequently-updated power data, with a time-resolution of at least one reading every 10 seconds, allows automatic algorithms to "disaggregate" the household consumption, detecting the operation of individual appliances, and revealing when and how they are being used. It is not necessary to detect every appliance in the home; limiting this to major appliances allows the consumer to be presented with a full "itemised bill" for their household, These algorithms are run either in the home in a CAD or IHD, or in the Cloud, and their operation is entirely automatic – the consumer sees only the results.

For example, if Analytics detects that a consumer is often setting their washing to do 90°C boil washes, it can give them feedback that with modern detergents washing at 30°C could give the same results but save them a substantial amount of money (e.g. £80/year). It can even predict accurately how much it would save them. Generic government energy-saving advice often isn't terribly effective because no-one thinks it applies to them. But when it is turned into specific, personal, quantified advice, the consumer is far more likely to accept it and use it to make a reasoned choice.

The kind of appliance-use information detected by disaggregation technology can also be used for other purposes, for example warning the consumer of abnormal situations, such as if they have left the fridge door open, or left the oven or iron on but gone out. It can also spot the gradual failure of appliances such as fridges and boilers, and suggest pre-emptive maintenance.

This doesn't just apply to electricity. Although gas data is much lower-resolution, the majority of energy consumption in UK homes is from gas use (heating and hot water) and therefore this is an important area to subject to analysis and behaviour change, for example by pointing out ways to optimise the heating system to reduce costs, or improving home insulation.

The patterns of consumption of appliance use can also be used to detect whether a vulnerable individual is acting normally, and to raise a timely alarm to carers if there are unexpected changes in behaviour. And a similar pattern, if explored over a longer timescale, can be used to give consumers an overall "big picture" of their energy consumption, for example through the different seasons, which can suggest behavioural and other changes.

Automation

If we give consumers information about their consumption, and manual control over it, then we have in theory empowered them. They can see what they need to do, and then do it. However if we stop at this point then we have still left them with a management burden – they are "in the loop", responsible for actually digesting that information and turning it into action. There are many reasons why they may not want to or be able to do this, including lack of time, lack of education, or lack of interest. Therefore it is also very important to deliver solutions for automating beneficial activities in the home, so that technologies which can drive increasing energy efficiency and comfort are "fit and forget". Examples of good automation include white goods which respond to pricing signals to automatically run themselves at the cheapest time, or heating systems which respond to occupancy (which can be detected by observing consumption patterns) in order to turn down the temperature when the home is unoccupied and therefore save energy.

Earnings

Of course we're moving into a future where consumers are increasingly producers too, from solar PV panels, and in future perhaps fuel cell boilers too. Microgen owners like to see how much money they are earning with their FIT or RHI tariffs, and what their net financial position is (i.e. whether they are a net producer or consumer in economic terms, or in energy terms). As anyone with solar panels will tell you, seeing that your home is a net producer (right now, or over the past day) is a very good feeling which you then feel strongly incentivised to achieve again and again.

6. Conclusion

We hope that this Paper shows how relatively simple energy data can offer many benefits to the consumer; directly, by reducing their consumption through behaviour change and automation; and also indirectly, by prompting them to take-up other measures such as insulation, by helping them see and quantify the benefits.

Unleashing energy data can lead to consumers who feel – and are – empowered to make decisions in their own interest, that of UK energy security and ultimately for the planet, leading to an engaged and positive attitude to energy use.

All these benefits rely on consumption data being available, at high-time-resolution, and promptly delivered – all key goals of the UK Smart Meter programme.

By opening up the data from Smart Meters, CEDIG members' products and services create a vibrant market for energy services and energy retail, empowering consumers to reduce their consumption and manage their homes, to the great benefit of the individual consumer and to society as a whole.

In this London Olympic year the meaning of Legacy as being a foundation for growth has been re-established. The Olympic Legacy is about the growth of involvement in sport and we suggest the Legacy for smart metering should be about the growth of consumer involvement in energy management. Furthermore, we believe this is not just "nice to have" but is essential. Rising energy prices, declining resources and climate change are all major issues that mean that consumers need to be involved if the issues are to be addressed effectively. Consumers are key to the demand side of the smart grid and need to become active participants.

The UK Government has quite rightly put consumers at the heart of the Smart Metering Programme and the provision of information to users is the foundation of this process. Many of the uses of data outlined in this Paper build on access to smart metering data ,thereby exploiting the infrastructure provided by smart metering and leveraging the benefits derived from the programme. All countries can now adopt a similar approach to drive the necessary rapid change.

7. Appendix: From Energy Data to Consumer Benefits

This section seeks to:

1. Enumerate the Consumer Benefits that Consumer Energy Displays can deliver.
2. Map these benefits against the data items available on the SMHAN, showing how access to particular items delivers particular benefits.

Consumer Benefits

Each benefit below is given a short "code", which is then used as shorthand in the following Data Dictionary.

- **VIS:** Live Energy Visibility. Making energy visible at-a-glance on a real- time display. Draws consumers' attention to unexpected events, alerts and notifications such as an imminent change in tariff. This allows consumers to correlate their behaviour (using an appliance) with the result (consuming energy, therefore increasing their energy bill). "Live" means every few seconds for electricity and up to every half-an-hour for gas (due to limitations of the battery in the gas meter). As well as showing instantaneous values (power) this can show cumulative values (energy) so far this day/week/month, and comparisons with past intervals too.
- **COST:** Live and historical energy use translated into pounds and pence which is much more meaningful to most consumers. This can be short-term (e.g. current power translated into £/hour), or cover the current billing period in which case it is an indicative bill.
- **CO_2:** As above, but translated into carbon-footprint terms, so consumers can minimise their own carbon emissions.
- **EARN:** Microgeneration owners like to see how much money they are earning with their FIT or RHI tariffs, and what their net financial position is (i.e. whether they are a net producer or consumer in economic terms, or in energy terms).
- **PRICESIGNAL:** Information on the current or future price of energy. This includes the current and upcoming tariff rate. Shows consumers whether now is a good time to carry out discretionary activities (such as washing, drying, dishwasher etc.). This allows Consumer Energy Displays to display consumption in cost terms (e.g. £/hour). It can take into account whether any Microgeneration is generating. This creates the opportunity to use these signals to choose whether to use, export or store local energy (e.g. as heat), or borrow it (e.g. from an EV). This may include taking into account parallel (non-utility) tariffs.
- **COMP:** Providing consumers with context for their consumption. Energy is a very abstract concept, and even when turned into pounds and pence it's just a number which is hard for most people to interpret – are they getting good value for money? Providing some context around their consumption is shown to affect behaviour (behaviour change). This can take the form of:
  - Comparison with previous intervals. "Have we used more energy today compared to yesterday, this time last week, this time last year?"
  - Descriptive Norms. People don't like to stray outside of mainstream behaviour. A "most people in similar homes are consuming 20% less than you" message is a powerful message.
  - Injunctive Norms (culturally approved/disapproved behaviour). "Well done, your savings last year are equivalent to planting 100 trees".
  - Comparison with others. "You use 35% more gas than your neighbours, maybe your insulation needs upgrading. For a £200 investment you could save an estimated £300/year".
- **PREDICT:** Prediction of energy usage, helping consumers to budget, or to hit a reduction target.
- **SWITCH:** Switching of supplier or tariff: How much would switching to a new supplier or tariff save based on actual consumption patterns?
- **PREPAY:** Allowing a consumer to see and manage their debt and credit.
- **DISCONNECT:** Allowing the consumer to be warned prior to disablement of their energy supply, and understand when their supply has been disabled and why.

- **ANALYTICS:** Frequently-updated power data (of the order of one reading every 10 seconds, and ideally every 1 second) allows the use of individual appliances to be "disaggregated", i.e. enabling the detection of individual appliances in the home, and analysis of how they are being used:
    - **ITEMISE:** Usage segmentation or "smart bill" shows a user where their energy is being used and how much individual appliances cost to run. It allows a breakdown of an Energy Bill by major appliance. This can also be a trigger to buy more efficient appliances, or to use them in a better way, e.g.
        - "Washing at 30°C could save you £34/year"
        - "Boiling only a cupful of water in your kettle could save you £12/year"
        - "25% of your bill is spent on 'baseload' Click for tips on what might be causing this and how to address it".

NB: Small loads such as mobile phone chargers cannot be detected or identified in this way.

- **WARN:** Live appliance warnings: e.g. users could receive a text message to inform them of abnormal situations, such as "Fridge door left open", or "Oven/iron left on"
- **MAINT:** Appliance maintenance monitoring, e.g. fridge compressor failing, boiler needs servicing.
- **HEAT:** Heating optimisation advice (e.g. "you spent £200 last year heating an empty home"), or automation (see below). This is an example of how other useful data (e.g. occupancy patterns) can be deduced from energy data.
- **ASSIST:** Assisted living. Patterns of consumption (occupancy, kettle being boiled) can show whether a vulnerable individual is OK, and raise a timely alarm to carers if there are unexpected changes in behaviour.
- **AUDIT:** Energy Audits, giving consumers savings advice based on their overall consumption levels and patterns, suggesting behavioural changes they can make, products they should consider replacing and modifications to make to the home to save energy.

- **AUTOAPP:** Power an appliance only when energy is sufficiently cheap (or low-carbon). This might be based on Time of Use tariffs, Critical Peak Pricing, and the net import/export position of any consumer Microgeneration. Some high-consumption appliances (Electric Vehicles, Heat Pumps and Storage Radiators) might be managed directly by the SMHAN, if they are installed or managed by the Utility directly. But otherwise they can be managed by the CAD in response to SMHAN data such as pricing.
    - E.g. "charge my car only with green electricity"
- **OPTIM:** Optimise the home based on live energy consumption, or patterns of consumption over time, or renewable generation
    - e.g. optimise Heating based on Occupancy which is detected from electricity consumption.
- **PRIVACY:** Measures which explicitly help consumers to protect their privacy.
- **MESSAGE:** Useful timely messages from the utility or DNO, e.g. warning of scheduled outages, price changes etc.
- **SMSOK:** Confirmation that the Smart Metering system is all working correctly.
- **TIME:** A definitive reference time-of-day, which is useful to display to the consumer (generally useful to have an accurate clock, and this is the definitive time against which Time Of Use etc. is enacted, so it of use to automation too).
- **READINGS:** Very occasionally, such as if a consumer has concerns around billing and may want to check that the numbers on their meter(s) match the numbers in their bills, so they will want access to the raw readings held in the meter. They may also want to verify that the meter(s) serial number on a bill matches the meter in their property.

In addition to the above specific benefits, more general benefits will arise simply from the consumer having access to their data. These include being able to obtain data locally (e.g. capture it on a PC spreadsheet for custom analysis), or export the data into other products or services, possibly in the Cloud where it can be used by 3rd-party services, and also enabling future products and services that we can't even imagine today.

Data Dictionary

This section enumerates all SMHAN data types that are of benefit to the Consumer, and maps them back to the Benefits listed in the above section.

It is not an exhaustive list of all SMHAN data types, e.g. doesn't cover system-management data about which the consumer does not need to be aware.

Note: "Update Rate" is the rate at which data is updated by the originating meter. It is up to the IHD or CAD to determine the update rate and then poll at the appropriate frequency. Data may be cached by the Comms Hub, so e.g. rapid polling of Gas data does not equate to rapid polling of the gas meter itself.

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Basic Consumption Readings																											
Electricity Current Day Cumulative Consumption	How much electricity has been consumed since midnight	X		X			X	X																	kWh	Between 1 and 5 minutes	Cumulative
Electricity Current Day Cumulative Consumption Cost	How much the electricity consumption since midnight has cost		X																						£	Between 1 and 5 minutes	Cumulative
Electricity Current Week Cumulative Consumption	How much electricity has been consumed during the current week (since 00:00:00 on Monday)	X		X			X	X									X								kWh	Between 1 and 5 minutes	Cumulative
Electricity Current Week Cumulative Consumption Cost	How much the electricity consumption has cost during the current week (since 00:00:00 on Monday)		X																						£	Between 1 and 5 minutes	Cumulative
Electricity Current Month Cumulative Consumption	How much electricity has been consumed during the current month (presumably since 00:00:00 on the first of the month)	X		X			X	X	X								X								kWh	Between 1 and 5 minutes	Cumulative
Electricity Current Month Cumulative Consumption Cost	How much the electricity consumption has cost during the current month (presumably since 00:00:00 on the first of the month)		X						X								X								£	Between 1 and 5 minutes	Cumulative
Electricity Instantaneous Active Import Power	Note: instantaneous power measurement (measured over 20m = 1 mains cycle – not averaged over update rate)	X	X	X								X	X	X	X	X		X	X						kW	At least every 10 secs	Instantaneous (transient)
Electricity Instantaneous Active Import Power (High Granularity)	Instantaneous measurement (as above)	X	X	X								X	X	X	X	X		X	X						kW	1 sec. [this may be an optional feature and time-limited]	Instantaneous (transient)
Power thresholds (High/Medium/Low)	The three power thresholds																								Watts	n/a (available to be read)	Configuration
Power threshold status (High / Medium / Low)	A signal to alert the user as to whether their consumption is judged to be High, Medium or Low. The thresholds are set remotely by the utility.	X																							None (ternary)	At least once every 10 seconds	On change

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Basic Consumption Readings																											
Gas Current Day Cumulative Consumption (since we can't get instantaneous gas Power readings, we differentiate these 30 min readings to do Gas Analytics)	How much gas has been consumed since midnight	X		X			X	X				X	X	X	X	X			X						kWh	30 min	Cumulative
Gas Current Day Cumulative Consumption Cost	How much the gas consumption since midnight has cost		X																						£	30 min	Cumulative
Gas Current Week Cumulative Consumption	How much gas has been consumed during the current week (since 00:00:00 on Monday)	X		X			X	X																	kWh	30 min	Cumulative
Gas Current Week Cumulative Consumption Cost	How much the gas consumption has cost during the current week (since 00:00:00 on Monday)		X																						£	30 min	Cumulative
Gas Current Month Cumulative Consumption	How much gas has been consumed during the current month (presumably since 00:00:00 on the first of the month)	X		X			X	X																	kWh	30 min	Cumulative
Gas Current Month Cumulative Consumption Cost	How much the gas consumption has cost during the current month (presumably since 00:00:00 on the first of the month)		X						X																£	30 min	Cumulative
Elec/Gas Import ToU registers	Where Time-of-Use Pricing is employed, these registers record the energy usage for each of the respective Time-of-use prices in the associated Tariff Rate Matrix		X			X																		X			Cumulative

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Basic Consumption Readings																											
Elec/Gas Import HH interval data	The amount of energy consumed within a 30-minute period (starting at minutes 00 and 30). Allows a finer-granulation picture of consumption to be painted.		X			X			X															X	kWh / m^3	30 min	13 month half-hourly record (rolling)
Critical Peak Pricing	Critical Peak Pricing is used during unplanned, abnormal peaks in energy usage. It is envisaged that 2 ToU prices will be reserved for this purpose																										
Asset Management																											
Electricity Meter Serial Number	Unique identification of the electricity meter																							X	Text	On meter installation	Fixed
Electricity Meter Point Administration Number (MPAN)	Uniquely identifies electricity supply point																							X	Text		Fixed
Gas Meter Serial Number	Unique identification of the gas meter																							X	Text	On meter installation	Fixed
Meter Point Reference Number (MPRN)	Uniquely identifies gas supply point																							X	Text		Fixed
Time																											
Time (UTC)	System Information – absolute time.																	X	X						UTC	Daily (kept locally)	Instantaneous

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Time																											
Time (Local)	Local time, accounting for DST and any other changes.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X		Local Time	Daily (kept locally)	Instantaneous
DST	Daylight Savings Time Table for coming year																								TBD	Daily	
Messaging																											
Message ID	[support for messaging is not mandated for minimum IHD, but SMS needs to be able to carry it for IHDs which do] System information needed for message control. To prevent duplication, cancel a message, prioritisation, whether a message requires acknowledgement.																			X					n/a	As reqd.	System
Message Display Start Time	System information needed for message control																			X					n/a	As reqd.	System
Message Duration	System information needed for message control																										
Message payload																				X					n/a	As reqd.	Text
Page (fragmentation control) if used	System information needed for message control																			X					n/a	As reqd.	System
Tariff & Supplier																											
Currency	Billing currency		X																						Currency	Set by supplier	System
Electricity Provider ID	Name of electricity supplier								X															X	n/a	On change of supplier	Text

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Tariff & Supplier																											
Electricity Tariff Name	Name of Tariff								X															X	n/a	On change of tariff	Text
Electricity Active Tariff Rate	Current rate for electricity consumption		X			X																			Currency/kWh ("ppu")	30 min	Rolling
Electricity Next Active Tariff Rate	The cost of consumption at the next tariff change					X												X	X						Currency/kWh ("ppu")	30 min	Fixed until update
Electricity Next Active Tariff Time	Time when next tariff becomes active					X												X	X						hh:mm		
Electricity Tariff ToU Price Matrix	The full set of unit prices used in a Time-of-use pricing scheme		X			X		X	X									X	X						Currency/kWh ("ppu")	On change of tariff and/or season	
Electricity Tariff Switching Table	A set of switching rules to allocate consumption to a tariff register for Time-of-Use pricing with or without Block Pricing. Rules for allocation can be based on time, day or date		X			X		X	X									X	X						dd/mm/yyyy, hh:mm, text	On change of tariff and/or season	
Electricity Tariff Block Price Matrix	A series of prices, for each block within a Block Pricing scheme																								Currency/kWh ("ppu")	On change of tariff	
Electricity Block Thresholds (identifiable/assignable to ToU rate)	Block Thresholds indicate the points at which the energy consumed within a Block Period causes the price to change within a Block Tariff		X			X		X	X									X	X						kWh	On change of tariff	
Electricity Standing Charge	A charge to be levied, in Currency Units per period of time, when operating in either Credit or Prepayment Mode		X			X			X															X	Currency	On change of tariff	
Electricity Block period info (start time/date and duration)	Where Block Pricing is employed, this information specifies the time period over which price varies based on the quantity of energy consumed; this maybe one and the same as the billing period below		X			X			X									X	X					X			
Electricity Billing period info (start time/date and duration)	Start date and period over which a consumer's bill will be calculated and over which the pricing parameters above may be applied		X			X		X										X	X					X	dd/mm/yyyy, duration	On change of tariff	

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Tariff & Supplier																											
Gas Provider ID	Name of gas supplier								X															X	n/a	On change of supplier	Text
Gas Tariff Name	Name of Tariff								X															X	n/a	On change of tariff	Text
Gas Active Tariff Rate	Current rate for gas consumption		X			X																			Currency/kWh (“ppu”)	30 min	Instantaneous (Transient)
Gas Next Active Tariff Rate	The cost of consumption at the next tariff change					X												X	X						Currency/kWh (“ppu”)	30 min	Fixed until update
Gas Next Active Tariff Time	Time when next tariff becomes active					X												X	X						hh:mm	30 min	Rolling
Gas Tariff ToU Price Matrix	The full set of unit prices used in a Time-of-Use pricing scheme		X			X		X	X									X	X						Currency/kWh (“ppu”)	On change of tariff and/or season	
Gas Tariff Switching Table	A set of switching rules to allocate consumption to a tariff register for Time-of-use pricing with or without Block Pricing. Rules for allocation can be based on time, day or date		X			X		X	X									X	X						dd/mm/yyyy, hh:mm, text	On change of tariff and/or season	
Gas Tariff Block Price Matrix	A series of prices, for each block within a Block Pricing scheme		X			X		X	X									X	X						Currency/kWh (“ppu”)	On change of tariff	
Gas Block Thresholds (identifiable/assignable to ToU rate)	Block Thresholds indicate the points at which the energy consumed within a Block Period causes the price to change within a Block Tariff		X			X		X	X									X	X						kWh	On change of tariff	
Gas Standing Charge	A charge to be levied, in Currency Units per period of time, when operating in either Credit or Prepayment Mode		X			X			X															X	Currency	On change of tariff	

Data Item	Description	VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS	Units	Update Rate	Data Type
		Consumer Benefits																									
Tariff & Supplier																											
Gas Block period info (start time/date and duration)	Where Block Pricing is employed, this information specifies the time period over which price varies based on the quantity of energy consumed; this may be one and the same as the billing period below		X			X			X									X	X					X			
Gas Billing period info (start time/date and duration)	Start date and period over which a consumer's bill will be calculated and over which the pricing parameters above may be applied		X			X		X										X	X					X	dd/mm/yyyy, duration	On change of tariff	

Footnote. "Block" means volume-based stepped pricing. Period can be daily, monthly or quarterly. So prices can go up as you use more energy (green), or down as you use more energy (standing charge equivalent)

Data Item	Description	VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS	Units	Update Rate	Data Type
Unit Conversion																											
Electricity kWh to CO_2 conversion factor				X																							
Gas m³ to kWh conversion factors – CV and PTZ (NCF)	Internal conversion. Only necessary if calculations are not done by meter	X	X																								
Gas m³/kWh to CO_2 conversion factor	Internal conversion. Only necessary if calculations are not done by meter			X																					Kg of CO_2 per m³/kWh		
Microgen																											
Instantaneous Power generated		X																X							kWh		
Generation register(s)	Total amount of electricity generated on or within the premises (may be a register for EACH form of micro generation)				X			X										X							kWh		

Data Item	Description	VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS	Units	Update Rate	Data Type
Microgen																											
Feed in Tariff					X																				Currency/kWh		
Generation HH interval data	The amount of energy generated within a 30-minute period (starting at minutes 00 and 30). Allows IHD to catch-up for any data it has missed in case of HAN glitches etc.				X			X																	kWh		
Change of Tenancy/Change of Supplier																											
Data from a previous tenant must be cleared-off on a change-of-tenancy event, for privacy reasons.																					X						
Privacy Control																											
[PINs hiding debt or similar]																					X						
Prepayment/Debt																											
Electricity Supply Status	Indicated the current status of the electricity supply										X		X												(binary, or normal/credit low/credit expired (emergency credit)/ disconnected)		
Electricity Payment Mode	Indicates the mode of payment currently active on the electricity meter, i.e. Prepay or credit mode									X																	
Electricity Meter Balance	The balance of monies owed by the consumer (Credit Mode) or remaining on the meter (Prepayment Mode)		X					X		X															Currency		
Electricity Meter Balance Last Update Time	The date and time when the Electricity Meter Balance was last updated									X															UTC		
Electricity Emergency Credit Available	An indication that Emergency Credit is available for activation of the electricity meter. Can press a button on the IHD or the meter to accept the offer.									X															(binary)		

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Prepayment/Debt																											
Electricity Emergency Credit Balance	When Emergency Credit is selected, indicates the amount of Emergency Credit remaining on the electricity meter		X							X															Currency		
Electricity Low Credit Alert	An indication that the credit remaining on an electricity prepayment meter has fallen below the Low Credit Threshold		X							X															(binary)		
Electricity Aggregate Debt	There are 3 kinds of debt defined. The sum of all [time-based] remaining on an electricity prepayment meter		X							X															Currency		
Electricity Aggregate Debt Recovery Rate	The sum of all debt recovered, per period of time, using Time-based Debt Recovery		X							X															Currency/day?		
Gas Supply Status	Indicated the current status of the gas supply										X														(binary, or normal/ credit low/credit expired (emergency credit)/disconnected)		
Gas Payment Mode	Indicates the mode of payment currently active on the gas meter		X							X																	
Gas Meter Balance	The balance of monies owed by the consumer (Credit Mode) or remaining on the meter (Prepayment Mode)		X							X															Currency		
Gas Meter Balance Last Update Time	The date and time when the Gas Meter Balance was last updated									X															UTC		

Data Item	Description	Consumer Benefits VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS	Units	Update Rate	Data Type
Prepayment/Debt																											
Gas Emergency Credit Available	An indication that Emergency Credit is available for activation of the gas meter									X															(binary)		
Gas Emergency Credit Balance	When Emergency Credit is selected, indicates the amount of Emergency Credit remaining on the gas meter		X							X															Currency		
Gas Low Credit Alert	An indication that the credit remaining on a gas prepayment meter has fallen below the Low Credit Threshold		X							X															Binary		
Gas Aggregate Debt	The sum of all [time-based debt] remaining on a gas prepayment meter		X							X															Currency		
Gas Aggregate Debt Recovery Rate	The sum of all debt recovered, per period of time, using Time-based Debt Recovery		X							X															£/day?		
Time-based Debts from the Time Debt Registers [1 … 3]	[Debts can be recovered either per time unit, or per topup] Debts which will be recovered based on an amount of currency units per unit of time																								£/time		
Time-based Debt Recovery rates from the Debt Recovery Rates [1 … 3]	The monetary amounts, recovered per period of time, from Time-based debts																								£/time		
Payment-based Debt from the Payment Debt Register	Debts which will be recovered based on a percentage of each payment made to the prepayment meter																								% (of topup amount)		

Data Item	Description	Consumer Benefits																							Units	Update Rate	Data Type
		VIS	COST	CO_2	EARN	PRICESIGNAL	COMP	PREDICT	SWITCH	PREPAY	DISCONNECT	ITEMISE	WARN	MAINT	HEAT	ASSIST	AUDIT	AUTOAPP	OPTIM	MESSAGE	PRIVACY	SMSOK	TIME	READINGS			
Tariff & Supplier																											
Non-Disablement Calendar	A calendar defining times, days and dates that specify periods when a supply will not be disabled even if the credit remaining on a prepayment meter has fallen below the Disablement Threshold. AKA "friendly credit periods" when would be hard for user to top-up from post-office. Helps IHD to warn consumer of "time to disconnect"										X																
System Management																											
Electricity Total Import register	Actual reading shown on face of meter [questionable whether you'd want this on an IHD – very rarely needed and can just look at the meter]																							X	kWh		
Electricity Total Export register	Total amount of electricity exported from the premises																							X	kWh		
Gas Meter Reading	Actual reading shown on face of meter																							X	Numeric	30 min	Cumulative
Electricity Meter Link Quality	Where applicable, an indication of the signal strength between the electricity meter and the ESI																					X			TBD		
Gas Meter Link Quality	An indication of the signal strength between the gas meter and the ESI																					X			TBD	30 min	Instantaneous
Power Quality	Consumers might want proof that their supply voltage is exceeding regulatory limits, or that an outage had occurred. [Unlikely that a consumer will be able to make sense of detailed stats such active & reactive power though]																					X					

8. Glossary

TERM	DEFINITION
ATP	Authorised Third party
CAD	Consumer Access Device (aka Consumer Gateway)
CH	Communication Hub
DCC	Data Communications Company
DDS	Detailed Design Specification
DNO	Distribution Network Operator
ESCO	Energy Services Company
EV	Electrical Vehicle
FIT	Feed in Tariff
HAN	Home Area Network
IDTS	Industry Draft Technical Specification
IHD	In Home Display
PPU	Pence per Unit
RHI	Renewable Heat Incentive
SM	Smart Meter
SMETS	Smart Metering Equipment Technical Specification
SMHAN	Smart meter HAN
SMS	Smart Meter System
ToU	Time of Use
WAN	Wide Area Network