Smart Metering:

A review of Smart Metering and Survey options for Energy.

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September 2010

As part of the Nuffield Bursary Scheme

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1.1 - Introduction

Whether you believe in manmade climate change or not, one fact is certain; we our depleting our energy supplies faster than we can replace them. The majority of fossils fuel supplies are likely to run out this century and until we achieve an equivalent energy production from renewable sources, we need to monitor and control our daily energy consumption.

One way we can do this is by using Smart Meters; smart meters are an advanced form of meter which can collect accurate readings of energy consumption and feed them back to the supplier (as well as the consumer) on at least a daily basis. Smart Meters come in a wide range of different intelligences making them suitable devices to monitor energy consumption at any level. By using Smart Meters it is hoping that consumers' energy usage will be made 'visible', allowing them to see what they're using. Although just seeing the amount of energy they're using per unit (e.g. kWh) might not motivate consumers to cut down, many of the Smart Meters have the ability to show the real time cost of energy consumption; allowing consumers to see the effects of their actions (e.g. leaving a TV on standby or turning a light off) on the cost of their bills. Financial incentives may well encourage more people to reduce their household energy consumption, especially in the current times of economic hardship.

The UK Government plans for Smart Meters to be in every household by 2020 at the latest, with the rollout starting summer 2012; details of their proposed specifications as well as independent research is summarised further on in this document. This proposal is one of the ways the Government aims to cut the United Kingdom's carbon emissions down by 60% by the year 2050.

1.2 – Existing Smart Meter Trials

Extensive research on the existing smart meter trials available on the internet has provided me with very little data as very few of the trials have published results. One report made by Centrica in 2007 [1], suggests the reason being that "suppliers involved in less successful trials have not always chosen to make their results public", with this in mind it suggests that previous trials have failed to show that Smart Meters actually make a difference in the consumers energy usage.

However this report was published in 2007, since then Smart Meters have evolved and new companies have brought out their own smart meters, making the market more competitive. Despite of this possibility, there is still a lack of data available in the public domain on how effective smart meters actually are. We are only at the beginning of our research into smart meters and far more needs to be carried out before we can safely say that they are the way forward. There are however, two existing reports which do present a positive outlook on smart metering; these are the Centre of Sustainable Energy's report to the Energy Saving Trust [2] and the Tyndall Centre report by Tom Hargreaves [3], both of which are covered in more detail further on in the document in Sections 2.4 and 2.5 respectively.

As well as the two for mentioned reports, I have also gained the following knowledge, both on Smart Meters and the trials themselves, from other reports. Firstly, the Centrica report [1] also states that many of the previous trials have consisted of only a small group of voluntary participants and therefore the results may not reflect that of the general population, as it is likely those people who volunteer for the trial would be more environmentally minded, so in turn be more likely to act in order to reduce their energy consumption.

Another issue which will need to be addressed in the future is what type of energy the meter can measure, as it's not only electricity that adds to a household's carbon emissions but also gas and water consumption. However few smart meters are available which can measure these sources and again the majority of trials have only took into account electricity meters, so gas and water smart meters have relatively little known about them and also how well they work at cutting down energy consumption.

The Centrica report also makes a suggestion that electricity consumption can cause significant sources of indirect heating, meaning that savings in electricity consumption could be offset by increased gas consumption used for heating; however this is only a hypothesis and more research needs to be undertaken before we know if this is actually true.

The University of Oxford has also produced a review [4] on smart meters, but was faced with similar problems that I found when trying to collect feedback from studies of smart meters from within the UK or from low-income households. This reaffirms the case that more research and trials need to be carried out upon smart meters, so we get a larger idea of how effective they are at monitoring consumers consumption and also encouraging them to cut down on it.

The following are the Smart Metering Trials which I have heard about whilst collating data, however not all of them have concluded or have a published report in the public domain:

- Large Scale Smart Meter Trial of 15, 000 homes, by Ofgem, reported expected 2010
- Tyndall's Green Energy Options Trial, by Tom Hargreaves, pub Feb 2010
- Centre for Sustainable Energy's Smart Meter Comparison, by Vicki White and Will Anderson, pub Sep 2009
- Warm Plan Smart Metering Trial, by New Perspectives and Ofgem, pub June 2008

1.3 - Existing Smart Meters

After performing research on what smart meters are currently available on the market, I have been able to categorise them into three main groups:

- Group 1's meters provide a real time display of the energy consumption in the household, as well as approximating the rough cost of your energy usage.
- Group 2, advances on the capabilities of Group 1 by monitoring your energy consumption and alerting you to significant changes and also provides you with the ability to set alerts for when different conditions have been reached or breached.
- The final group, Group 3, is the most advanced, giving the user control over their appliances from anywhere within their home, as well as detailed energy consumption analysis.

Group 1

- Tendril Insight [5]

The Tendril Insight is an In Home Display of your current energy consumption, which the manufactures hope will encourage the customer to make more informed choices on how much energy they use. The display communicates with networked smart devices, such as thermostats and electricity meters, within the home; to provide data on the consumption rate and also the cost of energy usage. Data collect from the Insight is sent to the utility provider, allowing them to produce accurate monthly bills. The device also acts as a platform for the utility provider to send messages to the customer, informing them of the latest offers and rates of electricity.

- Energy Controls – Three Phase Smart Meter [6]

This meter, once connected can record your energy consumption then transmit it, via the plug & play port which takes advantage of your Ethernet or other form of communications network. The meter transmits the collected data to Energy Control's Smart Meter Online System which the consumer can access from their PC; allowing for precise bills to be calculated.

- GEO – Minim Energy Monitor [7]

This Standalone display, orignally designed for British Gas, tells you how much energy you are using within your home. The "speedometer" shows the amount of energy currently being used, whilest the center shows the total amount of electricity that has been consumed, whilst the bottum bar allows you to set a consumption target for the month. The minim proved popular in the Energy Saving Trust's report and can even be self-installed by the user.

- The Watson [8]

The Watson is easy to self install, by clipping the sensor chip to the mains electricity cable leading to your fuse box. The sensor chip is then plugged into a transmitter which will send the Watson real time data on the amount of energy you are using, in either watts or cost. An additional feature of the Watson is that its underside changes colour depending on if you are saving energy (blue) or wasting energy (red) from a calculated set average amount (purple).

- Current Cost – Envi [9]

The Envi is essentially designed to encourage you to cut down on energy wastage and to save money. It calculates the current amount of energy your home is using at any moment and also provides a cost for it. Additionally there are three bar charts: day, evening and night; these record data over the whole day to show you what times you need to cut down on your energy consumption the most. The Envi also displays the time and temperature providing it with extra features designed to make it more useable and noticeable.

- E2 Wireless Electricity Monitor [10]

The E2 allows you to track energy consumption on your PC; it is capable of calculating the size of your carbon footprint, over a set time period and can also calculate an estimate of your electricity bill. Graphing functions allow you to understand trends in your usage as well as highlighting where the most energy is used, allowing you to easily target specific areas you can cut back on.

- OWL Micro [11]

The OWL Micro is a wireless electricity monitor which shows you how much energy you are consuming at any moment in time. Also displayed is the cost of the energy you are using, providing you with up to the second costs, so the user can see the savings they'd make by turning off a plug or a light.

- Eco-Eye [12]

The Eco-Eye consists of a transmitter connected to your mains supply cable and a portable display. The display is updated every 4 seconds, showing the effects of switching appliances on or off. The display can show the data in kilowatts, costs or CO_2 emissions.

Group 2

- Tendril Vision [13]

The Tendril Vision allows consumers to manage their energy consumption in an easy to use manner that keeps them engaged and participating in the process. Providing current and historical household energy usage, as well as calculating the real time price of their usage. Customers can create their own rules for consumption over different periods of time; an alert is created if the terms of the rule are broken. The vision shares data between the customer and service provider over the Tendril Platform, which requires internet access. The platform contains characterization software which analyses, predicts and compares the consumption of the user with that of others, providing useful features for service providers. The device has alternative features, such as current weather and forecast information, thermostat features and a clock. As well as being helpful to the customer, this data can be used to predict how much energy consumption will occur in certain weathers (e.g. Hot temps will have greater use of air conditioning so more energy consumption from that product). The vision also has a striking colour scheme, allowing the consumer to easily distinguish between energy consumption.

- GEO – Solo [14]

The GEO – Solo is the next stage up from the minim, once again it can be self installed and has many features of the minim, such as: the "speedometer" and total electricity consumption. The Solo also has a "Fuel Gauge" feature which acts as a target setter for the day, if your reading is below that of the bar, then you have saved energy. This function tells the user that they are not only saving energy, but also money. The Solo will also alert you to any abnormal amounts of usage for the time of day, allowing you to deal with the situation, for example if you have left the light on. The device is portable and has a modern look and colour scheme, similar to that of an Iphone. The Solo is ideal for collecting data as it can back up data for up to two years on an internal SD card; data from which can be downloaded GEO online platform, providing you with more in-depth analysis of your energy consumption.

Group 3

- GEO – Duet [15]

The Duet is the next step on from the Solo and can be bought as an addition to your Solo unit or as a pair of devices. The Duet has all the main features that the Solo had plus a few more. The Duet is capable of monitoring Electricity, Heating and Hot Water energy consumption. As well as this, the device is capable of managing up to six additional appliances (as long as you have the additional sensors), through the Duet you can monitor the energy consumption of the appliances as well as tuning them on and off at the control of your finger tips.

- GEO – Trio [16]

The Green Energy Options, Trio device gives an in-depth view of where energy is being used, wasted and consumed the most in the household. With the capability of controlling and monitoring over 30 appliances with this one device; the Trio would be ideal for energy monitoring and potentially saving throughout the whole home. The device offers a simple to see traffic light scheme which clearly illustrates which rooms or appliances are saving energy and which are wasting it. As well as the traffic light system the Trio can generate a range of graphs and charts, illustrating the energy usage over a day, month or year, providing more in-depth details if the user requests them. Like the Duet & Solo the Trio will alert you to any radical changes in your energy consumption, allowing you to act on the situation. To encourage the user to save energy, reward points are generated depending on the amount of energy they save or waste. These points can then be

compared through the community, workplace or household, creating a competitive edge, for who can save the most energy and money. The Trio also has a touch screen for easy navigation. A more advanced version, the Trio + is also available, with the additional feature of being able to monitor energy usage in circuits, e.g. lighting, and it also takes into account any energy you generate yourself when calculated reward points.

- GEO – Quartet [17]

The GEO Quartet is the professional version of the GEO Trio, designed for large scale schools, companies, universities, etc. The Quartet is tailor made for the users building and can monitor the energy consumption of the Electricity, Heating, Hot Water, Circuitry, Appliances, as well as anything else that is required. The Quartet is easy to use, splitting the building up into floors, showing where the most energy is being consumed and what appliance is responsible for the usage; this allows the users to be able to target what areas need to save energy the most. Display screens can also be set up in visitor areas so they can see if the building is running efficiently, more senior members of the customers' staff are able to control the appliances, in the same manner as the GEO Trio. Again a reward point system for good and bad energy consumption is present, ideal for a way to monitor targets and to encourage departments/individuals to save energy and in the long term money.

- Alert Me Smart Energy [18]

The Alert Me Smart Energy meter communicates your energy usage to the display unit, Google Powermeter via the internet and even to your Iphone. The device clips onto your home energy meter where it can monitor your energy consumption before securely transmitting the data to the users preferred device. Operating at a frequency of 2.4 GHz, the alert me meter is capable of ignoring most interference and its self-healing properties allow it to function even when conditions change (e.g. with a door closing, etc.). From your display unit, Google Powermeter or Iphone you can then monitor how much energy your household is consuming and get an accurate estimate of what your bill is likely to cost. The device also monitors what appliances are on all the time and calculates a base load; from that information the meter will generate alerts if it notices any anomalous readings. If you combine your Smart Meter with Smart Plugs you will be able to monitor the individual energy consumption of each appliance; the traffic light system easily shows you what appliances are saving or wasting energy. As well as that you can even turn appliances on and off from your Iphone, useful for if you've gone out and realised you've left the light on.

2.1 – Smart Metering Implementation Program Prospectus

The Smart Metering Implementation Program Prospectus[19], released 27th July 2010, contained the Coalition Government's plan on the issuing of Smart Meters to every household within the United Kingdom. They hope by issuing smart meters the consumers will be given the information they need to fully understand and manage their energy consumption; thus allowing them to save money and cut down on their carbon emissions. Smart meters will also allow energy providers to read and control meters remotely; allowing them to reduce their costs and also provide more effective customer response.

The key points of the document effecting the technical specification of smart meters are summarised below:

- Energy providers will be responsible for providing a free display device along with the actual smart meter, during the rollout.
- The most visual part of the meter will be the standalone in-home display (IHD). This will provide near real time readings on the user's energy consumption.
- The minimum functional requirements of the IHD are as followed:
    - It must be capable of displaying details of both gas and electricity consumption.
    - It will present information on the current electricity and gas consumption.
    - It will present information on historical consumption, allowing customers to compare current and previous usage.
    - Usage information must be display in pounds and pence, as well as kW and kWh.
    - There must be a visual (non numerical) presentation, which allows users to easily distinguish between high and low levels of current consumption.
    - It will present an accurate view on the account balance, providing a cumulative cost of energy usage so far.
- As well as receive direct feedback provided by the IHD, consumers will be able to access historical data stored on their meter. Customers will be able to access this data free of charge and in a suitable format, most likely on a private webpage or a program run on their PC. The ability of accessing this data means that customer can compare their energy consumption over time, as well as tariff rates more easily, giving them the ability to manage both their energy consumption and provider in order to save both money and emissions.

This document is the first proposals on Smart Meters; confirmation of the meters' technical specification is expected to occur by winter 2011, with rollout targets then being issued in early 2012. Suppliers will therefore be expected to commence rollout of the devices which conform to the technical specifications laid down by summer 2012.

Suppliers can install, and are installing, smart meters prior to the meters' technical specifications being published but this would be done entirely at their own commercial risk.

2.2 – Smart Metering Implementation Program – IHD

The Smart Metering Implementation Program – IHD[20], released 27th July 2010, contained a detail view on the features and functionality of the In-Home Display (IHD); released by Ofgem as a supporting document to the Government's Smart Metering Implementation Program Prospectus. The document sets out their proposals for the minimum functional requirements of the IHD which will be issued to customers; a summary of which can be seen below.

- Energy Units (kW and kWh) are not widely understood, therefore it important the current consumption is expressed in currency as well as in energy units, so that fair comparisons of consumption can be made when tariff rates change.
- Cumulative information is often used for budgeting purposes. Therefore the data is expected to be accurate and reflective of all energy-related consumption costs (e.g. VAT and standing charges), thus allowing for a cumulative cost similar to that of the actual energy bill to be calculated.
- The meter should retain historical data so consumers can compare their consumption over time periods and help identify what may have caused the changes. Data should be provided in a range of different ways, for example profiling the last hour/day/week/month/billing period or by providing comparisons of cumulative data. Having a wide range will allow the consumer to find their most suitable means of getting a meaningful analyse their energy consumption.
- Carbon Dioxide Emissions might also be included on the IHD, although on existing meters this information has been mainly ignored as consumers have not felt the data to be relevant as they cannot relate to the units kg of CO_2.
- The IHD should always show the local time, ideally being synchronised remotely.
- The IHD should also be capable of determining the signal strength of the Home Area Network (HAN) that it is connected to. Indicating on the display when the signal strength is too week for reliable communications, thus enabling the consumer to determine a suitable location to leave the display.
- Close to "real time" updates, must be sent from the meter to the display to keep the consumer informed of current energy consumption. For Gas Meters in order for their battery to last the expected 15 years life expectancy, updates should be sent no more frequently than every 15 minutes. For electricity information, given the constraints around the availability of technical communication solutions, updates are currently able to be sent every 5 seconds. This IHD must be able to cope with updates at those rates.
- Visual feedback of energy consumption has proven more effective than numerical data (a combination of visual and numerical is ideal) according to a recent EDRP trial and report to the EST. Ambient Displays such as "traffic lights" or a "speedometer" have proven to work well, providing a feel for what is going on without requiring detailed attention. These types of displays have also been shown to alert users to unusually high consumption, more efficiently than numerical data.
- Proper support and advice is to be made available to vulnerable consumers.

2.3 - Smart Metering Implementation Program - Meter Comparison

	Type of Smart Meter											
Functions/Features the Smart Meter must have	Tendil Insight	Energy Controls	Current Cost - Envi	E2 Wireless Monitor	Owl Micro	Eco-Eye	Tendril Vision	GEO Minim	GEO Solo	GEO Duet	GEO Trio	Alert Me Smart Energy
IHD (In Home Display)	1	0	1	1	1	1	1	1	1	1	1	1
Displays Current Electricity Consumption	1	1	1	1	1	1	1	1	1	1	1	1
Displays Current Gas Consumption	0	0	0	0	0	0	0	0	0	0	0	0
Provides Historical Consumption Data	1	1	1	1	0	0	1	1	1	1	1	1
Information Displayed in Pounds and Pence	1	0	1	1	1	1	1	1	1	1	1	1
Information Displayed in Kilowatts	0	1	1	1	1	1	0	1	1	1	1	1
Information Displayed in Kilowatt-hours	1	0	0	1	1	0	1	1	1	1	1	1
Numerical Feedback	1	1	1	1	1	1	1	1	1	1	1	1
Visual Feedback	0	0	1	0	0	0	1	1	1	1	1	1
Provides an accurate account balance	0	0	0	0	0	0	0	0	0	0	0	1
Allows for multiple Tariff Rates	0	0	0	1	0	0	0	1	1	1	1	1
15 Minute Gas Updates	0	0	0	0	0	0	0	0	0	0	0	0
5 Second Electricity Updates	0	0	0	0	0	1	0	0	0	0	0	0
Shows Signal Strength	0	0	1	0	0	0	0	1	0	0	0	0
Displays Current Time	1	0	1	0	1	1	1	0	0	0	0	0
Percentage of Agreeability with Specification	47%	27%	60%	53%	47%	47%	53%	67%	60%	60%	60%	67%

2. 4 - Energy Saving Trust – Smart Meter Review

The Energy Saving Trust (EST) published the document, The Smart Way to Display[21], which explored consumer preferences for home energy display (Smart Meter) functionality. The trial tested out seven different Smart Meters: The Wattson, Current Cost Envi, Owl, Eco-Eye, Geo Minim, Efergy Lite and the Owl Micro. After eight days trialling the device, the volunteers gave their opinions on the meters and stated what features they would like to them contain. Below is a summary of their views.

- Changing values are poorly served by numeric displays.
- Display the energy consumption in currency.
- Some users did not want to interact with the device for fear they might lose the current settings.
- Mobility is useful to begin with, after an initial phase many volunteers left the meter in a prominent location.
- The group decided that all Smart Meters should have the following:
  - A clear analogue gage of rate of consumption.
  - Current rate of consumption displayed as a numerical value of cost per day.
  - Cumulative Spending and historic data in the form of pounds.
  - Be able to display spend in the last seven days, day by day.
  - Be able to display spend in the last complete week.
  - Be able to display spend in the last complete month.
  - Be able to display spend in the last complete quarter.
  - There should be the option to change units from £ to kW or kWh.
  - The device should be mains powered, but have internal batteries for mobility.

2.5 - Tyndall Centre – Visible Energy Trial

The Visible Energy Trial: Insights from Qualitative Interviews[22], released in February 2010 contains the qualitative results of a smart meter trial in the East of England; run by Carbon Connections in partnership with Green Energy Options (GEO), Sys Consulting Limited and the UEA's School of Environmental Sciences. The trial collected feedback from consumers about their experiences and opinions of using the devices; although the trial was solely focused on the Smart Meters that GEO provides for domestic consumers, the data collected can still be useful for getting an insight for the features that customers find useful. Below is a summary of some of the main points that were collected during the course of the interviews.

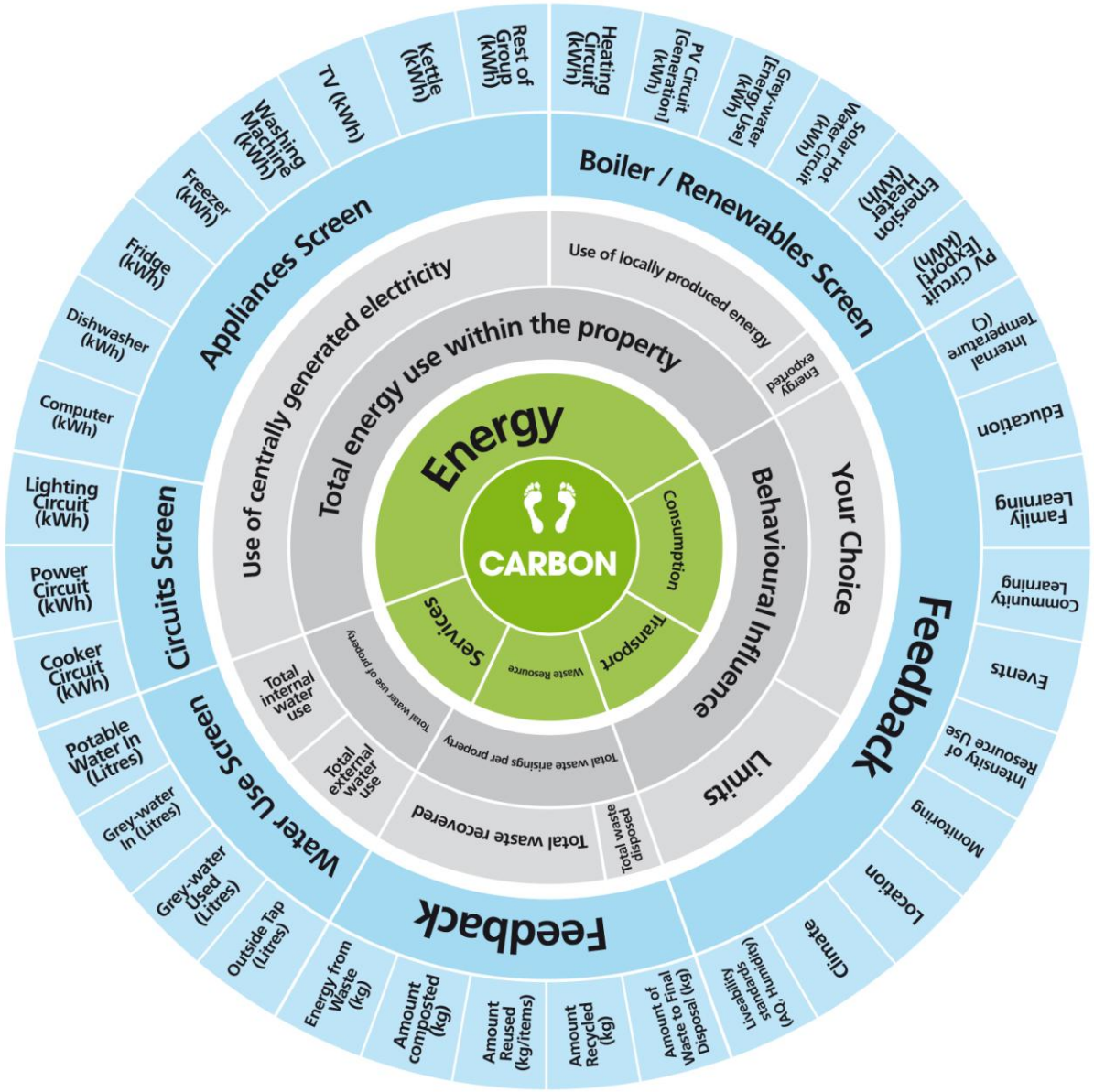
- The device needs to have some way of showing signal strength of communications.
- Detailed Insulation Guides to be provided or professional insulation offered.
- The ability to have data streamed to Laptops/Iphone etc. would be useful.
- Visual displays are more useful for users to understand their energy consumption; interviewees did not appear interested in exact figures.
- Historical Data is useful, provides a way for consumers to compare usage from certain periods, and helps them to understand why differences appear.
- Consumers would like to receive more information on certain appliances energy consumption, i.e. dishwasher, kettle, fridge-freezer, etc...
- Good aesthetics are essential; eye catching colour display encourages immediate action from the consumer.
- The device needs to be positioned where it will be seen, requires device to have good signal strength.
- CO_2 figures are seen as meaningless and difficult to relate to everyday practises.
- Figures need to be in an understandable format, i.e. Pounds and Pence, as well as kWh
- Needs to allow for multiple tariff rates to be programmed or to already contain the major tariffs from the major electricity supplies stored in the device itself.
- Device should have additional features, such as an inbuilt thermometer.
- Remote sensors for plugs "plugbugs" should come with the device, allowing for the energy consumption of individual devices to be monitored.
- Some degree of portability would benefit consumers.
- Consumers would like alerts or email reminders to warn them when there had been significant unusual energy consumption.
- Graphical information would be useful, as long as the data displayed is well annotated so its meaning can be understood and that the data can be "drill down" to provided more detailed information on specific appliances.

2.6 - Consumer Preference - Smart Meter Comparison

Functions/Features the Smart Meter must have	Tendil Insight	Energy Controls	Current Cost - Envi	E2 Wireless Monitor	Owl Micro	Eco-Eye	Tendril Vision	GEO Minim	GEO Solo	GEO Duet	GEO Trio	Alert Me Smart Energy
Signal Strength	0	0	1	0	0	0	0	1	1	1	0	0
Connectable to Laptops / Iphone	0	1	0	1	0	0	0	0	1	1	1	1
Visual Displays of Data	0	0	1	0	0	0	1	1	1	1	1	1
Historical Data (HD) available	1	1	1	1	0	0	1	1	1	1	1	1
Last 7 Days HD	0	1	1	0	0	0	0	1	1	1	1	1
Last Week HD	0	1	0	1	0	0	0	0	1	1	1	1
Last Month HD	1	1	0	1	0	0	0	0	1	1	1	1
Last Quarter	0	1	0	0	0	0	0	0	0	0	0	1
Individual Appliance Consumption	0	0	0	0	0	0	0	0	0	1	1	1
Good Aesthetics, Eye Catching Colours etc.	0	0	0	0	0	0	1	0	1	1	1	1
Units given in Pounds and Pence	1	0	1	1	1	1	1	1	1	1	1	1
Units given in kW or kWh	1	1	1	1	1	1	1	1	1	1	1	1
Programmable Multiple Tariff Rates	0	0	0	1	0	0	0	1	1	1	1	1
Additional Features - Thermometer	1	0	1	0	0	0	1	0	0	0	0	1
Additional Features - Display Clock	1	0	1	0	1	1	1	0	0	0	0	0
Portable	0	0	0	1	1	1	0	1	1	0	1	1
Alerts or Email Reminders Available	1	0	0	0	0	0	1	1	0	0	0	0
Graphical Information	1	1	1	1	0	0	1	0	1	1	1	1
Mains Powered	1	1	1	0	0	0	1	1	1	1	1	0
Percentage of Agreeability with Specification	47%	47%	53%	47%	21%	21%	53%	53%	74%	74%	74%	79%

2.7 - Green Lane West Monitoring Plan

The Green Lane West housing development[23] is a project which plans to construct twelve affordable homes for social rent within the parish of Rackheath. The homes will be designed and built to meet the Code for Sustainable Homes Level 6, so that Rackheath can be considered an Eco-community. As part of this, the houses need to be fitted with monitoring devices that get an accurate measure of each household's energy consumption, be that in the form of electricity, gas or water. The LCIC scoping approach to monitoring has produced a table of variables that can be used to monitor the carbon footprint of a household; not all of the variables can/need to be monitored on the Green Lane West site, those which need to be monitored are seen on the table[24] below.



The main areas which need to be monitored consist of the following:

- The Total Energy Usage by Appliances in the property. (kWh)
  - The energy consumption of the main circuits, including Cooker, Lighting and Power.
  - The energy consumption of individual appliances: Computer, Dishwasher, Fridge, Freezer, Washing Machine, TV and Kettle.
  - Any additional appliances' energy consumption.
- The Total Energy Usage from Heating. (kWh)
  - The amount of energy used by the Heating Circuit.
  - The amount of energy consumed by Grey-Water Usage.
  - The amount of energy used by the Emersion Heater.
- The total energy used in Water Supply. (l)
  - The amount of water collected from the outside tap.
  - The amount of portable water brought in.
  - The amount of Grey-Water in.
  - The amount of Grey-Water used.
- CO_2 produced from waste products. (kg)
  - Total recovered energy from waste materials.
  - The amount of waste recycled.
  - The amount of waste disposed of in landfill.

The majority of the first three main bullet points can all be measured using a form of Smart Meter. However there is no current base line for what the meters must be able to measure in order to be classed as a smart meter; this means that meters can differ between providers, so it is important to compare all available functions of the meters before selecting which one would be best suited to serve the Green Lane West development.

2.8 - Green Lane West - Smart Meter Monitoring Comparison

	Type of Smart Meter											
Substance to be monitored	Tendil Insight	Energy Controls	Current Cost - Envi	E2 Wireless Monitor	Owl Micro	Eco-Eye	Tendril Vision	GEO Minim	GEO Solo	GEO Duet	GEO Trio	Alert Me Smart Energy
Total Energy Consumption	1	1	1	1	1	0	1	1	1	1	1	1
Circuit Energy Consumption	0	0	0	0	0	0	0	0	0	0	1	1
Appliance Energy Consumption	0	0	0	0	0	0	0	0	0	1	1	1
Additional Energy Consumption	0	0	0	0	0	0	0	0	0	0	1	1
Heating Circuit Consumption	0	0	0	0	0	0	0	0	0	1	1	1
Energy Consumed by Grey-Water Usage	0	0	0	0	0	0	0	0	0	0	0	0
Emersion Heater Consumption	0	0	0	0	0	0	0	0	0	0	1	1
The amount of water collected from outside	0	0	0	0	0	0	0	0	0	0	0	0
The amount of Grey-Water in	0	0	0	0	0	0	0	0	0	0	0	0
The amount of Grey-Water used	0	0	0	0	0	0	0	0	0	0	0	0
Percentage of Agreeability with Specification	10%	10%	10%	10%	10%	0%	10%	10%	10%	30%	60%	60%

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2.9 – Ideal Smart Meter for Green Lane West

	Type of Smart Meter											
Comparison	Tendil Insight	Energy Controls	Current Cost - Envi	E2 Wireless Monitor	Owl Micro	Eco-Eye	Tendril Vision	GEO Minim	GEO Solo	GEO Duet	GEO Trio	Alert Me Smart Energy
Government Comparison	47%	27%	60%	53%	47%	47%	53%	67%	60%	60%	60%	67%
Consumer Comparison	47%	47%	53%	47%	21%	21%	53%	53%	74%	74%	74%	79%
Green Lane West Comparison	10%	10%	10%	10%	10%	0%	10%	10%	10%	30%	60%	60%
Percentage of Agreeability with Specifications	35%	28%	41%	37%	26%	23%	39%	43%	48%	55%	65%	69%

The above table is a summary of the previous three tables; it shows which currently available smart meter would be best suited to be used for the GLW housing development as well as which devices most fit what the government and consumers want. None of the devices are perfect in all aspects but the one that I believe to be most suitable to be used is the Alert Me Smart Energy Meter (http://www.alertme.com). This device can come with a range of other features, such as burglar alarms and the company is working on developing even more sophisticated devices. The data collected can be viewed in a wide range of mediums either form the IHD, a computer or even your Iphone with the help of the iAlert me application. After the Alert Me meter I would recommend the usage of either the Green Energy Options Duet or Trio, depending on who the user would be. The Duet is more suited for consumers who just want to know how much energy their using, whilst the Trio is for those who want to "drill down" into the data to learn more about their energy consumption and ways to reduce it.

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3.1 – Existing Consumer Motivation

As mentioned before in section 1.2, the Centrica report[25] stated that many of the previous trials have consisted of only a small group of voluntary participants and therefore the results may not reflect that of the general population. This suggests that the volunteers have generally been more environmentally minded, in that they wanted to change to a greener lifestyle and change their carbon consuming habits; whilst this is the case for some people, it will not be the same for all. A form of motivation will need to be developed, either at a local, regional or national level, which will encourage people to use their smart meters (which will have been issued to every household in the UK by 2020) to cut down on their energy consumption, thus reducing carbon emissions.

Smart meters can help people save energy and therefore save money on their bills, though for some people the savings may not seem significant enough for them to act on it; however if everybody in the country was to perform these small changes the effect would be obvious to the UK's carbon emissions total. It has been proven in the past that forms of motivation can encourage people to adopt greener lifestyles, as seen by some of the incentives below:

- **Tesco's Green Club Card Points**
  When Tesco's introduced Green Club Card Points in August 2006, they were able to save over 500 million carrier bags in the first six months[26]. Customers preferred to use their existing bags instead of Tesco's so that they could gain extra club card points which could then get turned into more money off vouchers for them to use in store. Tesco's were the first to have a scheme of this sort, now the majority of major supermarkets have similar schemes to encourage bag reuse. It is also believed that most Tesco's customers reused their bags, not just at Tesco's but all over.
- **Chip and Bin Scheme**
  The government hoped the Chip and Bin Scheme would encourage households to recycle more and to send less waste to landfill sites, by weighing the bins each time they we're collected, with some councils offering possible refunds or increases in council tax, depending on how much rubbish was being produced. Although this scheme had good intentions and may well have worked, the general public protested against the scheme as it was too "big brother", acting as an invasion of their privacy, so the scheme had to be scrapped.
- **Congestion Charge**
  The London Congestion Charge was set up more as a hindrance than a motivation, in order to encourage drivers to keep out of the centre of London, where possible. However, this scheme did also act as a form of motivation as drivers, who had an alternative fuel car (e.g. Bio fuel or electric) where exempt from the charges[27]; encouraging those drivers who entered London frequently to purchase "greener" cars.
- **Free Loft Insulation and Cavity Wall Filling**
  The government provided grants so that all pensioners could receive free insulation fitting, as well as providing discounts for all other households. This scheme encouraged many more people to purchase insulation than would have otherwise done so.

- **Green Energy Options – My Energy Website**
  Green Energy Options (GEO) have an online website (My Energy) where users can upload their consumption data, for it to be compared against others in the neighbour, town, workplace etc... GEO's Trio and Quartet devices have the ability to calculate a point score; based on how much energy you have saved or wasted. This could be done room by room for households and workplaces, or it can be calculated overall for the whole household. This can encourage households to save more energy, in order to get a higher point score than their neighbours and encourages friendly competition about who can cut down their carbon emissions the most.

The above, apart from the Chip and Bin scheme which failed to get off the ground, have all succeeded in encouraging people to adopt a greener lifestyle; with many other schemes also changing people's habits for the better. One thing that has been in common with all of the schemes (apart from GEO's, which is based more on competitive nature) though is that they all offer a financial incentive if consumers change their habits.

Incentives we're also offered to participants in some of the smart meter trials, with the aim being to encourage a more diverse group of participants to take part in the survey, so that the results would be a better reflection of the general public's response on smart meters. The incentives that we're offered are as followed:

- **Centre of Sustainable Energy's trial[28]**
  This trial provided three continuous incentives for its participants, in order to keep them active in the trial. If they attended the first meeting they would receive, £25 and a free Smart Meter, attending the second meeting gained them a further £25 and when they had completed and returned the paperwork, they received a final £25. As a result, this trial had no drop from its 38 participants.

- **The Visible Energy Trial[29]**
  This trial placed adverts in local newspapers, energy fairs and housing authority agencies, so it attracted people who we're motivated to take part as they wanted to save money, cut emissions, gaining information or understand the technology. Although this trial didn't offer incentives itself, it shows us the four main reasons people wanted to participate in the trial for, when can then be used to draw up proposals for further incentive schemes.

Like the first trial, when the national roll out of smart meters starts in 2012, all of the smart meters along with in home displays will be installed free of charge by the utility providers, with no cost being passed on to the consumers.

3.2 – Possible means of Encouraging Energy Conservation

After researching existing incentives for consumers to change their lifestyle and cut down on their carbon emissions, I have developed the following ways that consumers could be motivated to use their smart meter in order to save money and more importantly energy.

- Club Card points scheme, working similarly to how the GEO Trio and Quartet devices work, a point score can be calculated for how much energy has been saved each day relative to the household's normal amount. This point score could then be transcribed into corresponding reward points with participating retailers; points could then be used to gain money off purchases. Negative point scores could also be included in order to prevent users from going excessively over their average daily amount, although people may object to loosing reward points. Furthermore, instead of allowing the points to be spent on anything, the vouchers could only be made available for environmentally friendly products, like low-energy light bulbs or cavity wall insulation.

- Tax Relief or Credit, available to those consumers who cut down on their energy consumption by a significant amount or keep their usage below a government based target; giving consumers a target to work towards may make them more driven to cut down on their consumption, especially if they get an award for doing so.

- If energy suppliers provided greater incentives for off-peak usage, for example multi-tariffs, consumers may be encouraged to use more energy demanding appliances when the electricity supply is cheaper during off-peak times. This would balance out the load on the national grid, meaning it could cope with fewer power stations, so therefore less emissions being produced.

- Design the smart meters, to analyse the consumer's energy usage and alert them to any anomalous measurements and advise them on ways to save energy/money. This turns the smart meter from a passive device to an active one; depending on the "nag" factor of the alerts and reminders, the meter is more likely to be noticed and read, than if it had no audio or eye-catching visible means of communicating.

- Education, if consumers are taught how their smart meter works and how to use it, they will then be more likely to use it. This be can be done via many different mediums, such as TV or internet adverts, as well as helpful and easy to read websites and instruction manuals; though the most essential means of educating the user will be during the initial insulation, where the installer should be able to answer any questions the consumer has, and should have time explain the device fully.

3.3 – Consumer Questionnaire

In order to find out what type of incentives would motivate customers to continually use their Smart Meter I have devised the following questionnaire which will be asked to 15 people; these 15 people will consist of 5 people from the Village of Bradwell, 5 People from the Town of Great Yarmouth and 5 people from the City of Norwich. Dividing the questionnaire into three groups, depending on the location the people live in, will allow me to see if there is any variation in the results between those who live in Villages compared to those in larger cities. The results gained from the questionnaire, won't produce an accurate view of the population of those settlements due to the small numbers being surveyed due to time constraints; however the results gained can show if a trend is starting to emerge and suggest if further research would be required in the future.

	Male	Female			
Gender?					
	Under 21	21-30	31-40	41-50	50+
Age Range?					
	Yes	No			
Home Owner?					

	Yes	No			
1) Do you currently have an Electricity Meter in your home?					
	Weekly	Monthly	Quarterly	Yearly	Never
2) If Yes, how often to you check your meter?					
	Yes	No			
3) Are you aware of Smart Meters and what they do?					
	Yes	No	Already Have One		
4) Would you consider buying a Smart Meter?					
	Yes	No			
5) If No, would you use one if it was given to you?					

6) Which of the following Incentives would motivate you to use/continue to use a Smart Meter in order to reduce your energy consumption?

Cheaper Energy Bills?	
Club Card Point Scheme (Rewards for saving)?	
Tax Relief or Credit, for those who save a specific amount?	
Cheaper Off-Peak Tariffs?	
Higher nag factor provided by the Smart Meter?	
Education Schemes?	
Advertisements (i.e. TV or Web)?	
Greener Living	

3.4 – Consumer Feedback

After collecting the raw data[30] and collating it into groups, depending on location[31], I have received the following overall data, which is presented in tabular form below.

	Male	Female
Gender?	9	6

	Under 21	21-30	31-40	41-50	50+
Age Range?	2	4	3	4	2

	Yes	No
Home Owner?	8	7

	Yes	No
1) Do you currently have an Electricity Meter in your home?	15	0

	Weekly	Monthly	Quarterly	Yearly	Never
2) If Yes, how often to you check your meter?	2	2	3	2	6

	Yes	No
3) Are you aware of Smart Meters and what they do?	7	8

	Yes	No	Already Have One
4) Would you consider buying a Smart Meter?	5	9	1

	Yes	No
5) If No, would you use one if it was given to you?	7	2

6) Which of the following Incentives would motivate you to use/continue to use a Smart Meter in order to reduce your energy consumption?

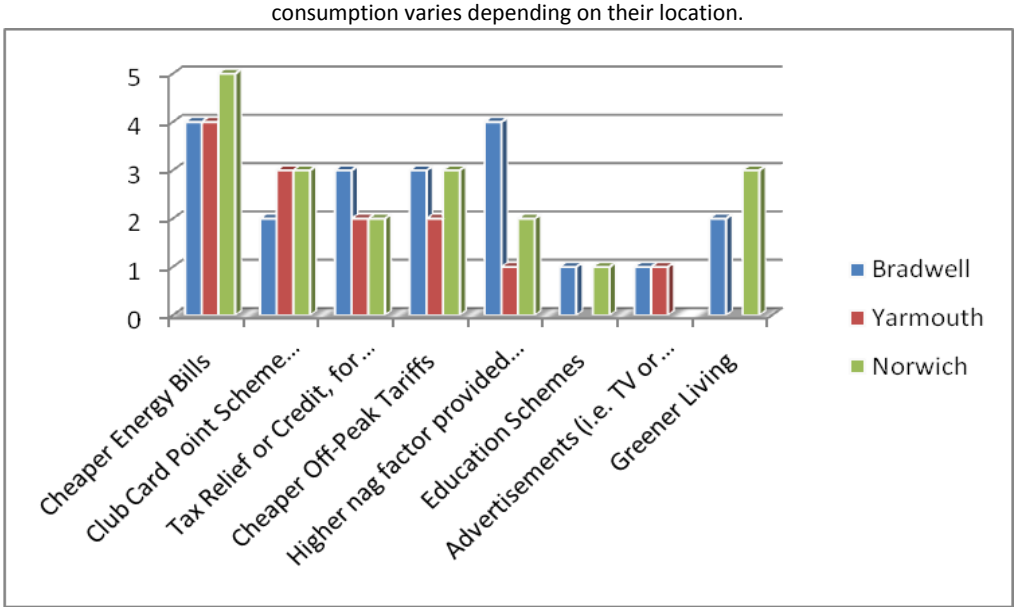
	Yes
Cheaper Energy Bills?	13
Club Card Point Scheme (Rewards for saving)?	8
Tax Relief or Credit, for those who save a specific amount?	7
Cheaper Off-Peak Tariffs?	8
Higher nag factor provided by the Smart Meter?	7
Education Schemes?	2
Advertisements (i.e. TV or Web)?	2
Greener Living	5

The results show approximately half of the interviewees are aware of smart meters, and when it was explained to the others what they are, almost two thirds said they would not buy a smart meter. However the vast majority of them would probability use one if it was provided to them free of charge. The key point of the questionnaire was to find out what would motivate customers to cut down on energy consumption, from which the front runner was to receive cheaper energy bills, but other incentives that people said they would respond to were a reward scheme for saving energy, with the benefits being either a Club Card Point based scheme or a form of tax relief. Only one third said they would cut energy consumption for a greener lifestyle.

Graphical data can better represent the differences in views between the three locations, Bradwell, Great Yarmouth and Norwich; below is a selection of graphs which illustrate the similarities and differences between the locations. Please remember that the information shown below was taken from a small sample of 15 random people so therefore any trends suggested are only suggestions and may lead to further investigations taking place, in order to confirm if the trend matches the views of the general population.

Incentives

A graph to show how the incentives that would encourage people to cut down their energy consumption varies depending on their location.



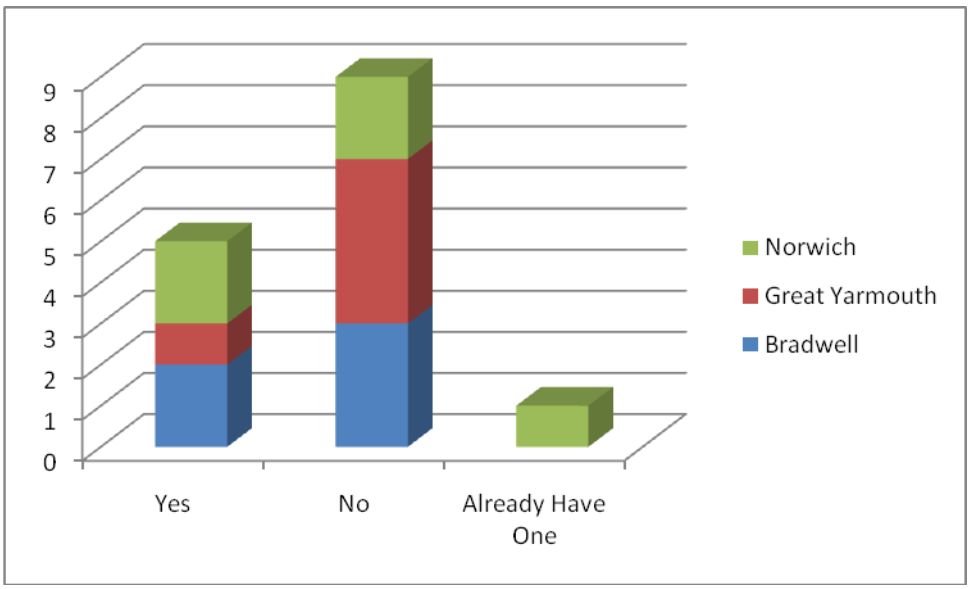
For the majority of people interviewed the incentives that would most encourage them to save on their energy consumption were the same no matter where they lived. In all cases the most popular incentive for people to use smart meters to cut down on their energy consumption was to save money on their energy bills. One of the biggest differences in opinion was the "nag" factor. This proved to be a popular incentive in the village of Bradwell, but it was less well received in the City of Norwich and even fewer people from the Town of Great Yarmouth liked the suggestion.

This could tie in with the second main difference between the locations, which was seen in the drive of the inhabitants to change to a greener lifestyle. Residents of Norwich and Bradwell seemed to have roughly the same amount of drive (with only 1 person difference) but the residents of Great Yarmouth that were interviewed had no desire to change to a greener lifestyle. This could be the reason that they don't want to be nagged about saving energy when they have no intentions of changing to a greener lifestyle.

This graph also shows that the incentives which would have the least effect overall, regardless of location are education schemes or TV or Internet advertisements. Another incentive suggested (by a woman from Yarmouth) during the interviews was being able to see exactly what each appliance was consuming, so that you knew where to target your energy savings, i.e. Computers being left on overnight.

Would you consider buying a Smart Meter?

A graph to show if location plays a factor in whether or not people would buy a smart meter.



This graph appears to show a trend, in that people from Great Yarmouth are almost completely against buying their own smart meter; residents from Bradwell appear to be tied in their views on whether or not to buy their own. Finally those people from Norwich are more willing to purchase their own, with one resident already having done so.

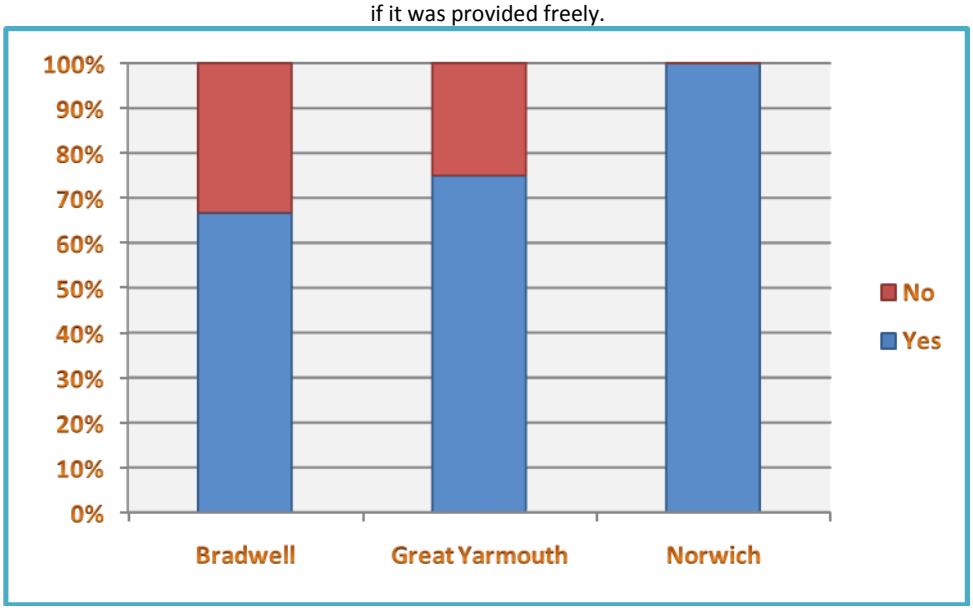
This result maybe down to the different socio-economic groups that inhabit these areas, the majority of people who inhabit Great Yarmouth tend to be less well off so maybe less likely to purchase a device that isn't a necessity to them; whereas people in Norwich are generally more financially stable so would be able to invest in a smart meter, knowing that it may well pay for itself in the long run with the energy savings they could make from it.

To be certain if the main factor affecting the results is the socio-economic variant between locations, question five asked if you would use a smart meter if it was given to you, i.e. like in the government's proposal of a national rollout. The results of this question will show if people wouldn't purchase their own smart meter due to financial reasons or because they aren't interested in using smart meters.

Would you use a Smart Meter if it was given to you?

This question was only asked to those who answered no to the last question, would you consider buying a smart meter? As this meant a different amount of residents would be interviewed from each location, I have included the graph in percentage format, so a clear and fair comparison can be made between the different locations as to how many people were put off having a smarter because they had to pay for them and how many people just didn't want one.

A graph to show if those people would didn't want to pay for a smart meter would still use one if it was provided freely.



The graph shows that the vast majority of people interviewed who said they would buy a smart meter, would still use one if it was provided free of charge. 100% of the people interviewed from Norwich said they would probably use a smart meter if it was given to them; whilst there is a percentage difference between Bradwell and Great Yarmouth, in both places only one person from each location said they wouldn't use a smart meter even if it was provided freely.

From the small amount of people surveyed it is not possible to get definite answers and results from this questionnaire, however the results do raise questions which can be answered at a later date through a larger scale and more national questionnaire. That questionnaire, if ever launched could cover the following areas:

1) Does the type of location (e.g. village, town, city) affect attitude towards smart meters?

2) Are preferred incentives on a national or local basis?

3) Does the social-economic group of the location affect attitude towards smart meters?

4) What is the maximum cost people would be willing to pay for a smart meter?

4.1 – Existing iPhone Smart Metering Applications

After researching the current Iphone Applications on the market for use in conjunction with Smart Meters or for combing the data of your smart meter with that of the energy consumption used in transportation, I have found very few applications that fit this criteria. However there is existing technology currently available on the market, which when combined together, could create an application built into an Iphone (or like device) that can calculate the energy consumption of the user's transportation and then link that in with the data collected from their smart meter to calculate a more accurate figure of their carbon emissions. Section 4.2 goes into more detail on how these technologies could possibly be combined.

Smart Meter Related Apps

- **iAlert Me**[32] by Matt Winterbottom – £3.99

The iAlert Me allows you to directly control your Alert Me Hub from your Iphone, anywhere in the world. From this app you can arm or disarm your home security systems as well as monitoring the energy consumption of your household. The device also receives data about the temperature of your home, ideal for controlling your heating so that it is only on when it needs to be, saving both energy and money. The iAlert Me also gives you control over any Smart Plugs installed in your home, allowing you to turn appliances on and off, at the power of your finger tips.

- **My Usage Mobile**[33] by Exceleron Software - Free

My Usage Mobile is an application that allows you to get information from your smart meter, anywhere in the world, about how much energy is being consumed by your Gas, Electricity and Water supply in real time. The app can also calculate a rough guide as to how much your energy bill will cost.

- **Cortexa**[34] by Cortexa Systems LLC – Free

  The Cortexa application allows gives you control of your house from anywhere in the world; you can access the lighting, security and climate controls at your finger tips. However you home will need to be connected to the Cortexa Intelligent Home Managing System in order for this app to work.

Transport Related Apps

- **Carbon Footprint**[35] by Don Frehulfer - £0.64

Carbon Footprint is an application that allows you to calculate fuel usage for multiple cars. The app requires you to input data (which is this applications main draw back) every time you fill up, in order to get an accurate calculation of your miles per gallon and carbon emissions, etc. The data collected is stored in the app and generates statistics, which over time can show if your driving style has became more environmentally friendly. At the moment the application only works in the U.S.

4.2 – iPhone Smart Metering Possibilities

Green technologies and industries are still only relatively new concept so it is to be expected that there will be relatively few products available on the market to start with; below are some of the current iPhone Applications that if developed further or combined together could be able to calculate and monitor your total carbon emissions; including energy (electricity, water, gas) transportation, food and waste disposal.

The iPhone and the majority of other Apple products seem to be the current must have item, so it makes sense to design carbon reducing applications that can run on the products and that also encourage the user to cut down on their carbon consumption.

Transportation Applications

- **Carbon Tracker**[36] by Clear Standards Incorporated - Free

The Carbon Tracker App allows you to monitor your transportations carbon footprint on a day to day basis. The app works by calculating the straight-line distance between your starting and finishing GPS, which obviously is no good for a round trip and ignores the many bends that occur in the roads; the app will then determine an approximation of the carbon emission for the type of vehicle used. Monthly targets can be programmed into the app, which will hopefully encourage the user to cut down on their emissions.

- **Carbon Clock**[37] by Creative Software Design Ltd. - £0.64

Carbon Clock is an Iphone app which provides the user with information on the battery level, cornering G-forces, the current time and the ground speed of the vehicle in mph. The ground speed is calculated by using GPS satellites which can calculate your approximate speed by the distance you have travelled in a set time period.

- **Speed Box**[38] by Hans M Schneider – £2.56

The Speed Box app is a speedometer for your Iphone, as with the Carbon Clock app it calculates your ground speed, using GPS satellites. The app also contains an odometer which provides the sum distance travelled by the vehicle, data which could later be used to work out the carbon footprint of the journey. The application also contains data on the speed limits of the roads and will warn you when you are travelling too fast.

- **Path Tracker**[39] by MarketWall.com - £1.28

This app transforms your iPhone into a speedometer, odometer, stopwatch, altimeter and GPS locator. The data it collects can save the route you took, or calculate speed at each point in your journey and even any changes in altitude during it.

There are also many apps available for purchase which provides the user with detailed city maps, including transport maps of Underground and Bus networks.

Helpful Applications

- **iGuides Energy Tips**[40] by Brighthouse Labs - £2.56

iGuides provides you with a catalogue of helpful tips which allows you to save energy and more importantly from the consumers point of view money.

As the above applications show there is already advanced technology being used in iPhone applications, which if we combine different aspects together, could develop an application which would enable the user to receive an accurate figure for the carbon emissions of their journey.

To develop the application I would suggest basing it on the Path Tracker technology, which can already calculate your route, speed, altitude etc. This would enable the application to know how far the user has gone at what speed and how much effort it took to do so, i.e. if the vehicle was going up or down hill. This would allow the application to calculate a typical carbon emission for that journey. However to make the calculation more accurate the device could work out what type of transportation you were in (e.g. bus, car, train etc.) by observing the route you took, along with any stationary points and comparing that to known public transport maps. The main problems with this idea at the moment are that it would take up a large amount of memory and processing to be able to perform all of these tasks automatically, in turn this would cause the battery to drain rapidly. Also iPhones can only deal with one task at a time, so if you received a call the data collected would be lost unless the application had a regular auto save feature.

By developing that application it would enable us to calculate personal carbon emissions for transportation as well as the existing smart meters for energy consumption; water can also easily be measured using a meter and its carbon emissions calculated. This just leaves food and waste as the two main categories left not being measured.

Waste is probably the easier one of the two to measure, using the chip and bin scheme that councils tried to launch previously you would be able to get a value for the amount of waste which is sent directly to landfill and that which is recycled, from which the carbon emissions can be calculated.

In order to calculate the emissions related to food, we would need to have the co-operation of the main supermarkets. The supermarkets track all of their stock in and out of depots and stores so they will be able to obtain a distance the product had travelled before reaching their store, from which the relative carbon emissions can be calculated depending on the vehicles used. The carbon emissions of your shop could then be printed onto your receipt for self entry or could be emailed directly to your smart meter, if for example you were part of their club card scheme.

All of this data could then be collated by one device, in the home or portable such as an iPhone so you could work out your total carbon emissions and know exactly where to target your reductions.

4.3 - History of Metering Technology[41]

1872 – Samuel Gardiner
DC Lamp-hour meters, which consisted of a clock and an electromagnet which started and stopped the timing.
These calculated the time the electricity was being used for not the amount.

1879 – J. B. Fuller
AC Lamp-hour meters, consisting of an armature which vibrated between two coils when current was flowing.
Again these only calculated the time of energy consumption.

1879
Thomas Edison invented the first practical incandescent light bulb.

1882 – Thomas Edison
Edison developed a chemical ampere-hour meter that consisted of a jar containing two zinc plates connected across a shunt in the circuit. The electrodes were weighed each month and the change in mass corresponded with the cost of their bill.

1885
Galileo Ferraris discovered that two out of phase AC fields can make a solid Armature rotate. This lead to induction-type motors and watt-hour meters being

1886 – Professor Forbes
Forbes created the first AC Meter which used a heating element connected into the circuit which operated a small windmill connected to a register to record the consumption.
However this design was far too delicate for commercial use.

1889 – Professor Elihu Thompson
Thompson introduces the first recording watt-hour meter; this soon becomes the standard model and could work on AC and DC Circuits.

1914
WW1 interrupted the supply of Tungsten, a key ingredient of the steal used to make the brake magnets. Manufactures therefore switched to a different type of steal using Chromium.

1928 – George Westinghouse
Westinghouse developed the first socket type meter, the OB "detachable" this allowed for meters to be tested and faulty ones to be replaced effortlessly.

1960's
The final major change is made to the Single Phase meter, making it less obvious and prone to damage.

1934
Before now meters made by different companies weren't consistent in design; this meant when a new meter was installed it would be necessary to rearrange the wires to the meter.
In 1934 a committee of companies and large utility supplies standardised two designs; the S-type socket and the A-Base connector.

1948 – General Electrics
The magnetic bearing is introduced within the I-50 Single Phase Meter; allowing more accurate readings to be taken in the absence of friction.

Current Day "Dumb" Electricity Meter

4.4 – The Future of Smart Metering

The future of smart metering and its advancements will depend on the success of the governmental smart meter rollout starting in summer 2012. As I found out earlier in the document not as much published research is available in the public domain as I imagined it to be, especially for the long term use of smart meters. This means that we will not get data that will allow us to say for certain how effectively the meters are working at cutting consumers carbon emissions until approximately 2017, five years into the rollout scheme. After meeting with Josh Cooper of Hildebrand[42] and listening to his views and opinions on the possible advancements of smart meters. Based on that meeting and Josh's comments I have developed the following possible developments of smart metering technology.

1) If the data obtained from the smart meter rollout is positive, it will be likely that the meters will continue to get more advanced and be able to provide consumers with more precise data, for example showing clearly how much each appliance uses and providing alerts and tips to the consumer in order to cut their usage even further. The meters may also then begin to focus on balancing out the load on the national grid, encouraging consumers to use power hungry appliances at off-peak times (which could then tie in with the incentives in section 3) so that there is less demand at peak times, meaning the country can run on less power stations.

2) If the results show that people initially use their smart meter then forget about it, which is probably the most likely outcome at the moment as this seems to be the trend in the few previous trials I have found information on. If this is the case then there is likely to be one of two outcomes occur. The first outcome may be that smart meters are scraped as devices used to encourage energy conservation and are just used to measure energy consumption for billing purposes. The second outcome is that the meters could be given intelligence; allowing them to control household appliances by themselves, letting them turn off appliances when they can tell there not in use by the consumer, i.e. if they go out and leave a light on. This could also help to balance the load as the smart meter could turn off the fridge for a safe period of time when other power hungry devices are running such as the dish washer. However this outcome may well be opposed by large amounts of people, not wanting their lifestyles controlled by a computer and it will also have to be carefully programmed so that it doesn't turn off any essential appliances which could then cause an accident or injury to occur.

3) If smart meters are used, but do not work at cutting energy consumption then an alternative will have to be found. One thing that was suggested is making the appliances themselves more efficient, so even if we can't encourage people to use their appliances less we would still be saving energy as the appliances would be wasting less. Another area which could be made more efficient and reliable are transformed, both internal and external ones. Very few devices use the mains voltage, the majority converting it down to 3, 5, or 12 volts, however the transformers which lower the voltage do not have high life expectancy and degrade rapidly, making them less efficient and waste a lot of energy. If there design could be improved then energy savings could be made.

5 – Conclusion

In conclusion I believe that smart meters will make a difference to the majority of consumers' energy consumption if they are used regularly so that the consumer knows what uses the most energy and if the actions they're taking are actually working to cut down on their consumption. However I believe that more research and trials, with published results should be carried out before a national rollout takes place, so we know how much of a long term effect smart meters will have; if smart meters only cause a small drop in emissions, though it will be worthwhile for the environment it may not be from an economic point of view.

Another thing which I believe needs to happen in advance before the rollout happens is for a smart meter to be designed and constructed which meets all of the specifications the government has laid down. This needs to happen in advance I feel as it is important that the chosen smart meters are trailed on the public for a reasonable amount of time, before being issued nationwide; as it is important that the devices are approved and found easy to use by the consumers, as if not they won't be used so it would be pointless issuing them.

This brings me onto my next point, in that for the consumer to continually use their smart meter I believe that they will need to be incentivised in order to do so. The incentive could be in any form which would motivate to consumer to cut down their energy consumption, whether this is in the form of cheaper energy bills, tax relief or credit, a reward point scheme etc. Further research would need to be taken into this area however, with the possibility of extending the questionnaire to ask a wider range of people and also in different locations to see if there are any trends between views of people who live in cities compared to villages. It may even come to the incentives being provided by the local council so that they can set up incentives which would target the area which would get the greatest response from people in their constituency.

Portability is one of the features people most value nowadays, even though the majority of In-Home Displays have some slight portability this is still limited to within the house, however if the data could be transmitted over the mobile networks to "smart" devices such as iPhones it should then be possible for consumers to check their energy anywhere and to even control their appliances from the office, turning off a light which they accidently left on for example. This could become a strong possibility as though the government is making the utilities provide the infrastructure for the smart meter rollout at no cost to the consumer, they don't want to do this as there is no way they can make a profit from this rollout. This leaves the door open for other companies to put in bids, Sky and Tesco both seem interested in developing their own energy companies and provide basic smart meters to the households with the chance of upgrading to a better meter for a slight fee. The second group that may take this on, as previously mentioned are the mobile phone companies, such as Vodafone, Orange and T-Mobile; unlike the utilities they could make money from the rollout by charging for data to be transmitted on their network during the night when they are less busy.

In general I believe smart meters to be a good thing as they have the potential to allow us to make our energy visible and allows us to target our emissions cutting to the most power hungry devices, making people realise the true usage of their appliances. However I do not believe they should be rolled out in 2012 as from the data and information I have gathered during this report, more published trials, especially those that take place over a longer period of time, need to be carried out, in order for us to assess the viability of issuing smart meters to every home.

6 – Acknowledgements

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