Task II: Communication Technologies And Customer Services

Definitions of Field Trials of Bundled Customer Services in Finland, Netherlands and UK

(Sub Task 10, Stage 1)

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Richard Formby, EA Technology, UK
Pekka Koponen, VTT Processes, Finland
Pentti Uuspää, VTT Processes, Finland
Seppo Kärkkäinen, VTT Processes, Finland
Arnold Sijben, Novem, Netherlands
Jan Griffioen, Innomet, Netherlands
Andrew David, South Wales Energy Centre, UK

International Energy Agency

International Project Participants

Pekka Koponen, VTT Processes, Finland
Pentti Uuspää, VTT Processes, Finland
Seppo Kärkkäinen, VTT Processes, Finland
Pertti Ahonen, Elektroniikkatyö Oy, Finland
Tapio Gylling, Soon Communications Oyj, Finland
Reijo Tsupari, Sato Oyj, Finland
Janne Huotari, Espoon Sähkö Oyj, Finland

Jan Griffioen, Innomet, Netherlands
Dutch Distribution Company, Metering Service Co Netherlands
Dutch Energy Lease Company
Telecom company & Home building corporation
DutchTechnical University
Arnold Sijben, Novem, Netherlands

UK Partners:
Zeno Kerr, Amoza Limited
Keith Edwards, AWG plc
Steve Gorrell, Baxi UK Ltd
John Heathcock/Andy Hind, BCN Data Systems Limited
Barbara Hassall, Chestercare CDHT
Neil Phillips, Dyson Ltd
Jonathan Cape/John Ewen, East of Scotland Water
Andrew Smith, Eastern Contracting Ltd
Luca Coppadoro, Echelon Europe
Grant Ross, City of Edinburgh Council
Brian Cornelius/John Richards, General Domestic Appliances (GDA)
Sandy Gataora, Gledhill Water Storage Ltd
Stephen Meredith, LiveDevices
Jose Luna-Santos, London Power Networks
Steve Lain, Mutual Systems Ltd
Lynton Mogridge, Innogy plc
Laura Webb, npower
Catherine Mullen, PowerGen plc
Andrew Martindale, R L Martindale Ltd
Bill Marshall, Remcon Control Systems Ltd
John Cowburn/James Slade, Siemens Metering Services
Andrew David, South Wales Energy Centre
Jerome Partington, SURF @ 359 Ltd
Bill Evans, Viterra Energy Services Ltd

Richard Formby, EA Technology Limited, UK (Project Manager)
Maureen Smith, EA Technology Limited, UK (Project Administrator)

GLOSSARY

SAP	Standard Assessment Procedure (energy use)
CELECT	In-house energy optimiser based on energy price
CREDANET	In-house energy optimiser based on energy tariff
DNO	Distribution Network Operator
Energy Supplier	Retail (kWh) supplier
Orange House	An intelligent house developed by Orange
PIR	Passive Infra Red
RF	Radio Frequency
Meter Operator	Business which installs and reads meters
C Band PL	Power line communication frequency band for “in-house”
A Band PL	Power line communication frequency band for “out-house”
GSM	General system for mobiles
Leo Satellites	Low earth orbit satellites
Packet	Block of data in defined format
Black start	Starting electricity supply restoration from a completely dead network
WAP	Wireless Application Protocol
SMS	Short Messaging Services
DSL	Digital Subscriber Line
OFGEM	UK Energy Regulator
COP7	Code of Practice (usually for metering applications)
Ethernet	The most widely used local area network (LAN) access method, defined by the IEEE 802.3 standard
GPRS	General Packet Radio Service, a mobile packet switching network
TCP/IP	Transmission Control Protocol/Internet Protocol. A data communications protocol suite to internetwork dissimilar systems. It is de facto UNIX standard and the protocol suite of the Internet.
BT	British Telephone
TP	Twisted Pair
PL	Powerline
LPR	Low power radio

EXECUTIVE SUMMARY

Definitions of Field Trials of Bundled Customers Services in Finland, Netherlands and UK

Background

The provision of wide ranging householder and small business services using communications is a developing major market in the deregulation of energy, communications and services. The market for services is large with, as yet, no "killer" application identified which can on its own justify the services infrastructure. Services bundling is required, within which each service contributes to the financial viability of providing the services to large numbers of beneficiaries. Technologies have been developed which enable services to be bundled together which use different communication media and protocols within the household. This removes the requirement for complete standardisation. From a receiver of services perspective, services are required to be provided so that choice can be exercised on the basis of quality and cost of services from different providers. Finland, Netherlands and the UK are participating in this project to define a Field Trial of Bundled Services. A Field Trial demonstration of the cost-effective provision of bundled services is required in order to demonstrate the methodology and drive the market forward. A consortium of international partners has been formed in order to complete the project.

Objectives

This Stage 1 project is to define the services, service businesses and service implementation architectures to be included in the Field Trials of bundled services in participating countries. The later Stage 2 project is to co-ordinate the implementation of Services Field Trials in participating countries. In order to define the Field Trials and deliver results which reflect a real market implementation, a definition of how real services markets would operate is required. Costs for implementing the Field Trials and the scope of the Trials in terms of numbers of households and services to be provided require estimation. Operational and business architectures to deliver a market for services are required to be defined together with the responsibilities of the various actors. Issues of enabling and disabling access by Service Providers to householder and building services are critical to the efficient functioning of a services market and need to be considered in the technical architecture. The benefits of providing bundled services and also carrying out Field Trials require assessment.

Approach

The approach taken to define the Field Trials of bundled services in participating countries has been to firstly define attractive, potential service bundles in terms of their content, benefit and method of implementation. Business and Technical architectures have been developed which are applicable to the wider market and a subset of these defined for the Field Trials. Major business functions have been identified and described for the wide scale implementation of bundled services. Based on the definition of bundles of services to be installed and delivered to a population of households, implementation and management costs for the Field Trial have been estimated.

Results

The content, scope and costs for Field Trials in participating countries have been defined, comprising hundreds of households and several buildings. Preferred, operational and business architectures have been defined, as well as functional responsibilities. The Field Trials have been scheduled over a several year time frame. The total costs of implementing the Field Trials include all work carried out, financial payments and project management.

Implications

The provision of bundled services to achieve “hands free serviced homes” and buildings is potentially a multi-billion business world-wide. It is essential that manufacturing industries in the participating countries are able to obtain a major share of that business in terms of enabled service technologies, communication access and customer gateways and servers. It is also essential that service companies are established which have the capability and vision to provide bundled services to the market. Services within the bundles, if provided on a wide scale, have implications for energy saving and efficiency, infirm and medical monitoring and impact on care homes construction, service contracts for household equipment as well as household insurance. Electricity supply and network businesses could also be impacted in some situations as a result of managed generation embedded at the householder and building level.

Implementation of the defined Field Trials using flexible gateways and servers is recommended in order to demonstrate the provision of diverse, bundled services and to prime the market for their wide scale implementation.

DEFINITION OF FIELD TRIAL OF BUNDLED CUSTOMER SERVICES IN FINLAND, NETHERLANDS AND UK

SERVICES AVAILABLE AND BUNDLING FOR FIELD TRIAL

INDEX

1 POTENTIAL SERVICES AND BUNDLING FOR FIELD TRIAL

1.1 Introduction and Background

The provision of wide ranging, utility type customer services using communications is the next major competitive market to develop in the deregulation of energy, communications and services businesses. The potential market for services is large, but it mainly consists of many cost-sensitive applications. None of these applications can on its own justify the services infrastructure. Consequently bundles of services are required, within which, each service contributes positively to the financial viability of providing the bundle of services to large numbers of customers.

It is important in some participating countries that services are provided in such a way that a competitive market for services can operate using the common communication infrastructure.

This Stage 1 project is to define the services which will be included in Field Trials of bundled customer services. It is possible that several bundles, offered to different types of customer, will be included in the trials. It is also possible that an initial small bundle of services is installed with a migration to larger bundles over the duration of the trials. This could represent the most likely route to wide scale provision of services in a commercial market in some countries. In order to reduce the number of variables associated with defining the services for the Field Trial, only services which are commercially available now, or prototype services, are specified.

A collection of actual services has been compiled which represents a cross-section of the potential services market from the customer and beneficiaries' perspectives. The technologies likely to be required and the requirement for diverse service providers are considered. It is also likely that more than one "in house" communication medium and protocol will be required in order to use services now available and also probably for future services.

Each service is considered in detail regarding what it is, who the beneficiaries of the service are and the organisations most likely to provide the service.

The Field Trials in Finland complement the Field Trials in UK and the concept trials in Netherlands. All Field Trials focus on the bundling of services. Different gateway technologies will be used in Finland and the UK. Both approaches have their own limitations and merits. They are also aimed at somewhat different customer dwellings. However, individual services and the commercial and technical infrastructure provided are likely to have a high degree of commonality. In Finland the communication gateway is based on a small building automation server located in multi home houses. In the Field Trials new applications will be bundled to use this existing platform. In the UK the applications will use a simple but flexible gateway for single home houses. Irrespective of the different technological solutions, the bundling of services is the main concept to be tested in the Field Trials in each country. All countries have both single home houses and multiple home blocks so that the systems and technologies will be complementary.

1.2 SERVICE CATEGORIES FOR FIELD TRIAL

Table 1 illustrates categories of services which are either available now in some form, possibly without communications, or which are imminent in terms of their nearness to market, and which are likely to appeal to the market and Service Providers.

Table 1 Categories of Services

Service Category	**Service Topics**
Manage energy supply and energy demand (Building Energy Management)	Metering, supply on/off, fault notification, quality, dynamic choice, demand bidding, disaggregation, comfort, provision supply network, time of use pricing, space and water heating control, sauna control, lighting control, car heating control, ventilation control, control of vacation house heating
Management of customer generation	energy import/export, reactive power and power quality management, network support, network backup, possibly CHP
Remote alarms	CO and gas, security, elderly
Remote diagnostics of applications	Leakage detection, district heat heat-exchanger diagnostics, cool storage diagnostics, electricity supply, heaters, lifts, ventilation, pay/wash, (white goods, gas boiler, water quality) etc.
Customer information display	Energy advice, peer comparison, affinity deals, special offers, electricity supply outage information

1.2.1 Building Energy Management

Building energy management comprises many features of energy control, from direct control of comfort etc to using the dynamic price of energy as input to set point controllers to optimise cost to user and supplier of energy. Co-ordination of heating and ventilation according to space usage, hot water demand and energy costs reduces waste of heating energy and optimises energy costs.

In Finland electric heating is mostly used in small houses and vacation houses. In urban areas bigger buildings are usually connected to district heating. Almost half of the energy used for space heating is provided by district heating networks. The rest consists mainly of electricity (13%), fuel oil (20%) and wood (20%). District heat is produced in plants that also produce electricity (large CHP-plants). In the UK, gas is the dominant form of heating for residential properties.

Time of day or dynamic tariffs

In all partner countries, time of day tariffs are widely applied. These typically consist of two or three time zones with different fixed prices. These tariffs suffer from the fact that the differences in price between night and day have diminished in the competitive electricity market. Dynamic tariffs are more interesting, because of their potential for dealing with price peaks but require more communication and more intelligent customer load management systems. In Finland at least one electricity retailer offers dynamic tariffs that are the hourly spot market prices added with a fixed margin.

Time of day tariffs can apply to any customer or appliance with a storage capacity or ability to have its operation delayed. The timing of space and water heating can be adjusted according to the price variations. Mutual co-ordination of ventilation with space heating improves the efficiency and control potential. However, modern houses in Finland are often so well insulated that most heat is lost via ventilation even when some heat from out flowing air is recovered. Increased comfort and efficiency can be achieved by coordinated control of heating, ventilation and lighting according to the demand and energy price. In-house communications are among the most important aspects here. Communications with the outside world relates to Energy Demand Management, remote control, monitoring etc. As the intelligent controller will probably be central to other services, reliability of internal and external communications has to be high as it will affect comfort, which is often the most important consideration. It is possible that some security issues exist: the control system may exchange information concerning, for example, occupancy and temperature with security systems. Lack of heating can also sometimes be a safety issue in Finland. There are already specific interfaces available, but it could be advantageous to have a common interface to minimise cost and increase functionality. This could be at the centre of many other services. The comfort service provider could be an energy service company with the requirement to provide comfort at minimum cost.

In the UK Credanet is on the market and CELECT has been tested in prototype form in matching comfort needs with dynamic energy prices.

Timing tariff possibilities also exist with cold storage, certain sauna stove types and some white goods. Failure to communicate tariff or control information with individual customers is acceptable (provided there are no cost penalties) but not for the entire system. There are no security implications and it may be possible to achieve a trial of this service by re-commissioning existing systems. A Customer interface should be provided within the appliance or on white goods. A central user interface is required for space and water heating with intelligence within the central interface or distributed.

Remote control and/or monitoring of energy and comfort

Some electricity distribution companies in Finland offer services for remotely setting and managing the heating of vacation houses. They have implemented the service via their load control and meter reading systems. Some security services may also include this feature. Sauna or car heating can be started this way, too. Only a very small amount of data needs to be transferred for the services. Some monitoring and alarm functionality is also useful with this service, because blindly setting heating off or on can occasionally have severe consequences such as fires and freezing of pipes by accident. The functionality of the existing systems tends to be too limited in this respect.

The reliability of these systems needs to be high with few failures tolerated by the user. There are low data security implications. There are possible security implications for home security, if the communications is used to switch security lights. Customer target types: disabled householders and their carers and second home owners.

Information on energy use

Both peer group comparisons and disaggregation within specific homes would be attractive services for householders. This could be linked with the provision of energy efficiency advice. A trial of this service was carried out in Denmark as part of the European Union, Ethos project. Beneficiaries of such services include the householder as information could help identify areas of excessive use and possibly contribute to energy savings. The Danish system used a p.c. as the customer interface. Sener, the Finnish Electricity Association, has developed a service that provides information on the electricity usage in homes. The customers can use the system over the Internet using web-browsers. The name of the service is Sähkötohtori (Electricity Doctor). The electricity utilities can automatically provide metered electricity consumption and possibly also some other data from the customer database as inputs. The customer tells the program what kind of electricity consuming devices and appliances they have and how they are used. The system will estimate the yearly energy consumption of each device and appliance and possibly give some suggestions on how to improve the situation. This service can be further developed with the help of non-intrusive appliance load monitoring (NIALM). The appliance models can be updated and their accuracy improved. It may also become possible in the future that NIALM-systems provide most of that input data that is presently given manually.

Information on the heating and ventilation energy consumption of the building may help the users of the building to reduce the energy costs. Similarly information on water usage may be useful. Larger amount of data are involved compared with most other Energy Management Services but long data acquisition times mean that communication capacity can be low. Low reliability required. This is however annoying if the system is not available when required, but it is not critical. There is a low security level. Customer target types: anyone with a computer who is interested in saving money or an environmental interest.

Comfort optimisation

The purpose of comfort optimisation is to achieve comfortable temperature and air quality with minimum energy costs. This can be mostly achieved through Intelligent Controls within the home. The main beneficiaries of this service are customers with improved comfort and lower energy costs. Energy supply companies can also benefit if storage capacity is available within the household and reduced wholesale energy costs can be obtained.

Demand management

Demand-Side Management has been practised by electricity companies for many years. Before deregulation and restructuring of the electricity market, direct load control systems were successfully used to limit the demand peaks on electricity company networks and reduce energy purchase costs in participating countries. The purchase tariffs of supply companies gave very strong incentives to limit peak demand. Now, electricity supply companies are allowed to buy electricity from any source and there is a common market place. Consequently, the incentives for limiting the peak demand to a predetermined level have mostly disappeared. The new rules have made it more difficult to develop direct load control contracts. In the present situation the normal electricity trade mechanisms can not really use the available direct load control capacity to reduce targeted network demand. Demand Side Bidding could enable better use of this valuable control resource to be included in trading mechanisms. Dynamic pricing fits better with the existing electricity market mechanisms and principles.

In Finland, managing network bottlenecks by load control is seldom needed in normal operating conditions. The distribution networks are generally new – due to rapid load growth in recent years and reserve capacity has been designed to allow increases in load, maintenance and limitation of areas suffering from interruptions. Now there is pressure to minimize investments in the network. Thus the situation is changing and the importance of managing network bottlenecks with load control is increasing. Especially load management is needed during the recovery from major faults. The voltage can be restored faster, if some load can be turned off, especially because heating loads typically increase temporarily after an interruption.

The main beneficiaries of Demand Side Management in the UK and Netherlands may be the electricity network operator (DNO), electricity supplier who may need to balance contracts and customers who benefit, if cost savings are shared with them. With a dynamic system, response times would have to be reasonably short, probably within 5 to 30 minutes. A less dynamic system could operate on a day ahead basis but then the potential benefits are much smaller. The amount of data needed to be exchanged in order to implement this service is low. Failures for individual customers (provided no cost penalties) could be accepted on an infrequent basis but not for entire system. There are no specific security implications. Customer target types: electric heated homes. Most of these are small houses and vacation houses in Finland and Netherlands and single family houses in UK. Service Provider: Energy Service Company.

Fuel switching

Dual fuel appliances switching between gas, electricity, oil or renewables etc depending on prevailing price are a possible method for reducing energy costs in the UK, especially with the predicted growth of micro generation. This service does not appear to be available but could benefit customers and supplier/broker. Nothing is readily available on the domestic market and so space and water heating systems would have to be adapted along with controls. As this would be a dynamic system, response time would have to be short, probably within 30 minutes in order to obtain maximum benefits from short-term price changes. High acceptable failures for individual customers (provided no cost penalties) but not for entire system. There is a low security level. Customer target types: anyone with appropriate appliances but probably larger properties. Appliances and services would need developing. System would be fully automated with either a dedicated interface incorporated in appliance or via a common Energy Management Interface.

Heat recovery/air quality

Heat recovery

Heat recovery systems can be used to benefit the customer. They could benefit from Intelligent Controls within the home and are usually self-contained systems. Response time is not critical and so only a slow response with minimal capacity is required. Low required reliability with no security implications. Customer target types: could be anyone as the market for heat recovery is likely to grow. An external service could be monitoring as an extension of the remote diagnostic being carried out for other appliances (filter cleaning, proper operation of heat exchangers, ventilation motors, etc).

Air quality

CO, CO_2 and exhaust fumes are often measured. Alarms are generated, if preset levels are exceeded. Ventilation control may also use these measurements within the building.

Micro CHP

In the UK and Netherlands units are already near to market and offer huge potential to increase overall power consumption efficiency and reduce CO_2 emissions. The potential of natural gas fueled Micro CHP is much smaller in Finland than in UK or Netherlands due to extensive district heating networks. Micro CHP units benefit customer plus Electricity Suppliers if used for minimising purchase costs as well as in Distribution Network (DNO) demand management role. Trials of units are in place now. Extensive trials are likely soon as part of the UK Government's Fuel Poverty Strategy. Intelligent controls are providers on plant and heating installation plus communications with Supplier/DNO to manage operation and availability. A service to manage these installations could be Energy Suppliers and possibly Social Housing providers as well as Energy Service Companies. For contract balancing a short response time (half an hour) would be required. For Demand Management for network benefits, a 12 hour response time would be acceptable. Data communication capacity required, both up and down, would be low. Fault monitoring and diagnostics would require a reasonably short response time (1 hour). High acceptance of failures on individual systems but not for system as a whole. No security implications but would not want plant to malfunction such as failing to provide heating through nuisance messages. Micro CHP will be installed in a variety of homes including use in Fuel poverty schemes. Electricity network control issues are not yet fully understood but modifying the boiler control software contained within existing intelligent controllers could deliver a communications and control system as part of the bundled service.

Dynamic supplier switching

This is a potential new service for the competitive energy supply market in some partner countries and already exists for the telecommunications market. This would benefit the customer plus Broker who could match customer to cheapest Supplier as a dynamic process. It is unlikely that an individual Supplier would want to fund systems and infrastructure that competitors could use. However, it could be a bundled service provided by a third party and carried out as an automatic process to minimise cost of energy to customer. Response times – anything from days to minutes depending on how dynamic the system is going to be. Not a critical system but benefit would be diminished if too many good offers were missed or errors lead to wrong offers being accepted. There will be security issues if bank details are being transmitted.

Remote monitoring of district heat heating

In the cities of Finland and Netherlands combined production of electricity and district heat is very common. The district heat networks are connected via heat exchangers to the in house heating networks and hot tap water networks. In the heating networks circulating water is the heat transfer medium. Correct operation of these networks and heat exchangers is monitored at least twice a month. For example it is important to detect leakage from and between the different networks. Also the temperatures and pressures are monitored in order to detect faults that may cause heat losses, equipment failures or risk of injury. At the same time the billing meters of district heat are read. This meter reading and monitoring is still often done manually. However, new building automation systems include automatic remote reading of these meters and consequent diagnosis functions. Automation enables much better time resolution of the metered data. Thus possible leaks and other faults are detected much faster and more reliably. This is important, because the consequences of undetected faults can be expensive. Customer target types: buildings connected to district heating. Service provider: Building management company or district heat company. Beneficiaries: the owner(s) of the building, landlord, building management company, district heat company. Bundles of services: can be connected with reading of billing consumption meters for electricity, water etc. Is also closely related to many kinds of building energy management services.

Sauna control

The sauna is a common steam bath in Finland. Saunas have been heated traditionally by firewood. Presently, electrically heated saunas are very common, especially in cities, residences, hotels, and sports facilities. Saunas take typically 2 – 20 kW electrical power. The power required depends mostly on the size of the steam room and also on the type of use. Safety regulations spell out some minimum safety distances between the sauna stove and the floor, walls, and ceiling in the steam room.

An electric sauna can be heated at any time during the week. The challenge to the electrical utilities is caused by the tradition to use the sauna typically on Friday and Saturday evenings. Sauna time causes a clear peak in electrical power demand. On Christmas Eve, sauna and cooking accumulate to a significant electrical load.

Electrical saunas often have a small control panel, which allows setting the sauna heating time. There is normally a thermostat in the steam room. Safety rules may limit the time that the sauna can be switched on, at one time. The rationale is to reduce the likelihood of forgetting the sauna is switched on, and thus reduce fire hazard, and danger to human beings.

Saunas are quite common in summer house cabins in Finland. The owners can have an interest in switching electrical saunas on remotely. Saunas can also be controlled by switching on and off with a weekly programmable clock.

To give an idea of the scale, in a country of five million people in Finland, there are more than two million saunas and about half a million summer cabins. Some of these have saunas heated by firewood, but many have electrical saunas. The number of saunas in flats is 1.2 million. Thus, the number of electrical saunas can be assumed to be about 1.5 million.

Apartment buildings, hotels and resorts have saunas in both Finland and Netherlands (only hotels and resorts) that are common to all residents and each of them may have a scheduled time. Traditionally the schedule is fixed and exceptions are controlled manually. However, flexible scheduling remotely and automatic control according to usage save energy and improve safety. Ventilation is controlled according to usage. Good ventilation is needed for comfort and afterwards for removal of moisture. However, unnecessary ventilation wastes energy.

Car heating control

Newer residential areas in Finland often have quite large parking areas that are equipped with electrical outlets for vehicle pre-heating systems. There may be one heater for the engine and another for the car interior space. These are used in the winter to warm the car up before starting. Starting of cold car motors shortens the engine life expectancy, causes exhaust emissions and wastes fuel. Cold cars also degrade traffic safety and comfort. The power of a single heater is typically from 0,5 to 1 kW. Usually two cars may be connected to one pole equipped with power outlets. An arrangement, where the power sockets are energised only a part of the day, is often used. The heating is scheduled using programmable clocks with manual override possibility. Typical heating times vary from 15 minutes to 2 hours depending on the temperature. Motor cooling happens within a couple of hours. Remote control possibilites are rare, although it can be useful for those whose timing of car usage is not fixed.

Energy use schedules

Many building automation functions that are operated according to schedules have already been mentioned. It may still be appropriate to list such functions here:

- locking doors
- outdoor lighting
- ventilation
- sauna control
- use of different heating system set-points during night and day

- changing heating system control curves according to the season
- electric space and water heating vs. time variable tariffs
- car heating

In all these cases fixed schedules can only approximate the desired operation. Input from users and various sensors can be used to improve comfort and reduce energy costs.

1.2.2 Customer Equipment Monitoring and Diagnostics

Appliance monitoring

Appliance Load Monitoring can be applied to monitoring load cycles and performances of appliances. These may reveal developing faults, equipment with high standby energy consumption, burnt lamps or fuses etc. Often appliance loads can be monitored from the local metering point by using special Non-Intrusive Appliance Load Monitoring (NIALM) techniques. VTT Processes in Finland have developed such methods and tested them with prototype systems. For example it may be useful to remotely monitor that the deep-freezer at the vacation house is working properly if the contents are valuable. However, these systems have not yet demonstrated their cost effectiveness for general use within the customer population for providing load disaggregation information.

White goods monitoring

White goods are already available that can report their maintenance needs and usage over the Internet or other communication architecture. Such white goods have not entered the market yet in any of the participating countries, although they are being used in demonstrations and field trials.

Consumer white goods which have communication intelligence are attractive to home users, white goods manufacturers and energy suppliers. Devices which can monitor their own performance and relay early signs of wear/failure to the servicing organisation can minimise nuisance breakdown – this benefits the consumer by preventing a requirement for “crisis management”. It also benefits service organisations by alerting them to a requirement for their services. It also benefits white goods manufacturers by allowing them to monitor customer usage of equipment and therefore more accurately understand customer behaviours and demands and assists in the development of new and improved products.

Technologies already exist and have been demonstrated (e.g. De Montfort University, the Orange House in the UK and also in other countries) which allow equipment either to record usage and cycle information or alert a service provider to faults during use (e.g. e-mail error message with appliance ID via modem). Commercially available software/hardware that supports this communication via telephone connectivity is already available.

Communications of this sort, which are 2-way, allow not only the sending out of information from the appliance to servicers/manufacturers but can also allow external organisations to communicate with the appliance. This communication could be used by the appliance manufacturer to send programme upgrades to the appliance, which could improve customer loyalty via the "self-upgrading" appliance. Specific user information can be obtained and archived by the manufacturer to ensure targeted marketing. Local organisations may also send details of targeted marketing direct to the user interface on the device e.g. a washing machine interface alerts the user to local offers on detergent.

Opportunities exists to allow a "green" appliance to function via interaction with a utility supplier. In this instance, a home user may select a "cheap power" or "environmentally friendly" button on their appliance which would then prevent the device from operating until a signal was received from the utility supplier that energy was either cheap or in low demand. This process could alternatively be linked to an "off-peak" tariff purchased specifically for this purpose by the home user.

Two way communication for these services requires secure data transfer – particularly where consumer information and access to a general device network are established. Reliability of the service should be at a moderate to high level. Network over-ride would be an essential feature to allow continued use of domestic appliances when network errors occur. In general use, the home energy management system would be provided by a Service Provider or Energy Service Company. This would enable communication between utility suppliers and appliances or appliances and manufacturers.

Remotely monitored "pay per wash" services using energy efficient machines could also be an attractive service to some customers and service providers.

The costs of providing some of these systems can be set against the different actors in their provision:-

- **White goods manufacturer** – in device hardware and software to allow data logging, diagnostics, auto-upgrade and delayed start functionality

- **Service aggregator** – home installation of gateway, communication and management software/hardware – some of this cost would be recouped from the utility companies due to reduced cost from supply flattening and some from advertising etc. from third parties

- **Utility supplier** – contribution to operating and installation costs which are recovered by ability to modify demand curve

- Home user – small monthly subscription costs to service aggregator

1.2.3 Household Security Monitoring

Implementing Security Systems consists of ensuring readiness, preparedness, and implementing countermeasures against numerous unwanted effects. Security systems usually protect against intrusions by outside parties, and also against the effects of technical malfunctions within the property. Person Monitoring may also serve the security requirements of an individual, but is discussed separately in 1.2.4.

For residences, there are security systems available in the market. To reach high reliability, security systems are often designed to be independent of any other systems in the building. They could still receive useful information from other information systems, such as building automation systems. Specific intrusion detectors give input about presence of people that are in the building, as well as presence of uninvited visitors.

A security system can also monitor a number of other things, such as functioning of technical systems within the building. Specifically various doors that should normally be closed, or open, can be monitored. More advanced reasoning about combinations and sequences of events are also possible.

Home security and monitoring is a well established market with various companies providing stand alone systems or fully monitored systems via call centres. The private home owner is the largest sector in this market. Residential security systems in Finland, Netherlands and the UK may forward alarms and messages to given telephone numbers, dialling the list of numbers in a given order. Intrusion alarm systems can also send SMS messages to mobile telephones. There is also available through telephone companies, a secure alarm transmission service, which always ensures the arrival of the alarm. Passive Infra Red Detector and Sensor technology has improved over the years, as has the elimination of false alarms. RF systems can still have reliability problems. Communications in smaller systems is still expensive costing upward of 500€ up front and 400€ per year and is not widely used. "Out of house" systems, the ability to detect or indeed stop a stolen car, are available but are very expensive.

Fire detection, often deemed the poor relation in domestic controls, is now being taken seriously. Unfortunately high cost is a major factor in the domestic market, although legislation is now playing its part to help reduce costs. CO and CO_2 detectors have, as yet, not been successful in the domestic market. Unit costs are coming down but at 30€ - 50€ each, they are still deemed expensive. Insurance premiums can be reduced if security and fire alarms are fitted.

A residential building benefits most from the installation of an intrusion alarm system, which includes smoke detectors (now mandatory in Finland). The alarms should always be directed to an alarm centre to ensure that appropriate action is taken immediately. The less time-critical alarms can be directed to the resident. The provision of video surveillance systems is now increasing rapidly due to the easy transmission of pictures through the Internet. Systems include an IP-camera on the premises, a communications medium e.g. an ADSL connection (which can also be used for other purposes) and a computer with an Internet connection and a web browser for picture monitoring. Larger apartment buildings, especially those with parking houses, are sometimes equipped with access control systems. Fire alarm systems are common in office and industrial buildings. These also form the major clientele for other security services in Finland.

Telecommunications companies in Finland offer security services that detect specific conditions in the customer's premises, and notify the appropriate parties by the communications network. Some 20 local telephone companies in Finland offer a wide range of security services under the brand name “TurvaLinja“. The services include e.g. intrusion alarm monitoring, video surveillance systems (CCTV), access control and time attendance systems, fire alarm systems, person monitoring systems and, of course, the communication services needed for these security services. There are a few security companies in Finland that offer complete security systems.

Several large companies in the UK are in both security and fire alarm markets and Building Energy Management Systems (BEMS) technology is being installed in larger sites. Mostly smaller service/maintenance companies serve the domestic market who are quite insular in their approach to business. To help overcome high costs, call centres operating for several companies monitor systems for alarm purposes.

Security and fire monitoring can and should be part of any bundled service proposal. Person monitoring complements security monitoring, intelligent controls can duplicate fire and gas monitoring. Other benefits can be emergency lighting and switching off the gas supply in the event of a fire or gas leak.

Security and fire alarm Service Providers dealing with remote security and fire alarms already exist. The Service Aggregator role could be provided by metering, remote diagnostics or Energy Service Companies.

1.2.4 Person Monitoring

Description and background

Person monitoring is important for both old and “at risk” people. There are also activities in professions and in hobbies, where person monitoring can add security or other added value to everyday life. Examples are persons working alone in the isolated places and some urban areas especially at night.

In Finland, Netherlands and the UK there are old people’s homes and housing units that are operated by municipalities. There are housing arrangements operated by commercial businesses, and there are old people living in their homes, either with their relatives or alone. The task of person monitoring needs specific attention in each case. The number of personnel is always limited.

Generally it can be stated that most District or Local Authorities in UK have their own monitoring centre for the care of “at risk” persons. Providers of Local Authority Housing established monitoring centres in the 70’s and 80’s as part of the support they provided to their own sheltered tenants. There are also national Housing providers who have National Monitoring Centres and equipment providers who also provide a monitoring service nationally.

Entering a municipal old people’s home is a turning point in a person’s life. Typical reasons are reduced mobility or reduced memory function. Sometimes this decision is postponed as long as possible. For the individual, the old people’s home may appear as a restriction. For the municipality, a new dweller increases the cost. There are also smaller housing units and service buildings for old people, such as in a Finnish “row-house“ format, or in multi-story apartment buildings. Some people in old people’s homes may be confined to their beds or may be constrained to stay indoors.

Keeping in touch with family members is largely dependent on phones. In Finland the number of GSM mobile phones is still growing. Most people have a mobile phone, and the percentage is among the highest in the world. Both voice calls and SMS text messages are used. Quite young children have mobile phones, typically from 10 years upwards. Old people use mobile phones also, but the percentage of old people depending on mobile phones is smaller than the percentage of children and young people. Mobile phones are small in size and may be perceived to be complicated by old people. Special rates are offered for phone calls between family members to phone numbers that have been listed in advance.

Schoolchildren in Finland increasingly use mobile phones. About 60 per cent of children aged 9 to 12 years have their own mobile phones. With young people aged 13 to 16, the corresponding figure is almost 90 per cent. Every third 10-year-old schoolchild in Helsinki has a mobile phone in his/her use. [Views on Finnish Technology 2002. Published by Tekes, The national technology agency].

Status now and future

The personal emergency alarm is a well-established product in some partner countries within alarm monitoring services. In Finland and the UK there are specialised alarm centres for receiving personal emergency alarms especially from the elderly. Some of these companies also provide home nursing services. Security companies’ alarm centres accept normally personal emergency alarms only from commercial customers.

Automatic fire alarms, emergency push-buttons, video surveillance of public areas and safety wristbands are applied and tested. There are also devices, systems and furniture specially designed for elderly and handicapped people.

Person monitoring systems may use wristband or pendant around the neck, with a push button as an alarm interface between the person and the communication system. Other input devices are movement detectors inside rooms and buildings, and indicators on doors, such as on the bathroom door. These detectors give an indication of regular activities in the building.

In all countries a range of sensors are used:

- Personal Emergency Alarm
- Activity Pressure Mats
- Smoke Detectors
- Fire Alarms
- Intruder Alarms
- Pull Cord Switches
- Fall Detector
- Flood Detector
- PIR Activated On Entry/Exit
- Temperature Sensors
- Carbon Monoxide Detectors

- Fill Dispensers
- Tele Medicine

Other services which are available include Home Care Management where carers input details of activities carried out etc on the keypad. This information is used in monitoring, billing and finance.

The local sensors for person monitoring are connected wirelessly to a local data collection device within the building. This device communicates through the Gateway to the service providers for person care.

The costs in providing a 24 hour service are high. Local arrangements between neighbouring authorities are the emerging trend. Since Finland is a rural country with long distances and person monitoring services are often time critical, the local authorities are forced to use the nearest service provider, e.g. local ambulance service. So the co-operation is limited to the contracting of alarm center and alarm system installation services.

The workloads of traditional monitoring centres are also changing. Also there is an ageing population all over Europe which will require increased use of Telecare.

At present there are too many monitoring centres in the UK and it is expected in the next 5 years that the total will fall as local government organisations put this work out to tender and close down their own operations.

Beneficiaries of services

- The customer or user of the alarm/sensor
- The Landlord providing supported accommodation
- The Local Authority (Social Services) providing a package of care to the individual
- The Local Authority (Social Services) is able to reduce costs for residential care
- Health Authority is able to reduce bed blocking and costs
- Other Landlords and organisations able to support their customers/tenants by purchasing the service
- Families/Relatives/Carers have peace of mind
- Politicians promote independence in old age and achieve national policy
- Communities benefit

Development Needed

The number of elderly people is increasing rapidly in all western countries and the big challenge for the future is to develop systems that are totally transparent to the user and more cost-effective. The user need not think how or when to use the systems to call for help as the system automatically senses abnormal changes in heart beat, blood pressure or mobility.

1.2.5 Metering and Quality of Supply Services

Remote metering services

Metering services can include remote metering, settlement period metering, pre-payment metering, change of supplier, customer usage data, leakage detection and other diagnostics, occupancy detection, usage limit alarm, load forecasting, tariff analysis, flexibility in energy purchasing, supply disconnection and connection, accurate bills, fraud detection, arbitraging between fuels (with remote control), council/housing association combined heat and rent schemes (monitoring of usage versus credit), water metering with leakage detection, voltage quality monitoring, pressure and pH monitoring (water), gas leakage detection and gas composition monitoring, remote temperature monitoring and CO, CO_2 and exhaust fumes detection, power outage alarm and power restoration notification. These are potential services for inclusion in Field Trials in Finland, Netherlands and the UK.

In Finland and Netherlands the market for pre-payment metering is small because of the environmental conditions and historical practices. The consequences of cutting off the electricity can be too costly for the owner of the building compared to the possible benefits of pre-payment. Heating and ventilation are necessary to prevent freezing pipes, condensing moisture or in extreme cases even death by freezing. However, there are some cases where pre-payment metering can be a feasible option. Fraud detection has been considered insignificant in Finland. However, fraud is one possible explanation for the high losses observed in some networks.

The accuracy of the distribution network state estimation often suffers from poor load models. Often the customer load curves do not represent the current situation in the particular area. Customer group load curves are also used for billing of small customers in the electricity market. Measurements from a representative number of customers are needed for maintenance of the accuracy of load curves. Use of measurements from the particular area reduces the dependency on the load models.

Remote temperature measurements may indicate open/broken windows/doors, failure of heating or cooling etc. Load cycle monitoring for example using NIALM may indicate earlier developing faults in heating/cooling systems.

The detailed consumption profile data that can be provided through smarter metering can enable utility suppliers to provide optimum tariffs readily. This could provide the necessary input marketing data necessary in order to devise appropriate bundles of services, or cross-selling opportunities. The metering service could be included in an Energy Service Company or Meter Operator bundle of services.

The readily available services based on remote meter reading, include metering of the consumption of electricity, district heat, water and possibly gas. Monitoring of the supply voltage quality is also available integrated in some electricity consumption meters and related meter reading systems. These services include collection of data for billing, sub-billing and aggregated billing, load modeling and forecasting, as well as leakage detection, energy management and other building management services.

The existing services have potential for further development. For example the cost of many services is still too high for normal Finnish individual small houses. Also in other respects the services are designed to meet the requirements of somewhat bigger units, such as blocks of flats, bigger row houses and office buildings and commercial buildings. For example voltage quality limits as defined in the European standard EN 50160 can be monitored with some exceptions and also some other useful voltage quality characteristics can be measured. Monitoring reactive power compensation can also be combined with voltage quality monitoring.

Many of the other services are available in prototype form from a technology perspective, but not as services in the market. These services include non-intrusive (appliance) load monitoring (NIALM).

Many different remote metering technologies have been trialled over the last 10 years or more. Technologies exist which are ready for deployment for remote metering. There will be some regulatory issues to deal with, e.g. both with Ofgem in the UK (on the limitations of existing industry practices) and the communications licensing agencies, but these are non-technical issues. Many of the other services are available in prototype form from a technology perspective, but not as services in the market.

Remote power quality monitoring

Remote monitoring of power supply quality produces much measurement data. It may reach or exceed the available narrow band communication capacity. Thus it needs to be considered separately. However, there are many simple voltage quality monitoring and alarm functions that can readily be carried out using narrow band. Customers with special sensitivity to power quality may need detailed power quality monitoring. Simple power quality alarms and functions are needed more often.

Power outage alarms and notifications as well as voltage level monitoring are needed especially in rural areas. Some meter reading systems include the outage alarm feature. Faults and blown fuses can be located faster and the length of the interruption for the customer measured. The traditional method is based on phone calls from the customers. This method has two problems.

1) During large faults too many staff are required for processing the incoming phone calls
2) When the house suffering from the outage is empty, the problem may remain undetected.

Power outage monitoring also enables contracts that include compensation for long outages. These can be beneficial for both the network operator and the customer.

Water quality monitoring may not be relevant in those areas where water quality is good. For example, the tap water in Helsinki area is usually very good for drinking. However, there are certain areas in Finland with water quality problems.

Different buildings have different needs for power quality monitoring. Continuous power quality monitoring is justified only in certain places that are either sensitive to power quality problems or have potential sources of severe power quality problems.

In such locations power quality problems can cause significant costs due to increased heat and energy losses, shortened insulator age and, system and equipment malfunctioning, for example.

Expertise and prior knowledge of the loads and power quality problems that can be expected in a certain site is often rather limited and it is often easier to monitor rather many power quality quantities. The limit values defined in the standard EN-50160:1999 are used as a basis for contracts and legislation in Finland and some other European countries. This standard defines limits for acceptable values of power frequency, magnitude and variations of the supply voltage, flicker severity, supply voltage negative sequence unbalance, harmonic voltages and mains signaling voltages. There are some important power quality characteristics that do not have limit defined in this standard. These include voltage interruptions, dips and swells as well as transient over-voltages, DC-component and inter-harmonic voltages. Most of the power quality characteristics are very seldom at problematic levels in the public power distribution networks. With them the problems are typically caused by faults or design errors in grounding or equipment connected to the network (such as power electronics or capacitor banks). Otherwise problematic values of only certain power quality characteristics are reported. The union of electricity industry (Eurelectric) has in February 2002 published a report on Power Quality in European Electricity Supply Networks. It reports that a tendency of steady increase of harmonic levels is to be recognized. Most surveys show that the 5^{th} harmonic is predominant. Flicker levels are relatively low in general, but in some cases exceed the compatibility values. Problems with unbalance may occur only in certain special places where the loads or other equipment connected to the network are very unbalanced. The report also states that voltage dips and short interruptions can be expected at any place and any time and that the frequency of their occurrence is highly variable and unpredictable both from place to place and year to year. The problem is that some modern electrical equipment is sensitive to voltage dips. The report does not consider variations of the supply voltage. However, problems with them may sometimes occur in rural networks.

The above mentioned standard and report consider power quality in public distribution networks. Often power quality problems are more severe within the electricity consumers own power network than in the interface to the public network. It is also normal that he is not aware of the long-term effects and costs due to power quality problems although some of his equipment can be more sensitive than the equipment of the power distributor.

Beneficiaries of remote metering and power quality measurement

(1) Utilities - both supply and networks (better data, productivity, better customer retention, reduced losses, improved supply performance, e.g. lost minutes (electricity) or leakage (water), etc).

(2) Consumers (accurate bills, more payment and billing options, credit status warnings, related services, faster response to power outage, etc) - break down further into groups, e.g. elderly, fuel-poor, premium service users.

(3) Government (better energy usage data, altered consumption patterns, reduced CO emissions, enables active networks and therefore supports embedded generation).

Overview of remote metering technical requirements

Home gateways may require on-line access to metering and supply status information. Hence, an “in-house” network can be permanently connected to the meter, via a gateway (e.g. “in-house” short-range radio, c-band powerline communications) or the meter can be directly accessed via “out-house” radio, a-band powerline communications, pstn, gsm, leo satellite. Only a few of these technologies have been proven to deliver a reliable and economically viable service in scale (millions of meters).

Response times/capacity ("up" "down")
In terms of data transport requirements there are two important issues:

(a) the actual amount of data per "packet" - determined largely by the application; and

(b) the frequency of sending the "packet" upstream and any control-type signals downstream to the home. There will be at least two types of "packet", i.e. data logged over a certain period, e.g. consumption profiles, voltage trends, flow data, etc; and "event alarm” signals, e.g. power outage, flow over/under limit, tamper alarm, etc. There will be some requirement to access some of this data in pseudo real-time, e.g. for on-demand reads, or for network load "snapshots", but in general the logged data will be sent up to the control centre typically once per day. Taking this into account, it is unlikely that the system would need to deal with more than a few kilobytes of data per day; even for high resolution metering data, e.g. half-hourly and for the other services.

It is likely that the requirements on both response time (frequency of interrogation) and capacity (amount of data per endpoint and number of endpoints) will increase with time due to a number of influencing factors. For example, if half-hourly metering becomes a desired service for domestic consumers, then the volume of data per household could increase significantly. Suppliers may also wish to move more customers to monthly billing with such systems. Also, once a communications path into the home for low-bandwidth applications has been established it is likely that service providers will seek to exploit it. Some of these new applications will be meter, or quality of supply-related, e.g. on-demand reads for bill dispute resolution, remote disconnection for non-payment, over-limit alarms, etc; and some will be non-meter related, e.g. appliance monitoring and control.

Reliability of systems
Meter reading has historically been a manual and time-consuming activity. This is changing, with consumers demanding accurate and frequent bills. Remote meter monitoring can provide more than just the consumption level and profile. Different services will have different requirements concerning reliability, e.g. power outage monitoring, requiring relatively low reliability and highly accurate billing. As far as customers are concerned the top three complaints associated with metering and billing

are:

(1) Mis-selling,
(2) Estimated or Incorrect Bills, and
(3) Poor change of supplier processes (disputes over opening/closing accounts).

Remote meter reading can assist greatly with (2) and (3) due to the greatly enhanced reliability, accuracy and timeliness of the data.

Data security/confidentiality
The data transferred to the utility is important and valuable for their business. It is also valuable for the householder, and can promote energy and water efficiency. It would also be valuable to a utility's competitors (cherry picking of households). It can also indicate in-home activity and therefore in the wrong hands could be a threat to property and personal security. There is, therefore, a need for secure data transmission; but going beyond that there is a need to store and process the data in a secure manner to reduce unauthorised access.

Overview of other bundling related issues

Typical Bundle for this service (Service Aggregator)
This relates to how to package the different services to different consumer groups. The detailed consumption profile data, which can be provided through smarter metering, can enable utility suppliers to perform this segmentation far more readily. This could provide the necessary input marketing data necessary in order to devise appropriate bundles of services, or cross-selling opportunities. This metering service could easily be included in an Energy Service Company, Meter Operator or Building Management bundle of services.

Customer types to target services
All utility customers are potential customers for metering and related services, but certain attributes of enhanced services will appeal more to some than others, e.g. Commercial and Industrial customers (more frequent bills, energy usage data), "Greens" (energy usage profile and energy efficient tariffs), elderly (no intrusive meter reader visits), etc. Network operators will be able to better manage their assets by receipt of timely information on outage, losses, leaks, quality of supply, etc.

Who are the Service Provider and Service Aggregator companies
New metering and data services companies, utility network operators, integrated utilities (water companies), new entrants (Energy Service Company, ESCO), building management operators. However, it may depend on which service provider "enters" the home first with the appropriate technology linked to the launch application.

1.2.6 Remote Monitoring and Management of Customer Generation

Introduction

Increasing amounts of Combined Heat and Power (CHP) and renewable plant are being connected to electricity distribution systems in many countries. Many such plants are relatively small and known as embedded generation plants. For Finland the plan is to increase the volume of energy produced from renewable sources by 50% from the level of 1995 in primal energy. That means about 27% on the total primal energy consumption in 2010. Renewable sources include hydro, wind (about 0.1%) and combustible biomasses and wastes. With minor exceptions the hydropower resources in Finland are already built. Transporting biofuels and wastes over long distances is not feasible. That is why the plan effectively means that the increase in capacity is largely based on relatively small generation units.

For the UK, this plant is predicted to reach 20% of the market share for generation by the year 2010 in the UK with a significant proportion being small scale, residential and small commercial customer systems. UK Government targets for renewable generation (wind, sun, tidal etc) are 10% of electricity production with 10GW of installed capacity provided by CHP by 2010.

ETSU
Comment [1]: Reference needed

Domestic scale micro-CHP in the UK

Electricity generated by micro-CHP, using Stirling engine or solid oxide fuel cell technology, is likely to be available in the near future in the domestic/small commercial markets for own electricity use and, where it exceeds demand, exported electricity to the LV network for use in nearby homes.

In autumn, winter and spring seasons, micro-CHP systems run for heating and hot water. In summer, it may be switched off completely, or run for one or two short periods a day to provide hot water. If it is used during the summer, it would be available for exporting electricity provided the hot water tank was not fully heated. Present micro-CHP generators are averse to being repetitively turned on and off on a short duration cycle, so will be operated to run for the longest possible periods.

In Netherlands, district heating schemes are connected to CHP or renewable plant as a heat source. Micro CHP is just starting with the rate of expansion significantly determined by decisions regarding the energy tax.

The provision of control and communication technologies allow the optimisation of micro-CHP operation in order to minimise cost. Several distinct categories of generator scheduling can be envisaged for both electricity market trading arrangements and distribution network support purposes; some scheduling arrangements include:

- Permanently beneficial electricity demand profiles can be created associated with particular classes of customer. Classes could potentially include low income customers such as members of a Housing Association or social group such as retired couples, or perhaps by business type, such as Restaurants.

- Day-ahead modification of demand profiles for electricity supply or distribution purposes. Primarily associated with storage of hot water for subsequent space-heating, employing, once a day switching signals, based on predicted electricity trading prices for the following 24 hour period.

- On-the-day modification of electricity demand profiles, ranging from a few hours to seconds (including interruptible demand). Control signals at short notice would be required, together with broadcast command features in order to operate, in the balancing market or to support the electricity distribution system, with reserve capacity.

The ability to control CHP operating profiles depends mainly on the availability of hot-water storage, and the ability of homes to absorb additional heating directly. Two types of generation capacity can be defined:

- Total (gross) generating capacity, including on-site use displacing import of electricity from the network;

- Additional (net) generating capacity, excluding what would normally be generated anyway from micro-CHP systems operating on a normal cycle.

A distribution company could request a micro-CHP system to run to support the electricity network until the local hot water tank reached its maximum temperature. The highest gross capacity potential exists mainly during occupancy, and is lowest at night, which is usually favourable to distribution network needs.

With a suitable optimising control system, it would be possible to increase storage potential on a day-ahead basis, by turning off the unit towards the end of occupancy so that the hot water in the tank was used up. One simple way of doing this would be to send, via a communication system, cost messages to make the local generator think that imported electricity was very cheap at these times, so that it was uneconomic to run the CHP generator.

Most smaller embedded rotational generators are induction machines, and can in fact behave as a motor or a generator. Induction generators have the important advantage that they do not have to be driven at fixed speed. As long as the machine's speed is some value greater than the synchronous speed of the power system, it will function as a generator. Power factor correction can be achieved using capacitors.

Of particular concern in considering embedded generation as a replacement for centralised generation and network capacity is the "black start" of networks containing significant embedded generation. This is the issue of the possibility of the network being required to supplying all the connected load following a failure of the electricity network. Voltage quality issues resulting from significant quantities (>20% of the local network capacity) of embedded generation are also of major concern to network operators. Conventional off load LV tap changers and MV bar settings using AVC (automatic voltage control) relays may no longer produce adequate voltage control and accuracy at customer premises.

The issue of voltage management with significant penetration of embedded generation, is critical to network viability. Voltage management associated with induction generators can be a problem due to the variability of load and generation, and the operation of generators at different and varying locations across networks. Communications between selected customers and primary substations could be used for providing an input of processed customer voltages to the voltage control relay at the primary substation to improve the profiling of voltage across a network.

The demanding conditions of using the multiplicity of small units of generation capacity reliably to support the primary substation firm capacity require careful analysis. For this to be a viable option, it is essential to ensure that sufficient generation is available, with a high degree of reliability, to meet the firm capacity requirements. This may involve remote generation status monitoring and control. Also rapidly controllable loads may be needed to compensate the power flow variations caused by generator starting and stopping.

Micro CHP generation units are subject to delay in stopping and starting due to the necessity to dissipate heat prior to restarting and also due to a warm up period being required after starting before commencing generation. This could delay the restoration of supply following a network fault. There are also disadvantages in terms of possible reduced generator life of allowing generators to overspeed by disconnecting them from the load following a network fault. Consequently a preferred option for using these plants for the provision of firm capacity may be to devise methodologies to keep them running and supplying a small local load but disconnected from the network after loss of network infeed. A method for synchronising the rotating machines back on to the network following restoration would be required.

Control of small-scale induction generators

Most smaller embedded rotational generators are induction machines, and can in fact behave as a motor or a generator. Induction generators have the important advantage that they do not have to be driven at fixed speed. As long as the machine's speed is some value greater than the synchronous speed of the power system, it will function as a generator. Power factor correction can be achieved using capacitors.

The majority of small scale embedded generators connected to MV and LV networks are likely to be of the induction design on the grounds of cost. There are limited control and monitoring possibilities available with these generators for management of network voltage and network support purposes. Monitoring of generator on/off status and availability, together with the ability to control that status, would be beneficial for network firm capacity support.

A generation management scenario can be considered where primary substation networks containing significant generation are continuously assessed for firm capacity. The reliability of that firm capacity based on the status and availability of the network and generation, would be quantified and evaluated together with some financial criteria. Reporting to control room staff, on an exception basis, where supply reliability was being jeopardised, could be an option.

A summary of the control and status activities and estimates of the approximate response times required are listed below. These response time estimates are based on a balance between what may be reasonably required for operational purposes and what is achievable at modest cost.

Embedded generation management

Management could involve the following types of generator and electricity network monitoring and control, with different access times:

- Monitor status of generator and heat store (few minutes access time)
- Switch control to start and stop generator (few minutes access time)
- Monitor voltage at customer (2 minutes access time)
- Controlling voltage at customer or on network (2 minutes access time)
- Controlling status of generator schedule (few minutes access time)
- Sequential MV feeder switching for cold pick up after fault (few minutes)
- Controlling electrical heating loads to level out local power flow variations due to generator starting and stopping (perhaps about 1 second access time?)

An important consideration in including more communication in the operation and management of distribution networks is the potential unreliability introduced. For example, it is essential that safe limits for voltage excursions are not dependent on communication being available 100% of the time. Communication must be used to provide fine control within a wider stable voltage band.

These issues can be alleviated or solved if reliable and cost effective communications are available between embedded generators or blocks of generators, and network operation control rooms or primary substations.

Table 2 shows the communicated information needed to carry out different network support functions using embedded generation. Feedback on current output and status of the Micro CHP plant is particularly important and required for all roles.

Table 2 Information flows to support network functions

		Support function*					
Item	Direction	Def	Sup	Em	Volt	VAr	Red
Command to turn on/turn off now/soon	In	✓	✓	✓	✓		✓
Information on current output active power, reactive power, voltages	Out	✓	✓	✓	✓	✓	✓
Command to modulate output	In	✓	✓	✓	✓		✓
Command to modulate power factor	In					✓	
Next day plant schedule	Out	✓	✓	✓			✓
Next day required schedule	In	✓	✓				✓

* Def=Deferred reinforcement; Sup= Supporting network for maintenance etc.;
Em=Emergency support; Volt=Voltage support; VAr=VAr support;
Red=Reduce or turn off to protect network.

Types of Monitoring and Scheduling of Small Scale Generation

Most scheduling of embedded generation is done for:

- On-site requirements, e.g. CHP scheduled to match heat loads
- Operational reasons, e.g. maintenance of networks
- Electricity prices, e.g. maximise exports at times of high prices

Generators could be requested to run, or not run, at certain, unplanned times with agreed notice. Reasons for requiring generators to go off would include to avoid back-feeding at times of low demand, and to prevent voltage rise on electricity networks. Times when demand is low are predictable but times of high output for some generators (wind, small-scale hydro) are not. Hence a requirement to switch off is likely to be at short notice. When to turn on again depends on knowledge about future output and load. Simple arrangement would be to turn on when load recovers to exceed maximum generator output, though this is likely to lose some generation. By definition, electricity prices are usually low when demand is low so the loss of revenue should be reduced. Such arrangements could remain in place until the network configuration or load patterns change. Note that this is the only type of 'scheduling' which can be applied to variable renewable generators (wind, small scale hydro and PV without storage) which generate at maximum output according to resources available.

In order to confirm that generators had run, a record of operation, either from local logging or two-way communications would be required.

Communications for Embedded Generation, Automation and Customer Services

Communication for the remote control and monitoring of embedded generation and associated network parameters at distribution substations and customer premises will link together network automation and customer services technology implementations. Consequently micro generation management communications will be included as a bundle service for specific households and sites.

This service is likely to be offered as part of an energy management bundle. It could also be offered within a remote diagnostics and maintenance /service bundle.

Time scale for sending and reacting to communicated instructions
From days ahead to minutes ahead.

Communication media
Depends on notice period: days - hours, could use manual messages phone, fax, email. Minutes - seconds, requires direct communication which could be two-way for status and confirmation.

Definition of control parameters

Status of Service
Expected to be large market for control and monitoring service over 5-year time-scale.

Beneficiaries of remotely managed service
- Reduced costs for customers
- Reduced costs for electricity utility
- Reduced cost CO_2 emissions for government
- Reduced costs for service company

Technical needs of managed service
- CHP plant requires diagnostic sensors and controls to be fitted.

- Electricity network voltage and capacity issues need to be addressed.
- Slow speed communications will be sufficient for most features of monitoring and control.
- Fast commands to start and stop generation, and supporting load control may be needed if the network is weak.

Reliability and security
The remote monitoring and control communication needs of the service are relatively modest based on a large population of generators. Providing that control signals are likely to be applied to many small generators simultaneously for the purposes of supporting the electricity network, the failure to communicate to a single generator is not important.

It is very important that malicious simulation or corruption of generator remote control instructions are minimised.

Customer types
It is anticipated that this remotely managed generator service would be similar to remote boiler diagnostics and monitoring service, although with increased control. Consequently the market for this service will be residential and small commercial customers.

Development needed
- Remote diagnostics and control of mass market generator units
- Solution to some electricity network issues

Customer interface
This service does not really require a customer interface other than that provided at present for gas boiler scheduling. Generally the remote monitoring and control of the unit would be to ensure the customer received warmth and electricity at lowest cost while at the same time offering benefits to the utility. These processes would be largely transparent to the customer.

Who is service provider?
- Maintenance service providers for remote diagnostics
- Utility/Energy Service Company (ESCO) for operation and scheduling

1.2.7 Customer Information and Short Message Services

The short information service for inclusion in all country trials is where small amounts of data are converted into “sound bite” messages. These messages would typically prompt the customer to take some action. Examples include – “You have 3 new email messages on your PC”; “Your electricity bill this month is £35. Please press the accept button to authorise deduction of this amount from your account”; “the postman is at the door with a parcel to deliver, please press accept to open the front door remotely”. There are special deals on a specific commodity at specific local store.

Remote marketing can be carried out using the short information service. Data is used by businesses to target marketing information at the customer using various communication interfaces. This service has the potential to be very sophisticated.

The short information service could deliver messages to a mobile phone, a display panel in the home, a pop-up window on a PC and a pop-up window on a TV screen.

Simple message units capable of displaying short text messages could be placed at key points in the home. However, for a customer who is used to bright colours and full screen graphics on the web, this kind of interaction would not be perceived as groundbreaking technology. In the fast paced world of computing and electronics development, this kind of display would soon be outdated.

One methodology is the use of a home control panel. This could be unit at a fixed point in the home that acts as an interface to the service providers system and allows full colour and full size information alerts and marketing information to be displayed and responded to in a single unit.

The location of the unit would be key to its usefulness. Hidden under the stairs and only glanced at once a month would be of little benefit to either the customers or the service aggregator. Another possibility is to make the unit battery powered and portable utilising a wireless networking technology to communicate with a base point. Several wireless technologies now exist, including BlueTooth and IEEE 802.11. A further consideration is that of cost. A portable unit will be considerably more expensive than a fixed unit and more susceptible to damage. However the unit could also provide additional functionality to the customer, such as TV listing, news reports, lighting control etc. which can be enjoyed easily anywhere in the home.

Additional data services that support the users of buildings in buying, selling and exchanging of services:

- day care
- cleaning
- goods
- apartment renting
- renovation services
- etc.

Information on:
- contact persons
- scheduled maintenance and repair
- energy and water usage
- etc.

Customer Remote Access to Information and Applications

Access to applications in the customer's home from within the home or from remote locations enables:

- Monitor and Control of devices and applications within the home
    - Change lighting

- Change heating
- Prepare the home environment for customer's arrival
- Access to home PC
- Obtain messages information

- Monitor security in the home.
  - Remotely view images from security cameras in and around the home
  - Review periods of activity (Who were those people snooping around? Did the Postman try to deliver a parcel?)

- Easier control of home applications and services for persons of limited mobility
  - Ability to help people with disabilities from a remote location.

The "customer remote access service" allows the customer to remotely access useful information about the home and act on that information accordingly. The service does not "push" information to the customer, but instead allows the customer to "connect" to the home, initiate actions within the home and obtain information about the home environment.

For example:

1. The customer wishes to turn on the heating, run the bath and set the appropriate lighting and heating for his/her arrival home.

2. The customer is unable to easily move about the home and wishes to draw the curtains and switch off the lights upstairs using a remote control.

3. The customer is able to connect to his/her home PC and review previous bills, action payment, and configure home environment according to the suggestions on a report or calculated by the PC (this may be as simple as pressing a single button to accept new configuration). It is easier for the home PC to be a trusted entity in a payment system.

Where the proxy is a customer services provider, then the service provider is acting on behalf of the customer, typically because the customer either cannot be contacted or cannot effect a response themselves. An example would be when a burglar alarm has been triggered – a message is sent simultaneously to the customer's mobile phone and to the security service provider.

1.2.8 Bundling Services for UK Field Trials

The previous sections have considered the categories of services (Table 1) which are regarded as the most suitable for application within the first phase of any service bundling offer and field trial.

Table 2 has been compiled to summarise and describe the collection of services that could be implemented in separate bundles through a common architecture in the UK. These separate bundles could be targeted at specific customer groups in the field trial.

Figure 1 is an illustration of the provision of service bundles and service providers proposed and developed in the preceding sections and targets on the right-hand side three separate customer groups. Each customer group has been allocated a separate bundle of services, designed to appeal to their possible lifestyle. This process obviously would require considerable thought and analysis prior to any market rollout of services. On the left-hand side are the service provider companies, data for which has been extracted from the individual services texts. These service providers would be responsible for their individual applications and groups of applications in customer premises. The service bundler (Aggregator) and beneficiaries who would pay for the services are identified as separate entities at the bottom of the figure. This is an illustration of the fact that the financial transactions and settlement processes for providing and paying for the services could be separate to that for implementing services.