IEA Implementing Agreement on Communications Technologies for Demand Side Management

Final Report

Assessment of Research, Development and Demonstration Priorities for DSM and Value Added Services

Prepared by Operating Agent
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SUMMARY

This report is the final report describing progress made within Sub Task II/4 of the IEA Annex II project, Communications Technologies for Demand Side Management. It covers the collection and analysis of future customer and utility requirements for DSM functions and Value Added Services. It highlights functions and services which are considered to be most beneficial to customers and utilities. It also identifies research and development activity necessary to assist the growth of DSM, energy efficiency and other value added services in the customer market place.

Project proposals are outlined in some of these areas.

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1 Introduction

Demand Side Management (DSM) has a central theme of modifying customer end use of electricity (and other utility supplies) to shape demand in a beneficial manner to both customers and utilities. Demand shaping objectives include conservation, peak demand reduction, demand relocation, demand control and load growth.

Promotion of electricity consumption can also be a feature of DSM, particularly at periods of low demand, to maximise utilisation of generation and network assets.

The application among customers of many of DSM functions is greatly improved if increased communication between customers and utilities can be developed at acceptable cost. In order to obtain sufficiently low costs at the present time, many different functions are required to share communications capacity and infrastructure.

Utilities which provide enhanced customer services across a wide range of activities, together with increasing the customer focus of their businesses, are features of the directions being taken in many developed countries. These Value Added Services can include remote metering and end use energy consumption information on an itemised basis, planned and unplanned supply interruption details as well as information about supply quality and availability.

Communication infrastructures are being installed between utilities and distribution substations in order to carry out distribution network remote control and automation with the purpose of reducing supply restoration times to customers following faults and reducing manual switching costs. These communication systems can be shared by customer/utility, DSM and Value Added Services traffic to assist cost justification.

Consequently there is potential for many customer/utility services, which are not cost effective in their own right, to be integrated together to justify a communications infrastructure and enable financial benefits to be obtained for both customers and utilities.

Regulations applied to utilities requiring them to increase customer services and improve the quality of services are being introduced in many countries. These regulations influence utilities to offer general increases in functions to all customers

and to move towards enhancing customer/utility communications using standardised systems on a national or individual utility basis.

In competitive utility markets where competitive forces are the main driver for the development of DSM, Value Added Services and communications into the customer population, it is possible to consider groups of customers within specific areas being provided with different services using different communication media. Competition between energy suppliers would therefore take place on the basis of price as well as on the services provided. The requirements of customers for DSM functions and services at the right price will always be the main driver of market penetration.

2 Customers, Utilities and Value Added Services

The environment for the supply of traditional utility services is changing dramatically in many countries. This reflects the general move towards increasingly customer focused businesses where products are targeted at specific customer groups whose spending patterns and requirement profiles are known or estimated. As a result of these moves to focus more on customer requirements, customers are demanding more from suppliers of all services. This activity is heightened even more when competition in utility services is introduced and utilities only retain customers by being perceived as being as good as or better than their competitors. Utilities in this situation can compete on the basis of providing the core services or products in as efficient and cost effective way as possible. They can also impress customers by enabling easy dialogue between utility and customer and by facilitating easy payment and information access. However these routes, although contributing to customer satisfaction, ultimately result in all similar utilities achieving similar levels of service at the same prices. In a competitive environment this results in customers perceiving all utilities to be similar with no margin available to influence customers to change utility. Consequently, in order to differentiate themselves, utilities are investigating the provision of additional Value Added Services which complement their core businesses. In both competitive and non-competitive environments, utilities are investigating the provision of additional services to customers as new business ventures. Again, these services are usually complementary to the core businesses. Increasing dialogue between utility and customer through electronic communications is one of the routes to providing these services.

In a non-competitive environment, utilities can decide, with or without influence from government, to invest in infrastructures to provide customers with Value Added Services as business ventures. The investment would be recouped over a period of time, either through charging directly for the Value Added Service or by adding the cost of the additional service to that for providing the normal utility service. Remote meter reading can be considered as an example of this.

In a competitive environment, the situation is more complex because customers are able to choose between competing suppliers of the services. Consequently investment by utilities in communication infrastructures to customers, for example, requires more careful analysis of how to recover the costs of the investment. Mechanisms and

drivers are being developed which provide an environment to enable restructured utilities to make these investments. Linking communication systems developed for network automation to provide enhanced supply to customers with communication directly to customers can be attractive within a common network business. The communication system can then be made available to competing suppliers of customer services. The network owner could recover the investment costs from the customer service providers, as well as from the increased network utilisation resulting from energy management customer services.

Independent providers of communication infrastructure who lease communication capacity to service providers is also an alternative arrangement. Within all utility environments therefore there is interest in evaluating the provision of customer DSM and Value Added Services as businesses.

Customers are interested in reducing the price of utility services and generally obtaining increased comfort and convenience. In this regard, intelligent buildings have some appeal, particularly when security is included. However, in order to make Value Added Services attractive to customers, the costs have to be low and the user interface extremely simple.

Communications within the customer premises is an important requirement in order to provide many of the attractive Value Added Services. As described in Reference 1, many utility Value Added Services can be provided for customers using external to the premises communication channel capacity requirements of less than 100 bits/sec. This level of data exchange can be accommodated using well established narrowband communication media. More advanced Value Added Services, which may or may not be provided by utilities, such as home banking and interactive video, require wideband (> 2Mbits/sec) communication channels. Consequently from the utility perspective there is a need to decide whether to invest in narrowband channels in order to implement utility Value Added Services or to expand the business into providing advanced wideband services and invest in wideband communication infrastructure. An alternative to investing in wideband infrastructure and offering the data capacity to other organisations is to wait until other organisations have installed the communication infrastructure and then use the facilities for utility Value Added Services.

In order to assess the priorities, as seen by utilities and customers, for future customer/utility Value Added Services and to identify problems likely to impede their development, information has been collected by participating countries through questionnaires and the data analysed by the Operating Agent.

3 Data Collection

Based on discussions among Experts in participating countries, questionnaires were developed to collect information on customer/utility topics considered particularly important. The objective has been to use the questionnaires to collect information from the participating countries regarding customer/utility communications and

function developments in progress and needed for the future. Information extracted and processed from the questionnaires has been used to identify possible technical areas where participant country collaboration in development could be carried out. Collaboration and effort would be directed towards those areas where the work would be effective and assist the introduction and growth of DSM and related functions into markets.

The collated results of questionnaires completed by participating countries are shown in Tables 1, 2, 3 and 4.

In order to understand more fully the questions asked in the questionnaires, a short description of some of the topics has been prepared.

3.1 Home Energy Management and Security

a) Communication gateways to the home

` Utilities presently use communication systems to carry out control and switching at customer premises in many countries. This control is primarily for the purposes of tariff or price switching and meter rate switching or for control of end use devices. The equipment linking the external communication medium to the controller within the premises is called a gateway. In more advanced control systems, a separate communication system within the premises allows end use devices and controllers to exchange information and carry out more effective control. Gateways in these arrangements allow the internal and external communication systems to link together and exchange information.

Many different gateway combinations are possible, not just because of the different media possibilities for internal and external to the premises communication but also because of data capacity requirements of different applications.

An important activity which could be carried out by collaborative effort among participating countries would be the defining of gateway requirements for applications in specific circumstances.

Home Energy Optimisation

This is an important topic and a major driver for increased customer/utility dialogue and in house communication systems. It is able to provide major benefits to customers and energy utilities. Optimisation involves a close link between customer comfort, energy usage patterns and energy costs. Some form of communication system within the customer premises is usually necessary and many proprietary systems are becoming available on the market. However development is necessary to provide cost effective solutions for the mass market.

Appliance Monitoring, Load Profiling and Function Base Billing

Some studies have indicated that by providing customers with information about the costs of operating individual, energy end use appliances, customers will conserve energy and practise DSM. Many studies have been carried out and are still in progress to identify end use energy consumption. The methods range from using communication within customer premises between devices and the metering point to statistical correlation of step changes in demand and device load. This is an important area but to be effective, low cost solutions have to be found with appropriate accuracy.

In House Communication Media

Communication media most commonly considered and installed in trials of intelligent buildings are twisted copper pair and Power Line Communication. Other media being considered are pico cellular radio and coaxial cable, usually associated with CATV. Evaluation of the capability of each medium and suitability for carrying out different collections of utility functions are important areas of investigation. The impact of future loads on Power Line Communication is an important consideration.

b) Home Security and Alarm Systems

Home security alarms and alarms for utility and medical services are significant drivers in some countries for the development of communications both within and outside customer premises. These services can be considered as Value Added Services by utilities to complement core businesses services such as energy management. They are attractive additional services which can assist with cost justification of communication system infrastructures.

c) Customer Acceptance Studies of DSM

This activity aims to identify the most appropriate mechanisms for influencing customers to adopt DSM and Value Added Services.

d) Collaboration through the IEA and collaborative field trials

International collaboration in projects where there is a large overlap of interest among the participating countries can be attractive. The benefits of collaboration are the sharing of expertise and research and development costs. A disadvantage can be the extensive travelling and management requirement.

3.2 Communications for Future Customer Service

a) Migration Strategies from narrow to wideband communication channels

Utilities and potential DSM and Value Added Service providers are faced with issues of how to invest in and develop communication systems. Communication systems require sufficient capacity to meet the needs of the utility or service provider for the foreseeable future and be economically viable. Results of customer and utility function and communication requirement studies show that the data capacity for many utility functions can be met using narrowband communication links.

Rapid development is taking place by telephone companies and organisations, generally outside utilities, to install wideband (>144k bits/sec) communication systems. These systems are being developed to accommodate home computing to the outside world, competitive telephone systems and cable television. They are based on communication systems using enhanced technologies on copper twisted pair, hybrid coaxial cable and fibre and coaxial cable media. Much of the wideband communication infrastructure presently installed to residential customers is one way and used for cable television services. However, due to the demands of additional telephone services and systems, enhancements to these systems to two way communication is being carried out where the economic viability is positive. ISDN (Integrated Services Digital Network) is available as an option to many customers in developed countries but economics dictate that only a very small minority of residential customers are prepared to pay for the service.

Wideband, short range, two way radio links (2-7 GHz) to augment the twisted pair, standard telephone connection to residential customers are also being developed in many countries. However their market penetration is extremely small and they appear to be more viable in countries and areas where no telephone connection already exists.

However, based on many conflicting views of the future, it seems unlikely that wideband, two way communication will be installed to the majority of residential customer premises in less than 10 years. Another related issue is that even when wideband communication channels are installed to the majority of residential customers for purposes other than DSM and Value Added Services, their use for these services will still be charged on the basis of what the market will pay.

Consequently, Utility and Value Added Service providers and customers who require services now and in the immediate future and can benefit from those services, need to determine routes by which they can be provided using available, narrowband channels, yet take advantage of wideband channels when they become available. This issue requires consideration of functions and data capacity requirement, time scales and flexible hardware installed in customer premises.

b) Energy and Communication Implications of Home Working

Developments and improvements in communications with residential customers are enabling a change to take place in the location of the workplace. Workers in many industries can operate from a terminal, irrespective of where it is located, provided that adequate communications capacity to the outside world is available. Consequently the demand for energy both in the workplace and home environments, as well as for transport, are influenced significantly. The promotion of home working can be considered as a demand side management measure which requires communication.

c) Application of satellite/cable set top box interfaces to customer services and DSM

The interface to customers associated with providing Value Added Services is a critical ingredient in customer satisfaction and the penetration of those services into the market. Powerful and flexible interfaces are expensive so that sharing of common interfaces by many services is desirable. Set top boxes based on the television set are being developed to meet the requirements of interactive television as well as a host of extra services such as home banking and shopping. They are still very much at the advanced development stage. However they could be used to assist with the provision of Utility Value Added Services if the infrastructure and hardware costs are paid for by other services.

d) Application of the PC/Internet to Customer Service and DSM

In a similar manner to satellite/cable set top boxes, use of customer PCs connected to the Internet could be used to exchange information between customers and utilities and provide the interface. These functions could be related to account queries, energy consumption, competitive energy prices and estimated bills against customer profiles or just energy efficiency advice. However the service requires customers to have an Internet connection which would probably be justified for other purposes. Satellite/cable systems use the television as the customer visual interface, whereas the Internet route uses the PC display.

e) Development of high speed DLC Communication (>1200 baud)

This topic is relatively self explanatory with the objective of extending the effective data capacity of installed DLC systems from hundreds of baud to thousands of baud. Systems with bit rates of thousands of baud are being developed but are likely to require the use of several repeater stages in order to achieve reliable communication. These repeater stages reduce the effective capacity.

f) Application of new digital paging systems to customer service and DSM

Digital paging systems are being developed and made available in many countries to enable one way communication to take place between a centre and individual persons. These systems can be used to send short messages to advise the recipient to communicate in the other direction using another communication medium. Experimental systems using paging system technology to communicate in two directions have been carried out for providing customer services. However the economic viability of this arrangement, which requires multiplication of the number of cells used, has not yet been demonstrated.

g) Application of digital mobile telephone technology to customer service and DSM

This is an obvious candidate for consideration in the provision of customer Value Added Services. However the overall capital, annual costs and provision of facilities management infrastructure need to be evaluated when operating in the customer services mode.

h) Application of satellite technology to customer service and DSM

Two way satellite communication is being evaluated in trials of electricity substation control for remote areas. However two way communication using this medium is not an economic proposition for customer/utility communication. Communication from utility to customers could be viable for some functions and activities.

j) Application of wireless in the local loop

This radio technology is being considered by developed countries as a wideband alternative to the twisted pair local telephone connection. However the drivers to justify the infrastructure costs are unlikely to be customer/utility Value Added Services which generally can be carried out using the capacity available on twisted copper pairs. The potential for this medium is large once it has been installed for other purposes.

k) Application of telepoint technology (CT2) to customer service and DSM

This technology is used for credit card, point of sale and stock control systems in retail outlets. The technology could have some application to

customer/utility services in areas such as prepayment for energy. Smart cards for remote metering and exchanging customer/utility information are also being developed.

l) Can collective work on communications for future customer services be carried out through the IEA to share R&D work and results?

This is obviously an important question relating to IEA Agreements and explores the issues of differing populations and aspirations in different countries as well as intellectual property issues.

m) Can field trials be sponsored internationally through the IEA?

This question is related to question **2e** but specifically deals with the resourcing by one country of field trials in another.

4 Analysis of Collected Data

Information has been collected from ten countries regarding customer and utility functions, communications and utility network functions. The information has been categorised into functions which are applied currently, those which are planned for the future and those where more R&D work is necessary. The information was collected by Experts in the participating countries from utilities, manufacturers and customers. Consequently the results represent a reasonable view of where developed countries are regarding customer communications, DSM, Value Added Services and distribution network remote control and automation. It is therefore possible to promote and consider strategies for the future which include the application of collections of functions with which to justify the communications infrastructure costs.

Table 1 shows highlighted with * the functions and applications, current and planned for the future, which received more than 50% support, (Ref 1). It is easy to identify that load control, meter rate switching, automated meter reading are currently being applied, in possibly small quantities in some cases, to all customer categories. Interruptible tariffs are currently applied generally to industrial customers.

Remote and automated operation of network switchgear, fault detection and network load monitoring are all topics being pursued currently by utilities in order to improve supply availability and quality.

Planned future applications to all categories of customer include the downloading of energy price information, remote reading of gas meters and itemised load monitoring and disaggregated billing. Other topics which received strong support, but for selected

customer categories, are remote reading of water meters, quality of supply monitoring, residential security alarms and home energy management.

For the planned future as far as the distribution network is concerned, generation control and monitoring was considered of major interest.

Customer and utility functions where more R&D is considered to be needed were treated differently in the questionnaires. The topics considered in the questionnaires have been briefly described in Chapter 3 and categorised under the two broad headings of a) Home Energy Management and Security, and b) Communications for Future Customer Services.

Home Energy Management and Security, Table 2, shows strong support for additional work to be carried out into communication gateways to the home, home energy optimisation, appliance load monitoring and disaggregated billing and "in house" communication media.

Communications for Future Customer Services, Table 3, shows strong support for additional work on migration strategies from narrow to wide band communication systems, customer acceptance studies of DSM and Value Added Services, high speed power line communications and the application of digital mobile telephony. Also strongly supported was that additional work can be carried out under the auspices of IEA Agreements.

Project proposal outlines to address some of these areas of perceived future R&D requirement are attached in Appendices 1, 2 and 3.

5 Conclusions

Commonality of communication and function requirements and perceived problem areas among participating countries have been identified. Countries are moving in similar directions in terms of functional requirements of customer and utilities even though the structure of utilities is different between some countries. The main thrust of the requirement for R&D development has been identified as being to increase the monitoring and control at customer premises and within distribution networks. This increased monitoring and control is required to be of all items of equipment from distribution network switches to individual devices in customer premises. Communications and gateways to link these items together so as to share the costs of infrastructure development have been identified as important areas for increased development. The provision of services to customers in addition to the normal utility services are seen as vitally important in assisting the development of economically viable DSM and energy efficiency functions into the customer market place.

References

1 IEA Implementing Agreement on Communications Technologies for DSM, "Evaluation of Communications to meet Customer/Utility Requirements for DSM and Related Functions" dated January 1996