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Information technology –
Home Electronic System (HES) application model –

Part 3:
Model of an energy management system for HES

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INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) APPLICATION MODEL –

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FOREWORD

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2) In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC 15067-3, which is a technical report of type 3, was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

This publication was drafted in accordance with ISO/IEC directives, Part 3.

This document is not to be regarded as an International Standard. Comments on the content of this document should be sent to IEC Central Office.

ISO/IEC 15067 currently consists of four parts:

Part 1: Application services and protocol (under consideraton)

Part 2: Lighting model for HES

Part 3: Model of an energy management system for HES

Part 4: Model of a security system for HES (under consideration)

INTRODUCTION

This model of an energy management system for residences extends the set of HES (Home Electronic System) application models. Models for lighting and security have already been developed and accepted. These models should facilitate the validation of the language specified for HES in ISO/IEC 15067-1.

These models have been developed to foster interoperability among products from competing or complementary manufacturers. Product interoperability is essential when using home control standards, such as HES. This document defines a typical security system and describes the communications services needed. A high-level model for an energy management system using HES is presented.

ISO and IEC would appreciate comments by developers of energy management systems regarding possible enhancements to this model.

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) APPLICATION MODEL –

Part 3: Model of an energy management system for HES

1 Scope

The model for energy management presented in this Technical Report is generic and representative of a wide range of situations. Since one model cannot be completely comprehensive other models or operating modes may be more appropriate for certain applications.

This model for energy management accommodates a range of load control strategies. Examples of implementations that could be described with this model include:

– the CELECT Intelligent Load Management System in the United Kingdom. The utility transmits electricity cost data and forecasted outdoor air temperatures to residential heater controllers;

– the “bleu, blanc, rouge” technique used by Electricité de France to announce price tiers one day in advance. The tier signal is displayed using a blue, white or red light to alert the customer;

– real-time pricing experiments by Consolidated Edison of New York and by Pacific Gas and Electric, both in the United States.

2 Reference documents

ISO/IEC 15067-1: *Information technology – Home Electronic System (HES) Application Model – Part 1: Application Services and Protocol* (under consideration)

3 Abbreviations

DSM	Demand-Side Management
EPRI	Electric Power Research Institute (Palo Alto, California, U.S.A.)

4 Evolution of energy management

Electricity consumption patterns have high peaks. During weather extremes of heat and cold the demand for electricity rises sharply. In the United States the average rate of power generation is only about 46 % of the peak generation that occurs during these situations. Ideally, the utilities would like to maintain the supply of electricity sufficiently high to meet any demand. This has been achieved in some regions of developed countries. However, this is becoming less practical because of public pressure and government rules. Therefore, utilities have developed many methods of Demand-Side Management (DSM) for influencing the demand to match the available supply.

DSM tools enable utilities to modify the cumulative demand for energy, known as the load shape when plotted over a one-day interval. Utilities have developed a variety of DSM programs to manipulate the load shape. Different programs have different load shape goals, with the majority intended for peak clipping.

DSM programs initially focused on providing incentives for using electricity more efficiently. Customer cooperation may be obtained by offering a financial incentive, such as an up-front rebate, a loan guarantee, a lower rate for electricity, or free energy efficient planning and evaluation services. Some programs offer rebates for switching from tungsten to fluorescent lights, for adding building insulation, and for purchasing energy efficient appliances.

Utilities have developed more deterministic methods for influencing the demand through load control. The more innovative methods of load control depend on market forces for exerting control by varying the price of electricity. In the United States, almost 20 million customers out of a total of 130 million participate in some DSM program. About 30 % of these programs are load control.

5 Load control

5.1 Responding to pricing

In North America electricity traditionally has been sold at a flat rate or a volume-sensitive rate. New pricing schemes are adding time as a factor. Time-of-use rates vary the price according to the time of day. Typically, on-peak and off-peak rates are announced. The hours for each rate are fixed for each day, or at least for work days, similar to telephone rates. Rates that change dynamically with one-day or even no advance notice constitute real-time pricing.

Most load control programs by utilities have been limited to local control and direct control. However, the most innovative load control uses a combination called distributed control. These varieties of DSM help users respond effectively to utility price variations.

5.2 Local control

The utility publishes an electricity tariff that has between two and four different rates depending on the time of day. Customers with time-of-use pricing for electricity are encouraged to operate heavy power consuming appliances at off peak pricing times. In order to maximize the savings, the customer must know the rates, know the power requirements of the appliance, and know the cost of operating the appliance. Then the customer can decide if it is convenient to defer the operation or spend the money during the peak cost time.

A few utilities have instituted a tariff that discourages a peak load. The consumer pays a special charge called a demand charge if the total electricity consumed during a short interval (typically 15 or 30 min) exceeds a preset limit.

Control equipment in the house can assist in determining when to operate some appliances. For example, a programmable thermostat could lower the temperature setting for a furnace during a period of higher priced electricity. If the consumer is subject to demand charges, special equipment could measure the power drawn, and cut off selected appliances, such as an air conditioner, as the demand limit is approached.

5.3 Direct control

Whereas local control depends entirely on voluntary cooperation by customers, direct control forces a shift in the customer demand for electricity. When direct control is activated at times of peak consumption, the utility interrupts the operation of appliances, such as the water heater and air conditioner. This requires prior arrangements with customers for permission and equipment installation. Many customers in the U.S. are offered rebates of up to $ 10 a month for participating in direct load control. More than 90 % of load control programs in the U.S. are based on direct control.

The utility operates these switches by remote control. They may use signals sent over the power line, over a cable television channel, over the telephone line, or via radio waves. A typical pattern of control would occur during the peak usage on a very hot afternoon:

– the air conditioner is cycled off periodically for 15 min, then 15 min on. Half of the customers are on while the other half is off;
– the water heater is cycled off for two hours, then on for two hours.

5.4 Distributed control

Distributed control is a relatively new method of load control. It is a combination of local and direct control with much increased flexibility. The utility has the opportunity to change prices at will by following the wholesale market price of electricity to reflect actual utility costs.

Distributed control has the potential to satisfy both the utility and the consumer:

– the utility can price power to reflect costs and supply. Changes can occur quickly, as needed;
– the customer makes the fundamental choice of comfort and convenience of operating certain electric appliances versus the cost of electricity.

It should be noted that some countries do not presently permit residential users to be offered fully flexible real-time pricing. Utilities may be permitted tariffs with two or more price tiers to reflect their costs of energy generation and distribution. As these innovative pricing schemes lower the peak demand, utility costs are reduced.

Some utilities are capable of accurately forecasting the cost of energy in the near future, typically 24 hours in advance, and supplying this information to the residential consumer. Forecasted pricing enables the consumer, or an intelligent energy management system, to “draw forward” on consumption in anticipation of peak pricing. This may involve comparatively simple measures such as ensuring that heat storage devices, water heaters, and similar are fully charged when the peak price period starts. The supply of such forecast pricing enables peaks in demand to be smoothed both forward and backward in time, thereby reducing the impact of such measures on consumer comfort and convenience.

There are two important problems for effective use of the changing cost of power. First, the price data must be delivered to the customer in a timely fashion. Second, the customer must interpret the data and apply it to appliance operation. Since most customers do not understand electricity measures, such as kilowatthours, they are not likely to use this data correctly. Here is where home control technology can benefit the consumer and the utility.

Figure 1 shows a possible distributed load control residential implementation. Electricity price data are sent to all houses in real-time over a wide area network, such as radio, telephone, or cable television. An energy management controller in the house receives the electricity rate information via a home control communications network. The controller combines this information with stored data about appliance power requirements and customer information. The customer might enter preferences in some implementations for appliance operation and budget limitations for electricity expenditures. Having processed this information, the controller issues signals that are distributed over a home control network in the house to the relevant appliances.

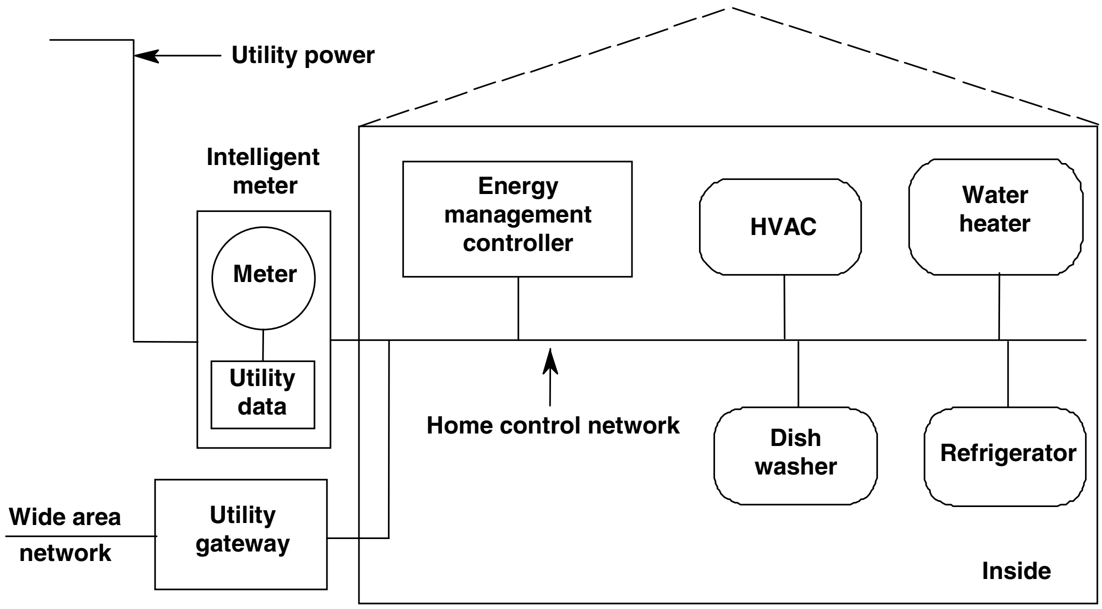

Figure 1 – A Distributed load control example

The energy management controller may not necessarily be a separate component. It could be combined with a security controller, an ISDN telephone decoder, or a cable television converter/decoder, or the functionality could be distributed among other components. Also, intelligent appliances may contain much or all of the functionality of an energy management controller. The location of energy management functions among a dedicated controller and appliances depends on the future market for appliances designed for integration with distributed control.

6 Value-added services

Communications between utilities and customers has been used on a very limited scale to implement load control for effective DSM. Typically, one-way communication is employed for switching customer loads. Utilities are now considering additional services that can be delivered using upgraded versions of these communications facilities. The objective is to retain customers with innovative services and to generate additional revenue with offering ancillary to power. Collectively, these are known as value-added services. Some governments have mandated that utilities, which traditionally were granted monopolies, start planning for competition. Therefore, utilities are seeking value-added services to make their products more attractive to customers.

Potential value-added services for electric utilities beyond load control are listed. The services preceded by a check-mark (✓) may be sold for additional revenue beyond the usual energy charges.

  Automatic meter reading
✓ Offer bills with details about consumption by major appliances
  Monitor power delivery
✓ Monitor power quality
✓ Offer load profiles
  Control customer access when customers move or don't pay bills
  Stagger power restoration in a neighborhood after a power failure

Detect tampering

- ✓ Diagnose appliances' problems and notify the customer
- ✓ Offer information and telemetry services

7 The utility gateway

Utilities use a variety of communications protocols for wide area network communications. These communication protocols are often different from the protocols used for home control. Communication gateways are required to link utility networks to home control networks when the protocols differ.

There is a multi-million dollar effort among some U.S. utilities to unify utility communications with a limited set of international standards. This project is the Utility Communications Architecture, sponsored by the Electric Power Research Institute [1] (EPRI). This new protocol and existing utility protocols are different from home control protocols. Therefore, a communications gateway will be needed to link utility networks with home control networks for load control and value-added services data.

Utilities have many options for implementing and locating the customer gateway. EPRI has defined the Customer Communications Gateway for linking utility signals to customer equipment. This gateway is located near the electric meter at each house or building. As shown in Figure 2, it links the utility wide area network with a local area network in the house. It is designed to accommodate a variety of home control networks. Also, it provides a communications port for an electric meter. In some gateway designs the meter is accessible from both the utility and home networks.

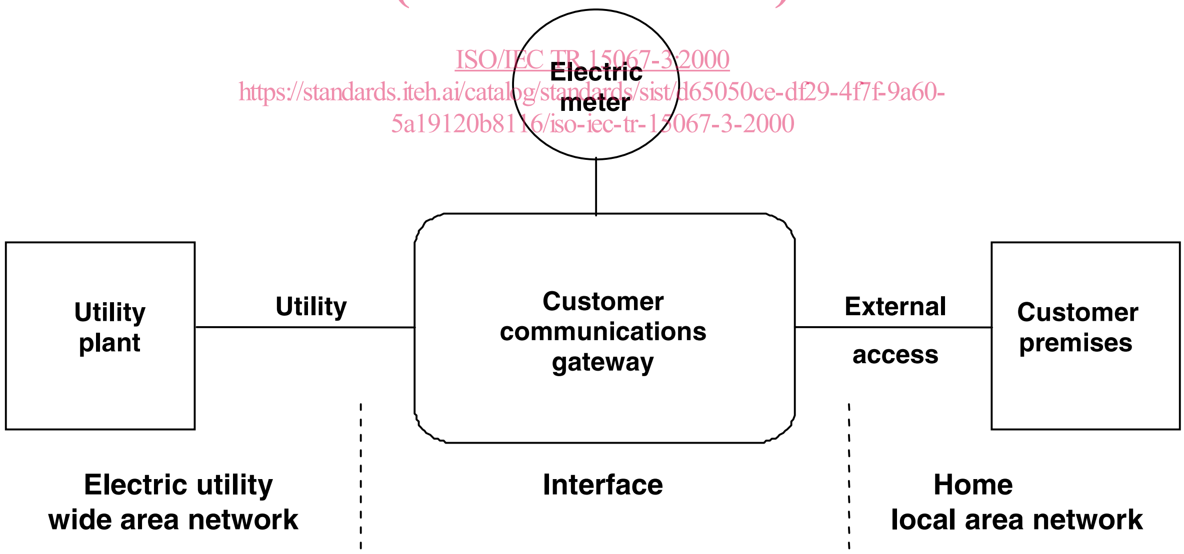

Figure 2 – EPRI Customer communications gateway

The gateway is responsible for converting the electrical signal from the wide area network format to that of the local area network. There may be differences in communications media, connectors, electrical waveforms, and timing. Data rate disparities on the two networks may require buffering and flow control in the gateway to avoid losing data. Also, the formats for commands and data are likely to be different and require translation.

[1] Many investor-owned utilities support EPRI (Palo Alto, California). EPRI uses member utility funds to sponsor research projects. Utilities outside the United States may join EPRI as foreign affiliates.