

My Home – The intelligent way

The Danish Electricity Saving Trust's Concept for Home Control

European consumers can save billions of Euros – simply by making sure that appliances in their homes only consume electricity when in use. The secret is to eliminate unnecessary standby consumption and ensure that lighting, ventilation, heating systems and air conditioners only operate when required. One way to do this is for consumers to use a correctly programmed home control and monitoring system.

This paper describes an international initiative taken by the Danish Electricity Saving Trust to develop a sizeable consumer market for standardised energy management devices and monitoring equipment. The key point is to offer consumers simple and affordable control devices that allow them to monitor and manage their homes easily and efficiently, with energy savings as an added bonus. It is also important that these devices can communicate wirelessly with each other – regardless of the manufacturer.

The basic idea is to offer consumers the opportunity to set up their own home energy management system on a step-by-step basis, based on Plug and Play products and wireless communication.

The Trust has taken the first step towards an integrated solution for this concept with the creation of the My Home Internet portal. At My Home, users can draw a floorplan of their home and equip it with electrical appliances and furniture. Options for controlling and monitoring electrical appliances in the home can then be added to the floorplan via a simple Internet browser, which consumers can use wherever they are.

The Trust is also developing an XML communication protocol alongside My Home, which hopefully will become a good de facto standard for communication between residential gateways, online portals and third-party suppliers.

The Danish Electricity Saving Trust is an independent not-for-profit organisation that helps Danish consumers and public sector institutions save energy.

The home control concept

Cost and user-friendliness are major obstacles to installing efficient private home control systems. The market is in a transition phase, however, with many manufacturers now supplying devices to private consumers. Many of these devices support the Z-Wave standard, and they can communicate with each other using this standard, irrespective of manufacturer. However, setting up and configuring these systems in private homes is often still too complicated for ordinary users, and set-up procedures differ from manufacturer to manufacturer. The Danish Electricity Saving Trust hopes that its concept will help eliminate these obstacles.

The Trust's concept involves offering consumers a common standard for controlling devices without tying them to one manufacturer. In order to achieve this, the Trust requires that the devices comply with the terms of its recommended Energy Saving Label, which generally ensures both uniformity and compatibility, but also guarantees energy efficient solutions for consumers that are both user-friendly and easy to set up and configure.

Energy Saving Label

The Trust recommends products that both save energy and meet its quality requirements. Recommended products can be found on the Trust's website and in printed material. See www.savingtrust.dk.

Manufacturers may also use the recommended Energy Saving Label on their products. However, this endorsement is subject to the fact that the products covered satisfy a number of conditions laid down by the Trust.

In general, a product needs to:

- Save energy in a straightforward way
- Be relevant to the general public
- Be safe and comply with regulatory requirements.

Specific requirements for wireless equipment:

- Residential gateways, sensors, actuators and remote controls must be approved by the Z-Wave Alliance and be labelled with the Z-Wave logo, thereby ensuring that products from different manufacturers can communicate
- The recommended residential gateways should be able to control other sensors, actuators and remote controls recommended by the Trust
- The recommended gateways should be able to upload measurements (e.g. meter data) to the Trust's server, and receive data and information from the server using the data format laid down by the Trust
- The recommended residential gateways should be capable of receiving automatic firmware upgrades to enable control of new types of products and the use of the latest software developed by the Trust
- The Trust will promote the above components on its website at www.savingtrust.dk
- The Trust will develop freeware applications for residential gateways, sensors, actuators and remote controls and data tools for analysing meter data.



Before recommending a product, the Trust must receive the necessary documentation from the manufacturer. The Trust will also continuously monitor recommended products on the market, and will display them at www.savingtrust.dk. Subject to a separate agreement, the Trust will allow manufacturers of recommended products to use the Trust's logo, software, etc., on a worldwide basis.

About Z-Wave

Nothing is more frustrating than buying electronic products that cannot interface with other products that you own. When you invest in technology for your home, you want to be sure that it will work seamlessly with what you already have, and can communicate with any other components you might want to add in the future. The Trust has chosen Z-Wave as its wireless control protocol because it is a widely accepted technical standard that ensures complete interoperability between all Z-Wave devices, no matter what the brand.



The main features of Z-Wave are the use of open communication protocols and low power consumption. Z-Wave is marketed worldwide and is a strong player on the American market.

The Trust's main reasons for recommending Z-Wave:

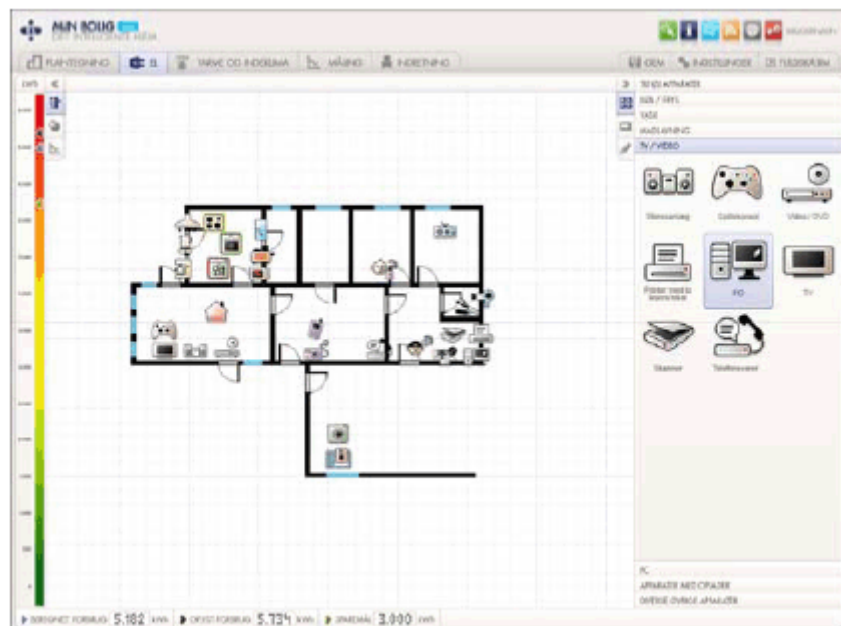
- Hardware comprises an inexpensive chip for integration into devices
- Low power consumption makes battery-powered sensors and switches a reality, even for extended operating periods
- 30-metre operating distance can be considerably extended thanks to the built-in repeat function that allows signals to be relayed from any other Z-Wave chip
- Rapidly growing market share with increasing numbers of manufacturers adopting the technology
- Alliance of companies using Z-Wave (Z-Wave Alliance Group) cooperates on protocol development, thereby ensuring connectivity between Z-Wave-equipped devices via open standards
- Z-Wave Alliance and communication protocol are available to everyone at low cost
- Well-defined communication protocols and an open approach create opportunities for a wide variety of third-party products, thereby ensuring competition in the market and ultimately lower prices for consumers.

My Home – The intelligent home

The My Home concept means that users can control their home appliances and devices even when they are somewhere else. They can program the automatic systems to control all appliances and equipment for which logical rules can be defined, for example, control of the indoor environment based on whether there are people in the house. They can also turn on the heating in their second or holiday home, or switch on the patio lights from a mobile phone.

Central control allows users to optimise their home's energy consumption while monitoring the building and receiving reports as required. Monitoring can include keeping an eye on elderly relatives, burglar alarms, flood warnings or any other form of desired monitoring – no further away than the nearest web browser or mobile phone. Users also have access to invaluable statistics about their home's energy consumption, and thus have a good basis for determining how 'green' a life they are living.

The environmental benefits of an intelligent home are self-evident; automated control saves energy simply by not wasting resources. The intelligent home automatically saves energy wherever possible (e.g. standby consumption or lighting, etc.) without compromising comfort or the quality of life. My Home also provides users with an overview that identifies energy wasteful products and encourages a greener lifestyle.



My Home is an integrated Internet portal for private homes. My Home allows users to draw a floorplan, install appliances and furniture, view current energy consumption and get tips for saving more energy by replacing appliances or using them in a more energy-efficient way.

My Home provides an overview and acts as a command and control centre

The first step towards an intelligent home is a basic floorplan that users create in their My Home profile on the Net. My Home offers several options for doing this. Users can use the built-in drawing tool to draw a floorplan of their home. Alternatively, they can scan in an existing floorplan, or choose one of several demo layouts of various standard homes such as a family with children, a retired couple or a single person. If users choose one of the demo homes, My Home will automatically suggest a range of electrical appliances for the home. Naturally, users can change the standard selection to suit their individual circumstances.

Apart from home control, the My Home floorplan can be used in other ways, such as experimenting with the layout and furniture. The Danish Electricity Saving Trust is continuously adding user-relevant functions to make My Home the preferred tool for all home control-related activities. For example, users will be able to store insurance company information such as photos of their home contents, create working drawings for installers, make notes about installations, store user manuals for electrical appliances, and so on.

The idea behind My Home is three-fold. The core function of My Home is as an electronic filing system for storing all important papers and information about the house. In Denmark, it will be part of www.borger.dk (the Danish household and consumer portal), which gives householders access to all information about their homes in the public domain.

Tools for metering electricity, calculating heating and overview functionality will be developed and added to this core function. This section will be supported by measuring and analytical tools to improve the transparency of users' energy consumption.



Intelligent monitoring and management form the apex of the pyramid.

Users are able to keep track of their energy consumption, with the picture becoming increasingly more detailed as users enter information about their electrical appliances and consumption patterns.

Overview of electricity consumption

The more users tell My Home about their electrical appliances, the more detailed the overview and the better advice they receive. Users can select relevant appliances and drag them into the rooms of the house on the floorplan corresponding to approximately the same location occupied by the appliances in real life.

The system's built-in calculator keeps track of the standard consumption for all appliances. As information about consumption patterns and the use of various products is entered, the system provides an increasingly precise estimate of annual consumption. My Home identifies energy wasteful equipment and advises on alternative solutions that offer the same performance but use less energy.

Users can analyse measurement data themselves – for example, by viewing graphs of various measurement values and total energy consumption and comparing them with standard consumption values for similar types

of homes. If the relevant meter data are available, users will be able to read detailed consumption figures as quarterly values.

The vision for My Home is to create a useful free tool that appeals to the general public, collects home-related topics together in a central location and offers the best starting point for home control – as opposed to a toy for energy buffs. The Danish Electricity Saving Trust wants to listen to users, and to grow with them and with the technology, because we know that more intelligent homes are also greener homes.

Energy Signatures

Several services will be developed for My Home. One of the services is energy signatures. Energy signatures are a way of characterising the energy demand and increasing the level of information for the time series of measurements uploaded to My Home. Quarterly or hourly time series of measured energy demands are automatically processed using an advanced statistical tool, with information embedded in the time series condensed into one or a few numbers characterising the demand.

By October 2008 a service called Base Consumption will come on stream. This will evaluate the minimum electricity required by a home (e.g. the minimum demand for each day). Although minimum demand varies the system will make it possible to decide the minimum demand level, and also to detect if this level changes, and on which day the change in demand level occurs. The user will then automatically receive a warning when the minimum demand level changes by more than a certain amount as defined by the user. This is useful feature when purchasing new electrical devices, for example those with an unknown level of standby consumption. If standby consumption is too high the user will receive a warning and be reminded that something should be done about the standby consumption of the recently purchased equipment.

Another service that is being developed is Determination of the UA-value (the overall heat loss coefficient) of a building. This facility processes and evaluates energy demand time series for space heating and domestic hot water. When combined with meteorological data it is possible to evaluate the performance of the thermal envelope and automatically provide the user guidelines on how to improve the thermal envelope, thereby saving energy. This makes it easy to quantify the value of the improvements by comparing the UA-value before and after an improvement to the thermal envelope.



Quarterly or hourly time series of measured energy demands are automatically processed using an advanced statistical tool. Information embedded in the time series is condensed into one or a few numbers characterising the demand.

How it works

Large buildings typically have a Building Management System (BMS) to control the heating, ventilation and cooling systems, and often also their lighting systems. Systems like this save huge amounts of energy if correctly commissioned and configured.

Historically, these conventional control systems have been too complicated and costly for use in ordinary homes. However, the advent of inexpensive wireless communication solutions, as well as cheap sensors and actuators has made intelligent home control a realistic possibility. But to generate the considerable energy savings desired, these systems have to be correctly set up and configured – something that is still complicated.

The Danish Electricity Saving Trust has set out to solve this problem with *My Home*, which offers a graphical user interface for helping consumers handle various problems, even complex ones. *My Home* already contains a floorplan, and consumers can quickly learn to use the icons representing various appliances and equipment. To set up their home control system, users drag icons into the rooms of their online floorplan corresponding to where the appliances are located in real life. Users then click the items to connect the components. Once the control system has been configured in *My Home*, the configuration is relayed to the physical residential gateway in the home, which handles the actual control.

Wherever users are

The Trust's concept puts users first. Home control systems should not only be easy to use and set up, but should also be accessible wherever users are.

The concept supports a broad spectrum of technologies that allow users on the move to directly control and monitor their homes via Z-Wave-compatible remote control or a residential gateway. Users can use a wide range of mobile phones and other mobile platforms, as well as *My Home* at www.savingtrust.dk/myhome.

At home

When people are at home, they want to be able to turn appliances on and off, adjust the lighting, check the temperature and perhaps regulate the heating. Users can control all these functions in their homes using one or more remote controls whose simple icons guide them through the control process and give them total command of the total environment. They can not only monitor the general situation, and the heating and energy consumption of their household, but also turn lighting and appliances on and off remotely – all via a residential gateway, which can be thought of as a small computer. Because these smart residential gateways are often very small, they can be centrally located, for example, in the kitchen or lounge, giving users easy access to all connected appliances and a good overall view.



The Trust's concept includes the option of creating program packages that can turn several appliances on and off simultaneously. This means users can quickly switch off all the lights or turn down the heating throughout the house.

On the move

Giving users full control and command of their house while they're at home is nice, but having access to some of the functions while they're on the move is often essential. Today many functions merge seamlessly in smart terminals, which we still tend to call mobile phones. Modern mobile phones usually have a good colour display, a reasonable camera and an Internet connection via Wi-Fi and GPRS (3G) or EDGE (GSM), in other words, reliable high-speed Internet access. These devices give users unique advantages undreamed of just a few years ago. The large display and Internet access give users access to their homes and full control of appliances and devices as well as an overview of temperature, heating and other functions. These possibilities are not only interesting for the home, but also have other uses, in second and holiday homes for example.

While travelling to their second home, users can use their mobile phone to turn up the heating and switch on the driveway lighting to welcome them on arrival. They can also check to make sure they have turned down the heating in their house in town and switched all the lights off. Also, they can easily switch their lights from manual control to automatic, giving the impression that they are still at home. Random lighting control prevents a repeat of typical 'all lights on at 7 PM, all lights off at 11 PM' solutions often selected when people go on holiday.

My Home on the Internet

Although mobile phones and local residential gateways in the home offer some clear advantages for day-to-day control and monitoring, they also have built-in limitations. Programming and monitoring complex set-ups from a mobile phone or the touchscreen of a residential gateway are often difficult. It is usually far better to monitor and program them using a large PC screen connected to the Net. The concept also gives users the possibility of monitoring and controlling their home from a remote location, because the only requirements are an Internet connection via a PC or MAC.



As mentioned earlier, the Trust has developed My Home as an integrated Internet portal for the home. My Home is where users can draw a floor plan and furnish their own home, view current energy consumption and get tips for saving more energy by replacing appliances or using them in a more energy-efficient way. My Home also provides an overview of the home's intelligent devices and how to program them.

Overview

In My Home, users can click on a control tab to register their residential gateway mentioned above. The residential gateway reports back to My Home that several devices are connected – for example, six on-off switches with built-in electricity meters, four temperature sensors, a garage door opener, four motorised

curtains, a coffee machine, three surveillance cameras, two digital TVs and three remote controls. All the appliances are listed by type, with names assigned to them by the user during the setup process (e.g. 'stairway light' or 'Siemens coffee machine'). All these devices now appear as easily recognisable icons in My Home, and can be dragged into place in the floorplan in the locations corresponding to the ones they occupy in real life. This gives a far better visual overview than a long list categorised by rooms or floors. Users now draw physical lines to connect the on-off switches with some of the appliances and lamps already shown on the floorplan. Consumers can instantly see which lamps in the house are physically lit, check the temperature in each room and read the current electricity consumption. They can also view live feeds from the surveillance cameras and check that the intruder alarm is on. In other words, users now have total command of their home via the Internet – wherever they are.

Configuration

But things don't stop here. Now that all the devices are displayed on the floorplan and connected to the residential gateway in the house, users might as well use the layout's logical visual structure to configure the devices and set up intelligent program packages to make daily living even easier.

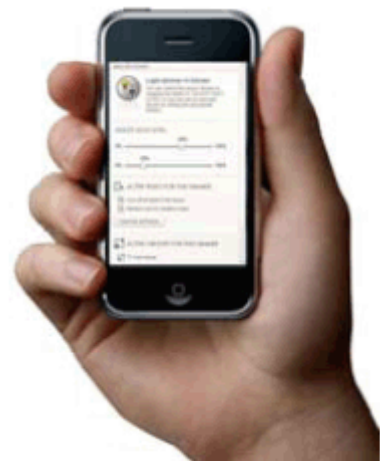
Simple guides explain the procedures step-by-step, helping the user to make simple choices. The concept offers a simple and intuitive way for users to establish even highly complex rules themselves. Having created a program package, users decide whether to activate it and how to access it – from a remote control, mobile phone, residential gateway and/or a switch in the house, etc.

Some program packages can be activated in ways other than by the user (e.g. when the temperature rises above a certain level, when movement is detected, when the car drives into the garage, or using a timer/calendar function). This makes the system both automated and user controllable, thereby allowing automatic systems to take over when user input is not required.

Management

Once the appliances and devices have been logically connected in My Home, and program packages set up, they can be activated via the residential gateway in the house or by mobile phone. For example, from the set-up menu in My Home, users can directly select whether program packages should be accessible via the residential gateway, the related remote controls, mobile phones, other smart devices, or even a button located by the main exits to the house. Users can thus create a program package called 'Switch off all indoor lights' that is linked to all on/off switches in the house and turns them all off.

Users will also be able to configure their mobile phones using a simple wizard in My Home. A few simple steps will guide users through the process, saving them the difficulty of configuring the set-up from a tiny mobile phone display.



There are five areas of monitoring and control available from My Home:

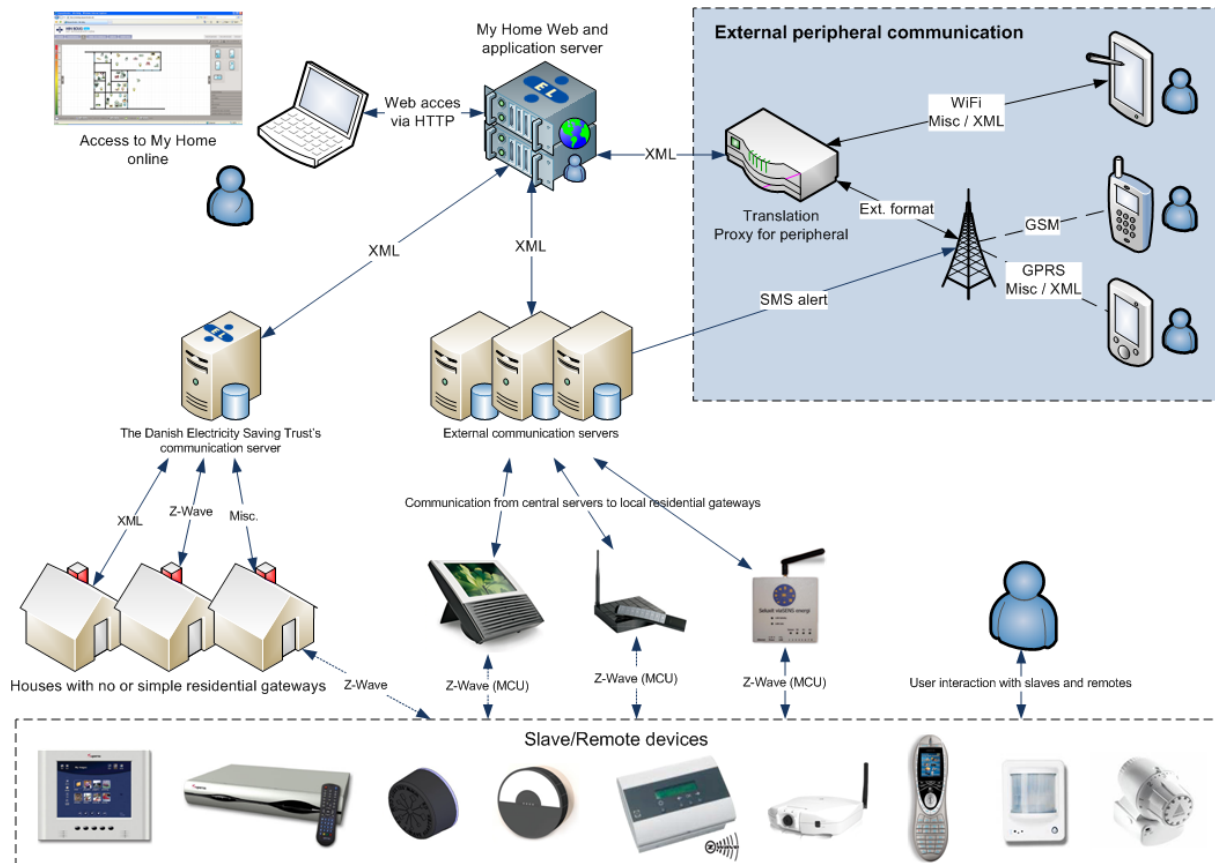
- Set-up and configuration allows consumers to activate and set up the smart devices directly from the graphical user interface, by dragging and dropping icons, linking devices and changing values.
- Online overview gives consumers the ability to instantly see which lamps in the house are physically lit, check the temperature in each room and read current electricity consumption.
- Direct control is control in real time where, for example, the user can turn on a device by clicking on it via My Home or a mobile phone. After receiving the command from My Home, the device in the home will send a reply with its current status, and shortly afterwards the user will be able to see that the device is now on.
- Rule control sets up simple rules for one or more devices. These rules can be set up for activation by sensors, by input from other devices, or by timer/calendar functions. The rules can overlap and be independent of each other. The rules can then be turned on or off, or be activated directly from My Home, enabling users to switch off all home lights or lock all doors with a single click of their mouse.
- Automatic control is a general term for all forms of control that do not fall into categories of either direct or rule control. Examples are climate control based on specific calculations for controlling the central heating boiler or stove, thermostats, etc. Automatic control can also be integrated with the household's energy measurements and local weather forecasts, with an analysis of the building's thermal profile providing a basis for ongoing control. In time, it will also be possible to align automatic control with users' typical consumption patterns – their regular daily wake-up time, for example, or the amount of hot water they use. Users will also be able to select default settings, with typical values predefined by experts to ensure that the controls are working properly and saving energy.

Users thus need no prior knowledge whatsoever about control to be able to install a home control system and thus make huge energy savings.



The underlying technology

In addition to the recommended Energy Saving Label, The Danish Electricity Saving Trust has developed a strategy covering the ways that wireless devices such as actuators, remote controls, residential gateways and online servers should communicate with each other.



The diagram illustrates the multiple communication layers from online user access to access via residential gateways and remote controls, and the communication to and from external devices such as mobile phones.

In the home

When users buy a new wireless device, they register it with the network by physically clicking on the new device and on the residential gateway. The residential gateway now knows a new device has been added and therefore expands the XML file that describes the whole system. This XML file is relayed up through the system to My Home with the device appearing in the user's device list at the next login.

Access via My Home

As mentioned earlier, consumers can draw or input their floorplan and instantly see the connected sensors, actuators and remote controls on My Home if their residential gateway is recommended by the Trust.



When users login to My Home, the XML file from the residential gateway is transferred to the user profile at My Home, where a new icon symbolising the new device will be ready and waiting for the user. My Home already knows the name of the device and its properties via the XML file, and can therefore show accurate icons of real products with the same properties as the new component. My Home is able to identify the new device once the user has selected the icon corresponding to the device. The user moves the icon symbolising the new device to the position it occupies in the real home, and draws joining lines between the new device and the appliance or appliances that it will control, or that will control it. Next, the user is asked how component control should be programmed. It is possible to select a default setting – typically preset values defined by experts to ensure the controller is working properly. Users can also change these values if they want more precise programming, or want to fine-tune the device control.

My Home then changes the XML file accordingly, relays this information to the residential gateway, which is then programmed with the updated control procedures.

Users therefore need no prior knowledge whatsoever about control to be able to install a home control system and thus make huge energy savings.

Using this procedure, consumers can establish rules for the whole house in one location, regardless of which manufacturer supplied their residential gateway and the individual sensors, actuators and remote controls.

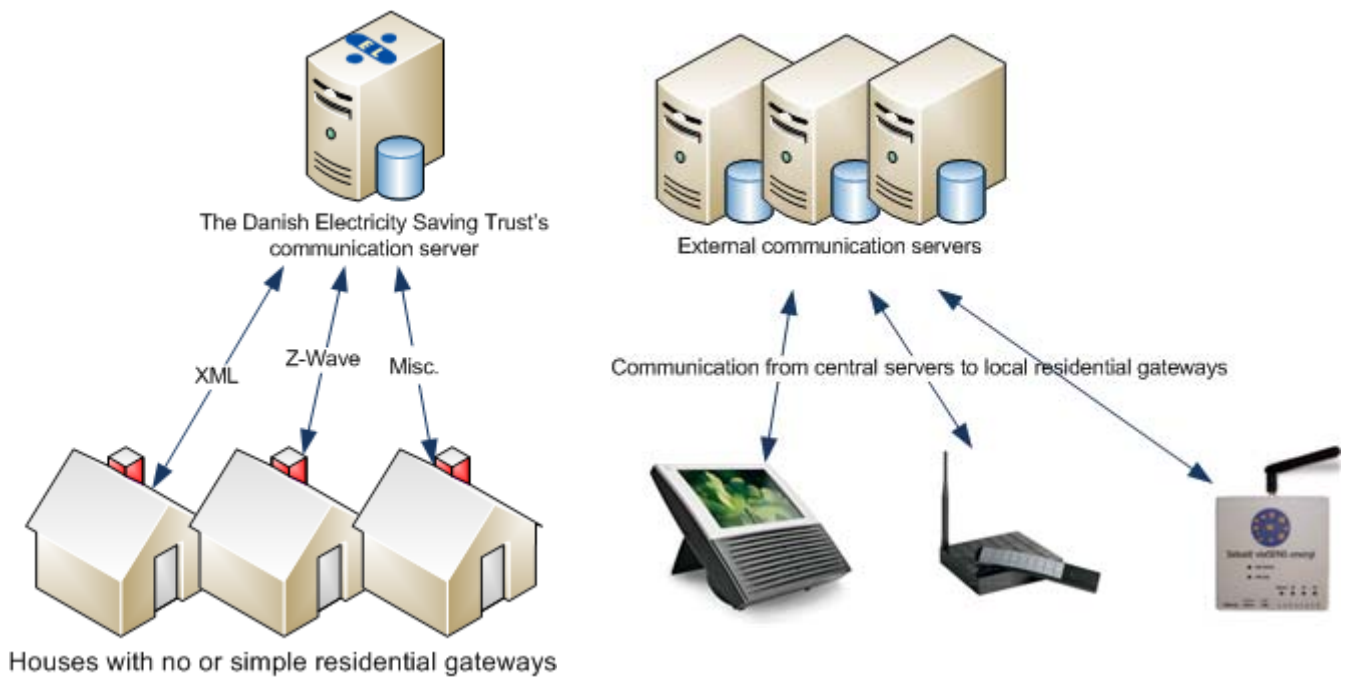
My Home application server

The device set-up and programs are saved on the application server along with other information about the construction and layout of the house. The consumer's local energy consumption, which is relayed from the residential gateway, is also accessible on the server and can be displayed together with the electrical appliances connected.

The application server communicates with local residential gateways via the manufacturer's or the Trust's communication servers, and data are exchanged between the application server and the local communication servers using the standard XML format developed by the Trust.

Communication server

The Danish Electricity Saving Trust sends XML commands or signals from the communication server to and from the devices in the homes. The Trust has decided to make its own communication server available to consumers who purchase a recommended residential gateway without a dedicated communication server. To some extent, the Trust's communication server may also be used in combination with simple TCP/IP to Z-Wave gateways, where commands are routed directly to the slave devices as Z-Wave commands. This also facilitates the option for uploading measuring data to My Home directly from the gateways via the communication server.



External communication servers

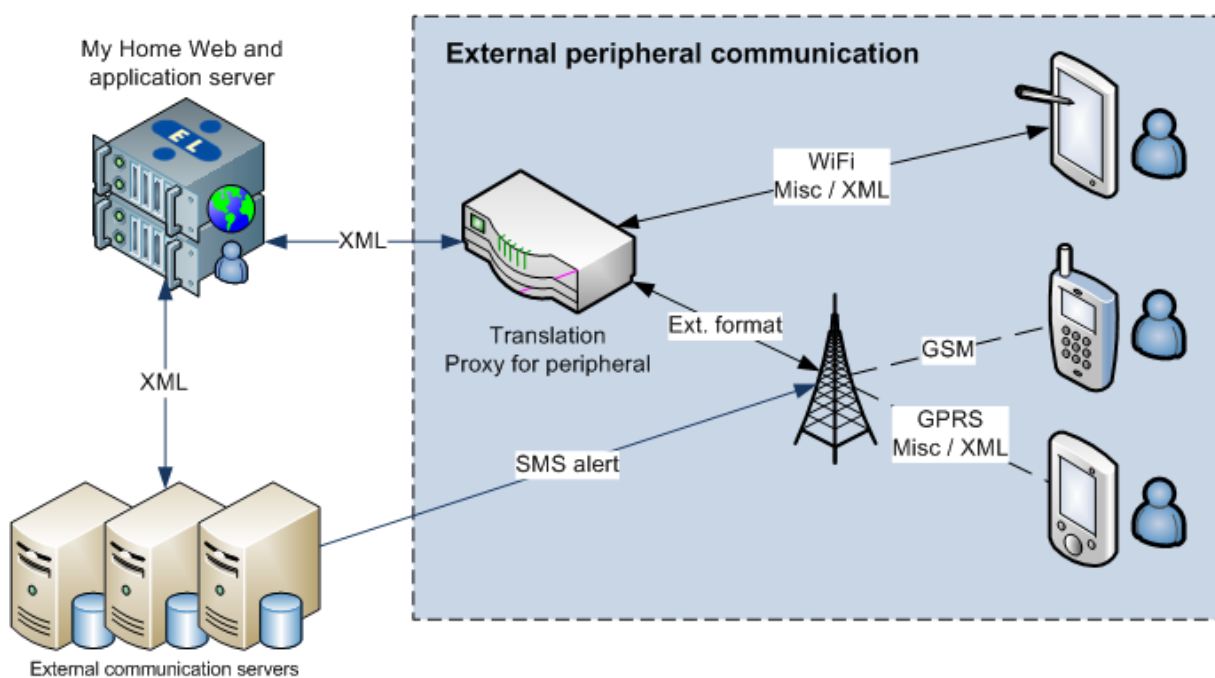
Many manufacturers of residential gateways and home control systems provide communication servers to consumers. These servers have no difficulty talking to My Home, which makes it possible to communicate with both simple and advanced systems. The only technology manufacturers have to support is the simple XML protocol that enables them to talk to the Trust's application server. In return, manufacturers enjoy the advantages of numerous free online tools offered on My Home, which also benefit the end-users of their products.



Regardless of whether communications are channelled through the Trust's communication server or via the home control manufacturer, communications are ultimately relayed as Z-Wave control signals to and from the individual slave and remote control devices.

External peripheral communication

A key element of home control and monitoring is access to the home via external devices such as PDAs, mobile phones and smart devices. Users must be able to control simple operations such as switching off all the lights, and checking that the front door is locked. However, they must also be able to access alarms in the case of unforeseen emergencies such as flooding, break-ins and frost damage.



This is why the Trust's control concept also includes a description of the communication between these external gateways. Some alarm calls will be relayed directly as text messages from the manufacturers' home control servers to their end-users while others will be communicated via XML through the Trust's application server, where a translation proxy converts them into GPRS signals.

Collaboration

As a not-for-profit organisation with no commercial affiliations, the Danish Electricity Saving Trust hopes that it will be possible to establish collaborations with not only the key players in the field of home control but also many smaller and innovative companies. The aim of the collaboration will be the creation of a de facto standard for communication, not only between My Home and home control systems but also with external communications platforms.

The Trust therefore invites all interested parties to join the collaboration with a view to establishing the above standard in the interests of customers, companies and a reduced carbon footprint. Companies producing Z-Wave devices are invited to send their products for approval by the Trust to qualify for the recommended Energy Saving Label. This will enable them to participate in the home control promotional campaign which the Trust will carry out during the second half of 2008.

The Trust offers

- Product endorsement with the widely recognised Energy Saving Label which is accepted by consumers as quality insurance
- An open XML standard that can be used as the communication protocol between residential gateways, online servers and external devices
- C code library with translation functions between Z-wave and XML, which allows manufactures to translate a list of devices in the Z-wave network to the standardised XML format, and send controlling rules from the XML document to the Z-Wave network
- C# code library for online servers to convert XML code to a graphical user interface.



The Danish Electricity Saving Trust

The Danish Electricity Saving Trust is an independent not-for-profit organisation that helps Danish consumers and public sector institutions save energy. The Trust has an annual budget of approximately EUR 13 million. The funds are spent on developing a market for energy efficient products, and campaigns offering sound and broadly-based information to consumers about potential electricity savings. In addition, the Trust is in continuous dialogue with manufacturers of electrical appliances with a view to negotiating product-related voluntary agreements. The Trust publicly recommends products covered by these agreements and thus aims to encourage consumers and public sector institutions to choose products featured on the Trust's recommended lists.

One aspect of the My Home initiative is that the Trust wishes to encourage consumers to purchase energy saving devices covered by the Trust's recommended Energy Saving Label.

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More information about Z-Wave:

www.zen-sys.com/

www.z-wavealliance.org/content/modules/Start/

The Danish Electricity Saving Trust on the Internet:

www.savingtrust.dk



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