The present invention relates to an energy management gateway (10) for controlling electrical loads of electrical devices (13-15) associated with the gateway. The gateway is configured for operating in a DR mode where the gateway is connected to a demand response (DR) service provider (12) and receives DR signals from said service provider, and in an isolated mode where the gateway is not connected to a DR service provider. The invention also relates to a method of an energy management gateway.

Title: ENERGY MANAGEMENT GATEWAY

Fig. 1
ENERGY MANAGEMENT GATEWAY

TECHNICAL FIELD

The invention relates to an energy management gateway for energy management of a building or such, and a method thereof.

BACKGROUND

According to the European Council (European Commission Research), the energy consumption of houses and buildings, taking into account the whole life cycle, stands for 40% of total EU energy consumption. Both transportation and food production consume less energy than our buildings.

In electricity grids, demand response (DR) is used to manage customer consumption of electricity in response to supply conditions, for example, having electricity customers reduce their consumption at critical times or in response to market prices. Demand response services, for industrial or residential buildings, have been around for long time, e.g., implemented as shutting offloads (load shedding) when the grid peak condition requires this. Direct control of heating, ventilation and conditioning (HVAC) equipment in industrial buildings are quite common today. But traditional DR is primary utilities' control task that often focuses on a few end users with limited customer options and fixed rates and participation incentives.

Energy gateways, used in today's DR, are usually provided by the utility (i.e. the energy provider) and tailored to fit in the certain configuration of the utility. Moreover, in order to take advantage of this type of products, customers have to be located in the areas where a utility offers automated demand response (ADR) programs.

US 2012/0053746 discloses a home energy management system for receiving data indicative of a current demand state of an associated utility supplying energy and transmitting data in response. The energy management system comprises at least one home energy consuming system and a controller being configured and arranged to communicate with the at least one home energy
consuming system, the controller is capable of automatically responding to the demand signal adopting an opt-in or an opt-out status for the home energy consuming system in compliance or in noncompliance with the demand signal. The controller includes an interface allowing optional programming by an associated user to automatically provide an opt-out response wherein the demand for limiting energy consumption is not recognized.

In contrast, there are energy management devices that increase customers' energy awareness and save energy by monitoring energy loads at customer's premises. Some of these products offer energy management functionalities, which are solely based on customer's preferences without ability to connect to energy providers.

SUMMARY
It is an objective of the present invention to improve the usability and flexibility of an energy management gateway.

According to one aspect of the present invention, there is provided an energy management gateway for controlling electrical loads of electrical devices associated with the gateway. The gateway is configured for operating in a DR mode where the gateway is connected to a demand response (DR) service provider and receives DR signals from said service provider, and in an isolated mode where the gateway is not connected to a DR service provider.

According to another aspect of the present invention, there is provided a method of an energy management gateway. The method comprises: determining whether the gateway is connected to a demand response (DR) service provider and can receive DR signals from said service provider; switching to a DR mode if it has been determined that the gateway can receive DR signals from said service provider, or staying in an isolated mode if it has been determined that the gateway can not receive DR signals from said service provider; and controlling electrical loads of electrical devices
associated with the gateway in accordance with a set of rules specified by the
mode the gateway is in.

An embodiment of the method aspect of the present invention may in some
embodiments be performed by an embodiment of the gateway aspect of the

According to another aspect of the present invention, there is provided a
computer program product comprising computer-executable components for
causing an energy management gateway to perform an embodiment of a
method of the present invention when the computer-executable components
are run on a processor comprised in the gateway.

According to another aspect of the present invention, there is provided a
computer program comprising computer program code which is able to,
when run on an energy management gateway, cause the gateway to:
determine whether the gateway is connected to a demand response (DR)
service provider and can receive DR signals from said service provider; switch
to a DR mode if it has been determined that the gateway can receive DR
signals from said service provider, or stay in an isolated mode if it has been
determined that the gateway can not receive DR signals from said service
provider; and control electrical loads of electrical devices associated with the
gateway in accordance with a set of rules specified by the mode the gateway is
in.

According to another aspect of the present invention, there is provided a
computer program product comprising an embodiment of a computer
program of the present invention, and a computer readable means on which
the computer program is stored.

Since the gateway is capable of operating both in a DR mode and in an
isolated mode, it can function as an energy management system (EMS), with
corresponding EMS logic, and could also be part of a utility's (service
provider/energy provider) Automated Demand Response (ADR) program.

The gateway can thus function as an EMS if no ADR or DR is available, and
can connect to an ADR program if available. This implies that an electricity customer, e.g. a private person or a company, can use the same gateway for energy management, regardless of whether an ADR program if available. Also, a producer of gateways do not have to produce different gateways for ADR and non-ADR. In isolated mode, the gateway may operate independently of any external input, possibly with the exception of local input from the user (customer) of the gateway. The gateway of the present disclosure may thus be suitable for local use in private homes or industrial buildings and may spread the use of ADR to a wider range of customers. Even if ADR is not available at the premises at installation there of a gateway, ADR may be available in the future, in which case the gateway is already configured to make use of it. In some embodiments, a user of the gateway can manually, via a user interface, switch the gateway from one mode to another mode (DR or isolated). In other embodiments, the gateway automatically enters the DR mode when it is connected to a DR service provider, otherwise staying in isolated mode.

Allowing the customer/user to be an active part of the decision making process, enhances general acceptance of DR system and methods, and accordingly contributes to even more energy consumption reduction in the society. One way to do that is to have energy management system installed locally at building/household level, another way is to allow the user to input its own preferences to control the gateway. Having energy management system (EMS) locally, larger number of devices can be made part of energy optimization. A way to enable local energy management may be an energy gateway that is responsible for handling outbound communication towards utilities and integration of building/household energy loads. Further, the gateway may hosts energy management logic for coordinate control of loads.

In some embodiments, the gateway is also configured for allowing a user to input preferences into the gateway for how the gateway should control the loads in view of the received DR signals when the gateway is in the DR mode. The user, e.g. a private person or company employee, may e.g. instruct the gateway to disregard some or all DR signals, or to take certain actions in
response to certain DR signals, the user may input the preferences (rules) via a user interface of the gateway.

In some embodiments, the gateway is pre-programmed with information about the available electrical energy. If e.g. the preferred local type of electricity is from solar power, the gateway may be preprogrammed to try to reduce the use of electricity at night time and increase the use of electricity during day time. Similar information may be used if e.g. wind power electricity is used. This may be especially beneficial when the gateway is in isolated mode, but the information may also be combined with DR signals to form a basis for energy management by the gateway. The preprograming may have been done by the user via a user interface, or e.g. at manufacturing of the gateway or by a service technician.

In some embodiments, the gateway is pre-programmed with a first set of rules for operation of the gateway in the DR mode, and with a second set of rules for operation of the gateway in the isolated mode. Thus, the gateway may operate according to one set of rules when no ADR input is available, and according to another set of rules when said rules can be considered in combination with information obtained from ADR input signals.

Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated. The use of "first", "second" etc. for different features/components of the present disclosure are only intended to distinguish the features/components from other similar features/components and not to impart any order or hierarchy to the features/components.
BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig 1 is a schematic diagram of a system comprising an embodiment of an energy management gateway of the present invention.

Fig 2 is a schematic box diagram of an embodiment of an energy management gateway of the present invention.

Fig 3 is a schematic diagram illustrating different types of input to an embodiment of an energy management gateway of the present invention.

Fig 4 is a schematic flow chart of an embodiment of a method of the present invention.

Fig 5 is a schematic illustration of a computer program product of the present invention.

DETAILED DESCRIPTION

The invention will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout the description.

Demand response (DR) and automated demand response (ADR) is herein used interchangeably for a system where signals are sent from a service provider to the gateway, which signals include information about the electricity being delivered now, or in the future, allowing the gateway to act on this information when controlling the electrical loads. The information which may be sent with DR signals include e.g. price, CO2 emission, general
availability of electricity, and/or availability of locally generated electricity such as solar or wind.

Figure 1 schematically illustrates an example of an environment in which an embodiment of an energy management gateway 10 of the present invention may operate in. The gateway 10 may be located locally in a building n, such as a private home, an office or an industrial building. The gateway is configured to control electrical loads of electrical devices 13-15 associated with the gateway. In some embodiments, the gateway is connected to a demand response (DR) service provider 12 and is able to receive DR signals from said service provider. The DR signals may be received wirelessly over a radio interface or via wire. Examples of devices in a private home 11 controlled by the gateway may e.g. be a fridge 14, a freezer 15 and an air conditioner (AC) 13. The gateway 10 is configured to be able to operate in a DR mode where the gateway is connected to a DR service provider 12 and receives DR signals from said service provider. The gateway 10 is also configured to be able to operate in an isolated mode where the gateway is not connected to a DR service provider 12. The gateway controls the devices 13-15 based on input from e.g. a user via a user interface and/or from the DR service provider 12 (if in DR mode), possibly in combination with preprogrammed user preferences and/or rules. Such preferences and/or rules may in the example of fig 1, e.g. be that the freezer 15 has highest priority, the fridge 14 has medium priority and the AC 13 has lowest priority. If e.g. the gateway is in isolated mode, the gateway may reduce the amount of electricity provided to the AC 13 e.g. in the middle of the day when the price of electricity may be expected to be high or in the night time when there is not solar power produced, but not reduce the amount of electricity provided to the freezer 15 which has a higher priority. If e.g. the gateway is in DR mode, the gateway may similarly reduce the amount of electricity provided to the AC 13 e.g. if the DR signals indicate a high price or high CO2 emissions, but not reduce the amount of electricity provided to the freezer 15 which has a higher priority.
Figure 2 schematically illustrates an embodiment of a gateway 10 of the present invention. The gateway 10 comprises a processor or central processing unit (CPU) 21. The processor 21 may comprise one or a plurality of processing units in the form of microprocessor(s). However, other suitable devices with computing capabilities could be used, e.g. an application specific integrated circuit (ASIC), a field programmable gate array (FPGA) or a complex programmable logic device (CPLD). The processor 21 is configured to run one or several computer program(s) or software (e.g. EMS logic) stored in a storage unit or memory 22. The storage unit is regarded as a computer readable means and may e.g. be in the form of a Random Access Memory (RAM), a Flash memory or other solid state memory, or a hard disk. The processor 21 is also configured to store data in the storage unit 22, as needed e.g. preferences/rules inputted by a user via a user interface. The storage unit 22 is also configured to hold any preprogrammed preferences/rules provided at manufacture or later. The gateway 10 also comprises a transmitter 23, a receiver 24, which may be combined to form a transceiver or be present as distinct units within the gateway 10. If the gateway 10 is configured for wireless communication, it will also comprise an antenna associated with the transmitter 23 and the receiver 24. The transmitter 23 is configured to cooperate with the processor 21 to transform data bits to a signal to be transmitted in accordance with the communication technology used. The receiver 24 is configured to cooperate with the processor 21 to transform a received signal to transmitted data bits. The user interface 25 cooperates with the processor 21 and may e.g. comprise button(s), switch(es), a touch screen and/or a display for allowing a user to input instructions, such as rules or preferences into the gateway 10 and/or for allowing the gateway to present information to the user. Additionally or alternatively, the user interface of the gateway may comprise a web server which may enable the user to use any of numerous standard display and/or input devices via said web server.

Figure 3 schematically illustrates some examples of different kinds of inputs to the EMS logic of the gateway 10. The examples in figure 3 comprises DR
signal relating to the CO2 emissions created by the production of electricity, DR signal relating to the price of electricity, user preferences e.g. inputted via a user interface, DR signal relating to a load constraint in the distribution or production of electricity, and availability of local energy generation e.g. wind or solar (which may be produced locally at the building e.g. by the user of the gateway). Other types of input are also contemplated. Thus, energy management can be based on different kinds of inputs.

Figure 4 is a schematic flow chart illustrating an embodiment of a method of the present invention. The gateway 10 determines whether said gateway is connected to a DR service provider 12 and can receive DR signals from said service provider. If the gateway determines that it can receive DR signals from said service provider, the gateway switches 2 to a DR mode. If the gateway determines that it cannot receive DR signals from said service provider, the gateway switches to or remains in the isolated mode. The electrical loads of electrical devices 13-15 associated with the gateway 10 can then be controlled 4 in accordance with a set of rules specified by the mode the gateway is in. There may be a first set of rules associated with the DR mode, and a second set of rules associated with the isolated mode. Additionally, the method may comprise receiving input from a user via a user interface of the gateway, e.g. before, during or after the controlling of loads.

Figure 5 illustrates an embodiment of a computer program product 50 of the present invention. The computer program product 50 comprises a computer readable medium 52 comprising a computer program 51 in the form of computer-executable components 51. The computer program/computer-executable components 51 may be configured to cause an energy management gateway 10, e.g. as discussed herein, for controlling electrical loads of electrical devices associated with the gateway to perform an embodiment of the method of the present invention. The computer program/computer-executable components may be run on the processor 21 of the gateway 10 for causing the gateway to perform the method. The computer program product 50 may e.g. be comprised in a storage unit or memory 22 comprised in the gateway 10 and associated with the processor.
21. Alternatively, the computer program product 50 may be, or be part of, a separate, e.g. mobile, storage means, such as a computer readable disc, e.g. CD or DVD or hard disc/drive, or a solid state storage medium, e.g. a RAM or Flash memory.

Example

In this example, there is presented an energy management gateway 10 that offers energy management functionalities regardless if a customer (i.e. user) can be part of a utility's ADR program or not.

Buildings 11 with a local energy management gateway, with corresponding EMS logic, could be part of the utility's Automated Demand Response (ADR) program, if such a program is possible and available at that location. The demand response signals coming from the utility or independent retail operator (the DR service provider 12) depend on the customer's demand response electricity contract.

In contrast, if a customer is located in an area where there is no utility or independent retail operator that offers an ADR program, the local energy management gateway 10 and its EMS logic is configured to work in isolated mode, where load balancing and energy optimization is only based on the locally available inputs, e.g., customer's preferences or available local energy production.

An energy management gateway 10, located at the electricity customer's premises 11, involves a control of load shedding or load shifting of the customer's energy, according to its configuration mode. The energy management gateway can also involve control of charging or discharging of local electricity storage.

In this example, the following configuration modes are possible:

1. Automated Demand Response (ADR) enabled (i.e. DR mode)
2. Isolated (i.e. isolated mode)
In the DR mode, the demand response signals from the utility are turned into more fine-grained demand response control of electricity loads, electricity production and storage by the demand response logic, which is a part of the locally EMS logic. Thus, the electricity loads are shifted/shed in order to conform to demand response service provider’s signals and/or customer's preferences.

While in the isolated mode, the electricity loads are managed only according to the user set preferences and information about local energy production (e.g. wind or solar PV).

The energy management gateway and its EMS logic could be configured in DR, or isolated mode, and in that way offer different subsets of its functionality.

In some embodiments, when configured in isolated mode, the local energy management by means of the gateway offers enhanced energy awareness, reduced energy consumption, and less CO2 emissions of an industrial/residential building. Rules and preferences for management of energy consumption are completely based on:

- Locally available inputs, i.e. a customer's preferences and/or
- Availability of the locally generated energy (e.g. solar PV or wind)

In some other embodiments, when configured in DR mode, the local energy management system provided by the gateway accepts and translates demand response service provider's high-level demand response signals into low-level demand response signals to control building's electric loads, electricity storage and production. In this case, the EMS logic could e.g. be configured such that energy management is based on one or some of the following signals:

- DR Price signal (day ahead)
- DR CO2 signal (day ahead)
- DR load reduction signal
- Availability of the locally generated energy (e.g. solar PV or wind)
- Customer set preferences

The exemplary embodiment enables energy management in industrial/residential buildings, e.g. decreased greenhouse gas emissions and energy cost, even when a customer is located in an area where a utility or independent retail operator cannot offer an ADR program. However, the customer can later be incorporated in demand response program (when it is available) by means of the gateway. Also, the customer can choose based on which inputs the locally based EMS logic should be configured.

In an embodiment of the present invention, there is provided an energy management gateway for controlling electrical loads of electrical devices associated with the gateway, the gateway comprising: means for determining whether the gateway is connected to a demand response (DR) service provider and can receive DR signals from said service provider; means for switching to a DR mode if it has been determined that the gateway can receive DR signals from said service provider, or staying in an isolated mode if it has been determined that the gateway can not receive DR signals from said service provider; and means for controlling electrical loads of electrical devices associated with the gateway in accordance with a set of rules specified by the mode the gateway is in.

In an embodiment of the present invention, there is provided an energy management gateway for controlling electrical loads of electrical devices associated with the gateway. The gateway comprises a processor configured for: determining whether the gateway is connected to a demand response (DR) service provider and can receive DR signals from said service provider; switching to a DR mode if it has been determined that the gateway can receive DR signals from said service provider, or staying in an isolated mode if it has been determined that the gateway can not receive DR signals from said service provider; and controlling electrical loads of
electrical devices 13-15 associated with the gateway 10 in accordance with a set of rules specified by the mode the gateway is in.

The invention has mainly been described above with reference to a few embodiments. However, as is readily appreciated by a person skilled in the art, other embodiments than the ones disclosed above are equally possible within the scope of the invention, as defined by the appended patent claims.
CLAIMS

1. An energy management gateway for controlling electrical loads of electrical devices associated with the gateway, wherein the gateway is configured for operating in a DR mode where the gateway is connected to a demand response, DR, service provider and receives DR signals from said service provider, and in an isolated mode where the gateway is not connected to a DR service provider.

2. The energy management gateway of claim 1, wherein the gateway is also configured for allowing a user to input preferences into the gateway for how the gateway should control the loads in view of the received DR signals when the gateway is in the DR mode.

3. The energy management gateway of any preceding claim, wherein the gateway is configured for receiving information about local energy production.

4. The energy management gateway of any preceding claim, wherein the gateway is pre-programmed with a first set of rules for operation of the gateway in the DR mode, and with a second set of rules for operation of the gateway in the isolated mode.

5. A method of an energy management gateway, comprising:

   determining whether the gateway is connected to a demand response, DR, service provider and can receive DR signals from said service provider;

   switching to a DR mode if it has been determined that the gateway can receive DR signals from said service provider, or staying in an isolated mode if it has been determined that the gateway can not receive DR signals from said service provider; and
controlling electrical loads of electrical devices associated with the gateway in accordance with a set of rules specified by the mode the gateway is in.

6. The method of claim 5, further comprising:

receiving input from a user via a user interface of the gateway.

7. The method of claim 6, wherein the input comprises an instruction to switch from one of the modes to another of the modes.

8. The method of claim 6, wherein the input comprises preferences for how the gateway should control the loads in view of the received DR signals when the gateway is in the DR mode.

10. A computer program product comprising computer-executable components for causing an energy management gateway to perform the method of any one of claims 5-8 when the computer-executable components are run on a processor comprised in the gateway.

11. A computer program comprising computer program code which is able to, when run on an energy management gateway, cause the gateway to:

   determine whether the gateway is connected to a demand response, DR, service provider and can receive DR signals from said service provider;

   switch to a DR mode if it has been determined that the gateway can receive DR signals from said service provider, or stay in an isolated mode if it has been determined that the gateway can not receive DR signals from said service provider; and

   control electrical loads of electrical devices associated with the gateway in accordance with a set of rules specified by the mode the gateway is in.

12. A computer program product comprising a computer program according to claim 11 and a computer readable means on which the computer program is stored.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. H02J3/14 H02J3/38

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols):

H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US 2012/049639 AI (BESORE JOHN K [US] ET AL) 1 March 2012 (2012-03-01)</td>
<td>1,2,4-11</td>
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<td>DE 197 45 210 AI (UNI DATA GES FUER DATENVERARBEI [DE]) 12 May 1999 (1999-05-12) abstract; claim 11</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search: 9 August 2013

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Authorized officer:

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