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(54) **SYSTEMS, METHODS AND APPARATUS FOR ENCOURAGING ENERGY CONSCIOUS BEHAVIOR BASED ON AGGREGATED THIRD PARTY ENERGY CONSUMPTION**

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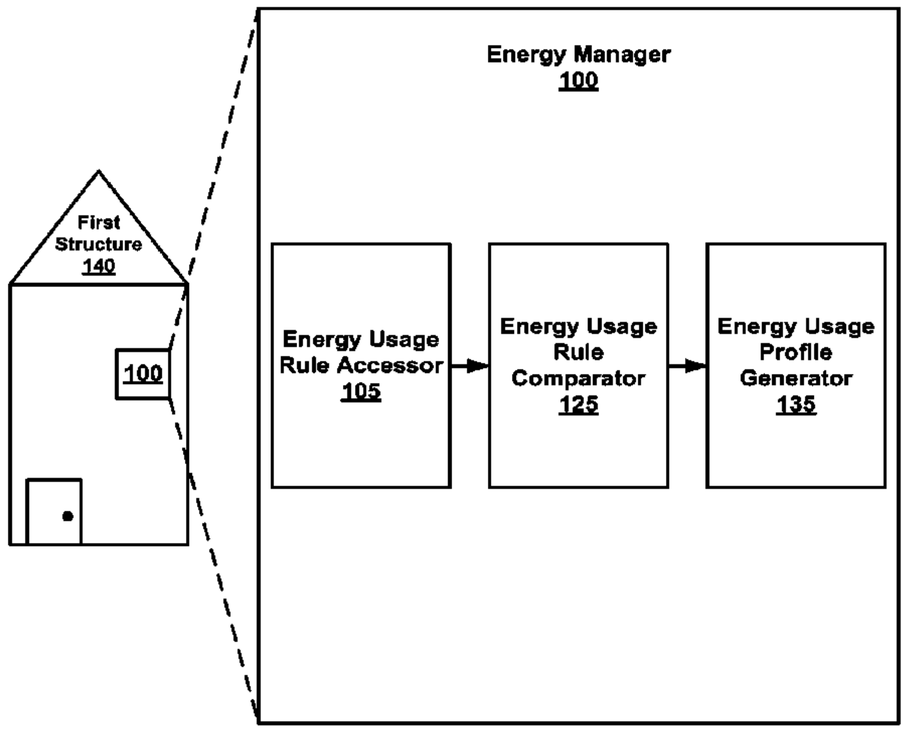
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(57) **ABSTRACT**

Accessing an energy management policy for a plurality of devices is described, wherein the devices are coupled with a first structure. The energy usage of the devices is monitored. An energy usage rule and energy usage is then compared. The energy management policy and energy usage is also compared. Based on the comparing, an instruction is generated to modify an energy usage profile of said device to correlate with the energy usage rule associated with the devices and the energy management policy, thereby enabling efficient energy management.

19 Claims, 6 Drawing Sheets



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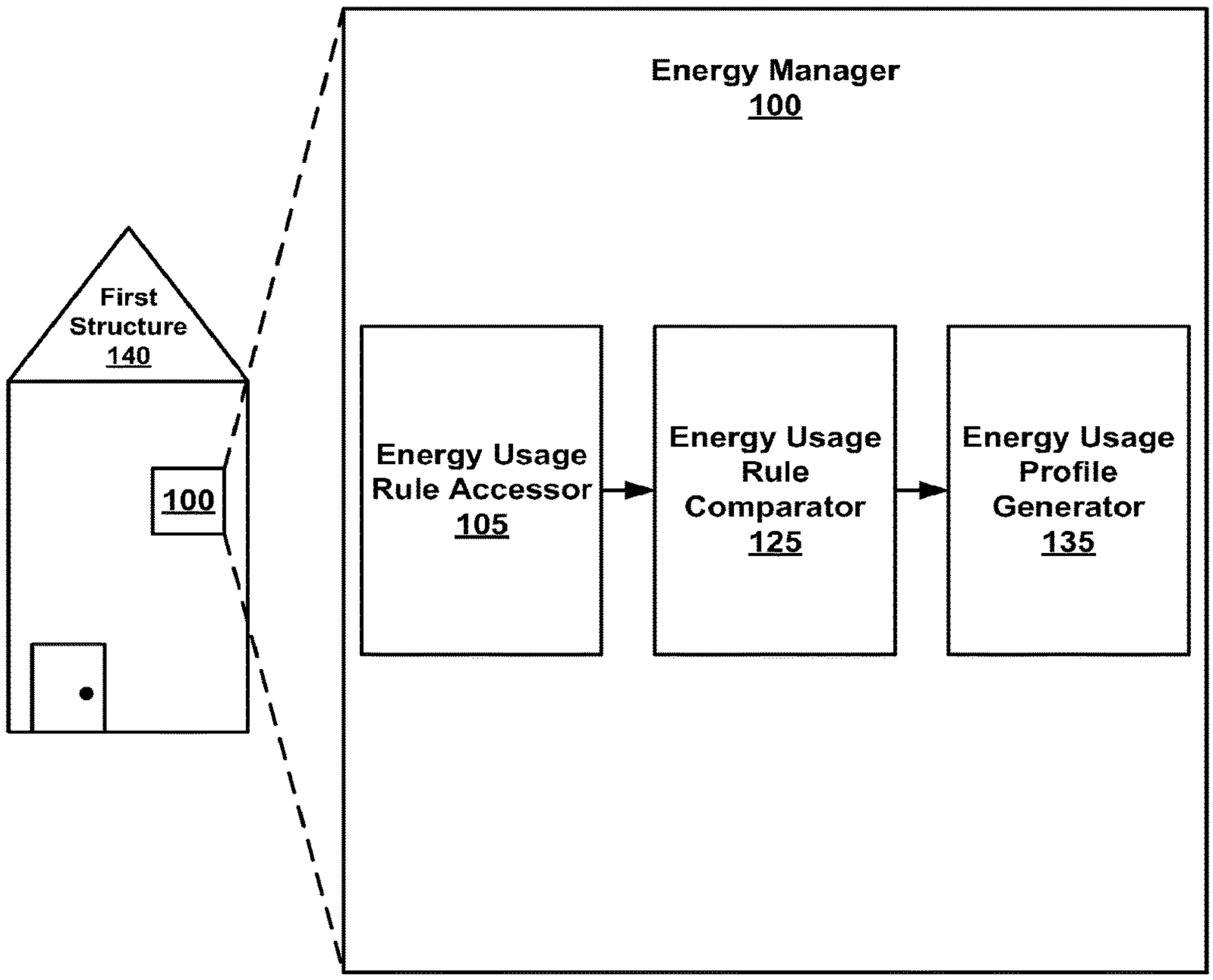

Energy Manager
100
First Structure
140
100
Energy Usage Rule Accessor
105
Energy Usage Rule Comparator
125
Energy Usage Profile Generator
135

FIG. 1

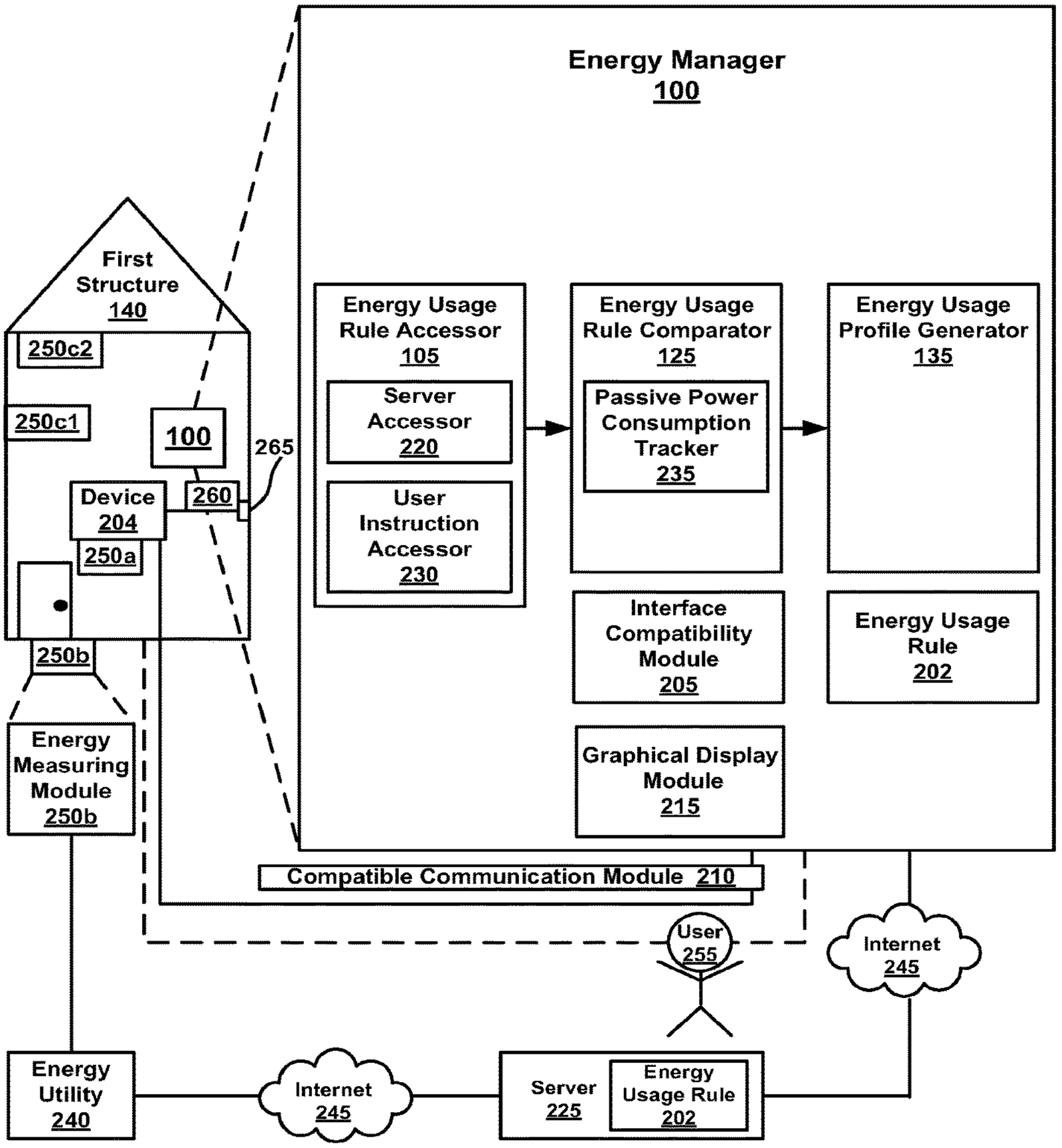

Energy Manager
100
First Structure
140
250c2
250c1
100
265
Device
204
260
250a
250b
Energy Measuring Module
250b
Energy Usage Rule Accessor
105
Server Accessor
220
User Instruction Accessor
230
Energy Usage Rule Comparator
125
Passive Power Consumption Tracker
235
Energy Usage Profile Generator
135
Interface Compatibility Module
205
Energy Usage Rule
202
Graphical Display Module
215
Compatible Communication Module 210
User
255
Internet
245
Energy Utility
240
Internet
245
Server
225
Energy Usage Rule
202

FIG. 2

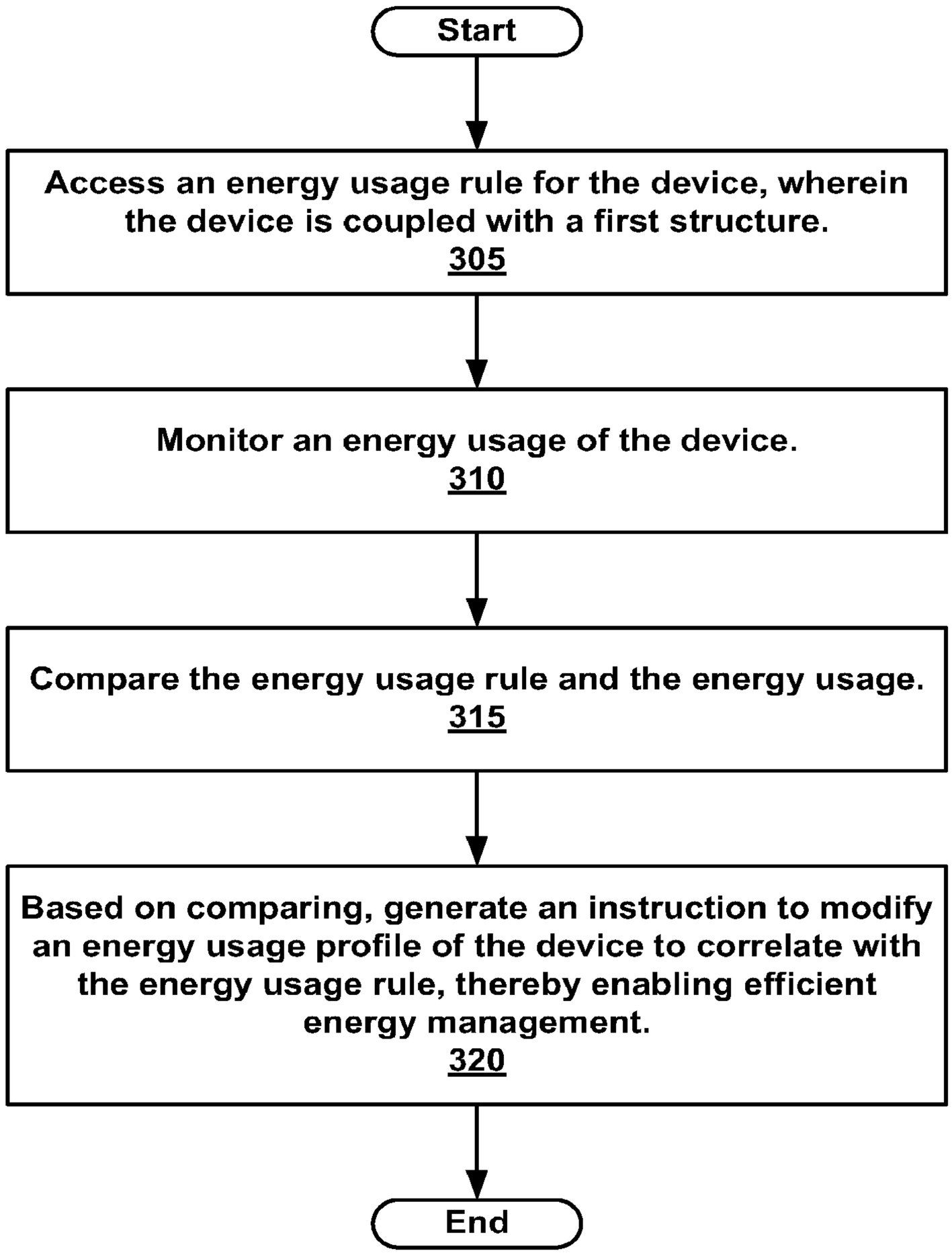

300
Start
Access an energy usage rule for the device, wherein the device is coupled with a first structure.
305
Monitor an energy usage of the device.
310
Compare the energy usage rule and the energy usage.
315
Based on comparing, generate an instruction to modify an energy usage profile of the device to correlate with the energy usage rule, thereby enabling efficient energy management.
320
End

FIG. 3

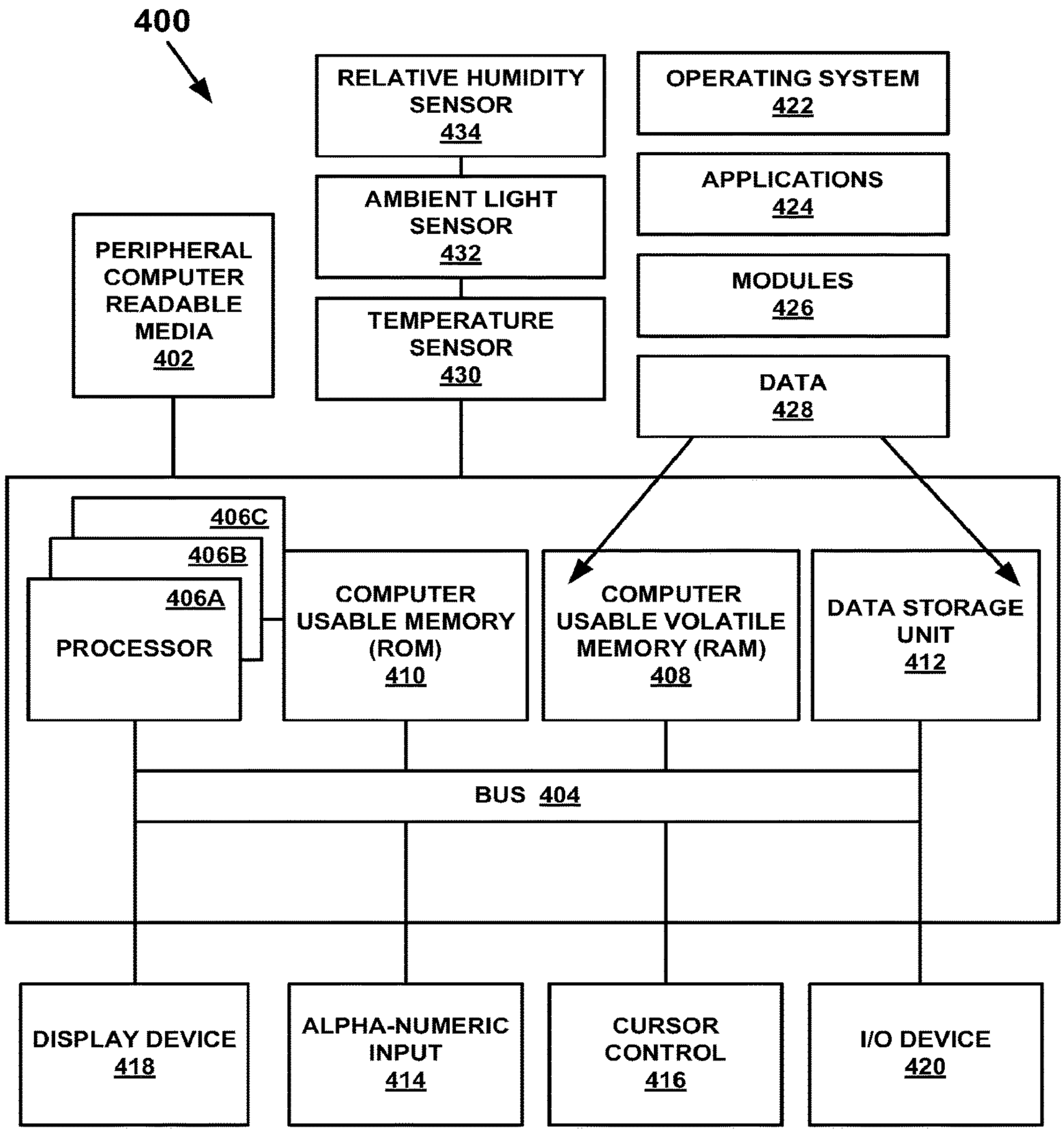

400
RELATIVE HUMIDITY SENSOR 434
OPERATING SYSTEM 422
AMBIENT LIGHT SENSOR 432
APPLICATIONS 424
PERIPHERAL COMPUTER READABLE MEDIA 402
TEMPERATURE SENSOR 430
MODULES 426
DATA 428
406C
406B
406A
PROCESSOR
COMPUTER USABLE MEMORY (ROM) 410
COMPUTER USABLE VOLATILE MEMORY (RAM) 408
DATA STORAGE UNIT 412
BUS 404
DISPLAY DEVICE 418
ALPHA-NUMERIC INPUT 414
CURSOR CONTROL 416
I/O DEVICE 420

FIG. 4

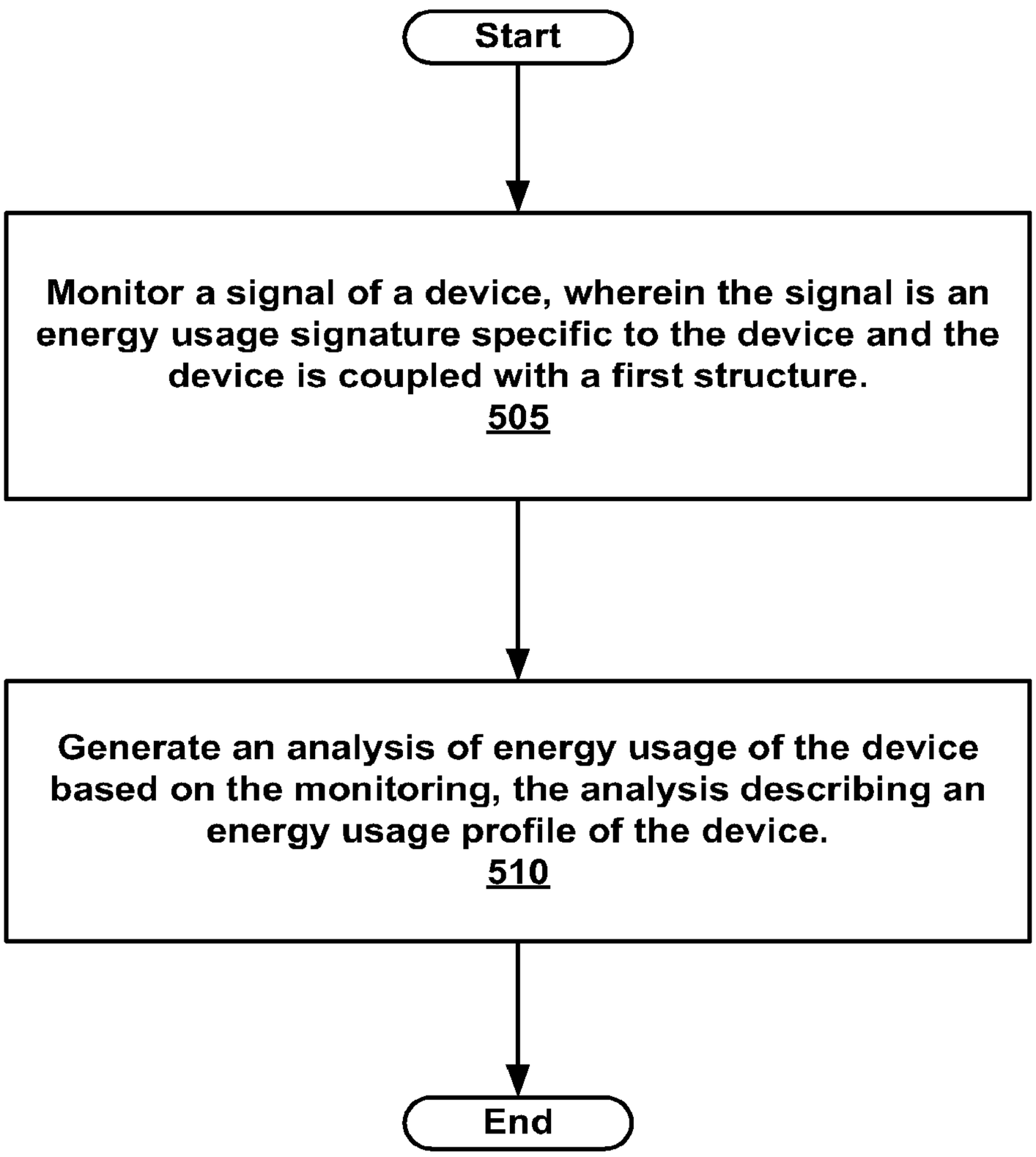

500
Start
Monitor a signal of a device, wherein the signal is an energy usage signature specific to the device and the device is coupled with a first structure.
505
Generate an analysis of energy usage of the device based on the monitoring, the analysis describing an energy usage profile of the device.
510
End

FIG. 5

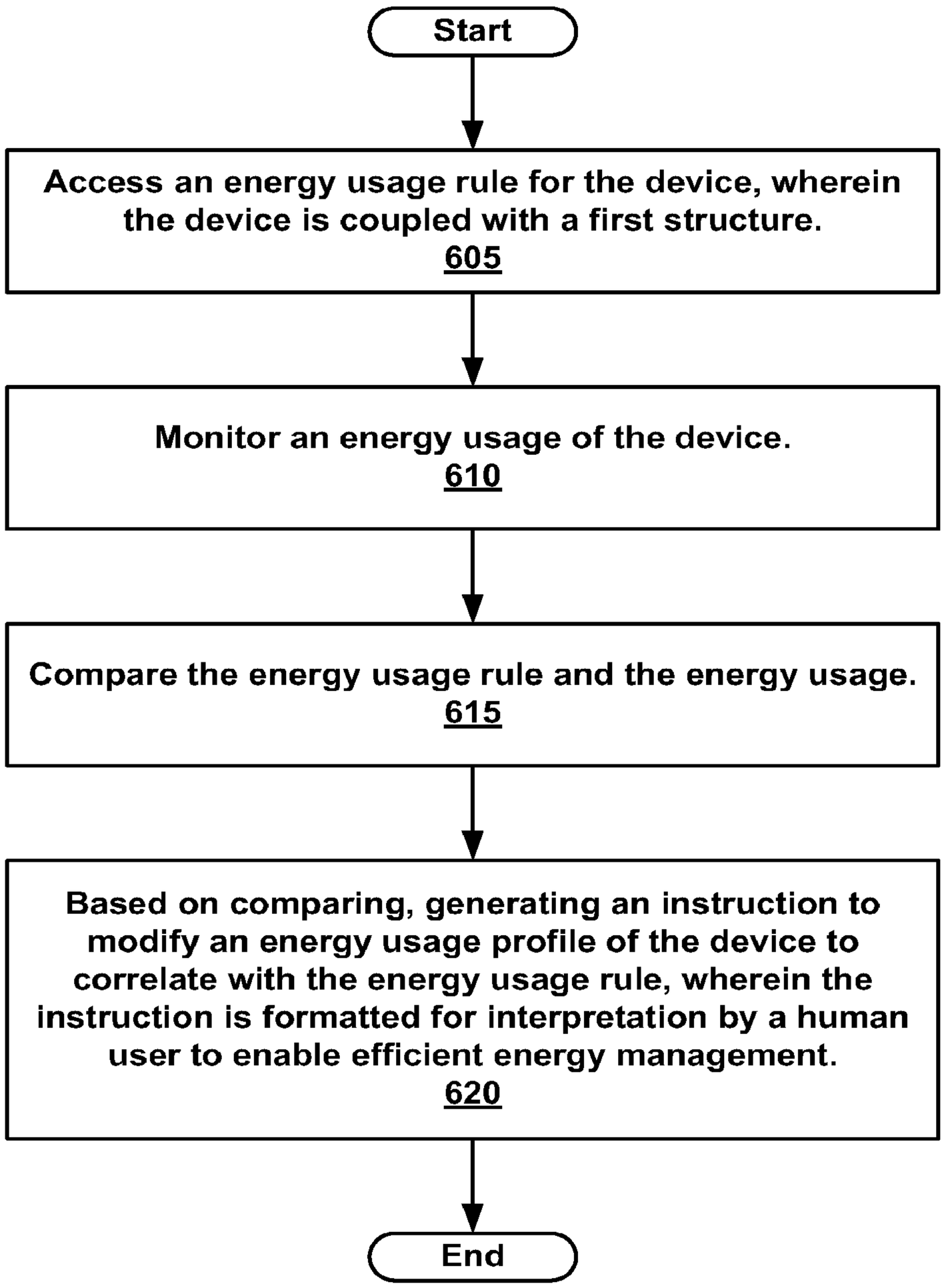

600
Start
Access an energy usage rule for the device, wherein the device is coupled with a first structure.
605
Monitor an energy usage of the device.
610
Compare the energy usage rule and the energy usage.
615
Based on comparing, generating an instruction to modify an energy usage profile of the device to correlate with the energy usage rule, wherein the instruction is formatted for interpretation by a human user to enable efficient energy management.
620
End

FIG. 6

SYSTEMS, METHODS AND APPARATUS FOR ENCOURAGING ENERGY CONSCIOUS BEHAVIOR BASED ON AGGREGATED THIRD PARTY ENERGY CONSUMPTION

CROSS REFERENCES

This application is a continuation of U.S. patent application Ser. No. 14/752,453 filed on Jun. 26, 2015, which is incorporated herein by reference. U.S. patent application Ser. No. 14/752,453 is a continuation of U.S. patent application Ser. No. 14/473,893 filed on Aug. 29, 2014, which is incorporated herein by reference. U.S. patent application Ser. No. 14/473,893 is a continuation of U.S. patent application Ser. No. 13/327,459 filed on Dec. 15, 2011, which is incorporated herein by reference. U.S. patent application Ser. No. 13/327,459 is a continuation of U.S. patent application Ser. No. 12/241,588 filed on Sep. 30, 2008, which is incorporated herein by reference.

FIELD

The field of the present invention relates to computer systems. More particularly, embodiments of the present invention relate to energy management systems.

BACKGROUND

Consumers experiment with different ways of reducing household energy usage. For example, consumers may turn off air conditioning during certain parts of the day, run certain appliances only during the early morning hours, and replace large inefficient appliances with smaller energy efficient ones. Additionally, consumers may use measuring devices to calculate the energy usage rate of a particular device. Then, depending upon the measured energy usage, a consumer may decide to turn the device on and off to adjust the home's overall energy usage.

However, there exist limitations as to the current system for measuring the energy usage of a particular device. While a device's energy usage may be determined for a given point in time, it is unclear what this determination means. For example, an energy usage measurement might specify that a device is using 2 kilowatts per hour. While this information may be useful to a scientist, the average consumer is not well acquainted with the kilowatt. Furthermore, it is not clear to the consumer what the 2 kilowatts per hour static measurement means in context with the energy usage of a possible new device, other devices, and/or the entire household of devices. Thus, current energy usage measurements are cryptic and not very useful to the average consumer.

BRIEF SUMMARY

Accessing an energy management policy for a plurality of devices is described, wherein the devices are coupled with a first structure. The energy usage of the devices is monitored. An energy usage rule and energy usage is then compared. The energy management policy and energy usage is also compared. Based on the comparing, an instruction is generated to modify an energy usage profile of said device to correlate with the energy usage rule associated with the devices and the energy management policy, thereby enabling efficient energy management.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the present invention for managing energy usage and, together with the description, serve to explain principles discussed below:

FIG. **1** is a block diagram of an example system for managing energy usage in accordance with embodiments of the present invention.

FIG. **2** is a block diagram of an example system for managing energy usage in accordance with embodiments of the present invention.

FIG. **3** is a flowchart of an example method of managing energy usage in accordance with embodiments of the present invention.

FIG. **4** is a diagram of an example computer system used for managing energy usage in accordance with embodiments of the present invention.

FIG. **5** is a flowchart of an example method of managing energy usage in accordance with embodiments of the present invention.

FIG. **6** is a flowchart of an example method of managing energy usage in accordance with embodiments of the present invention.

The drawings referred to in this description should not be understood as being drawn to scale unless specifically noted.

DESCRIPTION OF EMBODIMENTS

Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with various embodiment(s), it will be understood that they are not intended to limit the present invention to these embodiments. On the contrary, the present invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the various embodiments as defined by the appended claims.

Furthermore, in the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, the present invention may be practiced without these specific details. In other instances, well known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the present embodiments.

Unless specifically stated otherwise as apparent from the following discussions, it is appreciated that throughout the present detailed description, discussions utilizing terms such as "accessing", "monitoring", "comparing", "modifying", "enabling", "tracking", "generating", "estimating", "alerting", or the like, refer to the actions and processes of a computer system, or similar electronic computing device. The computer system or similar electronic computing device manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission, or display devices. The present invention is also well suited to the use of other computer systems such as, for example, optical and mechanical computers.

OVERVIEW OF DISCUSSION

Embodiments in accordance with the present invention pertain to a system for managing energy usage. In one embodiment, the system described herein enables conserva-

tion of household energy by advising a user to modify the household's energy usage to correlate to a desired energy usage for that household.

More particularly, one embodiment of the present invention functions as a household energy manager. For example, the energy manager attaches to a household wall and replaces the typical heating-cooling thermostat controller. The energy manager then utilizes an energy-measuring module coupled with a household device to monitor the energy usage of the household device. For example, an energy-measuring module coupled with a dishwasher may measure a dishwasher utilizing 1.20 kilowatts per hour of electricity.

In addition to monitoring individual appliances, the energy manager may utilize an energy-measuring module, such as a smart meter, coupled with the house to monitor the total household's energy usage. For example, a smart meter may measure the overall energy usage of all appliances within a household, including the dishwasher, to be 21 kilowatts per hour of electricity.

The energy manager then may access an energy usage rule describing a desired energy usage for a device and/or the household. This energy usage rule may be preprogrammed and internal to the energy manager or may be accessed at a server positioned external to the energy manager. This server in turn may receive a demand-response call from an energy utility company. For example, a demand-response call may indicate that it is desirable that the aforementioned dishwasher is to use up to a maximum of 1.00 kilowatt per hour of electricity at any given time. Furthermore, an overall energy management policy may specify that the household may use up to a maximum of 20 kilowatts per hour of energy at any point in time.

Based on the comparison between the measured energy usage of a household device and that device's desired energy usage, the energy manager may modify the device's energy usage to conform with the overall desired energy usage. For example, based on the comparison between the dishwasher's measured 1.20 kilowatts per hour of energy usage, and the household's use of 21 kilowatts per hour of electricity, the energy manager may modify the dishwasher's energy usage by turning it off and on at time periods separate from other high energy usage appliances, to keep the overall household energy use below 20 kilowatts per hour at any given point in time.

Thus, an energy manager may utilize an internally preprogrammed energy usage rule and/or a demand-response call received via a server from an energy utility company to advise a user to modify a device's energy usage.

The following discussion will begin with a detailed description of the structure of components herein in accordance with the present invention. This discussion will then be followed by a detailed description of the operation and function of the components herein.

ENERGY MANAGER

FIG. **1** is a block diagram of an example energy manager **100** in accordance with embodiments of the present invention. Energy manager **100**, coupled with first structure **140**, comprises energy usage rule accessor **105**, energy usage rule comparator **125**, and energy usage profile generator **135**

Continuing with FIG. **2**, a block diagram is shown of an example energy manager **100** in which energy usage rule accessor **105** comprises server accessor **220** and user instruction accessor **230**. In another embodiment, energy usage rule comparator **125** comprises passive power consumption tracker **235**. In one embodiment, energy manager **100** further comprising interface compatibility module **205** and graphical display module **215**.

Energy manager **100** is shown coupled wirelessly with device **204** via energy-measuring module **250***a* and compatible communication module **210**. Of note, energy-measuring module **250***a* may be coupled with energy manager **100** in such a way as to be part of energy manager **100**. Energy-measuring module **250***a* operates as an inductive donut surrounding the electrical cord that couples device **204** with an electrical outlet of first structure **140**. As will be described herein, energy-measuring module **250***a* listens for information such as energy usage signatures specific to device **204**. This information is communicated wirelessly to energy manager **100** via a wireless transmitter and receiver coupled with energy measuring module **250***a* and compatible communication module **210**, such as but not limited to the wireless Ethernet, ZigBee, X10, or some other suitable wireless protocol.

In another embodiment, energy manager **100** is shown coupled wirelessly with energy-measuring module **250***b*. Energy-measuring module **250***b* may be a digital meter coupled with the outside of the home. Energy utility **240** has access to this digital meter. The digital meter provides information regarding the total energy usage of the household. This information is communicated wirelessly to energy manager **100** via a wireless transmitter and receiver coupled with energy-measuring module **250***b* and energy manager **100**, such as such as but not limited to the wireless Ethernet, ZigBee, X10, or some other suitable wireless protocol.

In one embodiment, energy manager **100** is shown coupled wirelessly with energy-measuring modules **250***c***1** and **250***c***2** of a group of energy-measuring modules denoted as **250***c*, that are themselves coupled with subpanels positioned on the side wall and ceiling of first structure **140**. Of note, in another embodiment, energy manager **100** may also be coupled with energy-measuring modules **250***c***1** and **250***c***2** via a wire. Additionally, energy manager **100** is well suited to being coupled with a plurality of more than two energy-measuring modules of energy-measuring module group **250***c* at any number of locations within first structure **140**.

Energy-measuring modules **250***c***1** and **250***c***2** that are coupled with the subpanels and positioned in the proximity of device **204** listen for information such as energy usage signatures specific to device **204**. For example, a certain amount of signal noise flows between and through energy-measuring modules **250***c***1** and **250***c***2**. By identifying and comparing said signal noise received at energy-measuring modules **250***c***1** and **250***c***2**, better granularity in reading the energy signature of device **204** can be obtained. The more **250***c* energy-measuring modules that are positioned at first structure **140**, the more data that can be collected. The more data that can be collected, the more accurate is the determination of energy usage per device **204**.

Of note, energy usage rule **202** may be any recommendation or instruction for energy usage as it relates to device **204**, either alone, or as part of an energy management policy for one or more devices. In one embodiment, an energy management policy may designate the overall desired household energy usage as well as the desired energy usage for individual devices therein.

In one embodiment, energy usage rule **202** is preprogrammed within energy manager **100**. In another embodiment, energy usage rule **202** is external to energy manager **100**, located at server **225**, and provided to server **225** via energy utility **240** or other Internet hosted servers. In one

embodiment, server **225** acts as a central management server. Energy utility **240** is coupled with energy manager **100** via Internet **245** and server **225**, and is coupled with first structure **140** via energy-measuring module **250***b*.

In another embodiment, unit **260** is coupled with device **204** and electrical outlet **265** with which device **204** is also coupled. Additionally, the present invention is well suited to having any number of units **260** coupled with any number of devices and any number of electrical outlets. Unit **260** is configured to receive an instruction to modify an energy usage profile of device **204** to correlate with device **204**'s energy usage rule. In essence, unit **260** may control the power to device **204**. Of note, unit **260** may receive instructions to modify the energy usage profile of device **204** from any device capable of sending receivable instructions.

In one embodiment, an energy manager **100** coupled with a subpanel within first structure **140** wirelessly transmits an instruction to unit **260** to modify the energy usage profile of device **204**. In another embodiment, user **255** may email an instruction to unit **260** to modify device **204** coupled therewith. More particularly, in one example, unit **260** is coupled with a lamp. Energy manager **100** sends a message to unit **260** that the lamp is utilizing too many kilowatts per hour of energy and needs to be turned down. Unit **260** then dims the lamp's lighting, thus decreasing the lamp's energy usage according to the instructions.

Continuing with FIG. **2**, device **204** may be any device that may be coupled with first structure **140**. Of note, device **204** may be any device capable of utilizing energy within first structure **140**. However, for purposes of brevity and clarity, device **204** is sometimes referred to herein as "household device". For example, device **204** may be a washer, a dryer, a refrigerator, a dishwasher, a toaster, etc. Furthermore, first structure **140** may be any structure with which one or more devices may be coupled and within which one or more devices may use electricity. However, for purposes of brevity and clarity, first structure **140** is sometimes referred to herein as "household".

OPERATION

More generally, in embodiments in accordance with the present invention, energy manager **100** is used to monitor and instruct a user to modify the energy usage profile of one or more devices within a household to correlate to a desired energy usage for that device and/or household. In another embodiment, energy manager **100** is used to monitor and automatically modify the energy usage profile of one or more devices within a household to correlate to a desired energy usage for that device and/or household. Desired energy usage may be based on energy usage rules internal to energy manager **100** and/or energy usage rules ultimately received from an energy utility. Such an instruction and/or modification are particularly useful to conserve household energy usage.

More particularly, and referring to FIG. **2**, in one embodiment, energy usage rule accessor **105** accesses an energy usage rule **202** of device **204**, wherein device **204** is coupled with first structure **140**. Then, energy usage rule comparator **125** receives an energy usage measurement of device **204** and compares energy usage rule **202** with the energy usage measurement. Next, energy usage profile generator **135** generates an instruction to modify an energy usage profile of device **204** to correlate with the energy usage, thereby enabling efficient energy management.

An energy usage measurement of one or more devices refers to the total amount of energy measured for each device and/or for cumulative devices within first structure **140**. For example, energy-measuring module **250***a* measures energy through a study of a device's energy usage signature that vacillates with its energy usage. For example, every device that plugs into an electrical system has a unique energy usage signature. In other words, every device exhibits its unique signal patterns during its electrical usage. These signals are used to calculate a total amount of energy being used at any given time by device **204**.

An energy usage profile of device **204** refers to the overall energy usage of device **204** and device's **204** interaction with other devices within first structure **140**, taking into account all available input, such as user **255** input, energy utility **240** input, and/or other input received via Internet **245** and server **225**. Additionally, an energy usage profile of device **204** may be integrated with an energy usage profile of a device located within one or more structures other than first structure **140**.

In one embodiment, energy usage rule accessor **105** comprises server accessor **220**, configured for accessing an energy management instruction at server **225**, wherein server **225** is positioned apart from first structure **140**. Server **225** holds instructions received from energy utility **240**. These instructions, for example, may command energy manager **100** to conserve energy relating to one or more structures that are subscribed to a demand response program. This command to conserve energy may take the form of an instruction to turn down a thermostat's set-point in the summer and to turn up the thermostat's set-point in the winter during critical peak energy draw situations. In essence, the instructions provide that the AC is to be turned down in the summer and that the heater is to be turned down in the winter at certain critical points in time.

However, "cheaters" could put a local heat source such as a match (in the summer) or a local cold source such as an ice-cube (in the winter) to attempt to trick the thermostat that the adjustment being made will have a positive effect on the energy load. Energy manager **100** may then profile the actual energy load reduction vs. the projected energy load reduction. If it is determined that the difference between the actual energy load reduction vs. the projected energy load reduction is too great, then a demand response situation may be triggered.

In a demand response situation, energy manager **100** may ignore the actual temperature reading and may alert authorities of the cheating. For example, when the demand response situation has been triggered and using sophisticated algorithms, energy manager **100** may determine the appropriate actions in proceeding with an energy load reduction, regardless of the energy manager **100**'s local temperature reading. Energy manager **100** may also flag a server **225** as to suspicious behavior for later follow-up by authorities.

In another embodiment, user instruction accessor **230** is configured for accessing an instruction from user **255**, wherein the instruction provides guidance as to user's **255** desired energy usage for device **204**. For example, in one embodiment, user **255** may input information into energy manager **100** such as to what temperature user **255** would like a room to remain for the next five hours.

In one embodiment, the user instruction is a result of a dialogue generated by energy manager **100** with user **255**. For example, energy manager **100** may create a dialogue with user **255** via text and/or sound to learn how and when to automatically modify the in-home environment taking into account the comfort of user **255**. Energy manager **100**, for example, may interview user **255** to improve user's personal satisfaction with the HVAC and energy automation

effectiveness. One or all of the available energy manager **100**'s available user interfaces may query, "Are you cold, hot, or just right now?" or "We made the assumption due to the time of day and day-in-the-month not to turn the heat on at this time to save you money . . . did you like the decision?" The answers to these queries may be used to create an energy usage profile of user **255** and the household.

After establishing a home owner's preference in temperature and pattern of usage, energy manager **100** may also factor in local weather conditions into pro-active plans for heating and cooling. For example, an Internet hosted server (coupled with server **225** via Internet **245**) may provide forecasted weather data for the home in neighborhood, identifiable by zip code. Energy manager **100** may use the anticipation of a coming weather pattern, user preference knowledge, and scheduled or critical peak energy rates (actual or expected) to take pro-active steps. For example, these pro-active steps may include gradually cooling down the house to 65 degrees throughout the morning until 11 am, while taking into account that user's **255** disregard for the cold in the morning as well as taking advantage of cheaper energy rates.

In another embodiment, an instruction is generated to modify an energy usage profile of first device **204** coupled with first structure **140** according to an energy usage profile of a second device coupled with a second structure, such that the energy usage associated with first structure **140** and the energy usage associated with the second structure does not occur at the same time. For example, two different homes both have an energy manager **100**, are coupled with server **225**, and enter into a local grid "balancing algorithm". Home #1 wants to use its compressor. Home #2 wants to heat its swimming pool. If both homes use this type of energy at the same time, the power grid will be taxed with a cumulative amount of power usage. However, if the two homes stagger its energy usage, then the power grid's average usage will remain the same. In other words, when home #1 is done with using its compressor, the pool heater of home #2 will be recommended to be powered on.

For example, energy manager **100** of home #1 generates an instruction to the effect that home #1 should power on its compressor between the hours of 2 p.m. and 4 p.m. Energy manager **100** of home #2 generates an instruction to the effect that home #2 should power on its pool heater between the hours of 4 p.m. and 6 p.m. The residents of home #1 may then follow its energy manager **100**'s instructions. The residents of home #2 may also then follow its energy manager **100**'s instructions.

In another embodiment of the present invention, when home #1 is done with using its compressor, the pool heater of home #2 will automatically power on.

In other words, energy manager **100** causes "peak load management" to occur, in which some or all devices within a home may be turned off in critical peak power situations. This peak load management can be performed based on geography, such as but not limited to peak load management per house and peak load management per neighborhood.

In one embodiment of the present invention, energy manager **100** comprises interface compatibility module **205**, configured for enabling coupling of energy manager **100** with compatible communication module **210**, wherein energy manager **100** utilizes compatible communication module **210** to access an energy usage measurement. For example, interface compatibility module **205** provides a means of choosing the best method of Internet connectivity for user **255**. It comprises a compatible communication module **210** that allows user **255** to buy a compatible wireless networking module, a household-wiring module, or other appropriate module that allows for further customization by user **255** to match user's **255** existing home network. For example, compatible communication module **210** enables the coupling of wireless connector 802.11 with energy manager **100**. Wireless connector 802.11 then enables communication with energy measuring module **250***a*.

In another embodiment of the present invention, energy manager **100** comprises graphical display module **215**, configured for enabling communication with user **255**. For example, graphical display module **215** may include various aesthetic properties relating to color, texture, shape, and lighting. In one embodiment, graphical display module **215** may be a glass touch screen panel. The panel may be color and incorporate graphics. The panel may enable communication via icons, graphs, pie charts, etc.

In one embodiment, energy manager **100** generates an instruction that is receivable by a human user **255** of device **204**. This instruction may be receivable through any number of mediums, including graphical display module **215** positioned as shown in FIG. **2** or positioned anywhere that enables coupling wired or wireless coupling with first structure **140**. Additionally, human user **255** of device **204** may access the generated instruction at any device within first structure **140** that is configured to transmit the instruction, such as but not limited to a desktop computer and/or portable electronic devise. Further, human user **255** of device **204** may access the generated instruction as an email message, SMS message, or other electronic message via a device capable of supporting the transmission and display of the message. In another embodiment, energy manager **100** generates an instruction that is receivable by device **204**. The instruction enables device **204** to alter its energy usage profile based on the comparing of the energy usage rule for device **204** and device **204**'s energy usage.

In one embodiment, energy manager **100** comprises passive power consumption tracker **235**, configured for tracking a difference between the sum of energy usage of all devices, wherein all these devices are in an active state and coupled with first structure **140**, and a total energy used within first structure **140** to generate a passive power consumption analysis. For example, energy manager **100** may provide calculated estimates of passive power consumption. The difference between the sum of each appliance's energy usage and the total energy usage is per household is passive power consumption and untracked power usage. This untracked power usage is un-optimizable usage. Passive power consumption is considered to be the most significant drain of power on a power grid. Wall nuts and other passive power drains are undocumented and yet pull more current than any other sink. Even though an appliance is "off" doesn't mean that the appliance isn't consuming power. Tracking this passive power usage increases the user's **255** awareness of energy usage and creates opportunities to conserve overall energy.

In one embodiment of the present invention, an upgrade to energy manager **100** is accessed. For example, energy manager **100** may access, via server **225**, upgrades to its functionalities and interoperability capacity with devices. In one embodiment, device **204** is upgraded within the home. Energy manager **100** may then access, via server **225**, device **204**'s manufacturer to receive upgraded energy standards for device **204**.

It is important to note that energy manager **100** may be a direct replacement for the heating-cooling thermostat controller that connects to the home air conditioner/heater. For

example, a consumer may purchase energy manager **100**, pull their current thermostat off their household wall, and mount energy manager **100** in its place. Energy manager **100** then performs all of the air conditioner/heater operations that would be expected from the displaced heating-cooling thermostat as well as the operations attributable to energy manager **100** described herein. Furthermore, a new face plate may include, but is not limited to, an increased display size, a faster processor within, added features to make energy manager **100** more user friendly.

FIG. **3** is a flowchart **300** of an example method of managing energy usage. With reference now to **305** of FIG. **3**, an energy usage rule **202** for device **204** is accessed, wherein device **204** is coupled with first structure **140**.

With reference to **310** of FIG. **3**, in another embodiment energy usage of device **204** is monitored. This monitoring may be automatically performed or upon command by user **255**, energy utility **240**, or some other authorized monitor. For example, a device's **204** energy usage may be monitored by energy utility **240** via energy measuring module **250***b* for inconsistencies in thermostat readings.

With reference to **315** of FIG. **3**, in one embodiment, energy usage rule **202** is compared with the energy usage of device **202**. Finally, with reference to **320** of FIG. **3**, in one embodiment, based on **315** comparing of energy usage rule **202** and the energy usage of device **204**, an instruction is generated to modify an energy usage profile of device **204** to correlate with energy usage rule **202**, thereby enabling efficient energy management.

Thus, embodiments of the present invention enable the generation of an instruction for a user to modify an energy usage profile of one or more devices within a household to correlate to a desired energy usage for that device and/or household. Additionally, embodiments of the present invention enable the generation of an instruction to automatically modify an energy usage profile of one or more devices within a household to correlate to a desired energy usage for that device and/or household. Furthermore, an instruction to modify an energy usage profile for a device and/or household may be based on instructions from a user and instructions from a utility company via a server.

EXAMPLE COMPUTER SYSTEM ENVIRONMENT

With reference now to FIG. **4**, portions of the invention for generating a pre-recorded quick response are composed of computer-readable and computer-executable instructions that reside, for example, in computer-usable media of a computer system. That is, FIG. **4** illustrates one example of a type of computer that can be used to implement embodiments, which are discussed below, of the present invention.

FIG. **4** illustrates an example computer system **400** used in accordance with embodiments of the present invention. It is appreciated that system **400** of FIG. **4** is an example only and that the present invention can operate on or within a number of different computer systems including general purpose networked computer systems, embedded computer systems, routers, switches, server devices, user devices, various intermediate devices/artifacts, stand alone computer systems, and the like. As shown in FIG. **4**, computer system **400** of FIG. **4** is well adapted to having peripheral computer readable media **402** such as, for example, a floppy disk, a compact disc, and the like coupled thereto.

System **400** of FIG. **4** includes an address/data bus **404** for communicating information, and a processor **406**A coupled to bus **404** for processing information and instructions. As depicted in FIG. **4**, system **400** is also well suited to a multi-processor environment in which a plurality of processors **406**A, **406**B, and **406**C are present. Conversely, system **400** is also well suited to having a single processor such as, for example, processor **406**A. Processors **406**A, **406**B, and **406**C may be any of various types of microprocessors. System **400** also includes data storage features such as a computer usable volatile memory **408**, e.g. random access memory (RAM), coupled to bus **404** for storing information and instructions for processors **406**A, **406**B, and **406**C.

System **400** also includes computer usable non-volatile memory **410**, e.g. read only memory (ROM), coupled to bus **404** for storing static information and instructions for processors **406**A, **406**B, and **406**C. Also present in system **400** is a data storage unit **412** (e.g., a magnetic or optical disk and disk drive) coupled to bus **404** for storing information and instructions. System **400** also includes an optional alphanumeric input device **414** including alphanumeric and function keys coupled to bus **404** for communicating information and command selections to processor **406**A or processors **406**A, **406**B, and **406**C. System **400** also includes an optional cursor control device **416** coupled to bus **404** for communicating user input information and command selections to processor **406**A or processors **406**A, **406**B, and **406**C. System **400** of the present embodiment also includes an optional display device **418** coupled to bus **404** for displaying information.

Referring still to FIG. **4**, optional display device **418** of FIG. **4** may be a liquid crystal device, cathode ray tube, plasma display device or other display device suitable for creating graphic images and alpha-numeric characters recognizable to a user. Optional cursor control device **416** allows the computer user to dynamically signal the movement of a visible symbol (cursor) on a display screen of display device **418**. Many implementations of cursor control device **416** are known in the art including a trackball, mouse, touch pad, joystick or special keys on alpha-numeric input device **414** capable of signaling movement of a given direction or manner of displacement. Alternatively, it will be appreciated that a cursor can be directed and/or activated via input from alpha-numeric input device **414** using special keys and key sequence commands.

System **400** is also well suited to having a cursor directed by other means such as, for example, voice commands. System **400** also includes an I/O device **420** for coupling system **400** with external entities.

Referring still to FIG. **4**, various other components are depicted for system **400**. Specifically, when present, an operating system **422**, applications **424**, modules **426**, and data **428** are shown as typically residing in one or some combination of computer usable volatile memory **408**, e.g. random access memory (RAM), and data storage unit **412**. However, it is appreciated that in some embodiments, operating system **422** may be stored in other locations such as on a network or on a flash drive; and that further, operating system **422** may be accessed from a remote location via, for example, a coupling to the internet. In one embodiment, the present invention, for example, is stored as an application **424** or module **426** in memory locations within RAM **408** and memory areas within data storage unit **412**. System **400** is also well suited to having a temperature sensor **430**, an ambient light sensor **432**, and a relative humidity sensor **434**.

Computing system **400** is only one example of a suitable computing environment and is not intended to suggest any limitation as to the scope of use or functionality of the present invention. Neither should the computing environment **400** be interpreted as having any dependency or

requirement relating to any one or combination of components illustrated in the example computing system **400**.

The present invention may be described in the general context of computer-executable instructions, such as program modules, being executed by a computer. Generally, program modules include routines, programs, objects, components, data structures, etc., that perform particular tasks or implement particular abstract data types. The present invention may also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, program modules may be located in both local and remote computer-storage media including memory-storage devices.

FIG. **5** is a flowchart illustrating a process **500** for managing energy usage, in accordance with one embodiment of the present invention. In one embodiment, process **500** is carried out by processors and electrical components under the control of computer readable and computer executable instructions. The computer readable and computer executable instructions reside, for example, in data storage features such as computer usable volatile and nonvolatile memory. However, the computer readable and computer executable instructions may reside in any type of computer readable medium. In one embodiment, process **500** is performed by energy manager **100** of FIG. **1**.

With reference to **505** of FIG. **5**, a signal of device **204** is monitored, wherein the signal is an energy usage signature specific to device **204** and device **204** is coupled with first structure **140**. With reference to **510** of FIG. **5**, an analysis of energy usage of device **204** is generated based on the monitoring of a signal of device **204**. The analysis describes an energy usage profile of device **204**.

In one embodiment, method **500** further comprises estimating savings with regards to replacing device **204** with a new device, wherein the estimating is based on the analysis described herein of method **500**. For example, by installing energy manager **100**, user **255** can get contextual advice on how to efficiently and affordably upgrade user's **255** current HVAC unit. Energy manager **100** estimates how much money would be saved by installing a new HVAC unit based on algorithms that do the following: measure, store, and analyze energy usage history; utilize a Seasonal Energy Efficiency Rating (SEER) of a new HVAC unit and how it would profile in the current household; and measure current HVAC unit run time and the temperature drop rate over various time intervals.

Energy manager **100** may, through its back-end server **225** connection in Internet **245**, enable partnerships with local (or national) HVAC companies. Energy manager **100** may change its line-up of eligible replacement HVAC units based on factors such as pricing and availability in real-time. Energy manager **100** may provide contextual advertisement for HVAC unit vendors, or for any other product or service. The messaging from energy manager's **100** face-plate, connected PC interface, or connected mobile interface provides such useful information as, "You would save $130 per month if you upgraded to a Y SEER AC."

In yet another embodiment of the present invention, method **500** further comprises generating an analysis that informs user **255** of the costs associated with changing the settings of device **204**. For example, energy manager **100** may generate an analysis that informs user **255** that changing the dishwasher to run at half power instead of at full power may save user **255** $20 per month.

In another embodiment, method **500** further comprises comparing the energy usage of first structure **140** with an energy usage of a second structure based on the analysis described herein of method **500**. For example, with energy managers **100** in different homes, comparisons may be made between and among homes. A home in neighborhood N1 can compare its energy usage to a friend's home in neighborhood N2. Energy manager **100** may then relay to user **255** the following, "Your friend, Jim Smith, is spending $500 per month to heat/cool their house." Or, energy manager **100** may relay to user **255**, "Your sister's fridge is costing $50 per month to keep the food cold, which is in the top 10% of homes in the nation in terms of effectiveness and efficiency." This neighbor comparison functionality works on competitive psychology. This functionality enables more sales of new and energy efficient units and overall electricity conservation for the power energy grid.

In another embodiment, method **500** further comprises alerting user **255** to specific maintenance tasks for device **204** that are recommended based on an analysis of energy usage of device **204** described herein. For example, method **500** comprises alerting user **255** that a new filter for device **204** is needed based on the analysis described herein of method **500**. For example, energy manager **100** may estimate when enough time has passed based on overall usage to determine that a new filter for the HVAC unit is needed. Energy manager **100** may show reminders for replacing these HVAC filters. Energy manager **100** may show statistics on how much money is saved or lost by replacing or waiting to replace HVAC filters.

In another embodiment, method **500** further comprises calculating the efficiency of the HVAC correlated to the energy efficiency of the home (including insulation and air leakage through ducts, under doors, and around windows). For example, based on the duration that it takes to drop the temperature of the home to the desired temperature while taking into consideration the cost of electricity, energy manager **100** calculates the efficiency of the HVAC correlated to the energy efficiency of the home.

Similarly, energy manager **100** may calculate the current efficiency of an appliance such as a refrigerator. Utilizing an energy-measuring module **250***a* between the refrigerator and the electrical outlet, energy manager **100** can make algorithmic conclusions based on the setting and the history of the refrigerator. Thus, energy manager **100** may generate an analysis on the estimated energy efficiency of the refrigerator.

In another embodiment, method **500** further comprises alerting user **255** of a possible failure of device **204** based on an analysis of historical data or data on a remote server. This historical data includes the monitored energy usage data for device **204** described herein. Method **500** further comprises alerting user **255** of possible device **204** failure based on device's **204** history. For example, circuits sometimes begin to eat up larger and larger amounts of current or show erratic current draw before they fail. A "healthy history" of current usage per device **204** may be compared to current spikes or other erratic current draw to predict the failure of device **204**.

In another embodiment, method **500** further comprises calculating the break even date of a replacement product. For example, energy manager **100** monitors the energy usage history for device **204**. Then, after device **204** is replaced, energy manager **100** marks the replacement date. Energy manager **100** may then calculate the break even date and any realized savings based off of electric rate data. Energy manager **100** may then communicate these calcula-

tions to user **255** via graphical display module **215**. Energy manager **100** may also communicate a victory notification to user **255**.

In another embodiment, method **500** further comprises assisting user **255** with achieving a money savings goal by managing user's **255** energy usage. For example, a user's **255** financial savings goal and an interaction between user **255** and user's **255** device(s) **204** may result in a dialogue with device(s) **204** or even with the whole house. Energy manager **100** may also keep user **255** current on user's **255** financial savings. Energy manager **100** may tie its energy usage management of device(s) **204** with an incentive, such as, "By turning the AC up to 89 degrees, we are saving for our Fiji vacation.".

In another embodiment, method **500** further comprises querying and negotiating with user **255** to assist user **255** in meeting an energy budget target. For example, energy manager **100** may both interview and negotiate with user **255**. The interviews may be periodic questions, posed through user-interfaces. These question posed may relate to personal comfort, and preferences on HVAC and energy automation effectiveness. For example, one question might be, "Are you cold, hot, or just right at this time?" The answer to this question will inform energy manager **100** of the threshold of environmental comfort for user **255** based on a registered temperature reading. Energy manager **100** may also poll user **255** if user **255** is the only one home or if other friends or relatives are at home to determine what actions should be taken.

Another possible question may be, "We made the assumption due to the time of day and the day in the month not to turn the heat on at this time in order to save you money . . . did you like this decision?" A positive response from user **255** will reinforce the algorithmic decision made. Whereas a negative response will provide the initiative to make a change.

The negotiation (via email, SMS, Instant Messaging, or directly accessing the interface of energy manager **100**) of user **255** with energy manager **100** relates to trying to help user **255** hit a pre-set energy budget target. For example, if after 20 days into the month the user's **255** trend line is above the forecasted month end bill and/or energy usage, energy manager **100** may send user **255** an SMS messaging requesting permission to turn the heat down three degrees.

In another embodiment, method **500** further comprises profiling a device **204** based on the history of device **204** and environmental factors. For example, energy manager **100** may support the use of one energy-measuring module **250***a* used to connect device **204** to energy manager **100**. Based on the energy consumption over time and against assorted environmental factors energy manager **100** will profile device **100** as to its energy consumption, energy costs, and as a percentage of room device class, and whole-home totals. This one energy-measuring module **250***a* may be rotated around the home to eventually construct a whole home energy profile, with or without the presence of energy-measuring module **250***b*.

Furthermore, this device-level energy audit can be conducted over varying levels of time and report to user **255** its higher level of confidence on its estimates based on the variable of time allowed to measure a particular device **204**. Energy manager **100** may compare similar devices of its class via information on Internet hosted servers. Moreover, energy manager **100** may compare similar devices for the home via historical information from one or more energy utility **240**. Energy manager may also make a forecast regarding device **204** based on company trends and forecasts.

In another embodiment, method **500** further comprises managing an energy co-op of a pool of energy manager **100** user(s) **255**. For example, energy manager(s) **100** is able to aggregate homes within and across neighborhoods, grouping them into a logical large single pool. A logical large single pool of houses might be homes located geographically near each other. Energy manager **100** thus provides a distributed "buying block" of energy user's **255**. This "buying block", having purchased from energy wholesalers, is able to act in a cooperative capacity as energy manager **100** user(s) **255**. Beneficially, user(s) **255** would experience reduced energy costs. Server **225** may manage this co-op.

In yet another embodiment of the present technology, a plurality of energy usage signatures is aggregated by remote server **225**. This plurality of energy usage signatures is compiled for comparison with subsequently received energy usage signatures. One or more of the energy usage signatures may be identified by user **255** of the device(s). In one embodiment, remote server **225** receives from user **255** of device **204** the identification information, including but not limited to device type, manufacturer, and model information to be associated with its energy usage signature. The server then aggregates this identification of device **204** in a database at server **225**.

More particularly, energy manager **100** may detect a new energy usage signature within first structure **140**. Energy manager **100** may notify user **255** that a new energy usage signature (device **204**) exists and prompt user **255** for the device's identification. User **255** then may identify device **204** as washer model #4305. Energy manager **100** then sends this energy usage signature along with its identification to server **225**. Remote server **255** stores this identification in a database that is accessible to users of device **204** and devices other than device **204**. In this way, a database of energy usage signatures and related identifications is built and accessible by, but not limited to, users of various devices, manufacturers, and energy utility companies.

In another embodiment, the plurality of energy usage signatures of first structure **140** received by server **225** are provided for use and comparison of one or more energy usage signatures by an energy manager **100** in a second structure. For example, the energy usage signatures detected in structure **140** and their identification that is stored in a database at server **225** are provided to an energy manager **100** of a second structure for use and comparison with one or more energy usage signatures therein.

For example, energy manager **100** of a second structure uses the identified energy usage signatures associated with the devices in first structure **140** to identify the energy usage signatures detected in the second structure. In this manner, energy manager **100** takes advantage of a database of identifications of energy usage signatures located at a remote server in order to more quickly identify the devices within a household with which it is coupled. Of note, users of devices coupled with different structures provide assistance in the collection and identification of energy usage signatures for any number of devices.

FIG. **6** is a flowchart illustrating a process for managing energy usage in accordance with embodiments of the present invention is shown. With reference now to **605** of FIG. **6**, an energy usage rule **202** for device **204** is accessed, wherein device **204** is coupled with first structure **140**.

With reference to **610** of FIG. **6**, in another embodiment energy usage of device **204** is monitored. This monitoring

may be automatically performed or upon command by user **255**, energy utility **240**, or some other authorized monitor. For example, a device's **204** energy usage may be monitored by energy utility **240** via energy measuring module **250***b* for inconsistencies in thermostat readings.

User **255** may access these instructions at, but not limited to, energy manager **100**, at a device coupled with first structure **140**, at a server **255** coupled with energy manager **100** and/or first structure **140**, and/or at a device at a second structure coupled wired or wirelessly with first structure **140**.

With reference to **615** of FIG. **6**, in one embodiment, energy usage rule **202** is compared with the energy usage of device **202**. Finally, with reference to **620** of FIG. **6**, in one embodiment, based on **615** comparing of energy usage rule **202** and the energy usage of device **204**, an instruction is generated to modify an energy usage profile of device **204** to correlate with energy usage rule **202**, wherein the instruction is formatted for interpretation by a human user, thereby enabling efficient energy management. An instruction is formatted for interpretation by a human user if the instruction is transmitted in such a way that it could be understood by a human user.

Thus, embodiments of the present invention enable the generation of an instruction for a human user to modify an energy usage profile of one or more devices within a household to correlate to a desired energy usage for that device and/or household. Additionally, embodiments of the present invention enable the generation of an instruction to automatically modify an energy usage profile of one or more devices within a household to correlate to a desired energy usage for that device and/or household.

Thus, embodiments of the present invention increase consumer awareness as to conservation of energy by enabling the generation of an analysis of a device's energy usage. In one embodiment, the analysis informs a consumer of estimated savings with regards to replacing a device with a new device. In another embodiment, the analysis provides a comparison of the energy usage and energy costs of two different households. Furthermore, embodiments of the present invention inform a consumer when a new filter for a device is needed based on a generated analysis. Thus, embodiments of the present invention are beneficial by increasing a consumer's awareness of energy conservation opportunities.

Although the subject matter has been described in a language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

What is claimed is:

1. A method of encouraging resource-conscious behavior, comprising:

determining, using a resource management system, resource usage information for each of a plurality of homes, the resource usage information for each home in the plurality of homes indicating an amount of resource consumption associated with the home;

comparing the amount of resource consumption associated with a first home in the plurality of homes to the amount of resource consumption associated with one or more other homes in the plurality of homes;

determining similarities and/or differences between the amount of resource consumption associated with the first home and the amount of resource consumption associated with the one or more other homes in the plurality of homes based on the comparing;

anonymizing the amount of resource consumption associated with the one or more other homes in the plurality of homes to generate anonymized resource consumption information;

communicating, with a first user of the first home, the anonymized resource consumption information, the anonymized resource consumption information for the one or more other homes in the plurality of homes being indicative of the amount of resource consumption associated with one or more other homes in the plurality of homes; and

causing a device to be controlled in the first home based on the anonymized resource information and/or on feedback from the first user in response to receiving the anonymized resource consumption information.

2. The method of claim **1**, wherein communicating with the first user of the first home is performed via a user interface.

3. The method of claim **1**, wherein the one or more other homes in the plurality of homes are within a neighborhood of the first user.

4. The method of claim **1**, wherein a resource, for which the resource usage information is determined, is a form of energy.

5. The method of claim **1**, wherein the resource usage information for each home represents total resource consumption of the home.

6. The method of claim **1**, wherein the resource usage information for each home represents resource consumption of a subset of devices operating in the home.

7. The method of claim **1**, further comprising:

determining a first cost of operating a device associated with one of the plurality of homes based on a first operational parameter of the device;

determining a second cost of operating the device associated with the one of the plurality of homes based on a second operational parameter of the device different than the first operational parameter of the device; and

communicating to a user of the device information indicative of a difference in cost between the first cost and the second cost resulting from changing from the first operational parameter to the second operational parameter.

8. The method of claim **7**, wherein the second operational parameter is indicative of the device consuming less resource as compared to the first operational parameter, and the difference in cost is a cost saving.

9. The method of claim **7**, further comprising:

communicating a query to the user of the device regarding accepting the second operational parameter;

receiving feedback from the user of the device in response to the query; and

controlling the device in accordance with the second operational parameter based on the received feedback.

10. The method of claim **1**, further comprising:

determining a goal of the first user associated with the first user's resource consumption;

monitoring resource consumption of the first user; and

sending information to the first user regarding the goal when the first user's resource consumption approaches the goal.

11. The method of claim **10**, wherein the goal is a pre-set resource budget target for a given period of time.

12. The method of claim 11, further comprising:

partway through the period of time, determining a trend of the first user's resource consumption;

determining that the first user's resource consumption is likely to exceed the pre-set resource budget target; and

sending information to the first user encouraging the first user to adjust their resource consumption upon determining that the first user's resource consumption is likely to exceed the pre-set resource budget target.

13. A system for encouraging resource-conscious behavior, comprising:

one or more computer servers communicatively coupled to a plurality of resource management devices and configured to:

determine resource usage information for each of a plurality of homes, the resource usage information for each home in the plurality of homes indicating an amount of resource consumption associated with the home;

compare the amount of resource consumption associated with a first home in the plurality of homes to the amount of resource consumption associated with one or more of other homes in the plurality of homes;

determine similarities and/or differences between the amount of resource consumption associated with the first home and the amount of resource consumption associated with the one or more other homes in the plurality of homes based on the comparing;

anonymize the amount of resource consumption associated with the one or more other homes in the plurality of homes to generate anonymized resource consumption information;

communicate, with a first user of the first home, the anonymized resource consumption information, the anonymized resource consumption information for the one or more other homes in the plurality of homes being indicative of the amount of resource consumption associated with one or more other homes in the plurality of homes; and

cause a device to be controlled in the first home based on the anonymized resource information and/or on feedback from the first user in response to receiving the anonymized resource consumption information.

14. The system of claim 13, wherein a resource, for which the resource usage information is determined, is a form of energy.

15. A non-transitory computer-readable medium, having instructions stored therein, which when executed cause a computer to perform a set of operations comprising:

determining resource usage information for each of a plurality of homes, the resource usage information for each home in the plurality of homes indicating an amount of resource consumption associated with the home;

comparing the amount of resource consumption associated with a first home in the plurality of homes to the amount of resource consumption associated with one or more other homes in the plurality of homes;

determining similarities and/or differences between the amount of resource consumption associated with the first home and the amount of resource consumption associated with the one or more other homes in the plurality of homes based on the comparing;

anonymizing the amount of resource consumption associated with the one or more other homes in the plurality of homes to generate anonymized resource consumption information;

communicating, with a first user of the first home, the anonymized resource consumption information, the anonymized resource consumption information for the one or more other homes in the plurality of homes being indicative of the amount of resource consumption associated with one or more other homes in the plurality of homes; and

causing a device to be controlled in the first home based on the anonymized resource information and/or on feedback from the first user in response to receiving the anonymized resource consumption information.

16. The non-transitory computer-readable medium of claim 15, having further instructions stored therein, which when executed cause the computer to perform a set of operations comprising:

generating an advertisement for the first user.

17. The non-transitory computer-readable medium of claim 16, wherein the advertisement is for an upgraded device to replace a device associated with the first home of the first user.

18. The non-transitory computer-readable medium of claim 16, having further instructions stored therein, which when executed cause the computer to perform a set of operations comprising:

personalizing the advertisement to target the first user based on the resource usage information for the first home of the first user.

19. The non-transitory computer-readable medium of claim 16, having further instructions stored therein, which when executed cause the computer to perform a set of operations comprising:

communicating an incentive to the first user for accepting the advertisement.

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