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Electric vehicle, and charging and discharging facility, and system

Abstract

A new system is provided that enables a resource aggregator to smoothly use on-board batteries of electric vehicles as an energy resource. A user is allowed to select whether or not to permit interchange of electric power between a charging and discharging facility and an electric vehicle through the resource aggregator when the electric vehicle is connected to the charging and discharging facility.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS

(1) The present application claims priority from Japanese Patent Application No. 2021-146113 filed on Sep. 8, 2021, which is incorporated by reference herein in its entirety.

BACKGROUND

(2) The present invention relates to electric vehicles, and charging and discharging facilities, and systems.

(3) International Publication No. 2011/077780 discloses an electric power grid control system. The electric power grid control system includes a power aggregator that ranks the degrees of need of charging and discharging the storage batteries of electric vehicles and creates a ranking list that shows the ranks. The power aggregator distributes information for guiding the electric vehicles so as to charge or discharge at designated charging and discharging stations according to the ranking list. It is stated that this enables guiding the electric vehicles in motion to charging and discharging stations and thereby allows the power grid side to retain sufficient electric power for charging and discharging more reliably.

SUMMARY

(4) The present inventors are investigating to develop a system for adjusting electric power supply and demand by utilizing on-board batteries of electric vehicles connected to a power utility grid via charging stations, in response to an instruction for interchanging of electric power from a power utility company. the system being made available to resource aggregators. In the course of the investigation, the present inventors believe that resource aggregators need a new system that enables on-board batteries of electric vehicles to be used as an energy resource smoothly.

(5) An electric vehicle according to the present disclosure includes a selection process unit configured to select whether or not to permit the electric vehicle, when connected to the charging and discharging facility, to interchange electric power with a charging and discharging facility through a resource aggregator. The just-described electric vehicle makes it possible to select, when connected to the charging and discharging facility, whether or not to permit interchange of electric power with the charging and discharging facility through the resource aggregator, so that the resource aggregator can smoothly use the electric vehicle connected to the charging and discharging facility as an energy resource.

(6) The electric vehicle may include a condition setting unit configured to set conditions for interchanging electric power. The condition setting unit may be configured to set at least a lower

limit value of an electricity sales price that is applied when electric power is discharged from the electric vehicle through the resource aggregator. The condition setting unit may also be configured to set at least an upper limit value of the electricity purchase price that is applied when electric power is charged to the electric vehicle through the resource aggregator. The condition setting unit may also be configured to be able to set a required amount of charge.

(7) A charging and discharging facility according to the present disclosure includes a selection process unit configured to select whether or not to permit the charging and discharging facility, when an electric vehicle is connected thereto, to interchange electric power with the electric vehicle through a resource aggregator. The just-described charging and discharging facility makes it possible to select, when the electric vehicle is connected to the charging and discharging facility, whether or not to permit interchange of electric power between the electric vehicle and the charging and discharging facility through the resource aggregator, so that the resource aggregator can smoothly use the electric vehicle connected to the charging and discharging facility as an energy resource.

(8) The charging and discharging facility may include a condition setting unit that sets conditions for interchanging electric power. The condition setting unit may be configured to set at least a lower limit value of an electricity sales price that is applied when electric power is discharged from the electric vehicle through the resource aggregator. The condition setting unit may also be configured to set at least an upper limit value of the electricity purchase price that is applied when electric power is charged to the electric vehicle through the resource aggregator. The condition setting unit may be configured to be able to set a required amount of charge for the electric vehicle.

(9) A program according to the present disclosure may be configured to cause a control terminal of a user to serve functions of selecting whether or not to permit interchange of electric power between an electric vehicle and a charging and discharging facility through a resource aggregator when the electric vehicle is connected to the charging and discharging facility, and transmitting a result of the selection to a predetermined server. The just-described program is able to cause the control terminal of the user to function so as to select whether or not to permit interchange of electric power between the electric vehicle and the charging and discharging facility through the resource aggregator when the electric vehicle is connected to the charging and discharging facility. This enables the resource aggregator to smoothly use the electric vehicle connected to the charging and discharging facility as an energy resource.

(10) The program may cause the control terminal of the user to function so as to show a display screen for selecting whether or not to permit interchange of electric power between the electric vehicle and the charging and discharging facility through the resource aggregator when the electric vehicle is connected to the charging and discharging facility. In addition, the program may cause the control terminal of the user to function so as to set conditions for permitting interchange of electric power between the electric vehicle and the charging and discharging facility through the resource aggregator. In addition, the program may cause the control terminal of the user to function so as to show a display screen for setting conditions for permitting interchange of electric power between the electric vehicle and the charging and discharging facility through the resource aggregator.

(11) The program may cause the control terminal of the user to function so as to store conditions for permitting interchange of electric power between the electric vehicle and the charging and discharging facility through the resource aggregator. The program may be configured to cause the control terminal of the user to function so as to store a compensation obtained by a sale of electricity from the electric vehicle or the user. The program may be configured to cause the control terminal of the user to function so as to use the compensation obtained by the sale of electricity from the electric vehicle or the user for a purchase of electricity by the electric vehicle or the user. The program may be configured to cause the control terminal of the user to function so as to exchange the compensation obtained by the sale of electricity from the electric vehicle or the user

with points that are commercially usable by the electric vehicle or the user.
(12) The control terminal of the user may be a mobile communication terminal of the user. It is also possible that the control terminal of the user may be incorporated in the electric vehicle. It is also possible that the control terminal of the user may be incorporated in the charging and discharging facility.
(13) A charging and discharging management system according to the present disclosure includes a server connected to a communication network. The server includes: a memory storage unit storing data representing electric vehicles and data representing users respectively in association with each other; a detection unit detecting, through the communication network, that at least one of the electric vehicles has been connected to a charging and discharging facility managed by a resource aggregator; and a controller configured to start interchange of electric power through the resource aggregator between the charging and discharging facility and the at least one of the electric vehicles detected to have been connected to the charging and discharging facility, based on permission information acquired from a control terminal operated by one of the users through the communication network. The just-described charging and discharging management system is able to select whether or not to permit interchange of electric power between the electric vehicle and the charging and discharging facility through the resource aggregator when the electric vehicle is connected to the charging and discharging facility. This enables the resource aggregator to smoothly use the electric vehicle connected to the charging and discharging facility as an energy resource.
(14) The server may further include a notification unit notifying the control terminal of the user associated with an electric vehicle connected to the charging and discharging facility that the electric vehicle has been connected to the charging and discharging facility. The server may be configured to start, after the notification from the notification unit, interchange of electric power between the charging and discharging facility and the electric vehicle through the resource aggregator, based on the permission information acquired from the control terminal of the user.
(15) In addition, the server may further include a condition storing unit storing conditions for interchanging electric power in association with at least one of the electric vehicles or at least one of the users. It is also possible that the server may be configured to store the compensation obtained by the sales of electricity from the electric vehicle or the user. It is also possible that the server may be configured to use the compensation obtained by the sales of electricity from the electric vehicle or the user for a purchase of electricity by the user. It is also possible that the server may be configured to exchange the compensation obtained by the sales of electricity from the electric vehicle or the user with points that are commercially usable by the user.
(16) The server may be configured to provide any of the above-described programs through a communication network.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a schematic view schematically illustrating a charging and discharging management system **10**.
(2) FIG. **2** is another schematic view schematically illustrating the charging and discharging management system **10**.
(3) FIG. **3** is a schematic view schematically illustrating another embodiment of the charging and discharging management system **10**.
DETAILED DESCRIPTION
(4) Embodiments of the present disclosure will be described hereinbelow. It should be noted, however, that the embodiments illustrated herein are, of course, not intended to limit the disclosure.

The drawings are depicted schematically and do not necessarily accurately depict actual objects. The features and components that exhibit the same effects are designated by the same reference symbols as appropriate, and the description thereof will not be repeated.

Charging and Discharging Management System **10**

(5) FIGS. **1** and **2** are schematic views schematically illustrating a charging and discharging management system **10**.

(6) The charging and discharging management system **10** involves, as illustrated in FIG. **1**, an aggregation coordinator **11**, a charging and discharging facility **12**, a resource aggregator **13**, an electric vehicle **14**, and a user **15** of the electric vehicle **14**.

(7) FIG. **1** illustrates the relationship, centered around a distribution grid provided by the aggregation coordinator **11**, between the aggregation coordinator **11**, the charging and discharging facility **12**, the resource aggregator **13**, the electric vehicle **14**, and the user **15**, which are in the charging and discharging management system **10**. The dashed lines PN in FIG. **1** represent power lines.

(8) FIG. **2** illustrates the relationship between the aggregation coordinator **11**, the charging and discharging facility **12**, the resource aggregator **13**, the electric vehicle **14**, and the user **15** through a communication network NW. Herein, the user **15** may be an individual human user. However, in cases where processes implemented by a computer are illustrated, the term "user **15**" may be used to mean a control terminal operated by the user, such as a smartphone. Likewise, the aggregation coordinator **11** and the resource aggregator **13** may represent management servers managed by the aggregation coordinator **11** and the resource aggregator **13** respectively for the processes implemented by a computer. The charging and discharging facility **12** may be configured to be able to perform communication by means of power line communication. The electric vehicle **14** may also be configured to be capable of communication via the charging and discharging facility **12**, by being connected to the charging and discharging facility **12**. The electric vehicle **14** may be configured to be able to perform communication through a control terminal **15***a* operated by the user **15**. The electric vehicle **14** may be directly connected to the communication network NW by other means of communication. The control terminal **15***a* operated by the user **15** may be an information terminal such as a smartphone, for example. The control terminal **15***a* operated by the user **15** may be provided in the electric vehicle **14**, and it may also be one that is operated on, for example, a control screen panel provided in the electric vehicle **14**. The control terminal **15***a* operated by the user **15** may be provided in the charging and discharging facility **12**, and it may also be one that is operated on, for example, a control screen panel provided in the charging and discharging facility **12**.

(9) The charging and discharging management system **10** is, as illustrated in FIG. **1**, a system that is applied to what is called a virtual power plant (VPP) service **20** that utilizes electric vehicles **14**. Here, the term "virtual power plant (VPP)" generally means that consumers **21**, owners of power generating facilities and electricity storage facilities **22** directly connected to the power utility grid, and third parties perform controlling of their energy resources to provide the function equivalent to a power generation plant.

(10) The controlling of the energy resources may include a reverse power flow from the energy resources on the consumer **21** side to the power utility grid. The power generating facilities **22** connected to the virtual power plant (VPP) service may include various types of power generating facilities, such as regional solar power generation, wind power generation, small-sized hydroelectric power generation, and fuel cells. The electricity storage facilities may include storage batteries installed in households, factories, commercial facilities, and the like. The reverse power flow may include reversing excess electric power to the power utility grid side in cases where, for example, the electric power stored in the above-mentioned electricity storage facilities **22** is abundant.

(11) Herein, the power utility grid is a system that integrates power generation, electrical

substations, power transmission, and power distribution together, for supplying electric power to consumers' power receiving facilities. The power utility grid may include, for example, a transmission grid from power generation plants, and a distribution grid that supplies electric power from the transmission grid to end consumers.

(12) The distribution grid may be provided with a large number of distributed power supplies, such as solar power generation, wind power generation, small-sized hydroelectric power generation, storage batteries including electric vehicles, fuel cells, and cogeneration. The operation status of these distributed power supplies is monitored through, for example, online digital data communication, so that a control system can be constructed that is able to smoothly supply electric power corresponding to the consumption in the grid. Power utility grids that contain such distributed power supplies may be considered as independent small-sized grids (microgrids) each of which has the function similar to a large-scale transmission and distribution grid operated by an electric power enterprise. Such small-sized power distribution grids are called microgrids.

(13) The aggregation coordinator **11** is a business operator that aggregates the amount of electric power controlled by the resource aggregator **13** and engages in electric power transactions with general transmission-and-distribution operators and retail electric providers. The aggregation coordinator **11** is served by, for example, a power utility company.

(14) Consumers **21** refer to those who receive and use electricity. The energy resources on the consumer **21** side include solar power generation, storage batteries including electric vehicles, fuel cells, cogeneration, and the like.

(15) The technique in which demand patterns of electric power are changed by owners of the consumer-side energy resources or third parties by controlling their energy resources is called demand response (DR). According to the patterns of demand control, the demand response is classified into two types, “downward DR” in which demand is reduced (i.e., suppressed) and “upward DR” in which demand is increased (i.e., created).

(16) The charging and discharging facility **12** is connected to the power utility grid. The electric vehicle **14** is connected to the charging and discharging facility **12** so that the charging and discharging facility **12** can perform charging from the power utility grid to the electric vehicle **14** and discharging from the electric vehicle **14** to the power utility grid. The charging and discharging facility **12** may be, for example, a charging station for electric vehicles **14**. The charging and discharging facility **12** may be installed in, for example, residential houses, commercial facilities, and factories, so as to connect an electric vehicle **14** connected thereto to the power utility grid. In this embodiment, the charging and discharging facility **12** may be controlled by the resource aggregator **13**. The electric vehicle **14** includes an on-board battery. The on-board battery has a required capacity for supplying electric power as a driving power source to the electric vehicle **14**. The electric vehicles **14** may include a wide range of vehicles that store electric power in on-board batteries to drive the vehicles, such as pure electric vehicles, hybrid electric vehicles including plug-in hybrid vehicles, and fuel cell vehicles.

(17) The resource aggregator **13** is generally a business operator that directly makes VPP service agreements with consumers of electric power to control the resources. In this embodiment, the resource aggregator **13** utilizes the electric vehicles **14** as an energy resource to contribute to demand response (DR). To use the electric vehicle **14** as an energy resource, the resource aggregator **13** stores electric power in the electric vehicle **14** when there is a surplus of electric power in the power utility grid, while it transmits the electric power stored in the electric vehicle **14** to the power utility grid when there is a shortfall of electric power in the power utility grid. This makes it possible to adjust the electric power demand in the microgrid to which the electric vehicle **14** is connected.

(18) As illustrated in FIG. **1**, the aggregation coordinator **11** requests the resource aggregator **13** to perform control for adjusting demand according to demand response (D**1**). The resource aggregator **13** responds to such a control request according to the agreement with the aggregation coordinator

11 (R**1**). The adjustments that are required of the resource aggregator **13** are two types, “downward DR” in which electric power demand is reduced (i.e., suppressed) and “upward DR” in which electric power demand is increased (i.e., created).

(19) The present inventors intend to provide a system that enables the resource aggregator **13** to utilize the charging and discharging facilities **12** in the city, to allow even the users **15** of the electric vehicles **14** that have not signed up for the service in advance to make use of the electric vehicles **14** as energy resources as appropriate. For example, it is possible to construct a system in which the user **15** is able to allow the resource aggregator **13** to use his/her electric vehicle **14** to use as an energy resource when the user **15** connects the electric vehicle **14** to a charging and discharging facility **12** not only at a nearby destination but also at a distant destination to which the user **15** travels by the electric vehicle **14**, such as a travel destination or a business trip destination. When such a system is accomplished, it is possible to use the electric vehicle **14** as an energy resource when the electric vehicle **14** is connected to a charging and discharging facility **12** in the city that is provided by the resource aggregator **13**.

(20) For example, the resource aggregator **13** may respond to the request for “downward DR” with discharging from the electric vehicle **14** through the charging and discharging facility **12**. On the other hand, the resource aggregator **13** may respond to the request for “upward DR” with charging to the electric vehicle **14** through the charging and discharging facility **12** (see D**2**, D**3**, R**2**, and R**3** in FIG. **1**). The resource aggregator **13** is able to respond to the request for demand response adjustment from the aggregation coordinator **11** by controlling charging and discharging of the electric vehicle **14** through the charging and discharging facility **12**.

(21) This enables the resource aggregator **13** to obtain the opportunity to widely use the electric vehicles **14** in the city as the energy resources, making it possible to obtain a greater energy resource. Because a larger number of electric vehicles **14** can be used as the energy resources, the resource aggregator **13** is allowed to more easily respond to the request for demand response (DR) from the aggregation coordinator **11** and to have more freedom in responding to greater fluctuations in electric power demand. As a result, the operation of the resource aggregator **13** becomes more stable.

(22) In addition, profit is distributed to the users **15** of the electric vehicles **14** according to the amount by which the resource aggregator **13** uses the electric vehicles **14** as the energy resource. Thus, the profits earned by the resource aggregator **13** are distributed to the users **15** of the electric vehicles **14**. This brings a win-win relationship to both the resource aggregator **13** and the users **15** of the electric vehicles **14**. Furthermore, it is possible to achieve a system that is also significant for the community in which electric power is supplied through the aggregation coordinator **11** or microgrids, in the aspect of more stable supply of electric power.

(23) In the course of achieving such a system, the present inventors intend to make participation in the service more easy and lower the barriers to the participation so that even the users **15** of the electric vehicles **14** who have not signed up for the service in advance can allow their electric vehicles **14** to participate as an energy resource of the resource aggregator **13** easily.

Electric Vehicle **14**

(24) As illustrated in FIGS. **1** and **2**, the electric vehicle **14** in this embodiment includes a detection unit **14***a*, a selection process unit **14***b*, a condition setting unit **14***c*, and a recording unit **14***d*. The detection unit **14***a*, the selection process unit **14***b*, the condition setting unit **14***c*, and the recording unit **14***d* are each implemented as one of the functions of a computer incorporated in the electric vehicle **14** as respective cooperative processes of the computer with the software incorporated in the computer.

(25) Herein, the electric vehicle **14** includes a computer, such as an electronic control unit (ECU). The computer incorporated in the electric vehicle **14** performs required functions according to, for example, a predetermined program. Various functions of the computer may be processed by cooperation of software with an arithmetic unit [also referred to as a processor, CPU (central

processing unit), or MPU (micro-processing unit)] and a memory storage device (such as a memory and a hard disk) of the computer. By such an electronic control unit, the electric vehicle **14** may also function as a control terminal operated by the user **15**. For example, it is possible to use a display panel for showing map information or the like as a control screen panel operated by the user **15**. The software may be, for example, provided from the resource aggregator **13** through a communication network NW, or may be configured to be able to be updated as appropriate. The software may be provided to the electric vehicle **14** through the charging and discharging facility **12**. Various processes of the electric vehicle **14** may be implemented by cooperative processes with the charging and discharging facility **12**.

(26) The detection unit **14***a* may be configured to detect that the electric vehicle **14** has been connected to the charging and discharging facility **12** managed by the resource aggregator **13**. In this embodiment, the detection unit **14***a* may be configured to be able to detect that the electric vehicle **14** has been connected to the charging and discharging facility **12** based on, for example, a connection signal through a power line.

(27) The selection process unit **14***b* may be configured to select whether or not to permit interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12**. The selection process unit **14***b* may be configured to cause a display or the like mounted in the electric vehicle **14** to show a control screen panel for selecting whether or not to permit interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13**.

(28) The electric vehicle **14** may be connected to the control terminal **15***a* of the user **15** through a communication means. When this is the case, the selection process unit **14***b* may be configured to cause the control terminal **15***a* of the user **15** to display a selection screen through software embedded in the control terminal **15***a* of the user **15**. In this case, the electric vehicle **14** may be configured to execute a process of participating in the service as an energy resource of the resource aggregator **13** through the charging and discharging facility **12**, upon receiving a permission signal D**5** from the control terminal **15***a* of the user **15**. The electric vehicle **14** may also be configured to notify the control terminal **15***a* of the user **15** that the process of participating in the service as an energy resource of the resource aggregator **13** has been executed.

(29) Thus, this charging and discharging management system **10** obtains permission from the user **15** and makes use of the electric vehicle **14** as an energy resource when the electric vehicle **14** is connected to the charging and discharging facility **12** that is provided in the city by the resource aggregator **13**. As a result, it is possible to make use of the electric vehicles **14** owned by the users **15** of the electric vehicles **14** that have not signed up for the service in advance as energy resources. The user **15** gives permission to the resource aggregator **13** to use the electric vehicle **14** as an energy resource (R**5**). In response to this, the resource aggregator **13** may distribute a profit earned from the use of the electric vehicle **14** as an energy resource to the user **15** (D**5**).

(30) The condition setting unit **14***c* is a processing unit that sets conditions for interchanging electric power. The condition setting unit **14***c* sets conditions for which the electric vehicle **14** interchanges electric power with the charging and discharging facility **12**. This enables the user **15** to set conditions under which the electric vehicle **14** is permitted to participate in the demand response service as an energy resource of the resource aggregator **13**. In this case as well, the condition setting unit **14***c* may be configured to be able to set conditions through the control screen panel of the electric vehicle **14** or through the control terminal **15***a* of the user **15**.

(31) The condition setting unit **14***c* may set at least a lower limit value of the electricity sales price (electricity purchase price for the resource aggregator **13**) that is applied when electric power is discharged from the electric vehicle **14** through the resource aggregator **13**. Setting the lower limit value of the electricity sales price applied when electric power is discharged from the electric vehicle **14** through the resource aggregator **13** allows the user **15** to permit the electric vehicle **14** to

participate as an energy resource of the resource aggregator **13**, and to sell electric power from the electric vehicle **14** when the electricity sales price is higher than a certain level. Also, the user **15** is allowed to prohibit the electric vehicle **14** from participating as an energy resource of the resource aggregator **13** and to limit the sales of electricity by the electric vehicle **14** when the electricity sales price is low. As a result, the user **15** is able to sell electricity from the electric vehicle **14** only when the price of electric power is high.

(32) On the other hand, the resource aggregator **13** may control the price of electricity so as to raise the electricity purchase price (the electricity sales price for the electric vehicle **14**) when the request for "downward DR" for reducing demand becomes higher in the demand response. In the case where at least the lower limit value of the electricity sales price applied when electric power is discharged from the electric vehicle **14** through the resource aggregator **13** is set in the condition setting unit **14***c*, raising the electricity purchase price by the resource aggregator **13** results in an increase in the number of electric vehicles **14** participating in the demand response service as the energy resources. This enables the resource aggregator **13** to attract more electric vehicles **14** to participate as the energy resources, to respond to the request for "downward DR" with discharging from the electric vehicles **14**, and to more easily deal with the demand response.

(33) It is also possible that the condition setting unit **14***c* may set a required amount of charge at which the user **15** wishes to store in the electric vehicle **14**, irrespective of the upper limit of the electricity sales price that is set herein. For example, when the user **15** wishes to keep at least about 60% state of charge of the full charge level for the electric vehicle **14**, the required amount of charge may be set to 60% of the full charge level (i.e., 60% SOC). In this case, the electric vehicle **14** is not permitted to participate as an energy resource of the resource aggregator **13**, for example, up to 60% of the full charge level irrespective of the electricity sales price, so that the sale of electricity electric vehicle **14** can be limited. As a result, the user **15** is able to obtain a sufficient amount of charge required for the electric vehicle **14**.

(34) The condition setting unit **14***c* may set at least the upper limit value of the electricity purchase price (electricity sales price for the resource aggregator **13**) that is applied when electric power is charged to the electric vehicle **14** through the resource aggregator **13**. Setting the upper limit value of the electricity purchase price applied when electric power is charged to the electric vehicle **14** through the resource aggregator **13** allows the user **15** to permit the electric vehicle **14** to participate as an energy resource of the resource aggregator **13**, and to purchase electric power by the electric vehicle **14** when the electricity purchase price is lower than a certain level. Also, the user **15** is allowed to prohibit the electric vehicle **14** from participating as an energy resource of the resource aggregator **13** and to limit the purchase of electricity by the electric vehicle **14** when the electricity purchase price is higher than a certain level. As a result, the user **15** is able to charge the electric vehicle **14** only when the price of electric power is low.

(35) On the other hand, the resource aggregator **13** may control the price of electricity so as to lower the electricity sales price (the electricity purchase price for the electric vehicle **14**) when the request for "upward DR" for increasing demand becomes higher in the demand response. In cases where at least the upper limit value of the electricity purchase price applied when electric power is charged to the electric vehicle **14** through the resource aggregator **13** is set in the condition setting unit **14***c*, lowering the electricity purchase price by the resource aggregator **13** results in an increase in the number of electric vehicles **14** participating in the demand response service as the energy resources. This enables the resource aggregator **13** to attract more electric vehicles **14** to participate as the energy resources, to respond to the request for "upward DR" with charging to the electric vehicles **14**, and to more easily deal with the demand response.

(36) It is also possible that the condition setting unit **14***c* may set a required amount of charge at which the user **15** wishes to store in the electric vehicle **14** irrespective of the upper limit of the electricity purchase price that is set herein. For example, when the user **15** wishes to keep at least about 60% state of charge of the full charge level for the electric vehicle **14**, the required amount of

charge may be set to 60% of the full charge level (i.e., 60% SOC). In this case, the electric vehicle **14** is permitted to be charged, for example, up to 60% of the full charge level irrespective of whether or not the electric vehicle **14** is allowed to participate as an energy resource of the resource aggregator **13**. As a result, the user **15** is able to obtain a sufficient amount of charge required for the electric vehicle **14**.

(37) A condition for the electric vehicle **14** to interchange electric power through the charging and discharging facility **12** may be, for example, an incentive distributed to the user **15** of the electric vehicle **14** according to the use of the electric vehicle **14** by the resource aggregator **13** as an energy resource, when the electric vehicle **14** is connected to the charging and discharging facility **12**. In this case, it is possible that, on the resource aggregator **13** side, the condition for interchanging electric power may be set so that, for example, the higher the request for demand response is higher, the greater the incentive distributed to the user. Setting the condition in this way increases the incentive distributed to the user **15** when the request for demand response is high. Accordingly, it is expected that this increases the number of users **15** who permit the resource aggregator **13** to use their electric vehicles **14** as energy resources. In addition, the resource aggregator **13** is allowed to use more electric vehicles **14** as energy resources when the request for demand response (DR) is high. Thus, the resource aggregator **13** can more easily respond to the request for demand response (DR), reducing the burden to operate the service.

(38) On the other hand, in the electric vehicle **14**, the conditions for interchanging electric power are set appropriately by the condition setting unit **14***c*. This allows the user **15** to permit the electric vehicle **14** to participate in the demand response operated by the resource aggregator **13** when the electricity purchase price is raised by the resource aggregator **13** or when the electricity sales price is lowered by the resource aggregator **13**. This allows the user **15** to sell and buy electric power at a price the user **15** considers appropriate, which provides benefit for the user **15**. Moreover, the user **15** is able to permit the electric vehicle **14** to participate in the demand response operated by the resource aggregator **13** at a time appropriate for the demand and supply adjustment that is performed when the electric power demand response is urgent, according to the price adjustment on the resource aggregator **13** side. Through the use of this charging and discharging management system **10**, the user **15** can also obtain the satisfaction of contributing to social responsibility of alleviating the urgently required electric power demand adjustment.

(39) It is described herein that the condition for interchanging electric power is set by the user **15** using the condition setting unit **14***c*, but it is also possible that the condition may not be set by user **15**. In this case, for example, the charging and discharging management system **10** may be configured so that the resource aggregator **13** is entrusted with control for interchanging electric power and the user **15** can obtain a compensation accordingly. The condition setting unit **14***c* may include a mode in which control for interchanging electric power is entrusted to the resource aggregator **13**. This enables the resource aggregator **13** to make use of the electric vehicle **14** as an energy resource as appropriate according to the demand response. The condition setting unit **14***c* may also be configured to be able to set a date and time at which the resource aggregator **13** is permitted to perform the control for interchanging electric power. For example, the condition setting unit **14***c* may be configured to reserve a day and a time slot in which it is desired to interchange electric power periodically. In this case, if the electric vehicle **14** is connected to the charging and discharging facility **12** on the reserved day or in the reserved time slot, electric power is interchanged in a predetermined mode according to the control performed by the resource aggregator **13**.

(40) In addition, the electric vehicle **14** may be configured to store records of sales and purchase of electricity in interchanging electric power. Storing records of sales and purchases of electricity in interchanging electric power allows the electric vehicle **14** to be configured to present the records of sales and purchases of electricity to the user **15**. From this viewpoint, the electric vehicle **14** may further include a recording unit **14***d* that stores records of sales and purchase of electricity when

electric power is interchanged with the charging and discharging facility **12** through the resource aggregator **13**. This enables the user **15** to check the interchanging of electric power when the electric vehicle **14** is used as an energy resource of the resource aggregator **13**.

(41) FIG. **3** is a schematic view schematically illustrating another embodiment of the charging and discharging management system **10**. As illustrated in FIG. **3**, the charging and discharging management system **10** may be configured to cause the charging and discharging facility **12** to execute the process in which the user **15** permits the electric vehicle **14** to participate in the demand response operated by the resource aggregator **13**.

(42) For example, the charging and discharging facility **12** may include a detecting unit **12***a* that detects that an electric vehicle **14** is connected thereto, and a selection process unit **12***b* configured to select whether or not to permit the charging and discharging facility **12** to interchange electric power with the electric vehicle **14** through the resource aggregator **13** when the electric vehicle **14** is connected thereto. In this case, the user **15** is able to select whether or not to permit interchange of electric power between the charging and discharging facility **12** and the electric vehicle **14** through the resource aggregator **13** by operating the charging and discharging facility **12**.

(43) The charging and discharging facility **12** may include a condition setting unit **12***c* that sets conditions for interchanging electric power. The condition setting unit **12***c* may be configured to set at least the lower limit value of the electricity sales price that is applied when electric power is discharged from the electric vehicle **14** through the resource aggregator **13**. The condition setting unit **12***c* may be configured to set at least the upper limit value of the electricity purchase price that is applied when electric power is charged to the electric vehicle **14** through the resource aggregator **13**. The condition setting unit **12***c* may be configured to be able to set a required amount of charge for the electric vehicle **14**. The condition setting unit **12***c* may include a mode in which control for interchanging electric power is entrusted to the resource aggregator **13**. The condition setting unit **12***c* may also be configured to be able to set a date and time at which the resource aggregator **13** is permitted to perform the control for interchanging electric power. The charging and discharging facility **12** may further include a recording unit **12***d* that stores records of sales and purchase of electricity when electric power is interchanged with the charging and discharging facility **14** through the resource aggregator **13**. This enables the user **15** to check the interchanging of electric power when the electric vehicle **14** is used as an energy resource of the resource aggregator **13**.

(44) Server **60**

(45) The charging and discharging management system **10** may include a server **60** as a computer that manages the system. The server **60** may be connected to a communication network NW. The communication network NW may be either a wired network or a wireless network, or may be a communication network such as the Internet or a communication network that uses power line communication utilizing the power grid. The server **60** is provided in, for example, a facility managed by the resource aggregator **13**. The server **60** may be configured to serve the function within the country through the communication network NW, but the server **60** itself may be located outside the country.

(46) Various processes of the charging and discharging management system **10** may be configured to be implemented by the server **60**. The server **60** may be implemented by either a single computer or a cooperative process of a plurality of computers. Various processes of the charging and discharging management system **10** may be implemented by a cooperative process of the server **60** with the control terminal **15***a* of the user **15**, the charging and discharging facility **12**, the computer of the electric vehicle **14**, and the like. The control terminal **15***a* of the user **15**, the charging and discharging facility **12**, the computer of the electric vehicle **14**, and the like may incorporate necessary corresponding software.

(47) In this embodiment, the server **60** includes a memory storage unit **61**, a detection unit **62**, a controller **63**, a notification unit **64**, and a condition storing unit **65**.

(48) The memory storage unit **61** is configured to associate electric vehicles and users respectively

with each other and store the associated information. More specifically, the memory storage unit **61** is configured to store vehicle information identifying electric vehicles and user information identifying users in association with each other. Herein, the vehicle information is information identifying the electric vehicle **14**. The user information is information identifying the user **15**. The vehicle information may be assigned, for example, an ID for identifying the electric vehicle **14**. For the vehicle information of the electric vehicle **14**, it is possible to adopt a vehicle registration number (number on the registration plate), for example. The user information may be assigned, for example, an ID for identifying the user **15**. The user information may be a terminal device information identifying the control terminal **15***a* operated by the user **15**, or may be a user ID provided by what is called a digital platform service provider. The server **60** may associate electric vehicles and users with each other by storing vehicle information and user information in association with each other.

(49) For example, the server **60** of the resource aggregator **13** may be configured to store the vehicle information of the electric vehicle **14** and the control terminal **15***a* of the user **15** in association with each other based on the information acquired from the user **15** when the user **15** uses the charging and discharging management system **10** provided by the resource aggregator **13** for the first time.

(50) The user information may include payment information used when a payment is made for sales and purchase of electricity. For example, the user information may be configured so that the user **15** can use the compensation obtained by the sales of electricity through the resource aggregator **13** when purchasing electric power through the resource aggregator **13** (i.e., when charging the electric vehicle **14**). In this case, for example, the user information may be configured to store the compensation obtained by the sales of electricity through the resource aggregator **13**, which will be offset when purchasing electric power through the resource aggregator **13** (i.e., charging the electric vehicle **14**). Alternatively, the user information may be configured so that the compensation obtained by the sales of electricity through the resource aggregator **13** can be exchanged with points that are commercially usable by the user. In this case, the user information may contain information that enables the user to exchange the compensation with commercially usable points. For the commercially usable points, it is possible to employ various types of points that are usable for cashless payments.

(51) The detection unit **62** is configured to detect that the electric vehicle **14** has been connected to the charging and discharging facility **12** through the communication network NW. For example, the server **60** of the resource aggregator **13** may be configured to cooperate with the charging and discharging facility **12** by power line communication, to detect that the electric vehicle **14** has been connected to the charging and discharging facility **12**. The charging and discharging facility **12** may incorporate a controller that operates according to a required program.

(52) The controller **63** is configured to start interchange of electric power between the charging and discharging facility **12** and the electric vehicle **14** through the resource aggregator **13**, based on the permission information acquired from the control terminal **15***a* of the user **15** through the communication network NW. In this case, the controller **63** of the server **60** starts interchange of electric power between the charging and discharging facility **12** and the electric vehicle **14** through the resource aggregator **13** when permission information acquired from the control terminal **15***a* of the user **15** is obtained. This prevents the electric vehicle **14** from being used as an energy resource of the resource aggregator **13** against the intention of the user **15**.

(53) Such a charging and discharging management system **10** enables the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12**. As a result, the user **15** is able to clearly indicate his/her intention on the interchange of electric power through the resource aggregator **13**. The resource aggregator **13** is allowed to clearly confirm the indication of intention of the user **15** who connects the electric vehicle **14** to the charging and discharging facility **12** by

the function of the server **60**, and also to store the indication of intention of the user **15** in the server **60**. The resource aggregator **13** is allowed to use the electric vehicle **14** as an energy resource based on such an intention of the user **15**. Thus, it is possible to confirm the intention of the user **15** more easily, making it easier to use the electric vehicle **14** as an energy resource reliably. As a result, the resource aggregator **13** is allowed to deal with the demand response that is required from the aggregation coordinator **11** more easily.

(54) The notification unit **64** is configured to notify that the electric vehicle **14** has been connected to the charging and discharging facility **12** to the control terminal **15***a* of the user **15** associated with the electric vehicle **14** connected to the charging and discharging facility **12**. Furthermore, the charging and discharging management system **10** is configured to start interchange of electric power between the charging and discharging facility **12** and the electric vehicle **14** through the resource aggregator **13**, based on the permission information acquired from the control terminal **15***a* of the user **15** after the notification from the notification unit **64**.

(55) For example, the charging and discharging management system **10** may be configured to cause the control terminal **15***a* of the user **15** to show a display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12**. In one specific example, when the detection unit **62** detects that the electric vehicle **14** is connected to the charging and discharging facility **12**, the notification unit **64** may send detection information to the control terminal **15***a* of the user **15** through the communication network NW. The control terminal **15***a* of the user **15** may be configured to show a display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13** based on the detection information acquired from the notification unit **64**.

(56) Furthermore, interchange of electric power may be started between the charging and discharging facility **12** and the electric vehicle **14** through the resource aggregator **13**, based on the permission information acquired from the control terminal **15***a* of the user **15** after the notification from the notification unit **64**. For example, in this embodiment, the charging and discharging management system **10** may be configured to cause the control terminal **15***a* of the user **15** to show a display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12**. The charging and discharging management system **10** may be configured so that, when the user **15** selects to permit interchange of electric power through the resource aggregator **13** using the control terminal **15***a*, required permission information is transmitted to the server **60** of the resource aggregator **13** through the communication network NW. The server **60** starts interchange of electric power between the charging and discharging facility **12** and the electric vehicle **14** through the resource aggregator **13** based on the permission information that permits interchange of electric power through the resource aggregator **13**. In this case, a control signal for controlling such interchange of electric power may be transmitted from the server **60** to the charging and discharging facility **12**.

(57) The condition storing unit **65** stores conditions for interchanging electric power between the charging and discharging facility **12** and the electric vehicle **14** through the resource aggregator **13**, the conditions being associated with the electric vehicle **14** or the user **15**. For the conditions for interchanging electric power, it is possible to set at least the lower limit value of the electricity sales price (electricity purchase price for the resource aggregator **13**) that is applied when electric power is discharged from the electric vehicle **14** through the resource aggregator **13**. For the conditions for interchanging electric power, it is also possible to set at least the upper limit value of the electricity purchase price (electricity sales price for the resource aggregator **13**) that is applied when electric power is charged to the electric vehicle **14** through the resource aggregator **13**. It is also possible for the conditions for interchanging electric power to set a required amount of charge at which the user **15** wishes to store in the electric vehicle **14** irrespective of the electricity sales price or the

electricity purchase price. Such conditions for interchanging electric power as described above may be set for each user **15** or each electric vehicle **14**. The conditions for interchanging electric power may be associated with the vehicle information identifying the electric vehicles **14** and the user information identifying the users **15** and be stored in the condition storing unit **65**.

(58) It is also possible that the user **15** may entirely entrust the resource aggregator **13** with setting the conditions for interchanging electric power and entrust the control. It is also possible to set the date and time (day and time slot) at which electric power is permitted to be interchanged with the resource aggregator **13**. In this case, the resource aggregator **13** may identify the usage of the electric vehicles **14** by the users **15** and manage the information with the server **60**. The usage of the electric vehicle **14** by the user **15** may be, for example, the past usage of the electric vehicle **14** by month, by day, or by hour. By acquiring these pieces of information, the resource aggregator **13** is able to judge an appropriate amount of charge required, to determine the amount of electric power to be interchanged with the electric vehicle **14**.

(59) In addition, the server **60** may be configured to record the amount and price of electricity charged and sold to the electric vehicle **14** and the amount and price of electricity purchased from the electric vehicle **14**. The server **60** may also be configured to obtain the balance of the amount and price of electricity charged and sold to the electric vehicle **14** and the amount and price of electricity purchased from the electric vehicle **14** within a predetermined period. By using this, the server **60** may manage the past balance of the amount and unit price of electricity charged and the amount and unit price of electricity purchased. The server **60** may be configured to present the income and expenditure within a designated period in response to the request from the user **15**.

(60) The server **60** may be configured to store the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15**. In this case, the server **60** may store such a compensation in association with the electric vehicle **14** or the user **15**. The compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** may be configured to be able to be used for the purchase of electricity by the electric vehicle **14** or the user **15**. This makes it possible to pay the compensation obtained by the sale of electricity from the electric vehicle **14** or the user **15** at the time of the purchase of electricity, not by cash or a bank transfer. As a result, the profit can be distributed to the user **15** without making an exchange of monetary compensation. Also in this case, the distribution of profit is made within the bounds of the service provided by the resource aggregator **13**. Normally, the electric vehicle **14** consumes electric power through driving. For this reason, from a long-term viewpoint, it is expected that the compensation obtained by the sale of electricity from the electric vehicle **14** or the user **15** does not exceed the compensation obtained by the purchase of electricity. This means that, in the management of the compensation obtained by the sale of electricity from the electric vehicle **14** or the user **15**, the resource aggregator **13** is able to offset the compensation against the purchase of electricity made by the electric vehicle **14** or the user **15**, so that the process of paying money from the resource aggregator **13** to the user **15** is unnecessary. This enables easy management for the resource aggregator **13**.

(61) The server **60** may be configured so that the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** is exchanged with points that can be commercially used by the user **15**. The commercially usable points include digital currency, affiliated points that are usable at various kinds of stores, and the like. The compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** may be configured to be exchangeable with commercially usable points. In this case as well, the process of paying money from the resource aggregator **13** to the user **15** is unnecessary. This enables easy management for the resource aggregator **13**. Moreover, the user **15** is able to use the compensation a greater variety of ways and therefore gain benefits more easily.

Program

(62) Herein, a program **80** is the software that is embedded in the control terminal **15***a* of the user **15** so that the control terminal **15***a* of the user **15** can serve required functions. In order to

accomplish the charging and discharging management system **10** as described above, appropriate software may be embedded in the control terminal **15***a* of the user **15**. The control terminal **15***a* of the user **15** includes a computer incorporated in the electric vehicle **14**. For example, the control terminal **15***a* may be one that allows the user **15** to perform required operations through a control screen panel of the electric vehicle **14**. The control terminal **15***a* of the user **15** includes a computer incorporated in the charging and discharging facility **12**. For example, the control terminal **15***a* may be one that allows the user **15** to perform required operations through a control screen panel provided for the charging and discharging facility **12**. The above-described program **80** may be configured to be distributed through the communication network NW so as to be installed in the control terminal **15***a* of the user **15**. The program **80** may be distributed from the server **60** or may be provided through a website that is dedicated to providing software to the control terminal **15***a* of the user **15**. The program **80** may be configured to be updated as appropriate to the latest software. The program **80** may be embedded in a mobile terminal of the user **15**, a computer incorporated in the electric vehicle **14**, a computer incorporated in the charging and discharging facility **12**, or the like, each of which can serve as the control terminal **15***a* of the user **15** as described above. The program **80** may be programmed according to the control terminal **15***a* of the user **15**. The program **80** may be stored in, for example, a non-transitory computer readable medium. Examples of the non-transitory computer readable medium include magnetic recording media (such as flexible disks, magnetic tapes, and hard disk drives) and CD-ROMs.

(63) Herein, the program **80** may be configured to cause the control terminal **15***a* of the user **15** to serve the functions of selecting whether or not to permit interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12** and transmitting the result of the selection to a predetermined server **60**. The program **80** may cause the control terminal **15***a* of the user **15** to function to show a display screen for selecting whether or not to permit interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12**. For example, the program **80** may cause the control terminal **15***a* of the user **15** to be equipped with a selecting unit **81** as a processing module that serves such a function. The selecting unit **81** may be configured to be able to select whether or not to permit interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12**. In addition, the program **80** may implement a communication unit **82** that mutually communicates required information with the server **60**. The communication unit **82** may be configured to transmit the result of selection by the user **15** to the server **60**.

(64) Herein, the control terminal **15***a* of the user **15** may be a mobile communication terminal of the user **15** that is communicable with the electric vehicle **14**, such as a smartphone. When this is the case, the information indicating that the electric vehicle **14** has been connected to the charging and discharging facility **12** may be acquired from the electric vehicle **14**. For example, in the case where a charging station as the charging and discharging facility **12** is provided in a parking space and the connection between the electric vehicle **14** and the charging and discharging facility **12** is completed when a connector plug of the charging station is connected to the electric vehicle **14**, the user **15** is already off the electric vehicle **14**. In such a case, it is believed convenient for the user **15** that the mobile communication terminal of the user **15** shows a display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13**. Thus, the control terminal **15***a* of the user **15** may be a mobile communication terminal of the user **15**. It is also possible that the control terminal **15***a* of the user **15** may be provided in the charging and discharging facility **12**. For example, it is also possible that the display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator

13 may be configured to be shown on a control screen panel of the charging and discharging facility **12**. This enables the user **15** to operate the control screen panel of the charging and discharging facility **12** after the user **15** has got off the vehicle, which is believed to be convenient for the user **15**.

(65) Alternatively, it is also possible that a control screen panel of the electric vehicle **14** may be configured to show a display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13**. For example, the charging and discharging facility **12** may be a non-contact charging facility buried in a parking space. In this case, the user **15** may move the electric vehicle **14** to a space above the non-contact charging facility, and the electric vehicle **14** is connected to the charging and discharging facility **12** while the user **15** stays on board the electric vehicle **14**. It is convenient for the user **15** when the control screen panel of the electric vehicle **14** shows a display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13**. The program **80** may be configured to prompt the user **15** to perform a selection operation before the user **15** gets off the vehicle. Thus, the control terminal **15***a* of the user **15** may be provided in the electric vehicle **14**. In this case, the program **80** may be configured to cause the control screen panel of the electric vehicle **14** to show a display screen allowing the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13** when the electric vehicle **14** is connected to the charging and discharging facility **12**.

(66) Thus, the program **80** may be configured to allow the user **15** to select whether or not to permit interchange of electric power through the resource aggregator **13**, with the use of the control terminal **15***a* of the user **15**, such as a mobile communication terminal of the user **15** and a control terminal provided in the electric vehicle **14** or the charging and discharging facility **12**. The program **80** may be embedded in the mobile communication terminal of the user **15**, or may be embedded in a computer of the electric vehicle **14** or the charging and discharging facility **12**. The program **80** may cause the mobile communication terminal of the user **15**, or the control terminal of the electric vehicle **14** or the charging and discharging facility **12**, to serve required functions.

(67) The program **80** may further cause the control terminal **15***a* of the user **15** to function to set conditions for permitting interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13**. For example, the program **80** may cause the control terminal **15***a* of the user **15** to be equipped with a condition setting unit **83** as a processing module that serves such a function. In this case, the condition setting unit **83** may also be configured to be able to arbitrarily set conditions for permitting interchange of electric power through the resource aggregator **13**. The program **80** may further cause, for example, the control terminal **15***a* of the user **15** to function to show a display screen for setting conditions for permitting interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13**. For the conditions for permitting interchange of electric power through the resource aggregator **13**, it is also possible to prepare several patterns in advance. The control terminal **15***a* of the user **15** may be configured to be able to select a condition for permitting interchange of electric power through the resource aggregator **13** from the prepared patterns of conditions.

(68) The program **80** may further cause the control terminal **15***a* of the user **15** to function to store conditions for permitting interchange of electric power between the electric vehicle **14** and the charging and discharging facility **12** through the resource aggregator **13**. For example, the program **80** may cause the control terminal **15***a* of the user **15** to be equipped with a condition storing unit **84** as a processing module that serves such a function. In this case, the control terminal **15***a* of the user **15** stores the conditions for permitting interchange of electric power through the resource aggregator **13**, making it unnecessary to set the conditions every time. In addition, it is easy for the user **15** to reuse or reset the conditions. Therefore, this is convenient when repeatedly using the services provided by the charging and discharging management system **10**, such as when

permitting interchange of electric power through the resource aggregator **13**. Moreover, the user **15** is able to check the conditions for permitting interchange of electric power through the resource aggregator **13** with the use of the control terminal **15***a* even in an environment that is not connected to the server **60**.

(69) The program **80** may be configured to cause the control terminal **15***a* of the user **15** to store the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15**. For example, the program **80** may cause the control terminal **15***a* of the user **15** to be equipped with a compensation storing unit **85** as a processing module that serves such a function. This makes it possible to check the compensation obtained by the sale of electricity from the electric vehicle **14** or the user **15** with the control terminal **15***a* of the user **15** at an appropriate time. As a result, the user **15** can easily confirm the benefit of interchanging electric power through the resource aggregator **13**. Accordingly, it is more likely to produce a motivation to permit interchange of electric power through the resource aggregator **13**. The program **80** may be configured so that the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** is obtained by communication with the server **60** of the resource aggregator **13**.

(70) The program **80** may be configured to cause the control terminal **15***a* of the user **15** to function so as to use the compensation obtained by the sale of electricity from the electric vehicle **14** or the user **15** for the purchase of electricity by the electric vehicle **14** or the user **15**. For example, the program **80** may be configured to allow the user **15** to select to use the compensation obtained by the sale of electricity from the electric vehicle **14** or the user **15** for the purchase of electricity by the user **15**, as a condition for permitting interchange of electric power through the resource aggregator **13**. For example, when the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** is offset by the purchase of electricity by the user **15**, that information may be processed by the server **60** of the resource aggregator **13**. Even in such cases where the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** is offset by the purchase of electricity by the user **15**, the program **80** may be configured to allow the user **15** to check the information on the offset.

(71) The program **80** may be configured so that the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** is exchanged with points that can be commercially used by the user **15**. For example, when the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** is exchanged with points that can be commercially used by the user **15**, that information may be processed by the server **60** of the resource aggregator **13**. The program **80** may be configured so that when the compensation obtained by the sales of electricity from the electric vehicle **14** or the user **15** is exchanged with commercially usable points, the information indicating that exchange or the like can be checked with the use of the control terminal **15***a* of the user **15**. This allows the user **15** to perceive the benefit of the sales of electricity easily, and to have a motivation to permit interchange of electric power through the resource aggregator **13** easily.

(72) In the case where the compensation is used for a purchase of electricity or exchanged with points that can be commercially used by the user **15** as described above, that information may be stored in the control terminal **15***a* of the user **15**. For example, the program **80** may cause the control terminal **15***a* of the user **15** to be equipped with a compensation processing unit **86** as a processing module that serves such a function.

(73) In addition, the program **80** may cause the control terminal **15***a* of the user **15** to function so as to display the records of the amount and price of electricity charged and sold to the electric vehicle and the amount and price of electricity purchased from the electric vehicle. Also, the program **80** may cause the control terminal **15***a* of the user **15** to function so as to display the income and expenditure of the amount and price of electricity charged and sold to the electric vehicle and the amount and price of electricity purchased from the electric vehicle within a predetermined period. When this is the case, the predetermined period for displaying the income and expenditure may be

specified by the user **15**. The program **80** may be configured to cause the control terminal **15***a* of the user **15** in cooperation with the server **60** to display the records and balance of the amount and price of electricity charged and sold to the electric vehicle and the amount and price of electricity purchased from the electric vehicle. This allows the user **15** to easily check the records and balance of the amount and price of electricity charged and sold to the electric vehicle and the amount and price of electricity purchased from the electric vehicle. Moreover, according to these data, the user **15** may receive a proposal from the resource aggregator **13** about advice for future improvement of the balance. The server **60** may include an AI processing unit capable of providing the user **15** with advice for future improvement of the balance based on the big data of the records and balance of the amount and price of electricity charged and sold to the electric vehicle and the amount and price of electricity purchased from the electric vehicle.

(74) The resource aggregator **13** may be configured to cause the server **60** to acquire the battery capacity and deterioration condition of the electric vehicle **14**. When a plurality of electric vehicles **14** are available for use as the energy resources, the server **60** may be configured to select and use a more appropriate electric vehicle **14**. This enables a more stable service operation.

(75) Various embodiments of the invention have been described hereinabove according to the present disclosure. Unless specifically stated otherwise, the embodiments described herein do not limit the scope of the present disclosure. It should be noted that various other modifications and alterations may be possible in the embodiments of the present disclosure. In addition, the features, structures, or steps described herein may be omitted as appropriate, or may be combined in any suitable combinations, unless specifically stated otherwise.

Claims

1. An electric vehicle comprising: a detector configured to detect whether the electric vehicle is connected to a charging and discharging facility; a computer configured to select whether to permit the electric vehicle, in response to being connected to the charging and discharging facility, to interchange electric power with the charging and discharging facility based on commands from a resource aggregator, wherein the computer is mounted in the electric vehicle; and a battery configured to interchange the electric power with the charging and discharging facility in response to a determination to permit interchanging of the electric power with the charging and discharging facility by the computer, wherein the computer is configured to receive conditions for interchanging electric power, the conditions comprise a minimum state of charge of the battery, and the computer is configured to not permit discharging of the battery in response to the condition of the minimum state of charge of the battery failing to be satisfied, wherein the conditions include both the minimum state of charge of the battery and a sale price of electricity to the resource aggregator, wherein the computer is configured to set at least a lower limit value of an electricity sales price applied when electric power is discharged from the electric vehicle through management server managed by the resource aggregator.

2. The electric vehicle according to claim 1, wherein the computer is configured to set a required amount of charge.

3. The electric vehicle according to claim 1, wherein the computer includes a mode in which control for interchanging electric power is entrusted to the management server managed by the resource aggregator.

4. The electric vehicle according to claim 1, wherein the computer is configured to be able to set a date and time at which the management server managed by the resource aggregator is permitted to perform control for interchanging electric power.

5. The electric vehicle according to claim 1, further comprising a memory that stores records of sales and purchase of electricity when electric power is interchanged with the charging and discharging facility through the management server managed by the resource aggregator.

6. The electric vehicle according to claim 1, further comprising a display screen, wherein the computer is configured to cause the display screen to automatically show a request to permit interchange of the electric power in response to the electric vehicle being connected to the charging and discharging facility.

7. An electric vehicle comprising: a detector configured to detect whether the electric vehicle is connected to a charging and discharging facility; a computer configured to select whether to permit the electric vehicle, in response to being connected to the charging and discharging facility, to interchange electric power with the charging and discharging facility based on commands from a resource aggregator, wherein the computer is mounted in the electric vehicle; and a battery configured to interchange the electric power with the charging and discharging facility in response to a determination to permit interchanging of the electric power with the charging and discharging facility by the computer, wherein the computer is configured to receive conditions for interchanging electric power, the conditions comprise a minimum state of charge of the battery, and the computer is configured to not permit discharging of the battery in response to the condition of the minimum state of charge of the battery failing to be satisfied, wherein the conditions include both the minimum state of charge of the battery and a sale price of electricity to the resource aggregator, wherein the computer is configured to set at least an upper limit value of an electricity purchase price applied when electric power is charged to the electric vehicle through management server managed by the resource aggregator.