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(54) Title: METHOD AND SYSTEM FOR REVENUE GENERATION USING AN ENERGY SYSTEM

(57) Abstract: A method and system for determining compensation to be paid for using any one of, an energy storage system and an energy system (100) is provided. The energy system is at least partially powered by electricity stored in the energy storage system (100). The method includes, determining amount of consumption of electric energy from the energy storage system (102) during a period of usage. Additionally, carbon credit associated with the energy storage system or the energy system during the period of usage is determined. Thereafter, the compensation is calculated based on the amount of consumption of the electric energy and the carbon credit.
DISCLOSURE

This disclosure relates to energy systems which are at least partially powered by electricity and, more particularly but not exclusively, to determining compensation for use of energy systems which are at least partially powered by electricity.

BACKGROUND

Energy systems which are at least partially powered by electricity include, but are not limited to, electric vehicles, hybrid vehicles and uninterrupted power supply systems. Such energy systems generally include an energy storage system (ESS) which is capable of storing electric energy and an energy consumption system (ECS) which is capable of consuming energy stored in the ESS. The energy systems also include an energy management system (EMS) which is generally configured to manage electric energy associated with the ESS and ECS. Such energy systems can be leased.

One method of charging the lessee includes determining the duration for which the energy system is leased and charging the lessee based on the duration.

Another method of charging the lessee includes determining an amount of electricity stored in the ESS when the energy system is given out on lease and, thereafter, determining the amount of electricity stored in the ESS at the completion of the lease.
The lessee is charged based on the amount of electricity consumed during the period of lease.

[005] Certain existing methods of leasing energy systems, only the duration of lease and the consumption of energy while the energy system is leased are considered. Certain existing methods may ignore some of the factors that may affect the cost incurred by the leaser by leasing the energy systems. Further, existing methods may not motivate the leasee to be eco friendly when the lessee uses the energy system.

STATEMENT OF INVENTION

[006] Accordingly, an embodiment provides a method for determining compensation to be paid upon taking an energy storage system or an energy system on lease, wherein the energy system is at least partially powered by electricity stored in the energy storage system. The method includes determining amount of consumption of electric energy from the energy storage system during the lease; determining a carbon credit associated with the energy storage system or the energy system during the lease; and calculating the compensation based on the amount of consumption of the electric energy and the carbon credit.

[007] There is also provided a system for determining compensation to be paid upon leasing an energy storage system or an energy system, wherein the energy system is at least partially powered by electricity stored in the energy storage system. The system includes an energy management system and a data processing system configured to determine an amount of consumption of electric energy from the energy storage system during the lease; determine a carbon credit associated with the energy storage system or
the energy system during the lease; and calculate the compensation based on the amount of consumption of the electric energy and the carbon credit.

[008] These and other aspects of the embodiments disclosed herein will be better appreciated and understood when considered in conjunction with the following description and the accompanying drawings. It should be understood, however, that the following descriptions, while indicating preferred embodiments and numerous specific details thereof, are given by way of illustration and not of limitation. Many changes and modifications may be made within the scope of the embodiments disclosed herein without departing from the spirit thereof, and the embodiments disclosed herein include all such modifications.

BRIEF DESCRIPTION OF FIGURES

[009] Embodiments illustrated in the accompanying drawings, throughout which like reference letters indicate corresponding parts in the various figures. The embodiments disclosed herein will be better understood from the following description with reference to the drawings, in which:

[0010] FIG. 1 illustrates an energy system 100, in accordance with an embodiment;

[0011] FIG. 2 is a flow chart illustrating a method for determining compensation to be paid upon taking an energy system on lease, in accordance with an embodiment; and

[0012] FIG. 3 is a flow chart illustrating a method for determining compensation to be paid upon taking an energy system on lease, in accordance with an embodiment.
DETAILED DESCRIPTION

The embodiments disclosed herein and the various features and advantageous details thereof are explained more fully with reference to the non-limiting embodiments that are illustrated in the accompanying drawings and detailed in the following description. Descriptions of well-known components and processing techniques may be omitted so as to not unnecessarily obscure the embodiments disclosed herein. The examples used herein are intended merely to facilitate an understanding of ways in which the embodiments disclosed herein may be practiced and to further enable those of skill in the art to practice the embodiments disclosed herein. Accordingly, the examples should not be construed as limiting the scope of the embodiments disclosed herein.

The embodiments disclosed herein enable determining compensation to be paid for use of an energy storage system or an energy system (for example, upon taking the energy system on lease). Referring now to the drawings, and more particularly to FIGS. 1 through 3, where similar reference characters denote corresponding features consistently throughout the figures, there are shown preferred embodiments.

ENERGY SYSTEM

FIG. 1 illustrates an energy system 100 in accordance with an embodiment. The energy system 100 is a system which is at least partially powered by electricity, such as an electric vehicle, a hybrid vehicle, an uninterruptible power supply system, or another system. The energy system 100 includes an energy storage system (ESS) 102, an energy consumption system (ECS) 104 and an energy management system (EMS) 106.
The ESS 102 is capable of storing electric energy and provides the electric energy for consumption. The ESS 102 can be recharged to replenish the consumed electric energy. Examples of an ESS 102 include, but are not limited to, a lead-acid battery system, a gel battery system, a lithium ion battery system, a lithium ion polymer battery system, a NaS battery system, a nickel-iron battery system, a nickel metal hydride battery system, a nickel-cadmium battery system, capacitors, other energy storage systems, or a combination of systems. At least a portion of the electric energy stored in the ESS 102 can be at least partially consumed by the ECS 104.

The ECS 104 can comprise subsystems which at least partially consume energy stored in the ESS 102. The subsystems of the ECS 104 can be one or more of a drive train, a motor controller, a cabin climate control, a subsystem climate control, a charging system, a dashboard display, a car access system, a drive motor, a seat climate control, a cabin HVAC, an add-on heating system, a battery heater, a battery ventilation, an on board charger, a safety system, a crash sensor, a sensing system, a temperature sensor, a fluid level sensor, and a pressure sensor, among others. The consumption of energy stored in the ESS 102 by the ECS 104 is managed by the EMS 106. Additionally, the dissipation of energy and storage of energy in the ESS 102 can be managed by the EMS 106. In some embodiments, at least some of the energy stored in the ESS 102 is electric energy.

The EMS 106 can include components configured to perform one or more of the following functions: managing the distribution of energy stored in the ESS 102, receiving instructions for the managing the distribution of energy, and providing information about the distribution of energy. In some embodiments, the EMS 106
comprises a processor, a memory device, an input and output (I/O) device and a signal transmitting and receiving device. The processor can be configured to receive and process data obtained from the I/O device, the signal transmitting and receiving device, and the memory device. Further, the processor can be configured to send data to the memory device for storage. Additionally, the processor can be configured to send commands to the I/O device, which can communicate the commands to devices associated with the I/O device. Further, the processor can be configured to send data to the signal transmitting and receiving device for transmitting the data to remote locations.

The processor can include, for example, a general-purpose microprocessor, an application-specific integrated circuit, a field-programmable gate array, another device capable of manipulating data, or a combination of devices. In an embodiment, the processor is made of electronic circuits comprising commercially available general purpose microcontroller chips. The memory device may comprise a combination of volatile and non-volatile memory chips that can store information in digital form. The I/O device can comprise sets of output lines, each of which is individually connected to the processor. These output lines may include analog inputs, analog outputs, digital inputs, digital outputs, pulse/frequency outputs and data lines, or a combination of line types. The data lines can be connected to the external world through the signal transmitting and receiving device.

[0019] The EMS 106 can be configured to transmit data to remote locations and receive data from remote locations. In some embodiments, the EMS 106 communicates with one or more data processing systems (DPS), which can be located at any location, including one or more remote locations. The DPS can include one or more memory
devices connected to one or more processing units. The one or more processing units can include, for example, a general-purpose microprocessor, an application-specific integrated circuit, a field-programmable gate array, another device capable of manipulating data, or a combination of devices. In certain embodiments, at least some of the one or more memory devices are integrated with at least one of the processing units. In an embodiment, a DPS is a dedicated computer capable of wirelessly communicating over a telecommunication network, hi other embodiments, the DPS may be a discrete set of components that perform the functions of a DPS as described herein.

METHOD FOR DETERMINING COMPENSATION

[0020] Various methods for compensating the owner of an energy system 100 for use of the energy system 100 are possible. Factors that can be considered in determining compensation include energy usage, the duration of use, carbon credit usage, the location(s) of use, other usage metrics, or a combination of factors. Certain embodiments of methods for determining compensation for use of the energy system 100 will be discussed with reference to the figures. The patentability of any of the disclosed embodiments may lie in a combination of fewer than all of the features or steps disclosed. Thus, any feature, step, or factor can be removed or omitted from disclosed embodiments, and the resulting methods are within the scope of this disclosure. While some methods may be described in the context of a lease of an energy system 100, the disclosed methods can be applied in the context of any other temporary or long-term use arrangements for the energy system 100.

[0021] It may be further noted that either the ESS 102 can be leased out individually, as against leasing out the energy system 100, which includes the ESS 102.
Additionally, in some embodiments the ESS 102 can have a management system that is configured to communicate and be managed by the EMS 106 that may be located at a remote location with respect to the ESS 102.

[0022] FIG. 2 is a flow chart illustrating a method for determining compensation to be paid for the use of an energy storage system or an energy system, in accordance with an embodiment. The method includes, at step 202, determining an amount of consumption of electric energy from the ESS 102 while the ESS 102 or the energy system 100 is used (for example, while the energy system 100 is on lease). In an embodiment, an amount of electric energy consumed is determined by determining the state of charge (SOC) of the ESS 102 at the beginning of the period of use and the SOC of the ESS 102 at the end of the period of use. The SOC of the ESS 102 can be determined by the processor of the EMS 106 using data collected from the ESS 102. Thereafter, a difference in the SOC of the ESS 102 at the beginning of the period of use and the SOC of the ESS 102 at the end of the period of use is determined, thereby determining the electric energy consumed during the period of use (for example, during the term of a lease). In an embodiment, the processor of the EMS 106 determines the electric energy consumed while the ESS 102 or the energy system 100 is used by using data corresponding to the SOC of the ESS 102 at the beginning of use and at the end of use. In an embodiment, the EMS 106 transmits data corresponding to the energy consumed to the DPS through the communication network. Alternatively, the EMS 106 transmits data corresponding to the SOC of the ESS 102 at the beginning and at the end of the period of use to the DPS. The DPS can use the data transmitted by the EMS 106 to determine the electric energy consumed while the ESS 102 or the energy system 100 is
used. In an embodiment where the ESS 102 is recharged while on lease, the amount of electric energy replenished into the ESS 102 from the recharge can also be considered in determining the amount of consumption of electric energy.

[0023] In addition to determining the amount of consumption of electric energy, the carbon credit associated with the ESS 102 or the energy system 100 can be determined at step 204. In an embodiment, the carbon credit associated with the ESS 102 or the energy system 100 is based on the source of electric energy that is used to recharge the ESS 102. In an embodiment, fewer carbon credits are required if the ESS 102 is recharged using a source which provides electricity generated from comparatively lesser polluting techniques as compared to a source which provides electricity generated from comparatively more polluting techniques. Hence, the source from which the ESS 102 is recharged is considered to determine the carbon credit associated with the ESS 102 or the energy system 100. In an embodiment, when the ESS 102 is being charged, the EMS 106 identifies the source from which the ESS 102 is being recharged. Further, the EMS 106 can determine the carbon credit obtained by using the source. In an embodiment, the EMS 106 transmits data corresponding to the source to the DPS. The DPS can use the data transmitted by the EMS 106 to determine the carbon credit associated with the energy system 100.

[0024] In an embodiment, the carbon credit associated with the ESS 102 or the energy system 100 can also depend on the efficiency at which the ESS 102 or the energy system 100 is utilized. For example, fewer carbon credits may be required if the energy system 100 is utilized efficiently.
Subsequent to determination of the carbon credits associated with the ESS 102 or the energy system 100 and the amount of electric energy consumption, one or both of the carbon credits and the energy consumption can be used to calculate the compensation to be paid for use of the ESS 102 or the energy system 100, at step 206. In an embodiment, the compensation is calculated by increasing the compensation proportionally with the increase in the amount of electric energy consumed and increase in the carbon credit utilized. Further, the compensation may be reduced as a result of any carbon credit obtained during the period of use. For example, as discussed above, carbon credits may accrue due to usage of a recharging source which provides electricity generated from a lesser polluting electricity generation technique.

The various actions in the above method may be performed in the order presented, in a different order, or simultaneously. Further, in some embodiments, some actions listed in FIG. 2 may be omitted.

In an embodiment, the duration for which the ESS 102 or the energy system 100 is used is determined. Thereafter, the based on the duration, the compensation is determined. In an embodiment, the compensation is determined by increasing the compensation with an increase in the duration for which the ESS 102 or the energy system 100 is used. The compensation to the owner of the ESS 102 or the energy system 100 can be determined by considering the duration of time for which the ESS 102 or the energy system 100 is used, the amount of electric energy consumed while the ESS 102 or the energy system 100 is used, and/or the carbon credit associated with use of the ESS 102 or the energy system 100.
In an embodiment, the steps of determining the amount of consumption of electric energy from the energy storage system during its use, determining the carbon credit associated with use of the ESS 102 or the energy system, and calculating the compensation based on the consumption of the electric energy and the carbon credit are performed by the EMS 106. The data relating to the compensation that is computed can be sent to the DPS, which can be located in a remote location.

In another embodiment, the EMS 106 provides data relating to the SOC of the ESS 102 and the source used for charging the ESS 102 to the DPS. The DPS can be configured to use this data to determine the amount of consumption of electric energy from the energy storage system during the period of use, to determine the carbon credit associated with the use of the ESS 102 or the energy system, and to calculate the compensation based on the consumption of the electric energy and the carbon credit. In an embodiment, the EMS 102 and DPS share the steps involved in calculating the compensation.

In an embodiment, the DPS receives data from the EMS corresponding to a fleet of ESSs or the energy systems. For example, the energy systems may be a fleet of electric cars owned or operated by a service provider who offers cars for use (example: on lease or on other terms for temporary or long-term use). The DPS may be configured to receive data from EMS corresponding to each car in the fleet of cars. The DPS, in addition to determining the compensation to be paid when any of the car from the fleet of cars is used, can also determine the carbon credit associated with the car. Further, the DPS can be configured to determine the efficiency with which each of the cars in the fleet is being used. For example, the DPS can be configured to evaluate differences among the
carbon credits associated with different cars in a fleet of cars or differences among the carbon credits associated with different fleets of cars. Information derived from such an evaluation may be used in determining the efficiency with which the cars are being used, in calculating the compensation due for use of the cars, or for other purposes.

EXAMPLE

[0031] FIG. 3 is a flow chart illustrating a method for determining compensation to be paid upon taking an energy system on lease, in accordance with an embodiment, of an embodiment, the energy system 100 which is leased is an electric vehicle (EV). When the EV is given on lease, at step 302 the SOC of the ESS 102 in the EV is determined by the EMS 106. The SOC of the ESS 102 is stored in the EMS 106. Thereafter, at the completion of lease, at step 304, the SOC of the ESS 102 is determined. The difference in the SOC of the ESS 102 at the beginning and at the end of the lease is the amount of electric energy consumed while the EV was on lease. The amount of energy consumed while the EV was on lease is used for computing compensation. Further at step 310, it is checked whether the ESS 102 is recharged while the EV is on lease, the amount of electric energy replenished in the ESS 102 is considered to determine the amount of electric energy consumed while the EV was on lease. Additionally, if the ESS 102 is recharged, information relating to the source of electricity which is used for recharging is collected. The information is used to determine the carbon credit associated with the EV at step 312. Further, if carbon credit is obtained as a result of the source of electricity used for recharging, a discount on the compensation can be offered to the lessee. Further, it is checked at step 316 whether duration of the lease is to be considered in determining the compensation. If the duration is to be considered, then the duration along with other
parameters may be considered while determining the compensation. Further, it is checked at step 320 whether the distance travelled in the EV while in lease is to be considered while determining the compensation. If the distance travelled is to be considered, then the distance travelled along with other parameters may be considered for determining the compensation. Subsequently, at step 324, the compensation is computed using the desired parameters.

[0032] The various actions in the above method may be performed in the order presented, in a different order or simultaneously. Further, in some embodiments, some actions listed in FIG. 3 may be omitted.

[0033] The embodiments disclosed herein can be implemented through at least one software program running on at least one hardware device and performing network management functions to control the network elements.

[0034] The embodiments disclosed herein include methods and systems for determining compensation to be paid for use of an energy system (for example, upon taking an energy system on lease). Therefore, it is understood that the embodiments disclosed include a program and a computer readable medium having data stored therein. The computer readable medium can contain program code for implementing one or more steps of the disclosed methods. The disclosed embodiments also include a server or any suitable programmable device configured to execute that program code. One or more of the disclosed methods can be implemented through or together with a software program written in, e.g., very high speed integrated circuit hardware description language (VHDL) or another programming language. Further, the disclosed methods can be implemented by one or more software modules being executed on at least one hardware device. The at
least one hardware device can include any kind of portable device that can be programmed. The at least one hardware device may also include devices that can be programmed (e.g., a hardware device like an ASIC, a combination of hardware and software devices, such as an ASIC and an FPGA, or at least one microprocessor and at least one memory with software modules located therein). The methods described herein can be implemented partly in hardware and partly in software. Alternatively, embodiments may be implemented on different hardware devices, e.g. using a plurality of CPUs.

[0035] The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments disclosed herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments disclosed herein have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments disclosed herein can be practiced with modification within the spirit and scope of the embodiments as described herein.
We Claim:

1. A method for determining compensation to be paid for using any one of, an energy storage system and an energy system, wherein the energy system is at least partially powered by electricity stored in the energy storage system, the method comprising:
   - determining an amount of consumption of electric energy from the energy storage system during a period of usage;
   - determining a carbon credit associated with the energy storage system or the energy system during the period of usage; and
   - calculating the compensation based on the amount of consumption of the electric energy and the carbon credit.

2. The method according to claim 1, further comprising:
   - determining duration for which the energy storage system or the energy system is used; and
   - utilizing the determined duration to calculate the compensation.

3. The method according to claim 1, wherein the carbon credit is based on efficiency in utilizing the electric energy.

4. The method according to claim 1, wherein the carbon credit is based on source utilized for recharging the energy storage system.

5. The method according to claim 1, further comprising determining a carbon credit associated with a fleet of energy storage systems or energy systems.

6. A system for determining compensation to be paid for using any one of, an energy storage system and an energy system, wherein the energy system is at least partially powered by electricity stored in the energy storage system, the system comprising
an energy management system and a data processing system, wherein the system is configured to:

determine consumption of electric energy stored in the energy storage system;

collect information affecting carbon credit associated with the energy storage system or the energy system;

determine carbon credit associated with the energy storage system or the energy system during a period of usage; and

calculate the compensation based on consumption of the electric energy and the carbon credit.

7. The system according to claim 6, wherein the energy management system and the data processing system are further configured to:

determine duration for which the energy storage system or the energy system is used; and

utilize the determined duration to calculate the compensation.

8. The system according to claim 6, wherein the energy management system and the data processing system are configured to determine the carbon credit based on efficiency in utilizing the electric energy.

9. The system according to claim 6, wherein the energy management system and the data processing system are configured to determine the carbon credit based on source utilized for recharging the energy storage system.

10. A method substantially as herein above described in the specification with reference to the accompanying drawings.
11. A system substantially as herein above described in the specification with reference to the accompanying drawings.
Determine amount of consumption of electric energy

Determine carbon credit

Calculate the compensation based on the amount of consumption of the electric energy and the carbon credit.

FIG. 2
Determine SOC of ESS at the beginning of lease

Determine SOC of ESS at the end of lease

Compute electric energy consumed during lease

Consider amount of energy consumed for computing compensation

Was the ESS recharged during lease?

YES

Determine carbon credit obtained

Use discount to be provided for carbon credit obtained for computing compensation

NO

Is the duration of lease considered for computing compensation?

FIG. 3
Consider duration of lease for computing compensation

Is distance travelled considered for computing compensation?

Consider distance travelled for computing compensation

Compute compensation

FIG. 3