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(54) ELECTRICITY SUPPLY SYSTEM, CONTROL DEVICE, AND NON-TRANSITORY STORAGE MEDIUM

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(57) ABSTRACT

An electricity supply system includes a solar panel, a solar converter, a group of auxiliaries, a battery, a bidirectional converter, and a control device. The control device is configured to control the bidirectional converter. The control device is configured to execute specific control during a period when a fluctuation condition is met. The fluctuation condition is a condition showing that fluctuation in at least either electricity output by the solar panel or electricity consumed by the group of auxiliaries is large. The specific control is control configured to control one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same.

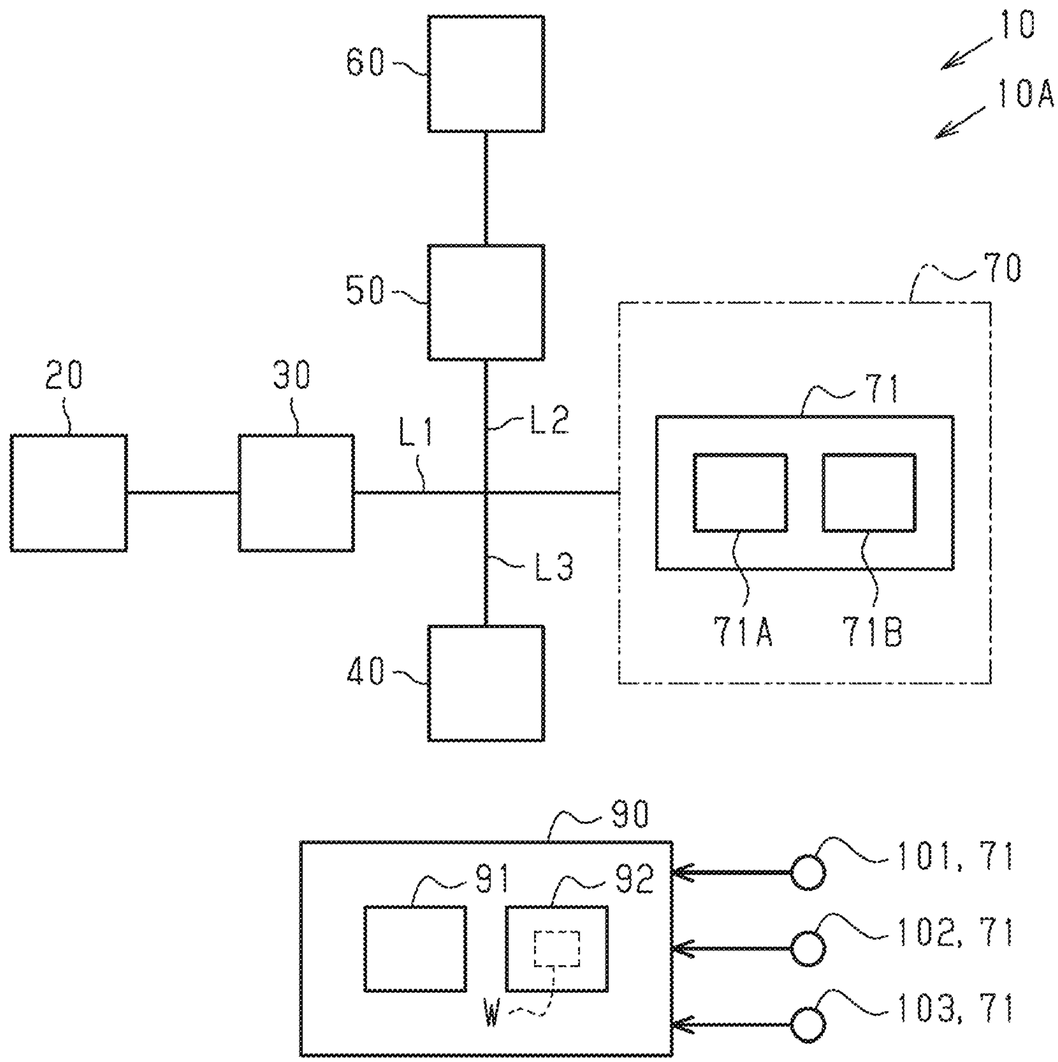


FIG. 1

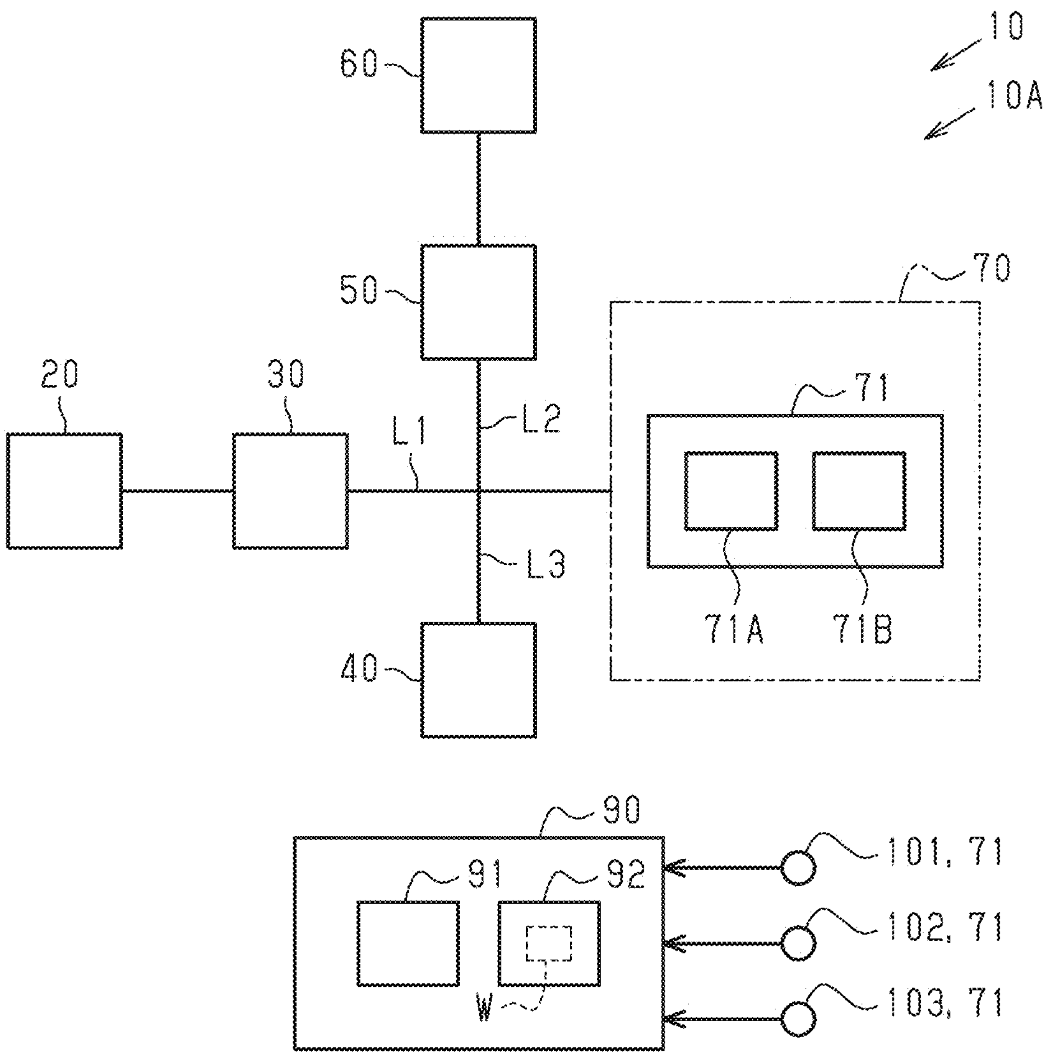
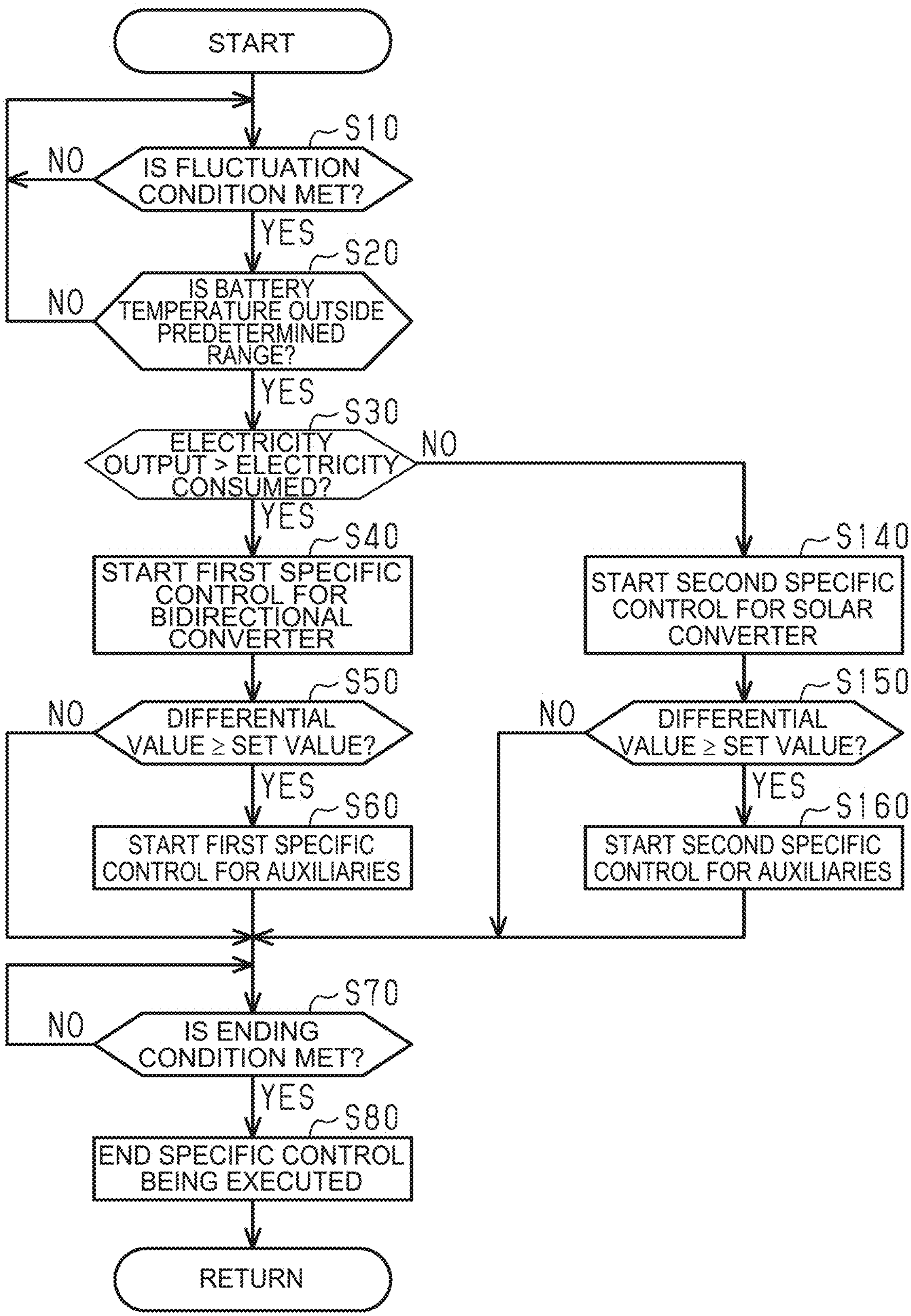

10
10A
60
50
70
71
20
30
L1
L2
L3
71A
71B
40
90
91
92
W
101, 71
102, 71
103, 71

FIG. 2


START
S10
IS FLUCTUATION CONDITION MET?
NO
YES
S20
IS BATTERY TEMPERATURE OUTSIDE PREDETERMINED RANGE?
NO
YES
S30
ELECTRICITY OUTPUT > ELECTRICITY CONSUMED?
NO
YES
S40
START FIRST SPECIFIC CONTROL FOR BIDIRECTIONAL CONVERTER
S50
DIFFERENTIAL VALUE ≥ SET VALUE?
NO
YES
S60
START FIRST SPECIFIC CONTROL FOR AUXILIARIES
S140
START SECOND SPECIFIC CONTROL FOR SOLAR CONVERTER
S150
DIFFERENTIAL VALUE ≥ SET VALUE?
NO
YES
S160
START SECOND SPECIFIC CONTROL FOR AUXILIARIES
S70
IS ENDING CONDITION MET?
NO
YES
S80
END SPECIFIC CONTROL BEING EXECUTED
RETURN

ELECTRICITY SUPPLY SYSTEM, CONTROL DEVICE, AND NON-TRANSITORY STORAGE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Japanese Patent Application No. 2024-017779 filed on Feb. 8, 2024, incorporated herein by reference in its entirety.

BACKGROUND

1. Technical Field

[0002] The present disclosure relates to an electricity supply system, a control device, and a non-transitory storage medium.

2. Description of Related Art

[0003] The vehicle disclosed in Japanese Unexamined Patent Application Publication No. 2021-083248 (JP 2021-083248 A) includes a solar panel, auxiliaries, a driving battery, and a control device. The auxiliaries are supplied with electricity generated by the solar panel. The driving battery is a high-voltage battery that supplies electricity to a driving source of the vehicle. The driving battery is located on a branch path branching off from an electricity supply path leading from the solar panel to the auxiliaries. When the amount of electricity generated by the solar panel is large, the control device switches the electricity supply path such that the electricity generated by the solar panel is supplied not only to the auxiliaries but also to the driving battery.

SUMMARY

[0004] In a technology like JP 2021-083248 A, a bidirectional converter that can switch the direction of electricity supply is sometimes employed at a point short of the driving battery in the branch path. This bidirectional converter is sometimes controlled as follows according to which of the electricity generated by the solar panel and the electricity consumed by the auxiliaries is higher or lower. When the electricity generated by the solar panel is excessive relative to the electricity consumed by the auxiliaries, the electricity generated by the solar panel is supplied to the driving battery. On the other hand, when the electricity generated by the solar panel is insufficient relative to the electricity consumed by the auxiliaries, the electricity is supplied from the driving battery to the auxiliaries. In the case where such a manner of control is adopted, the magnitude relationship between the electricity generated by the solar panel and the electricity consumed by the auxiliaries can switch frequently as the electricity generated or the electricity consumed fluctuates. In this case, the direction of electricity supply by the bidirectional converter is frequently switched, which places burden on the bidirectional converter.

[0005] A first aspect of this disclosure is an electricity supply system. The electricity supply system includes: a solar panel; a solar converter that is able to convert electricity output by the solar panel and output the electricity; a group of auxiliaries that is supplied with the electricity output by the solar converter; a battery; a bidirectional converter that is able to convert a voltage of electricity output by the battery and supply the electricity to the group of auxiliaries, as well as to convert a voltage of the electricity output by the solar converter and supply the electricity to the battery; and a control device configured to control the solar converter, the group of auxiliaries, and the bidirectional converter. As switching control, the control device is configured to, when a first condition is met, control the bidirectional converter such that the electricity is directed from the solar converter to the battery, and when a second condition is met, control the bidirectional converter such that the electricity is directed from the battery to the group of auxiliaries. The first condition is a condition that the electricity output by the solar converter is higher than electricity consumed by the group of auxiliaries. The second condition is a condition that the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries. The control device is configured to execute specific control during a period when a fluctuation condition is met. The fluctuation condition is a condition that is set beforehand as a condition showing that fluctuation in at least either the electricity output by the solar panel or the electricity consumed by the group of auxiliaries is large. The specific control is control configured to control one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same.

[0006] In the electricity supply system according to the first aspect of this disclosure, the fluctuation condition may be a condition that a difference between a maximum value and a minimum value of the electricity consumed by the group of auxiliaries during a unit period is equal to or larger than a specified value that is set beforehand.

[0007] The electricity supply system according to the first aspect of this disclosure may include a second battery to and from which the electricity output by the solar converter is chargeable and dischargeable, and a temperature sensor configured to detect a temperature of the second battery. The battery may be a first battery. The control device may be configured to execute the specific control based on a requisite condition that the temperature of the second battery is outside a predetermined range that is set beforehand.

[0008] In the electricity supply system according to the first aspect of this disclosure, the control device may be configured to, when the first condition is met at a predetermined timing, control the bidirectional converter in the specific control such that the electricity supplied from the bidirectional converter to the battery becomes lower than that in a state where the fluctuation condition is not met. The predetermined timing may be a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

[0009] In the electricity supply system according to the first aspect of this disclosure, the control device may be configured to, when the first condition is met at a predetermined timing, control the group of auxiliaries in the specific control such that the electricity consumed by the group of auxiliaries becomes lower than that in a state where the fluctuation condition is not met. The predetermined timing may be a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

[0010] In the electricity supply system according to the first aspect of this disclosure, the control device may be configured to, when the second condition is met at a predetermined timing, control the solar converter in the specific control such that the electricity output by the solar converter becomes lower than that in a state where the fluctuation condition is not met. The predetermined timing may be a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

[0011] In the electricity supply system according to the first aspect of this disclosure, the control device may be configured to, when the second condition is met at a predetermined timing, control the group of auxiliaries in the specific control such that the electricity consumed by the group of auxiliaries becomes higher than that in a state where the fluctuation condition is not met. The predetermined timing may be a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

[0012] A second aspect of this disclosure is a control device configured to execute control of a solar converter, a group of auxiliaries, and a bidirectional converter as a processor executes instructions stored in a storage medium. The control device includes the processor. The control device is configured to apply the control to a vehicle. The vehicle includes: a solar panel; the solar converter that is able to convert electricity output by the solar panel and output the electricity; a group of auxiliaries that is supplied with the electricity output by the solar converter; a battery; and the bidirectional converter that is able to convert a voltage of electricity output by the battery and supply the electricity to the group of auxiliaries, as well as to convert a voltage of the electricity output by the solar converter and supply the electricity to the battery. As switching control, the control device is configured to, when the electricity output by the solar converter is higher than electricity consumed by the group of auxiliaries, control the bidirectional converter such that the electricity is directed from the solar converter to the battery, and when the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries, control the bidirectional converter such that the electricity is directed from the battery to the group of auxiliaries. The control device is configured to execute specific control during a period when a fluctuation condition is met. The fluctuation condition is a condition that is set beforehand as a condition showing that fluctuation in at least either the electricity output by the solar panel or the electricity consumed by the group of auxiliaries is large. The specific control is control configured to control one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same.

[0013] A third aspect of this disclosure is a non-transitory storage medium storing instructions that are executable by one or more processors and that cause the one or more processors of a control device to perform the following functions. The functions include: executing switching control that, when electricity output by a solar converter is higher than electricity consumed by a group of auxiliaries, controls a bidirectional converter such that the electricity is directed from the solar converter to a battery, whereas when the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries, controls the bidirectional converter such that the electricity is directed from the battery to the group of auxiliaries; and executing specific control during a period when a fluctuation condition is met. The fluctuation condition is a condition that is set beforehand as a condition showing that fluctuation in at least either electricity output by a solar panel or the electricity consumed by the group of auxiliaries is large. The specific control is control that controls one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same. The functions are applied to a vehicle. The vehicle includes: the solar panel; the solar converter that is able to convert the electricity output by the solar panel and output the electricity; the group of auxiliaries that is supplied with the electricity output by the solar converter; the battery; the bidirectional converter that is able to convert a voltage of electricity output by the battery and supply the electricity to the group of auxiliaries, as well as to convert a voltage of the electricity output by the solar converter and supply the electricity to the battery; and the control device configured to control the solar converter, the group of auxiliaries, and the bidirectional converter.

[0014] According to each of the above-described technical ideas, burden on the bidirectional converter can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Features, advantages, and technical and industrial significance of exemplary embodiments of the disclosure will be described below with reference to the accompanying drawings, in which like signs denote like elements, and wherein:

[0016] FIG. **1** is a view schematically representing the general configuration of a vehicle; and

[0017] FIG. **2** is a flowchart showing a processing routine executed by a control device.

DETAILED DESCRIPTION OF EMBODIMENTS

[0018] In the following, one embodiment of an electricity supply system, a control device of a vehicle, and a program for a vehicle will be described with reference to the drawings.

Overall Configuration

[0019] As shown in FIG. **1**, a vehicle **10** includes an electricity supply system **10**A. The electricity supply system **10**A includes a first battery **60**, a second battery **40**, a solar panel **20**, a solar converter **30**, a bidirectional converter **50**, and a group of auxiliaries **70**.

[0020] The first battery **60** is a secondary battery. The first battery **60** is a high-voltage battery for the vehicle **10** to travel. The first battery **60** supplies electricity to one or more motors that make the vehicle **10** travel. A rated voltage of the first battery **60** is, for example, about 200 [V] to 250 [V].

[0021] The second battery **40** is a secondary battery. The second battery **40** is a battery for the group of auxiliaries **70**. A rated voltage of the second battery **40** is lower than that of the first battery **60**. The rated voltage of the second battery **40** is, for example, about 12 [V] to 48 [V].

[0022] The solar panel **20** has a configuration in which a plurality of solar cells, each generating electricity by being irradiated with sunlight, is arrayed into a panel form. The solar panel **20** is installed, for example, on a roof of the vehicle **10**.

[0023] The solar converter **30** is electrically connected to the solar panel **20**. The solar converter **30** is a circuit that converts a voltage of direct-current electricity input from the solar panel **20** and outputs the converted electricity. The solar converter **30** sometimes steps down and sometimes steps up the electricity output by the solar panel **20**.

[0024] The group of auxiliaries **70** is a group of a plurality of auxiliaries **71**. In FIG. **1**, one of the plurality of auxiliaries **71** is shown as a representative. Details of the auxiliary **71** will be described later. The group of auxiliaries **70** is electrically connected to the solar converter **30**. The group of auxiliaries **70** is supplied with the electricity output by the solar converter **30**.

[0025] An electricity path leading from the solar panel **20** to the group of auxiliaries **70** via the solar converter **30** will be referred to as a first path L**1**. The above-described first battery **60** is located on a second path L**2** that is an electricity path branching off from an intermediate point in the first path L**1**. The above-described second battery **40** is located on a third path L**3** that is an electricity path branching off from the first path L**1**. Thus, the second battery **40** is electrically connected to both of the solar converter **30** and the group of auxiliaries **70**. The second battery **40** allows the electricity output by the solar converter **30** to be charged. The second battery **40** can discharge electricity stored therein to the group of auxiliaries **70**.

[0026] The bidirectional converter **50** is located at an intermediate point in the second path L**2**. Thus, the bidirectional converter **50** is electrically connected to the solar converter **30** as well as the group of auxiliaries **70**. The bidirectional converter **50** is also electrically connected to the first battery **60**. The bidirectional converter **50** is a circuit that converts a voltage of direct-current electricity input into it and outputs the converted electricity. The bidirectional converter **50** is a circuit that can switch the direction of electricity supply. The bidirectional converter **50** can convert a voltage of the electricity output by the solar converter **30** and supplies the converted electricity to the first battery **60**. Specifically, the bidirectional converter **50** can step up the electricity output by the solar converter **30** and supply the stepped-up electricity to the first battery **60**. The bidirectional converter **50** can convert a voltage of electricity output by the first battery **60** and supply the converted electricity to the group of auxiliaries **70**. Specifically, the bidirectional converter **50** can step down the electricity output by the first battery **60** and supply the stepped-down electricity to the group of auxiliaries **70**.

Auxiliaries

[0027] The auxiliaries **71** are devices of which the operation does not require as high a voltage as the output voltage of the first battery **60**. Each auxiliary **71** includes an auxiliary ECU **71**A and a target device **71**B that operates according to a command signal from the auxiliary ECU **71**A. One example of the auxiliaries **71** is an electric power steering device that adjusts a steered angle of turning wheels in the vehicle **10**. Other examples of the auxiliaries **71** include a display device, an acoustic device, an air-conditioning device, lighting devices such as cabin lights and headlights, a wiper device, and surroundings monitoring devices such as a camera and a radar. Some types of auxiliaries **71** include an input device, for example, an input switch, for a user to give instructions about the operation of the auxiliary **71**. The input device outputs a signal according to the user's manipulation to a control device **90** to be described later.

[0028] The auxiliary ECU **71**A is a computer including a processing circuit. The processing circuit includes a CPU and a memory. In the memory, various programs describing processes to be executed by the CPU and various pieces of data required for the CPU to execute the programs are stored beforehand. The auxiliary ECU **71**A controls the target device **71**B based on a command signal from the control device **90** to be described later. The auxiliary ECU **71**A switches between a sleep state and an active state. The sleep state is a state where an activation command from the control device **90** is waited for while various processes are in pause. In the sleep state, electricity consumed by the auxiliary ECU **71**A per unit time is lower than that in the active state. The auxiliary ECU **71**A controls the target device **71**B when the auxiliary ECU **71**A is in the active state. Some auxiliary ECUs **71**A can operate the target device **71**B in different electricity modes. The electricity modes include a normal electricity mode and an electricity saving mode. In the electricity saving mode, the electricity consumed by the target device **71**B per unit time is lower than that in the normal electricity mode. Hereinafter, those auxiliaries **71** among the group of auxiliaries **70** that can switch the electricity mode will be referred to as switchable auxiliaries.

[0029] Some of the plurality of auxiliaries **71** are various sensors. Examples of the various sensors include a first sensor **101**, a plurality of second sensors **102**, and a temperature sensor **103**. In FIG. **1**, one of the plurality of second sensors **102** is shown as a representative. The first sensor **101** repeatedly detects the current and the voltage output by the solar converter **30** on a predetermined detection cycle. The second sensor **102** is provided for each auxiliary **71**. The second sensor **102** repeatedly detects a current flowing through the target auxiliary **71** and a voltage applied to the target auxiliary **71** on a predetermined detection cycle. The temperature sensor **103** repeatedly detects a temperature of the second battery **40** on a predetermined detection cycle. There are various other sensors as the auxiliaries **71**. One example of the other sensors is a sensor that detects a steering angle of a steering wheel. The various sensors repeatedly output signals according to information they have detected to the control device **90** to be described later.

Control Device

[0030] The electricity supply system **10**A includes the control device **90**. The control device **90** is a computer including a processing circuit. The processing circuit includes a CPU **91** and a memory **92**. In the memory **92**, various programs W for the vehicle that describe processes to be executed by the CPU **91** and various pieces of data required for the CPU **91** to execute the programs W are stored beforehand. The control device **90** acquires signals from the above-described various sensors and input devices as needed. The control device **90** calculates required parameters based on the acquired information. For example, the control device **90** calculates the electricity output by the solar converter **30** based on a detection signal of the first sensor **101**. The control device **90** calculates electricity consumed by the group of auxiliaries **70** based on detection signals of the plurality of second sensors **102**. The electricity consumed by the group of auxiliaries **70** refers to the sum of electricity consumed by all the auxiliaries **71**. The control device **90** repeats the calculation of the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** on a predetermined calculation cycle.

[0031] The control device **90** controls the solar converter **30**, the bidirectional converter **50**, and the group of auxiliaries **70** as the CPU **91** executes the programs W stored in the memory **92**. To control the solar converter **30**, the bidirectional converter **50**, and the group of auxiliaries **70**, the control device **90** basically performs modes of basic control to be described below that are specifically intended for these respective devices.

Basic Control for Solar Converter

[0032] First, a PV characteristic line that is a premise for the basic control for the solar converter **30** will be described. An orthogonal coordinate system with the voltage output by the solar converter **30** plotted on the X-axis and the electricity output by the solar converter **30** plotted on the Y-axis will be considered. In this orthogonal coordinate system, the PV characteristic line represents a correspondence relationship between the voltage output by the solar converter **30** and the electricity output by the solar converter **30** that the solar converter **30** can realize according to a status of electricity generation by the solar panel **20** at the current point in time. The PV characteristic line has basically a mountain-shaped distribution. Specifically, on the PV characteristic line, there is a local maximum point at which the electricity output by the solar converter **30** shifts from increasing to decreasing as the voltage output by the solar converter **30** increases. The electricity output at this local maximum point will be referred to as maximum electricity. In the basic control for the solar converter **30**, the control device **90** controls the solar converter **30** such that the electricity output by the solar converter **30** becomes the maximum electricity. Specifically, on a predetermined cycle, for example, a one-minute cycle, the control device **90** searches for an output voltage at which the maximum electricity can be obtained at the current point in time. Then, the control device **90** controls the solar converter **30** for a certain period so as to output that output voltage and therefore the maximum electricity. The control device **90** repeats the search for the maximum electricity and the control of the solar converter **30** according to the search result.

Basic Control for Bidirectional Converter

[0033] The basic control for the bidirectional converter **50** is control relating to a voltage output by the bidirectional converter **50**. In this basic control, when the destination of electricity supply by the bidirectional converter **50** is the first battery **60**, the control device **90** steps up the voltage output by the solar converter **30** to a voltage equivalent to the rated voltage of the first battery **60** and outputs the stepped-up voltage to the first battery **60**. On the other hand, when the destination of electricity supply by the bidirectional converter **50** is the group of auxiliaries **70**, the control device **90** steps down the voltage output by the first battery **60** to a voltage equivalent to the rated voltage of the second battery **40** and outputs the stepped-down voltage to the group of auxiliaries **70**.

Basic Control for Auxiliaries

[0034] Based on signals from the various input devices and sensors, etc., the control device **90** can grasp the auxiliaries **71** of which the operation is requested at the current point in time and the electricity mode specified. In the basic control for the auxiliaries **71**, the control device **90** controls the auxiliaries **71** of which the operation is requested at the current point in time in the electricity mode as requested. In essence, the control device **90** controls each auxiliary **71** of which the operation is requested at the current point in time by outputting a command signal to the auxiliary **71**. Hereinafter, the description that the control device **90** outputs a command signal in controlling each auxiliary **71** will not be individually given.

Switching Control for Bidirectional Converter

[0035] The control device **90** constantly performs switching control in controlling the bidirectional converter **50**. The switching control is control for switching the direction of electricity supply by the bidirectional converter **50**. In the switching control, the control device **90** switches the direction of electricity supply by the bidirectional converter **50** according to a magnitude relationship at that point in time between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70**. When the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70**, the control device **90** controls the bidirectional converter **50** such that the electricity is directed from the solar converter **30** to the first battery **60**. On the other hand, when the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70**, the control device **90** controls the bidirectional converter **50** such that the electricity is directed from the first battery **60** to the group of auxiliaries **70**.

Specific Control

[0036] The control device **90** can execute specific control separately from the modes of basic control for the respective devices. The control device **90** performs the specific control during a period when a predetermined fluctuation condition is met. When performing the specific control, the control device **90** suspends the basic control for the solar converter **30** or for the auxiliaries **71** as necessary. Even during the period when the fluctuation condition is met, the control device **90** continues the switching control and the basic control for the bidirectional converter **50**. The fluctuation condition in this embodiment is set beforehand as a condition showing that fluctuation in the electricity consumed by the group of auxiliaries **70** is large. Specifically, the fluctuation condition is that a difference between a maximum value and a minimum value of the electricity consumed by the group of auxiliaries **70** during a unit period is equal to or larger than a specified value. The unit period is set beforehand. The unit period is, for example, a few seconds. The specified value is set beforehand. As the specified value, such a value is set as to be able to grasp a situation where the electricity consumed by the group of auxiliaries **70** is so large that the magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** becomes reversed. In the control device **90**, the unit period and the specified value are stored beforehand.

[0037] In the specific control, the control device **90** controls the solar converter **30**, the group of auxiliaries **70**, and the bidirectional converter **50** such that the magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** remains the same. The control device **90** in this embodiment executes the specific control based on a requisite condition that the temperature of the second battery **40** is outside a predetermined range. The predetermined range is set beforehand as a temperature range within which the charge-discharge performance of the second battery **40** does not degrade. In the control device **90**, an allowable lower limit value that is a lower limit value of the predetermined range and an allowable upper limit value that is an upper limit value of the predetermined range are stored beforehand. As the allowable lower limit value, for example, a temperature below a freezing point can be set. As the allowable upper limit value, for example, a temperature equal to or higher than 50 degrees can be set.

[0038] The specific control includes first specific control and second specific control. The control device **90** performs the first specific control when the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70** at a timing when a state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met. The first specific control is control for maintaining the state where the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70**. On the other hand, the control device **90** performs the second specific control when the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** at the timing when the state where the fluctuation condition is not met has switched to the state where the fluctuation condition is met. The second specific control is control for maintaining the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70**.

[0039] The first specific control includes first specific control for the bidirectional converter **50** and first specific control for the group of auxiliaries **71**. In the first specific control for the bidirectional converter **50**, while maintaining the above-described control of the output voltage relating to the basic control for the bidirectional converter **50**, the control device **90** controls the bidirectional converter **50** such that the electricity supplied from the bidirectional converter **50** to the first battery **60** becomes lower than that in the state where the fluctuation condition is not met. In the first specific control for the auxiliaries **71**, the control device **90** controls the group of auxiliaries **70** such that the electricity consumed by the group of auxiliaries **70** becomes lower than that in the state where the fluctuation condition is not met. Thus, when the first specific control for the bidirectional converter **50** is being executed, the electricity supplied from the bidirectional converter **50** to the first battery **60** is lower compared with that when the first specific control for the bidirectional converter **50** is not being executed. When the first specific control for the auxiliaries **71** is being executed, the electricity consumed by the group of auxiliaries **70** is lower compared with that when the above-described basic control for the auxiliaries **71** is being executed.

[0040] The second specific control includes second specific control for the solar converter **30** and second specific control for the auxiliaries **71**. In the second specific control for the solar converter **30**, the control device **90** controls the solar converter **30** such that the electricity output by the solar converter **30** becomes lower than that in the state where the fluctuation condition is not met. In the second specific control for the auxiliaries **71**, the control device **90** controls the group of auxiliaries **70** such that the electricity consumed by the group of auxiliaries **70** becomes higher than that in the state where the fluctuation condition is not met. Thus, when the second specific control for the solar converter **30** is being executed, the electricity output by the solar converter **30** is lower compared with that when the above-described basic control for the solar converter **30** is being executed. When the second specific control for the auxiliaries **71** is being executed, the electricity consumed by the group of auxiliaries **70** is higher compared with that when the above-described basic control for the auxiliaries **71** is being executed.

Processing Routine

[0041] By executing the programs W, the control device **90** repeats a sequential processing routine described below. The control device **90** thereby executes the specific control as necessary. This processing routine is repeatedly executed when the control device **90** is being driven. Therefore, even when the vehicle **10** is stationary or parked, the following sequential processing routine is repeatedly executed as long as electricity enough to drive the control device **90** is supplied to the control device **90**.

[0042] As shown in FIG. **2**, after starting the processing routine, the control device **90** first executes a process of step S**10**. In step S**10**, the control device **90** determines whether the fluctuation condition is met. Specifically, until a unit period has passed since the process of step S**10** has been started, the control device **90** monitors transition of the electricity consumed by the group of auxiliaries **70**. Then, the control device **90** identifies the maximum value and the minimum value of the electricity consumed during the unit period. Then, the control device **90** determines whether a differential value that is a value obtained by subtracting the minimum value from the maximum value is equal to or larger than the specified value. When the differential value is smaller than the specified value, the control device **90** determines that the fluctuation condition is not met (step S**10**: NO). In this case, the control device **90** executes the process of step S**10** again. The control device **90** repeats the process of step S**10** until the differential value becomes equal to or larger than the specified value, i.e., until the fluctuation condition is met. When the fluctuation condition is met (step S**10**: YES), the control device **90** proceeds to a process of step S**20**. A situation where the determination in step S**10** yields a YES is a situation where the state where the fluctuation condition is not met has switched to the state where the fluctuation condition is met.

[0043] In step S**20**, the control device **90** determines whether the temperature of the second battery **40** is outside the predetermined range. The control device **90** compares the latest value of the temperature of the second battery **40** with the allowable lower limit value and the allowable upper limit value. When the temperature of the second battery **40** is equal to or higher than the allowable lower limit value and equal to or lower than the allowable upper limit value (step S**20**: NO), the control device **90** returns to the process of step S**10**.

[0044] On the other hand, when the temperature of the second battery **40** is lower than the allowable lower limit value or this temperature is higher than the allowable upper limit value (step S**20**: YES), the control device **90** proceeds to a process of step S**30**. When the determination in step S**20** yields a YES, this means that the requisite condition for executing the specific control is met.

[0045] In step S**30**, the control device **90** determines whether the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70**. The control device **90** compares the latest value of the electricity output by the solar converter **30** and the latest value of the electricity consumed by the group of auxiliaries **70**. Here, at the point in time when step S**30** is reached, the control device **90** is performing the basic control for the solar converter **30**. Therefore, the electricity output by the solar converter **30** at this point in time is the maximum electricity on the PV characteristic line at the current point in time. When the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70** (step S**30**: YES), the control device **90** proceeds to a process of step S**40**. After the determination in step S**10** yields a YES, the control device **90** promptly performs the processes of step S**20** and step S**30**. Thus, the timing when the control device **90** performs the process of step S**30** corresponds to the timing when the state where the fluctuation condition is not met has switched to the state where the fluctuation condition is met.

[0046] In step S**40**, the control device **90** starts the first specific control for the bidirectional converter **50**. Here, in a situation where the processing proceeds to step S**40**, in connection with the switching control for the bidirectional converter **50**, the destination of electricity supply by the bidirectional converter **50** is the first battery **60**. In the first specific control for the bidirectional converter **50**, the control device **90** controls the bidirectional converter **50** such that the electricity supplied from the bidirectional converter **50** to the first battery **60** becomes lower than that before execution of the first specific control and therefore in the state where the fluctuation condition is not met. After starting the first specific control for the bidirectional converter **50** in step S**40**, the control device **90** proceeds to a process of step S**50**.

[0047] In step S**50**, the control device **90** determines whether the differential value calculated in the most recent process of step S**10** is equal to or larger than a set value. The set value is set beforehand as such a value as to be able to grasp that fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large. The set value is stored in the control device **90** beforehand. When the differential value is smaller than the set value (step S**50**: NO), the control device **90** skips a process of step S**60** to be described later and proceeds to a process of step S**70**. On the other hand, when the differential value is equal to or larger than the set value (step S**50**: YES), the control device **90** proceeds to the process of step S**60**.

[0048] In step S**60**, the control device **90** starts the first specific control for the auxiliaries **71**. In this case, the control device **90** suspends the basic control for the auxiliaries **71**. In the first specific control for the auxiliaries **71**, the control device **90** controls, among auxiliaries **71** of which the operation is requested at the current point in time, all switchable auxiliaries in the electricity saving mode. In the first specific control for the auxiliaries **71**, the control device **90** controls, among the auxiliaries **71** of which the operation is requested at the current point in time, all the other auxiliaries **71** than the switchable auxiliaries as at normal times. When the control device **90** starts the first specific control for the auxiliaries **71**, the switchable auxiliaries switch from the normal electricity mode to the electricity saving mode. Accordingly, the electricity consumed by the group of auxiliaries **70** decreases by an amount corresponding to the number of auxiliaries **71** that have switched to the electricity saving mode. As a result, when the first specific control for the auxiliaries **71** is being executed, the electricity consumed by the group of auxiliaries **70** is lower compared with that before execution of the first specific control and therefore in the state where the fluctuation condition is not met. Thus, in the first specific control for the auxiliaries **71**, the control device **90** controls the group of auxiliaries **70** such that the electricity consumed by the group of auxiliaries **70** becomes lower than that in the state where the fluctuation condition is not met. During execution of the first specific control for the auxiliaries **71**, the control device **90** displays, on the display device, to the effect that each auxiliary **71** is being operated in the electricity saving mode with the objective of protecting parts. After starting the first specific control for the auxiliaries **71** in step S**60**, the control device **90** proceeds to the process of step S**70**.

[0049] In step S**70**, the control device **90** determines whether an ending condition is met. The ending condition is that the difference between the maximum value and the minimum value of the electricity consumed by the group of auxiliaries **70** during the unit period is smaller than the specified value. Due to the relationship between the ending condition and the fluctuation condition, the control device **90** performs the determination with affirmation and negation reversed from the process of step S**10**. As in step S**10**, the control device **90** monitors the transition of the electricity consumed by the group of auxiliaries **70** until the unit period has passed since the processing has proceeded to step S**70**. Then, the control device **90** determines whether the ending condition is met based on the difference between the maximum value and the minimum value of the electricity consumed that is grasped from this transition. When the ending condition is not met (step S**70**: NO), the control device **90** performs the process of step S**70** again. The control device **90** repeats the process of step S**70** until the ending condition is met. When the ending condition is met (step S**70**: YES), the control device **90** proceeds to the process of step S**80**. A situation where the determination in step S**70** yields a YES is a situation where the state where the fluctuation condition is met has switched to the state where the fluctuation condition is not met.

[0050] In step S**80**, the control device **90** ends all modes of specific control that are being executed. Then, the control device **90** resumes each mode of basic control that has been suspended to execute the specific control. Thereafter, the control device **90** executes the process of step S**10** again.

[0051] When the electricity output by the solar converter **30** is equal to or lower than the electricity consumed by the group of auxiliaries **70** in step S**30** (step S**30**: NO), the control device **90** proceeds to a process of step S**140**.

[0052] In step S**140**, the control device **90** starts the second specific control for the solar converter **30**. In this case, the control device **90** suspends the basic control for the solar converter **30**. In the second specific control for the solar converter **30**, the control device **90** controls the solar converter **30** such that the electricity output by the solar converter **30** becomes specific electricity. The specific electricity in this embodiment is a value of half the maximum electricity according to the basic control for the solar converter **30** that has been executed until just before that point in time. As can be seen from the magnitude relationship between the maximum electricity and the specific electricity, in the second specific control for the solar converter **30**, the control device **90** controls the solar converter **30** such that the electricity output by the solar converter **30** becomes lower than that before execution of the second specific control and therefore in the state where the fluctuation condition is not met. After starting the second specific control for the solar converter **30** in step S**140**, the control device **90** proceeds to a process of step S**150**.

[0053] In step S**150**, the control device **90** performs the same process as in step S**50**. When the differential value is smaller than the set value (step S**150**: NO), the control device **90** skips a process of step S**160** to be described later and proceeds to the process of step S70. On the other hand, when the differential value is equal to or larger than the set value (step S**150**: YES), the control device **90** proceeds to the process of step S**160**.

[0054] In step S**160**, the control device **90** starts the second specific control for the auxiliaries **71**. In this case, the control device **90** suspends the basic control for the auxiliaries **71**. In the second specific control for the auxiliaries **71**, the control device **90** controls those auxiliaries **71** of which the operation is requested at the current point in time as requested and, in addition, controls the auxiliary ECUs **71**A of all the auxiliaries **71** of which the operation is not requested into the active state. Thus, when the control device **90** starts the second specific control for the auxiliaries **71**, all the auxiliary ECUs **71**A that have been in the sleep state switch to the active state. Accordingly, the electricity consumed by the group of auxiliaries **70** increases by an amount corresponding to the number of auxiliary ECUs **71**A that have switched to the active state. As a result, when the second specific control for the auxiliaries **71** is being executed, the electricity consumed by the group of auxiliaries **70** is higher compared with that before execution of the second specific control and therefore in the state where the fluctuation condition is not met. Thus, in the second specific control for the auxiliaries **71**, the control device **90** controls the group of auxiliaries **70** such that the electricity consumed by the group of auxiliaries **70** becomes higher than that in the state where the fluctuation condition is not met. After starting the second specific control for the auxiliaries **71** in step S**160**, the control device **90** proceeds to the process of step S70. Then, the control device **90** performs the processes of step S70 and step S**80**.

Workings of Embodiment

[0055] As the control device **90** executes the above-described processing routine, a first aspect or a second aspect as follows is realized.

[0056] The first aspect will be described. Now, it is assumed that in the situation where the temperature of the second battery **40** is outside the predetermined range, the state where the fluctuation condition is not met has switched to the state where it is met (step S**10**: YES, step S**20**: YES). It is assumed then that at this point in time the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70** (step S**30**: YES). In this case, due to the settings of the switching control for the bidirectional converter **50**, the destination of electricity supply by the bidirectional converter **50** is the first battery **60**. In such a situation, the control device **90** performs the first specific control for the bidirectional converter **50** (step S**40**). That is, the control device **90** reduces the electricity supplied from the bidirectional converter **50** to the first battery **60**. This leads to the electricity being accumulated between the solar converter **30** and the bidirectional converter **50**, which creates a situation where there is a margin for supplying additional electricity to the group of auxiliaries **70**. Further, when the fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large (step S**50**: YES), the control device **90** performs the first specific control for the auxiliaries **71** (step S**60**). That is, the control device **90** performs switching to the electricity saving mode for the auxiliaries **71** of which the electricity mode is switchable. Accordingly, the electricity consumed by the group of auxiliaries **70** decreases. Thus, when the first specific control is performed, the margin for supplying additional electricity to the group of auxiliaries **70** increases while the electricity consumed by the group of auxiliaries **70** decreases. Accordingly, the difference between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** becomes so large that, even when the electricity consumed by the group of auxiliaries **70** fluctuates, the magnitude relationship between the electricity output and the electricity consumed does not become reversed. Therefore, during the period when the fluctuation condition is met, the state where the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70** is maintained. Due to the settings of the switching control for the bidirectional converter **50**, the destination of electricity supply by the bidirectional converter **50** remains the first battery **60**. In the case where the determination in step S**50** yields a NO, when the control device **90** simply performs the first specific control for the bidirectional converter **50** between the first specific control for the bidirectional converter **50** and the first specific control for the auxiliaries **71**, the following is realized: The difference between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** becomes so large that, even when the electricity consumed by the group of auxiliaries **70** fluctuates, the magnitude relationship between the electricity output and the electricity consumed does not become reversed.

[0057] The second aspect will be described. Now, it is assumed that in the situation where the temperature of the second battery **40** is outside the predetermined range, the state where the fluctuation condition is not met has switched to the state where it is met (step S**10**: YES, step S**20**: YES). It is assumed then that at this point in time the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** (step S**30**: NO). In this case, due to the settings of the switching control for the bidirectional converter **50**, the destination of electricity supply by the bidirectional converter **50** is the group of auxiliaries **70**. In such a situation, the control device **90** performs the second specific control for the solar converter **30** (step S**140**). That is, the control device **90** makes the electricity output by the solar converter **30** lower than the maximum electricity on the PV characteristic line. Further, when the fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large (step S**150**: YES), the control device **90** performs the second specific control for the auxiliaries **71** (step S**160**). That is, the control device **90** puts each auxiliary ECU **71**A that has been in the sleep state into the active state. Accordingly, the electricity consumed by the group of auxiliaries **70** increases. Thus, when the second specific control is performed, the electricity output by the solar converter **30** decreases while the electricity consumed by the group of auxiliaries **70** increases. Accordingly, the difference between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** becomes so large that, even when the electricity consumed by the group of auxiliaries **70** fluctuates, the magnitude relationship between the electricity output and the electricity consumed does not become reversed. Therefore, during the period when the fluctuation condition is met, the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** is maintained. Due to the settings of the switching control for the bidirectional converter **50**, the destination of electricity supply by the bidirectional converter **50** remains the group of auxiliaries **70**. In the case where the determination in step S**150** yields a NO, when the control device **90** simply performs the second specific control for the solar converter **30** between the second specific control for the solar converter **30** and the second specific control for the auxiliaries **71**, the following is realized: The difference between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** becomes so large that, even when the electricity consumed by the group of auxiliaries **70** fluctuates, the magnitude relationship between the electricity output and the electricity consumed does not become reversed.

Advantages of Embodiment

[0058] (1) As described above in Workings of Embodiment, in the configuration of the embodiment, each device is controlled during the period when the fluctuation condition is met such that the magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** remains the same. This increases the likelihood that the destination of electricity supply by the bidirectional converter **50** remains the same during the period when the fluctuation condition is met. Thus, even in a situation where the destination of electricity supply by the bidirectional converter **50** can switch frequently according to the related art, burden on the bidirectional converter **50** can be minimized.

[0059] (2) For example, when there are repeated straight sections and curved sections in a travel route of the vehicle **10**, the electric power steering device is driven and stopped repeatedly. In this case, the electricity consumed by the group of auxiliaries **70** can fluctuate significantly. The electricity consumed by the group of auxiliaries **70** can also fluctuate significantly, for example, as the air-conditioning device or the headlights are repeatedly turned on and off. If the fluctuation condition using the degree of fluctuation in the electricity consumed by the group of auxiliaries **70** as an index is adopted as in the embodiment, the aforementioned situations where the electricity consumed by the group of auxiliaries **70** fluctuates significantly can be grasped. Thereby the burden on the bidirectional converter **50** in the situation where the fluctuation in the electricity consumed by the group of auxiliaries **70** is large can be minimized.

[0060] (3) When the temperature of the second battery **40** is within the predetermined range, the second battery **40** fulfils a sufficient charge-discharge function. In this case, when the electricity consumed by the group of auxiliaries **70** fluctuates, excess or shortage of the electricity supplied from the solar converter **30** relative to the electricity consumed by the group of auxiliaries **70** can be compensated for by charge or discharge of the second battery **40**. Thereby the magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** can be maintained. On the other hand, when the temperature of the second battery **40** is excessively low or high, the charge-discharge performance of the second battery **40** can degrade. In such a situation, the aforementioned excess or shortage of the electricity accompanying the fluctuation in the electricity consumed by the group of auxiliaries **70** may fail to be compensated for by charge or discharge of the second battery **40**. In the embodiment, the specific control is performed only in such a situation. Here, when the specific control is performed, control restrictions different from those at normal times are imposed, which can have various influences, for example, that another control that is being performed in conjunction with the basic control is also changed. The configuration of the embodiment can preclude unnecessarily increasing the opportunities to perform the specific control.

[0061] (4) As described above in the first aspect of Workings of Embodiment, in the configuration of the embodiment, the electricity supplied from the bidirectional converter **50** to the first battery **60** is reduced when the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70** at the point in time of switching to the state where the fluctuation condition is met. As described above in Workings of Embodiment, this leads to an increased margin for supplying additional electricity to the group of auxiliaries **70**. Here, since the solar converter **30** is outputting the maximum electricity on the PV characteristic line, it is difficult for the solar converter **30** to make the electricity output any higher by itself. In the configuration of the embodiment, the margin for supplying electricity to the group of auxiliaries **70** can be increased even in such a situation by adjusting the electricity output by the bidirectional converter **50**. This configuration of the embodiment is favorable in maintaining the state where the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70**.

[0062] (5) As described above in the first aspect of Workings of Embodiment, in the configuration of the embodiment, switching to the electricity saving mode is performed for the auxiliaries **71** of which the electricity mode is switchable when the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70**, and moreover the fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large, at the point in time of switching to the state where the fluctuation condition is met. Accordingly, the electricity consumed by the group of auxiliaries **70** decreases. In this configuration of the embodiment, even when the fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large, the state where the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70** can be reliably maintained. As the auxiliaries **71** are switched to the electricity saving mode only when the fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large, opportunities to compel the auxiliaries **71** to change their operation modes can be minimized.

[0063] (6) As described above in the second aspect of Workings of Embodiment, in the configuration of the embodiment, the electricity output by the solar converter **30** is reduced when the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** at the point in time of switching to the state where the fluctuation condition is met. This configuration of the embodiment is favorable in maintaining the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70**.

[0064] (7) As described above in the second aspect of Workings of Embodiment, in the configuration of the embodiment, the auxiliary ECUs **71**A that have been in the sleep state are put into the active state when the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70**, and moreover the fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large, at the point in time of switching to the state where the fluctuation condition is met. Accordingly, the electricity consumed by the group of auxiliaries **70** increases. In this configuration of the embodiment, even when the fluctuation in the electricity consumed by the group of auxiliaries **70** is considerably large, the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** can be reliably maintained. If a measure to maintain this magnitude relationship is simply to put the auxiliary ECUs **71**A into the active state, since it does not involve starting the target devices **71**B or changing the operation modes of the target devices **71**B, the behavior of the vehicle **10** essentially does not change at all. Therefore, the user is not affected either.

Modified Examples

[0065] The above-described embodiment can be implemented with changes made thereto as follows. The above-described embodiment and the following modified examples can be implemented in combination within such a range that no technical contradiction arises.

[0066] Regarding step S**40**, the contents of the first specific control for the bidirectional converter **50** are not limited to the example in the above-described embodiment. At a minimum, the first specific control for the bidirectional converter **50** should be able to control the bidirectional converter **50** such that the electricity supplied from the bidirectional converter **50** to the first battery **60** becomes lower than that in the state where the fluctuation condition is not met. At a minimum, the first specific control for the bidirectional converter **50** should be able to reduce one or more selected from the current and the voltage supplied from the bidirectional converter **50** to the first battery **60**.

[0067] Regarding step S**60**, the contents of the first specific control for the auxiliaries **71** are not limited to the example in the above-described embodiment. At a minimum, the first specific control for the auxiliaries **71** should be able to control the group of auxiliaries **70** such that the electricity consumed by the group of auxiliaries **70** becomes lower than that in the state where the fluctuation condition is not met. For example, switchable auxiliaries to be switched to the electricity saving mode may be selected from among a plurality of switchable auxiliaries that is operating at the point in time of execution of step S**60**. In this case, the electricity consumed by each auxiliary **71** may be taken into account. Selecting switchable auxiliaries that consume high electricity as targets to be switched to the electricity saving mode is favorable in reducing the electricity consumed by the group of auxiliaries **70**. In addition, for example, the number of auxiliaries **71** to be controlled into the electricity saving mode may be increased or decreased in the middle of execution of the first specific control for the auxiliaries **71**.

[0068] In the first specific control for the auxiliaries **71**, the operation of the auxiliaries **71** itself may be stopped. For example, a situation where the first specific control for the auxiliaries **71** is performed can be a situation where the vehicle is parked. In such a situation, monitoring of an outside or an inside of the vehicle by the camera can be unnecessary. In this case, the camera may be stopped.

[0069] The order of the process of step S**40** and the process of step S**60** may be reversed. The process of step S**50** may be omitted. In addition to omitting the process of step S**50**, either the process of step S**40** or the process of step S**60** may be omitted. In short, at a minimum, the processes should be arranged such that when the determination in step S**30** yields a YES, the state where the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70** can be maintained.

[0070] Regarding the processes after the determination in step S**30** yields a YES, to maintain the state where the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70**, the solar converter **30** may be controlled instead of or in addition to controlling the bidirectional converter **50** and the group of auxiliaries **70**. For example, it is assumed that a mode of basic control for the solar converter **30** is adopted in which the electricity output by the solar converter **30** is set to a value lower than the maximum electricity on the PV characteristic line. In this case, the electricity output by the solar converter **30** is allowed to be further increased. In such a case, the magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** can be maintained by increasing the electricity output by the solar converter **30**. Such control of the solar converter **30** may be adopted as the first specific control. Thus, the first specific control is not limited to the example in the above-described embodiment. At a minimum, the first specific control should be able to maintain the state where the electricity output by the solar converter **30** is higher than the electricity consumed by the group of auxiliaries **70**. At a minimum, by controlling one or more selected from the solar converter **30**, the group of auxiliaries **70**, and the bidirectional converter **50**, the first specific control should be able to maintain the magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** during a period when the fluctuation condition is met.

[0071] Regarding step S**140**, the contents of the second specific control for the solar converter **30** are not limited to the example in the above-described embodiment. At a minimum, the second specific control for the solar converter **30** should be able to control the solar converter **30** such that the electricity output by the solar converter **30** becomes lower than that in the state where the fluctuation condition is not met. The above-described specific electricity according to the second specific control for the solar converter **30** may be set to a value other than half the maximum electricity on the PV characteristic line. As in the above-described modified example of step S**60**, for example, the above-described specific electricity may be increased or decreased in the middle of execution of the second specific control for the solar converter **30**.

[0072] Regarding step S**160**, the contents of the second specific control for the auxiliaries **71** are not limited to the example in the above-described embodiment. At a minimum, the second specific control for the auxiliaries **71** should be able to control the group of auxiliaries **70** such that the electricity consumed by the group of auxiliaries **70** becomes higher than that in the state where the fluctuation condition is not met. For example, among the switchable auxiliaries that are operating at the point in time of execution of step S**160**, those that are operating in the electricity saving mode may be switched to the normal electricity mode. As in the above-described modified example of step S**60**, for example, the number of auxiliary ECUs **71**A to be controlled into the active state may be increased or decreased in the middle of execution of the second specific control for the auxiliaries **71**.

[0073] The order of the process of step S**140** and the process of step S**160** may be reversed. The process of step S**150** may be omitted. In addition to omitting the process of step S**150**, either the process of step S**140** or the process of step S**160** may be omitted. In short, at a minimum, the processes should be arranged such that when the determination in step S**30** yields a NO, the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** can be maintained.

[0074] Regarding the processes after the determination in step S**30** yields a NO, to maintain the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70**, the bidirectional converter **50** may be controlled instead of or in addition to controlling the solar converter **30** and the group of auxiliaries **70**. The control of the bidirectional converter **50** may be adopted as the second specific control. Thus, as with the first specific control, the second specific control is not limited to the example in the above-described embodiment. At a minimum, the second specific control should be able to maintain the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70**. At a minimum, by controlling one or more selected from the solar converter **30**, the group of auxiliaries **70**, and the bidirectional converter **50**, the second specific control should be able to maintain the magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** during a period when the fluctuation condition is met.

[0075] What is determined in step S**30** is not limited to the example in the above-described embodiment. In other words, the manner of determining which of the first specific control and the second specific control to execute is not limited to the example in the above-described embodiment. For example, in step S**30**, which of the first specific control and the second specific control to execute may be determined based on a time period in a day. Here, in the case of night-time, the vehicle **10** is made to travel with the headlights on. Therefore, during night-time, the electricity consumed by the group of auxiliaries **70** is highly likely to increase. From this perspective, during night-time, the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** is likely to arise. Thus, it is highly likely that the state where the electricity output by the solar converter **30** is lower than the electricity consumed by the group of auxiliaries **70** can be maintained without the control contents being much changed from the basic control in performing the specific control. In step S**30**, therefore, whether the current time is in a night-time period or a day-time period may be determined. In the case of the night-time period, the second specific control may be performed, and in the case of the day-time period, the first specific control may be performed. From the same perspective, in step S**30**, which of the first specific control and the second specific control to execute may be determined based on, for example, weather. Specifically, in the case of rainy weather, the vehicle **10** is made to travel with the wipers operating, so that the electricity consumed by the group of auxiliaries **70** is highly likely to increase. In step S**30**, therefore, the determination may be performed in such a manner that in the case of rainy weather, the second specific control is performed, and that in the case of fine weather, the first specific control is performed. Thus, what is determined in step S**30** can be changed as appropriate. No matter what manner of determination is adopted in step S**30**, continuing only either the first specific control or the second specific control during a period when the fluctuation condition is met can maintain the direction of electricity supply by the bidirectional converter **50** in the same direction during that period. Thus, burden on the bidirectional converter **50** can be reduced.

[0076] The process of step S**30** may be omitted. The first specific control may be always performed when the determination in step S**10** and the determination in step S**20** each yield a YES. Also in this case, continuing the first specific control until the determination in step

S70 yields a YES, i.e., throughout a period when the fluctuation condition is met, can maintain the direction of electricity supply by the bidirectional converter **50** in the same direction. From the same perspective, the second specific control may be always performed when the determination in step S**10** and the determination in step S**20** each yield a YES. In short, only either the first specific control or the second specific control should be continued during a period when the fluctuation condition is met.

[0077] The process of step S**20** may be omitted. For example, in a case where the capacity of the second battery **40** is relatively small, it is possible to adopt a form in which the first specific control or the second specific control is performed when the determination in step S**10** yields a YES, regardless of whether the temperature of the second battery **40** is high or low.

[0078] If the process of step S**20** is omitted, the temperature sensor **103** may be omitted.

[0079] Regarding step S**10**, the fluctuation condition is not limited to the example in the above-described embodiment. A fluctuation condition of a different substance from the above-described embodiment may be adopted in grasping a state where the fluctuation in the electricity consumed by the group of auxiliaries **70** is large. For example, in connection with fluctuation in the amount of solar radiation, the electricity generated by the solar panel **20** and, by extension, the electricity output by the solar panel **20** can fluctuate within a short time. With this in mind, a condition showing that the fluctuation in the electricity output by the solar panel **20** is large may be adopted as the fluctuation condition. In the case where the fluctuation condition relating to the solar panel **20** is adopted, for example, it is conceivable to set the substance thereof to the effect that a difference between a maximum value and a minimum value of the electricity output by the solar panel **20** during a unit period is equal to or larger than a criterial value that is set beforehand. The fluctuation condition may take both the electricity output by the solar panel **20** and the electricity consumed by the group of auxiliaries **70** into account, or may take only either of them into account. At a minimum, the fluctuation condition should show that the fluctuation in at least either the electricity output by the solar panel **20** or the electricity consumed by the group of auxiliaries **70** is large. In the case where the fluctuation condition has been changed from the example in the above-described embodiment, the ending condition should be changed accordingly.

[0080] The contents of each mode of basic control are not limited to the example in the above-described embodiment. At a minimum, the first specific control and the second specific control should be configured so as to be able to maintain the same magnitude relationship between the electricity output by the solar converter **30** and the electricity consumed by the group of auxiliaries **70** regardless of the contents of the basic control.

[0081] To restrict the amounts of charge and discharge of the second battery **40** according to the temperature of the second battery **40**, it is possible to impose restrictions on the amount of the electricity output by the solar converter **30**, etc. when the temperature of the second battery **40** is outside the predetermined range. The basic control, the first specific control, and the second specific control may be performed under such restrictions.

[0082] The configuration of each auxiliary **71** is not limited to the example in the above-described embodiment. For example, each auxiliary **71** may be such that the electricity mode can be switched in three or more levels. At a minimum, each auxiliary **71** should be configured to operate by being supplied with the electricity output by the solar converter **30**.

[0083] Depending on the configuration of the path leading from the solar panel **20** to the solar converter **30**, it is possible that alternating-current electricity is input into the solar converter **30**. In this case, the solar converter **30** may be configured to convert the alternating current into a direct current and output the direct current. Thus, the solar converter **30** is not limited to one that converts the voltage, and may instead be one that performs AC-DC conversion or one that rectifies the voltage or the current, according to the circuit configuration around the solar converter **30**.

[0084] The bidirectional converter **50** may be composed of a plurality of converters. This group of converters may realize the functions of performing voltage conversion and switching the direction of electricity supply among the first battery **60**, the group of auxiliaries **70**, and the solar converter **30**.

[0085] The overall configuration of the vehicle **10** and, by extension, that of the electricity supply system **10**A are not limited to the example in the above-described embodiment. For example, the second battery **40** may be omitted.

[0086] The control device **90** may be composed of a plurality of information processing devices that individually controls the devices such as the group of auxiliaries **70**, the solar converter **30**, and the bidirectional converter **50**. Each information processing device is a computer equipped with a processing circuit including a CPU and a memory. Also in the case where the control device **90** is composed of a plurality of information processing devices, if these information processing devices are able to exchange information with one another, the various processes and controls described in the above-described embodiment and the above-described modified examples can be realized.

[0087] The configuration of the processing circuit of the control device **90** is not limited to the example in the above-described embodiment. At a minimum, the processing circuit should have the configuration of one of the following (a) to (c):

[0088] (a) The processing circuit includes one or more processors that execute various processes according to a computer program. Each processor includes a CPU and a memory such as an RAM and an ROM. The memory stores program codes or commands configured to cause the CPU to execute processes. As the memory, i.e., a computer-readable medium, all available media that can be accessed by a general-or special-purpose computer are included.

[0089] (b) The processing circuit includes one or more dedicated hardware circuits that execute various processes. Examples of dedicated hardware circuits include an application-specific integrated circuit, i.e., an ASIC and an FPGA.

[0090] (c) The processing circuit includes a processor that executes some of the various processes according to a computer program, and a dedicated hardware circuit that executes the other processes of the various processes.

Additional Statement

[0091] The above-described embodiment and modified examples include the configurations described in the following additional statement.

[0092] [Additional Statement 1] An electricity supply system, including: a solar panel; a solar converter that is able to convert electricity output by the solar panel and output the converted electricity; a group of auxiliaries that is supplied with the electricity output by the solar converter; a battery; a bidirectional converter that is able to convert a voltage of electricity output by the battery and supply the converted electricity to the group of auxiliaries, as well as to convert a voltage of the electricity output by the solar converter and supply the converted electricity to the battery; and a control device configured to control the solar converter, the group of auxiliaries, and the bidirectional converter, wherein: the control device executes switching control that, when the electricity output by the solar converter is higher than electricity consumed by the group of auxiliaries, controls the bidirectional converter such that the electricity is directed from the solar converter to the battery, whereas when the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries, controls the bidirectional converter such that the electricity is directed from the battery to the group of auxiliaries; and during a period when a fluctuation condition is met that is set beforehand as a condition showing that fluctuation in at least either the electricity output by the solar panel or the electricity consumed by the group of auxiliaries is large, the control device executes specific control that controls one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same.

[0093] [Additional Statement 2] The electricity supply system according to [Additional Statement 1], wherein the fluctuation condition is that a difference between a maximum value and a minimum value of the electricity consumed by the group of auxiliaries during a unit period is equal to or larger than a specified value that is set beforehand.

[0094] [Additional Statement 3] The electricity supply system according to [Additional Statement 1] or [Additional Statement 2], including, with the battery being a first battery, a second battery to and from which the electricity output by the solar converter is chargeable and dischargeable, and a temperature sensor that detects a temperature of the second battery, wherein the control device executes the specific control based on a requisite condition that the temperature of the second battery is outside a predetermined range that is set beforehand.

[0095] [Additional Statement 4] The electricity supply system according to any one of [Additional Statement 1] to [Additional Statement 3], wherein when the electricity output by the solar converter is higher than the electricity consumed by the group of auxiliaries at a timing when a state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met, the bidirectional converter is controlled in the specific control such that the electricity supplied from the bidirectional converter to the battery becomes lower than that in the state where the fluctuation condition is not met.

[0096] [Additional Statement 5] The electricity supply system according to any one of [Additional Statement 1] to [Additional Statement 4], wherein when the electricity output by the solar converter is higher than the electricity consumed by the group of auxiliaries at a timing when a state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met, the group of auxiliaries is controlled in the specific control such that the electricity consumed by the group of auxiliaries becomes lower than that in the state where the fluctuation condition is not met.

[0097] [Additional Statement 6] The electricity supply system according to any one of [Additional Statement 1] to [Additional Statement 5], wherein when the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries at a timing when a state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met, the solar converter is controlled in the specific control such that the electricity output by the solar converter becomes lower than that in the state where the fluctuation condition is not met.

[0098] [Additional Statement 7] The electricity supply system according to any one of [Additional Statement 1] to [Additional Statement 6], wherein when the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries at a timing when a state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met, the group of auxiliaries is controlled in the specific control such that the electricity consumed by the group of auxiliaries becomes higher than that in the state where the fluctuation condition is not met.

What is claimed is:

1. An electricity supply system, comprising:

a solar panel;

a solar converter that is able to convert electricity output by the solar panel and output the electricity;

a group of auxiliaries that is supplied with the electricity output by the solar converter;

a battery;

a bidirectional converter that is able to convert a voltage of electricity output by the battery and supply the electricity to the group of auxiliaries, as well as to convert a voltage of the electricity output by the solar converter and supply the electricity to the battery; and

a control device configured to control the solar converter, the group of auxiliaries, and the bidirectional converter, wherein:

the control device is configured to execute the following as switching control:

when a first condition is met, controlling the bidirectional converter such that the electricity is directed from the solar converter to the battery; and

when a second condition is met, controlling the bidirectional converter such that the electricity is directed from the battery to the group of auxiliaries;

the first condition is a condition that the electricity output by the solar converter is higher than electricity consumed by the group of auxiliaries;

the second condition is a condition that the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries;

the control device is configured to execute specific control during a period when a fluctuation condition is met;

the fluctuation condition is a condition that is set beforehand as a condition showing that fluctuation in at least either the electricity output by the solar panel or the electricity consumed by the group of auxiliaries is large; and

the specific control is control configured to control one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same.

2. The electricity supply system according to claim **1**, wherein the fluctuation condition is a condition that a difference between a maximum value and a minimum value of the electricity consumed by the group of auxiliaries during a unit period is equal to or larger than a specified value that is set beforehand.

3. The electricity supply system according to claim **1**, further comprising:

a second battery to and from which the electricity output by the solar converter is chargeable and dischargeable; and

a temperature sensor configured to detect a temperature of the second battery, wherein:

the battery is a first battery; and

the control device is configured to execute the specific control based on a requisite condition that the temperature of the second battery is outside a predetermined range that is set beforehand.

4. The electricity supply system according to claim **1**, wherein:

the control device is configured to, when the first condition is met at a predetermined timing, control the bidirectional converter in the specific control such that the electricity supplied from the bidirectional converter to the battery becomes lower than that in a state where the fluctuation condition is not met; and

the predetermined timing is a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

5. The electricity supply system according to claim **1**, wherein:

the control device is configured to, when the first condition is met at a predetermined timing, control the group of auxiliaries in the specific control such that the electricity consumed by the group of auxiliaries becomes lower than that in a state where the fluctuation condition is not met; and

the predetermined timing is a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

6. The electricity supply system according to claim **1**, wherein:

the control device is configured to, when the second condition is met at a predetermined timing, control the solar converter in the specific control such that the electricity output by the solar converter becomes lower than that in a state where the fluctuation condition is not met; and

the predetermined timing is a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

7. The electricity supply system according to claim **1**, wherein:

the control device is configured to, when the second condition is met at a predetermined timing, control the group of auxiliaries in the specific control such that the electricity consumed by the group of auxiliaries becomes higher than that in a state where the fluctuation condition is not met; and

the predetermined timing is a timing when the state where the fluctuation condition is not met has switched to a state where the fluctuation condition is met.

8. A control device configured to execute control of a solar converter, a group of auxiliaries, and a bidirectional converter as a processor executes instructions stored in a storage medium, the control device comprising the processor, wherein:

the control device is configured to apply the control to a vehicle;

the vehicle includes the following:

a solar panel;

the solar converter that is able to convert electricity output by the solar panel and output the electricity;

a group of auxiliaries that is supplied with the electricity output by the solar converter;

a battery; and

the bidirectional converter that is able to convert a voltage of electricity output by the battery and supply the electricity to the group of auxiliaries, as well as to convert a voltage of the electricity output by the solar converter and supply the electricity to the battery;

the control device is configured to execute the following as switching control:

when the electricity output by the solar converter is higher than electricity consumed by the group of auxiliaries, controlling the bidirectional converter such that the electricity is directed from the solar converter to the battery; and

when the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries, controlling the bidirectional converter such that the electricity is directed from the battery to the group of auxiliaries;

the control device is configured to execute specific control during a period when a fluctuation condition is met;

the fluctuation condition is a condition that is set beforehand as a condition showing that fluctuation in at least either the electricity output by the solar panel or the electricity consumed by the group of auxiliaries is large; and

the specific control is control configured to control one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same.

9. A non-transitory storage medium storing instructions that are executable by one or more processors and that cause the one or more processors of a control device to perform functions comprising:

executing switching control that, when electricity output by a solar converter is higher than electricity consumed by a group of auxiliaries, controls a bidirectional converter such that the electricity is directed from the solar converter to a battery, whereas when the electricity output by the solar converter is lower than the electricity consumed by the group of auxiliaries, controls the bidirectional converter such that the electricity is directed from the battery to the group of auxiliaries; and

executing specific control during a period when a fluctuation condition is met, wherein:

the fluctuation condition is a condition that is set beforehand as a condition showing that fluctuation in at least either electricity output by a solar panel or the electricity consumed by the group of auxiliaries is large;

the specific control is control that controls one or more selected from the solar converter, the group of auxiliaries, and the bidirectional converter such that a magnitude relationship between the electricity output by the solar converter and the electricity consumed by the group of auxiliaries remains the same;

the functions are applied to a vehicle; and

the vehicle includes the following:

the solar panel;

the solar converter that is able to convert the electricity output by the solar panel and output the electricity;

the group of auxiliaries that is supplied with the electricity output by the solar converter;

the battery;

the bidirectional converter that is able to convert a voltage of the electricity output by the battery and supply the electricity to the group of auxiliaries, as well as to convert a voltage of the electricity output by the solar converter and supply the electricity to the battery; and

the control device configured to control the solar converter, the group of auxiliaries, and the bidirectional converter.

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