

DESCRIPTION

Title of Invention: BATTERY CONTROL SYSTEM, BATTERY CONTROL METHOD,
BATTERY CONTROL PROGRAM, AND INTEGRATED CONTROLLER

5 Technical Field

[0001]

The present disclosure relates to a battery control system, a battery control method, a battery control program, and an integrated controller.

Background Art

10 [0002]

Patent Document 1 discloses a distributed power supply system including a plurality of distributed power supplies and a control device. Each of the distributed power supplies is used as any of a current source and a voltage source. The current source is operated so as to be synchronized with the voltage and frequency output by the voltage source.

Citation List

Patent Documents

[0003]

Patent Document 1: Japanese Unexamined Patent Application, First Publication
20 No. 2008-278700

Summary of Invention

Problem to be Solved by the Invention

[0004]

In a case where a battery is used as the distributed power supply, a battery used
25 as a voltage source and a battery used as a current source are present when the disclosure

of Patent Document 1 is applied. In this case, the load may be biased in each battery, and the deterioration of a specific battery may progress.

[0005]

In consideration of the above circumstances, an object of the present disclosure
5 is to provide a battery control system, a battery control method, a battery control program, and an integrated controller that can prevent progression of deterioration of a specific battery.

Means to Solve the Problem

[0006]

10 An aspect of a battery control system according to the present disclosure is a battery control system that controls a plurality of batteries, the battery control system including a first inverter configured to convert direct current power from a first battery into alternating current power, a second inverter configured to convert direct current power from a second battery into alternating current power, and an integrated controller
15 configured to control the first inverter and the second inverter, in which the first inverter is configured to switch operations between GFM control for causing the first battery to function as a voltage source and GFL control for causing the first battery to function as a current source, the second inverter is configured to switch operations between GFM control for causing the second battery to function as a voltage source and GFL control for
20 causing the second battery to function as a current source, the integrated controller switches operations of the first inverter and the second inverter between the GFL control and the GFM control based on feature values of the first battery and the second battery or temperatures of the first inverter and the second inverter, and an operating state of the current source is adjusted based on a change in amplitude and frequency in an alternating
25 current voltage generated by the voltage source.

[0007]

An aspect of a battery control method according to the present disclosure includes a step of switching operations of a first inverter is configured to convert direct current power from a first battery into alternating current power and a second inverter is
5 configured to convert direct current power from a second battery into alternating current power between GFL control and GFM control based on feature values of the first battery and the second battery or temperatures of the first inverter and the second inverter, and a step of adjusting an operating state in the GFL control based on a change in amplitude and frequency in an alternating current voltage generated based on the GFM control, in
10 which the GFM control is control for causing the first battery or the second battery to function as a voltage source, and the GFL control is control for causing the first battery or the second battery to function as a current source.

[0008]

A battery control program according to the present disclosure causes a computer
15 to execute a step of switching operations of a first inverter configured to convert direct current power from a first battery into alternating current power and a second inverter configured to convert direct current power from a second battery into alternating current power between GFL control and GFM control based on feature values of the first battery and the second battery or temperatures of the first inverter and the second inverter, and a
20 step of adjusting an operating state in the GFL control based on a change in amplitude and frequency in an alternating current voltage generated based on the GFM control, in which the GFM control causes the first battery or the second battery to function as a voltage source, and the GFL control causes the first battery or the second battery to function as a current source.

25 [0009]

An aspect of an integrated controller according to the present disclosure is an integrated controller that controls a first inverter converting direct current power from a first battery into alternating current power and a second inverter converting direct current power from a second battery into alternating current power, the integrated controller is
5 configured to output an operation switching signal for switching operations of the first inverter and the second inverter between GFL control and GFM control based on feature values of the first battery and the second battery or temperatures of the first inverter and the second inverter, in which the GFM control causes the first battery or the second battery to function as a voltage source, the GFL control causes the first battery or the
10 second battery to function as a current source, and an operating state of the current source is adjusted based on a change in amplitude and frequency in an alternating current voltage generated by the voltage source.

Effects of the Invention

[0010]

15 According to the present disclosure, it is possible to provide the battery control system, the battery control method, battery control program, and the integrated controller that can prevent the deterioration of the battery.

Brief Description of Drawings

[0011]

20 [FIG. 1] A diagram showing a configuration example of a microgrid according to the present disclosure.

[FIG. 2] A diagram showing GFM control according to the present disclosure.

[FIG. 3] A diagram showing GFL control according to the present disclosure.

Description of Embodiments

25 [0012]

Hereinafter, embodiments of the present disclosure will be described with reference to the drawings. The scope of the present disclosure is not limited to the following embodiments, and can be changed in any way within the scope of technical ideas of the present disclosure.

5 [0013]

Embodiment 1.

FIG. 1 is a schematic diagram showing a microgrid in Embodiment 1. As shown in FIG. 1, a microgrid 1 is provided with a power generation facility 2, a plurality of power reception and distribution facilities 4, a plurality of batteries 5, a power
10 transmission and distribution network 6, and a battery control system 10. The battery control system 10 includes an integrated controller 11 and a plurality of power conditioning systems (PCSs) 12. The microgrid 1 is connected to a power system 3 by the power transmission and distribution network 6. In addition, the components in the microgrid 1 are connected to each other by the power transmission and distribution
15 network 6.

[0014]

For example, the power generation facility 2 is a wind power plant, a solar cell, a hydroelectric power plant, or the like. A type of power generation facility 2 other than these facilities may be used. In addition, a combination of a plurality of types of power
20 generation facilities 2 may be used. The microgrid 1 is configured to charge and discharge the plurality of batteries 5 according to a supply and demand situation of power. For example, in a situation where the power demand is low, the plurality of batteries 5 are charged using the power generated by the power generation facility 2. In addition, in a situation where the power demand is high, the power generated by the
25 power generation facility 2 and the power of the plurality of batteries 5 are combined and

output to the power system 3. Alternatively, the combined power may be supplied to the load in the microgrid 1.

[0015]

In addition, a switch (not shown), may be provided between the microgrid 1 and the power system 3. The switch can be switched between a closed state and an open state. When the switch is in the closed state, the microgrid 1 and the power system 3 are separated from each other. This state is referred to as an island mode. In the island mode, the microgrid 1 independently generates and consumes power. When the switch is in the open state, the microgrid 1 and the power system 3 are connected. This state is referred to as a system connection mode.

[0016]

For example, each battery 5 may be a lithium-ion battery, a NAS battery, a redox flow battery, or the like. Another type of battery 5 may be used. Each PCS 12 incorporates an inverter INV that controls the charging and discharging of each battery 5. In addition, each PCS 12 includes a control unit C that controls the inverter INV, a communication unit T that communicates with the integrated controller 11, and the like.

[0017]

In the following description, any two PCSs of the plurality of PCSs 12 are referred to as a first PCS 12a and a second PCS 12b. In addition, any two PCSs of the plurality of batteries 5 are referred to as a first battery 5a and a second battery 5b. The first PCS 12a controls the charging and discharging of the first battery 5a, and the second PCS 12b controls the charging and discharging of the second battery 5b. In addition, the inverter INV included in the first PCS 12a is referred to as a "first inverter". The inverter INV included in the second PCS 12b is referred to as a "second inverter".

[0018]

The first PCS 12a and the second PCS 12b can switch operations between grid following (GFL) control and grid forming (GFM) control. The GFL control is an operation for causing the corresponding battery 5 to function as a current source. The GFM control is an operation for causing the corresponding battery 5 to function as a voltage source. That is, the first PCS 12a can switch whether to cause the first battery 5a to function as a voltage source or a current source. Similarly, the second PCS 12b can switch whether to cause the second battery 5b to function as a voltage source or a current source.

[0019]

The integrated controller 11 switches the operation of the first PCS 12a and the second PCS 12b between the GFL control and the GFM control. Specifically, the integrated controller 11 outputs an operation switching signal to the first PCS 12a and the second PCS 12b. The operation switching signal is a signal for switching the operation between the GFL control and the GFM control.

[0020]

The integrated controller 11 may output the operation switching signal to the first PCS 12a and the second PCS 12b based on the temperatures of the first inverter and the second inverter. In this case, the temperatures of the first inverter and the second inverter are input to the integrated controller 11. The integrated controller 11 outputs the operation switching signal to the first PCS 12a and the second PCS 12b such that a temperature difference between the first inverter and the second inverter is low.

[0021]

For example, a case is assumed where the temperature of the inverter performing the GFM control tends to be higher than that of the inverter performing the GFL control.

In addition, it is assumed that the first inverter performs the GFM control and the second

inverter performs the GFL control. The integrated controller 11 calculates a temperature difference between the first inverter and the second inverter. In a case where the temperature difference exceeds a threshold value, the integrated controller 11 outputs an operation switching signal for performing the GFL control to the first PCS 12a. Furthermore, the integrated controller 11 outputs an operation switching signal for performing the GFM control to the second PCS 12b.

[0022]

As a result, the temperature difference between the first inverter and the second inverter is low. Therefore, it is possible to prevent only the specific inverter included in the microgrid 1 from being heated to a high temperature. In other words, it is possible to level the load of the plurality of inverters included in the microgrid 1.

[0023]

In addition, the integrated controller 11 may output the operation switching signal to the first PCS 12a and the second PCS 12b based on the feature values of the first battery 5a and the second battery 5b. In this case, the feature values of the first battery 5a and the second battery 5b are input to the integrated controller 11. For example, the feature value is a parameter such as a temperature, a state of charge (SOC), or a state of health (SOH). In addition, these parameters may be used in combination. The integrated controller 11 outputs the operation switching signal to the first PCS 12a and the second PCS 12b such that the difference in feature values between the first battery 5a and the second battery 5b is small.

[0024]

For example, a case is assumed where the battery in which the GFM control is performed tends to deteriorate more than the battery in which the GFL control is performed. In addition, it is assumed that the first inverter performs the GFM control

and the second inverter performs the GFL control. The integrated controller 11 calculates a difference in feature values between the first battery 5a and the second battery 5b. In a case where the difference exceeds the threshold value, the integrated controller 11 outputs an operation switching signal for performing the GFL control to the first PCS 12a. Furthermore, the integrated controller 11 outputs an operation switching signal for performing the GFM control to the second PCS 12b.

[0025]

As a result, the difference in feature values between the first battery 5a and the second battery 5b is reduced. Therefore, it is possible to prevent the progression of deterioration only in the specific battery included in the microgrid 1. In other words, it is possible to level the degree of deterioration of the plurality of batteries included in the microgrid 1. The above-described term "threshold value" is determined in advance by, for example, a preliminary experiment and is stored in a memory or the like of the integrated controller 11.

[0026]

The integrated controller 11 includes a calculation unit, a communication unit, and the like. The calculation unit is a CPU or the like and performs calculations for realizing the function of the integrated controller 11. The communication unit performs wireless or wired communication with each PCS 12. For example, the operation switching signal generated by the calculation unit is transmitted to each PCS 12 via the communication unit.

[0027]

In addition, in the present embodiment, the operating states of the battery and the inverter as the current source are adjusted based on the change in the amplitude and the frequency in the alternating current voltage generated by the battery and the inverter

as the voltage source. For example, the "operating state" is the magnitude of the active power and the reactive power. In the following description, the inverter that performs the GFL control is referred to as a "current source inverter". Similarly, the inverter that performs the GFM control is referred to as a "voltage source inverter". Hereinafter, an
5 example of the GFM control and the GFL control will be described with reference to FIGS. 2 and 3.

[0028]

FIG. 2 is a diagram showing an example of GFM control. The "power supply target" shown in FIG. 2 is a target of power supply by the plurality of batteries 5. For
10 example, in a case where the plurality of batteries 5 supply power to the power system 3, the power line connecting the microgrid 1 and the power system 3 is a "power supply target". At least one of the plurality of batteries 5 included in the microgrid 1 is used as a voltage source. In other words, at least one inverter of the plurality of PCSs 12
included in the microgrid 1 performs the GFM control.

15 [0029]

The Q_{measure} shown in FIG. 2 is an actual measurement value of the reactive power Q supplied to the power supply target. P_{measure} is an actual measurement value of the active power P supplied to the power supply target. The actual measurement value Q_{measure} and the actual measurement value P_{measure} are measured by, for
20 example, a measuring instrument attached to a power line to be the power supply target. The measured actual measurement value Q_{measure} and the actual measurement value P_{measure} are subjected to zero order hold (ZOH) and are input to the PCS 12 that performs the GFM control. Hereinafter, the processing in the control unit C of the PCS
12 will be described.

25 [0030]

Q_{ref} is a command value of the reactive power Q . P_{ref} is a command value of the active power P . For example, the command value P_{ref} and the command value Q_{ref} may be calculated by the integrated controller 11. The command value P_{ref} and the command value Q_{ref} are input to the control unit C of the PCS 12 that performs the GFM control.

[0031]

The control unit C that performs the GFM control calculates a deviation dQ between the command value Q_{ref} and the actual measurement value $Q_{measure}$ related to the reactive power Q . The control unit C performs the Q_v control in a control block B11 of FIG. 2. In the " Q_v control", the amplitude of the alternating current voltage output to the power supply target by the voltage source inverter is calculated based on the command value Q_{ref} . In addition, the Q_v control is feedback control for bringing the deviation dQ close to zero. This feedback control may be, for example, PI control. In addition, the control unit C adds the rated voltage V_m [V] to the output in the control block B11. A value obtained by addition is an output amplitude V_v of the voltage output to the power supply target by the voltage source inverter.

[0032]

The control unit C that performs the GFM control performs the virtual synchronous generator control as shown in a control block B12 of FIG. 2. The virtual synchronous generator control is control of imparting characteristics imitating a synchronous generator when the voltage source inverter converts direct current power of the battery 5 into alternating current power. The virtual synchronous generator control is also referred to as virtual synchronous generator (VSG) control. By performing the VSG control, it is possible to impart inertia to the alternating current power generated by using the battery 5 and to enhance stability against load fluctuation. The control block

B12 shown in FIG. 2 shows a specific example of the VSG control.

[0033]

The control unit C that performs the VSG control calculates a deviation dP between a command value P_{ref} and an actual measurement value $P_{measure}$ related to the active power P. In addition, the control unit C calculates a deviation df related to the frequency based on the deviation dP . When the deviation df is calculated, a transfer function simulating the damper component D and the inertia component M of the actual synchronous generator is set. The control unit C adds the rated frequency f_n [Hz] to the deviation df of which is the output in the control block B12. A value obtained by addition is an output frequency f_v at which the voltage source inverter outputs to the power supply target. In addition, the control unit C performs the governor control as shown in a control block B13. The governor control is control that imitates a governor that keeps the synchronous generator at a constant rotation speed.

[0034]

The voltage source inverter supplies an alternating current voltage having an output amplitude V_v and an output frequency f_v to a power supply target. The above is the operation of the PCS 12 that performs the GFM control as the voltage source. Next, an operation of the PCS 12 that performs the GFL control as the current source will be described.

[0035]

FIG. 3 is a diagram showing an example of the GFL control. V and f shown in FIG. 3 are actual measurement values of the alternating current voltage supplied from the voltage source inverter. V and f are a set of an actual measurement value of the voltage amplitude V and an actual measurement value of the frequency f . The current actual measurement value $I_{measure}$ is an actual measurement value of the current supplied to

the power supply target. In a case where the voltage amplitude corresponding to the frequency component of the frequency f , which is the actual measurement value, is the main component of the voltage waveform, the control described below may be performed using the effective voltage value instead of the described-above actual measurement value of the voltage amplitude V .

[0036]

The voltage amplitude V , the frequency f , and the current actual measurement value I_{measure} of the alternating current voltage are measured by, for example, a measuring instrument attached to a power line to be the power supply target. The measured actual measurement values V and f , and the current actual measurement value I_{measure} are subjected to zero order hold (ZOH) and are input to the PCS 12 that performs the GFL control. In the control unit C of the PCS 12, the fP control and the vQ control shown in a control block B21 of FIG. 3 are performed. In the " fP control", the control unit C calculates a target value P_{target} of the active power P based on the frequency f which is the actual measurement value. In the " vQ control", the control unit C calculates a target value Q_{target} of the reactive power Q based on the voltage amplitude V which is the actual measurement value. For example, a case where a set value f_r of the frequency f and a set value V_r of the voltage amplitude V , which are determined in advance by the control unit C , are present is considered. In this case, the control unit C calculates the target value P_{target} such that a difference between the set value f_r and the frequency f , which is the actual measurement value, is small. In addition, the control unit C calculates the target value Q_{target} such that a difference between the set value V_r and the voltage amplitude V , which is the actual measurement value, is small.

[0037]

Next, as shown in a control block B22 of FIG. 3, the current conversion is performed. That is, the control unit C of the PCS 12 converts the target value P_{target} and the target value Q_{target} into the current command value I_{ref} . In addition, the control unit C calculates a deviation ΔI between the current command value I_{ref} and the current actual measurement value $I_{measure}$. The control unit C performs feedback control with the deviation ΔI as an input in the control block B23. The transfer function in the control block B23 is set such that the deviation ΔI approaches zero. This feedback control may be, for example, PI control.

[0038]

The control unit C performs addition based on the voltage amplitude V , which is the actual measurement value, on the output of the control block B23. Based on the result of the addition, the current source inverter supplies power to the power supply target. The above is the operation of the PCS 12 that performs the GFM control as the current source.

[0039]

As described above, in the GFM control, the battery 5 and the inverter INV function as a voltage source, and the output amplitude V_v and the output frequency f_v in the alternating current voltage are generated. In the GFL control, the battery 5 and the inverter INV function as a current source, and supply the current (the active power P and the reactive power Q) based on the actual measurement values V and f . As a result, the active power and the reactive power supplied to the power supply target by the voltage source inverter can be shared by the current source inverter.

[0040]

The functions of the integrated controller 11 and the PCS 12 described above are realized by, for example, a processor such as a central processing unit (CPU) executing a

program stored in a program memory. A part or all of these functions may be realized by hardware such as a large scale integration (LSI), an application specific integrated circuit (ASIC), or a field-programmable gate array (FPGA), or may be realized by cooperation between software and hardware.

5 [0041]

The program for realizing the functions of the PCS 12 and the integrated controller 11 described above is recorded on, for example, a computer-readable recording medium. The program recorded on the recording medium may be read by the computer and executed to perform the processing in the PCS 12 and the integrated controller 11
10 described above. Here, the phrase "reading and executing a program recorded on a recording medium in a computer" includes installing the program on the computer. The term "computer" here includes hardware such as an OS and peripheral devices.

[0042]

In addition, the term "computer" may include a plurality of computer devices
15 connected via a network including a communication line such as the Internet, a WAN, a LAN, or a dedicated line. In addition, the term "computer-readable recording medium" refers to a portable medium such as a flexible disk, a magneto-optical disk, a ROM, or a CD-ROM, and a storage device such as a hard disk incorporated in a computer. As
described above, the recording medium on which the program is stored may be a non-
20 transitory recording medium such as a CD-ROM.

[0043]

In addition, the recording medium also includes an internal or external recording medium that is accessible by a distribution server to distribute the program. The program may be divided into a plurality of parts, and the parts may be downloaded at
25 different timings and then combined by the PCS 12 and the integrated controller 11. In

addition, the distribution servers that distribute each of the divided programs may be different from each other. Furthermore, the term “computer-readable recording medium” also includes a medium that holds the program for a certain period of time, such as a volatile memory (RAM) inside the computer that serves as a server or a client
 5 in a case where the program is transmitted via a network. In addition, the above-described program may be a program for realizing some of the above-described functions. Furthermore, the program may be a so-called difference file (difference program) that can realize the above-described functions in combination with a program already recorded on the computer.

10 [0044]

As described above, the battery control system 10 according to the present embodiment is a battery control system 10 that controls a plurality of batteries 5, and is provided with the first inverter that converts direct current power from the first battery 5a into alternating current power, the second inverter that converts direct current power
 15 from the second battery 5b into alternating current power, and the integrated controller 11 that controls the first inverter and the second inverter. The first inverter can switch operations between the GFM control for causing the first battery 5a to function as a voltage source and the GFL control for causing the first battery 5 to function as a current source. The second inverter can switch operations between the GFM control for
 20 causing the second battery 5b to function as a voltage source and the GFL control for causing the second battery 5b to function as a current source. The integrated controller 11 switches the operation of the first inverter and the second inverter between the GFL control and the GFM control based on the feature values of the first battery 5a and the second battery 5b or the temperatures of the first inverter and the second inverter. The
 25 operating state (the active power P and the reactive power Q) of the current source is

adjusted based on the change in the amplitude V and the frequency f in the alternating current voltage generated by the voltage source.

[0045]

According to the battery control system 10, it is possible to level the degree of deterioration of the plurality of batteries 5, and to prevent progression of deterioration only in the specific battery 5. Alternatively, it is possible to level the loads of the plurality of inverters, and to prevent only a specific inverter from being heated to a high temperature.

[0046]

10 In addition, the term “feature value” may be at least one of the temperature, the SOC, and the SOH. For example, in a case where the temperature is used as the feature value, the temperatures of the plurality of batteries 5 can be leveled. In a case where the SOC is used as the feature value, the SOC of the plurality of batteries 5 can be leveled. In a case where the SOH is used as the feature value, the SOH of the plurality of batteries 5 can be leveled.

[0047]

The present disclosure proposes a battery control method as follows. That is, the battery control method includes a step of switching operations of the first inverter that converts direct current power from the first battery 5a into alternating current power and the second inverter that converts direct current power from the second battery 5b into alternating current power between the GFL control and the GFM control based on feature values of the first battery 5a and the second battery 5b or temperatures of the first inverter and the second inverter, and a step of adjusting the operating state in the GFL control based on a change in amplitude V and frequency f in an alternating current voltage generated based on the GFM control. In the control method, the GFM control is

control for causing the first battery 5a or the second battery 5b to function as a voltage source, and the GFL control is control for causing the first battery 5a or the second battery 5b to function as a current source.

[0048]

5 In addition, the present disclosure proposes a battery control program as follows.

That is, the battery control program causes the computer to execute a step of switching operations of the first inverter and the second inverter between the GFL control and the GFM control based on the feature values of the first battery 5a and the second battery 5b or temperatures of the first inverter that converts direct current power from the first
10 battery 5a into alternating current power and the second inverter that converts direct current power from the second battery 5b into alternating current power, and a step of adjusting an operating state in the GFL control based on a change in amplitude and frequency in the alternating current voltage generated based on the GFM control. The GFM control is a control for causing the first battery 5a or the second battery 5b to
15 function as a voltage source, and the GFL control is control for causing the first battery 5a or the second battery 5b to function as a current source.

[0049]

Embodiment 2.

Next, a microgrid 1 and a battery control system 10 according to Embodiment 2
20 will be described. The microgrid 1 and the battery control system 10 according to the present embodiment have the same basic configuration as that of Embodiment 1, and thus, the description will be made focusing on the different points.

[0050]

In the present embodiment, the integrated controller 11 allocates the reference
25 power to each of the plurality of PCSs 12. The "reference power" is generated by the

plurality of PCSs 12 using the plurality of batteries 5, and is set such that the combined power is suitable for the power demand. For example, in the GFM control, the values of Q_{ref} and P_{ref} shown in FIG. 2 are set to values reflecting the reference power. In addition, in the GFL control, the values of Q_{target} and P_{target} shown in FIG. 3 are set to values reflecting the reference power.

[0051]

As described above, the integrated controller 11 sets the reference power for each PCS 12 (that is, each inverter INV), so that the loads of the plurality of batteries 5 can be leveled.

10 [0052]

However, the technical scope of the present disclosure is not limited to the above embodiments, and various modifications can be made without departing from the gist of the present disclosure.

[0053]

15 For example, the GFM control and the GFL control shown in FIGS. 2 and 3 are merely examples. The GFM control may be such that the electrical energy of the battery 5 can be extracted as a voltage source. In addition, the GFL control may be such that the electrical energy of the battery 5 can be extracted as a current source.

[0054]

20 In addition, the microgrid 1 may be completely independent of the power system 3. That is, a configuration may be adopted in which the power of the battery 5 is supplied only to the load (for example, a house in a rural area) included in the microgrid 1. In this case as well, the effect of preventing deterioration of the plurality of batteries 5 can be obtained.

25 [0055]

In addition, in the embodiment, the inverter INV of the PCS 12 that performs the GFL control adjusts the operating state (the active power P and the reactive power Q) of the current source based on the change in the amplitude V and the frequency f in the alternating current voltage generated by the voltage source. The present invention is not limited thereto, and for example, the integrated controller 11 may adjust the operating state of the current source.

[0056]

In addition, the above-described embodiments or modification examples may be combined as appropriate.

10 Reference Signs List

[0057]

5a First battery

5b Second battery

10 Battery control system

15 11 Integrated controller

CLAIMS

[Claim 1] A battery control system that controls a plurality of batteries, the battery control system comprising:

5 a first inverter configured to convert direct current power from a first battery into alternating current power;

a second inverter configured to convert direct current power from a second battery into alternating current power; and

an integrated controller configured to control the first inverter and the second inverter, wherein

10 the first inverter is configured to switch operations between GFM control for causing the first battery to function as a voltage source and GFL control for causing the first battery to function as a current source,

the second inverter is configured to switch operations between GFM control for causing the second battery to function as a voltage source and GFL control for causing
15 the second battery to function as a current source,

the integrated controller switches operations of the first inverter and the second inverter between the GFL control and the GFM control based on feature values of the first battery and the second battery or temperatures of the first inverter and the second inverter, and

20 an operating state of the current source is adjusted based on a change in amplitude and frequency in an alternating current voltage generated by the voltage source.

[Claim 2] The battery control system according to Claim 1, wherein

the feature value is at least one of a temperature, an SOC, and an SOH.

25 [Claim 3] The battery control system according to Claim 1 or 2, wherein

the integrated controller sets reference power for the first inverter and the second inverter.

[Claim 4] The battery control system according to Claim 1 or 2, wherein

the operating state is active power and reactive power of the current source, and
5 the first inverter or the second inverter that performs the GFL control adjusts the active power and the reactive power of the current source based on the change in the amplitude and the frequency.

[Claim 5] A battery control method comprising:

a step of switching operations of a first inverter configured to convert direct
10 current power from a first battery into alternating current power and a second inverter configured to convert direct current power from a second battery into alternating current power between GFL control and GFM control based on feature values of the first battery and the second battery or temperatures of the first inverter and the second inverter; and
a step of adjusting an operating state in the GFL control based on a change in
15 amplitude and frequency in an alternating current voltage generated based on the GFM control, wherein

the GFM control is control for causing the first battery or the second battery to function as a voltage source, and

the GFL control is control for causing the first battery or the second battery to
20 function as a current source.

[Claim 6] A battery control program that causes a computer to execute:

a step of switching operations of a first inverter configured to convert direct
current power from a first battery into alternating current power and a second inverter
configured to convert direct current power from a second battery into alternating current
25 power between GFL control and GFM control based on feature values of the first battery

and the second battery or temperatures of the first inverter and the second inverter; and

a step of adjusting an operating state in the GFL control based on a change in amplitude and frequency in an alternating current voltage generated based on the GFM control, wherein

5 the GFM control causes the first battery or the second battery to function as a voltage source, and

 the GFL control causes the first battery or the second battery to function as a current source.

[Claim 7] An integrated controller that controls a first inverter converting direct
10 current power from a first battery into alternating current power and a second inverter converting direct current power from a second battery into alternating current power,

 wherein the integrated controller is configured to output an operation switching signal for switching operations of the first inverter and the second inverter between GFL control and GFM control based on feature values of the first battery and the second
15 battery or temperatures of the first inverter and the second inverter,

 the GFM control causes the first battery or the second battery to function as a voltage source,

 the GFL control causes the first battery or the second battery to function as a current source, and

20 an operating state of the current source is adjusted based on a change in amplitude and frequency in an alternating current voltage generated by the voltage source.