POWER-DEMAND CONTROL APPARATUS AND METHOD

Background

The present invention relates to power-demand control apparatus and method capable of controlling operation of loading apparatuses such that the predicted power consumption does not exceed the target power consumption.

In the past, power demand is controlled as follows (for example, see Japanese Patent Application Laid-open No. H04-183226). A consumption (i.e., real power consumption) of power supplied from the outside by an electric-load group of a customer from the start of a control-interval period (i.e., predetermined period) until the current time is measured for each control-interval period. A consumption of power supplied from the outside during the control-interval period is predicted based on the measured real power consumption. If the predicted power consumption based on the prediction exceeds a preset target power consumption, operation of loading apparatuses of the electric-load group, which are registered as an apparatus for adjustment of power consumption, are controlled such that the real power consumption does not exceed the preset target power consumption.

With reference to Fig. 7, an example of a power-demand control of a related art will be described. Fig. 7 shows a central monitoring apparatus 100 and an electric-load group 200 of a customer. The electric-load group 200 includes loading apparatuses, i.e., an air conditioner, a pump, a fan, a PAC (water-cooling/air-

cooling packaged air conditioner), a chiller/boiler, a centrifugal chiller, a heat storage tank, and a like. The operation of the central monitoring apparatus 100 is realized by hardware and programs. The hardware includes a processor and storage. The programs realize various functions when the hardware executes the programs. A power-demand control program, which is one of the programs, is installed in the central monitoring apparatus 100.

Based on the power-demand control program, the central monitoring apparatus 100 measures a consumption (i.e., real power consumption PW_R) of power supplied from the outside by the electric-load group 200 of a customer from the start of a control-interval period T (e.g., thirty minutes) until the current time for each control-interval period T. Then, the central monitoring apparatus 100 predicts a consumption of power supplied from the outside during the control-interval period T based on the measured real power consumption PW_R. The central monitoring apparatus 100 compares the predicted power consumption PW_P based on the prediction with a preset target power consumption PW_T.

Here, if the predicted power consumption PW_P exceeds the target power consumption PW_T, the central monitoring apparatus 100 controls operation of loading apparatuses of the electric-load group 200, which are registered as apparatuses for adjustment of power consumption, such that the difference between the predicted power consumption PW_P and the target power consumption PW_T (i.e., power-to-be-adjusted) becomes zero. For example, the central monitoring apparatus 100 sends an instruction

to lower a set value of temperature and an instruction to lower a set value of CO2 concentration to the air conditioner. The central monitoring apparatus 100 sends stop instructions to the pump, the fan, the PAC, and the like. The central monitoring apparatus 100 sends an instruction to change allocation of intensity and the like to each of the chiller/boiler and the centrifugal chiller. The central monitoring apparatus 100 sends a startup instruction to the heat storage tank.

Summary

However, some apparatuses of the electric-load group 200 are operated irrespective of power-demand control. For example, apparatuses such as a lifting pump and a drain pump are operated based on the level of water in a tank. They are operated irrespective of the power-demand control.

Fig. 8 shows the way to control a drain pump automatically. Fig. 8 shows a drain pump 1A, a water gauge 2A, and a tank 3A. The drain pump 1A is controlled automatically as follows. If the water level is equal to or higher than a predetermined level, the drain pump 1A is turned on, and water is drained from the tank 3A. Then, if the water level becomes equal to or lower than the predetermined level, the drain pump 1A is turned off, and water is not drained from the tank 3A anymore.

Fig. 9 shows the way to control a lifting pump automatically. Fig. 9 shows a lifting pump 1B, a water gauge 2B, and a tank 3B. The lifting pump 1B is controlled automatically as follows. If the water level is equal to or lower than a predetermined level, the lifting pump 1B is turned on, and water is supplied to

the tank 3B. Then, if the water level becomes equal to or higher than the predetermined level, the lifting pump 1B is turned off, and water is not supplied to the tank 3B anymore.

In addition, a ventilation fan is one example of an apparatus, which is operated irrespective of power-demand control. The ventilation fan is started and stopped based on the CO2 concentration or the CO concentration of a parking.

As described above, some apparatuses of the electric-load group 200 are operated irrespective of power-demand control. Because of this, according to the power-demand control of the related art, the following situation may occur frequently. That is, such apparatuses are started during a peak period (i.e., period in which power may be overused). Then the predicted power consumption exceeds the target power consumption. Then other apparatuses are forced to be stopped.

Embodiments of the present invention are made to solve the above-mentioned problems. Embodiments of the present invention provide power-demand control apparatus and method capable of reducing the frequency of starting apparatuses, which are operated irrespective of power-demand control, during a period in which power may be overused, and having a smaller impact on power-demand control.

According to a first aspect of the present invention, there is provided a power-demand control apparatus for controlling power demand, the power-demand control apparatus being configured to measure a real power consumption for each control-interval period, the control-interval period being a predetermined period, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time, to predict a consumption of power supplied from the outside during the control-interval period based on the measured real power consumption, and to control, if the predicted power consumption based on the prediction exceeds a preset target

power consumption, operation of a loading apparatus of the electric-load group such that the real power consumption fails to exceed the preset target power consumption, the loading apparatus being registered as an apparatus for adjustment of power consumption, the power-demand control apparatus comprising: a real-power-consumption measuring unit configured to measure a real power consumption, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time; a power predicting unit configured to predict a consumption of power supplied from the outside during the control-interval period based on the real power consumption, the real power consumption being measured by the real-power-consumption measuring unit; a standby-apparatus storage unit configured to store information on a loading apparatus of the electric-load group as a standby apparatus, the loading apparatus being registered as an apparatus operated irrespective of power-demand control; an additional-startup-control unit configured to compare the predicted power consumption with the target power consumption, the predicted power consumption being predicted by the power predicting unit, and to output a startup instruction to an additional-startup-apparatus if there is a margin between the predicted power consumption and the target power consumption, the predicted power consumption being lower than the target power consumption, the additional-startup-apparatus being the standby apparatus capable of being started by using the margin power; and a unit configured to ban operation of the additional-startup-control unit until an elapsed time after the control-interval period is started is within a predetermined period.

According to a second aspect of the present invention, there is provided a power-demand control method for controlling power demand, the power-demand control method including measuring a real power consumption for each control-

interval period, the control-interval period being a predetermined period, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time, predicting a consumption of power supplied from the outside during the control-interval period based on the measured real power consumption, and controlling, if the predicted power consumption based on the prediction exceeds a preset target power consumption, operation of a loading apparatus of the electric-load group such that the real power consumption fails to exceed the preset target power consumption, the loading apparatus being registered as an apparatus for adjustment of power consumption, the power-demand control method comprising: measuring a real power consumption, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time; predicting a consumption of power supplied from the outside during the control-interval period based on the measured real power consumption; storing information on a loading apparatus of the electric-load group as a standby apparatus, the loading apparatus being registered as an apparatus operated irrespective of power-demand control; comparing the predicted power consumption based on the prediction with the target power consumption, and outputting a startup instruction to an additional-startup-apparatus if there is a margin between the predicted power consumption and the target power consumption, the predicted power consumption being lower than the target power consumption, the additional-startup-apparatus being the standby apparatus capable of being started by using the margin power; and banning operation of the additional-startup-control until an elapsed time after the control-interval period is started is within a predetermined period. According to embodiments of the present invention, the real power

consumption is measured. The real power consumption is a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time. A consumption of power supplied from the outside during the control-interval period is predicted based on the measured real power consumption. The predicted power consumption is compared with the target power consumption. A startup instruction is output to an additional-startup-apparatus if there is a margin between the predicted power consumption and the target power consumption, and the predicted power consumption is lower than the target power consumption. The additional-startup-apparatus is the standby apparatus capable of being started by using the margin power.

For example, in embodiments of the present invention, a drain pump is registered as a standby apparatus. If it is possible to start the drain pump by using the margin power, the power-demand control apparatus decides the drain pump as an additional-startup-apparatus. The power-demand control apparatus starts (additionally starts) the drain pump by using the margin power. In this case, as shown in the part (a) of Fig. 5, even if the water level is low, the drain pump is started by using the margin power. Water is thus drained from a tank. As a result, in the next control-interval period, it is unlikely that the drain pump will be started (see the part (b) of Fig. 5).

As described in this example, according to embodiments of the present invention, the power-demand control apparatus starts as many apparatuses, which are operated irrespective of power-demand control in a case where there is a power margin, as possible. The frequency of starting apparatuses, which are operated irrespective of power-demand control, is reduced during a period in which power may be overused.

According to embodiments of the present invention, the standby-apparatus storage unit may be configured to store information on a rated power of the standby apparatus. The

standby-apparatus storage unit may be configured to store, in a case where there are a plurality of standby apparatuses, startup-priority-levels of the standby apparatuses, respectively. In this case, the additional-startup-control unit is configured to determine an additional-startup-apparatus, to which the startup instruction is output, based on the stored startup-priority-levels.

Further, according to embodiments of the present invention, the additional-startup-control unit may be configured to output a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, when the next control-interval period is started. The additional-startup-control unit may be configured to output a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, in response to an instruction from the outside. Further, the power-demand control apparatus may include a stop-instruction-output-mode selecting unit configured to select a mode of outputting a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, from two modes, one mode being to output the stop instruction when the next control-interval period is started, the other mode being to output the stop instruction in response to an instruction from the outside. The additional-startup-control unit may be configured to output the stop instruction to the additional-startup-apparatus, to which the startup instruction is output, based on the output mode selected by the stop-instruction-output-mode selecting unit.

Further, according to embodiments of the present invention, the additional-startup-control unit may be configured to output a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, after an operable time passes, the operable time being calculated based on a rated power of the additional-startup-apparatus and the margin power.

Further, according to embodiments of the present invention, operation of the additional-startup-control unit may be banned until an elapsed time after the control-interval period is started is within a predetermined period. The power-demand control apparatus may further include a unit configured to store an additional-startup-control effectiveness judgment threshold, the additional-startup-control effectiveness judgment threshold being a predetermined value lower than the target power consumption. Operation of the additional-startup-control unit may be banned if the predicted power consumption is equal to or lower than the additional-startup-control effectiveness judgment threshold.

According to embodiments of the present invention, the real power consumption is measured. The real power consumption is a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time. A consumption of power supplied from the outside during the control-interval period is predicted based on the measured real power consumption. The predicted power consumption is compared with the target power consumption. A startup instruction is output to an additional-startup-apparatus if there is a margin between the predicted power consumption and the target power consumption, and the predicted power consumption is lower than the target power consumption. The additional-startup-apparatus is the standby apparatus capable of being started by using the margin power. As a result, the power-demand control apparatus starts as many apparatuses, which are operated irrespective of power-demand control in a case where there is a power margin, as possible. The frequency of starting apparatuses, which are operated irrespective of power-demand control, is reduced during a period in which power may be overused. There is thus a smaller impact on power-demand control.

Brief Description of Drawings

Fig. 1 is a functional block diagram showing the

main part of a power-demand control apparatus according to an embodiment of the present invention;

Fig. 2 is a diagram showing the relationship of the real power consumption, a predicted power consumption, a target power consumption, margin power, and the like in a control-interval period of the power-demand control apparatus;

Fig. 3 is a flowchart showing processing operations performed by the power-demand control apparatus;

Fig. 4 is a diagram illustrating a specific example of the way to determine additional-startup-apparatuses by an additional-startup-apparatus determining unit;

Fig. 5 is a diagram showing a state where a drain pump is started by using the margin power and a state where the drain pump is stopped;

Fig. 6 is a diagram corresponding to Fig. 1 where a stop-instruction-output-mode selecting unit is provided;

Fig. 7 is a diagram showing an example of power-demand control of a related art;

Fig. 8 is a diagram showing a state where a drain pump is controlled automatically; and

Fig. 9 is a diagram showing a state where a lifting pump is controlled automatically.

Detailed Description of Embodiments

Hereinafter, an embodiment of the present invention will be described with reference to the drawings. Fig. 1 is a functional block diagram showing the main part of a power-demand control apparatus according to an embodiment of the present invention.

The power-demand control apparatus 101 performs the function (additional-startup control function) unique to

this embodiment. This function is added to the power-demand control program, which is performed by the central monitoring apparatus 100 of Fig. 7. Fig. 1 only shows the functional blocks of the main part of the power-demand control apparatus 101.

That is, according to this embodiment, the central monitoring apparatus 100 has not only the power-demand control function of the related art described with reference to Fig. 7, but also the additional-startup control function unique to this embodiment. Note that, in Fig. 1, the functional blocks of the power-demand control function of a related art are not illustrated.

The power-demand control apparatus 101 includes, as the functional blocks for realizing the additional-startup control function, the real-power-consumption measuring unit 101A, the power-consumption predicting unit 101B, the target-power-consumption storage 101C, the additional-startup-control effectiveness judgment threshold storage 101D, the additional-startup judgment period storage 101E, the additional-startup-control execution determining unit 101F, the margin-power calculating unit 101G, the additional-startup-apparatus determining unit 101H, the additional-startup-apparatus start/stop unit 101I, the standby-apparatus rated-power and priority-level table storage 101J, and the current-time measuring unit 101K. Hereinafter, with reference to Fig. 2, the functions of the respective units of the power-demand control apparatus 101 will be described.

The real-power-consumption measuring unit 101A measures consumption of power supplied from the outside (excluding in-house power generation) (i.e., real power

consumption PW_R) by the electric-load group 200 of a customer from the start of a control-interval period T (in this example, T is thirty minutes) until the current time for each control-interval period T. The real-power-consumption measuring unit 101A measures the real power consumption PW_R at a constant frequency after the start of the control-interval period T until the end of the control-interval period T.

The power-consumption predicting unit 101B predicts the consumption of the power supplied from the outside during the control-interval period T based on the real power consumption PW_R from the real-power-consumption measuring unit 101A. The power-consumption predicting unit 101B outputs the predicted power consumption PW_P based on the prediction. The target-power-consumption storage 101C stores the target power consumption PW_T, which is compared with the predicted power consumption PW_P. The additional-startup-control effectiveness judgment threshold storage 101D stores the additional-startup-control effectiveness judgment threshold PW_{th}. The additional-startup-control effectiveness judgment threshold PW_{th} is predetermined and is lower than the target power consumption PW_T.

The additional-startup judgment period storage 101E stores the additional-startup judgment period Tx. The additional-startup judgment period Tx is a latter period of the control-interval period T until the end of the control-interval period T. In this example, Tx is ten minutes. The current-time measuring unit 101K measures the current time T_R every time the control-interval period T is started. The current time T_R is the time

after the present control-interval period T is started.

The additional-startup-control execution determining unit 101F determines if additional-startup-control is executed or not based on the predicted power consumption PW_P from the power-consumption predicting unit 101B, based on the target power consumption PW_T stored in the target-power-consumption storage 101C, based on the additional-startup-control effectiveness judgment threshold PW_{th} stored in the additional-startup-control effectiveness judgment threshold storage 101D, and based on the current time T_R from the current-time measuring unit 101K. The additional-startup-control will be described later. Note that no demand warning is a precondition for execution of the additional-startup-control.

The additional-startup-control execution determining unit 101F determines that the additional-startup-control is executed. In this case, the margin-power calculating unit 101G calculates the difference between the target power consumption PW_T and the predicted power consumption PW_P at this time to thereby obtain the margin power PW_M. The additional-startup-apparatus determining unit 101H determines standby apparatuses to be started (i.e., additional-startup-apparatuses) by using the margin power PW_M from the margin-power calculating unit 101G with reference to the standby-apparatus rated-power and priority-level table TB1 stored in the standby-apparatus rated-power and priority-level table storage 101J.

In the standby-apparatus rated-power and priority-level table TB1, standby apparatuses, the rated power of each standby apparatus, and the priority level of each

standby apparatus are registered. The standby apparatus is a loading apparatus registered as an apparatus of the electric-load group 200, which is operated irrespective of power-demand control. In this example, for example, the drain pump #1 is registered with its rated power as a standby apparatus having the priority level 1. The lifting pump #2 is registered with its rated power as a standby apparatus having the priority level 2. The ventilation fan #3 is registered with its rated power as a standby apparatus having the priority level 3.

The additional-startup-apparatus start/stop unit 101I outputs startup instructions to the additional-startup-apparatuses, which are determined by the additional-startup-apparatus determining unit 101H. The additional-startup-apparatus start/stop unit 101I outputs stop instructions to the additional-startup-apparatuses, to which the startup instructions are output, after the control-interval period T (i.e., when the next control-interval period T is started).

Fig. 3 shows a flowchart showing the operation of the power-demand control apparatus 101. Hereinafter, with reference to the flowchart, the functions of the respective units of the power-demand control apparatus 101 will be described in more detail.

The control-interval period T is started (Step S101, YES). Then, the real-power-consumption measuring unit 101A starts to measure the consumption of the power supplied from the outside by the electric-load group 200 (i.e., measures real power consumption PW_R) (Step S102). Further, the power-consumption predicting unit 101B predicts the consumption of the power supplied from the

outside during the control-interval period T based on the real power consumption PW_R measured by the real-power-consumption measuring unit 101A (Step S103). That is, the power-consumption predicting unit 101B calculates the predicted power consumption PW_P. The real power consumption PW_R is measured again and again at a constant frequency. The predicted power consumption PW_P is calculated again and again at a constant frequency.

The real power consumption PW_R is measured again and again, and the predicted power consumption PW_P is calculated again and again. The current time (i.e., time after the control-interval period T is started) T_R measured by the current-time measuring unit 101K is in the additional-startup judgment period Tx (Step S104, YES). Then, the additional-startup-control execution determining unit 101F confirms if the predicted power consumption PW_P from the power-consumption predicting unit 101B is between the target power consumption PW_T and the additional-startup-control effectiveness judgment threshold PW_{th} ($PW_{th}<PW_P<PW_T$) or not (Step S105).

Here, the predicted power consumption PW_P is between the target power consumption PW_T and the additional-startup-control effectiveness judgment threshold PW_{th} (Step S105, YES). Then, the additional-startup-control execution determining unit 101F determines that the additional-startup-control is to be executed under the condition that no demand warning is issued. That is, the additional-startup-control execution determining unit 101F allows the additional-startup-control.

[Additional-startup-control]

The additional-startup-control execution determining

unit 101F determines that the additional-startup-control is to be executed. Then, the margin-power calculating unit 101G calculates the difference between the target power consumption PW_T and the predicted power consumption PW_P at this time to thereby obtain the margin power PW_M ($PW_M=PW_T-PW_P$) (Step S106). The margin-power calculating unit 101G sends the margin power PW_M to the additional-startup-apparatus determining unit 101H.

The additional-startup-apparatus determining unit 101H receives the margin power PW_M from the margin-power calculating unit 101G. Then, the additional-startup-apparatus determining unit 101H retrieves the standby-apparatus rated-power and priority-level table TB1 from the standby-apparatus rated-power and priority-level table storage 101J (Step S107). The additional-startup-apparatus determining unit 101H determines standby apparatuses to be started as additional-startup-apparatuses based on the margin power PW_M and based on the rated powers and the priority levels of the standby apparatuses in the standby-apparatus rated-power and priority-level table TB1 (Step S108).

A specific example of the way to determine additional-startup-apparatuses by the additional-startup-apparatus determining unit 101H will be described. Normally the interval period T is thirty minute. To explain this example easily, as shown in Fig. 4, T is sixty minutes. The interval period T is sixty minutes, the current time T_R is forty minutes, the margin power PW_M is 10 kWh. In this case, in the standby-apparatus rated-power and priority-level table TB1 (see Fig. 1), the rated power of the drain pump #1 is 11 kW (power

consumption is 11 kW per hour), and the drain pump #1 is the standby apparatus of the priority level 1. The rated power of the lifting pump #2 is 15 kW (power consumption is 15 kW per hour), and the lifting pump #2 is the standby apparatus of the priority level 2. The rated power of the ventilation fan #3 is 30 kW (power consumption is 30 kW per hour), and the ventilation fan #3 is the standby apparatus of the priority level 3. The power consumption during the remaining time in sixty minutes is calculated. As shown in Fig. 4, the power consumption of the drain pump #1 is 3.67 kWh (= 11 kW x (20/60 h)). The power consumption of the lifting pump #2 is 5 kWh (= 15 kW x (20/60 h)). The power consumption of the ventilation fan #3 is 10 kWh (= 30 kW x (20/60 h)). In this case, the margin power PW_M is 10 kWh. In view of this, it is to possible to start both the drain pump #1 of the priority level 1 and the lifting pump #2 of priority level 2 simultaneously. However, it is to not possible to start the ventilation fan #3 of the priority level 3 simultaneously. As a result, the additional-startup-apparatus determining unit 101H determines the drain pump #1 of the the priority level 1 and the lifting pump #2 of the priority level 2 as additional-startup-apparatuses.

As described above, the additional-startup-apparatus determining unit 101H determines additional-startup-apparatuses. The additional-startup-apparatus determining unit 101H sends information on the determined additional-startup-apparatuses to the additional-startup-apparatus start/stop unit 101I. The additional-startup-apparatus start/stop unit 101I outputs the startup

instructions to the additional-startup-apparatuses, which are determined by the additional-startup-apparatus determining unit 101H. The additional-startup-apparatus start/stop unit 101I thus starts (additionally starts) those apparatuses (Step S109).

Then, after the control-interval period T is finished (Step S110, YES), i.e., when the next control-interval period T is started, the additional-startup-apparatus start/stop unit 101I outputs the stop instructions to the additional-startup-apparatuses, to which the startup instructions are output. The additional-startup-apparatus start/stop unit 101I thus stops those apparatuses (Step S111).

For example, in this embodiment, let's assume that the drain pump #1 is determined as an additional-startup-apparatus, and is started. In this case, as shown in the part (a) of Fig. 5, even if the water level of the tank 3A is low, the drain pump #1 is started by using the margin power PW_M. Water is thus drained from the tank 3A. As a result, in the next control-interval period T, it is unlikely that the drain pump #1 will be started (see the part (b) of Fig. 5). The same applies to the case where the lifting pump #2 is determined as an additional-startup-apparatus. Even if the water level of the tank is high, the lifting pump #2 is started by using the margin power PW_M. Water is thus supplied to the tank. As a result, in the next control-interval period T, it is unlikely that the lifting pump #2 will be started.

As described in this example, according to this embodiment, the power-demand control apparatus 101 starts as many loading apparatuses as possible. The loading

apparatuses are registered as standby apparatuses in the standby-apparatus rated-power and priority-level table TB1. Note that the loading apparatuses are operated irrespective of power-demand control in a case where there is a power margin. The frequency of starting apparatuses, which are operated irrespective of power-demand control, is reduced during a period in which power may be overused. There is thus a smaller impact on power-demand control.

Further, according to this embodiment, the additional-startup judgment period Tx is provided. It is determined if the additional-startup-control is executed or not in a latter period of the control-interval period T. According to this configuration, additional-startup-control is banned at the beginning of the control-interval period T. It is possible to prevent a standby apparatus from being additionally started based on a less-accurate predicted power consumption PW_R.

Further, according to this embodiment, the additional-startup-control effectiveness judgment threshold PW_{th} is provided. The additional-startup-control is executed under the condition that the predicted power consumption PW_R is between the target power consumption PW_T and the additional-startup-control effectiveness judgment threshold PW_{th}. As a result, the additional-startup-control is banned if the predicted power consumption PW_R is equal to or lower than the additional-startup-control effectiveness judgment threshold PW_{th}. It is possible to prevent a standby apparatus from being started additionally and to control the standby apparatus automatically as usual in a period

in which the actual cost may not exceed the basic charge. An example of such a period is an interim period, in which there is a power margin.

Note that, in the above-mentioned embodiment, a stop instruction is output to an additional-startup-apparatus, to which a startup instruction is output, when the next control-interval period T is started. Alternatively, the additional-startup-apparatus start/stop unit 101I may output the stop instruction in response to an instruction from the outside. For example, if an additional-startup-apparatus is a drain pump, a water-level sensor detects the minimum water level. In response to a detection signal from the water-level sensor, the additional-startup-apparatus start/stop unit 101I may output a stop instruction to the drain pump. The additional-startup-apparatus start/stop unit 101I may output a stop instruction only after it receives a stop instruction based on a different program. Further, as shown in Fig. 4, a stop-target power consumption may be different from a startup-target power consumption to deal with hunting. When the real power consumption reaches the stop-target power consumption, an apparatus is stopped under the normal power-demand control. Based on the startup-target power consumption, additional-startup-apparatuses are started. There may be a difference between the stop-target power consumption and the startup-target power consumption (stop-target power consumption > startup-target power consumption).

Further, as shown in Fig. 6, the stop-instruction-output-mode selecting unit 101L may be provided. A mode of outputting a stop instruction to an additional-

startup-apparatus, to which a startup instruction is output, may be selected. That is, a stop instruction may be output at the beginning of the next control-interval period or in response to an instruction from the outside. In this case, the additional-startup-apparatus start/stop unit 101I outputs a stop instruction to an additional-startup-apparatus, to which a startup instruction is output, based on the output mode selected by the stop-instruction-output-mode selecting unit 101L.

Further, the additional-startup-apparatus determining unit 101H may have a function of calculating an operable time of a determined additional-startup-apparatus based on the rated power of the additional-startup-apparatus and the margin power. The operable time is calculated based on this function. After the operable time passes, the additional-startup-apparatus start/stop unit 101I may output a stop instruction to an additional-startup-apparatus, to which a startup instruction is output.

Further, in the above-mentioned embodiment, the additional-startup-control effectiveness judgment threshold PW_{th} is provided. As a result, the additional-startup-control is not performed automatically in a period in which the actual cost may not exceed the basic charge. Alternatively, an operator may select on a display if the additional-startup-control is to be performed or not.

Further, in the above-mentioned embodiment, the power-consumption predicting unit 101B may predict power consumption in any way. For example, the power-consumption predicting unit 101B may predict power

consumption based on the inclination of the real power consumption PW_R.

Further, in Fig. 1, the function of the additional-startup-control execution determining unit 101F of comparing the target power consumption PW_T with the predicted power consumption PW_P, the margin-power calculating unit 101G, the additional-startup-apparatus determining unit 101H, and the additional-startup-apparatus start/stop unit 101I correspond to the additional-startup-control unit of the present invention. The determining function in the additional-startup judgment period Tx of the additional-startup-control execution determining unit 101F corresponds to "a unit configured to ban operation of the additional-startup-control unit until an elapsed time after the control-interval period is started is within a predetermined period". The determining function based on the additional-startup-control effectiveness judgment threshold PW_{th} of the additional-startup-control execution determining unit 101F corresponds to "a unit configured to ban operation of the additional-startup-control unit if the predicted power consumption is equal to or lower than the additional-startup-control effectiveness judgment threshold".

[Wider scope of embodiment]

The embodiment of the present invention has been described. The present invention is not limited to the above-mentioned embodiment. It should be understood by those skilled in the art that various modifications, combinations, sub-combinations, and alterations may occur depending on design requirements and other factors

insofar as they are within the scope of the appended claims or the equivalents thereof.

What is claimed is:

1. A power-demand control apparatus for controlling power demand, the power-demand control apparatus being configured

to measure a real power consumption for each control-interval period, the control-interval period being a predetermined period, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time,

to predict a consumption of power supplied from the outside during the control-interval period based on the measured real power consumption, and

to control, if the predicted power consumption based on the prediction exceeds a preset target power consumption, operation of a loading apparatus of the electric-load group such that the real power consumption fails to exceed the preset target power consumption, the loading apparatus being registered as an apparatus for adjustment of power consumption,

the power-demand control apparatus comprising:

a real-power-consumption measuring unit configured to measure a real power consumption, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the

current time;

a power predicting unit configured to predict a consumption of power supplied from the outside during the control-interval period based on the real power consumption, the real power consumption being measured by the real-power-consumption measuring unit;

a standby-apparatus storage unit configured to store information on a loading apparatus of the electric-load group as a standby apparatus, the loading apparatus being registered as an apparatus operated irrespective of power-demand control;

an additional-startup-control unit configured

to compare the predicted power consumption with the target power consumption, the predicted power consumption being predicted by the power predicting unit, and

to output a startup instruction to an additional-startup-apparatus if there is a margin between the predicted power consumption and the target power consumption, the predicted power consumption being lower than the target power consumption, the additional-startup-apparatus being the standby apparatus capable of being started by using the margin power; and

a unit configured to ban operation of the additional-startup-control unit until an elapsed time after the control-interval period is started is within

a predetermined period.

2. The power-demand control apparatus according to claim 1, wherein

the standby-apparatus storage unit is configured to store information on a rated power of the standby apparatus.

3. The power-demand control apparatus according to claim 1 or claim 2, wherein

the standby-apparatus storage unit is configured to store, in a case where there are a plurality of standby apparatuses, startup-priority-levels of the standby apparatuses, respectively, and

the additional-startup-control unit is configured to determine an additional-startup-apparatus, to which the startup instruction is output, based on the stored startup-priority-levels.

4. The power-demand control apparatus according to any one of claim 1 to claim 3, wherein

the additional-startup-control unit is configured to output a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, when the next control-interval period is started.

5. The power-demand control apparatus according to any one of claim 1 to claim 3, wherein

the additional-startup-control unit is configured to output a stop instruction to the additional-startup-apparatus, to which the startup instruction is output,

in response to an instruction from the outside.

6. The power-demand control apparatus according to any one of claim 1 to claim 3, further comprising:

a stop-instruction-output-mode selecting unit configured to select a mode of outputting a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, from two modes, one mode being to output the stop instruction when the next control-interval period is started, the other mode being to output the stop instruction in response to an instruction from the outside, wherein

the additional-startup-control unit is configured to output the stop instruction to the additional-startup-apparatus, to which the startup instruction is output, based on the output mode selected by the stop-instruction-output-mode selecting unit.

7. The power-demand control apparatus according to any one of claim 1 to claim 3, wherein

the additional-startup-control unit is configured to output a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, after an operable time passes, the operable time being calculated based on a rated power of the additional-startup-apparatus and the margin power.

8. The power-demand control apparatus according to any one of claim 1 to claim 7, further comprising:

a unit configured to store an additional-startup-

control effectiveness judgment threshold, the additional-startup-control effectiveness judgment threshold being a predetermined value lower than the target power consumption; and

a unit configured to ban operation of the additional-startup-control unit if the predicted power consumption is equal to or lower than the additional-startup-control effectiveness judgment threshold.

9. A power-demand control method for controlling power demand, the power-demand control method including

measuring a real power consumption for each control-interval period, the control-interval period being a predetermined period, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time,

predicting a consumption of power supplied from the outside during the control-interval period based on the measured real power consumption, and

controlling, if the predicted power consumption based on the prediction exceeds a preset target power consumption, operation of a loading apparatus of the electric-load group such that the real power consumption fails to exceed the preset target power consumption, the loading apparatus being registered as an apparatus for adjustment of power consumption,

the power-demand control method comprising:

measuring a real power consumption, the real power consumption being a consumption of power supplied from the outside by an electric-load group of a customer from the start of the control-interval period until the current time;

predicting a consumption of power supplied from the outside during the control-interval period based on the measured real power consumption;

storing information on a loading apparatus of the electric-load group as a standby apparatus, the loading apparatus being registered as an apparatus operated irrespective of power-demand control;

comparing the predicted power consumption based on the prediction with the target power consumption, and outputting a startup instruction to an additional-startup-apparatus if there is a margin between the predicted power consumption and the target power consumption, the predicted power consumption being lower than the target power consumption, the additional-startup-apparatus being the standby apparatus capable of being started by using the margin power; and

banning operation of the additional-startup-control until an elapsed time after the control-interval period is started is within a predetermined period.

10. The power-demand control method according to claim 9, further comprising:

storing information on a rated power of the standby apparatus.

11. The power-demand control method according to claim 9 or claim 10, further comprising:

storing, in a case where there are a plurality of standby apparatuses, startup-priority-levels of the standby apparatuses, respectively; and

determining an additional-startup-apparatus, to which the startup instruction is output, based on the stored startup-priority-levels.

12. The power-demand control method according to any one of claim 9 to claim 11, further comprising:

outputting a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, when the next control-interval period is started.

13. The power-demand control method according to any one of claim 9 to claim 11, further comprising:

outputting a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, in response to an instruction from the outside.

14. The power-demand control method according to any one of claim 9 to claim 11, further comprising:

selecting a mode of outputting a stop instruction to the additional-startup-apparatus, to which the

startup instruction is output, from two modes, one mode being to output the stop instruction when the next control-interval period is started, the other mode being to output the stop instruction in response to an instruction from the outside;

outputting the stop instruction to the additional-startup-apparatus, to which the startup instruction is output, based on the selected output mode.

15. The power-demand control method according to any one of claim 9 to claim 11, further comprising:

outputting a stop instruction to the additional-startup-apparatus, to which the startup instruction is output, after an operable time passes, the operable time being calculated based on a rated power of the additional-startup-apparatus and the margin power.

16. The power-demand control method according to any one of claim 9 to claim 15, further comprising:

storing an additional-startup-control effectiveness judgment threshold, the additional-startup-control effectiveness judgment threshold being a predetermined value lower than the target power consumption; and

banning operation of the additional-startup-control if the predicted power consumption is equal to or lower than the additional-startup-control effectiveness judgment threshold.