

DESCRIPTION

TITLE OF THE INVENTION:

WEATHER CORRECTION DEVICE, AIR CONDITIONING
MANAGEMENT SYSTEM, AND WEATHER CORRECTION METHOD
TECHNICAL FIELD

[0001]

The present invention relates to a weather correction device, an air conditioning management system, and a weather correction method.

BACKGROUND ART

[0002]

Prediction of a consumed power in a building, etc. is performed to level a power load. As power prediction, electric consumed power prediction has been performed based on past consumed power data and weather forecast data. The weather forecast data used in the prediction is data delivered to each area (for example, each of municipal areas) from a weather forecast company, the Meteorological Agency, or the like.

[0003]

For example, in the technique disclosed in Patent Document 1, a weather forecast value is substituted into a regression expression including various including a factor representing a weather condition and a consumed power. The technology disclosed in Patent document 1 calculates a prediction value of the consumed power for a prediction target period on the bases of the substitution result. Further, the technology disclosed in Patent Document 1 calculates the predicted value of the consumed power and changes coefficients in the regression formula to minimize a deviation of the prediction value from a load quantity which is measured data belonging to the same

pattern as a pattern of the prediction value out of measured data previously registered each pattern to be classifiable according to day of week.

PRIOR ART

PATENT DOCUMENT

[0004]

Patent Document 1: JP 2013-5465

SUMMARY OF INVENTION

PROBLEM TO BE SOLVED BY INVENTION

[0005]

Here, the actual temperature and humidity may differ from the weather forecast value in accordance with an installation position of the building and the like. For example, the actual temperature and humidity may differ between those in the vicinity of a building in the coastal area and those in the vicinity of a building located in the mountain area even in the same municipality. Further, the deviations of the weather forecast value and the actual temperature and humidity in accordance with time such as late night, dawn, daytime, night, etc.

[0006]

From these reasons, it is important in prediction of the electric consumed power of a building to predict the electric consumed power in consideration of weather condition at the place where the building is installed. In other words, it is considered that to predict the electric consumed power from the weather condition at the place where the building is installed may cause improvement in prediction accuracy of the electric consumed power.

[0007]

However, the technology disclosed in Patent Document 1 uses the weather forecast value without consideration of placement

condition, etc. of the building to be predicted.

Accordingly, the technology cannot calculate an accurate consumed power in the vicinity of the building to be a target of prediction because the technology does not use the weather condition reflecting the placement condition. Further, because the technology uses the weather forecast value made depending on the pattern classified according to day of the week, that is, the technology does not take in consideration of a variation in the weather conditions varying depending on time such as late night, dawn, daytime, night, etc., the technology cannot calculate actual consumed power amounts at each hour.

[0008]

Further, the technology disclosed in Patent Document 1 cannot make prediction of the consumed power having a wider range because the technology cannot use the predicted weather information as intermediate information since the technology calculates the consumed power directly from the weather information.

[0009]

The present invention is developed in consideration of the backgrounds as described above and aims to improve the prediction accuracy in the weather value at the prediction place and at time of prediction.

MEANS FOR SOLVING PROBLEM

[0010]

To solve the problems described above, an aspect of the present invention provides correction of the weather forecast value to be a target of prediction based on the past weather forecast values acquired at each time and past measured weather value at corresponding time.

Other solving means are described in the embodiments.

ADVANTAGEOUS EFFECT OF INVENTION

[0011]

According to the present invention, it is possible to improve the prediction accuracy of the weather values at the prediction place and the predication time.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

Fig. 1 is a block diagram showing an example of configuration of a weather correction system according to the present embodiment.

Fig. 2 a block diagram showing an example of another weather correction system.

Fig. 3 is a drawing showing an example of configuration of a correction device.

Fig. 4 is a flowchart (of a first part) showing operations of a whole process of the weather data correcting process.

Fig. 5 is a drawing showing outline of the data.

Fig. 6A is a drawing showing actual weather forecast data.

Fig. 6B is a drawing showing the weather measured data.

Fig. 7 is a flowchart of calculating the correction efficient.

Fig. 8A is a chart for explanation of the correction coefficient calculation of a temperature at 0 o'clock.

Fig. 8B is a chart for explaining calculating the correction coefficient of temperature at 13 o'clock.

Fig. 9 is a drawing for explaining a period used for calculating the correction coefficient.

Fig. 10A is a chart for explaining calculating correction coefficient of a specific humidity at 0 o'clock.

Fig. 10B is a chart for explaining calculating the correction efficient of the specific humidity.

Fig. 11A is a chart for explaining a method of calculating a

corrected temperature.

Fig. 11B is a chart for explaining a method of calculating a corrected specific humidity.

Fig. 12 is a chart representing a relation between the weather forecast temperature and measured temperature acquired from the weather forecast server.

Fig. 13 is a chart showing a relation between the corrected temperature which is undergone correction with the correction coefficient and the measured temperature.

Fig. 14 is a chart showing a relation between the weather forecast specific humidity calculated on the basis of the value acquired from the weather forecast server.

Fig. 15 is a chart showing a relation between the corrected absolute humidity corrected with the correction coefficient and the measured specific humidity.

Fig. 16 is a block diagram showing an example of a configuration of the correction device according to the embodiment.

Fig. 17 is a flowchart (of second) showing operations of the whole process of the weather data correction process.

Fig. 18 is a chart for explaining interpolation of weather forecast values.

Fig. 19 is a block diagram of an air conditioning system including an air conditioning management server according to the embodiment.

Fig. 20 is a block diagram of the air conditioning management server according to the embodiment.

Fig. 21 is a flowchart (first part) showing a flow of processing executed by the air conditioning management server.

Fig. 22 is a flowchart (second part) showing a flow of process executed by the air conditioning management server.

Fig. 23 is a flowchart (third part) showing a flow of process executed by the air conditioning management server.

Fig. 24 is a flowchart (fourth part) showing a flow of process executed by the air conditioning management server.

Fig. 25 is a flowchart (fifth part) showing a flow of process executed by the air conditioning management server.

Fig. 26 is a block diagram of the air conditioning system including the air conditioning management server according to the embodiment.

Fig. 27 is a block diagram of the air conditioning management server according to the embodiment.

Fig. 28 is a flowchart (sixth part) showing a flow of process executed by the air conditioning management server.

Fig. 29 is a flowchart (seventh part) showing a flow of process executed by the air conditioning management server.

Fig. 30A is a chart showing result of a heat load prediction before the correction of the weather forecast value.

Fig. 30B is a chart showing a result of the heat load prediction after correction of the weather forecast value.

MODES FOR CARRYING OUT INVENTION

[0013]

Next an embodiment for carrying out the present invention is described below in detail referring to the drawings appropriately.

[0014]

<<Weather correction system>>

Referring to drawings 1 to 15 a first embodiment of the present invention is described below.

<Configuration of the system>

Fig. 1 is a block diagram showing an example of configuration of the weather correction system according to the present embodiment.

Weather correction systems Z1 and Z are connected with the weather forecast server 103 installed at the weather forecast center each other through a network 104. Here, the network 104 is, for example, WAN (Wide Area Network), etc.

A computer 101 is a correction device 200 which will be described later, referring to Fig. 3 and acquires the weather forecast data 221 (see Fig. 3), calculates a correction coefficient included in the weather forecast data 221, and performs calculation, etc, of the weather forecast data 221 using the correction coefficient.

A temperature and humidity sensor 102 measures an outdoor temperature and an outdoor humidity (measured values of temperature and humidity: hereinbelow referred to as the weather measured data 222 (see Fig. 3). The term "temperature" means a "dry-bulb temperature".

The weather forecast server 103 performs weather forecast using a weather forecast device, etc. installed inside the weather forecast server 103 and delivers the weather forecast data 221 including a weather forecast value such as a prediction temperature, weather forecast humidity, etc. to the network 104.

[0015]

Fig. 2 is a block diagram showing an example of another configuration of the weather correction system.

In the weather correction system Z2, Z, a cloud server 105 is connected to the network 104 relative to the weather correction system Z1 shown in Fig. 1.

The cloud server 105 corresponds to the correction device 200 which will be described with reference to Fig. 3 and acquires the weather measured data 222 measured by the temperature and humidity sensor 102 through the computer 101. Further, the cloud server 105 acquires the weather forecast data 221 (see Fig. 3)

including the weather forecast value from the weather forecast server 103. The cloud server 105 calculates the correction coefficients on the basis of the acquired weather measured value and the acquired weather forecast value.

[0016]

<Configuration of correction device>

Fig. 3 is a drawing showing an example of configuration of the correction device.

Further, the correction device 200 corresponds, in the configuration shown in Fig. 1, to the computer 101. In the configuration shown in Fig. 2, the cloud server 105 corresponds to this.

[0017]

The correction device 200 includes a memory 201 such as RAM (Random Access Memory), a CPU (Central Processing Unit) 202, a storage 203 such as a HD (Hard Disk), and a transmitting and receiving device 204 such as NIC (Network Interface Card).

A program stored in the storage 203 is stored in a memory 201 and is carried out by the CPU 202, which realizes a processing unit 211 and the weather forecast data acquiring unit 212 forming the processing unit 211, the weather forecast data acquiring unit 212, a specific humidity calculating unit weather measured data acquiring unit 213, the specific humidity calculating unit 214, a correction coefficient calculating unit 215, and the corrected weather value calculating unit 216.

[0018]

The weather forecast data acquiring unit 212 acquires the weather forecast data 221 delivered by the weather forecast server 103 (see Figs. 1 and 2) through the transmitting and receiving device 204. In the weather forecast data acquiring unit 212, weather forecast values such as the weather forecast temperature, a weather

forecast humidity, are stored.

The weather measured data acquiring unit 213 acquires the weather measured data 222 from the temperature and humidity sensor 102 (see Figs. 1 and 2) through the transmitting and receiving device 204. In the weather measured data 222, a plurality of weather measured values such as a measured temperature and a measured humidity are stored.

The specific humidity calculating unit 214 calculates the forecast specific humidity from the forecast humidity included in the weather forecast data 221 and calculates the measured specific humidity from the measured humidity included in the weather measured data 222.

[0019]

The correction coefficient calculating unit 215 calculates the correction coefficients at every hour on the basis of the weather forecast value and the weather measured value at every hour.

The corrected weather value calculating unit 216 applies the correction coefficients calculated by the correction coefficient calculating unit 215 to the weather forecast values at time to be corrected to calculate the weather corrected value.

Further, in the storage 203, the weather forecast data 221, the weather measured data 222, etc. are stored.

[0020]

<General operation of correction device>

Fig. 4 is a flowchart indicating a procedure of the general process for the weather data correction.

At first, the correction device 200 acquires, in the step S301, weather forecast data 221 from the weather forecast server 103 using the weather forecast data acquiring unit 212.

The correction device 200 calculates, in a step S302, the

forecast specific humidity from the forecast humidity included in the weather forecast data 221 acquired by the specific humidity calculating unit 214. The correction device 200 stores the calculated weather forecast data 221 including the calculated forecast specific humidity in the storage 203.

[0021]

The correction device 200 acquires, in a step S311, the weather measured data 222 from the temperature and humidity sensor 102 using the weather measured data acquiring unit 213.

The correction device 200 calculates the measured specific humidity from the measured humidity included in the weather measured data 222 acquired by the specific humidity calculating unit 214. After this, the correction device 200 stores the weather measured data 222 including the calculated measured specific humidity in the storage 203.

[0022]

Next, the correction device 200 calculates, in step S321, the correction coefficient based on the weather forecast value included in the weather forecast data 221 and weather measured values included in the weather measured data 222 using the correction coefficient calculating unit 215. The calculating process of the correction coefficients will be described later.

Next, the correction coefficient calculating unit 215 stores the calculated correction coefficients in the storage 203.

Further, the correction device 200 calculates, in a step S322, a corrected weather value of which weather forecast value is corrected by applying the correction coefficient calculated in the step S321 to the weather forecast value included in the weather forecast data 221 using the corrected weather value calculating unit 216. After that, the correction device 200 stores the calculated corrected weather

value as the corrected weather data in the storage 203. Calculation of the corrected weather value will be described later.

[0023]

Fig. 5 is a drawing showing outline of the data.

As shown in Fig. 5, the weather forecast data 221 and the weather measured data 222 including temperatures (forecast temperatures and measured temperatures) and specific humidities (forecast specific humidity and measured specific humidities), respectively. Here, the specific humidity is the forecast specific humidity and the measured humidity calculated in the step S302 and a step S312.

As shown in Fig. 5, in the weather forecast data 221 and the weather measured data 222, temperature data and the specific humidity data are stored every one hour from 0 o'clock to 23 o'clock, respectively.

[0024]

Figs. 6A and 6B are drawings showing a format of data.

Fig. 6A shows the weather forecast data 221, and Fig. 6B shows the weather measured data 222.

As shown in Figs. 6A and 6B, the weather forecast data 221 and the weather measured data 222 includes date, temperatures (forecast temperature, measured temperature), specific humidity (forecast absolute humidity, actual absolute humidity), respectively.

The date is a date on which the weather forecast data 221 and the weather measured data 222 are acquired.

As shown in Figs. 6A and 6B, the weather forecast data 221 and the weather measured data 222 are stored every one hour from 0 o'clock to 23 o'clock. In this embodiment, the weather forecast data 221 and the weather measured data 222 are stored every hour. However, the embodiment is not limited to this, and the data can be

stored every predetermined interval, for example, every 30 minutes, every one minute, or the like.

[0025]

<Calculation of correction coefficient>

Fig. 7 is a flowchart of calculating the correction efficient. The flowchart shown in Fig. 7 shows the details of the process in a step S321 shown in Fig. 4

First, in the correction device 200, the correction coefficient calculating unit 215 acquires the forecast temperature and the measured temperature at time to be processed from the weather forecast data 221 and the weather measured data 222. Next, the correction device 200 calculates, in a step S401, the correction coefficient of the temperature at time to be processed on the basis of the forecast temperature and the measured temperature acquired by the correction coefficient calculating unit 215. The correction coefficient calculating unit 215 stores the calculated coefficient of temperature in the storage 203.

[0026]

Next, in the correction device 200, the correction coefficient calculating unit 215 acquires the forecast specific humidity at the time to be processed from the weather forecast data 221 and the weather measured data 222. In a step S402, the correction device 200 calculates a correction coefficient of the specific humidity at the time when the process should be made on the basis of the forecast specific humidity and the measured specific humidity acquired by the correction coefficient calculating unit 215. Next, the correction device 200 stores the calculated correction coefficient of the specific humidity in the storage 203.

[0027]

In a step S403, the correction device 200 determines whether

the correction coefficient calculating unit 215 has completed the calculation of the correction coefficients of the temperature and the specific humidity for all time to be processed. The time to be processed is time in which the corrected weather value should be calculated.

When the calculation has not been completed (No, in the step S403), the correction coefficient calculating unit 215 returns the processing to the step S401 and calculates the correction coefficients of the temperature and the specific humidity at the next hour.

Further, when the calculation has been completed (Yes, in the step S403), the correction coefficient calculating unit 215 returns the processing to the step S322.

[0028]

Referring to Figs. 8A to 10B, examples of correction coefficient calculating charts are described below.

(Correction coefficient calculation of temperature)

Figs. 8A and 8B are charts for explaining the calculation of correction coefficient for the temperature.

Here, Fig. 8A is an example of a chart for explaining the correction coefficient calculation of a temperature at 0 o'clock at a certain place, and Fig. 8B is an example of a chart for explaining the correction coefficient calculation of a temperature at 13 o'clock at the same place.

In the correction coefficient calculation chart, the axis of abscissa represents the forecast temperature and the axis of coordinate represents the measured temperature. Further, on the correction coefficient calculation chart, a forecast temperature and the measured temperature at the same time are plotted.

[0029]

More specifically, on Fig. 8A, the forecast temperatures and the

measured temperatures are plotted at 0 o'clock for past one year. Similarly, Fig. 8B associates the forecast temperatures with the measured temperatures, at 13 o'clock for past one year. Here, the forecast temperatures are associated with the measured temperatures for past one year. However, the present invention is not limited to the past one year as long as the period is constant. For example, the period may be past half year, but it is preferable that the period is about past two weeks. Further, a user can change a period for the weather forecast values and the measured forecast value.

As described above, the number of the weather forecast values and the weather measured values used for the correction efficient can be reduced, which may reduce the processing load.

Further, it is passable to avoid influence on the weather variation every year by no use of the data on the same day and the same month.

[0030]

For example, as shown in Fig. 9, if it is assumed that today is November 15, the correction coefficients are calculated hour by hour on the basis of the weather forecast data and the weather measured data at every hour for two weeks, i.e., from November 14 to November 1.

On the next day (November 16), the correction coefficients are calculated for every hour on the basis of the weather forecast data and weather measured data at every hour for two weeks from November 15 to November 2.

On the still next day (November 17), the correction coefficients are calculated for every hour on the basis of the weather forecast data and weather measured data at every hour for two weeks from November 16 to November 3.

As the data is acquired as described above, it is possible to

make it difficult to be influenced by fluctuation depending on seasons in calculating the coefficient.

[0031]

Further, the correction coefficient calculating unit 215 calculates the following equation (1) at time i by applying the least squares method to the points associated with the correction coefficient calculation graph.

[0032]

$$y = a_1^i x + b_1^i \cdots \text{Eq. (1)}$$

[0033]

Here, x indicates a forecast temperature and y indicates a measured temperature.

In Eq. (1), a_1^i and b_1^i are correction coefficients at time i . More specifically, in the correction coefficient calculation graph in Fig. 8A, an inclination a_1^0 and a y -intercept b_1^0 of the regression line 801 are the correction coefficients at 0 o'clock which can be acquired by applying the least squares method. Similarly, in the correction coefficient calculating graph in Fig. 8B, an inclination a_1^{13} and a y -intercept b_1^{13} of the regression line 802 are the correction coefficients at 13 o'clock which can be acquired by applying the least squares method. Here, " a_1^{13} " and " b_1^{13} " are not "13 square", but are one variables a_1^{13} , b_1^{13} , respectively. The same is applied to the following variables.

The correction coefficient calculating unit 215 calculates the correction coefficients for such temperatures hour by hour to be processed.

[0034]

(Calculation of correction coefficients of the specific humidity)

Figs. 10A and 10B are charts for explaining calculations of the correction coefficient of the specific humidity.

Fig. 10A is an example of a chart for explaining calculating correction coefficient at 0 o'clock at a certain place, and Figs. 10B is an example of a chart for explaining calculating correction coefficient at 13 o'clock at the same place as the place in the example of Fig. 10A.

The correction coefficient calculating graph has an axis of abscissa representing the forecast specific humidity and the axis of coordinate representing a measured specific humidity. In the correction coefficient calculation graph, the past forecast specific humidity is associated with the past measured specific humidity.

[0035]

More specifically, in Fig. 10A, the forecast specific humidity at 0 o'clock for past one year are associated with the corresponding measured humidity. Similarly, in Fig. 10B, the forecast specific humidities at 13 o'clock for past one year are associated with the corresponding measured humidity. In this example, the forecast specific humidity for past one year is associated with the measured specific humidity for past one year. However, the present invention is not limited to this. Similar to the temperature, this may be, for example, a past half year, but may be desirable that the period is about past two weeks.

[0036]

The correction coefficient calculating unit 215 calculates the following Eq. (2) by applying the least square method to the points associated in the correction coefficient calculating graph.

[0037]

$$y = a_2^i x + b_2^i \cdots \text{Eq. (2)}$$

[0038]

In the equation, "x" represents the forecast specific humidity, and "y" represents the measured humidity.

In Eq. (1), "a₂ⁱ" and "b₂ⁱ" are correction efficient of the specific

humidity at time i . More specifically, in the correction coefficient calculating graph in Fig. 10A, the inclination a_2^0 and the y interception b_2^0 of a regression line 901 which is acquired by applying the least square method to the plots in Fig. 10A are correction coefficients of the specific humidity at time of 0 o'clock. Similarly, in the chart for calculating the correction coefficient shown in Fig. 10B, an inclination a_2^{13} , and a y-intersection b_2^{13} of a regression line 902 acquired by applying the least square method.

The correction coefficient calculating unit 215 calculates the correction coefficients of the specific humidity to be processed at every hour.

[0039]

<Calculation of corrected weather value>

Next, calculation of the corrected weather value is described using the correction coefficient below.

Figs. 11A and 11B are charts for explaining a method of calculating the corrected weather value.

For example, a case where corrected weather values (corrected temperature and corrected specific humidity) of a temperature and a specific humidity at 0 o'clock are calculated, is described below.

The corrected weather value calculating unit 216 substitutes the forecast temperature at 0 o'clock into Eq. (1) at 0 o'clock ($i = 0$). More specifically, as shown in Fig. 11A, if it is assumed that the forecast temperature at 0 o'clock is x_1 , y_1 acquired by substituting x_1 for the variable at 0 o'clock ($i = 0$) is a corrected value of the temperature at 0 o'clock (corrected temperature).

[0040]

Further, the corrected weather value calculating unit 216 performs the same process for the specific humidity at 0 o'clock.

More specifically, the corrected weather value calculating unit

216 substitutes the forecast specific humidity at 0 o'clock into Eq. (2) at 0 o'clock. More specifically, as shown in Fig. 11B, assuming that the forecast specific humidity at 0 o'clock is x_2 , y_2 acquired by substituting x_2 into Eq. (2) at 0 o'clock is a corrected value of the specific humidity at 0 o'clock.

[0041]

As described above, the corrected weather value calculating unit 216 calculates the corrected temperature and the corrected specific humidity at every hour on the basis of the correction coefficient calculated at every hour.

[0042]

<Application result>

Next, referring to Figs. 12 to 15, the corrected weather value calculated according to the method of the present invention is compared with that in a comparative example.

(Temperature)

Fig. 12 is a chart representing a relation between the forecast temperature and the measured temperature acquired from the weather forecast server. Fig. 13 is a chart showing a relation between the corrected temperature which is undergone correction with the correction coefficient and the measured temperature.

In Fig. 12, the solid line indicates a measured temperature, and a broken line indicates a forecast temperature. Further, as shown in Fig. 13, the solid line indicates the measured temperature, and the broken line indicates the corrected temperature.

As it is clear from comparison between Figs. 12 and 13, the corrected temperature shown in Fig. 13 is closer to the measured temperature in Fig. 12.

[0043]

(Specific humidity)

Fig. 14 is a chart showing a relation between the forecast specific humidity calculated on the basis of the value acquired from the weather forecast server and the measured specific humidity, and Fig. 15 is a chart showing a relation between the corrected specific humidity which is corrected with the correction coefficient and the measured specific humidity.

In Fig. 14, a solid line indicates the measured specific humidity and a broken line indicates the forecast specific humidity. Further in Fig. 15, the solid line indicates the measured specific humidity and the broken line indicates corrected specific humidity.

As it is clear from comparison between Figs. 14 and 15, the corrected specific humidity in Fig. 15 is closer to the measured absolute temperature than the forecast specific humidity shown in Fig. 14.

[0044]

According to the first embodiment, the corrected weather value can be calculated in consideration of the weather information in the vicinity of a building to which the correction is applied (the vicinity of the temperature and humidity sensor 102). This enables calculation of the corrected weather value in consideration of influence according to the placement condition such as a geometrical condition such as mountain area and sunshine conditions. Further, it is possible to avoid larger deviation of the weather forecast values in the morning, daytime, and evening, etc. from the weather measured values by calculating the corrected weather values hour by hour.

[0045]

According to the first embodiment, the correction coefficient is calculated by the (linear) least square method. This can reduce the processing load. However, the calculation of the correction efficient is not limited to the (linear) least square method. For example, the

correction coefficient can be calculated by the non-linear least square method.

Further, in the first embodiment, the correction coefficient and the corrected weather value are calculated for both the temperature and the specific humidity which may be largely related to a heat load variation of the building. However, it is also possible that the correction coefficient and the corrected weather value of either of the temperature or the specific humidity are calculated. For example, if the forecast temperature has a relatively good accuracy, only the corrected specific humidity may be calculated.

Further, in the first embodiment, the corrected weather values regarding the temperature and the specific humidity are calculated. The present invention is not limited to this, but may be applied to the calculation of an air pressure, a wind velocity, etc.

[0046]

Next, referring to Figs. 16 to 18, a second embodiment of the present invention is described below. In the second embodiment, drawings and description of the same process as the first embodiment are omitted appropriately.

Further in the second embodiment, the system configuration is the same as those shown in Figs. 1 and 2, and its illustration and description are omitted.

<Configuration of the correction device>

Fig. 16 is a block diagram showing an example of configuration of the correction device according to the second embodiment.

An interpolation processing unit 217 is added to the memory 201 of a correction device 200a. The interpolation processing unit 217 is realized through which the CPU 202 executes the program loaded on the memory 201 from the storage 203.

The interpolation processing unit 217 interpolates the weather

forecast values.

Because other configuration is the same as those shown in Fig. 4, the same parts are designated with the same reference, and its description is omitted.

[0047]

<General operation of correction device>

Fig. 17 is a flowchart showing operations of the whole process of the weather data correction process.

In Fig. 17, the same process as those in Fig. 4 are designated with the same step reference numerals and its description is omitted.

After calculation of the forecast specific humidity in the step S302, in the correction device 200a, the weather forecast values are interpolated by the interpolation processing unit 217. The interpolated weather forecast values are called interpolation weather forecast value. The correction device 200a adds the calculated interpolation weather forecast value to the weather forecast data 221.

After the step S312, the correction device 200a calculates the correction efficient based on the weather forecast values including the interpolated weather forecast values which are added by the correction coefficient calculating unit 215, interpolated weather forecast values, and the weather measured values in the step S321.

The process after this is the same as the process in Fig. 4.

[0048]

<Interpolation of weather forecast value>

Fig. 18 is a chart for explaining interpolation for weather forecast values.

It is assumed that the user desires to calculate the corrected weather values hour by hour between six o'clock to twelve o'clock (the step S322 in Fig. 17) though the user could acquire only the weather forecast values (here it is assumed as the forecast temperature) at six

o'clock and twelve o'clock. In other words, the weather forecast values from seven o'clock to eleven o'clock are lack.

In this case, the interpolation processing unit 217 interpolates weather forecast values from seven o'clock to eleven o'clock as shown in Fig. 18 based on the weather forecast values at six o'clock and twelve o'clock which have been acquired.

In Fig. 18, the interpolated weather forecast values (interpolated weather temperature) acquired by equally dividing an interval between the weather forecast values (forecast temperature) at six o'clock and the weather forecast value at twelve o'clock into six are regarded as the interpolated weather forecast value (interpolated weather temperature). However, the present invention is not limited to this. For example, if a variation curve, etc. of the weather forecast value is known from past measured weather value, etc., it is possible to acquire the interpolation value from the variation curve, etc.

[0049]

Since the measured values can be acquired between six o'clock to twelve o'clock, the correction coefficient calculating unit 215 calculates the correction coefficients at six o'clock and twelve o'clock by the method disclosed in the first embodiment.

Further, between seven o'clock to eleven o'clock, the correction coefficient calculating unit 215 calculates the correction efficient using the interpolated weather forecast values in the method of the first embodiment in place of the weather forecast values (the step S321 in Fig. 1).

[0050]

According to the second embodiment, even at a place where fine weather forecast values cannot be acquired, such as developing countries, accurate weather interpolation values can be obtained as same as the first embodiment.

Next, the corrected weather value calculating unit 216 calculates the corrected weather values in the same method as the first embodiment (the step S322 in Fig. 17).

[0051]

<<Air conditioning system>>

Referring to Figs. 19 to 30B, a method of estimating a heat load of the air conditioning system S and estimates an consumed power of the air conditioning system using the corrected weather value calculated by the method according to the first and second embodiments on the basis of the estimated heat load.

[0052]

Fig. 19 is a block diagram of an air conditioning system including an air conditioning management server according to the embodiment. Arrows with solid lines in Fig. 19 indicate directions of cold water, etc. flowing in respective tubes, and arrows with broken lines indicate signal lines.

The air conditioning system S includes an air conditioning facility A, a temperature and humidity sensor 30, a controller 40, the correction device 200, and an air conditioning management server 60.

[0053]

The air conditioning facility A is a facility which stores cold water cooled by a refrigerator 11 in a heat storage tank 14 and, after that, circulates a cold water via an indoor unit 22 from at least one of the refrigerator 11 and the heat storage tank 14. The air conditioning facility A includes a primary side air conditioning facility 10 which generates and stores cold energy, and a secondary side air conditioning facility 20 which consume the cold energy.

[0054]

(Primary side air conditioning facility)

The primary side air conditioning facility 10 includes the

refrigerator 11, a cooling tower 12, a cold water pump 13, the heat storage tank 14, and a primary side cold water pump 15.

The refrigerator 11 is, for example, a turbo refrigerator which is a cold energy source which cools the cold water flowing therein through a tube q2.

[0055]

The cooling tower 12 is a facility which cools the cold water having absorbed heat by a condenser (not shown) of the refrigerator 11 and includes a blower 12a for taking outside air and supplying wind to the cold water.

Further, an upstream end of a tube p1 shown in Fig. 19 is connected to the refrigerator 11 and the downstream end is connected to an upper part of the cooling tower 12. An upstream end of a tube p2 is connected to the lower part of the cooling tower 12 and the downstream end is connected to the refrigerator 11.

[0056]

The cold water pump 13 is a pump for pressure-feeding the cold water cooled by the cooling tower 12 by heat radiation to the refrigerator 11 installed at an intermediate location of the tube p2.

The heat storage tank 14 is, for example, a temperature-stratified thermal storage tank and a facility which stores cold energy by storing cold water cooled by an evaporator (not shown) of the refrigerator 11. Regarding this, the cold water having the lower temperature tends to subside because of having the larger density, and the cold water stored in the heat storage tank 14 has the lower temperature as the cold water located in the heat storage tank 14.

[0057]

Further, an upstream end of a tube q1 is connected to the refrigerator 11 and the downstream end reaches a low end region of the heat storage tank 14. An upstream end of the tube q2 reaches an

upper region of the heat storage tank 14 and a downstream end of the tube q2 is connected to the refrigerator 11.

The primary side cold water pump 15 is a pump pressure-feeding the cold water to the refrigerator 11 from the heat storage tank 14.

[0058]

(Secondary side air conditioning facility)

The secondary side air conditioning facility 20 includes a secondary side cold water pump 21, and the indoor unit 22.

The secondary side cold water pump 21 is a pump for pressure-feeding the cold water from the heat storage tank 14 to an indoor heat exchanger 22a and installed at an intermediate location of a tube q3. Further, an upstream end of the tube q3 reaches a lower part region of the heat storage tank 14, and a downstream end of a tube q3 is connected to an upstream end of a heat transmitting tube r included in the indoor heat exchanger 22a. Further, an upstream end of a tube q4 is connected to a downstream end of the heat transmitting tube r, and a downstream end of the tube q4 reaches an upper part region of a heat 24.

[0059]

The indoor unit 22 (FCU: Fan Coil Unit) is a unit for cooling the indoor air with cold water with the heat exchanger and installed in a room of a facility K. The indoor unit 22 includes the indoor heat exchanger 22a and an indoor fan 22b. In the indoor heat exchanger 22a, heat exchange is made to cool the indoor air by heat exchange between the cold water having a low temperature flowing through the heat transmitting tube r and the air having a high temperature supplied by the indoor fan 22b.

[0060]

The refrigerator 11, the blower 12a of the cooling tower 12, the

cold water pump 13, the primary side cold water pump 15, the secondary side cold water pump 21, and the indoor fan 22b are driven by the power from a power grid (not shown) and are controlled by the controller 40.

[0061]

Further, in the room of the facility K, a plurality of devices are installed including an illuminating device R1 and a business use personal computer R2. The illuminating device R1, etc. are operated/stopped irrespective of the variation of the weather condition, so that the consumed power varies in a approximately fixed pattern in accordance with the date, the day of the week, a time zone. Further, the consumed power pattern such as the illuminating device R1 is stored in an consumed power pattern 61a (see Fig. 20) of the air conditioning management server 60 described later.

Hereinafter, the devices included by the air conditioning facility A and the devices (such as the illuminating device R1, etc.) not included in the air conditioning facility A are called together "load device".

[0062]

(Temperature and Humidity sensor)

The temperature and humidity sensor 30 is a sensor for actually measuring the temperature and the humidity of the outdoor air and installed in the vicinity of the facility K. The temperature and humidity actually measured by the temperature and humidity sensor 30 is applied to the controller 40.

[0063]

(Controller)

The controller 40 (control terminal) is a unit controlling each of the devices in the air conditioning facility A, and configured including electronic circuit such as a CPU, a ROM (Read Only Memory, a RAM,

and various types of interfaces.

As shown in Fig. 19, the controller 40 is connected to the air conditioning management server 60 through a network N. The temperature and humidity in the vicinity of the facility K measured by the temperature and humidity sensor 30 are transmitted to the air conditioning management server 60 through the network N by the controller 40.

[0064]

Further, information including an operation schedule of the air conditioning facility A is transmitted to the controller 40 through the network N from the air conditioning management server 60. The controller 40 switches the operation mode of the air conditioning in facility A in accordance with the information received from the air conditioning management server 60.

Regarding this, the controller 40 causes a display (not shown) to display information including the operation schedule. It is possible to switch the operation mode of the air conditioning facility A by an operation by the manager having watched this information.

[0065]

In the operation mode describe above includes a heat storage operation, a follow-up operation, and a heat radiation operation.

"Heat storage operation" is an operation mode in which the cold water is cooled by the refrigerator 11 and the cooled cold water is stored in the heat storage tank 14.

The "follow-up operation" is an operation mode in which the cold water cooled by the refrigerator 11 is supplied to the indoor unit 22 as it is.

The "heat radiation operation" is an operation mode in which the cold water having a low temperature stored in the heat storage tank 14 is circulated via the indoor unit 22. The consumed power

during the heat radiation operation of the air conditioning facility A stops the refrigerator 11 and the cooling tower 12, so that the consumed power of the air conditioning facility A largely decreases than that during the other operation mode.

[0066]

Further, in Fig. 19, the air conditioning facility A, the temperature and humidity sensor 30, the controller 40 are shown as one device respectively. However, actually, a plurality of the air conditioning facilities A, etc. are installed in respective locations. Further, the system is a system for cloud computing in which the controller 40 at each of sites transmits to and receives from the air conditioning management server 60 through the network N.

[0067]

(Correction device)

A correction device 200 is the same as the correction device 200 according to the first embodiment. Further, as the correction device 200, the correction device 200a according to the second embodiment may be used.

The correction device 200 is connected to the temperature and humidity sensor 102 and the weather forecast server 103 as shown in Figs. 1 and 2. However, the temperature and humidity sensor 102 and the weather forecast server 103 are omitted.

[0068]

(Air conditioning management server)

The air conditioning management server (air conditioning device) 60 is a server which generates an operation schedule of the air conditioning facility A on the basis of the corrected weather value received from the correction device 200 and a command signal to start a heat radiation operation in accordance with an measured value of the temperature and humidity received from the controller 40. The

air conditioning management server 60 is configured to integrally control operation schedules, etc. of the air conditioning facilities A installed at respective sites.

[0069]

<Configuration of air conditioning management server>

In Fig. 20, the network N (see Fig. 19) is omitted.

The air conditioning management server 60 includes a storage 61 which stores information regarding settings of the operation schedule and a computing processing unit 62 for executing various types of computing processes.

[0070]

The storage 61 stores the consumed power pattern DB (Data Base) 61a and a consumed power threshold DB 61b as database.

The consumed power pattern DB 61a stores consumed power patterns of the illuminating device R1, etc not included in the air conditioning facility A out of the "load devices" described earlier. More specifically, in the consumed power pattern DB 61a stores prediction values of the consumed power such as the illuminating device R1 associated with date, the day of week, and time.

[0071]

The consumed power threshold DB 61b stores information of a threshold PM (predetermined threshold) of the consumed power of the load device described earlier. The threshold PM is a threshold giving a reference determining whether the heat radiation operation is made or not and preset for each site of the air conditioning facility A. The threshold PM is set to a value which is smaller than a contract demand PC which is an upper limit in buying power.

[0072]

As shown in Fig. 20, the computing processing unit 62 includes: the corrected weather value acquiring unit 62a, a heat load prediction

unit 62b, a consumed power prediction unit 62c, a consumed power prediction unit 62d, a schedule setting unit 62e, an measured value acquiring unit 62f, a heat load calculating unit 62g, the consumed energy calculating unit 62h, a consumed power calculating unit 62i, a command signal generating unit 62j, and a command signal transmitting unit 62k.

[0073]

The corrected weather value acquiring unit 62a periodically acquires the corrected weather value of the area including the facility K from the correction device 200.

The heat load prediction unit 62b predicts a heat load in the facility K on the basis of the corrected weather value acquired by the corrected weather value acquiring unit 62a. The heat load is an air conditioning load (cooling load) to keep inside of the facility K at a predetermined temperature.

The heat load prediction unit 62b calculates the heat load within the facility K on the basis of the corrected weather value, a setting temperature within the facility K, and a structure of the building of the facility K.

[0074]

The consumed power prediction unit 62c predicts a consumed energy of the air conditioning facility A in the case where a cold energy is supplied from the refrigerator 11 to the facility K(to cool inside of the facility K by the follow-up mode operation) on the basis of the heat load predicted by the heat load prediction unit 62b.

The consumed power prediction unit 62c calculates a consumed energy of the air conditioning facility A on the basis of the heat load, the corrected weather values of the outdoor wet bulb temperature of the next day, specification information, etc. of the air conditioning facility A.

[0075]

The consumed power prediction unit 62d predicts a consumed power of the load device including the air conditioning facility A on the basis of the consumed energy predicted by the consumed power prediction unit 62c. The consumed power corresponding to a consumed power in a case where the inside of the facility K is cooled by the follow-up operation (i.e., heat radiation operation is not performed).

[0076]

The schedule setting unit 62e sets an operation schedule of the air conditioning facility A on the basis of the consumed power predicted by the consumed power prediction unit 62d. The schedule setting unit 62e transmits the set operation schedule to the controller 40 through the network N (see Fig. 19).

Further, details of the process executed by the schedule setting unit 62e will be described.

[0077]

The measured value acquiring unit 62f acquires current measured values of the temperature and humidity in the vicinity of the facility K every predetermined time interval (for example, five minutes) from the controller 40 through the network N (see Fig. 19). Further, "current" described earlier includes a case where several minutes or several tens minutes before the measured value acquiring unit 62f acquires the measured values of temperature and humidity.

[0078]

The heat load calculating unit 62g calculates the current heat load in the facility K on the basis of the measured values of temperature and humidity acquired by the measured value acquiring unit 62f.

The consumed energy calculating unit 62h calculates a

consumed energy of the air conditioning facility A in the case where the cold energy is supplied from the refrigerator 11 (cooling the inside of the facility K by a follow-up operation) on the basis of the heat load calculated by the heat load calculating unit 62g.

[0079]

The consumed power calculating unit 62i calculates the consumed power of the load devices including the air conditioning facility A on the basis of the consumed energy calculated by the consumed energy calculating unit 62h. The consumed power corresponds to a consumed power in the case where the inside of the facility K is cooled by the follow-up operation (i.e., heat radiation operation is not performed).

[0080]

The command signal generating unit 62j has a function of generating a command signal indicating whether the heat radiation operation is performed or not performed. As shown in Fig. 20, the command signal generating unit 62j includes a heat load comparator 621j, a consumed power comparator 622j, and a heat radiation start time changing unit 623j.

The heat load comparator 621j compares the heat load predicted by the heat load prediction unit 62b with the heat load (actual heat load) calculated by the heat load calculating unit 62g to have a comparison regarding large and small. The comparing result by the heat load comparator 621j is applied to the heat radiation start time changing unit 623j.

The consumed power comparator 622j compares a consumed power calculated by the consumed power calculating unit 62i with the threshold PM stored in the consumed power threshold DB 61b to have a comparing result regarding large and small. The comparing result by the consumed power comparator 622j is applied to the heat

radiation start time changing unit 623j.

[0081]

The heat radiation start time changing unit 623j changes the start time of the heat radiation set by the schedule setting unit 62e on the basis of the comparing results by the heat load comparator 621j and the consumed power comparator 622j. More specifically, the heat radiation start time changing unit 623j has a function to advance or delay the start time of the heat radiation operation from the scheduled start time of the operation schedule. Further, the process executed by the heat radiation start time changing unit 623j will be described later.

The command signal transmitting unit 62k transmits the command signal generated by the command signal generating unit 62j to the controller 40 through a network N (see Fig. 19).

[0082]

<Operation of air conditioning management server>

In a step S101, the air conditioning management server 60 determines whether current time reaches the delivering time of the corrected weather value.

In a step S102, the air conditioning management server 60 acquires the corrected weather value from the correction device 200 using the corrected weather value acquiring unit 62a (corrected weather value acquiring step). The "corrected weather value" includes, as described earlier, temperature correction values and specific humidity correction values for 24 hours (hour by hour).

[0083]

An air conditioning management server 60 predicts, in step S103, a heat load q_f of the inside of the facility K in respective time zones (24 hours are divided into plural time zones (for example, hour by hour) and at time when the corrected weather values are acquired

(heat load prediction step). Further, it is preferable to predict the heat load using a heat load simulator on the basis of the corrected weather value and a setting temperature, etc. within the facility K.

[0084]

In a step S104, the air conditioning management server 60 predicts consumed energy of the air conditioning facility A in respective time zones using the consumed power prediction unit 62c on the basis of the heat load q_f predicted in a step S103 (consumed energy predicting step). Further, it is preferable to predict the consumed energy of the air conditioning facility A using a heat source simulator on the basis of the heat load q_f , and specification information of the air conditioning facility A.

[0085]

The air conditioning management server 60 predicts, in a step S105, a consumed power $P1_f$ of the air conditioning facility A in respective time zones using the consumed power prediction unit 62d on the basis of the consumed energy predicted in the step S104. As described above, the consumed power $P1_f$ is a consumed power when the inside of the facility K is cooled by the follow-up operation.

In a step S106, the air conditioning management server 60 predicts consumed powers $P2_f$ of devices (the illuminating device R1, etc.) other than the air conditioning facility A with reference to the consumed power pattern DB 61a (see Fig. 20).

[0086]

The air conditioning management server 60 predicts, in a step S107, a consumed power $P3_f$ of a load device described above by adding the $P1_f$ of the air conditioning facility A to the consumed power $P2_f$ of the devices other than the air conditioning facility A (consumed power prediction step).

[0087]

The air conditioning management server 60 makes, in a step S108 in Fig. 22, setting of a value $n=1$, and an initial value of a required stored heat quantity Q_v to zero. In accordance with the value n , the time zone is specified from time $(t_1 + (n-1)\Delta t)$ to time $(t_1 + n\Delta t)$. Time t_1 is, for example, seven a.m. which is time to start the follow-up operation and stops the heat storage operation, and a predetermined time interval Δt is, for example, one hour.

Further, the required stored heat quantity Q_v is a quantity of cold energy necessary to cancel out a power in a region where the consumed power P_{3f} of the heat load exceeds the threshold P_M .

[0088]

The air conditioning management server 60 determines, in a step S109, whether the consumed power P_{3f} of the load device exceeds the threshold P_M in the time zone specified by the value n in the step S108 with reference to the consumed power threshold DB 61b. When the consumed power P_{3f} exceeds the threshold P_M (Yes, in the step S109), the processing of the air conditioning management server 60 advances to a step S110. On the other hand, when the consumed power P_{3f} is equal to or less than a threshold P_M (No, in the step S109), the processing by a step air conditioning management server 60 advances to the step S113.

[0089]

The air conditioning management server 60 calculates an excess power ΔP by subtracting the threshold P_M from the consumed power P_{3f} .

The air conditioning management server 60 calculates, in a step S111, calculates a stored heat quantity ΔQ corresponding to the excess power ΔP calculated in the step S110. More specifically, the air conditioning management server 60 calculates the stored heat quantity ΔQ necessary to cancel out the power calculated by the

excess power $\Delta P \times$ the predetermined time interval Δt . The stored heat quantity ΔQ is calculated on the basis of the specification information of the devices forming the air conditioning facility A and corrected weather values, etc of the outdoor wet valve temperature.

[0090]

The air conditioning management server 60 updates, in the step S112, the required stored heat Q_v by adding the stored heat quantity ΔQ calculated in a step S111 to the required stored heat quantity Q_v . In a case where $n = 1$, the air conditioning management server 60 updates the required stored heat quantity Q_v by adding the stored heat quantity ΔQ to an initial value of a required stored heat quantity Q_v having zero (S108).

[0091]

The air conditioning management server 60 determines, in the step S113, whether $n = N$. Further, the natural number N corresponds to end time of the time zone to be a prediction target for the required stored heat quantity Q_v (for example, 0 a.m. on the day after next).

When $n < N$, (No, in the step S113), the processing of the air conditioning management server 60 advances to a step S114. In the step S114, the air conditioning management server 60 makes increment in the value n and advances process in a step S119. For example, when $n = 2$, the stored heat quantity ΔQ in the time zone from time $(t1 + \Delta t)$ to $(t1 + 2\Delta t)$ on the next day is calculated in the step S111 which is added to the required stored heat quantity Q_v until the previous time in a step S112.

On the other hand, when $n = N$, (Yes, in the step S113), the processing by the air conditioning management server 60 advances to a step S115.

[0092]

The air conditioning management server 60 sets, in the step S112, a time zone (heat storing time zone) for heat storing operation and a stored heat quantity (load rate, etc. of the refrigerator 11) to fulfill the required stored heat quantity Q_v finally updated in the step S112. Further, it is preferable to set the time zone for heat storage such that the heat storage operation is carried out using a nighttime power which is cheap.

In a step S116, the air conditioning management server 60 sets the time zone for the heat radiation operation (heat radiation time zone) and a heat radiation quantity (a flow rate, etc. of cold water). For example, the air conditioning management server 60 sets an operation schedule to perform the heat radiation operation in the time zones where the consumed power P_{3f} of the load device exceeds the threshold P_M . This suppresses the consumed power of the load device under the threshold P_M when the temperature and humidity in the vicinity of the facility K vary as the corrected weather values indicate.

[0093]

In a step S117, the air conditioning management server 60 sets, using the schedule setting unit 62e, an operation schedule in which the schedule including the follow-up operation, etc. are added to the schedule of the heat storing operation set in the step S115 and the schedule of the heat radiation operation set in the step S116 (schedule setting step). The operation schedule includes a type of the operation (heat storage operation, follow-up operation, heat radiation operation, etc), and the time zone (start time, end time) for which respective operation modes are performed. .

The air conditioning management server 60 transmits the set operation schedule to the controller 40 through the network N.

[0094]

Fig. 23 is a flowchart showing a flow of process executed by the

air conditioning management server. Further, it is assumed that the controller 40 is performing the follow-up operation or the heat radiation operation in accordance with the operation schedule set in the step S117 in Fig. 22 because the heat storage tank 14 stores the cold energy at the start time of a step S118 (the heat storage operation has completed).

[0095]

In the step S118, the air conditioning management server 60 acquires the measured value of the temperature and the humidity in the vicinity of the facility K using the measured value acquiring unit 62f (measured value acquiring step). The temperature and humidity described above are values detected just before the process in a step S118 with the temperature and humidity sensor 30. Further, it may be possible to measure the temperature and the humidity every five minutes and average the measured values for one hour just before the process in the step S118.

[0096]

In the step S119, the air conditioning management server 60 calculates a current heat load q_r of the air conditioning facility A using the heat load calculating unit 62g on the basis of the measured values of the temperature and the humidity acquired in the step S118 (head load calculating step).

In a step S120, the air conditioning management server 60 calculates a current consumed power of the air conditioning facility A using the consumed energy calculating unit 62h on the basis of the heat load q_r calculated in the step S119 (consumed energy calculating step).

[0097]

In a step S121, the air conditioning management server 60 calculates a consumed power $P1_r$ of the air conditioning facility A

using the consumed power calculating unit 62i on the basis of the consumed energy calculated in the step S120 (consumed power calculating step). The consumed power $P1_r$ is a consumed power in the case where the air conditioning facility A continues the follow-up operation without performing the heat radiation operation.

In a step S122, the air conditioning management server 60 refers the consumed power pattern DB 61a and reads out a consumed power $P2_r$ of devices (illumination device, etc.) other than an air conditioning facility A.

[0098]

In the step S123, a consumed power air conditioning management server 60 calculates the consumed power $P3_r$ by adding the consumed power $P1_r$ to the consumed power $P2_r$ of the devices other than the air conditioning facility A.

[0099]

In a step S124 in Fig. 24, the air conditioning management server 60 determines whether the current heat load q_r calculated in the step S119 (see Fig. 23) is equal or higher than the heat load q_f predicted in the step S103 (see Fig. 21).

When the current heat load q_r is equal to or higher than a heat load q_f (Yes, in a step S124), processing of the air conditioning management server 60 advances to a step S125. For example, when the temperature detected by the temperature and humidity sensor 30 exceeds the corrected temperature delivered by the correction device 200, there is a high possibility that $q_r \geq q_f$.

[0100]

In the step S125, the air conditioning management server 60 determines whether the current time is included in the heat radiation time zone set in the S116 (see Fig. 22). When the current time is not included in the set heat radiation time zone (No, in Step S125), the

processing of the air conditioning management server 60 advances to a step S126. For example, the heat radiation time zone in the operation schedule is from 13 to 18 o'clock, and the current time is at eleven, the processing of the air conditioning management server 60 advances to the step S126.

[0101]

In the step S126, the air conditioning management server 60 determines whether the consumed power P_{3r} of the load device calculated in the step S123 (see Fig .23) exceeds the threshold P_M or not. When the consumed power P_{3r} exceeds the threshold P_M (Yes, in the step S126), the processing of the air conditioning management server 60 advances to a step S127.

[0102]

In the step S127, the air conditioning management server 60 determines whether the cold energy is stored in the heat storage tank 14 or not (heat storage is left or not). For example, the air conditioning management server 60 performs the determination process in the step S127 depending on whether the value is higher than zero, the value resulting from subtracting the cold energy quantity consumed in the secondary side air conditioning facility 20 during the heat radiation operation from the cold energy quantity generated by the primary side air conditioning facility 10 during the heat storing operation

[0103]

When the cold energy is stored in the heat storage tank 14 (there is left storage; Yes, in the step S127), the processing of the air conditioning management server 60 advances to a step S128.

In the step S128, the air conditioning management server 60 generates a command signal to perform (start) the heat radiation operation (command signal generation step). More specifically, when

the consumed power P_{3r} exceeds the threshold P_M before the scheduled start time of the heat radiation operation, the air conditioning management server 60 advances the start time of the heat radiation operation.

[0104]

On the other hand, when the cold energy is not stored in the heat storage tank 14 in the step S127 (no left heat storage; No, in the step S127), the processing of the air conditioning management server 60 advances to a step S129. In the step S129, the air conditioning management server 60 determines that the heat radiation operation is not performed (cannot be continued).

Further, at the start of the heat radiation operation, there is the cold energy in the heat storage tank 14. However, when the time zone of the great radiation operation is advanced there is a possibility that the cold energy may be used up at a final stage of the time zone.

[0105]

In a step S130, the air conditioning management server 60 sets another control by generating a command signal to perform another operation which is different from the heat radiation operation. For example, the air conditioning management server 60 decreases the consumed power of the illuminating device R1, etc. from the general value to reduce the consumed power of the load device under the threshold P_M while the follow-up operation is continued.

In the step S125, when the current time is included in the heat radiation time zone (Yes, in the step S125), the processing of the air conditioning management server 60 advances to the step S127. Further, the process after the step S127 is as described above.

[0106]

Further, in S126, when the current consumed power P_{3r} is equal to or smaller than the threshold P_M (No, in the step S126), the

processing of the air conditioning management server 60 advances to a step S131. In the step S131, the air conditioning management server 60 generates a command signal not to perform (do not start yet) the heat radiation operation.

For example, the heat load q_r based on the measured values of the temperature and humidity are larger than the heat load q_f based on the corrected weather values, but a consumed eclectic power P_r may not exceed the threshold P_M . In this case, it is not necessary to perform the heat radiation operation (step S131).

[0107]

Further, in the step S124, when the current heat load q_r is lower than the predicted heat load q_f (No, in the step S124), the processing of the air conditioning management server 60 advances to a step S132.

In the step S132, the air conditioning management server 60 determines whether the current time is included in the heat radiation time zone set in the step S116 (see Fig. 22). When the current time is not included in the set heat radiation time zone (No, in the step S132), the processing of the air conditioning management server 60 advances to a step S133.

In the step S133, the air conditioning management server 60 determines not to perform (not yet start) the heat radiation operation.

[0108]

In the step S132, when the current time is included in the set heat radiation time zone (Yes, in the step S132), the processing of the air conditioning management server 60 advances to a step S134.

In the step S134, the air conditioning management server 60 determines whether the current consumed power P_{3r} calculated in the step S123 exceeds the threshold P_M . When the current consumed power P_{3r} exceeds the threshold P_M (Yes, in the step S134), the

processing of the air conditioning management server 60 advances to a step S135.

[0109]

In the step S135, the air conditioning management server 60 determines whether there is the cold energy stored in the heat storage tank 14 (stored energy exists or not). When the cold energy is stored in the heat storage tank 14 (there is stored energy; Yes, in the step S135), the processing of the air conditioning management server 60 advances to a step S136.

In the step S136, the air conditioning management server 60 generates a command signal to perform (start) the heat radiation operation. More specifically, when the consumed power of the load device exceeds the threshold P_M though the heat load of the air conditioning facility A is slightly smaller than the prediction, there may be a heat generation by the load device other than the air conditioning facility A. So, the controller 40 performs the heat radiation operation.

[0110]

On the other hand, when the cold energy is not stored in the heat storage tank 14 (No heat storage; No, in the step S135), the processing of the air conditioning management server 60 advances to the step S137. In a step S137, the air conditioning management server 60 determines not to perform the heat radiation operation (cannot be continued).

In a step S138, the air conditioning management server 60 sets another operation by generating a command signal to perform another operation which is different from the heat radiation (for example, another operation is to decrease the consumed power of the illuminating devices R1).

[0111]

Further, when the current consumed power P_{3r} in the step S134 is not larger than the threshold P_M (No, in the step S134) the air conditioning management server 60 generates a command signal not to perform (not to start) the heat radiation operation in the step S133. More specifically, the air conditioning management server 60 delays the start time of the heat radiation operation when the consumed power P_{3r} is not greater than the threshold P_M after the start time of the heat radiation operation.

[0112]

In a step S139 the air conditioning management server 60 transmits the command signal generated in the step S128, etc. to the controller 40 using the command signal transmitting unit 62k (command signal transmitting step).

In the step S140, the air conditioning management server 60 calculates remaining heat energy in the heat storage tank 14. More specifically, the air conditioning management server 60 calculates a remaining stored heat quantity in the heat storage tank 14 on the basis of the cold energy supplied to the secondary side air conditioning facility 20 during the heat radiation operation. In the step S127 in the next cycle, the remaining heat quantity is used in the process in the step S135 (determination process as to whether there is stored heat; see Fig. 24).

[0113]

In a step S141, the air conditioning management server 60 determines whether the current time becomes the delivering time of the corrected weather value. When the current time becomes the delivering time of the corrected weather value (Yes, in the step S141), the processing of the air conditioning management server 60 returns to the step S102 in Fig. 21.

On the other hand, the current time does not become the

delivering time, (No, in the step S141), the processing by the air conditioning management server 60 returns to the step S118 in Fig. 23. Further, the series processes from the step S118 to the step S141 are repeated together with the delivering time of the corrected weather values (for example, every one hour). Regarding this, the processes from the step S118 to the step S141 may be performed every several minutes or several seconds.

[0114]

<Advantageous Effect>

In the third embodiment, there is provided a heat load prediction in which the placement condition of the building can be considered through the prediction of the heat load using the corrected weather value calculated by the correction device. Further, prediction of the heat load can be performed by prediction of the heat load using the corrected weather value calculated hour by hour. This prevents the weather forecast value from deviating from the weather measured value even at morning, daytime, and evening.

Further, the method according to the second embodiment is applied to the third and the fourth embodiments, so that the heat load prediction can be performed using the weather corrected value even at time when the weather forecast data cannot be acquired.

[0115]

As described above, according to the third embodiment, it is possible to predict the heat load or to predict the consumed power quantity in consideration of the placement condition, variation of the weather condition using the corrected weather value calculated in accordance with the first or second embodiment. This improves a prediction accuracy of the heat load or prediction accuracy of the consumed power. Further, according to the third embodiment and the fourth embodiment (described later), a suitable schedule can be made

regarding shifting of the peak, which can decrease a running cost due to decrease in the contract power.

Further, according to the air conditioning system S according to the third and fourth embodiments can be flexibly operation because the consumed power is calculated not directly from the past weather forecast value.

[0116]

Further in this embodiment, when the consumed power P_{3r} of the load device exceeds the threshold P_M before the scheduled start time of the heat radiation operation (Yes in the step S126), the air conditioning management server 60 advances the start time of the heat radiation operation from the schedule (the step S128). This provides leveling consumed power of the load devices more appropriate than the case where the air conditioning facility A is simply controlled in accordance with the operation schedule.

Further, after the scheduled start time of the heat radiation operation, when the consumed power P_{3r} of the load device is not higher than the threshold P_M (No, in the step S134), the air conditioning management server 60 delays the start time of the heat radiation operation from the schedule (the step S133). This prepares for the case that the heat load after that becomes larger than the prediction and it is possible to effectively use the cold energy stored in the heat storage tank 14.

[0117]

In addition, the air conditioning management server 60 checks, in real-time manner, whether the heat radiation time zone in the operation schedule is appropriate on the basis of the measured temperature and humidity and transmits a command signal to the controller 40 in accordance with the checking result. Accordingly, for example, though the heat load within the facility K rapidly increases

due to large deviation of the corrected weather value, the consumed power of the load device can be suppressed by immediately starting the heat radiation operation. Accordingly, this prevents the consumed power of the load device from exceeding the contract demand P_c .

[0118]

Further, the air conditioning system S integrally manages information regarding a plurality of air conditioning facilities A at the air conditioning management server 60 and thus operates as a system of Cloud computing for supplying information to many users. Accordingly, the user is required only to prepare a minimum communication connection environment, which largely saves the cost for managing the air conditioning facility A.

The process in the air conditioning management server 60 is performed by automatically using a heat source simulator, etc. Accordingly, leveling the consumed power at a higher accuracy than that in the case where the operator adjusts the operation schedule through trial and error.

[0119]

[Fourth Embodiment]

The fourth embodiment is substantially the same as the third embodiment. The difference is in addition of a power meter 70 (see Fig. 26) for actually measuring consumed power of each of devices to the air conditioning system S according to the third embodiment and in an air conditioning management server 60A (see Fig. 27). Accordingly, only the different points are described below and description of the duplicated parts are omitted.

[0120]

Fig. 26 is a block diagram of the air conditioning system including the air conditioning management server according to the

fourth embodiment. The power meter 70 actually measures the consumed power P_{3r} (total value) of respective devices within the facility K, such as the refrigerator 11, the blower 12a, the cold water pump 13, the primary side cold water pump 15, the secondary side cold water pump 21, and the indoor fan 22b. The value of the consumed power P_{3r} measured by the power meter 70 is transmitted to the controller 40. The controller 40 transmits the measured value of the temperature and humidity sensor 30 and the power meter 70 to the air conditioning management server 60A through the network N every predetermined time interval, for example, every five minutes.

[0121]

<Configuration of Air conditioning management server>

Fig. 27 is a block diagram of the air conditioning management server according to the fourth embodiment.

A configuration of the air conditioning management server 60A shown in Fig. 27 is substantially the same as that according to the third embodiment. The difference is in that the consumed energy calculating unit 62h is omitted from the air conditioning management server 60 (see Fig. 20) described in the third embodiment and the air conditioning management server 60A is provided with a consumed power acquiring unit 62m in place of the consumed power calculating unit 62i (see Fig. 20).

The consumed power acquiring unit 62m acquires the measured value of the power meter 70 from the controller 40 through the network N (i.e., an actual consumed power of the load devices). The measured value of the consumed power acquired by the consumed power acquiring unit 62m is transmitted to the consumed power comparator 622j.

The consumed power comparator 622j compares the measured value of the consumed power with the threshold P_M .

[0122]

<Operation of Air conditioning management server>

Fig. 28 is a flowchart showing a flow of process executed by the air conditioning management server.

The process for setting the operation schedule of the air conditioning facility A (see step S101 to S117 in Figs. 21 and 22) is the same as those in the third embodiment. Further, at the start of the process shown in Fig. 28, in the air conditioning facility A, the follow-up operation or the heat radiation operation is performed.

[0123]

In the step S118, the air conditioning management server 60A acquires the measured values of the temperature and the humidity in the vicinity of the facility K from the controller 40 using the measured value acquiring unit 62f.

In the step S119, the air conditioning management server 60A calculates the current heat load q_r of the air conditioning facility A on the basis of the measured values of the part temperature and humidity acquired in the step S118 using the heat load calculating unit 62g. The heat load q_r is used in a comparing process with the predicted heat load q_f (the step S124 in Fig. 29).

Next, in a step S201, the air conditioning management server 60A acquires a consumed power P_s from the controller 40 using the consumed power acquiring unit 62m (consumed power acquiring step). As described above, the consumed power P_s is a measured value actually measured with the power meter 70.

[0124]

After the process in the step S201, the processing by the air conditioning management server 60A advances to the step S124 shown in Fig. 29. Further, the sequential process shown in Fig. 29 is the same as that in the flowchart shown in Fig 24 which has been

described regarding the third embodiment except a step S202 and a step S203.

[0125]

For example, when the actually measured consumed power P_s exceeds the threshold P_M (Yes, in the step S202) before the scheduled start time of the heat radiation operation (No, in the step S125), the air conditioning management server 60A advances the start time of the heat radiation operation from the schedule (step S128).

Further, after the scheduled start time of the heat radiation operation (Yes, in the step S132 in which determination is made whether the current time is included in the scheduled heat radiation time zone), when the actually measured consumed power P_s is not larger than the P_M (No in the step S203), the air conditioning management server 60A delays the start time of the heat radiation operation is delayed from the schedule (the step S133) by not performing the heat radiation.

The process from the step S139 to S141 after the node D is the same as that in the third embodiment (see Fig 25).

[0126]

<Advantageous Effect>

According to the fourth embodiment, as same as the third embodiment, the operation schedule can be flexibly changed in accordance with the variation of the measured temperature and the humidity.

Further, in the third embodiment, the consumed power P_{1r} of the air conditioning facility A is calculated on the basis of the values measured by the humidity sensor 30 (the step S121 in Fig. 23) and the consumed power P_{2r} other than the air conditioning facility A are read out from the consumed power pattern DB 61a (the step S123). The consumed power P_{3r} is calculated by acquiring a sum of both (a

step S123).

On the other hand, according to the present embodiment, the consumed power of the load device is directly measured by the power meter 70, which improves accuracy in determination whether the consumed power of the load devices exceeds the threshold P_M . Accordingly, the adjustment for the operation schedule can be made at a higher accuracy than that in the third embodiment.

[0127]

<<Modification>>

As described above, the air conditioning management servers 60, 60A are described regarding the respective embodiments. However the present invention is not limited to these, but may be modified appropriately.

For example, respective embodiments have been described in which setting and adjustment of the operation schedule are integrally made by the air conditioning management server 60 (60A). However, this may be divided into a plurality of servers.

[0128]

Further, in the respective embodiments, descriptions have been made for a determination process (see S124 in Fig. 24) of whether the current heat load q_r is not smaller than the predicted heat load q_f . However, the present invention is not limited to this. More specifically, a process is repeatedly performed in which the heat radiation operation is continuously performed for a predetermined period when the consumed power measured by the power meter 70 exceeds the threshold P_M irrespective of smallness or largeness of the heat loads q_r , q_f . In this case, the consumed power of the load device can be suppressed not larger than the contract demand P_C .

[0129]

Further, in the respective embodiments, descriptions have been

made for the case in which the corrected weather values acquired by the corrected weather value acquiring unit 62a are corrected temperature and corrected specific humidity in the vicinity of the facility K. However, the present invention is not limited to this. For example, it is also possible to add a quantity of solar radiation as the corrected weather value to the corrected temperature and the corrected specific humidity.

Further, in the respective embodiments, descriptions have been made for the case in which the cold energy necessary for cancelling the power corresponding to the excess part of the consumed power P_{3f} over the threshold P_M is stored in the heat storage tank 14. The present invention is not limited to this. For example, it is also possible to make the heat storage tank 14 in a full stored state by the heat storing operation irrespective of the type of the corrected weather values.

Further, a method for predicting a consumed power other than the third and fourth embodiments may be used.

[0130]

<Application Result>

Figs. 30A and 30B are charts showing results of a heat load prediction before and after the correction of the weather forecast value.

As the heat load prediction, the method according to the third embodiment is used.

Fig. 30A is a chart showing a heat load using the weather forecast value as a comparative example, and Fig. 30B is a chart of the heat load calculation using the corrected weather value according to the first embodiment.

In Fig. 30A, the solid line indicates a variation in the actual heat load, and the broken line indicates a variation of the heat load

calculated using the weather forecast values. Further, in Fig. 30B, the solid line indicates a variation of the actual heat load and the broken line indicates a variation of the heat load calculated using the corrected weather values.

As clearly understood from comparing result of Figs. 30A and 30B, the heat load calculated based on the corrected weather values in Fig. 30B provides the heat load value which is closer to the actual heat load than the chart of the heat load calculated based on the weather forecast value in Fig. 30A.

[0131]

The present invention is not limited to the described embodiment, but may be modified in various manners. For example, the embodiments are described in detail to provide easy understandable embodiments of the present invention. This invention is not limited to the embodiments having all configurations disclosed above. Further a part of the embodiment may be replaced with a part in the different embodiment. A part of an embodiment may be added to the configuration according to another embodiment. Further, other configurations may be added to, replaced with a part of the respective embodiments or omitted.

[0132]

Further, respective configurations described above, such as the processing unit 211 to the interpolation processing unit 217, the computing processing unit 62, the corrected weather value acquiring unit 62a to the command signal transmitting unit 62k, the consumed power acquiring unit 62m, the heat load comparator 621j, the consumed power comparator 622j, the heat radiation start time changing unit 623j, the storage 203, the storage 61, etc. are partially or totally realized with hard ware by designing, for example, an integrated circuit. Further, as shown in Figs. 3, 16, 20, and 27, the

respective configuration and functions are realized with software by executing programs for operating to provide respective function with processor, CPU etc. Information of a program, a table, a file, etc for realizing respective functions can be stored in a recording unit such as a memory, an SSD (Solid State Drive), etc. or a recording medium such as IC(Integrated Circuit) card, an SD(Secure Digital) card, a DVD (Digital Versatile Disc) in addition to storing in an HD.

[0133]

Further, respective units designated with references 211 to 217, 62, 62a to 62k, 62m, 621j, 622j, 623j in the correction devices 200, 200a, the air conditioning management servers 60, 60A may be installed in one unit. Further, it is possible to install a unit including one of the units 211 to 217, 62, 62a to 62k, 62m, 621j, 622j, 623j separated from the correction devices 200, 200a, the air conditioning management servers 60, 60A.

[0134]

Further, in respective embodiments, control lines and information lines are shown as required for explanation, but does not necessarily indicate all control line or information lines which may be considered to be necessary in the product. Actually, almost configurations are connected to each other.

DESCRIPTION OF REFERENCE SYMBOLS

[0135]

S	air conditioning system (air conditioning management system)
K	facility
A	air conditioning facility
Z, Z1, Z2	weather correction system
11	refrigerator
14	heat storage tank
30	temperature and humidity sensor

40	controller
60	air conditioning management server
62	computing processing unit
62a	corrected weather value acquiring unit
62b	heat load prediction unit
62c	consumed power prediction unit
62d	consumed power prediction unit
62e	schedule setting unit
62f	measured value acquiring unit
62g	heat load calculating unit
62h	consumed energy calculating unit
62i	consumed power calculating unit
62i	consumed power calculating unit
62k	command signal transmitting unit
62m	consumed power acquiring unit
70	power meter
102	temperature and humidity sensor
103	weather forecast server
200, 200a	correction device
211	processing unit
212	weather forecast data acquiring unit
213	weather measured data acquiring unit
214	specific humidity calculating unit
215	correction coefficient calculating unit
216	corrected weather value calculating unit
217	interpolation processing unit
221	weather forecast data
222	weather measured data

CLAIMS:

1. A weather correction device comprising:

a weather forecast value acquiring unit that acquires a past weather forecast value at each of predetermined intervals;

a weather measured value acquiring unit that acquires a past weather measured value at each of the predetermined intervals;

a corrected value calculating unit that calculates a corrected weather forecast value at each of the predetermined intervals, the corrected weather forecast value being calculated by correcting the weather forecast value to be a target of prediction, on the basis of the acquired weather forecast value and the acquired weather measured value.

2. The weather correction device as claimed in claim 1, wherein the weather measured value acquiring unit acquires a weather measured value at each of the predetermined intervals for a past predetermined period.

3. The weather correction device as claimed in claim 1, wherein the weather forecast value acquiring unit acquires the weather forecast values at each of the predetermined intervals for the past predetermined period.

4. The weather correction device as claimed in claim 1, further comprising:

a correction coefficient calculating unit that associates

the weather forecast value with the weather measured value, calculates a linear equation by a least squares method on the basis of the associated the weather forecast value and the weather measured value to provide an inclination and a y-intercept in the linear equation as correction coefficients;

wherein the correction coefficient calculating unit outputs a result of substitution of the weather forecast value to be a target of prediction into the linear equation as the corrected weather forecast value.

5. The weather correction device as claimed in claim 1, further comprising: an interpolation process unit that interpolates a weather forecast value at an intermediate time between the timings when weather forecast values have been acquired.

6. An air conditioning system comprising:

a weather forecast value acquiring unit that acquires a past weather forecast value at each of predetermined intervals;

a weather measured value acquiring unit that acquires a past weather measured value at each of the predetermined intervals;

a corrected value calculating unit that calculates a corrected weather forecast value, which is calculated by correcting the weather forecast value or the weather measured value to be a target of prediction, on the basis of the acquired weather forecast value and the acquired weather measured value at each of the predetermined intervals;

a consumed power predicting unit that predicts a consumed power of an air conditioning facility on the basis of the weather corrected value; and

an air conditioning controller that controls the air conditioning facility on the basis of the predicted consumed power.

7. The air conditioning system as claimed in claim 6, further comprising

a heat load prediction unit that predicts a heat load in an air conditioning target region of the air conditioning facility on the basis of the weather corrected value,

wherein the consumed power predicting unit predicts a consumed power of the air conditioning facility on the basis of the weather corrected value and the predicted heat load.

8. A method of correcting a weather value, comprising:

acquiring a past weather forecast value at each of predetermined intervals;

acquiring a past weather measured value at each of the predetermined intervals; and

calculating a corrected weather forecast value at each of the predetermined intervals, the corrected weather forecast value being calculated by correcting the weather forecast value to be a target of prediction, on the basis of the acquired weather forecast value and the acquired weather measured value, which are performed by the weather correction device.