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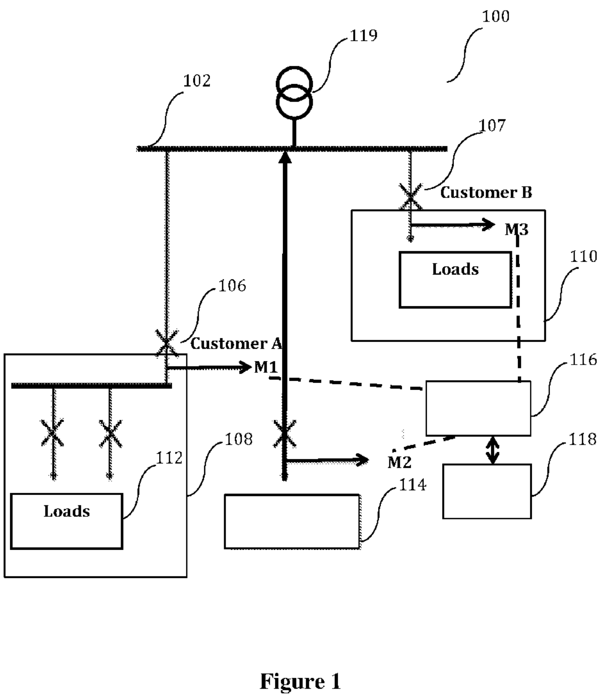

Figure 1

(57) Abstract: A power grid system and a method of consolidating power injection and consumption in a power grid system. The power grid system comprises a power grid; at least one load connected to the power grid; a first meter configured for metering power imported from the power grid to the load; at least one intermittent power source connected to the power grid, a second meter configured for metering power generated by the intermittent power source; and a consolidation unit configured for associating readings from the first and second meters such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load.

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POWER GRID SYSTEM AND METHOD OF CONSOLIDATING POWER INJECTION AND CONSUMPTION IN A POWER GRID SYSTEM

FIELD OF INVENTION

The present invention relates broadly to a power grid system and to a method of consolidating power generation and consumption in a power grid system.

BACKGROUND

To date, the majority of buildings, in particular commercial buildings such as shopping malls or industrial buildings, obtain all their power from a mains power grid system where a generator such as a coal-fired power plant or another combustion engine supply power to the power network pool through a power grid network as adjusted by the load demand on the power grid network. Generation of power from auxiliary generators associated with the buildings load may be performed independently of the mains power grid system as an embedded generator to the building solely reducing the total energy drawn by the buildings loads from the power network. For example, a solar power system may be connected directly through the buildings distribution board to supply the buildings loads with priority to the power grid.

Within the mains power grid system, intermittent sources for power generation may be used together with dispatchable sources such as coal-fired power plant or another combustion engine to contribute to the power network pool, i.e. in meeting the overall demand experienced in the mains power grid system. However, given the nature of the intermittent sources such as their inability to follow directly a changing load profile, and an output dependent on external factors like the weather, the availability of an environmental resource at a particular time local to the generator (eg. the flow of water or sunlight incident on a photovoltaic (PV) plate), their adoption as a means of supplying power through a mains power grid system to a load connected to the mains power grid system remains relatively underdeveloped.

Embodiments of the present invention provide a power grid system and a method of consolidating power generation and consumption in a power grid system that seek to address at least one of the above problems.

SUMMARY

In accordance with a first aspect of the present invention there is provided a power grid system comprising a power grid; at least one load connected to the power grid; a first meter configured for metering power imported from the power grid to the load; at least one intermittent power source connected to the power grid, a second meter configured for metering power generated by the intermittent power source; and a consolidation unit configured for associating readings from the first and second meters such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load.

In accordance with a second aspect of the present invention there is provided a method of consolidating power injection and consumption in a power grid system, the method comprising metering power imported from a power grid to a load using a first meter; metering power generated by an intermittent power source connected to the power grid using a second meter; and associating readings from the first and second meters such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load.

In accordance with a third aspect of the present invention there is provided a method of supplying power using the power grid system as defined in the first aspect.

In accordance with a fourth aspect of the present invention there is provided a method of supplying power using the method as claimed in the second aspect.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 shows a schematic drawing illustrating a power grid system 100 according to an example embodiment.

Figure 2 shows a series of voltages on a network associated with electrical conduction through various voltage transformers, each voltage level associated to a particular market settlement pool (.eg. Low Voltage, High Voltage, Extra High Voltage, etc.).

Figures 3a) and b) show graphs illustrating power consumption by, and power supply to, loads in the power grid system 100 as a function of time over a specified period, according to an example embodiment.

Figure 4 shows a histogram illustrating the probabilistic capacity of supply from an intermittent source assuming one time bin interval of supply, according to an example embodiment.

Figures 5a) – c) show a set of look-back supply profiles illustrating characteristic fluctuations in power capacity associated with particular time periods, according to an example embodiment.

Figure 6 shows a flow chart illustrating a method of consolidating power injection and consumption in a power grid system, according to an example embodiment.

DETAILED DESCRIPTION

Figure 1 shows a schematic drawing illustrating a power grid system 100 according to an example embodiment. The system 100 comprises a power grid 102. The power grid 102 is associated through flow of electrons and holes through the network and is associated with various voltages defined through the placement of voltage transformers matching a corresponding specification. Typically, the mains supply for a load or loads connected to the power grid 102 is from a transformer 119, as a step down from a higher voltage level. The application of transformers for establishing the various voltages on a power grid network is understood in the art and will not be described herein in any detail. Figure 2 shows example voltage levels, e.g. Low Voltage 203, High Voltage 204, and Extra High Voltage 205 in a power grid network 200. Each of the transformers 201, 202 or the Extra High Voltage generator 206 can take the role of the transformer 119 illustrated in Figure 1.

Returning to Figure 1, the power grid 102 establishes network used to transfer power among loads from various sources of electricity also establishes an energy market and settlement in a pool associated to the specific voltage range.

The power grid system 100 further comprises a plurality of building connections e.g. 106, 107, each building connection e.g. 106, 107 comprising power meters e.g. M1, M3, configured for metering power imported from the power grid 102 to a loads or loads 112 e.g. in the associated building 108.

One or more intermittent sources 114 are also connected to the power grid 102. Meter M2 is configured for metering power exported by the intermittent source 114 to the power grid 102. The intermittent source 114 may for example be a photovoltaic (PV) power generator.

It is understood that the person skilled in the art could additionally adapt the following protocol where the interconnection of the source is through an intermediary or injective power to an intermediate grid connected apparatus. For example, the source may inject power to a distribution board of a building attached to the grid, wherein the offset of power drawn by the building is in turn providing additional power at the grid from the supply of power through the intermittent source. Below the interconnection is referred to as "to the grid" but it is understood that for the purposes of establishing energy flow from an intermittent source to a load the consolidation unit may utilize the metering protocol described herein for a variety of kinds of interconnections of the source.

It has been recognized by the inventors that electricity from an intermittent source cannot be retailed "on demand" to any given load on the grid network, as is typically done for electricity from contestable energy sources on the power grid 102, i.e. from sources that "continuously" supply electricity from power conversion using e.g. natural gas or other fuel-based resources and flow adjusting to the capacity of a load. Such a source is limited by available fuel and the maximum capacity of the combustion engine, but is not limited by an external environmental variable and thus can follow the load profile.

For the purpose of supplying intermittent power to one or more characteristic loads on a power network, electricity transactions to a specific load are performed by accounting for at least one of the loads own characteristic profile (in time and in capacity – referred to herein as a "load profile" or a "demand profile") based on the reading from e.g. meters M1, M3, and accounting for a market based pricing scenario, such as an energy pool price and/or the relative level of energy demand at a specific point in time. Transactions on the market can be based on a particular period of time allocated to a time bin, for example one second, one minute, a half hour, or hour, etc. For example, the National Electricity Market of Singapore accounts for energy supply and demand on a half hourly basis – i.e in thirty minute intervals. The given time bin during which energy settlements occur is referred to by the inventor below and it is understood that this particular period of time is associated with a given market and may be a variety of time periods.

In example embodiments of the present invention, a characteristic generation of power from the intermittent source, as metered by e.g. M2 over a given period of time, for example spanning at least one time bin during which energy is settled in a given energy market, forms the retail basis for supply of power from the intermittent source 114, such as a PV power generator, to the consumer associated with the building 108/the loads e.g. 112. The supply characteristic is referred to herein as a supply profile and accounts for fluctuations in the resources and energy supply over time as associated to a given intermittent energy source.

In the example embodiment, the consumer associated with the building 108/the loads e.g. 112 is provided with an agreed amount of power from the intermittent source 114 over a billing period under a supply arrangement with the operator of the intermittent source 114. This billing period spans one or more than one interval as associated to the minimum time bin of settlement on a given market platform. This means that the uncertainty in the availability of the resource, here solar power, may be reduced by accounting for the statistics of the load profile (demand profile) and supply profile over time, and can be improved by adjusting the supply level over a variety of time bins associated to the load profile.

In an example embodiment, the histogram 400 of Figure 4 illustrates the probabilistic capacity of supply from an intermittent source assuming one time bin interval of supply. In this example, the total supply capacity at the specific time interval is associated with the probability of injection of power from the intermittent source and this distribution can be utilized for providing power to a load or loads connected to the power grid network. Such a scenario can be extrapolated for more than one time bin of power supply and consumption. In this sense, discrete probability models can be utilized to represent the supply characteristics of the intermittent source(s) and can be factored into a supply contract based on an associated demand profile of the load or loads. It will be appreciated by a person skilled in the art that a histogram illustrating probabilistic demand of the load(s) may be similarly derived.

As an example embodiment, the supply from the intermittent source 114 can be delivered to a specific load or loads on the power grid 102 by providing an average amount of power distributed over more than one time bin for supply. This allows the supplier of power from the intermittent source 114 to associate the characteristics of their source in time and capacity to the consumer and formulate a contract to supply energy to the consumer on the basis of e.g. a maximum and minimum amount of power that may be delivered in any given time interval to the consumer, or a minimum average amount of power that can be delivered over a specified time period spanning at least more than one time interval. The supplier can in addition use an adjusted transaction for the power on a look back basis by receiving or delivering the consumer with energy settlement transactions on the basis of any modification of the actual supply of power over the look back period as compared to the projected supplies of power associated with specific time intervals, or with a combination of those intervals.

The consumer advantageously avails themselves of an additional or supplemental power supply from the power grid 102 which offsets an alternative means of obtaining power from the power grid 102, which may for example be based on a separate power retail arrangement.

In example embodiments, the total supply and demand characteristics of a given market (i.e. by aggregating all the loads that demand power from the main power grid) may be accounted for using e.g. a consolidation unit 116 as will be described in more detail below. In the event that the time periods of the intermittent supply, i.e. the supply profile(s) of the intermittent source(s), show positive correlations to the total demand profile associated to the pool, the offsetting mechanisms obtained by the implementation of the supply source(s) to deliver intermittent power to a load or loads will in turn adjust the total capacities of power that are required to be delivered from the second supply source(s), as associated to a given period of time. A consumer may utilize these offsets to reduce the requirements of power at times associated with a peak or peaks in the total demand profile associated to the pool. When the peak or peaks are also correlated with a higher market rate, the supply of the intermittent source(s) advantageously reduces the amount of demand to be met from the second supply sources and thus the amount of cost associated with obtaining a supply of power from the second source(s). For example, the second source(s) can be a conventional power source that may deliver power to the power network, e.g. a dispatchable power source, however, the second source(s) can also generally be associated with the wholesale pool, i.e. irrespective of the type of power source(s) that provide the power for the wholesale pool.

For example Solar PV power is typically generated during peak demand periods, i.e. during the day time and in sunny, thus warm, conditions. This positively correlates to the total energy demand of a consumer, for example from air-conditioning units that cool the building e.g. 108. In addition, industrial and commercial activities are typically performed during normal business hours, and thus the energy that is demanded from these activities is positively correlated in time to the supply of Solar PV power (on average). It is noted that by accounting for a clearness index and an irradiance index, the total intermittency of a Solar PV supply source can be determined on average for any given time bin for the supply of power to a load.

By using the total capacity offsets obtained from the supply of the intermittent source 114, the consumer may negotiate a favorable power supply contract with a secondary retailer in the market at the relevant voltage of the power grid 102, since a peak demand that forms part of the power supply contract can be anticipated as lower than without the supply from the intermittent source 114.

A contestable retailer is obligated to procure wholesale electricity on the spot to fill the retail contract. Thus, the retailer bears a risk profile at the peak periods, which the retailer will consider in the terms of the supply contract offered to the consumer. If the consumer can anticipate a lower peak demand due to the power supply from the intermittent source 114, then the risk profile considered by the retailer will be "reduced" in the sense that the retailer can expect having to procure wholesale electricity less often for this consumer, or at a lower capacity of demand on average and as associated with the probabilities of supply determined for the specific intermittent source, putting the contestable retailer in a position to offer more favorable terms based on observing a modified supply profile, and modified risk profile associated with such supply, as determined by observing the alternative supply demand characteristics of the energy pool.

In the following, technical means for facilitating the implementation of the injection of power from the intermittent source 114 into the power grid 102, or supplied to the power grid through an intermediate or indirect manner, and associating the injected power with consumption at a specific load or loads e.g. 112 will be described.

A consolidation unit 116 in the example embodiment is configured for determining power supplied or injected by the intermittent source into the power grid 102 on the basis of the reading from the meter M2.

The consolidation unit 116 of the system 100 is also configured for determining power imported from the power grid 102 via the building connection e.g. 106 to the load or loads e.g. 112 at the relevant voltage of the power grid 102, based on readings from the meter M1.

The consolidation unit 116 in the example embodiment is configured to associate the readings from meter M1 and M2 such that respective time profiles of the power injected by the intermittent source 114 into the power grid 102 and of the power imported from the power grid 102 to the one or more loads e.g. 112 via the building connection e.g. 106 are associated with each other. At least a portion of the power injected by the intermittent source 114 into the power grid 102 through direct or indirect means, such as an intermediary, is offsetable against the power imported from the power grid 102 to the one or more loads e.g. 112 via the building connection e.g. 106

For example, that the intermittent source 114 may produce and inject 50 kW over a specified consolidation or billing period via the meter M2 into the power grid 102. The loads e.g. 112 in the associated building 108 may consume 100 kW over the specified period.

For the specified period, Ml meters 100 kW were imported from the power grid 102 into the building 108.

By providing the consolidation unit 116, i.e. a technical means to associate at least a portion of the power injected from the intermittent source into the power grid 102 with the power imported to the load or loads e.g. 112 in a time resolved manner, power from the intermittent source 114 can in effect be directly provided to a specific load or loads/consumed over the power grid 102.

Figure 3a) shows a graph illustrating power consumption by, and power supply to, the load(s) e.g. 112 (Figure 1) as a function of time over a specified period. Curve 302 schematically shows the consumption by a load, chosen in this example on account of having the peaks e.g. 304 and troughs e.g. 306 coincide with day and night time respectively. As will be appreciated by the person skilled in the art, during the day time power consumption is typically increased for e.g. an office building due to working hours and associated operation of appliances such as computers, printers, fans, air conditioning etc.

Curve 308 schematically shows the PV power generation profile from the PV power generator 114 (Figure 1) during the specified period. As will be appreciated by the person skilled in the art, the power generation peaks e.g. 310 coincide with the day time, while essentially no power is generated during the night time e.g. 312. That is, the generation profile 308 and the consumption profile 302 of the chosen source/load pair (or pairs) are preferably matched. In addition or alternatively the matching can also involve controlling the load or a subset of the load so that the controlled consumption profile matches a particular generation profile of the intermittent source(s) and/or vice versa.

Curve 314 schematically shows the portion of the power consumption that will be met by supply from the power grid 102 (Figure 1) using secondary energy source(s). As can be seen from a comparison of curves 302 and 314, the amount of power that needs to be met during the peak periods e.g. 304 is reduced accordingly. As mentioned above, the contestable retailer is obligated to procure wholesale electricity on the spot to fill the retail contract. Thus, the retailer bears a risk profile at the peak periods e.g. 304, which the retailer will consider in terms of the supply contract offered to the consumer. If the consumer can anticipate a lower peak demand due to the supplemental power supply from the PV power generator 114 (Figure 1), then the risk profile considered by the retailer will be "reduced", corresponding to the flattened supply profile represented by curve 314. Thus, the retailer can expect having to procure wholesale electricity less often for this consumer, putting the retailer in a position to offer more favorable terms to that consumer for the supply of the secondary energy source. This benefit is extended to a load or loads of specific characteristics being supplied to via the power grid. In Figure 3b), curves 316 and 318 schematically show the required supply needed from other (secondary) sources/the contestable retailer without and with the PV power generator capacity offset respectively.

Returning to Figure 1, upon installation of the intermittent source 114, an initial time profile of power to be supplied or injected into the power grid 102 may be based on calculations using the technical specifications of intermittent source 114, and available and/or historical statistical environment conditions such as the total irradiance, day-light hours and intensity, the clearness index, cloud formation, weather conditions etc. at the location of a PV power generator or in proximity to that generator as an example of the intermittent source 114 over a time period. In the later, for example, the formation of cloud cover within a few hours from the generator, and traveling in the direction of that generator, can be used as a forward supply prediction data point. Various external data may be incorporated into the consolidation unit 116 to achieve additional refinements to the forward looking supply available from the intermittent source 114, and can be adapted into the supply arrangement by varying characteristic profiles of associated demand and supply. In turn, this data may also be used to adapt a dispatch strategy actively given that the supply from intermittent sources has been predicted or refined.

Based on the initial amount, arrangements with consumers on the power grid 102 for supply of power via the power grid 102 can be made taking into account respective load profiles (demand profiles). Advantageously, the arrangements can be adjusted periodically, based on historic actual power supply data obtained by the consolidation unit 116, thus continually improving the cost/actual supply balance of the retail arrangement. Alternatively or additionally, the supply profile can be changed by adding additional intermittent sources and/or modifying an existing intermittent source.

As an example embodiment, a set of look-back supply profiles 500, 502, 504 are shown in Figures 5a) – c) having characteristic fluctuations in power capacity associated with particular time periods, derived from data over one single day each, wherein each of the Figures displays a unique look-back profile of supply from the source on three separate days. It will be appreciated by a person skilled in the art that the demand profile(s) of the load(s) may be similarly found e.g. on a look back basis from which a capacity offset can be determined, on average. Using the measured data, a consolidation can be technically enabled and can be performed according to example embodiments, to account for changes in the actual supply and the supply profile that was determined to be provided for the specific load. The supply profile statistics may be determined by aggregate of various determined fluctuations on the source determined through relevant factors, for example, but not limited to, the generators location, the local irradiance, wind speeds, cloud formation patterns as imaged via satellite, other meteorological information, etc.

Referring to the exemplary supply scenario described above, an optimization of the second source price through the use of the pool volatility and price can then be performed. The time correlation of the loads along with the sources can be combined to derive the capacity of remaining demand of the load/loads as associated to the pool supply and demand characteristics. By utilizing a cross correlation between the reduced demand of the remaining load capacity to be supplied through an alternate means, the load demand from the alternate means can be derived. In addition, deriving the quantitative risk as associated with a second supply can be technically enabled and be performed according to example embodiments. In turn, the second supply of power can be modified so as to account for the statistically modified demand associated with the load or loads which are offsetable utilizing the intermittent power supplied. In turn, the supply and demand as well as pricing of the second supply system can be modified to reflect an optimized scenario wherein the intermittent supply source is utilized.

In example embodiments, a Power Systems Operator may utilize the statistics of the supply source from the PV generator using e.g. the consolidation unit 116, along with a metrological unit 118 to adjust their dispatch systems to call on a secondary source (for example a conventional or dispatchable source). This can result in an operator of the power grid system 100 to modify their dispatch system against the pool demand. Through the technical implementation of embodiments of the present invention, the cost of electricity and the amount of resources consumed from conventional sources can be reduced, and instead harvested from renewable sources, while providing a technical means of optimization of the supply demand scenario of a given market.

In one embodiment, a power grid system comprises a power grid; at least one load connected to the power grid; a first meter configured for metering power imported from the power grid to the load; at least one intermittent power source connected to the power grid, a second meter configured for metering power generated by the intermittent power source; and a consolidation unit configured for associating readings from the first and second meters such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load.

The consolidation unit may be configured to associate the readings from the first and second meters such that respective time profiles of the power generated by the intermittent power source and of the power imported from the power grid to the load are associated with each other.

One or both of the intermittent source and the load may be configured to be controllable for facilitating matching the respective time profiles to each other.

The consolidation unit may be configured to calculate a power supply cost for the load based on one or both of the associated readings from the first and second meters.

The power grid system may further comprise at least one dispatchable power source connected to the power grid and may be configured such that a power injection by the dispatchable power source into the power grid is adjustable responsive to one or both of the associated readings from the first and second meters.

The intermittent source may be directly connected to the power grid or via an intermediate grid-connected apparatus.

The intermittent source and the load may be located at different locations relative to the power grid or substantially at a same location relative to the power grid.

The consolidation unit may be configured for deriving a histogram of a probabilistic demand of the load over one or more time bin intervals.

The consolidation unit may be configured for deriving a histogram of a probabilistic capacity of supply from the intermittent source over one or more time bin intervals.

A power injection by one or more dispatchable power sources into the power grid may be adjustable as associated with the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

A risk profile associated with supply to the load from one or more dispatchable power sources over the power grid may be modifiable as determined by observing a modified demand profile taking into account the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

The consolidation unit may be configured to receive external data such as location data, radiation data, wind speed data, cloud formation patterns as imaged via satellite, other meteorological information etc.

The consolidation unit may be configured to predict or refine a supply from the intermittent source to the load.

The consolidation unit may be configured to determine a look-back supply profile or profiles of the supply from the intermittent source to the load.

The consolidation unit may be configured to determine a look-back demand profile or profiles of a demand of the load.

Figure 6 shows a flow chart 600 illustrating a method of consolidating power injection and consumption in a power grid system, according to an example embodiment. At step 602, power imported from a power grid to a load is metered using a first meter. At step 604, power generated by an intermittent power source connected to the power grid is metered using a second meter. At step 606, readings from the first and second meters are associated such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load.

The method may comprise associating the readings from the first and second meters such that respective time profiles of the power generated by the intermittent power source and of the power imported from the power grid to the load are associated with each other.

The method may comprise controlling one or both of the intermittent source and the load for facilitating matching the respective time profiles to each other.

The method may comprise calculating a power supply cost for the load based on one or both of the associated readings from the first and second meters.

The method may further comprise adjusting a power injection by at least one dispatchable power source into the power grid responsive to one or both of the associated readings from the first and second meters.

The intermittent source may be directly connected to the power grid or via an intermediate grid-connected apparatus.

The intermittent source and the load may be located at different locations relative to the power grid or substantially at a same location relative to the power grid.

The method may comprise deriving a histogram of a probabilistic demand of the load over one or more time bin intervals.

The method may comprise deriving a histogram of a probabilistic capacity of supply from the intermittent source over one or more time bin intervals.

The method may comprise adjusting a power injection by one or more dispatchable power sources into the power grid as associated with the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

The method may comprise modifying a risk profile associated with supply to the load from one or more dispatchable power sources over the power grid as determined by observing a modified demand profile taking into account the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

The method may comprise considering external data such as location data, radiation data, wind speed data, cloud formation patterns as imaged via satellite, other meteorological information etc.

The method may comprise predicting or refining a supply from the intermittent source to the load.

The method may comprise determining a look-back supply profile or profiles of the supply from the intermittent source to the load.

The method may comprise determining a look-back demand profile or profiles of a demand of the load.

In one embodiment, a method of supplying power using the power grid system of the above embodiments is provided.

In one embodiment, a method of supplying power using the method of the above embodiments is provided.

Example embodiments can advantageously also enable methods for settlement and transaction of energy supply and demand over a power grid network.

In example embodiments, power generated from an intermittent source or a plurality of such sources is implemented so as to supply a load using the source or sources based on characteristic statistics of the source or sources; or characteristic statistics of the source or sources and other external factors such as local irradiance, wind speed, temperature, other meteorological factors, or the like. The supply to the load may account for characteristic statistics of that load. This contrasts with the supply of power from a source to a load is on a basis that supply of power is isolated at a specific time of supply of the power, given the dispatchable nature of a conventional electricity generator.

In one example embodiment, the specific time characteristics of the intermittent energy supply source is a solar energy generator supplying power to a load through a power grid network. In an alternative embodiment, supply of power by a plurality of generators including one or more intermittent or none or more non-intermittent generators, and supplying power through a power grid network to a load or plurality of loads connected to the power grid network.

Example embodiments can also provide transactional aspects of power settlement of intermittent generation to a load in terms of the transactional settlement of electricity, and in terms of optimization of the transaction of supply from any generator connected to the grid network through use of the characteristic time statistics of one or more generators supplying to a particular load. The optimization of the transaction of supply of power to the load or loads may in addition account for the characteristic time statistics of the load or loads.

Example embodiments can uniquely allow an intermittent source to be transacted as a generator to a particular load on a power grid network.

The present specification also discloses apparatus for implementing or performing the operations of the methods. Such apparatus may be specially constructed for the required purposes, or may comprise a device selectively activated or reconfigured by a computer program stored in the device. Furthermore, one or more of the steps of the computer program may be performed in parallel rather than sequentially. Such a computer program may be stored on any computer readable medium. The computer readable medium may include storage devices such as magnetic or optical disks, memory chips, or other storage devices suitable for interfacing with a device. The computer readable medium may also include a hard-wired medium such as exemplified in the Internet system, or Wireless medium such as exemplified in the GSM mobile telephone system. The computer program when loaded and executed on the device effectively results in an apparatus that implements the steps of the method.

The invention may also be implemented as hardware modules. More particular, in the hardware sense, a module is a functional hardware unit designed for use with other components or modules. For example, a module may be implemented using discrete electronic components, or it can form a portion of an entire electronic circuit such as an Application Specific Integrated Circuit (ASIC). Numerous other possibilities exist. Those skilled in the art will appreciate that the system can also be implemented as a combination of hardware and software modules.

It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive. Also, the invention includes any combination of features, in particular any combination of features in the patent claims, even if the feature or combination of features is not explicitly specified in the patent claims or the present embodiments.

For example, while PV power generators have been described in example embodiments, in different embodiments different intermittent sources may be used such as wind-based generators or water-based generators, etc., wherein the person skilled in the art would appreciate that each of the generators has a characteristic time based profile that may additionally be determined through various external information, and may in addition be correlated to the risk profile(s) and/or load profile(s) of a given power consumption scenario according to example embodiments.

CLAIMS

1. A power grid system comprising:

a power grid;

at least one load connected to the power grid;

a first meter configured for metering power imported from the power grid to the load;

at least one intermittent power source connected to the power grid,

a second meter configured for metering power generated by the intermittent power source; and

a consolidation unit configured for associating readings from the first and second meters such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load.

2. The power grid system as claimed in claim 1, wherein the consolidation unit is configured to associate the readings from the first and second meters such that respective time profiles of the power generated by the intermittent power source and of the power imported from the power grid to the load are associated with each other.

3. The power grid as claimed in claim 2, wherein one or both of the intermittent source and the load are configured to be controllable for facilitating matching the respective time profiles to each other.

4. The power grid system as claimed in any one of the preceding claims, wherein the consolidation unit is configured to calculate a power supply cost for the load based on one or both of the associated readings from the first and second meters.

5. The power grid system as claimed in any one of the preceding claims, further comprising at least one dispatchable power source connected to the power grid and configured such that a power injection by the dispatchable power source into the power grid is adjustable responsive to one or both of the associated readings from the first and second meters.

6. The power grid system as claimed in any one of the preceding claims, wherein the intermittent source is directly connected to the power grid or via an intermediate grid-connected apparatus.

7. The power grid system as claimed in any one of the preceding claims, wherein the intermittent source and the load are located at different locations relative to the power grid or substantially at a same location relative to the power grid.

8. The power grid system as claimed in any one of the preceding claims, wherein the consolidation unit is configured for deriving a histogram of a probabilistic demand of the load over one or more time bin intervals.

9. The power grid system as claimed in any one of the preceding claims, wherein the consolidation unit is configured for deriving a histogram of a probabilistic capacity of supply from the intermittent source over one or more time bin intervals.

10. The power grid system as claimed in claim 9, wherein a power injection by one or more dispatchable power sources into the power grid is adjustable as associated with the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

11. The power grid system as claimed in claims 9 or 10, wherein a risk profile associated with supply to the load from one or more dispatchable power sources over the power grid is modifiable as determined by observing a modified demand profile taking into account the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

12. The power grid system as claimed in any one of the preceding claims, wherein the consolidation unit is configured to receive external data such as location data, radiation data, wind speed data, cloud formation patterns as imaged via satellite, other meteorological information etc.

13. The power grid system as claimed in any one of the preceding claims, wherein the consolidation unit is configured to predict or refine a supply from the intermittent source to the load.

14. The power grid system as claimed in any one of the preceding claims, wherein the consolidation unit is configured to determine a look-back supply profile or profiles of the supply from the intermittent source to the load.

15. The power grid system as claimed in any one of the preceding claims, wherein the consolidation unit is configured to determine a look-back demand profile or profiles of a demand of the load.

16. A method of consolidating power injection and consumption in a power grid system, the method comprising:

metering power imported from a power grid to a load using a first meter;

metering power generated by an intermittent power source connected to the power grid using a second meter; and

associating readings from the first and second meters such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load.

17. The method as claimed in claim 16, comprising associating the readings from the first and second meters such that respective time profiles of the power generated by the intermittent power source and of the power imported from the power grid to the load are associated with each other.

18. The method as claimed in claim 17, comprising controlling one or both of the intermittent source and the load for facilitating matching the respective time profiles to each other.

19. The method as claimed in any one of claims 16 to 18, comprising calculating a power supply cost for the load based on one or both of the associated readings from the first and second meters.

20. The method as claimed in any one of claims 16 to 19, further comprising adjusting a power injection by at least one dispatchable power source into the power grid responsive to one or both of the associated readings from the first and second meters.

21. The method as claimed in any one of claims 16 to 20, wherein the intermittent source is directly connected to the power grid or via an intermediate grid-connected apparatus.

22. The method as claimed in any one of claims 16 to 21, wherein the intermittent source and the load are located at different locations relative to the power grid or substantially at a same location relative to the power grid.

23. The method as claimed in any one of claims 16 to 22, comprising deriving a histogram of a probabilistic demand of the load over one or more time bin intervals.

24. The method as claimed in any one of claims 16 to 23, comprising deriving a histogram of a probabilistic capacity of supply from the intermittent source over one or more time bin intervals.

25. The method as claimed in claim 24, comprising adjusting a power injection by one or more dispatchable power sources into the power grid as associated with the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

26. The method as claimed in claims 24 or 25, comprising modifying a risk profile associated with supply to the load from one or more dispatchable power sources over the power grid as determined by observing a modified demand profile taking into account the histogram of the probabilistic capacity of supply from the intermittent source over the one or more time bin intervals.

27. The method as claimed in any one of claims 16 to 26, comprising considering external data such as location data, radiation data, wind speed data, cloud formation patterns as imaged via satellite, other meteorological information etc.

28. The method as claimed in any one of claims 16 to 27, comprising predicting or refining a supply from the intermittent source to the load.

29. The method as claimed in any one of claims 16 to 28, comprising determining a look-back supply profile or profiles of the supply from the intermittent source to the load.

30. The method as claimed in any one of claims 16 to 29, comprising determining a look-back demand profile or profiles of a demand of the load.

31. A method of supplying power using the power grid system as claimed in any one of claims 1-15.

32. A method of supplying power using the method as claimed in any one of claims 16 to 30.

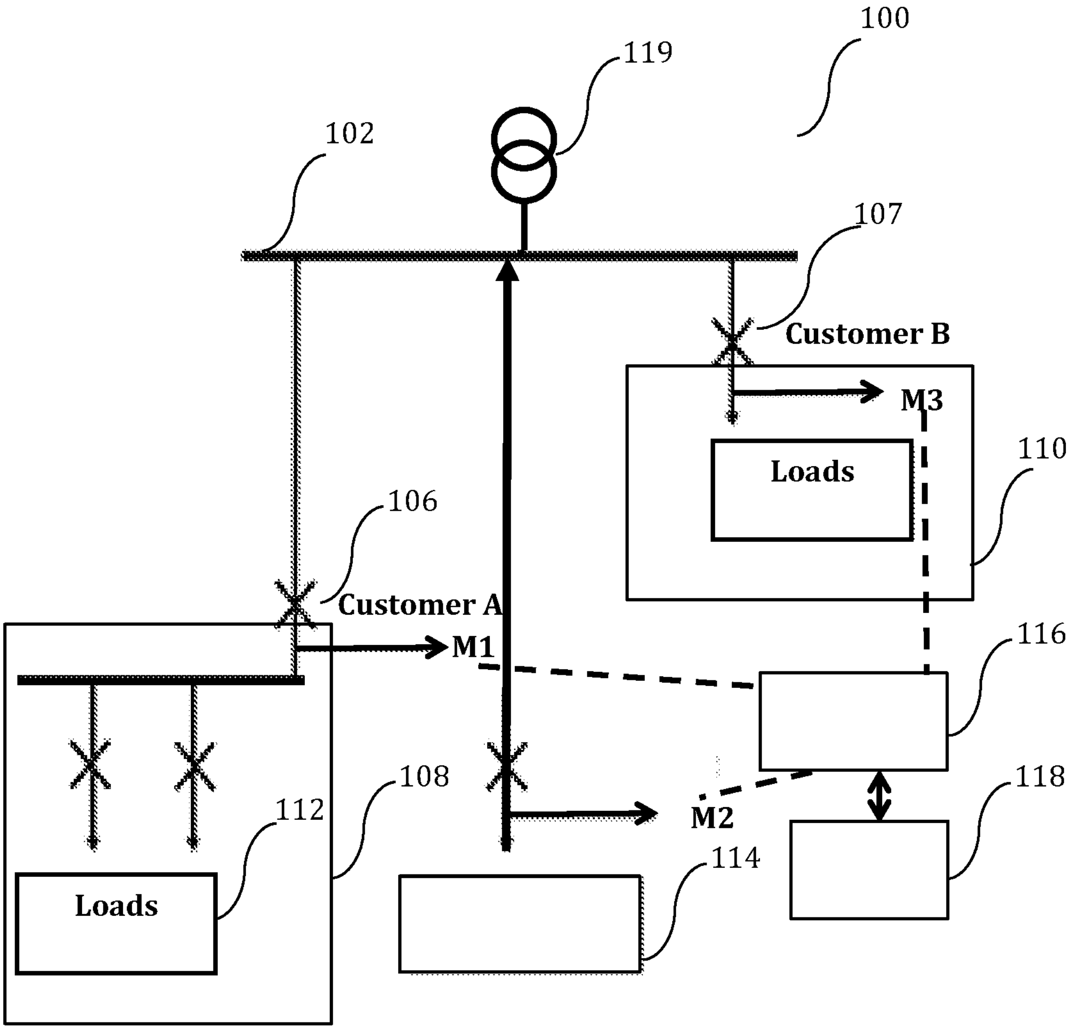

100
119
102
107
Customer B
M3
Loads
110
106
Customer A
M1
116
108
112
M2
118
114
Loads

Figure 1

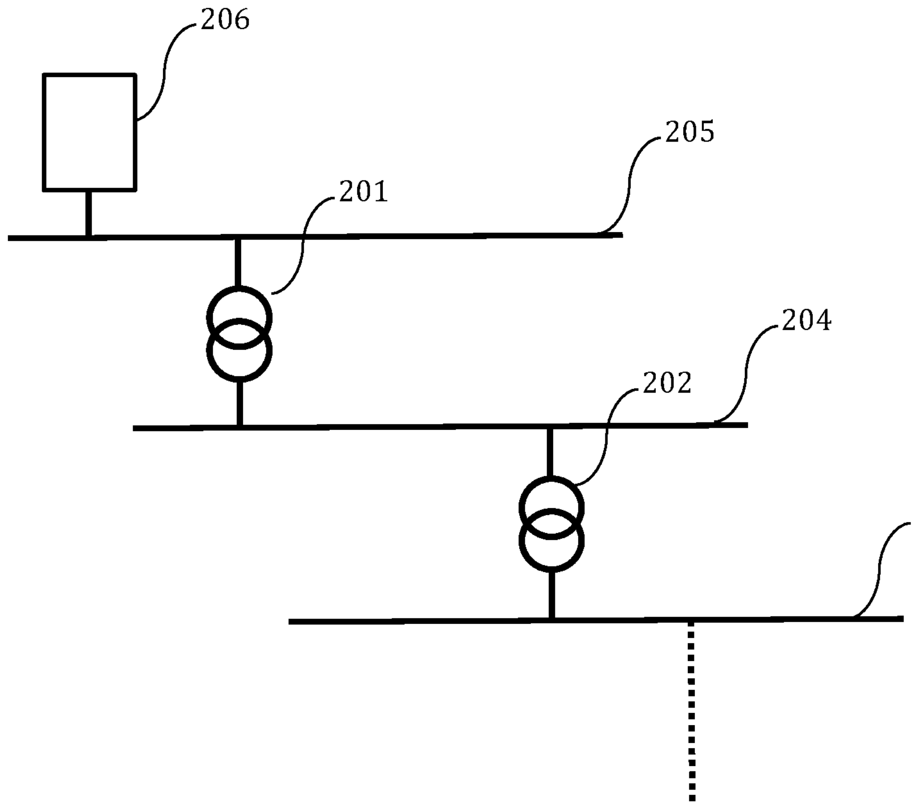
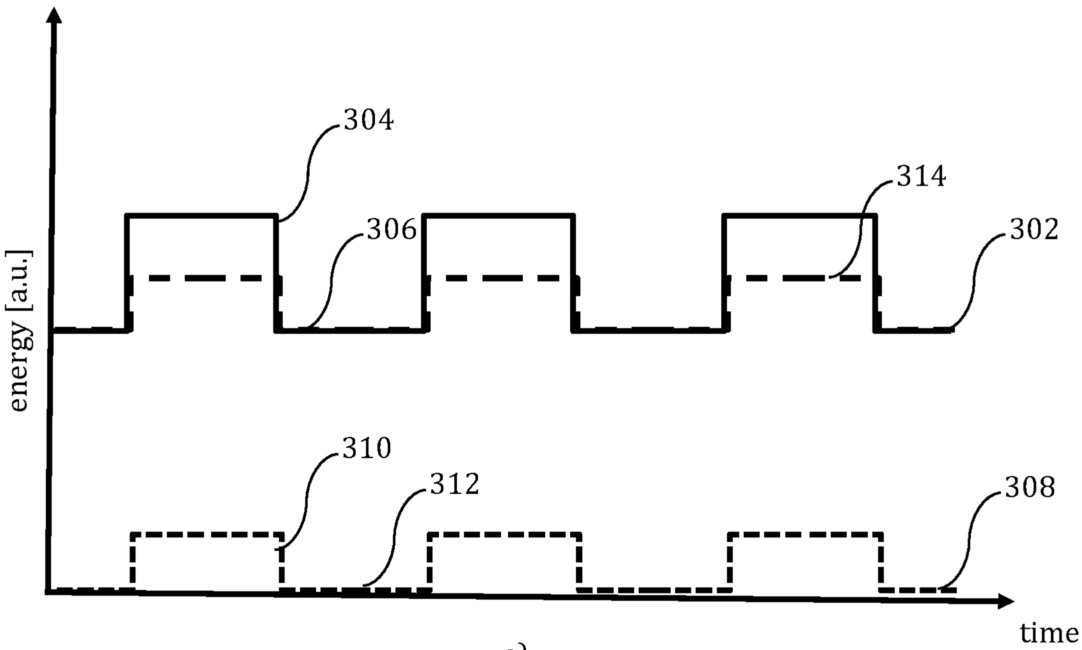
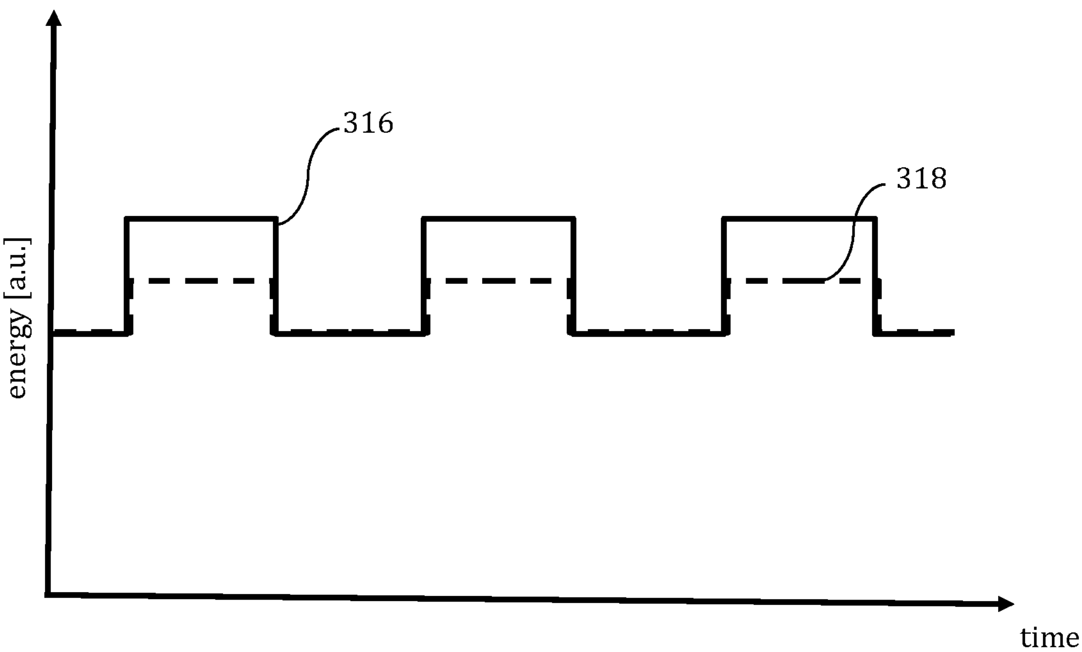


Figure 2


304
314
306
302
energy [a.u.]
310
312
308
time

a)


316
318
energy [a.u.]
time

b)

Figure 3

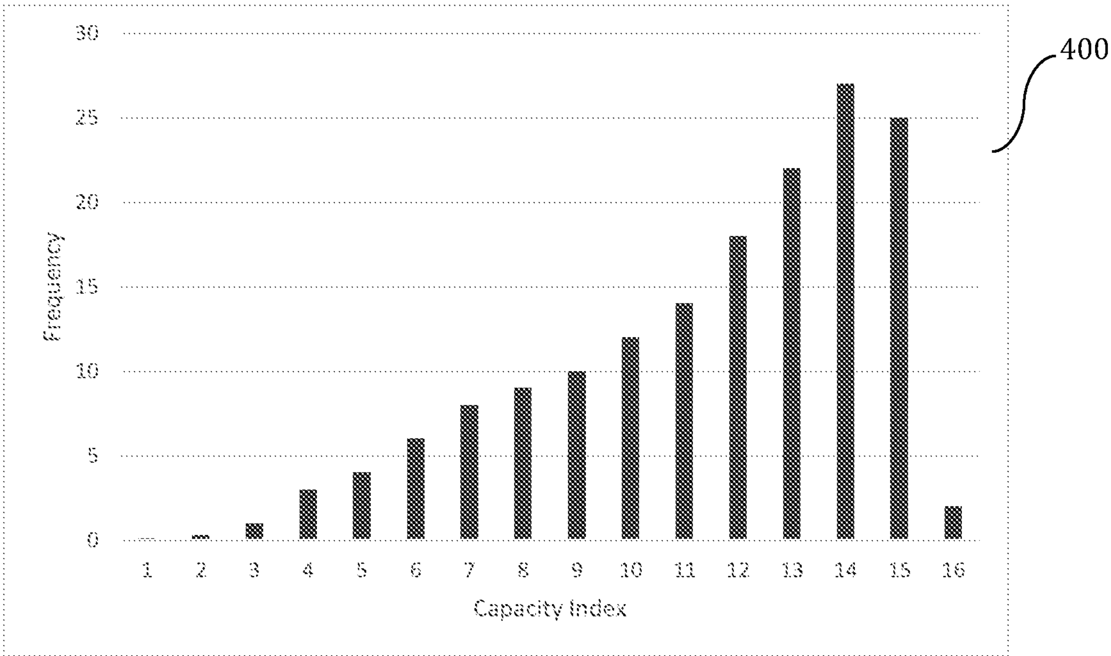

400
30
25
20
15
10
5
0
Frequency
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Capacity Index

Figure 4

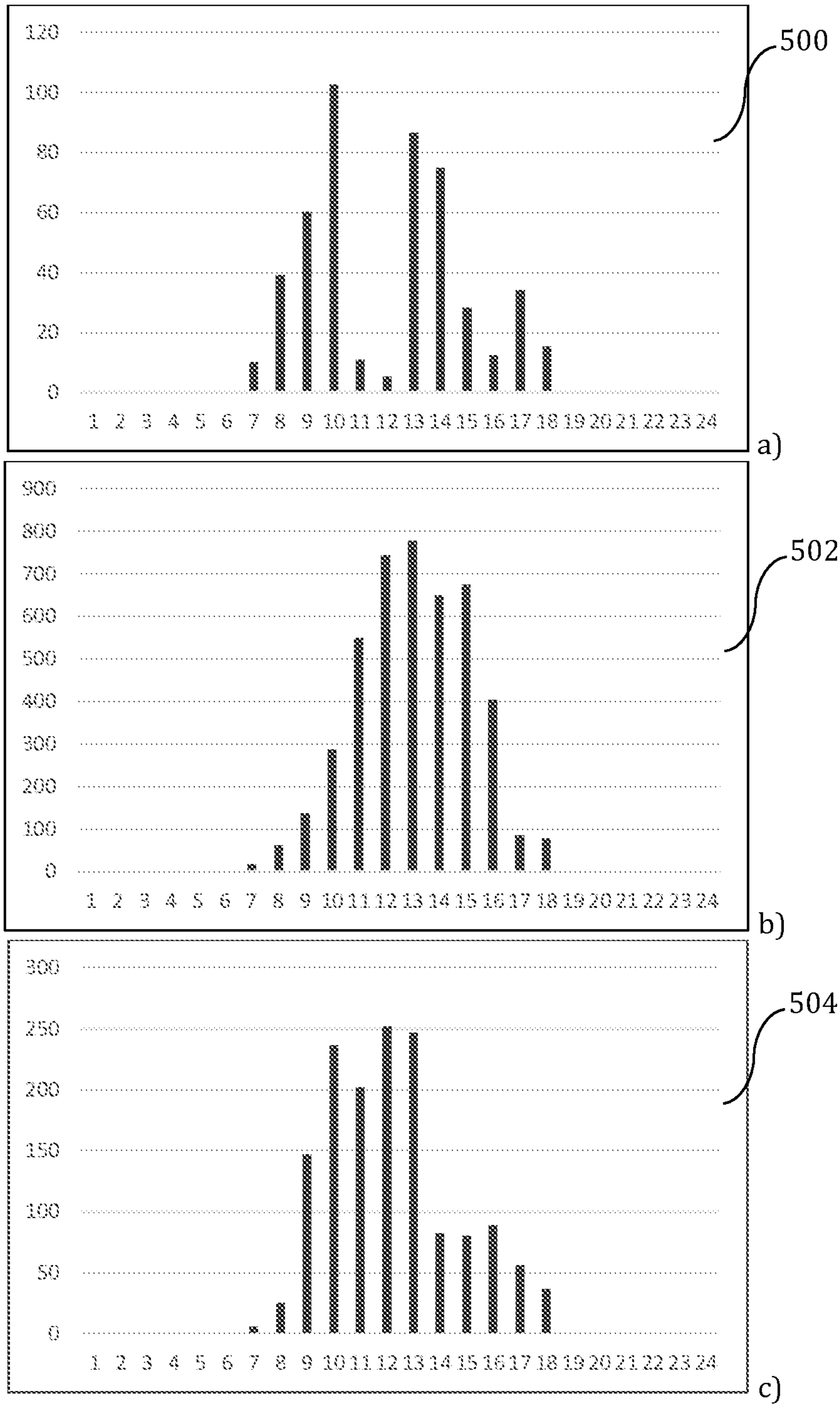

120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
500
a)
900
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
502
b)
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
504
c)

Figure 5

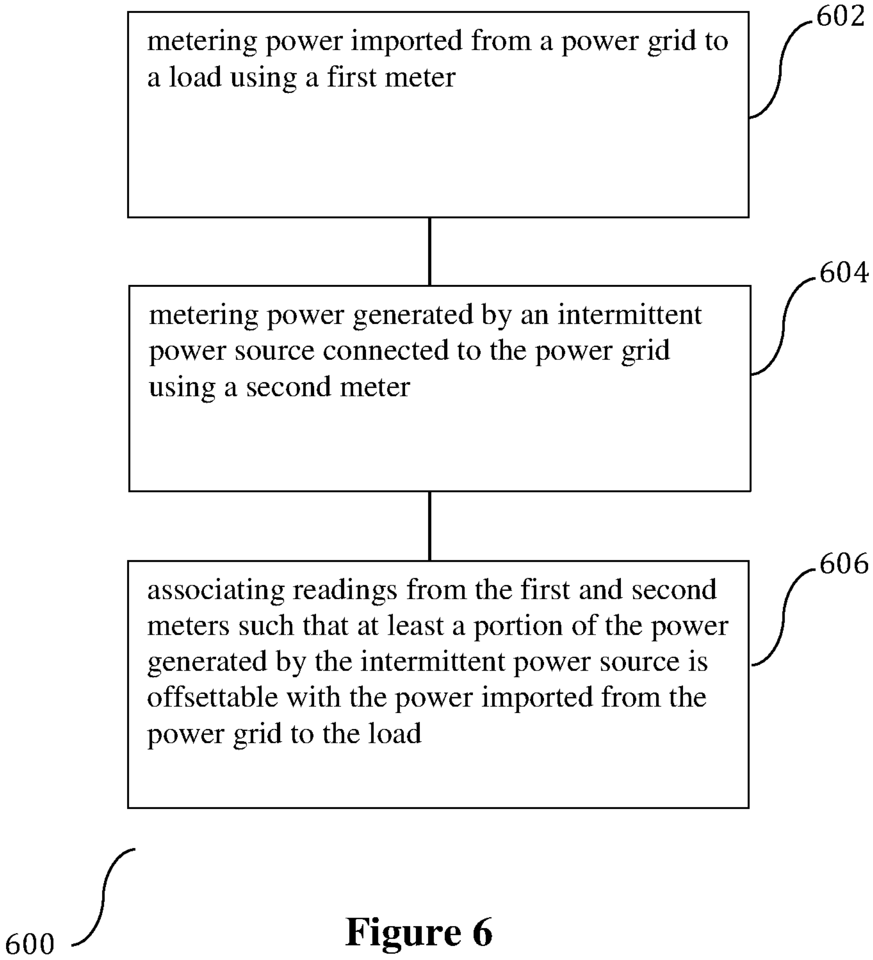

metering power imported from a power grid to a load using a first meter
602
metering power generated by an intermittent power source connected to the power grid using a second meter
604
associating readings from the first and second meters such that at least a portion of the power generated by the intermittent power source is offsettable with the power imported from the power grid to the load
606
600

Figure 6

INTERNATIONAL SEARCH REPORT

International application No. PCT/SG2015/050153

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H02J3/00(2006.01)i, H02J3/38(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H02J3/00, H02J3/38

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2015
Registered utility model specifications of Japan 1996-2015
Published registered utility model applications of Japan 1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2014-192981 A (CLEAN CRAFT CO., LTD.) 2014.10.06, paragraphs [0032], [0079], [0133], [0136], Fig. 1 (No Family)	1-3,16-18 4-10,12-15, 19-25,27-32
Y	JP 2012-010549 A (FUJITSU LIMITED) 2012.01.12, paragraph [0056] (No Family)	4-10,12-15, 19-25,27-32
Y	US 2014/0214219 A1 (KABUSHIKI KAISHA TOSHIBA) 2014.07.31, paragraphs [0060]-[0061], Figs. 11,16-17 & JP 2014-150641 A & WO 2014/119153 A1	8-10,12-15, 23-25,27-32
A	WO 2014/115556 A1 (KABUSHIKI KAISHA TOSHIBA) 2014.07.31, paragraphs [0052]-[0061] & JP 2014-143835 A	1-32

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24.08.2015	01.09.2015

Name and mailing address of the ISA/JP	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	5T 4052 Jun IWATA Telephone No. +81-3-3581-1101 Ext. 3568

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SG2015/050153

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2014-068426 A (HITACHI LIMITED) 2014.04.17, paragraph [0031] (No Family)	1-32

(19)中华人民共和国国家知识产权局

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(71)申请人 阳光电机私人有限公司
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代理人 张臻贤 韦燕凤
(51)Int.Cl.
H02J 3/00(2006.01)
H02J 3/38(2006.01)

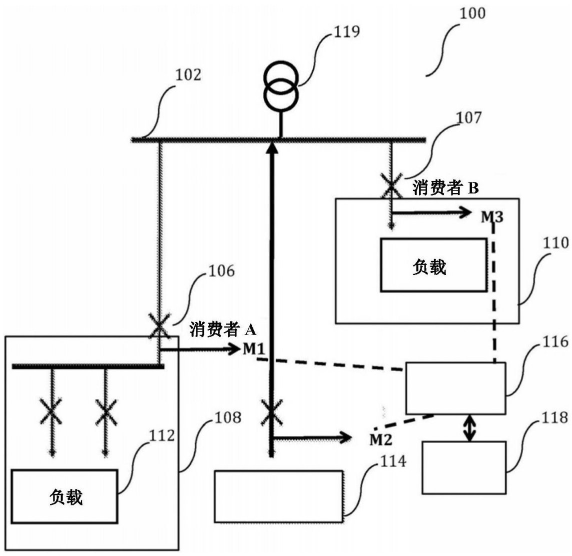
权利要求书3页 说明书9页 附图6页

(54)发明名称

电力网系统以及整合电力网系统中功率注入及消耗的方法

(57)摘要

一种电力网系统及一种整合电力网系统中功率注入及消耗的方法。电力网系统包括:电力网;与电力网连接的至少一个负载;第一计量器,其经配置以用于计量从电力网输入至负载的功率;与电力网连接的至少一个间歇性电源;第二计量器,其经配置以用于计量由间歇性电源产生的功率;以及整合单元,其经配置以用于关联来自第一计量器及第二计量器的读数,以使得由间歇性电源产生的功率的至少一部分能够被从电力网输入至负载的功率抵消。



CN 107112753 A

1.一种电力网系统，包括：

电力网；

至少一个负载，与所述电力网连接；

第一计量器，经配置以用于计量从所述电力网输入至所述负载的功率；

至少一个间歇性电源，与所述电力网连接；

第二计量器，经配置以用于计量由所述间歇性电源产生的功率；以及

整合单元，经配置以用于关联来自所述第一计量器的读数及所述第二计量器的读数，以使得由所述间歇性电源产生的功率的至少一部分能够被从所述电力网输入至所述负载的功率抵消。

2.如权利要求1所述的电力网系统，其中所述整合单元经配置以用于关联来自所述第一计量器的所述读数及所述第二计量器的所述读数，以使得由所述间歇性电源产生的功率及从所述电力网输入至所述负载的功率的相应时间轮廓彼此关联。

3.如权利要求2所述的电力网系统，其中所述间歇性电源及所述负载中的一个或两个经配置成可控制的，以用于促进将所述相应时间轮廓彼此匹配。

4.如前述权利要求中任一项所述的电力网系统，其中所述整合单元经配置以基于来自所述第一计量器及所述第二计量器的相关联读数中的一个或两个来计算用于负载的功率供应成本。

5.如前述权利要求中任一项所述的电力网系统，进一步包括至少一个可调度电源，所述至少一个可调度电源与所述电力网连接且经配置以使得由所述可调度电源至所述电力网中的功率注入可响应于来自所述第一计量器及所述第二计量器的相关联读数中的一个或两个来调整。

6.如前述权利要求中任一项所述的电力网系统，其中所述间歇性电源直接或经由中间并网设备与所述电力网连接。

7.如前述权利要求中任一项所述的电力网系统，其中所述间歇性电源及所述负载相对于所述电力网位于不同位置、或相对于所述电力网位于大体相同位置。

8.如前述权利要求中任一项所述的电力网系统，其中所述整合单元经配置以用于导出所述负载的概率性需求相对一个或多个时间格间隔的直方图。

9.如前述权利要求中任一项所述的电力网系统，其中所述整合单元经配置以用于导出来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图。

10.如权利要求9所述的电力网系统，其中由一个或多个可调度电源至电力网中的功率注入是可调整的，与来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图关联。

11.如权利要求9或10所述的电力网系统，其中与通过电力网从一个或多个可调度电源至所述负载的供应关联的风险轮廓是可修改的，通过考虑到来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图而观察经修改的需求轮廓来确定。

12.如前述权利要求中任一项所述的电力网系统，其中所述整合单元经配置以接收外部数据，诸如位置数据、辐射数据、风速数据、经由卫星成像的云形成图案、其他气象信息等。

13.如前述权利要求中任一项所述的电力网系统，其中所述整合单元经配置以预测或

精细化从所述间歇性电源至所述负载的供应。

14.如前述权利要求中任一项所述的电力网系统，其中所述整合单元经配置以确定从所述间歇性电源至所述负载的供应的一个或多个回顾供应轮廓。

15.如前述权利要求中任一项所述的电力网系统，其中所述整合单元经配置以确定所述负载的需求的一个或多个回顾需求轮廓。

16.一种整合电力网系统中的功率注入及消耗的方法，方法包括：

使用第一计量器计量从电力网输入至负载的功率；

使用第二计量器计量由与所述电力网连接的间歇性电源产生的功率；以及

关联来自所述第一计量器的读数及所述第二计量器的读数，以使得由所述间歇性电源产生的功率的至少一部分能够被从所述电力网输入至所述负载的所述功率抵消。

17.如权利要求16所述的方法，包括关联来自所述第一计量器的所述读数及所述第二计量器的所述读数，使得由所述间歇性电源产生的所述功率及从所述电力网输入至所述负载的所述功率的相应时间轮廓彼此关联。

18.如权利要求17所述的方法，包括控制所述间歇性电源及所述负载中的一个或两个，以用于促进所述相应时间轮廓彼此匹配。

19.如权利要求16至18中任一项所述的方法，包括基于来自所述第一计量器及所述第二计量器的相关联读数中的一个或两个来计算用于所述负载的功率供应成本。

20.如权利要求16至19中任一项所述的方法，进一步包括响应于来自所述第一计量器及所述第二计量器的相关联读数中的一个或两个，调整至少一个可调度电源至所述电力网中的功率注入。

21.如权利要求16至20中任一项所述的方法，其中所述间歇性电源直接或经由中间并网设备与所述电力网连接。

22.如权利要求16至21中任一项所述的方法，其中所述间歇性电源及所述负载相对于所述电力网位于不同位置、或相对于所述电力网位于大体相同位置。

23.如权利要求16至22中任一项所述的方法，包括导出所述负载的概率性需求相对一个或多个时间格间隔的直方图。

24.如权利要求16至23中任一项所述的方法，包括导出来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图。

25.如权利要求24所述的方法，包括调整由一个或多个可调度电源至所述电力网中的功率注入，与来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图关联。

26.如权利要求24或25所述的方法，包括修改与在所述电力网上从一个或多个可调度电源至所述负载的供应关联的风险轮廓，通过考虑到来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图而观察经修改的需求轮廓来确定。

27.如权利要求16至26中任一项所述的方法，包括考虑外部数据，诸如位置数据、辐射数据、风速数据、经由卫星成像的云形成图案、其他气象信息。

28.如权利要求16至27中任一项所述的方法，包括预测或精细化从所述间歇性电源至所述负载的供应。

29.如权利要求16至28中任一项所述的方法，包括确定从所述间歇性电源至所述负载

的供应的一个或多个回顾供应轮廓。

30.如权利要求16至29中任一项所述的方法,包括确定所述负载的需求的一个或多个回顾需求轮廓。

31.一种使用如权利要求1至15中任一项所述的电力网系统来供应功率的方法。

32.一种使用如权利要求16至30中任一项所述的方法来供应功率的方法。

电力网系统以及整合电力网系统中功率注入及消耗的方法

技术领域

[0001] 本发明广泛地涉及电力网系统，并且涉及整合电力网系统中功率产生及消耗的方法。

背景技术

[0002] 迄今为止，大多数建筑物(尤其是诸如购物中心的商业建筑物或工业建筑物)从主电力网系统获得其所有功率，其中诸如燃煤发电厂或另一燃烧引擎的发电机经由电力网网络向电源网络池供应功率，功率是根据电力网网络上的负载需求加以调整的。从与建筑物负载关联的辅助发电机发电可作为嵌入于建筑物的发电机独立于主电力网系统进行，这仅降低了建筑物负载从电源网络所汲取的总能量。例如，太阳能系统可直接经由建筑物配电板连接，以向建筑物负载供应对电力网的优先权。

[0003] 在主电力网系统内，用于功率产生的间歇性电源可与诸如燃煤发电厂或另一燃烧引擎的可调度源一起使用，以促成电源网络池，即，满足主电力网系统中所经历的整体需求。然而，考虑到间歇性电源的本质，诸如它们不能直接遵循变化的负载轮廓(profile)及取决于外部因素(如天气)的输出、在发电机局部的环境资源在特定时间的可用性(例如入射在光电(PV)板上的水流或日光流)，采用间歇性电源作为经由主电力网系统向与主电力网系统连接的负载供应功率的方法仍然相对地发展不完全。

[0004] 本发明的实施例提供一种电力网系统及一种整合电力网系统中功率产生及消耗的方法，其设法解决以上问题中的至少一个。

发明内容

[0005] 根据本发明的第一方面，提供一种电力网系统，其包括：电力网；与电力网连接的至少一个负载；第一计量器，其经配置以用于计量从电力网输入至负载的功率；与电力网连接的至少一个间歇性电源；第二计量器，其经配置以用于计量由间歇性电源产生的功率；以及整合单元，其经配置以用于关联来自第一计量器及第二计量器的读数，以使得由间歇性电源产生的功率的至少一部分能够被从电力网输入至负载的功率抵消。

[0006] 根据本发明的第二方面，提供一种整合电力网系统中功率注入及消耗的方法，方法包括：使用第一计量器计量从电力网输入至负载的功率；使用第二计量器计量由与电力网连接的间歇性电源产生的功率；以及关联来自第一计量器及第二计量器的读数，以使得由间歇性电源产生的功率的至少一部分能够被从电力网输入至负载的功率抵消。

[0007] 根据本发明的第三方面，提供一种使用如第一方面中所定义的电力网系统来供应功率的方法。

[0008] 根据本发明的第四方面，提供一种使用如第二方面中所主张的方法来供应功率的方法。

附图说明

[0009] 从以下所述的描述，仅借由实例且结合附图，本发明的实施例将被本领域技术人员更好地理解且易于显而易见。

[0010] 图1显示例示出根据示例性实施例的电力网系统100的示意图。

[0011] 图2显示与通过各种电压变压器的电传导关联的网络上的一系列电压，每一电压电平与特定市场结算池关联(例如低电压、高电压、超高电压等等)。

[0012] 图3a)及b)显示例示出根据示例性实施例的在指定时段内随时间而变的电力网系统100中的负载的功率消耗及至负载的功率供应的图表。

[0013] 图4显示例示出根据示例性实施例的来自间歇性电源的概率性供应容量的直方图，假定供应的一个时间格间隔。

[0014] 图5a)至c)显示例示出根据示例性实施例的与特定时间段关联的功率容量中的特性波动的一组回顾(look-back)供应轮廓。

[0015] 图6显示例示出根据示例性实施例的整合电力网系统中功率注入及消耗的方法的流程图。

具体实施方式

[0016] 图1显示例示出根据示例性实施例的电力网系统100的示意图。电力网系统100包括电力网102。电力网102经由电子及电洞通过网络的流动被关联，且与经由匹配对应规范的电压变压器的放置来定义的各种电压关联。通常，用于与电力网102连接的一个或多个负载的主电源来自于变压器119，如从较高电压电平的降压变压器。本领域中了解用于在电力网网络上建立各种电压的变压器的应用，且本文将不作任何详细描述。图2显示电力网网络200中的示例性电压电平，例如低电压203、高电压204及超高电压205。变压器201、202或超高压发电机206中的每一个可扮演图1中所例示的变压器119的角色。

[0017] 返回图1，电力网102建立用以从各种电力源在负载之间转移功率的网络，也建立关联至特定电压范围的池中的能量市场及结算。

[0018] 电力网系统100进一步包括多个建筑物连接，例如106、107，每一建筑物连接，例如106、107包括功率计量器，例如M1、M3，功率计量器经配置以用于计量从电力网102输入至例如在关联的建筑物108中的一个或多个负载112的功率。

[0019] 一个或多个间歇性电源114也与电力网102连接。计量器M2经配置以用于计量由间歇性电源114输出至电力网102的功率。间歇性电源114可例如为光电(PV)发电机。

[0020] 应了解，本领域技术人员可另外调适以下协定，其中源的互连系经由中间或内射电源至中间并网(grid-connected)设备。例如，源可将功率注入至附接至网格的建筑物的配电板，其中由建筑物汲取的功率的抵消又经由间歇性电源从功率供应在网格处提供额外功率。以下将互连称为“至网格”，但应了解，为了建立从间歇性电源至负载的能量流，整合单元可针对各种种类的源的互连利用本文所描述的计量协定。

[0021] 发明人已认识到，来自间歇性电源的电力不能“按需求”零售至网格网络上的任何给定负载，正如针对来自电力网102上的可竞争能量源的电力通常所做的一般，即来自使用例如天然气或其他基于燃料的资源“连续地”供应来自功率转换的电力且调整负载的容量的流动的源。此源受燃烧引擎的可用燃料及最大容量限制，但不受外部环境变数限制，从而可遵循负载轮廓。

[0022] 为了将间歇功率供应至电源网络上的一个或多个特性负载，考虑到基于来自例如计量器M1、M3的读数的负载中的至少一个自身的特性轮廓(在时间和容量方面——在本文称为“负载轮廓”或“需求轮廓”)，且考虑基于市场的定价方案(诸如能量池价格和/或特定时间点的能量需求的相对水平)，来进行至特定负载的电力交易。市场上的交易可基于分配给时间格的特定时间段，例如一秒、一分钟、半小时或一小时等等。例如，新加坡国家电力市场考虑以半小时(也即三十分钟间隔)为基础的能量供应及需求。发明人在以下提及给定时间格，在给定时间格期间发生能量结算，并且应了解，此特定时间段与给定市场关联且可为各种时间段。

[0023] 在本发明的示例性实施例中，来自间歇性电源的特性功率产生(如由例如计量器M2在给定时间段内所计量的，时间段例如跨至少一个时间格，在时间格期间在给定能量市场中结算能量)形成用于从诸如PV发电机的间歇性电源114至与建筑物108/负载(例如112)关联的消费者的功率供应的零售基础。本文将供应特性称为供应轮廓，且供应特性考虑了资源中的波动及随时间的能量供应，其关联至给定间歇能量源。

[0024] 在示例性实施方案中，在间歇性电源114操作者的供应配置下在计费时段内给与建筑物108/负载(例如112)关联的消费者提供来自间歇性电源114的同意量的功率。此计费时段跨一个或一个以上间隔，一个或一个以上间隔关联至给定市场平台上的结算的最小时间格。此意味着资源(此处为太阳能)可用性的不确定性可考虑到负载轮廓(需求轮廓)及供应轮廓随时间推移的统计量得以降低，并且可借由在关联至负载轮廓的各种时间格上调整供应水平加以改良。

[0025] 在示例性实施方案中，图4的直方图400例示出来自间歇性电源的概率性供应容量，假定供应的一个时间格间隔。在此实例中，在特定时间间隔的总供应容量与来自间歇性电源的功率注入的概率关联，且此分配可用于向与电力网网络连接的一个或多个负载提供功率。可针对功率供应及消耗的一个以上时间格外推此方案。在此意义上，离散概率模型可用来表示一个或多个间歇性电源的供应特性，并且可基于一个或多个负载的相关需求轮廓来在供应合同中作为因素考虑。本领域技术人员将了解，可类似地导出例示出一个或多个负载的概率性需求的直方图。

[0026] 作为示例性实施例，借由提供在用于供应的一个以上时间格内分配的平均量的功率，可将来自间歇性电源114的供应递送至电力网102上的特定一个或多个负载。这允许来自间歇性电源114的功率的供应者使其源在时间及容量上的特性关联至消费者，并且制定合同以基于例如在给定时间间隔内可递送至消费者的最大及最小量的功率、或在跨至少一个以上时间间隔的特定时间段内可递送的最小平均量的功率来向消费者供应能量。借由基于与关联于特定时间间隔或关联于那些间隔的组合的计划功率供应相比在回顾时段内的实际功率供应的任何修改来给消费者接收或递送能量结算交易，供应者可另外在回顾基础上针对功率使用经调整的交易。

[0027] 消费者有利地利用自己的来自电力网102的额外或补充的功率供应，功率供应抵消从电力网102获得功率的替代手段，手段可例如基于单独的功率零售配置。

[0028] 在示例性实施例中，可使用例如以下将更详细地描述的整合单元116来考虑给定市场的总供应及需求特性(即，借由汇总需要来自主电力网的功率的所有负载)。在间歇供应的时间段(即一个或多个间歇性电源的一个或多个供应轮廓)显示与关联至池的总需求

轮廓的正相关的情况下，借由实施一个或多个供应源来将间歇功率递送至一个或多个负载所获得的抵消机制又将调整关联至给定时间段的需要从一个或多个第二供应源递送的功率的总容量。消费者可利用这些抵消来减少在与关联至池的总需求轮廓中的一个或多个峰值关联的时间处的功率需求。当一个或多个峰值也与较高市场利率相关时，一个或多个间歇性电源的供应有利地降低了来自第二供应源的将要满足的需求量，且因此降低了与获得来自一个或多个第二源的功率的供应关联的成本量。例如，一个或多个第二源可为可将功率递送至电源网络的常规电源，例如可调度电源，然而，一个或多个第二源也可通常与批发池关联，即，不管为批发池提供功率的一个或多个电源的类型如何。

[0029] 例如，通常在峰值需求时段期间，即在白天及阳光充足，因此温暖的条件期间，产生太阳PV功率。这与消费者的总能量需求正相关，例如来自给例如建筑物108的建筑物制冷的空气调节单元的总能量需求。此外，工业及商业活动通常在正常营业时间期间进行，且因此这些活动所需要的能量在时间上与太阳PV功率(平均)的供应正相关。应注意，考虑到晴空指数及辐照度指数，可针对用于将功率供应至负载的任何给定时间格来平均确定太阳PV供应源的总间歇性。

[0030] 借由使用从间歇性电源114的供应获得的总容量抵消，消费者可在电力网102的相关电压处与市场上的二次零售商谈判优惠的功率供应合同，因为可预期形成功率供应合同的部分的峰值需求低于没有来自间歇性电源114的供应的情况。

[0031] 可竞争的零售商负责当场采购批发电力来履行零售合同。因此，零售商承担峰值时段的风险轮廓，零售商将依据提供给消费者的供应合同考虑风险轮廓。若消费者可预期由于来自间歇性电源114的功率供应所致的较低峰值需求，则由零售商考虑的风险轮廓将在如下意义上“降低”：零售商可预计针对此消费者必须较不经常地采购批发电力，或在平均需求的较低容量处且如与针对特定间歇性电源所确定的供应概率关联地采购批发电力，使可竞争的零售商基于观察经修改的供应轮廓及与此供应关联的经修改的风险轮廓(如借由观察能量池的替代供应需求特性所确定的)来提供更优惠的条款。

[0032] 在下文中，将描述用于促进实施以下操作的技术手段：将功率从间歇性电源114注入至电力网102、或经由中间或间接方式供应至电力网、以及使注入的功率与例如112的一个或多个特定负载处的消耗关联。

[0033] 示例性实施例中的整合单元116经配置以用于基于来自计量器M2的读数来确定由间歇性电源供应或注入至电力网102中的功率。

[0034] 电力网系统100的整合单元116也经配置以用于基于来自计量器M1的读数确定以电力网102的相关电压经由例如106的建筑物连接从电力网102输入至例如112的一个或多个负载的功率。

[0035] 示例性实施例中的整合单元116经配置以关联来自计量器M1及M2的读数，以使得借由间歇性电源114注入至电力网102的功率、及经由例如106的建筑物连接从电力网102输入至例如112的一个或多个负载的功率的相应时间轮廓彼此关联。借由间歇性电源114经由直接或间接手段(诸如中间手段)注入至电力网102中的功率的至少一部分可与经由例如106的建筑物连接从电力网102输入至例如112的一个或多个负载的功率抵消。

[0036] 例如，间歇性电源114可在指定的整合或计费时段内经由计量器M2产生并注入50kW至电力网102中。相关建筑物108中例如112的负载在指定时段内可消耗100kW。

[0037] 在指定时段内，M1计量到从电力网102输入100kW至建筑物108中。

[0038] 借由提供整合单元116，即用以使从间歇性电源注入至电力网102中的功率的至少一部分以时间解析方式与输入至例如112的一个或多个负载的功率关联的技术手段，来自间歇性电源114的功率可有效地被直接提供至一个或多个特定负载/在电力网102上被消耗。

[0039] 图3a)显示例示出在指定时段内随时间而变的例如112的一个或多个负载(图1)的功率消耗及至一个或多个负载的功率供应的图表。曲线302示意地显示负载的消耗，在此实例中选择负载是由于具有分别与白天及夜晚时间相符的例如304的峰值及例如306的谷值。如本领域技术人员将了解，在白天时间，功率消耗针对例如办公建筑物通常会增加，此是由于诸如计算机、印表机、风扇、空调等用具的工作时间及相关操作。

[0040] 曲线308示意地显示指定时段期间来自PV发电机(图1)的PV功率产生轮廓。如本领域技术人员将了解，例如310的功率产生峰值符合白天时间，而在例如312的夜晚时间基本上不产生功率。即，所选的源/一个或多个负载对的产生轮廓(曲线308)及消耗轮廓(曲线302)较佳地匹配。此外或另外，匹配也可涉及控制负载或负载的子集，以使得受控制的消耗轮廓匹配一个或多个间歇性电源的特定产生轮廓及/或反之亦然。

[0041] 曲线314示意地显示将由来自电力网102(图1)的供应使用二次能量源来满足的功率消耗的部分。从曲线302及曲线314的比较可看出，在峰值时段期间(例如304)需要满足的功率量相应地降低。如上所述，可竞争的零售商负责当场采购批发电力来履行零售合同。因此，零售商承担峰值时段(例如304)的风险轮廓，零售商将依据提供给消费者的供应合同来考虑风险轮廓。若消费者可预期由于来自PV发电机(图1)的补充功率供应所致的较低峰值需求，则由零售商考虑的风险轮廓将“降低”，对应于由曲线314表示的变平的供应轮廓。因此，零售商可预计针对此消费者必须较不经常地采购批发电力，使零售商针对二次能量源的供应向消费者提供更优惠的条款。此益处将扩展至经由电力网予以供应的具有特定特性的一个或多个负载。在图3b)中，曲线316及318示意地显示在分别没有及具有PV发电机容量抵消的情况下需要来自其他(二次)源/可竞争的零售商的所需供应。

[0042] 返回图1，在安装间歇性电源114后，将被供应或注入至电力网102中的功率的初始时间轮廓可基于：使用间歇性电源114的技术规范进行的计算，以及在一段时间内在作为间歇性电源114的实例的PV发电机间歇性电源的位置处或接近该发电机处的可用和/或历史统计环境条件，诸如总辐照度、光照时间及强度、晴空指数、云形成、天气条件等等。在后一种情况下，例如，在发电机的几小时内且沿该发电机的方向行进的云蔽的形成可用作前向供应预测数据点。各种外部数据可并入至整合单元116中，以达成对可从间歇性电源114获得的前瞻性供应的额外精细化，并且可借由改变相关需求及供应的特性轮廓来适应供应配置。随后，假定来自间歇性电源的供应已预测或精细化，此数据也可用以主动调适调度策略。

[0043] 基于初始量，可在考虑相应负载轮廓(需求轮廓)的情况下进行电力网102上的消费者的配置以用于经由电力网102的功率供应。有利地，该配置可基于由整合单元116获得的历史实际功率供应数据来周期性地调整，从而连续地改良零售配置的成本/实际供应平衡。替代地或另外，可借由添加额外间歇性电源和/或修改现有间歇性电源来改变供应轮廓。

[0044] 作为示例性实施例,图5a)至c)中显示具有与特定时间段关联的功率容量中的特性波动的一组回顾供应轮廓500、502、504,其各从一个单天内的数据导出,其中图中的每一个显示在三个单天内来自源的独特回顾供应轮廓。本领域技术人员将了解,可例如在回顾基础上类似地发现一个或多个负载的一个或多个需求轮廓,由此可平均确定容量抵消。使用测得的数据,整合可在技术上实现且可根据示例性实施例进行,以考虑实际供应的变化及经确定来提供给特定负载的供应轮廓。供应轮廓统计量可借由源上的各种所确定波动的汇总来确定,波动是经由相关因素来确定的,因素例如但不限于发电机位置、局部辐照度、风速、经由卫星成像的云形成图案、其他气象信息等等。

[0045] 参考如上所述的示例性供应方案,然后可进行经由使用池波动率及价格来最佳化第二源价格。可组合负载以及源的时间相关性以导出关联至池供应及需求特性的一个或多个负载的剩余需求的容量。借由利用将经由替代手段供应的剩余负载容量的降低的需求之间的交互相关性,可导出来自替代手段的负载需求。此外,导出与第二供应关联的定量风险可在技术上实现且根据示例性实施例进行。随后,功率的第二供应可被修改以便考虑与一个或多个负载关联的统计上经修改的需求,负载可利用所供应的间歇功率来抵消。随后,第二供应系统的供应和需求以及定价可被修改以反映最佳化的方案,其中利用间歇供应源。

[0046] 在示例性实施例中,电源系统操作者可利用来自PV发电机的供应源的统计量,使用例如整合单元116以及计量学单元118来调整其调度系统以调用二次源(例如常规源或可调度源)。这可导致电力网系统100的操作者针对池需求来修改其调度系统。经由本发明的实施例的技术实施方式,电力成本及来自常规源的资源消耗量可降低,并且改为从可更新源获得,同时提供最佳化给定市场的供应需求方案的技术手段。

[0047] 在一个实施例中,电力网系统包括:电力网;与电力网连接的至少一个负载;第一计量器,其经配置以用于计量从电力网输入至负载的功率;与电力网连接的至少一个间歇性电源;第二计量器,其经配置以用于计量由间歇性电源产生的功率;以及整合单元,其经配置以用于关联来自第一计量器及第二计量器的读数,以使得由间歇性电源产生的功率的至少一部分能够被从电力网输入至负载的功率抵消。

[0048] 整合单元可经配置来关联来自第一计量器及第二计量器的读数,以使得由间歇性电源产生的功率及从电力网输入至负载的功率的相应时间轮廓彼此相关联。

[0049] 间歇性电源及负载中的一个或两个可经配置为可控制的,以用于促进相应时间轮廓彼此匹配。

[0050] 整合单元可经配置来基于来自第一计量器及第二计量器的相关读数中的一个或两个来计算用于负载的功率供应成本。

[0051] 电力网系统可进一步包括至少一个可调度电源,至少一个可调度电源与电力网连接且经配置以使得由可调度电源至电力网中的功率注入可响应于来自第一计量器及第二计量器的相关读数中的一个或两个来调整。

[0052] 间歇性电源可直接或经由中间并网设备与电力网连接。

[0053] 间歇性电源及负载可相对于电力网位于不同位置、或相对于电力网位于大体相同位置。

[0054] 整合单元可经配置以用于导出负载的概率性需求相对一个或多个时间格间隔的直方图。

[0055] 整合单元可经配置以用于导出来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图。

[0056] 由一个或多个可调度电源至电力网中的功率注入是可调整的，与来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图相关联。

[0057] 与在电力网上从一个或多个可调度电源至负载的供应关联的风险轮廓可为可修改的，通过考虑到来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图而观察经修改的需求轮廓来确定。

[0058] 整合单元可经配置来接收外部数据，诸如位置数据、辐射数据、风速数据、经由卫星成像的云形成图案、其他气象信息等等。

[0059] 整合单元可经配置来预测或精细化从间歇性电源至负载的供应。

[0060] 整合单元可经配置来确定从间歇性电源至负载的供应的一个或多个回顾供应轮廓。

[0061] 整合单元可经配置来确定负载的需求的一个或多个回顾需求轮廓。

[0062] 图6显示例示出根据示例性实施例的整合电力网系统中功率注入及消耗的方法的流程图600。在步骤602处，使用第一计量器计量从电力网输入至负载的功率。在步骤604处，使用第二计量器计量借由与电力网连接的间歇性电源产生的功率。在步骤606处，关联来自第一计量器及第二计量器的读数，以使得由间歇性电源产生的功率的至少一部分能够被从电力网输入至负载的功率抵消。

[0063] 方法可包括关联来自第一计量器及第二计量器的读数，以使得由间歇性电源产生的功率及从电力网输入至负载的功率的相应时间轮廓彼此相关联。

[0064] 方法可包括控制间歇性电源及负载中的一个或两个，以用于促进相应时间轮廓彼此匹配。

[0065] 方法可包括基于来自第一计量器及第二计量器的相关读数中的一个或两个来计算用于负载的功率供应成本。

[0066] 方法可进一步包括响应于来自第一计量器及第二计量器的相关读数中的一个或两个来调整至少一个可调度电源至电力网中的功率注入。

[0067] 间歇性电源可直接或经由中间并网设备与电力网连接。

[0068] 间歇性电源及负载可相对于电力网位于不同位置、或相对于电力网位于大体相同位置。

[0069] 方法可包括导出负载的概率性需求相对一个或多个时间格间隔的直方图。

[0070] 方法可包括导出来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图。

[0071] 方法可包括调整一个或多个可调度电源至电力网中的功率注入，与来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图相关联。

[0072] 方法可包括修改与在电力网上从一个或多个可调度电源至负载的供应关联的风险轮廓，通过考虑到来自所述间歇性电源的概率性供应容量相对一个或多个时间格间隔的直方图而观察经修改的需求轮廓来确定。

[0073] 方法可包括考虑外部资料，诸如位置资料、辐射资料、风速资料、经由卫星成像的云形成图案、其他气象信息等等。

[0074] 方法可包括预测或精细化从间歇性电源至负载的供应。

[0075] 方法可包括确定从间歇性电源至负载的供应的一个或多个回顾供应轮廓。

[0076] 方法可包括确定负载需求的一个或多个回顾需求轮廓。

[0077] 在一个实施例中,提供使用以上实施例的电力网系统来供应功率的方法。

[0078] 在一个实施例中,提供使用以上实施例的方法来供应功率的方法。

[0079] 示例性实施例也可有利地实现用于在电力网网络上的能量供应及需求的结算及交易的方法。

[0080] 在示例性实施例中,实施从间歇性电源或多个此类源产生的功率,以便基于以下因素使用一个或多个源来供应负载:一个或多个源的特性统计量;或一个或多个源的特性统计量及诸如局部辐照度、风速、温度、其他气象因素等其他外部因素。至负载的供应可考虑负载的特性统计量。考虑到常规电力发电机的可调度本质,这种与从源至负载的功率供应形成的对照是基于功率供应在功率供应的特定时间处隔离。

[0081] 在一个示例性实施例中,间歇能量供应源的特定时间特性为经由电力网网络将功率供应至负载的太阳能发电机。在替代实施例中,多个发电机的功率供应包括一个或多个间歇发电机或一个或多个非间歇发电机,以及经由电力网网络将功率供应至与电力网连接网络的负载或多个负载。

[0082] 示例性实施例也可根据电力的交易结算,并且根据经由使用供应至特定负载的一个或多个发电机的特性时间统计量对来自与网格网络连接的任何发电机的供应的交易的最佳化,提供间歇产生至负载的功率结算的交易方面。至一个或多个负载的功率供应的交易的最佳化可另外考虑一个或多个负载的特性时间统计量。

[0083] 示例性实施例可独特地允许间歇性电源被处理为至电力网网络上的特定负载的发电机。

[0084] 本说明书还公开了用于实施或进行这些方法的操作的设备。此类设备可针对所需目的特别地构造,或可包括由储存在装置中的计算机程序选择性地启动或重新配置的装置。此外,计算机程序的步骤中的一个或多个可并行进行而非依序进行。这种计算机程序可储存于任何计算机可读介质上。计算机可读介质可包括储存装置,诸如磁盘或光盘、记忆芯片、或其他适合于与装置交互的储存装置。计算机可读介质也可包括诸如互联网系统中所例证的硬接线介质,或诸如GSM移动电话系统中所例证的无线介质。计算机程序在被载入且在装置上执行时有效地产生实施方法的步骤的设备。

[0085] 本发明也可实施为硬件模块。更具体而言,在硬件意义上,模块为经设计来与其他组件或模块一起使用的功能性硬件单元。例如,可使用离散电子组件来实施模块,或模块可形成诸如专用集成电路(ASIC)的整个电子电路的一部分。许多其他可能性存在。本领域技术人员将了解,系统也可实施为硬件模块及软件模块的组合。

[0086] 本领域技术人员将了解,可在不脱离如广泛描述的本发明的精神或范畴的情况下,对特定实施例中所显示的本发明进行许多改变和/或修改。因此,将在各个方面将本发明的实施例视为说明性的而非约束性的。此外,本发明包括特征的任何组合,尤其是专利申请范围中的特征的任何组合,即使在专利申请范围或本发明的实施例中未明确指定特征或特征的组合。

[0087] 例如,虽然在示例性实施例中已描述PV发电机,但在不同实施例中,可使用不同间

歇性电源，诸如基于绕组的发电机或基于水的发电机等等，其中本领域技术人员将了解，发电机中的每一个具有基于特性时间的轮廓，轮廓可经由各种外部信息来另外确定，并且可另外与根据示例性实施例的给定功率消耗情形的一个或多个风险轮廓和/或一个或多个负载轮廓相关。

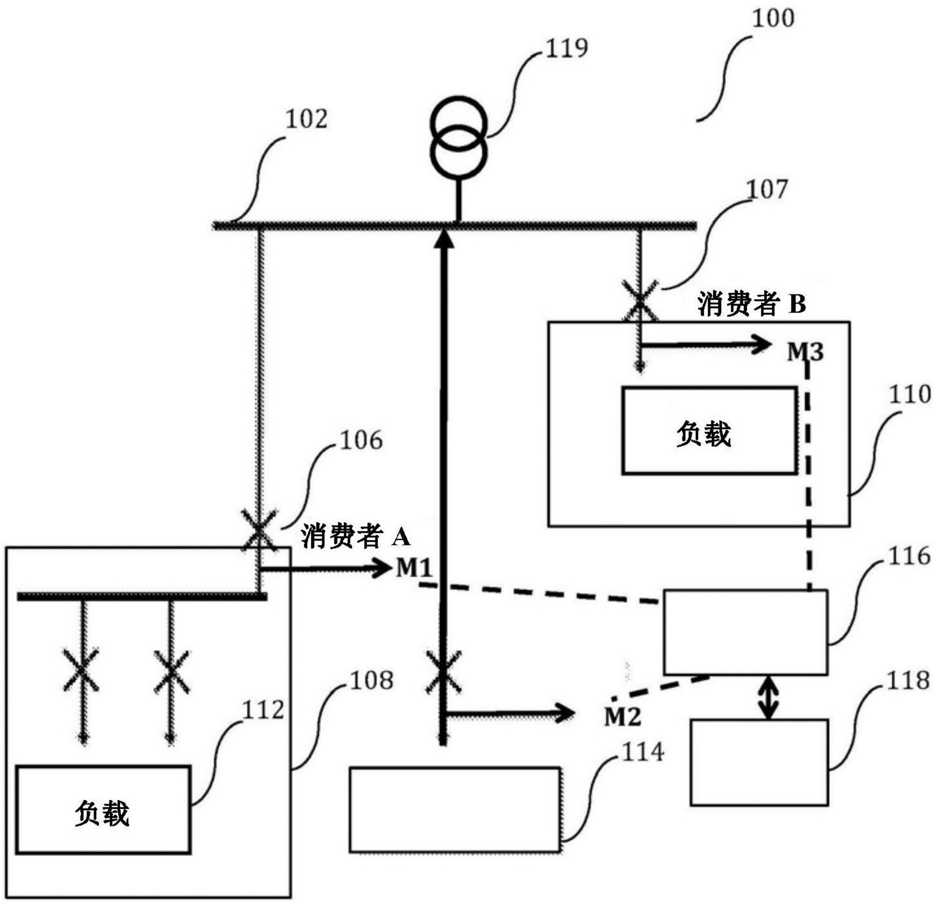

100
119
102
107
消费者 B
M3
110
负载
106
消费者 A
M1
116
108
112
M2
118
114
负载

图1

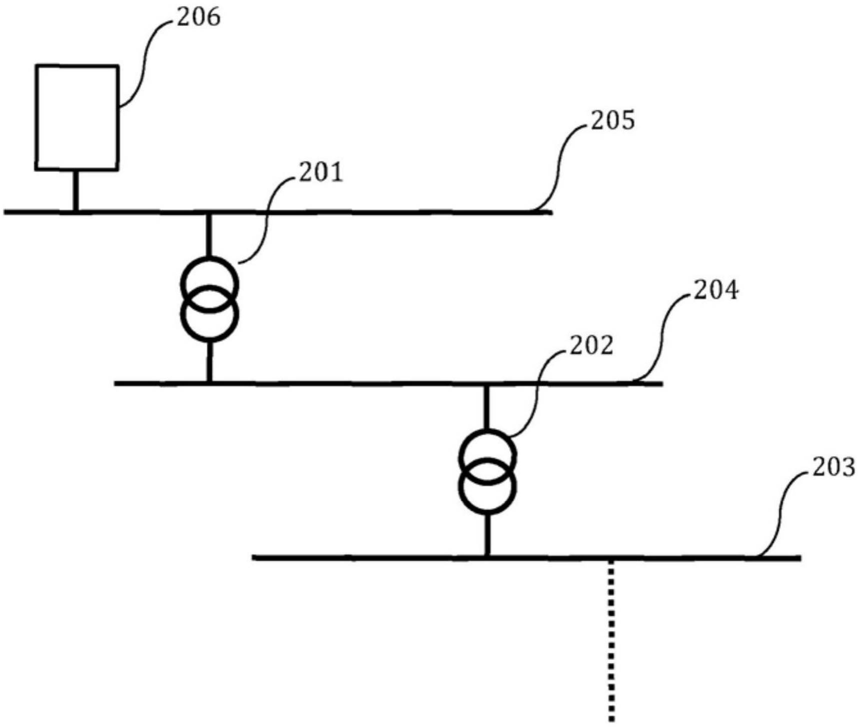


图2

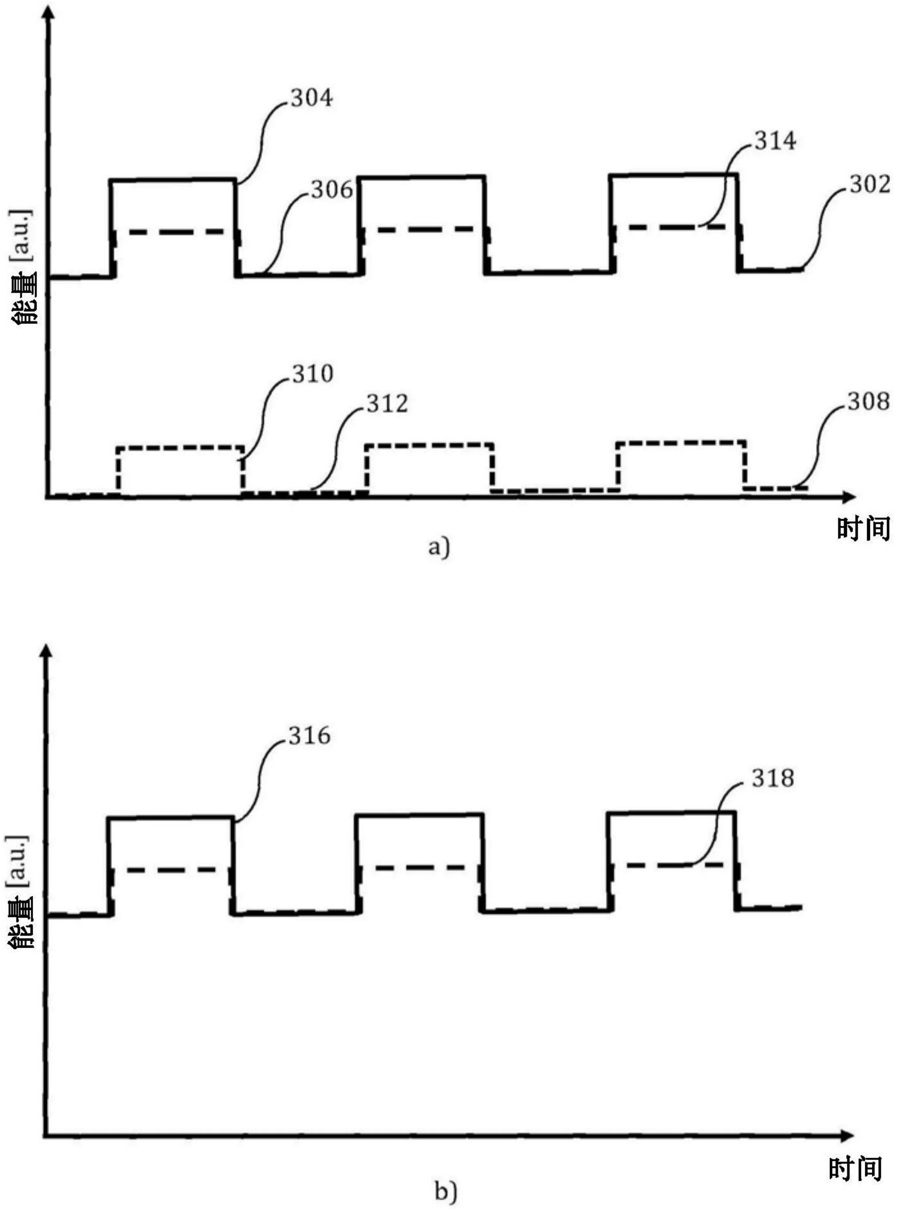


图3

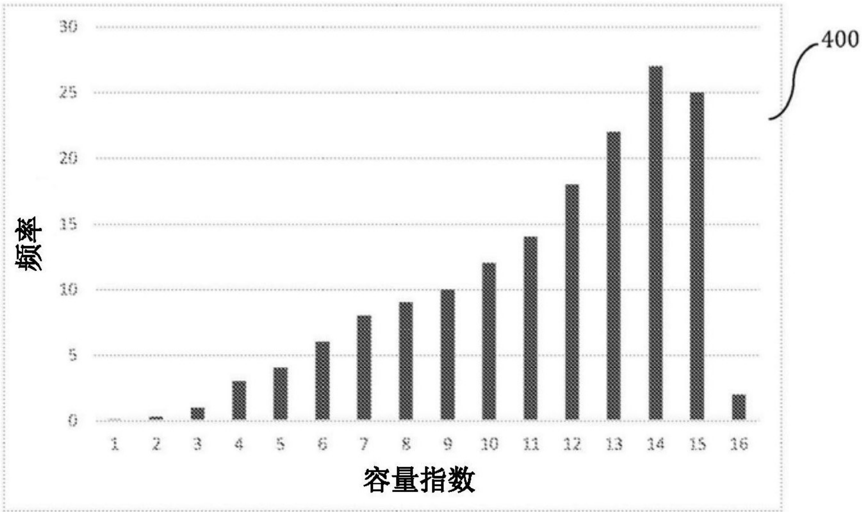


图4

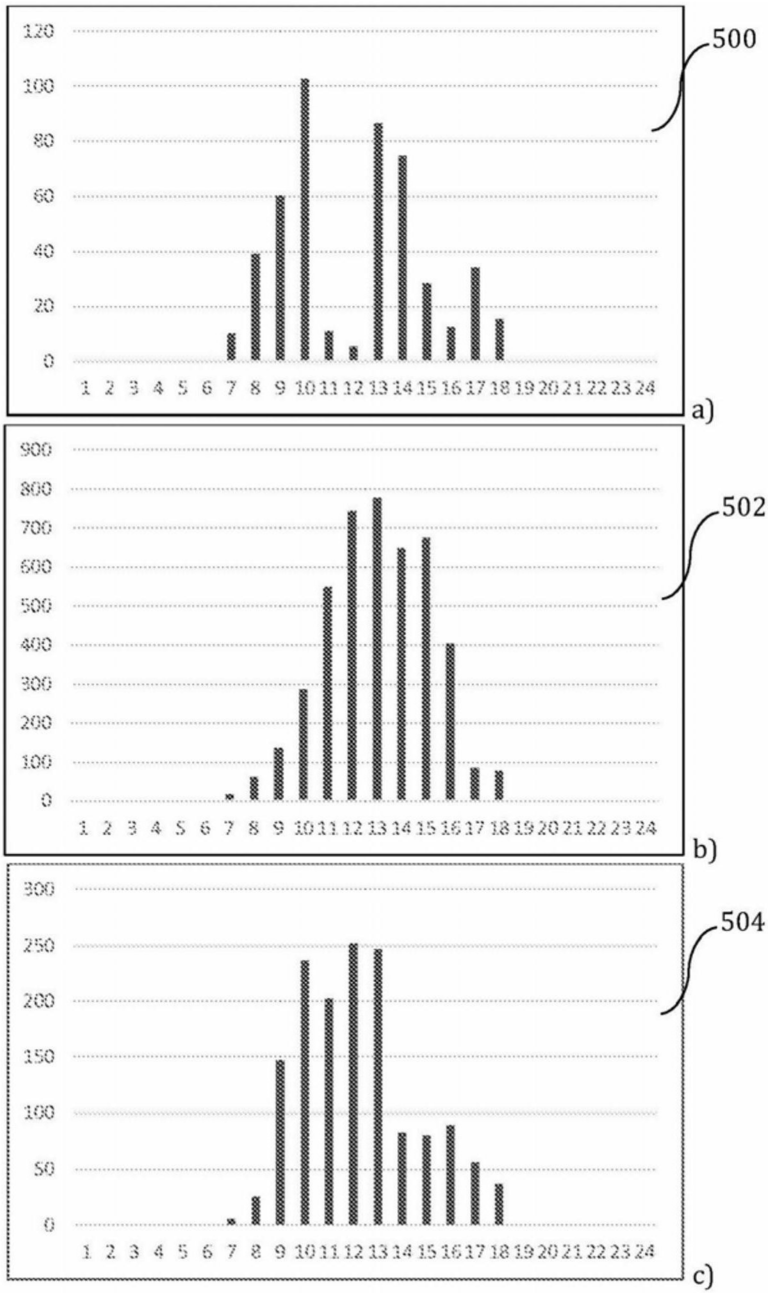

500
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
a)
502
900
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
b)
504
300
250
200
150
100
50
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
c)

图5

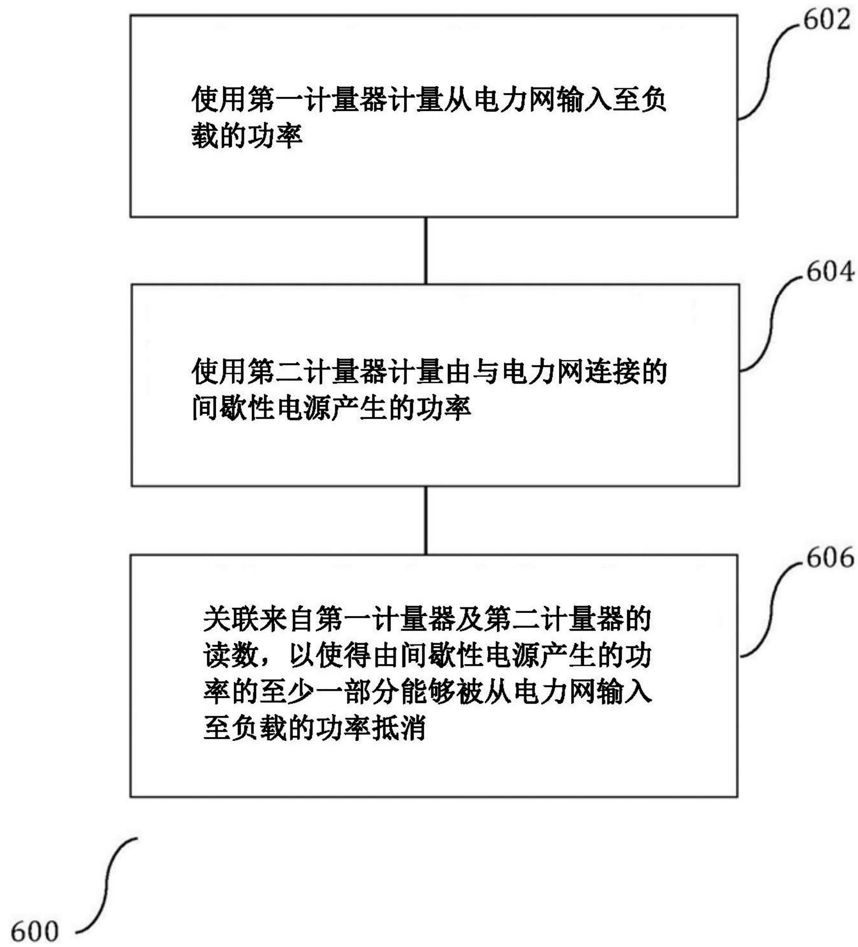

602
使用第一计量器计量从电力网输入至负载的功率
604
使用第二计量器计量由与电力网连接的间歇性电源产生的功率
606
关联来自第一计量器及第二计量器的读数，以使得由间歇性电源产生的功率的至少一部分能够被从电力网输入至负载的功率抵消
600

图6