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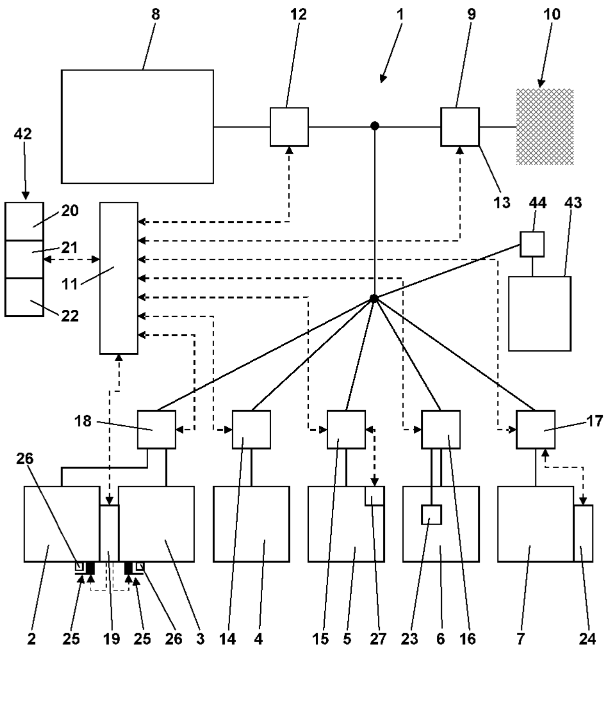

Fig. 1

(57) Abstract: For optimizing a chronological developing of consumption of electric power by a group of different consumers (2 to 7) with regard to a supply of electric power including electric power from at least one wind or solar power generator (8), characteristic time curves of the consumption of electric power by the individual consumers (2 to 7) of the group are determined at a high temporal resolution. A prognosis is made of a chronological developing of the supply of electric power from the at least one power generator (8) for a future period of time, and a plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time is made based on the characteristic time curves of the consumption of electric power by the individual consumers (2 to 7) and adapted to the prognosis.

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OPTIMIZED LOAD MANAGEMENT

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to German Patent Application No. DE 10 2011 001 918.9 entitled "Optimiertes Lastmanagement", filed on April 8, 2011.

FIELD OF THE INVENTION

The present invention generally relates to a method of and an apparatus for optimizing a chronological developing of consumption of electric energy by a group of different consumers with regard to a supply of electric power which includes electric power from at least one wind or solar power generator.

Further, the invention relates to a local power grid comprising such an apparatus, a group of different consumers and at least one wind or solar power generator. The local power grid may either be an island grid or it may comprise a connection to a public power grid.

The term consumer here refers to an electric load.

BACKGROUND OF THE INVENTION

Electric power from solar and wind power generators is not necessarily available at the same time when a need of electric power is present in a public power grid to which the power generators are connected. Rather, the supply of high electric power by the power generators, like for example by solar power generators at noon time, may coincide with a surplus of electric power already present in the connected public power grid. This may have the result that the output power of the power generators has to be curtailed and thus electric power gets lost which would be available at no additional cost.

If in a local power grid comprising a power generator more electric power is produced than consumed and the excess electric power is fed into a public power grid at one time, whereas more electric power is consumed than produced and the missing electric power is taken of the public power grid at another time, the public power grid essentially serves as a buffer for electric power. This buffer capability causes considerable cost to the operator of the public power grid for which he will ask for compensation.

By now, the supply price of electric energy already extremely depends on the point in time at which the electric energy is supplied. Power tariffs depending on the supply time will thus more and more also be offered to private consumers.

Against this background, a load management is desirable which is optimized with regard to the supply of electric power actually present and which fulfils the aims of a high local consumption of electric power at the location where the electric power is produced by solar or wind generators, i.e. achieving a minimum utilization of a connected public power grid.

A method of and an apparatus for optimizing a chronological developing of consumption of electric power by a group of different consumers with regard to a supply of electric power which includes electric power from at least one wind or solar generator and a local power grid including such an apparatus are known from DE 10 2008 037 575 A1. By means of a computer based method, the operation of consumers and energy sources of a local system are monitored, controlled and optimized. Solar and/or wind power generators belong to the local system as stationary power sources. Part of the known computer based method is making a plan for an optimized utilization of energy in the local system based on information which includes the prospective overall power consumption by the consumers and the prospective power supply by stationary power sources at future points in time. The prospective overall power consumption at the future points in time is calculated from the measured power consumption of one or several of the consumers. For calculating the power which is supplied by the stationary power sources at the future points in time, the prospective environmental conditions at these points in time are considered. In the diagrams of DE 10 2008 037 575 A1, the power consumption is plotted in blocks covering a duration of 40 minutes, and changes of the power consumption do not occur earlier than after two hours.

A method of optimizing a chronological developing of consumption of electric power by a group of different consumers with regard to a supply of electric power which includes electric power from at least one wind or solar power generator is also known from DE 10 2009 010 117 A1. The aim is here to level the electric power consumed by a group of different loads. In a first step, an uncontrolled consumption of power is determined over a defined period of time related to the calendar. In a second step, an average value is calculated from this uncontrolled consumption of power which is used as a preset target value during a similar future period of time. Different priorities are assigned to the consumers, and the consumers are operated according to their priority so that their presently consumed overall electric power does not exceed the target value. With this method, the consumption of electric power may be levelled, and this may, depending on tariff conditions, be economically advantageous for the operator of the local power grid. In the known method, maximum switch-off periods of individual loads, like for example a heat pump for heating a building are registered. Heat or cold generating consumers are purposefully operated during low load periods, so as to store heat or cold for succeeding high load periods in which these consumers are preferably not additionally operated. The operation of dishwashers and washing machines shall preferably also take place during low load periods. Thus, a low priority is assigned to such consumers. On the other hand, consumers like lamps or stoves get a high priority as the need of light or cooking energy depends on momentary desires to an extremely high extent. Further, it is considered that the power consumed by individual consumers varies depending on the progress of their operation cycles. Considering, for example, a washing machine, once switched on it will be in operation for up to two hours and more. The power demanded by the washing machine is comparatively high when water is heated up to a preset washing temperature. For subsequently moving the washing drum, however, only little power is needed. The present consumption of electric energy is measured at intervals of 1, 3 or 5 minutes in the known method. These intervals of time are adapted to a price calculation period of 15 minutes for which an average consumption value is transferred to the operator of the connected public power grid. The price to be paid for the power consumed is calculated based on these average consumption values. In the known method, a local generation of power by solar or wind power generators is considered. If the locally generated power is higher than the locally consumed power, the excess or surplus power is fed into the connected public power grid. Vice versa, missing power is taken from the public power grid.

So-called intelligent electrical sockets for connecting electric consumers are known from DE 44 25 876 A1. The consumers are controlled, i.e. they are switched on, switched off and/or dimmed, via a BUS system which uses the power mains as a transmission medium. Via an additional interface connector, sensors may be connected to the intelligent electric socket and interrogated via the BUS system.

An analyzing apparatus for current consumers in which at least one consumer comprises a unit which is suited for identifying the power consumption of exactly this one consumer and to provide it as information is known from DE 20 2008 009 128 U1. The analyzing apparatus comprises a receiver for the information provided by the at least one consumer. This receiver is suited for separately recording, processing and calculating results according to predetermined algorithms from information from each of the consumers upon switching on and/or switching off the consumers individually. The information transmission takes place via the power supply lines at more than 50 Hz, preferably more than 100 Hz, i.e. at more than 50 b/s or more than 100 b/s. The analyzing apparatus may determine and output the individual power consumption of each consumer and reduce the power supply to this current consumer or switch it on and off. In the known analyzing apparatus, the individual identification of the individual consumers is achieved by means of their individual consumption behaviour. Thus, inductive and capacitive consumption patterns of each consumer, in a figurative sense, comprise the properties of a finger print. This electric finger print consists of a switch-on current pulse and of harmonic waves imprinted in the local power grid. If these harmonic waves are analyzed, it is - due to their individual composition - possible to identify the causing consumer. Thus, by means of an identification of the individual consumption behaviour of the respective consumer, on the one hand, its identification is possible, and, on the other hand, it is possible to make statements on the present status of each individual consumer by comparing its present individual consumption behaviour with a stored nominal value or with a tolerated range of nominal values,.

There still is a need for a method of optimizing a chronological developing of consumption of electric power by a group a different consumers with regard to a supply of electric power which includes electric power from at least one wind or solar power generator, of an apparatus for carrying out this method, and of a local power grid comprising such an apparatus, by which a consumption of electric power from the power generator is optimized. This optimization may be an optimization with regard to a local use of the electric power from the power generator such that a connected public power grid is only utilized to a minimum extent and ideally not needed at all. The optimization may alternatively or additionally also be made with regard to one or several other criteria, like for example a maximum usage of electric power from regenerative power sources, an ecologically sensible power consumption or low energy cost.

SUMMARY OF THE INVENTION

The invention provides a method comprising the features of independent claim 1, an apparatus comprising the features of independent claim 27, and a local power grid comprising the features of independent claim 46. Preferred embodiments of the new method, the new apparatus and the new local power grid are defined in the dependent claims.

SUMMARY OF THE INVENTION

In the method of optimizing a chronological developing of consumption of electric power by a group of different consumers with regard to a supply of electric power which includes electric power from at least one wind or solar power generator, at first a consumption of electric power by the individual consumers is measured to determine characteristic time curves of the consumption of electric power by the individual consumers. Then, a prognosis is made of a chronological developing of the supply of electric power from the at least one power generator for a period of time in the future. In case of a power generator being a solar power generator, for example, the typical future period of time will be a day. It may, however, also be a part of a day or a plurality of days.

Based on the characteristic time curves of the consumption of electric power by the individual consumers, a plan for apportioning electric power to the individual consumers within the future period of time is made which is matched to the prognosis. Within the future period of time electric power is then apportioned to the individual consumers according to that plan. This apportionment corresponds to a rationing of electric power which may be consumed by the individual consumers, wherein the rationing may be accomplished by turning on or off or by reducing the electric power supplied to the individual consumer.

In order to effectively achieve a high local consumption without needing to resort to a connected public power grid by means of making the plan, the consumption of electric power by the individual consumers is measured at a sample rate of at least 0.1 Hz. This means that at least about every 10 seconds, preferably at least every second, more preferably at least every tenth of a second, even more preferably at least every hundredth of a second, i.e. once per half-wave of the usual 50 Hz alternating current, a value of consumption of electric power by the individual consumers is measured to consider it when determining the characteristic time curves of the consumption of electric power by the individual consumers.

As a result, the plan for apportioning electric power to the individual consumers within the future period of time may have a temporal resolution equal to this high sample rate. This, in turn, is a precondition for considering characteristic variations of the consumption of electric power by the individual consumers which occur at a high frequency when making the plan. Without this consideration of fast variations, i.e. if only average values over comparatively long periods of time are measured and considered, the consumption of electric power by the entirety of the individual consumers may considerably exceed the supply of electric energy by the power generator at one moment, whereas it does not exploit the power supplied at the next moment. As a result, an oscillation of electric power between the local power grid and a connected public power grid occurs which stresses the public power grid considerably although the average power imported from the public power grid is zero.

In that the characteristic time curves of the consumption of power by the individual consumers are determined at a comparatively high sample rate, temporal variations of the consumption by the individual consumers may be considered when making the plan for apportioning electric power to the individual consumers. In an ideal case, the available electric power is apportioned to two or more consumers with oscillating consumption of electric power in antiphase or at offset phases, so that the consumption of the consumers is mutually exclusive and the total consumption is balanced. At least, a consumption of electric power by such consumers which is temporarily higher than average may be considered when making the plan for apportioning electric power, and in the periods of low consumption by such consumers, the thus unused electric power may be apportioned to other consumers. For this purpose, besides consumers which also have an oscillating consumption and which may be operated in antiphase, particularly such consumers may be utilized which are not depending on a continuous supply with electric power. A lot of heating devices and energy storage devices, for example, belong to these consumers.

If a purposeful apportionment of electric power to individual consumers shall take place in gaps of the consumption by other consumers, it is clear that the apportionment of electric power according to the plan also has to take place at a high clock rate of at least 0.1 Hz, preferably at least 1 Hz, more preferably at least 10 Hz and most preferably at least 100 Hz, i.e. once per halve wave of the usual alternating current.

In the method, even faster variations of the consumption of electric power by the individual consumers may be considered than they can be determined by means of the limited sample rate at which the consumption of electric power by the individual consumers is measured. For this purpose, additional information on the respective consumer may be used which may already be identified by means of its characteristic consumption behaviour determined at the sample rate. This information may be retrieved from an external data base on basis of the characteristic consumption and/or on basis of an identification code entered by the user and identifying the consumer. This information may especially comprise histograms which relate the relative frequency of certain instantaneous values of electric power consumed by a consumer to the averaged electric power consumed by the consumer which is actually measured at the limited sample rate. Thus it is possible to infer from the measurements at limited sample rate the existence and frequency of instantaneous peak values of the power consumed by the consumer and to take these peak power values and their frequency into account when making the plan. The phase of variations at a higher frequency generally known in this way may still be determined at a sample rate which is not sufficient for completely recording the variations of the consumption of the consumer.

If no considerable security stock is built in the prognosis, which - if not needed - corresponds to a considerable amount of power which is not consumed locally, undershooting the prognosis by the electric power actually supplied by the power generator cannot be avoided. Similarly, there may be an unplanned consumption of electric power in that, for example, a consumer which is to be supplied with electric power unconditionally, like for example a lighting device, is switched on by a user. Thus, it is preferred that the plan for apportioning electric power to the individual consumers is continuously updated based on the actual supply of electric power and on the actual demand of electric power of the individual consumers.

Consumers whose demands of electric power result in exceeding the supply of electric power from the at least one power generator may, particularly if this happens repeatedly, be marked with a marker. This marker may then be considered in updating the plan for apportioning electric power to the individual consumers. This consideration may include that electric power will only be apportioned to the respective consumer if this power is available for certain. The marker may have a variable value which increases with the number and/or the height of the excesses of the supply of electric power from the at least one power generator.

In an embodiment, it is part of the plan that apportioning electric power to the individual consumers includes a limitation of the maximum power which may be consumed by at least one individual consumer. This means that electric power is apportioned to the at least one consumer but not to an unlimited extent, i.e. not to any extent which may be demanded by the consumer, but only to a limited extent. In this way, the function of the consumer may be ensured permanently, on the one hand, but an excess of the electric power supplied by the power generator may be avoided, on the other hand. The limitation of the power which may be consumed at maximum may particularly be applied to consumers which have already been marked with the marker explained above. Consumers to which a limited electric power may be supplied without generally affecting their function include many electric heating devices, including washing machines and dish washers during their heating phases, and many lighting devices.

The limitation of the maximum power which may be used by one individual consumer may, for example, be effected by pulse width modulation, preferably by so-called phase-controlled modulation, like it is common in dimmers, for example. In phase-controlled modulation only a part of each half wave of the alternating current is supplied to an AC consumer. The part of the half wave supplied may be varied half wave by half wave, i.e. at a clock rate of 100 Hz at maximum.

It is also possible to intervene in the consumption of electric power by consumers which may be arbitrarily switched on by a user or which may themselves arbitrarily switch on and to which electric power has to be supplied unconditionally to ensure their function. Thus, by limiting the electric power which may be consumed by a lighting device which has to function all the time for security reasons, for example, electric power may be saved which is needed elsewhere. By limiting the electric power which is supplied to an electric heating device, which operates in an on/off-operation to keep a preselected temperature, like for example an electric stove, the on-intervals will be extended without affecting the general function of the heating device. The electric power saved in this way of limiting the electric power consumable by an individual consumer can be used elsewhere. Further, it results in a levelling, i.e. in a homogenization of the electric power consumed by the individual consumer. This levelling is maximized when the on-intervals are only interrupted by short off-intervals at longer periods of time which indicate that the controller of the heating device is still functioning. Even this function may be monitored by measuring the actual consumption of the individual consumers at the high sample rate.

Apportioning electric power to the individual consumers may, for at least one individual consumer, take place via a switchable single connector, i.e. via a single connector for a single one of the individual consumers which can be switched on and off. Further, it is possible that apportioning electric power to the individual consumers is effected by accessing an interface of a controller of at least one individual consumer having such an accessible interface. For consumers which may neither be switched on and off via a switchable connector nor have an accessible interface, apportioning electric power may often be achieved via a controllable actuation element for a switch-on bottom of the consumer, which is mounted to the consumer. This, for example, applies to various washing machines and dish washers. Further, it is to be understood that the various procedures of apportioning the electric power to the individual consumers may also be used in combination.

Which options of intervening in the present consumption of electric power by the individual consumers exist, strongly depends on the individual consumers. These intervention options may to a certain extent be determined by tests. However, it is preferred that the intervention options are determined by accessing entries related to the individual consumers in an external data base.

Further, characteristic time curves of the consumption of electric power by the individual consumers may, via a bidirectional data base connection, be uploaded into an external data base and/or downloaded from there. The characteristic time curves may particularly comprise different consumption curves for different consumer settings.

The identification of the individual consumers which is necessary for downloading information with regard to the individual consumers from a data bank may be made by manual input. Often, however, this identification is also possible based on the characteristic time curves of the consumption of electric power by the individual consumers. This means that the characteristic time curve of the consumption is used as an identifying fingerprint of the respective consumer.

As some consumers only show individual characteristics of the time curve of their consumption of electric power in a higher range of frequencies, the consumption of electric power by the individual consumers in terms of the respective current and voltage curves at the individual consumers are preferably measured at a sample rate of at least 1 kHz, particularly of at least a several kilohertz. Often, an evaluation of this highly temporally resolved determination of the time curve of the consumption of the individual consumers also allows for conclusions on options of intervention in this consumption, like for example by pulse width modulation.

At least then when the members of the group of the individual consumers and the characteristic time curves of their consumptions are generally known, it is possible to allocate the individual consumers to single connectors at which a consumption with the respective characteristic time curves is measured, for example.

Further, the individual consumers may be monitored for proper function by comparing the actual time curves of their consumption with the characteristic time curve of their consumption. It is to be understood that any limitations to their consumption of electric power set as an apportionment measure according to the plan have to be taken into account here.

In an embodiment of the method, the consumption of electric power by each individual consumer is measured at its single connector to the local grid. Generally, however, one single electric meter is sufficient for measuring the consumption of electric power by each individual consumer. This electric meter indicates the sum of the consumption of electric power by all individual consumers. Particularly, when measuring the total consumption at a high temporal resolution it will be easily recognized whether the total consumption includes the characteristic time curves of the consumption of electric power by certain consumers, i.e. which consumers presently consume electric power and in which stage of their characteristic time curve of the consumption of electric power they presently are. At least by switching the individual consumers on and off, the contribution of each individual consumer to the total consumption can definitely be determined, even if the characteristic time curves of the consumption of the individual consumers are not yet known. Following this determination of the characteristic time curves of the consumption of electric power it is possible to take even those consumers whose consumption is not measured individually into account when making the plan for apportioning electric power to the individual consumers.

The total consumption may also be measured in order to determine a characteristic time curve of the consumption of electric energy by all those consumers whose consumption will not be modified because no intervention is possible at all due to missing technical options or because no sensible intervention is possible, and to consider this characteristic time curve in making the plan for apportioning electric power to the individual consumers whose consumption can be suitably modified. The characteristic time curve of the consumption of electric power by all consumers whose consumption is not modified typically relates to a comparatively long period of time, which particularly includes at least one day but which may also include a week, a month or even a year (to capture seasonal variations). The period of time to which the characteristic time curve of the consumption of electric power relates, may thus particularly be longer than the future period of time for which the plan for apportioning electric power is made. Vice versa, the characteristic time curve of the consumption of electric power by the individual consumers whose consumption is modified or intervened in particularly relates to a comparatively short period of time which typically includes an operation period from switching the individual consumer on or a start up of the individual consumer up to its next switching off or shutting down, and which is rarely longer than a day and thus rarely longer than the future period of time for which the plan for apportioning electric power is made. An operation period of a fridge, for example, runs from each start up to the next stop of its chiller, whereas an operation period of a washing machine corresponds to one washing program.

At this point it should be mentioned that in the method described here it is neither necessary to intervene in the consumption of electric power by each individual consumer of a local power grid nor to determine a characteristic time curve of the consumption of electric power for each individual consumer, particularly not for consumers whose consumption will not be modified. Instead, for example, several or all consumers whose consumption is anyway not modified may be regarded as one further individual consumer.

Actually, (i) the electric power fed into the public power grid, (ii) the power imported from the public power grid, and (iii) the power locally produced by all power generators may be measured to determine a total consumption of electric power in the local power grid and its time curve. Based on this total consumption a basic consumption prognosis is made by subtracting the consumption of electric power by all consumers whose consumption may be modified or intervened in. This basic consumption prognosis corresponds to the characteristic time curve of the consumption of electric power by all consumers whose consumption may not be modified or will not be intervened in. If the goal is to optimize local consumption, the difference between this basic consumption prognosis and the prognosis of the developing of the supply of electric power which is generated by the at least one power generator is the free range for the plan for apportioning electric power to the individual consumers whose consumption may be modified.

From a single connector of an individual consumer, further electric values of the respective consumer like for example an impedance between its connection lines may be measured besides the consumption of electric power. Based on these values, one may, for example, conclude on the present switching state and, by means of extrapolation or even directly, on the present temperature of heating or cooling devices switched by a bimetallic device. Another option of measuring electric values of at least one individual consumer from its single connector is to supply electric power to the consumer for testing whether and to which extent it would consume this power at present.

Even further physical values of an individual consumer may be measured by additional sensors and considered in updating the plan for apportioning the electric power. For example, temperature sensors may be mounted to refrigerators and other cooling devices or to heating devices, indicating by their signal how necessary apportioning electric power to the respective device is at present. In refrigerators, an opening of the door may also be captured by an appropriate sensor in order to activate the interior illumination of the refrigerator by supplying current to the refrigerator or by activating an auxiliary illumination. Additionally, an opening of the refrigerator door may be used as an indication of an approaching demand of electric power by the refrigerator, and this indication may be considered in updating the plan for apportioning the electric power.

The prognoses with regard to the chronological developing of the supply of electric energy from the power generator are preferably made on the basis of weather forecasts. Particularly local weather forecasts and also running weather reports belong to these weather forecasts. In case of a solar power generator, one also has to consider the course of the solar altitude over the present day in making the prognosis with regard to the chronological developing of the supply of electric energy. Further, the characteristics of the power generator have to be considered.

The weather forecasts used in making the prognoses with regard to the chronological developing of the supply of electric energy may also be used to notice thunderstorms at the location of the respective local power grid and to then switch off endangered consumers and/or power generators.

Particularly in situations when the supply of electric power by the power generator is not sufficient, a further prognosis of a chronological developing of conditions of an import of electric power from a public power grid may be made for the future period of time, and this further prognosis may be considered in making the plan for apportioning electric power to the individual consumers in the future period of time. Also in situation when the electric power supplied by the power generator is generally sufficient or even when excess electric power may be fed into the connected public power grid, such a further prognosis can be an advantage. For example, there may be an option to feed the electric power supplied by the power generator at a certain point in time into the public power grid at a very favourable, i.e. high tariff, whereas the generated electric power could only be fed into the public power grid at a less favourable tariff, but can be re-imported from the public power grid at a more favourable, i.e. lower tariff, at another point in time within the future period of time.

In the further prognosis, tariffs of different power suppliers may be considered in addition to variable tariffs. The effects of an achievement of a same result in an alternative way under other conditions of the import of electric power from the public power grid and/or of the feeding of electric power into the public power grid for the future period of time or for a past period of time may also be determined. In this way, one may for example search for the most favourable tariff of all available tariffs of different power suppliers under the conditions of the plan for apportioning electric power to the individual consumers in the future, and one may also countercheck such a decision afterwards.

When making the plan for apportioning electric power to the individual consumers in the future period of time, particularly the bidirectional exchange of electric power with an electrical storage device and/or a public power grid, e.g. buffering electric power in batteries or even feeding electric power out of batteries into the public power grid may be considered. For this purpose, a further prognosis of a chronological developing of conditions of buffering electric power in a storage for electric energy may be made for the future period of time, and this prognosis may be considered in making the plan for apportioning electric power to the individual consumers within the future period of time. The conditions of buffering electric power may comprise costs for this buffering which may be derived mainly based on the costs for purchasing and operating the electric storage device, taking into consideration the life expectancy as well as the total number of load cycles. Due to power tariffs varying over time, the plan for apportioning electric power to the individual consumers may result in the opposite of a maximum local consumption of locally produced electric power. In this case, the method described here utilizes the public power grid but actively supports the supply of electric power in the public power grid for matching the present demand of electric power.

According to the principles disclosed here, groups of consumers and/or power generators may be interconnected. Thus, a further prognosis of a chronological developing of conditions of transferring electric power to and from at least one other group of consumers and/or power generators for the future period of time may be made, and this prognosis may be considered in making the plan for apportioning electric power to the individual consumers within the future period of time.

There are cases in which a desired result achieved by means of one of the existing consumers or power generators may also be achieved to the same extent by means of one other present consumer or power generator or another existing device. This applies, for example, if a heating power for the heating of water may be either provided by burning a fuel or by transforming electric power into heating power, or if electric power may be provided by different fuel-driven generators and/or by a battery. In these cases, a further prognosis of a chronological developing of conditions of an achievement of a same result in an alternative way by means of another existing consumer or power generator or another existing device may be made for the future period of time and may be considered in making the plan for apportioning electric power to the individual consumers over the future period of time. The consideration of this prognosis may, for example, be made from the point of view of (i) the total cost, (ii) the CO_2 emission or (iii) the locally emitted exhaust gases.

Further, the potential effects of an achievement of a same result in an alternative way by means of another, presently not existing consumer or power generator or another, presently not existing device may be determined for the period of time in the future or a period of time in the past. From these determinations it may be derived whether it would be beneficial to exchange one of the consumers or power generators by another or to install a further power generator, for example.

Besides consumers which will demand power during each future period time of a certain length, there are many consumers which do only demand electric power at longer or even very irregular intervals of time. Such consumers may nevertheless be integrated in the plan for apportioning electric power, if advance notifications for the operation of these consumers are available, e.g. provided by a user.

Besides such advance notifications, the user may assign different priorities to the individual consumers for the future period of time. These priorities may then be considered when making the plan for apportioning electric power to the individual consumers. These priorities may range from such which guarantee an unconditional apportionment of electric power down to such which only allow an apportionment of electric power if there is an otherwise unusable surplus of power generated by the at least one power generator or if there is a demand of negative control power for a connected public power grid.

Actually, the different priorities may be defined by different weighting factors for the consumption of electric power by the individual consumers. A sum of such weighted consumptions may then be limited to a maximum value or generally minimized when making the plan for apportioning electric power to the individual consumers.

In a three-phase power grid, apportioning electric power to individual single-phase consumers may be uniformly distributed over the three phases according to the plan. This avoids unbalanced loads which despite of less overall consumption of electric power than produced by the power generator may nevertheless have the result that electric power is imported from a connected public power grid via one phase, while at the same time electric power is fed into the public power grid via another phase.

Besides a central controller for apportioning electric power to the individual consumers, which determines the characteristic time curves of the consumption of electric power by the individual consumers, and which makes the prognosis of the chronological developing of the supply of electric power by the at least one power generator for the future period of time and, based on the characteristic time curve of the consumption of electric power by the individual consumers, makes a plan adapted to the prognosis for apportioning electric power to the individual consumers in the future period of time and apportions the electric power according to the plan to the individual consumers in the future period of time, an apparatus as disclosed here will comprise measurement devices which measure the consumption of electric energy by the individual consumers at a sample rate of at least 0.1 Hz, thus being able to execute the method disclosed here.

Single connectors each connecting a single one of the individual consumers are preferably provided by sockets or socket adaptors switchable wirelessly or via power line communication. The sockets or socket adaptors may include measurement devices for the respective consumer which transfer their measurement values wirelessly or via power line communication to the central controller.

To also activate such consumers which may not simply be switched on and off by apportioning electric power according to the plan, the apparatus may comprise at least one controllable actuation element which may be mounted relative to a switch-on button of an individual consumer. This actuation element may be controlled by the central controller and presses the switch-on button of the consumer upon a trigger command sent by the central controller, so that the central controller starts the individual consumer and thus apportions electric power to it.

Alternatively, the central controller may also comprise an interface via which it communicates with at least one interface of a controller of one of the individual consumers.

To obtain information particularly with regard to the intervention options in the present consumption of electric power by the individual consumers, the central controller preferably comprises an interface via which it communicates with an external data base. This may, for example, be done via the internet. An interface to the internet may also be used by the central controller for receiving weather forecasts and weather reports as well as for receiving conditions of an import of electric power from the public power grid.

The central controller may also comprise an interface for receiving conditions of buffering electric power in a storage device for electric energy. This interface may actually be configured for receiving the conditions of buffering electric power in the storage device for electric energy from an energy management device of the energy storage device. Such energy management devices are included in known storage devices storing electric energy in batteries, for example.

The central controller may further have an interface for interconnecting with at least one further similar apparatus. Via this interface the central controller may exchange prognoses of the chronological developing of the supply of electric power in the future period of time with at least one further similar apparatus. The central controller may also exchange conditions of a transfer of electric power to and from devices connected to the at least one further similar apparatus via the interface to make a further prognosis of a chronological developing of the conditions of the transfer of electric power to and from the devices connected to the at least one further similar apparatus for the future period of time, and to consider this prognosis when making the plan for apportioning electric power to the individual consumers for the future period of time.

For accepting user-defined advance notifications of the operation of individual consumers within the future period of time, the apparatus described here preferably comprises input units to be arranged at or mounted to the individual consumers which communicate with the central controller. Via these input units the user may, for example, set a time frame for fulfilling the advance notifications and input other details of the advance notifications like for example the program of a washing machine which he has set and which has a considerable influence on the consumption of electric power by the washing machine during the future period of time once the washing machine has or has been started.

The input unit may have a display via which the central controller may give recommendations to the user in terms of preferable advance notifications which may comply particularly well when making the plan. Particularly then, when the respective input unit allows demanding immediate operation of the individual consumer, the display unit may also be used to indicate to the user whether this immediate operation will be possible within the limits of the power presently provided by the power generator. These indications with regard to the presently available electric power may also be provided at consumers which generally have a high priority in the apportionment of electric power, like for example lighting devices, to guide the user behaviour.

The apparatus disclosed here may also have a display unit for displaying the entire plan for apportioning electrical power to the individual consumers. This display unit may be provided at the central controller but may also be located remote thereof.

To avoid unbalanced loads within a three-phase local grid operated according to the plan for apportioning electric power in a simple way, the apparatus described here may have at least one adaptor with a three-phase AC power input and at least one single-phase AC power output which may be selectively connected or switched to the different phases of the three-phase AC power input.

Further preferred details of the apparatus describes here may be taken from the detailed description of the method disclosed here.

A local power grid described here comprises (i) the apparatus described here, (ii) a group of different consumers and (iii) at least one wind or solar power generator. The local power grid may be an island grid. If connected to a public power grid, the local power grid preferably has a bidirectional connection which is provided with a feeding meter for the power fed into the public power grid and at least one consumption meter for the electric power imported from the public power grid. There may be a plurality of consumption meters to be able to selectively consider different tariffs or different power supplies in consuming electric power imported from the power grid.

The size of the local power grid connected to the public power grid may vary from a single household over a street with connection to a local area power grid via a distribution point up to an intermeshed local area network connected to a medium voltage power grid via a local area transformer. The wind or solar power generator may be located somewhere in the local power grid. The households of a street or of a local area network which are interconnected to form the local power grid described here may all have a wind or a solar power generator, but this is no requirement. Any or even all wind and solar power generators integrated into the local power grid described here may be arranged remote from the individual households.

Preferred further developments of the invention result from the claims, the description and the drawings. Advantages of features and of combinations of several features mentioned in the introductional part of the description are only exemplary and may come into effect alternatively or cumulatively, without the necessity that the advantages have to be achieved by embodiments of the invention. Further features can be taken from the drawings - particularly from the depicted relative arrangement and operational connections of several parts. The combination of features of different embodiments of the invention and of features of different claims is also possible and is encouraged herewith. This also applies to such features which are depicted in separate drawings or mentioned in their description. These features may also be combined with features of different claims.

SHORT DESCRIPTION OF THE DRAWINGS

In the following, the invention is further explained and described with reference to preferred exemplary embodiments illustrated in the drawings.

Fig. 1 shows a block diagram of a local power grid.

Fig. 2 is a flow diagram of a method of optimizing the power consumption in the local power grid according to Fig. 1.

Fig. 3 shows an input device for use in connection with the method according to Fig. 2.

Fig. 4 shows another embodiment of an input device for use in the method according to Fig. 2.

Fig. 5 shows a further embodiment of an input device for use in the method according to Fig. 2.

Fig. 6 shows a controllable actuation element mounted relative to a switch-on button of an individual consumer; and

Fig. 7 shows an adaptor comprising a three-phase AC power input and a single-phase AC power output.

DETAILED DESCRIPTION

Now referring in greater detail to the drawings, **Fig. 1** schematically depicts a local power grid 1 including (i) a group of consumers 2 to 7, (ii) a power generator 8, particularly a solar power generator, (iii) a grid connection point 9 at which the local power grid 1 is connected to a public power grid 10, and (iv) a central controller 11. The central controller 11 apportions electric power provided by the power generator 8 to the consumers 2 to 7 such that, for example, a maximum local consumption of this power is achieved, i.e. a power consumption without use of the public power grid 10. For this purpose, the central controller 11 comprises the following communication connections which are all made wireless here:

- a connection to the power meter 12 which measures the actual power of the power generator 8;
- a connection to a power meter 13 at the grid connection point 9 which comprises at least one consumption meter for electric power imported from the public power grid 10, but preferably comprises several consumption meters, and at least one feed-in meter for electric power from the power generator 8 fed into the public power grid 10;
- connections to single connectors 14 to 17 of the consumers 4 to 7 and to a double connector 18 of the consumers 2 and 3;
- a connection to an input unit 19 for user-definable advance notifications of the operation of the consumers 2 and 3; and
- a connection to the internet 42.

The internet 42 provides the controller 11 with access to (i) a data base 20 including information about the consumers 2 to 7, (ii) a source 21 of weather reports, and (iii) a source 22 of tariff information about power tariffs for importing electric power out of the public power grid 10. The single connectors 14 to 17 include measurement devices for measuring the consumption of electric power by the individual consumers 4 to 7. The consumption measurements are carried out at a high sample rate of at least 0.1 Hz. The consumption measurement values are transferred to the central controller 11. Further, the individual connectors 14 to 17 are switchable to convey or interrupt the power supply to the consumers 4 to 7. This switching of the power supply may take place at a low or at a high frequency, the latter for example in the sense of a phase-controlled modulation of an alternating current. The individual connectors 14 to 17 may also comprise measurement devices for other electric values of the consumers 4 to 7 besides the measurement devices for the consumption of the individual consumers 4 to 7. Further, a sensor 23 may be connected to an individual connector, like here to the individual connector 16, to monitor further physical values of the consumers 6, like for example the temperature in the interior of a refrigerator. Additionally, an input unit 24 via which the user of the consumer 7 may make advance notifications of the operation of the consumer 7 may be connected to an individual connector like here to the individual connector 17. It belongs to this option that the user demands a direct availability of the consumer 7 to be able to directly switch it on independent of the plan of apportioning electric power of the power generator 8 by the central controller 11. The double connector 18 for the consumers 2 and 3 basically is a doubled single connector for two consumers in which the measurement devices are used for both consumers 2 and 3 connected. The double connector 18 may allow for the operation of one or both consumers 2 and 3 at one point in time. An input device 19 which directly communicates with the central controller 11 but which could also communicate with the central controller 11 via the double connector 18 is provided for user-definable advance notifications of the operation of the consumers 2 and 3. Actuation elements 25 for switch-on buttons 26 are mounted to the consumers 2 and 3 which are here controlled by the input unit 19 but which could also be directly controlled by the central controller 11 or via the double connector 18. The actuation elements 25 allow for purposefully activating the consumers 2 and 3, when their activation via simply apportioning electric power is not possible. Another activation mechanism than via simply switching on the current is carried out in case of the consumer 5 in that the central controller 11 communicates via the single connector 15 with the controller 27 of the consumer 5 and thus initiates a start or an interruption of its operation at a point in time determined by the central controller 11. Such a controller 27 comprising an interface for external communication is part of many but not of all, particularly not of old household equipment. By switching the single connectors 14 to 17 or the double connector 18, respectively, and by operating the actuation elements 25 for switch-on buttons 26, the central controller may, however, also control the time curve of the consumption of consumers without such a controller 27. Further consumers 43 which are only exemplarily depicted here, may be supplied with electric power in the power grid 1 via further single connectors 44 without own measurement or control facilities. The time curve of the power consumed by these consumers is represented by the time curve of the data of the power meters 9 and 12 and may thus also be considered in the method which will be described now in further detail with reference to Fig. 2.

Fig. 2 illustrates a method according to which the central controller 11 according to Fig. 1 may operate to achieve its goal of a maximum local consumption of the power supplied by the power generator 8 with minimum utilization of the public power grid 10. The central controller 11 at first measures the consumption of electric power by the individual consumers. This is done at a sample rate of at least 0.1 Hz; even considerably higher sample rates may be used. Sample rates of at least 100 Hz, i.e. once per half wave of a usual alternating current which flows in the respective power grid, or sample rates even in the kHz range are preferred. The consumption measurements are used to determine characteristic time curves of the consumption of electric power by the individual consumers. These characteristic time curves determine the expected power consumption of the individual consumers at certain future points in time after being switched on, on the one hand, and they provide an option of identifying the individual consumers, on the other hand. For both aspects, a high temporal resolution of the time curves of the consumption is a considerable advantage. Based on an identification of a consumer due to the characteristic time curve of its consumption, it may be determined, which intervention options in the consumption of electric power by the individual consumers are available. Particularly, these intervention options can be downloaded from an external data base. This download may be based either on the characteristic time curve of the consumption of the individual consumer and/or on an identification code of the consumer entered by a user or supplied by a controller of the consumer. It belongs to the intervention options which are available for a consumer that the consumer is operated earlier than usual at a point in time at which more electric power is available than needed. In this way, for example, a generation of cold or heat actually needed later may be pre-executed. This pre-execution of the generation of cold or heat can be very reasonable if it shifts forward a power demand of the same consumer from a later point in time at which the power supplied by the power generator is limited. Refrigerators and freezers may be cooled down to a lower temperature than actually needed at present; however, it has to be avoided that the temperature in a refrigerator is lowered too much as it would otherwise result in an undesired formation of ice.

The characteristic time curves of the consumption of the individual consumers and the intervention options in these time curves form a basis for making a plan according to which the central controller apportions electric power to the individual consumers in a future period of time. Another basis of this plan is a prognosis of the power which will be supplied by the power generator over this future period of time. This prognosis is preferably also based on measurements, namely on measurements of the power of the generator, which are evaluated in combination with the associated weather situations (and in case of a solar power generator also in combination with the associated solar altitudes), and from which a chronological power developing prognosis for the future is derived considering up to date weather forecasts. The plan for the future apportionment of electric power may include an adaptation of the points in time at which the individual consumers are switched on as well as a deformation of the characteristic time curves of the consumption of electric power by the individual consumers. These measures may particularly be taken to not exceed the supply of electric power from the power generator by the power demand of individual consumers, not even for a short time, and particularly not by consumers with oscillating consumption of electric energy. In an ideal case, the local power grid is operated even without short time import of electric power from the public power grid. As deviations from the plan due to not forecasted weather changes as well as due to unplanned demands of operation of individual consumers by a user can not be excluded, it is continuously checked whether the desired result is successfully achieved, like for example an exclusive local consumption of electric power, by comparing the actual supply of electric power with the actual consumption of electric power. If this success is not achieved, the plan is updated.

Fig. 3 shows the front of the input device 24 according to Fig. 1. This front includes a first selector switch 28 for selecting an "AUTO" operation mode in which the associated consumer 7 is controlled by the central controller 11 or a "READY" operation mode independent on the central controller 11. Via a second selector switch 29, the associated consumer 7 may be switched on for a point in time to be determined by the central controller 11 in the "AUTO" operation mode, or directly started in the "READY" operation mode, respectively. A status display 30 allows for monitoring the input via the selector switches 28 and 29. A switch-on time display 31 indicates after which time or at which point in time the consumer will presumably be switched on by the central controller 11. With the aid of this switch-on time display, the user may also enter a time frame within which the consumer has to be started by the central controller 11.

Fig. 4 shows the front of an input device 32 for a refrigerator as a consumer. Here, the same selector switches 28 and 29 as in Fig. 3 are provided. The status display 30 is also comparable. In addition to the switch-on time display 31, however, there is a temperature display 33 by means of which the user may select the target temperature in the interior of the refrigerator and which may display the actual temperature of the refrigerator, and a door opening display 34 which indicates the status of a door opening sensor. Such a door opening sensor may also be used for switching on a backup or auxiliary illumination for the interior of the refrigerator, if the power supplied to the refrigerator is apportioned by the central controller in such a way that the power is only supplied at longer intervals. Further, the door opening sensor may be used for indicating that due to the heating up of the interior of the refrigerator as a result of the door having been open, the refrigerator will demand a supply of electric power shortly. The input device 32 may directly comprise a backup light source 35 for the interior of the refrigerator, a temperature sensor and the door opening sensor and thus be configured for being placed within the interior of the refrigerator. It is to be understood that the built-in temperature control of the respective refrigerator has to be adjusted to the lowest allowable temperature for enabling the central controller to take over the temperature control by means of the temperature sensor of the input device 32, and to both pre-cool below the target temperature and accept temporal small excesses of the target temperature.

Fig. 5 shows the front of the input device 19 according to Fig. 1, wherein this input device 19 is also configured to handle a third consumer or unit. Via a unit selector switch 36 the consumer may be selected for which a user demand or advance notification is entered. The selected switch-on time is indicated for each unit separately by the switch-on time display 31. The form of this display is basically the same one as in Fig. 4 but differs from that one in Fig. 3 designed as a linear time bar.

Fig. 6, at an enlarged scale, depicts one of the actuation elements 25 for a switch-on button 26 of a consumer according to Fig. 1. The actuation element 25 comprises a drive 37 which is controlled by the input device 19 here. The drive 37 may be an electric motor or a simple pre-loadable spring-loading mechanism. Upon triggering of its operation, i.e. by starting the motor drive or releasing the pre-loaded spring-loading mechanism, the actuation element 25 presses the switch-on button 26 at a point in time determined by the central controller 11 of Fig. 1 in order to, for example, start a washing machine which was pre-programmed by the user. During the execution of the program of the washing machine, the controller 11 may then purposefully limit the supply of electric power via the respective connector, like for example temporarily during a heating phase, in order to comply with its plan for apportioning electric power to the individual consumers.

Fig. 7 shows an individual connector 38 for an individual consumer which can be controlled by the central controller 11 according to Fig. 1 and which comprises all features as they have already been explained with regard to the single connectors 14 to 17 of Fig. 1. Further, the single connector 38 has the function of an adaptor 39 between a three-phase AC power input

40 and a single-phase AC power output 41. The phase line of the single-phase AC power output 41 is selectively switchable to one of the phase lines of the three-phase AC power input 40. Thus, the central controller may, by connecting a single-phase consumer to a certain phase of a three-phase AC current which is provided by the power generator, or by switching between different phases, avoid unbalanced loads which, in an extreme case, may have the result that electric power is fed into the public power grid 10 out of the local power grid 1 of Fig. 1 via one phase, while at the same time the local power grid 1 imports electric power from the public power grid 10 via another phase.

LIST OF REFERENCE NUMERALS

1	local power grid
2	consumer
3	consumer
4	consumer
5	consumer
6	consumer
7	consumer
8	power generator
9	grid connection point
10	public power grid
11	central controller
12	power meter
13	electric meter
14	single connector
15	single connector
16	single connector
17	single connector
18	double connector
19	input device
20	data base
21	source of weather reports
22	source of power tariffs
23	sensor
24	input device
25	actuation element
26	switch-on button
27	controller
28	selector switch
29	selector switch
30	status display
31	switch-on time display
32	input device

33 temperature display
34 door opening display
35 light source
36 unit selector switch
37 drive
38 single connector
39 adaptor
40 three-phase AC power input
41 single-phase AC power output
42 internet
43 consumer
44 single connector

CLAIMS

1. A method of optimizing a chronological developing of consumption of electric power by a group of different consumers (2 to 7) with regard to a supply of electric power including electric power from at least one wind or solar power generator (8),

- wherein a consumption of electric power by the individual consumer (2 to 7) is measured to determine characteristic time curves of the consumption of electric power by the individual consumers (2 to 7);
- wherein a prognosis of a chronological developing of the supply of electric power from the at least one power generator (8) is made for a future period of time;
- wherein a plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time is made based on the characteristic time curves of the consumption of electric power by the individual consumers (2 to 7) and adapted to the prognosis; and
- wherein electric power is apportioned to the individual consumers (2 to 7) according to the plan within the future period of time,

characterized in that the consumption of electric power by the individual consumers (2 to 7) is measured at a sample rate of at least 0.1 Hz.

2. The method of claim 1, wherein the consumption of electric power by the individual consumers (2 to 7) is measured at a sample rate of at least 1 Hz, particularly of at least 10 Hz or at least 100 Hz or at least 1 kHz.

3. The method of claim 1 or 2, wherein the apportionment of electric power to the individual consumers (2 to 7) according to the plan within the future period of time is adjusted at a clock rate of at least 0.1 Hz, particularly of at least 1 Hz or at least 10 Hz or at least 100 Hz.

4. The method of any of the preceding claims, wherein a sum of the consumption of electric power by a plurality of individual consumers (43) is measured by means of an electric meter (13).

5. The method of any of the preceding claims, wherein the consumption of electric power by at least one individual consumer (2 to 7) is measured at its single connector (14 to 17, 38) .

6. The method of any of the preceding claims, wherein the plan for apportioning electric power to the individual consumers (2 to 7) is continuously updated based on an actual supply of electric power from the at least one power generator (8) and on an actual demand of electric power by the individual consumers (2 to 7).

7. The method of any of the preceding claims, wherein further electric values of at least one individual consumer (2 to 7) are measured at its single connector (14 to 17, 38) and considered in updating the plan.

8. The method of any of the preceding claims, wherein further physical values of at least one individual consumer (2 to 7) are measured with sensors (23) and considered in updating the plan.

9. The method of any of the preceding claims, wherein apportioning electric power to the individual consumers (2 to 7) is executed via at least one switchable single connector for a single one of the individual consumers (2 to 7).

10. The method of any of the preceding claims, wherein apportioning electric power to the individual consumers (2 to 7) includes limiting the maximum consumable electric power for at least one individual consumer.

11. The method of claim 10, wherein limiting the maximum consumable electric power for the at least one individual consumer (2 to 7) is effected by means of pulse width modulation.

12. The method of claim 10 or 11, wherein apportioning electric power to the individual consumers (2 to 7) includes levelling the electric power consumed by at least one of the individual consumers (2 to 7) over at least a part of the future period of time by limiting the maximum consumable electric power for the at least one individual consumer (2 to 7) while substantially keeping the average electric power consumed by the least one individual consumers (2 to 7) identical to the average power consumed without levelling.

13. The method of any of the preceding claims, wherein apportioning electric power to the individual consumers (2 to 7) is effected by purposefully activating at least one individual

consumer by means of an actuation element (25) for a switch-on button (26) of the individual consumer mounted to the individual consumer.

14. The method of any of the preceding claims, wherein apportioning electric power to the individual consumers (2 to 7) is effected by accessing an interface of a controller (27) of at least one individual consumer.

15. The method of any of the preceding claims, wherein the plan includes distributing the supply of electric power from a three-phase supply to individual single-phase consumers over the three phases of the three-phase supply.

16. The method of any of the preceding claims, wherein intervention options with regard to the actual consumption of electric power by the individual consumers (2 to 7) are determined by accessing entries for the individual consumers in an external data base.

17. The method of any of the preceding claims, wherein characteristic time curves of the consumption of electric power by the individual consumers (2 to 7) are uploaded into an external data base (20) and/or downloaded from there via a bidirectional data base connection.

18. The method of any of the preceding claims, wherein the individual consumers (2 to 7) and/or their connection to a particular single connector (14 to 17, 38) are identified by means of their characteristic time curves of the consumption of electric power.

19. The method of any of the preceding claims, wherein the individual consumers (2 to 7) are surveyed for proper function by comparing their actual time curves of the consumption of electric power with their characteristic time curves of the consumption of electric power.

20. The method of any of the preceding claims, wherein a basic consumption prognosis is made, that corresponds to the characteristic time curve of a consumption of electric power by all those consumers whose consumption of electric power is not limited, and that the basic consumption prognosis is considered when making the plan for apportioning electric power to the individual consumers.

21. The method of any of the preceding claims, wherein the prognosis of the chronological developing of the supply of electric power from the at least one power generator (8) is made on the basis of weather forecasts.

22. The method of claim 21, wherein at least one consumer (2 to 7) or power generator (8) is shut down in case of thunderstorm warnings.

23. The method of any of the preceding claims, wherein a further prognosis of a chronological developing of conditions of importing electric power from a public power grid (10) is made for the future period of time, and wherein this further prognosis is considered in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

24. The method of any of the preceding claims, wherein a further prognosis of a chronological developing of conditions of feeding electric power into the public power grid (10) is made for the future period of time, and wherein this further prognosis is considered in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

25. The method of claim 24 or 25, wherein potential effects of an achievement of a same result in an alternative way under other conditions of the import of electric power from the public power grid (10) and/or the feeding of electric power into the public power grid (10) are determined for the future period of time or for a past period of time.

26. The method of any of the preceding claims, wherein a further prognosis of a chronological developing of conditions of buffering electric power in a storage for electric energy is made for the future period of time, and wherein this further prognosis is considered in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

27. The method of any of the preceding claims, wherein a further prognosis of a chronological developing of conditions of transferring electric power to and from at least one other group of consumers and/or power generators is made for the future period of time, and

wherein this further prognosis is considered in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

28. The method of any of the preceding claims, wherein a further prognosis of a chronological developing of conditions of an achievement of a same result in an alternative way by another existing consumer or power generator or another existing device is made for the future period of time, and wherein this further prognosis is considered in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

29. The method of claim 29, wherein the same result is the provision of heating power.

30. The method of any of the preceding claims, wherein potential effects of an achievement of a same result in an alternative way by another presently not existing consumer or power generator or another presently not existing device are determined for the future period of time or a past period of time.

31. The method of any of the preceding claims, wherein user-defined advance notifications of the operation of at least one individual consumer (2 to 7) within the future period of time are considered in making the plan for apportioning electric power to the individual consumers (2 to 7).

32. The method of any of the preceding claims, wherein different priorities of the individual consumers (2 to 7) within the future period of time are considered in making the plan for apportioning electric power to the individual consumers (2 to 7).

33. The method of claim 33, wherein the different priorities are defined as different weighting factors for the consumption of electric power by the individual consumers, and wherein a sum of such weighted consumptions are limited or minimized when making the plan for apportioning electric power to the individual consumers (2 to 7).

34. An apparatus for optimizing the chronological developing of consumption of electric power by a group of different consumers (2 to 7) with regard to a supply of electric power including electric power from at least one wind or solar power generator (8), the apparatus comprising:

- measurement devices for determining time curves of a consumption of electric power by the individual consumers (2 to 7); and
- a central controller (11) for apportioning electric power to the individual consumers, the central controller (11) being configured to
    - determine characteristic time curves of the consumption of electric power by the individual consumers,
    - make a prognosis of a chronological developing of the supply of electric power from the at least one power generator (8) for a future period of time,
    - make a plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time based on the characteristic time curves of the consumption of electric power by the individual consumers (2 to 7) and adapted to the prognosis, and
    - apportion electric power to the individual consumers (2 to 7) according to the plan within the future period of time,

characterized in that the measurement devices are configured to measure the consumption of electric power by the individual consumers (2 to 7) at a sample rate of at least 0.1 Hz.

35. The apparatus of claim 34, wherein the measurement devices are configured to measure the consumption of electric power by the individual consumers (2 to 7) at a sample rate of at least 1 Hz, particularly of at least 10 Hz or at least 100 Hz or at least 1 kHz.

36. The apparatus of claim 34 or 35, wherein the central controller adjusts the apportionment of electric power to the individual consumers (2 to 7) according to the plan at a clock rate of at least 0.1 Hz, particularly of at least 1 Hz or at least 10 Hz or at least 100 Hz, within the future period of time.

37. The apparatus of any of the claims 34 to 36, wherein the measurement devices comprise an electric meter (13) configured to measure a sum of consumption of electric power by a plurality of individual consumers (43).

38. The apparatus of any of the claims 34 to 37, wherein the measurement devices measure the consumption of electric power by at least one individual consumer (2 to 7) at its single connector (14 to 17, 38).

39. The apparatus of any of the claims 34 to 38, wherein a further measurement device (12) is provided which measures the actual supply of electric power from the at least one power generator (8), and wherein the central controller (11) continuously updates the plan for apportioning electric power to the individual consumers (2 to 7) based on the actual supply of electric power from the at least one power generator (8) and on the actual consumption of electric power by the consumers (2 to 7).

40. The apparatus of any of the claims 34 to 39, wherein the measurement devices measure further electric values of at least one individual consumer (2 to 7) from its single connector (14 to 17, 38), and wherein the central controller (11) considers these further electric values in making and/or updating the plan for apportioning electric power to the individual consumers (2 to 7).

41. The apparatus of any of the claims 34 to 40, wherein the measurement devices include sensors (23) to be mounted to at least one of the individual consumers (2 to 7) to measure further physical values of the consumer (2 to 7), and wherein the central controller (11) considers these further electric values in making and/or updating the plan for apportioning electric power to the individual consumers (2 to 7).

42. The apparatus of any of the claims 34 to 41, comprising at least one switchable single connector (14 to 17, 38) via which the central controller (11) apportions electric power to a single one of the individual consumers (2 to 7).

43. The apparatus of claim 42, wherein the single connector (14 to 17, 38) is switchable at a high frequency to limit the maximum power which may be consumed by the single individual consumer (2 to 7) by means of pulse width modulation.

44. The apparatus of claim 42 or 43, wherein the single connector (14 to 17, 38) includes a switchable socket or a switchable socket adaptor comprising a communication interface for communicating wirelessly or via Power Line Communication.

45. The apparatus of any of the claims 34 to 44, comprising at least one controllable actuation element to be mounted to one of the individual consumers (2 to 7) for pressing its switch-on button (26).

46. The apparatus of any of the claims 34 to 45, wherein the central controller (11) comprises an interface via which it communicates with at least one interface of a controller (27) of one of the individual consumers (2 to 7).

47. The apparatus of any of the claims 34 to 46, comprising at least one adaptor (39) comprising a three-phase AC power input (40) and at least one single-phase AC power output (41) that is selectively switchable by the controller (11) to different phases of the AC power input.

48. The apparatus of any of the claims 34 to 47, wherein the central controller (11) comprises an interface via which it accesses an external data base (20).

49. The apparatus of any of the claims 34 to 48, wherein the central controller (11) comprises an interface via which it accesses the internet.

50. The apparatus of any of the claims 34 to 49, wherein the central controller (11) comprises an interface for receiving weather forecasts.

51. The apparatus of any of the claims 34 to 50, wherein the central controller (11)

- comprises an interface for receiving conditions of importing electric power from a public power grid (10) and
- is configured to
    - make a further prognosis of a chronological developing of the conditions of importing electric power from the public power grid (10) for the future period of time and
    - consider this prognosis in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

52. The apparatus of any of the claims 34 to 51, wherein the central controller (11)

- comprises an interface for receiving conditions of buffering electric power in a storage device for electric energy, and

- is configured to
  - make a further prognosis of a developing of the conditions of buffering electric energy in the storage device for the future period of time, and
  - consider this prognosis in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

53. The apparatus of claim 52, wherein the interface is configured to receive the conditions of buffering electric power in the storage device for electric energy from an energy management device of the storage device.

54. The apparatus of any of the claims 34 to 53, wherein the central controller (11)

- comprises an interface configured to interconnect with at least one further similar apparatus, and
- is configured to
  - exchange prognoses of chronological developings of the supply and/or the consumption of electric power for the future period of time with the at least one further similar apparatus via this interface, and
  - consider these prognoses in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

55. The apparatus of claim 54, wherein the central controller (11)

- also exchanges conditions of a transfer of electric power to inform the at least one further similar apparatus via the interface, and
- is configured to
  - make a further prognosis of a chronological developing of the conditions of the transfer of electric power to and from the at least one further similar apparatus for the future period of time and
  - to consider this prognosis in making the plan for apportioning electric power to the individual consumers (2 to 7) within the future period of time.

56. The apparatus of any of the claims 36 to 55, comprising at least one input unit (19, 24, 32) configured to accept user-defined advance notifications of the operation of at least one of the individual consumers (2 to 7), and to communicate with the central controller (11).

57. The apparatus of any of the claims 36 to 56, comprising at least one display unit configured to display the plan for apportioning electric power to the individual consumers (2 to 7) and/or an availability of electric power from the at least one power generator (8) which is not yet used according to the plan.

58. A local power grid (1) comprising an apparatus of any of the claims 34 to 57, a group of different consumers (2 to 7), and at least one wind or solar power generator (8).

59. The local power grid of claim 58, wherein a bidirectional grid connection point (9) connecting the local power grid to a public power grid (10) comprises a feed-in meter for electric power fed from the local power grid into the public power grid (10), and at least one consumption meter for electric power imported from the public power grid (10) into the local power grid.

60. The local power grid of claim 59, wherein the bidirectional grid connection point (9) to the public power grid (10) is a household connection point, a distribution point or a local transformer.

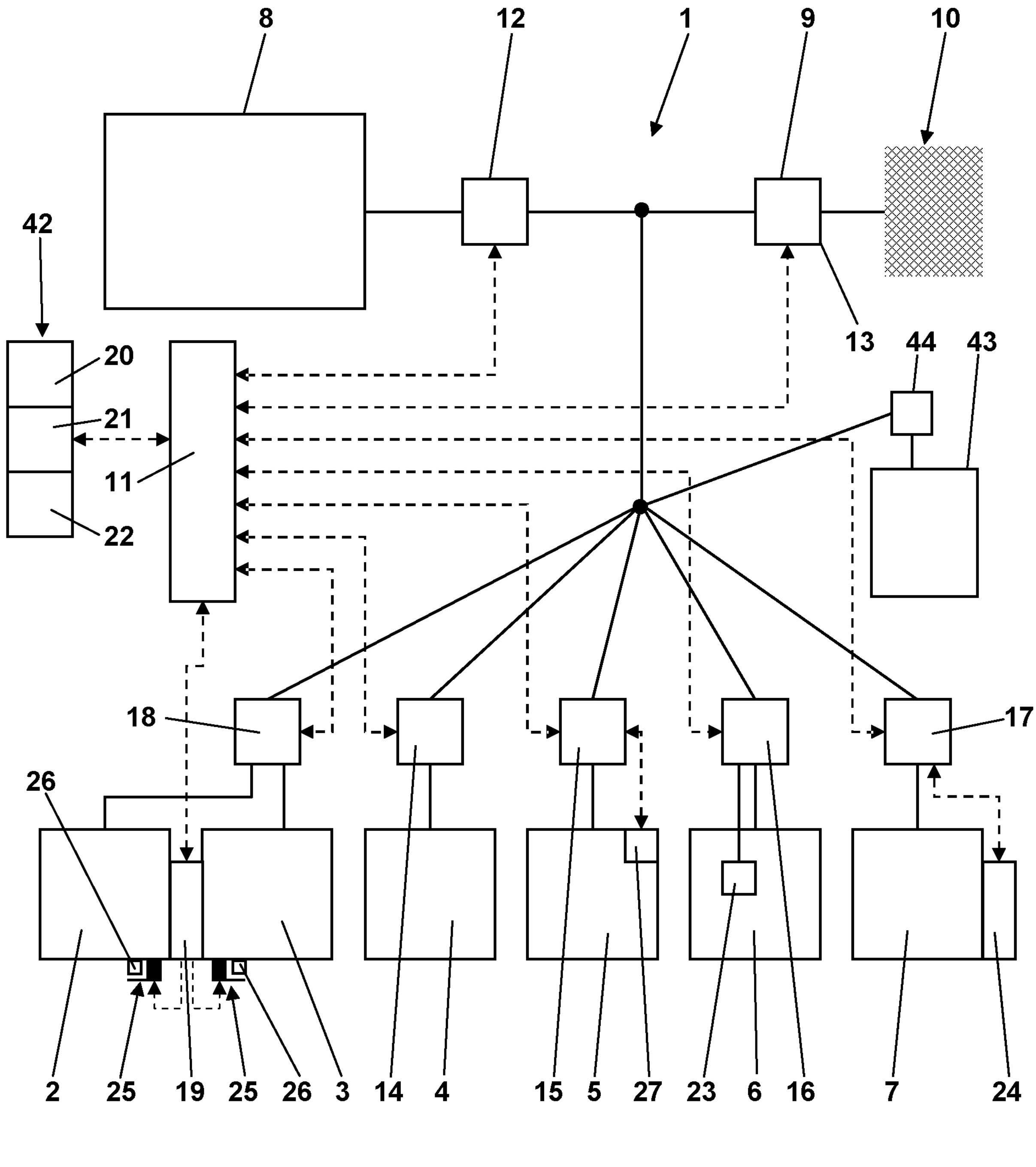
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Fig. 1

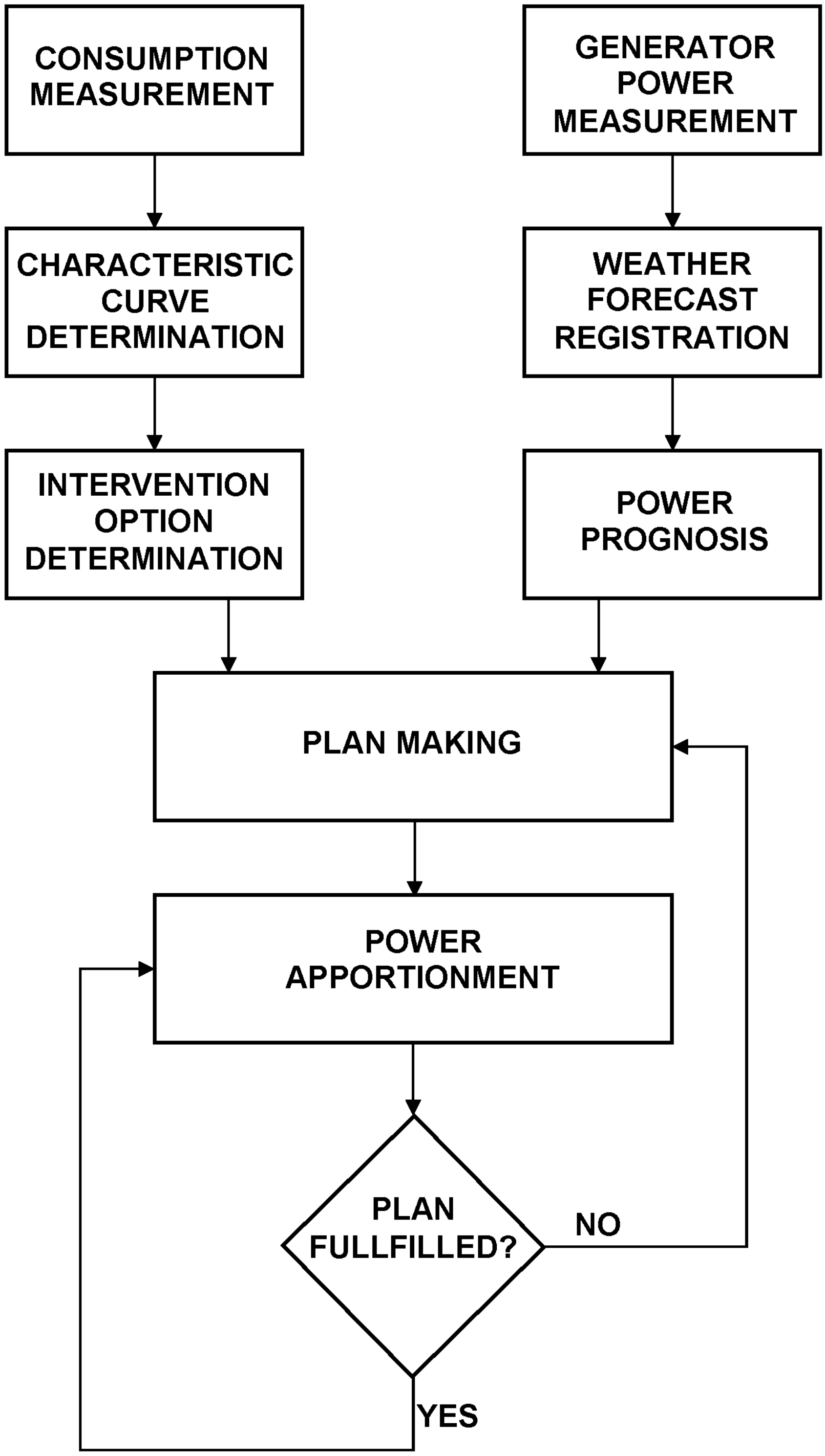
CONSUMPTION MEASUREMENT
GENERATOR POWER MEASUREMENT
CHARACTERISTIC CURVE DETERMINATION
WEATHER FORECAST REGISTRATION
INTERVENTION OPTION DETERMINATION
POWER PROGNOSIS
PLAN MAKING
POWER APPORTIONMENT
PLAN FULLFILLED?
NO
YES

Fig. 2

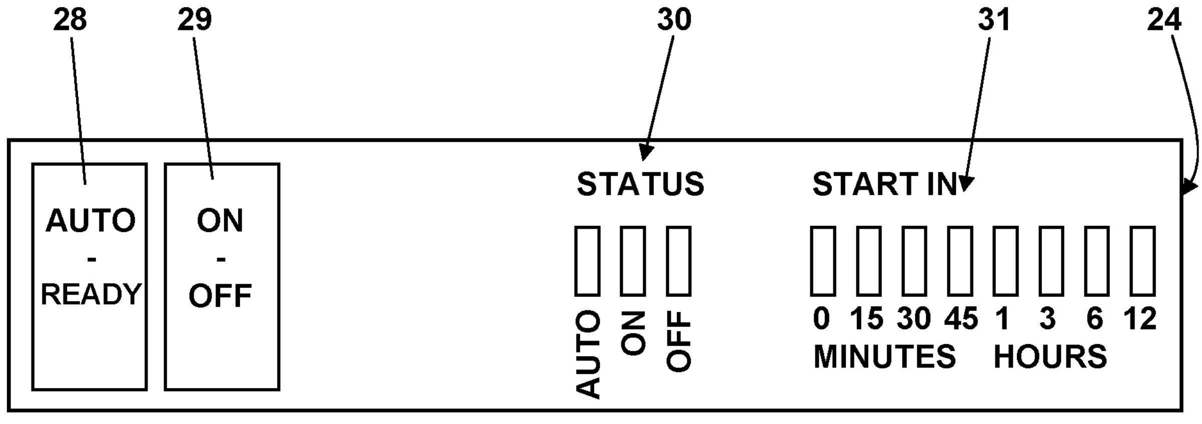

Fig. 3

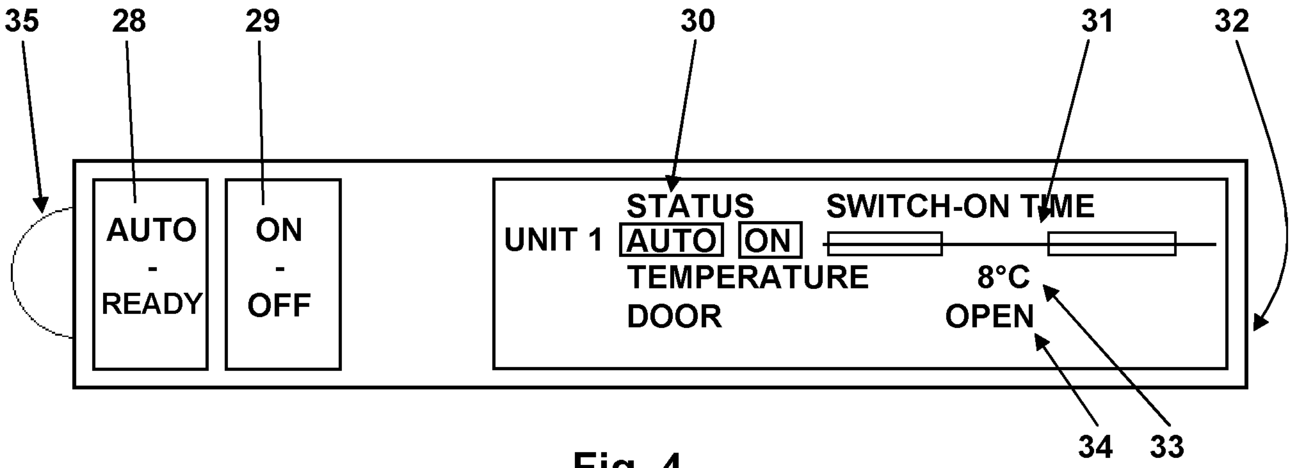

Fig. 4

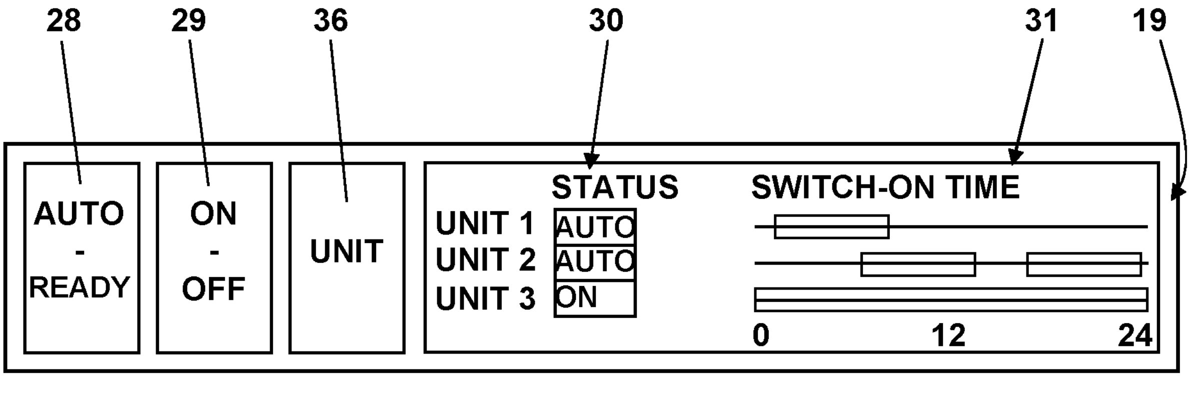

Fig. 5

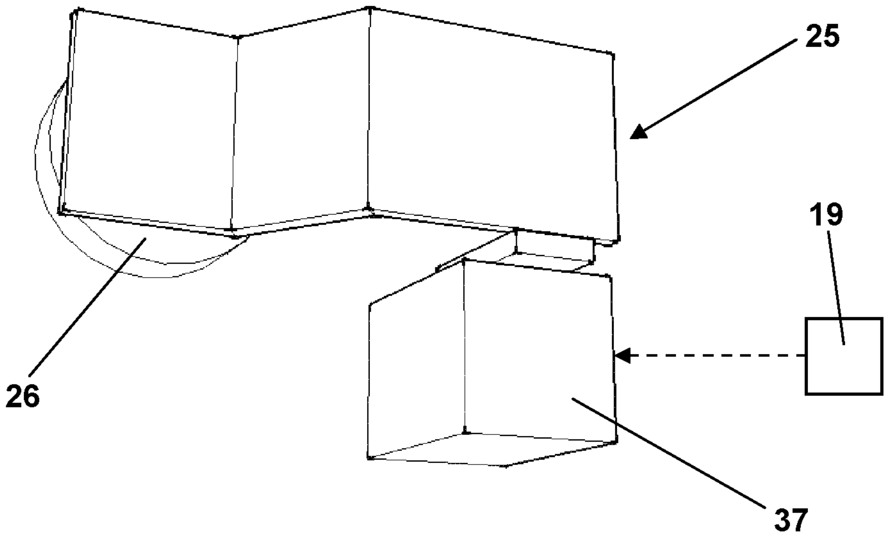

Fig. 6

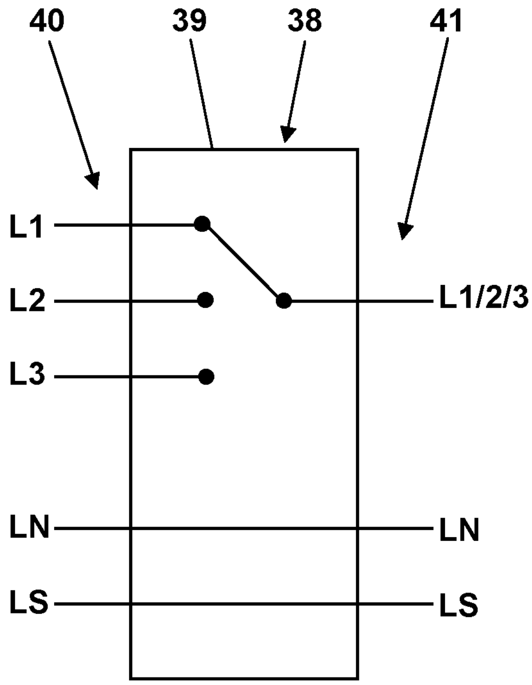

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/056423

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02J1/14 H02J3/28 H02J13/00
ADD.

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)
H02J

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 10 2008 037575 A1 (ENBW EN BADEN WUERTTEMBERG AG [DE]) 29 July 2010 (2010-07-29) the whole document -----	1,34
A	DE 10 2009 010117 A1 (BREUNING PETER [DE]; BUESSER JUERGEN [CH]; RUTTER JOHANNES [DE]) 2 September 2010 (2010-09-02) abstract paragraph [0032] paragraph [0032] - paragraph [0032] -----	1,34
A	US 4 620 283 A (BUTT JAMES A [US] ET AL) 28 October 1986 (1986-10-28) abstract -----	1,34

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"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
25 July 2012	02/08/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Poth, Hartwig

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2012/056423

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102008037575 A1	29-07-2010	DE 102008037575 A1 EP 2359453 A2 WO 2010057947 A2	29-07-2010 24-08-2011 27-05-2010
DE 102009010117 A1	02-09-2010	NONE	
US 4620283 A	28-10-1986	NONE	