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Method for load management for thermal loads or for generators

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Abstract

With the conventional control function, load management for thermal loads is based on a fixed parameterization which relates to statistical analysis of the measured loads over e.g. the last half-year or last quarter. This fixed parameterization takes the relevant outdoor temperatures into account only inadequately or not at all. To overcome this disadvantage, a method is proposed wherein

- each local unit (LU) is connected to a temperature sensor and an energy consumption meter and temperature values are recorded over a day by means of the temperature sensor;
- a predefined control output and a charging time are set as a function of the temperature value determined;
- the control output and charging time set are transmitted via the ripple control transmitter (RS) to the thermal loads in order to supply them with power accordingly.

The invention can also be used for connecting generators.

Fig. 2

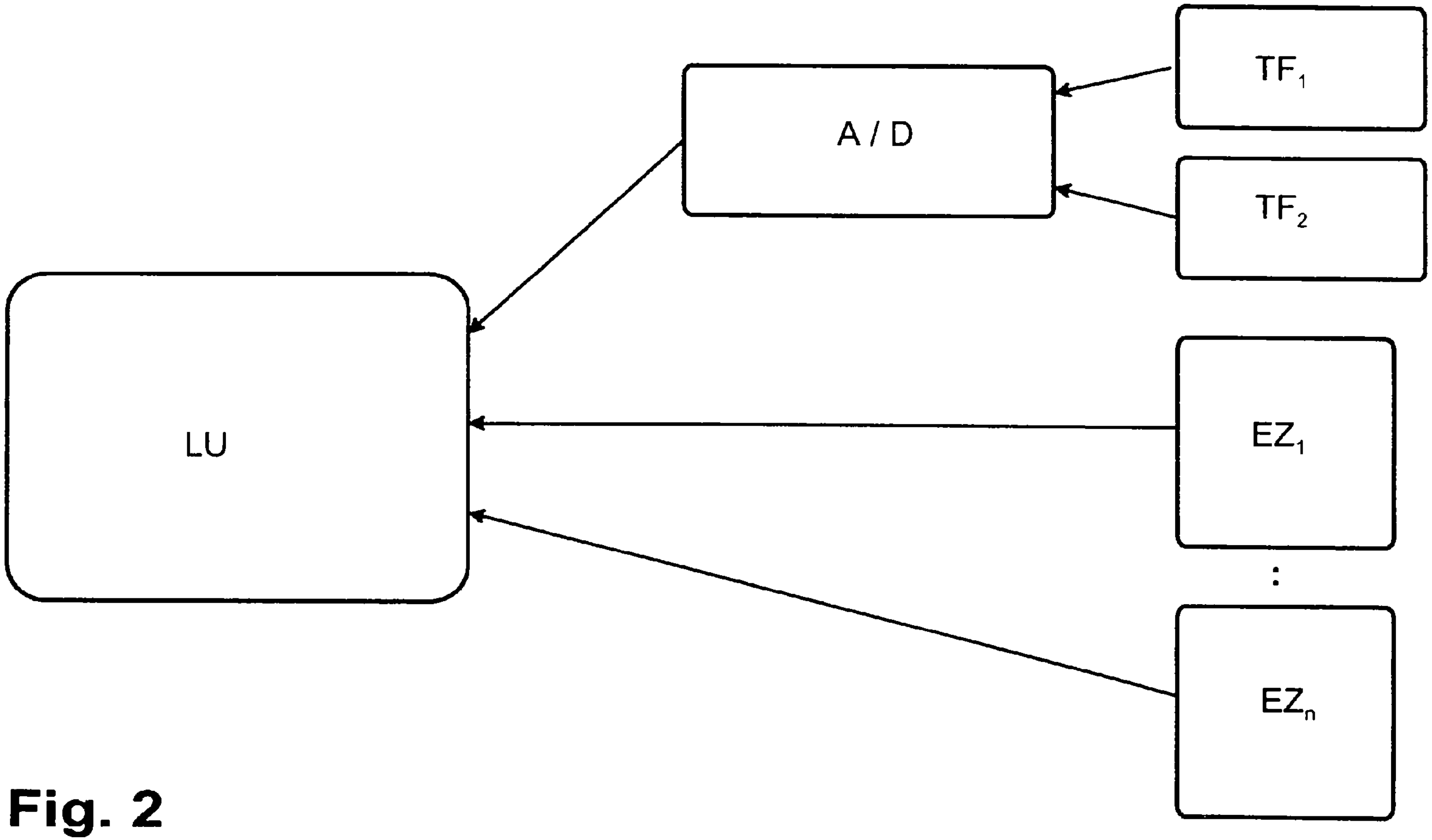

Fig. 2

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COMPLETE SPECIFICATION

Standard Patent

Applicant(s):

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Invention Title:

Method for load management for thermal loads or for generators

The following statement is a full description of this invention, including the best method for performing it known to me/us:

Method for load management for thermal loads or for generators

The present invention relates to a method for load management for thermal loads as claimed in the pre-characterizing clause of claim 1 and for load management for a generator as claimed in the pre-characterizing clause of claim 7.

Storage heaters are charged using off-peak electricity as a function of the outdoor temperature. Ripple control load management determines the charging times automatically and prevents any overloading in the electricity supply network, the charging times being calculated manually by the utility company and parameterized accordingly in a fixed manner for ripple control. An example of such fixed charging times LG_{dn} is shown in Figure 4: the charging times are fixed over the weekdays d and for each weekday over the hours t for a particular load group LG with subscript n. Figure 4 shows just one example with LG_{dn}. A load group can of course also be charged intermittently per day. The term load group encompasses all the loads that can be switched in or out by a ripple control signal. The main components of a ripple control system are the command unit, ripple control transmitter, transmission network (=power grid), and ripple control receiver at the load. The components are generally known from the prior art and for simplicity's sake will simply be referred to in the following description in terms of commands being sent via the ripple control transmitter to the (thermal) loads so that these can be supplied with power accordingly. Such ripple control systems and transmitters are disclosed in publications EP 0 729 213 B1 und EP 0 738 033 B1.

This fixed parameterization is based on statistical analysis of the loads measured e.g. over the last half-year or last quarter. The periods are typically:

1st period	September to November
2nd period	December to February
3rd period	March to May
4th period	June to August

This rigid setting suffers from operational disadvantages.

Currently known systems are not capable of performing dynamic instead of fixed parameterization, and in particular of performing charging geared to the temperatures currently obtaining.

The object of the present invention is therefore to specify a method for temperature-dependent load management for thermal loads of an electricity supply network for different load groups such as storage heaters or boilers which eliminates the above-mentioned shortcomings, said method operating automatically and therefore no longer requiring the earlier manual interventions. The object of the present invention is also to specify a method for production-dependent load management for a generator.

This object is achieved for the load by the measures set forth in claim 1, whereas the parallel object for a generator is achieved by the features set forth in claim 7.

The present invention enables the thermal loads assigned to a load group to be supplied with power on a locally temperature-dependent basis. In addition, a dynamic and automatically operating method is created thanks to the quasi locally measured temperature.

For the generator case, which includes in particular generators which are «driven», i.e. supplied with power, by so-called renewable or alternative energy sources, a method is created which, using existing infrastructure such as ripple control, enables non-centralized generators to be switched into a subnetwork when said generators are able to supply power to said subnetwork.

Advantageous embodiments of the invention are set out in further claims. Thus, for example, the availability of the method according to the invention is significantly increased by assigning two temperature sensors per local unit, the values being detected independently of one another and being fed to the local unit as separate values.

For the generator switch-in scenario, the sensors can be embodied in such a way that they accurately detect the external factors influencing energy generation, such as wind/wind direction and incidence of light.

The invention will now be explained in greater detail with reference to the accompanying drawings, in which:

Figure 1 shows the software structure in a local unit illustrated in Figure 1;
Figure 2 shows the peripheral components connected to a local unit;
Figure 3 shows an example of the load characteristic, specifying the charging times for a load group;
Figure 4 shows load management according to the prior art;
Figure 5 shows load management according to a preferred embodiment of the present invention.

The basic units for implementing a preferred embodiment of the present invention will be explained with reference to Figures 1 and 2, namely:
- a plurality of local units LU which are in turn connected to at least one ripple control transmitter RS.

The exemplary embodiment will first be related to the case of thermal loads. The local units LU are usually connected to two temperature sensors TF_1, TF_2 via an analogue/digital converter A/D, see Figure 2. It should be noted here that the local units LU are geographically distributed and measure the temperature in their supply area. The local units LU are connected to a plurality of energy consumption meters EZ_1, .. Ez_n which are read in a fixed time pattern, e.g. every 15 min, see likewise Fig. 2.

The temperature values and power consumption values recorded by the local units LU have the structure shown by way of example in Table 1.

Station name	Date	Time	Temperature °C	Energy consumption meter 1 (KWh)	Energy consumption meter 2 (KWh)
Belp	19.06.2006	00.00	3	100	200
Belp	19.06.2006	00.15	3	100	200
.	.	.	.	.	.
Belp	19.06.2006	23:45	3	100	300

Table 1: Data captured by a local unit LU.

The thermal loads are assigned to a load group. A load group, i.e. loads which can be switched in or disconnected using a ripple control signal, can be defined via the relevant charging power. If the loads are storage heaters, the term charging group is used as a set of a load group. For charging groups, load management is to be controlled as a function of the daily mean temperature of the previous day. This control has three components:

1. Controlling the total daily charging time of each charging group.

2. Setting the charging power of a charging group to one of e.g. four predefined control outputs, such as 100%, 80%, 60%, 40%.

3. Enabling or blocking supplementary power.

The functions implemented in the local units LU are as follows:

a) Substation control functions

Substation control is load management of the electric storage heaters using static switching blocks derived on the basis of years of empirical values. Supplementary control outputs, derived from the mean daily outdoor temperature, control the charging power. In addition, the heating is shut down completely in summer. The storage heater central heating systems have four thermostatic levels (40%, 60%, 80% and 100%). These are coarse levels. With a preferred embodiment of the present invention, substation control is replaced by dynamic load management. The switching blocks in their existing form are no longer used. The dynamic load management optimizes the load characteristic in relation to a specified maximum desired value (setpoint value). To detect the instantaneous load response and calculate the ¼h optimization, a meter pulse (= instantaneous power delivery) of the area to be controlled is required, either as a summation pulse or as a meter pulse of subareas which are then internally summed.

b) Parameters

The parameters of the substation control function are managed for each local control. For this purpose different charging groups are defined, e.g. 20.

Days of the week and special days (public holidays) are defined for each time program.

Using a separate process - see above - the mean daily outdoor temperature is measured, thereby generating the control output for the charging threshold, and also a blocking command.

The setpoint values are determined for each local unit area. Looked at in another way, a subarea of a supply area is referred to instead of a local unit area, each subarea being assigned a local unit LU. Load management adjusts energy transmission according to a wanted load in the network. This is input as a daily profile. For each load group or charging group, when and how it is available to load management is specified in a parameter set.

The mean temperature of the previous day is subdivided into a plurality of temperature ranges, e.g. 14. For each charging group a parameter set is defined for each of the defined temperature ranges. Depending on the temperature range, the corresponding parameter set of all the charging groups is activated. In addition, the control outputs for the thermostatic levels are sent depending on the temperature.

In the parameter sets, daily charging windows are specified for each charging instruction. Off-times, maximum and minimum on-times, etc. are parameterized therein.

c) Ripple control commands

The 20 load group or charging group commands for controlling the on- and off-times of the individual heating quantities (load packet) are consigned to load management using suitable parameterization:

- minimum on- and off-time,
- total on-time in the charging period as described above.

Two control output commands for controlling the charging power are additionally provided. Another blocking command for the supplementary energy is enabled via a sub-program depending on the mean outdoor temperature of the previous day and transmitted via a time instruction.

d) Temperature

For temperature-dependent control of the storage heaters, the temperature spectrum is subdivided into 12 ranges. Two other ranges mean: «Heating completely off» and «Heating maximum» (corresponds in function to the range -12.5° to -15°). This produces the above-mentioned total of 14 ranges.

Range	Temp. min.	Temp. max.	Level	Supplementary energy
1		-12.5 °C	100%	Enabled
2	-12.5 °C	-9.9°C	100%	Enabled
3	-9.9°C	-7.2°C	100%	Enabled
4	-7.2°C	-4.8°C	80%	Enabled
5	-4.8°C	-2.1°C	80%	Enabled
6	-2.1°C	0.5°C	80%	Enabled
7	0.5°C	3.0°C	60%	Enabled
8	3.0°C	5.8°C	60%	Enabled
9	5.8°C	8.2°C	60%	Enabled
10	8.2°C	10.8°C	40%	Enabled
11	10.8°C	13.4°C	40%	Enabled
12	13.4°C	16°C	40%	Enabled
13	16°C	23°C		Enabled
14	23°C			Blocked

Table 2: Typical subdivision of the temperature ranges.

Depending on the temperature, a different charging time of the charging groups, i.e. here the heaters, is applicable to load management. The temperature will therefore affect the parameter for the entire on-time of the charging groups. For example, the charging group 15h is only enabled for a total of 4h. This enables the quantity of energy to be dosed even more finely than the 4 levels permit by means of control output 1 and 2. Table 2 shows that at certain limits the load management parameter set changes. At other limits ripple control signals are triggered.

e) Switching blocks

The switching blocks contain the on- and off-times of each load packet over a day. The control output (=charging power) of the load packet is also defined in the switching block. The control output defines the charging power for the substation-controlled heater as a function of the temperature.

Switching blocks	Control output		Charging power
	1	2	
1 - 3	1	1	100%
4 - 6	0	1	80%
7 - 9	1	0	60%
10 - 12	0	0	40%

Table 3: Subdivision of switching blocks and assignment to charging power.

Like the blocking command, the control outputs are enabled via a subprogram by the mean temperature of the previous day. They are triggered via a time instruction.

e) Switching times

A maximum charging time is defined for each load packet and temperature range (switching block). This charging time is input in load management. For each temperature range a parameter set is defined which is enabled at the corresponding temperature and used by load management. The parameter sets of the other temperature ranges are blocked in each case. For example, this can be specified as follows: the shortest on-time must not be less than 30 min. No more than 6 switching times (enabling of charging) must be possible per day, of which 3 are AM and 3 are PM. This is in line with the requirements of the relevant power utility.

f) Load packet
The load packet size corresponds to the maximum power rating of the substation-controlled heaters of said load packet. Load management determines with which load packets LPx the nominal power can be optimally approximated to; a possible characteristic is shown in Figure 3. The totality of the power P = P(t) supplied via the relevant local LU over a day is additionally shown.

The present invention relates to thermal loads. However, the method according to the invention can also be applied to other load types using measured variables other than temperature.

The exemplary embodiment explained above can be transferred «mutatis mutandis» to the case where generators are present instead of thermal loads connected to a subnetwork, the term «subnetwork» introduced above being synonymous with the term «subarea» introduced in the introduction.

To this end a plurality of generators can be connected by means of a ripple control transmitter RS to a subnetwork which is generally defined via a smaller geographical region (= subarea).

Examples of generators:
- wind power plant, preferably installed on a hill;
- solar power plant.

To the substation LU there are connected, analogously to the temperature sensors, a plurality of sensors which measure the factors affecting power generation, i.e. according to the above-mentioned examples:

- wind strength, wind direction;
- brightness, incidence of solar radiation, incidence of light.

In the terminology of the first exemplary embodiment for loads, the generators are assigned to load groups. For each load group there are provided one or two sensors measuring the factors affecting power generation. So that the generators can be connected by the ripple control transmitters according to their current power generation depending on the consumption per subnetwork, the following method steps are executed:

i) physical measured values are recorded by each local unit LU by means of the sensors;

ii) energy consumption values are recorded in a fixed time pattern by means of the energy consumption meters EZ_1 .. EZ_n;

iii) for each load group there is determined as a function of the physical measured value recorded in method step i) and as a function of the energy consumption values recorded in method step ii):

- a predefined control output in the range 0% to 100% of the energy generation of the generators of the load group;
- a charging time for the load group;

iv) the control output determined in method step iii) and the defined charging time are transmitted via the ripple control transmitter RS to the generators in order to connect them accordingly to the relevant subnetwork.

The sensors are conventional wind measuring devices or light meters which measure wind strength and wind direction or the incidence of light.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

List of reference characters used, Glossary

A/D	Analogue/digital converter
CS	Cluster Service
Data-Anal	Data analysis
Data-Coll	Data collection
Data-Exp	Data export
DB	Database, Data Base File Server
DR	Duplex computer
EZ_1, .. Ez_n	Energy consumption meters
IP-Com	Interface unit for an IP connection of the local units LU
Java	User application in JAVA
LAZ	Long-term archiving
LP, LPx	Load packet
LU	Local Unit, generally subordinate to a CU, but with identical functionality; also termed substation
RS	Ripple control transmitter
TF_1, TF_2	Temperature sensors
TS	Terminal Server

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for load management for thermal loads in a supply area, wherein

- the supply area is subdivided into subareas;
- each subarea is assigned a local unit (LU) with an associated ripple control transmitter (RS);
- each local unit (LU) is connected to a temperature sensor (TF_1) and at least one energy consumption meter (EZ_1);
- each thermal load is assigned to a charging group;
- the thermal loads can be switched in or out via a ripple control transmitter (RS);

characterized by the following method steps

temperature values are recorded over a day by each local unit (LU) by means of the temperature sensor (TF_1);

ii) energy consumption values are recorded in a fixed time pattern by means of the energy consumption meters (EZ_1);

iii) for each charging group there is established as a function of a temperature values determined via method step i):

- a predefined control output in the range 0% to 100% of the charging power of the charging group;
- a charging time for the charging group;

iv) the control output established in method step iii) and the determined charging time are transmitted via the ripple control transmitter (RS) to the thermal loads in order to supply them with power accordingly.

2. The method as claimed in claim 1, characterized in that in method step iii) the values 100%, 80%, 60% and 40% are provided as predefined control outputs.

3. The method as claimed in claim 1 or 2, characterized in that
in method step ii) the fixed time pattern is 15 min.

4. The method as claimed in one of claims 1 to 3, characterized in that
in method step iii) a mean daily value is set for the temperature values determined in method step i).

5. The method as claimed in one of claims 1 to 3, characterized in that
in method step iv) a blocking command is additionally sent to each charging group for which a load above a specified limit value is determined, in order to shut down the thermal loads by means of this blocking command.

6. The method as claimed in one of claims 1 to 5, characterized in that
in method step i) two temperature sensors (TF_1) are provided for each local unit (LU), the measured values being fed to the local unit as separate values.

7. A method for load management for generators in a supply area, wherein

- the supply area is subdivided into subnetworks;
- each subnetwork is assigned a local unit (LU) with an associated ripple control transmitter (RS);
- each local unit (LU) is connected to at least one sensor and at least one energy consumption meter (EZ_1);
- each generator is assigned a load group;
- loads are connected in each subnetwork;

characterized by the following method steps
i) physical measured values are recorded by each local unit (LU) by means of the sensors;

ii) energy consumption values are recorded by means of the energy consumption meters (EZ_1) in a fixed time pattern;

iii) for each load group there is defined as a function of the physical measured value recorded in method step i) and as a function of the energy consumption value recorded in method step ii):

- a predefined control output in the range 0% to 100% of the energy generation of the generators of the load group;
- a charging time for the load group;

iv) the control output defined in method step iii) and the defined charging time are transmitted via the ripple control transmitter (RS) to the generators in order to connect them accordingly to the relevant subnetwork.

8. The method as claimed in claim 7, characterized in that as generators a solar cell plant is provided and the incidence of light is recorded as the physical variable in method step i).

9. The method as claimed in claim 7, characterized in that as generators a wind power plant is provided and wind strength and wind direction are recorded as the physical variable in method step i).

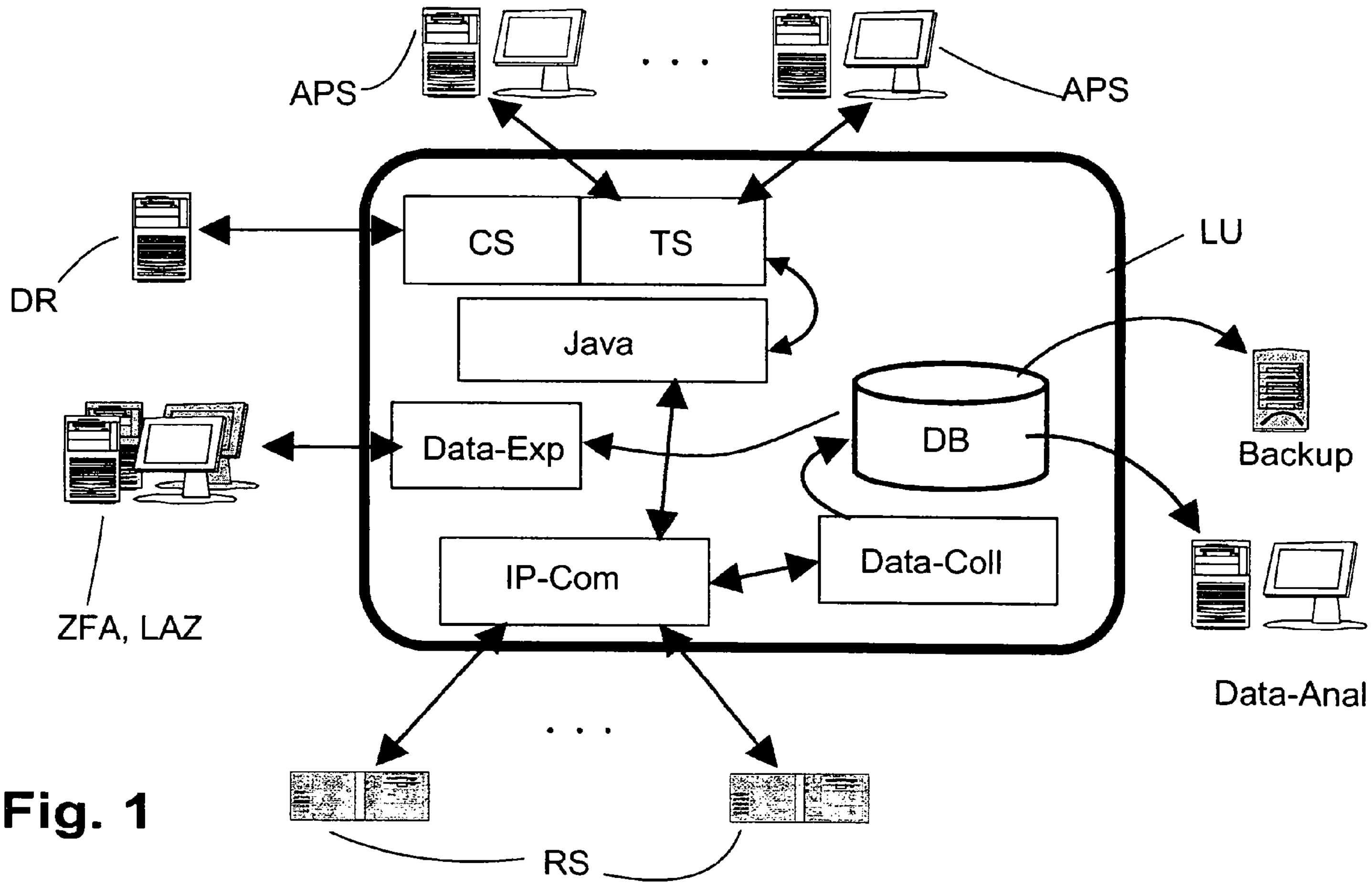
APS
APS
CS
TS
DR
LU
Java
Data-Exp
DB
Backup
IP-Com
Data-Coll
ZFA, LAZ
Data-Anal
RS

Fig. 1

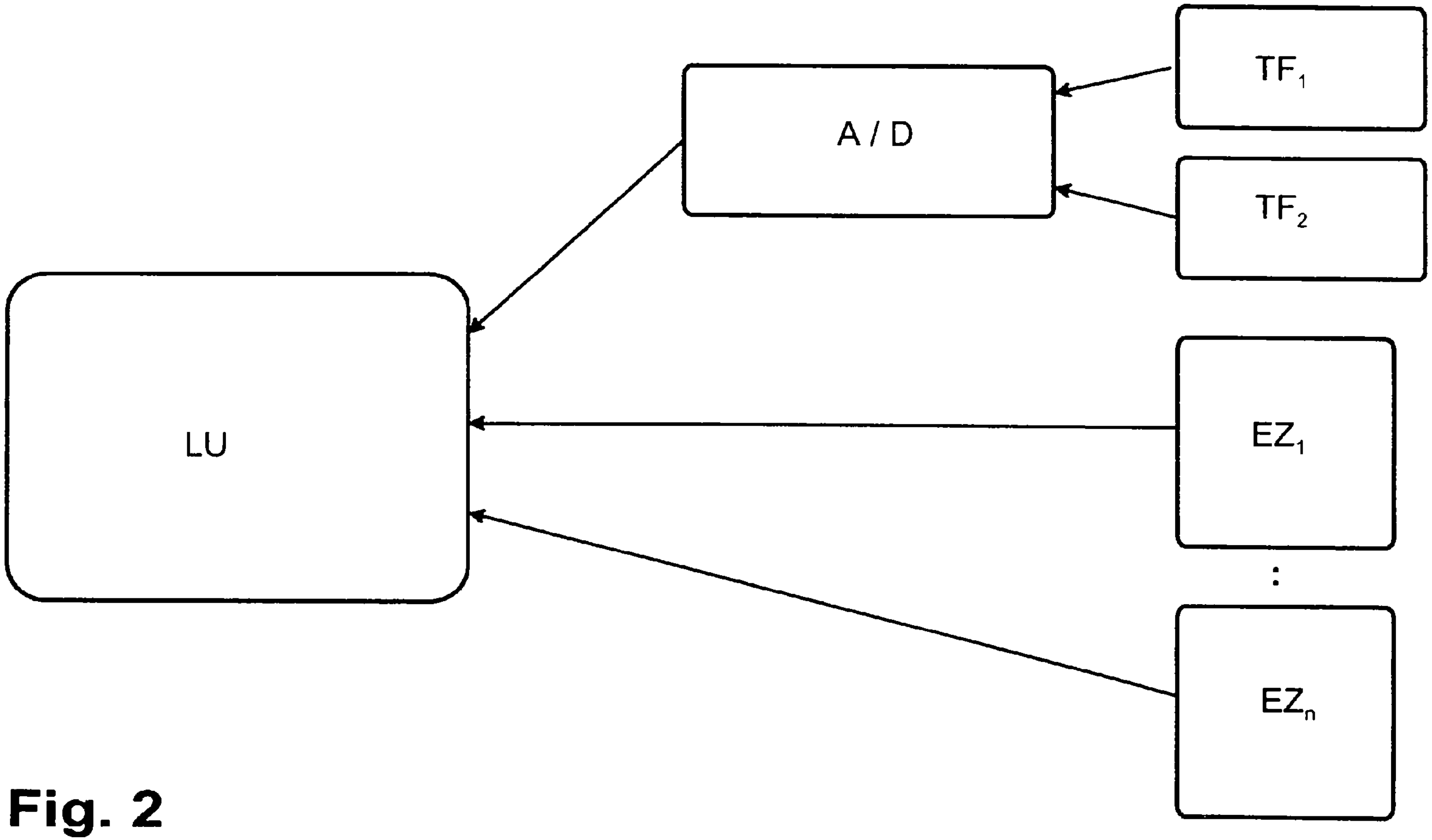

Fig. 2

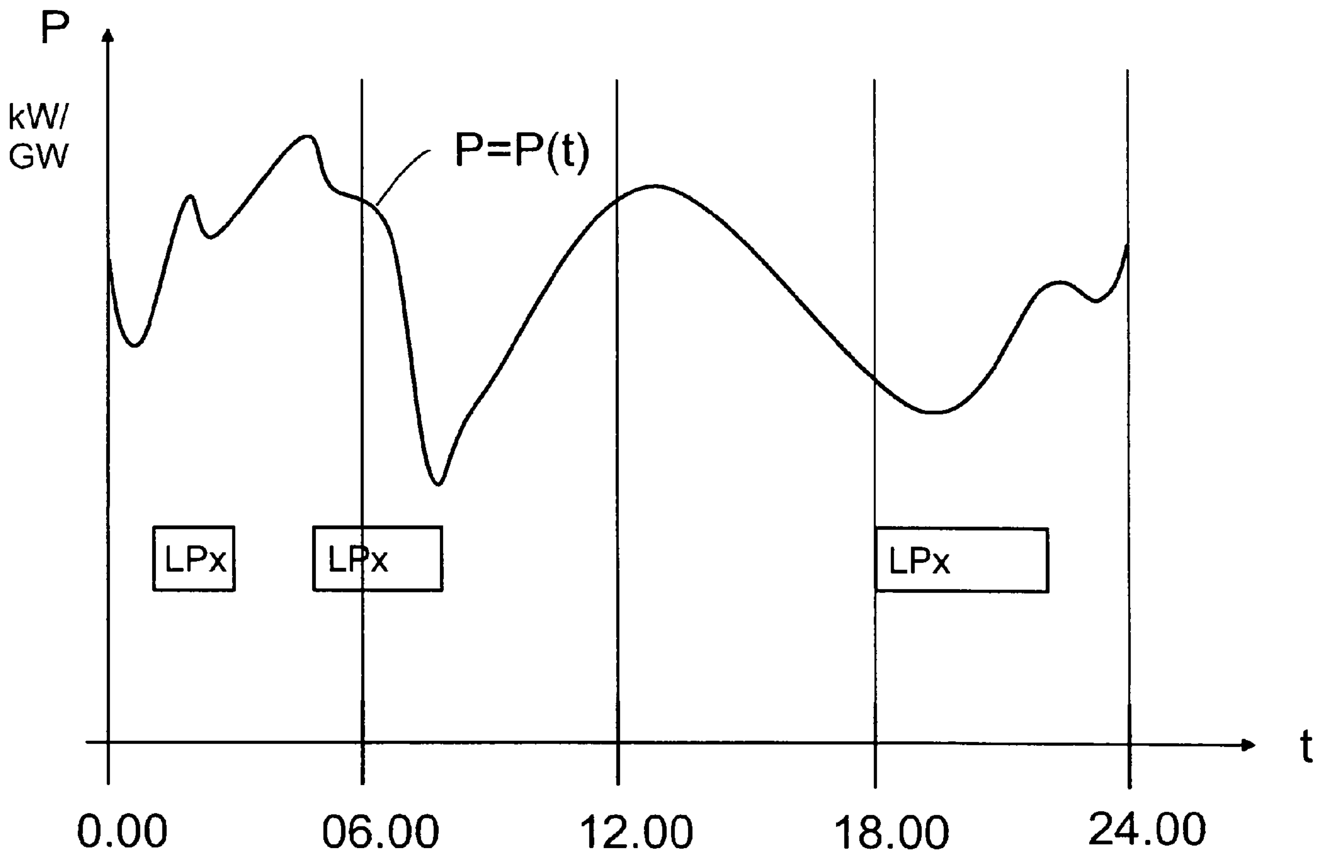

Fig. 3

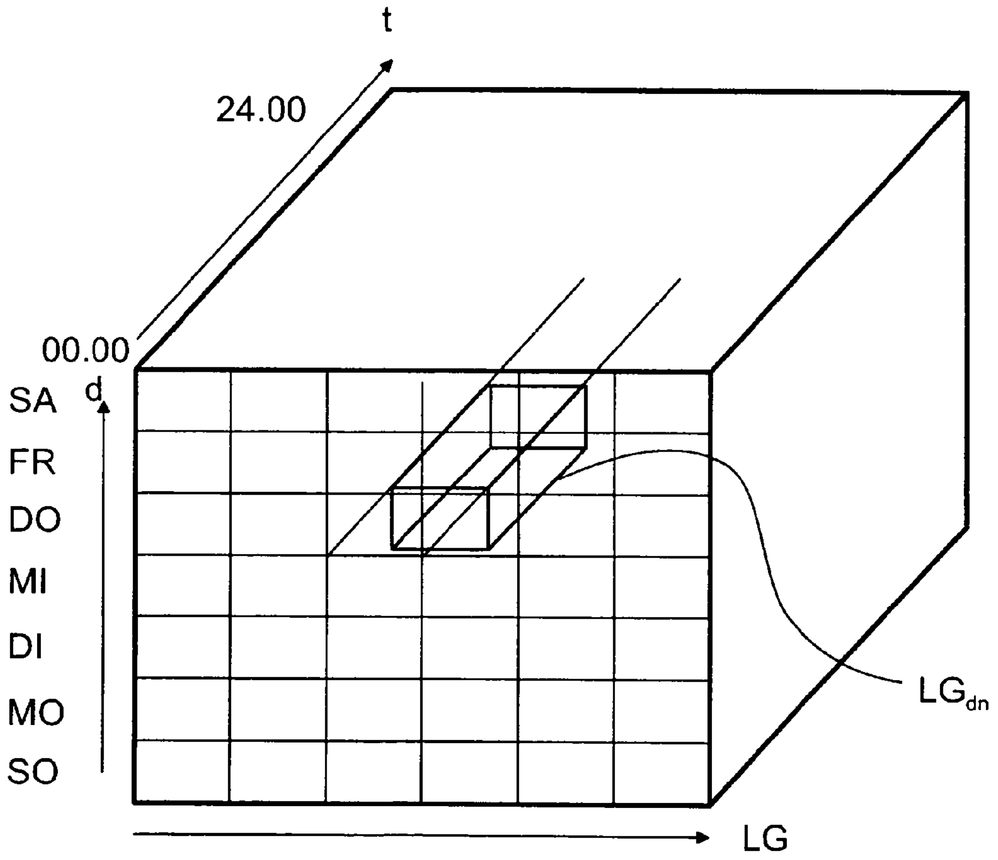

Fig. 4

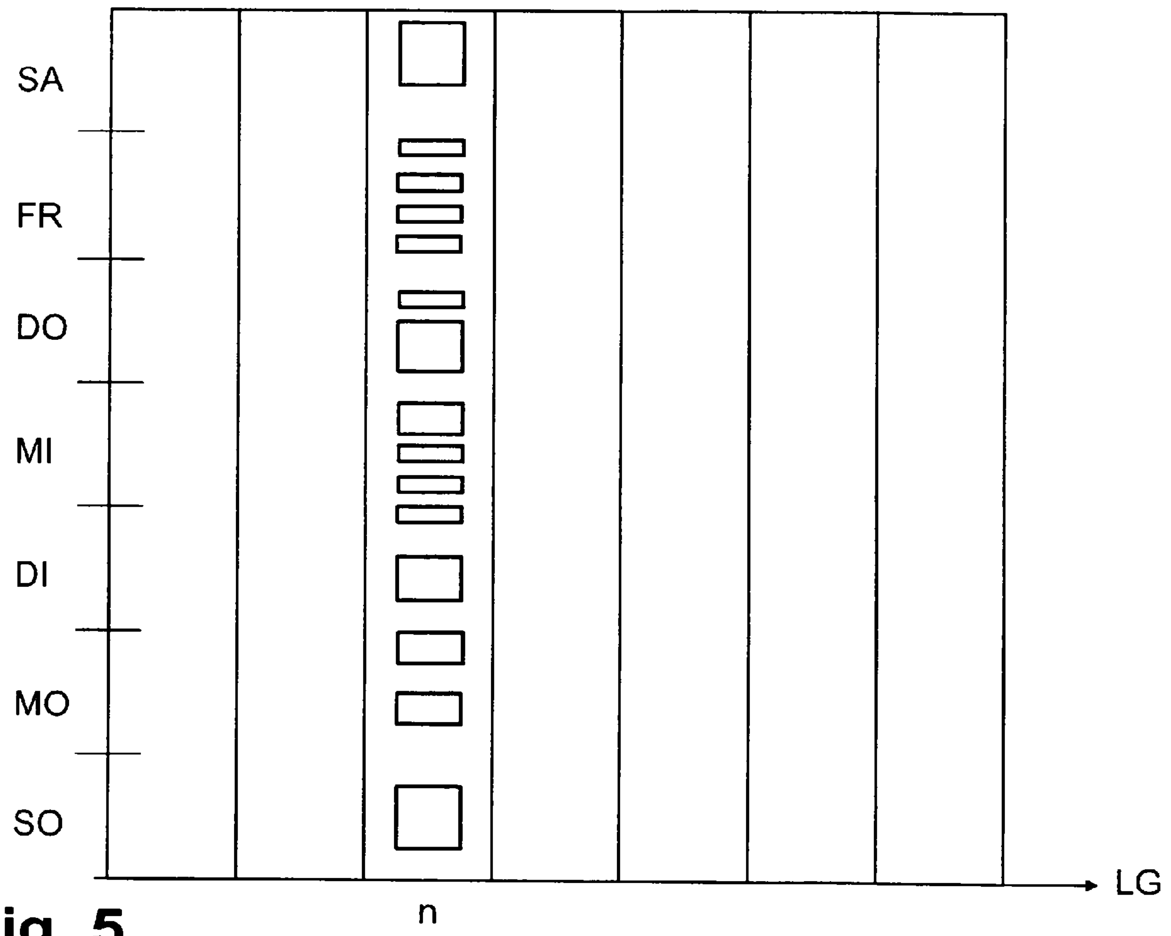

Fig. 5