Integrated system and method for the flexible use of electricity

The present invention relates to an integrated plant and a method for the flexible use of electricity.

The use of renewable energy sources, such as wind power, solar energy and hydropower, is gaining ever-increasing significance for the generation of electricity. Electrical energy is typically supplied to a multitude of consumers over long-ranging, supra-regional and transnationally coupled electricity distribution~~supply~~ networks, referred to as electricity networks for short. Since electrical energy cannot be stored to a significant extent in the electricity network itself or not without further devices, the electrical power fed into the electricity network must be made to match the consumer-side power demand, known as the load. As is known, the load fluctuates time-dependently, in particular according to the time of day, the day of the week and also the time of year. Classically, the load variation is divided into the three ranges, base load, medium load and peak load, and electrical energy generators are, according to type, suitably used in these three load ranges. For a stable and reliable provision of electricity ~~supply~~, a continuous balance of electricity generation and electricity consumption is necessary. Possibly occurring short-term deviations are balanced out by what is known as positive or negative control energy or control power. In the case of regenerative electricity generating devices, the difficulty arises that, in the case of certain types, such as wind power and solar energy, the energy generating capacity is not available at all times and cannot be controlled in a specific way, but is for example subject to time-of-day and weather-dependent fluctuations, which are only under some circumstances predictable and generally do

not coincide with the energy demand at the particular time.

The difference between the generating capacity of fluctuating renewable energy sources and the consumption at a given time usually has to be covered by other power generating plants, such as for example gas, coal and nuclear power plants. With fluctuating renewable energy sources being increasingly extended and covering an increasing share of the provision of electricity ~~supply~~, ever greater fluctuations between their output and the consumption at the particular time must be balanced out. Thus, even today, not only gas power plants but increasingly also bituminous coal power plants are being operated at part load or shut down in order to balance out the fluctuations. Since this variable operation of the power generating plants involves considerable additional costs, for some time the development of alternative measures has been investigated. As an alternative or in addition to varying the output of a power generating plant, one approach is to adapt the power required by one or more consumers (for example demand-side management, smart grids). Another approach is to store some of the power output when there are high generating outputs from renewable energy sources and retrieve it at times of low generating outputs or high consumption. For this purpose, even today pumped storage power plants are being used for example. Also under development are concepts for storing electricity in the form of hydrogen by electrolytic splitting of water.

The measures described here altogether involve considerable additional costs and efficiency-related energy losses. Against this background, there are increasing attempts to find better possibilities of balancing out the differences between electricity provision and electricity consumption that occur due to

sustainability and environmental protection, the use of plants based on fossil energy carriers or nuclear power is increasingly to be reduced in favour of electricity generators that are based on renewable energy sources. However, these electricity generators must be installed in relation to demand and for their part be able to be operated economically. As from a certain degree of installed capacity on the basis of renewable energy sources, it is economically more advisable to install storage capacity instead of further increasing renewable energy capacities, so that, at times when there is an excess of electricity from renewable energy, it can be appropriately used and stored and, at times when there is a shortfall of electricity, electricity can be provided from energy stores or conventional power generating plants. If energy consumption is expediently made more flexible, it can be assumed here that the times when there is a noticeable surplus or shortfall of electricity will become less. For these short times there is in spite of everything the necessity to safeguard the provision of electricity ~~supply~~, while accomplishing this as economically as possible.

In view of the prior art, it is thus an object of the present invention to provide an improved plant that is not affected by the disadvantages of conventional methods.

In particular, it was an object of the present invention to find ways of making it possible to increase the flexibility with regard to the storage and use of electrical energy in comparison with the prior art.

Furthermore, the plant should allow for flexible operation, so that it is possible to respond particularly flexibly to any change in the electricity