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OPERATIONAL PLANNING AND ENERGY MANAGEMENT OF A MICROGRID WITH A PV-BASED ACTIVE GENERATOR FOR SMART GRID APPLICATIONS

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ABSTRACT:

The development in the field of energy management tools may help to next generation, installations in solar cells and storage units which may provide the flexibility for control room operator. This paper tried to implement one of the best determinist energy management technique for industrial customers in microgrid, this also includes advance solar power generator with storage units and a smaller gas turbines. The implemented system organization divided in different categories and implementation carried out in two parts: central and local energy management. The load demand management is based on solar generation forecasting. The central and local energy systems exchange continous data via communication network. And based on the power flows between the various sources are managed via the SCADA control. In this paper application based on the case of a hybrid supercapacitor battery PV based generator is explained and implemented.

KEYWORDS: Load forecasting, Energy Management, Smart Grid, Renewable energy prediction, operation planning.

INTRODUCTION:

To reduce the green house gases and for the liberalization of the electricity market have directed large scale distributed energy generator in grids. In today's modern world renewable energy generator are used for consumption reduction of greenhouse gases. But most difficult part of renewable energy is continuous variation in output power causes excess variations in grid voltages and frequency. In recent years, storage systems had been use for the design of active generator which may provide an energy reserve with neglible fluctuation of output power[1].

Some days ago, smart energy meters were developed for collecting energy consumption data [2]. Continuous upgradation is been seen in energy meters to satisfy customer requirements and few meters were developed so that they can automatic control the output load based on predefined pattern.

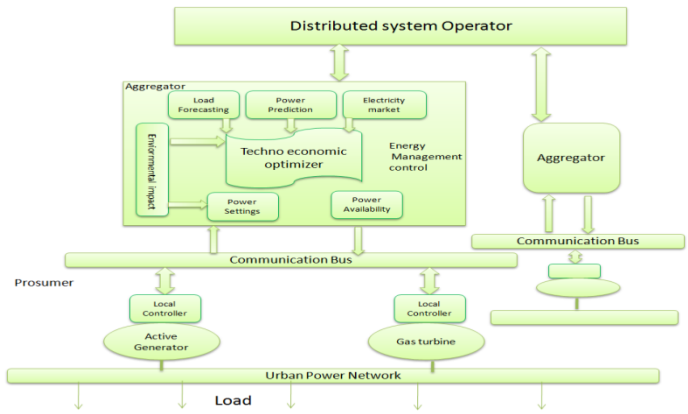

Fig. No.1. Central EMS framework

However implementation of these developments may require various changes in the design of grid control. In fig. no.1. overall architecture of an urban power system structure is considered as mean facilitate the combination of multiple distribute prosumers in electrical system and may be in the market. In this kind of architecture aggregators server the key role amidst prosumers and consumers on one side and the between DSO and market on other side as shown in fig.no.2.

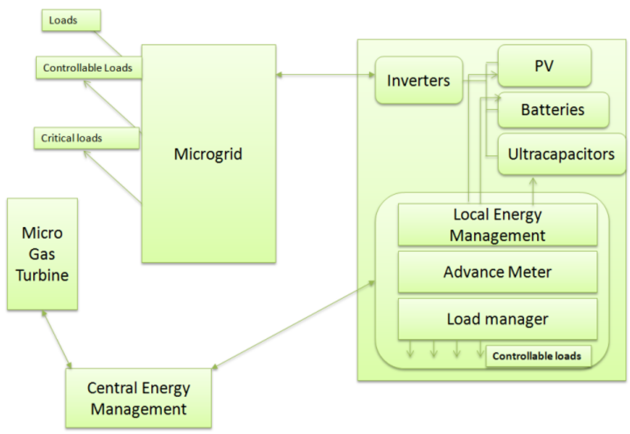

Fig. No. 2. Microgrid integration of a prosumer and a gas microturbine.

The main role of the aggregators is to collect the DSO the upcoming signals and signals from the prosumers, which may be located various locations. For gathering the market flexibilities and contributions provided by prosumers and consumers for efficient operation of the grid services.
In the prosumers area all electrical appliances, and distributed generation can be controlled by the Smart E-box which enable to communicate with external world.

LOCAL ENERGY MANAGEMENT:

For explaining the concept in detail with therotical developments, only one prosumers with gas microturbine are considered in microgrid shown in fig.no.3. The integration of load management, advanced metering and local energy management is accomplished by smart E-box.

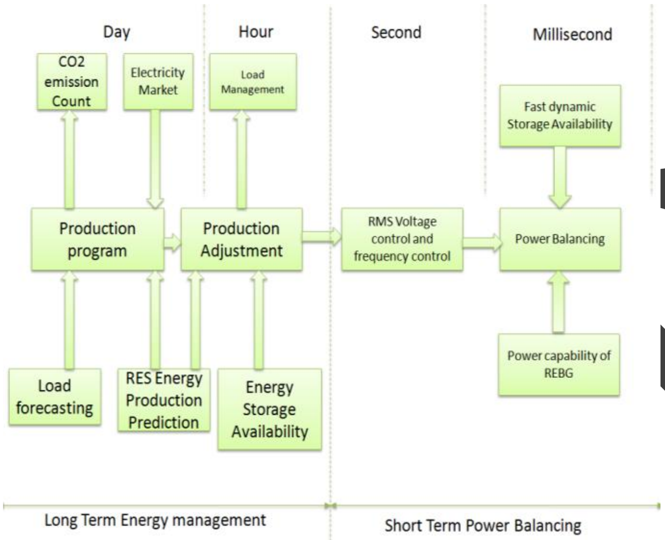

Fig. No.3. classification based on time for EMS facility

The load manager is designed in such a way that it automatically program appliances to turn on when tariff is lower for improving energy consumption habits. Moreover it can reduce a part of the power demand whenever the grid is under stress by facilitating the disconnection of programmed controllable loads.

Solar systems are provided with batteries, which can serves a purpose of long term electrical energy storage device[7] [8]. Few ultra capacitors are also involved for the purpose of fast dynamic power regulator all this items are coupled via Dc bus using choppers and connected with microgrid by using a inverter.

LONG-TERM ENERGY MANAGEMENT:
PV Power Prediction and Load Forecasting:

While carrying out this study, the solar energy prediction is very difficult and this is one of the biggest problem concerns with solar energy. The installed photovoltaic panels generates the power only during day time and it has got the peak around midday mean which huge fluctuations in electrical power generation are expected.

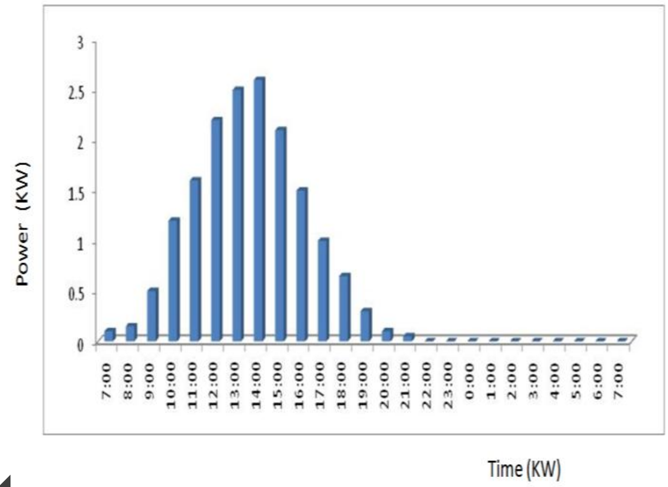

Fig. No.4. PV power prediction before 24Hour

Based on the weather forecasting and previous available data base 24 hour day ahead prediction of photovoltaic power is carried out as shown in fig. No.4. The load forecasting plays an very important role for the energy manager and it helps in managing the energy and the behavior of the loads can be estimated based on historical data.

Energy Estimation:

For the estimation of the energy, the initial conditions are need to be considered as the start time for the day ($t0$), and day's duration is termed as (Δt). And more important thing is both parameters depend on the season and weather conditions as shown in fig. no.5.

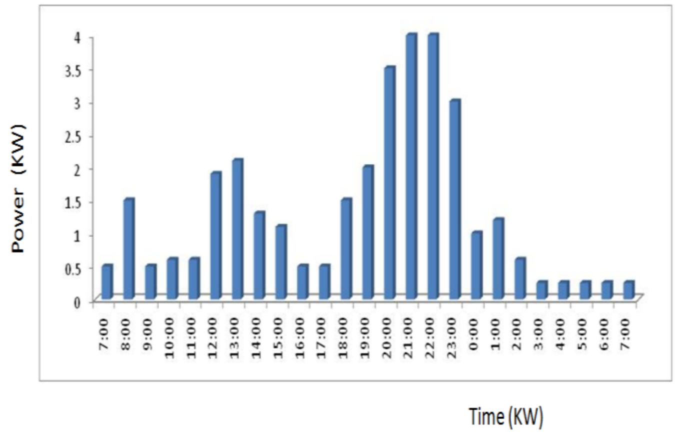

Fig. No. 5. Load forecasting 24hour ahead

The scheduled energy of the solar generation during each half-hour interval can be calculated as

$$\widetilde{E}_{PV\_1/2\,\mathrm{h}} = \int_{t_0+nTe}^{t_0+(n+1)Te} \widetilde{P}_{PV\_24\,\mathrm{h}}(t)dt$$

$$= Te.\widetilde{P}_{PV\_24\,\mathrm{h}}(t_0 + n.Te)$$

with $Te = 30$ min and $n \in \{0, 1, \ldots, 47\}$.

Load demand is also estimated for half hour and it can be calculated as

$$\widetilde{E}_{Load\_1/2\,\mathrm{h}} = \int_{t_0+nTe}^{t_0+(n+1)Te} \widetilde{P}_{Load\_24\,\mathrm{h}}(t)dt$$

$$= Te.\widetilde{P}_{Load\_24\,\mathrm{h}}(t_0 + n.Te).$$

Minimum power generated by microgas turbine is given by

$$\widetilde{E}_{MGT\_1/2\,\mathrm{h\_min}} = \int_0^{Te} P_{MGT\_\mathrm{min}} dt = Te.P_{MGT\_\mathrm{min}}$$

Because of the rating limitation of the batteries the exchanged energy by batteries is given by

$$\widetilde{E}_{bat\_1/2\,\mathrm{h\_max}} = \int_0^{Te} P_{bat\_\mathrm{max}} dt = Te.P_{bat\_\mathrm{max}}.$$

EXPERIMENTAL RESULTS AND CONCLUSION:

For implementation of the proposed idea for energy management a software simulation was been made. While carrying out simplation 10 k-W] batteries and two nos of 112KW (peak power) ultracapacitors were considered for storing electrical energy. First part of the results were obatained by using the hybrid generator and it is operated by using the storage mode of the ultracapacitor. As there will be no generation of electrical energy in the night mode, large variation in the grid power were obtained. For small step change in grid power reference may be from 0-200W occurs. The battery energy will beutilised for the supplying the load. However battery power cannot change suddenly, so ultracapacitors are normally discharged with a high power in order to this demand.

The second set of experiment is carried out in a day time and from grid reference 200W reference is generated. In this case batteries are discharging 100W of power and rest of part will be taken care by PV cells and it will respond to continuous variation of the grid reference voltage. However ultra capacitors are involved in power balancing task.

This paper concentrates on studies of microgrid organization and for defining the roles and required control system for the combination of dispersed solar generator and DER units in electrical smart grids. The major concern is that the output power from all renewable energy sources keeps fluctuating, as it depends on the weather conditions. As mentioned in many research paper maximum solar power generation in India will 30% of the total demand in the country. Looking at this percentage contribution we can concentrate on commercialization of smart micro grids.

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