Energy Management Strategies using Microgrid Systems

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***Abstract*— Traditional electric power system is examining a transformation to an intelligent, efficient, and cost-effective Smart Grid system. Creation of a Smart Grid provides utilities and their customers a significant improvement in power reliability and services. To date, Smart Grid has attracted various researchers from different perspectives. Coordinated control of multiple microsources in microgrid is one of the technical difficulties. Energy Management Strategy (EMS) is commonly integrated with optimization to ensure continuity of load supply and decrease the cost of energy production. Such strategies usually depend on type of energy systems and their components. Various approaches and techniques have been proposed to develop successful EMSs. In this paper, a comprehensive review of the approaches proposed by many researchers is conducted. Attention is focused on popularly used techniques to highlight the design features of each system. The advantages and disadvantages of each communication technology in the microgrid domain are also presented. The selected papers in this review cover the various configurations of the hybrid EMS for microgrids.**

Keywords— Smart Grid; Microgrid; EMS; Distributed generation;

I. INTRODUCTION

Microgrid technologies have been captured phenomenal global interest among academic institutions, industries and by governments because of their potential benefits to improve reliability and energy efficiency, and to reduce carbon emission. It is generally agreed that in both standalone and grid-connected modes of operation, Microgrid system is operated as a single controllable entity. The network boundary, operational capabilities and total generation capacity of Microgrid system can be different as it depends upon the served entity of end use. Microgrid systems are built on military installations, university campuses and on other industrial sites, to support both mission-critical and demonstration activities [1].

In the power grid more renewable energy sources are incorporated in the form of Distributed Energy Resources (DER) and Distributed Generation (DG) as with the rising prices of energy and increasing in concerns of environment. Energy storage such as ultra-capacitors and battery, offers fast response for load changes and frequency regulation coupled with power electronic converter instead of using fossil fuels. Different advantages like dis charge and high charge efficiency, high power and longer life are being offered by recent development. The system should providing electrical power for Microgrids to be reliable to the islanded loads to maintain frequency level and appropriate voltage levels within acceptable harmonics limits [2].

The designing and planning of electric power systems based on DG is a recent research area. Consumers will be using an isolated Microgrid having micro generation system in future and the consumption of these systems according to real time electricity cost will be done by EMS. The dispatch ability issues and reliability associated with the performance are main constraints related with renewable energy sources. The key problems in EMS design are power balance between consumer and producer and renewable sources outputs that are changed with weather conditions. Microgrid has capability to execute programs such as DR management to control the loads that is shifted. To confront the transient faults, the Microgrids consider error tolerance. When high electricity prices are available and Microgrid could not feed the load completely, curtailment so it utilizes load ability. It is self-revival that means after occurrence error the system can revive its self. All devices added with any capacity as micro source or put out of the system were provided by EMS, had plug and play capability. Furthermore Microgrid has power quality, High reliability, system efficiency and security [3].

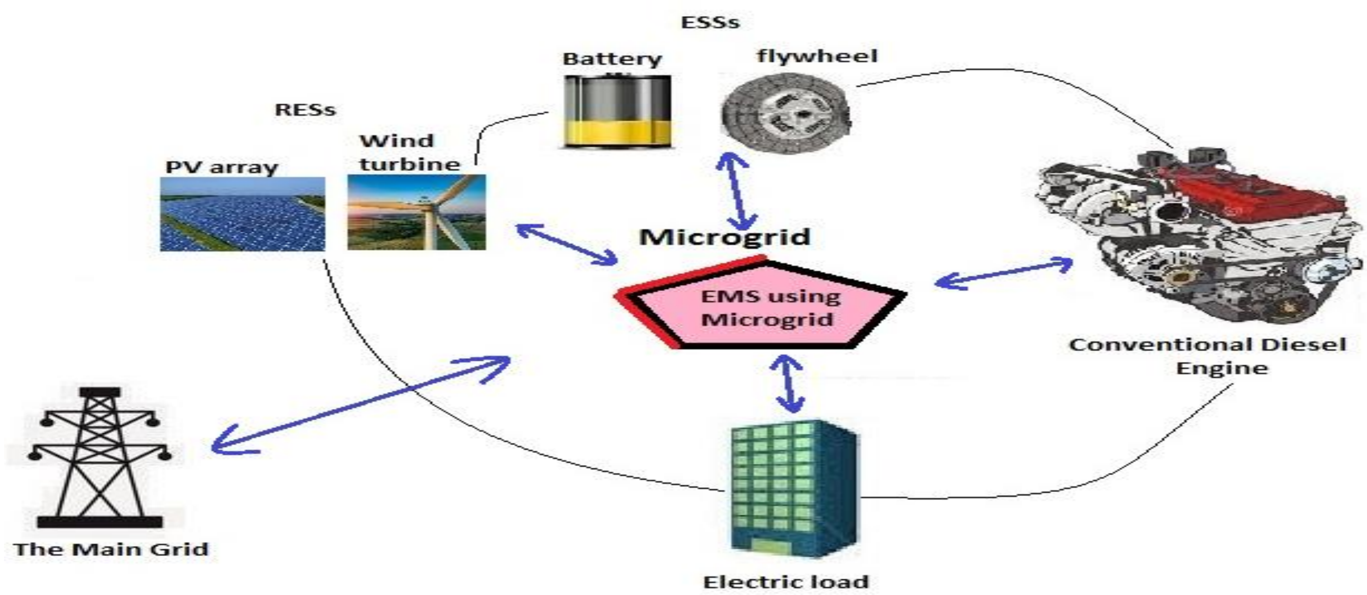

Figure1. EMS Scenario using Microgrid

Because of capabilities of Microgrid to alleviate the growing problems in energy supplies, it has received considerable attention. The power demand has been met with reduced environmental impact, as large distribution and transmission systems are no longer required due to the energy sources that are placed near consumption centers like communities and factories. A Microgrid is primarily composed of renewable nonconventional energy sources (RNCES) loads, and with nominal capacity approximately about tens of kilowatts and storage systems [4].

In Microgrid the as like bulk power systems, tasks are performed in a hierarchy manner. Local controllers drive energy sources particularly to their reference values and supervisory controller which is also known as EMS define energy source's reference values to an objective. EMS is responsible for secure, economical and reliable operations of Microgrid in either stand alone or grid connected mode. To find out the dispatched available generation units optimal commitment while considering the available energy in RNCES and expected demand are responsibilities of EMS. With respect to operating cost, the optimality is measured in an EMS [4].

Nowadays, researchers focus on hybrid systems and their applications in a significant way. A lot of configurations are developed so far in addition for providing electricity to rural areas, renewable energy sources are the most effective solutions for areas those are located very far from electric power grid and where to deliver reliable and high quality electricity have also been proved to be possible in these remote areas for different applications. For supplying certain load, an efficient energy management strategy arises whenever more than one energy sources are used. Through the supply system, the flow of energy is guided by this strategy. An efficient EMS connected with the main grid covers up essentials for hybrid renewable energy systems as well as for standalone hybrid system. For ensuring the maximum utilization of renewable sources and for ensuring continuity of load supplying in all conditions is the main role of standalone system's strategy to be integrated for minimizing the cost of energy production with the optimization problem, protecting components damaged by overloading and increasing stability in power systems [5].

The metering purposes and energy flow control to and from the grid, in grid connected systems are in the role of energy management strategy. The energy flow control utilizing the periods of low cost tariff or shifting the peak in the load curve are also falls in these objectives. For conducting any energy management strategy, selecting a central controller, installing it and programming is necessary for controlling the system according to an optimized strategy. With supervision environment and monitoring this controller can be integrated [5].

II. LITERATURE REVIEW

The demand for electricity has been increased with the increased number of devices which cannot be over-emphasized to be electrically powered. This further led into communication technologies, power systems and for information a lot of work for the researchers to the future grid known as smart grid. Smart Grid was expected to be a smart and intelligent Microgrid comprising of many more Microgrids with both distributed and centralized energy sources capabilities. Smart grid was motivated by political, economic, Social, technical and environmental factors for security, saving, efficiency and energy reliability. For the transformation of traditional grid into a smart grid, a very important aspect of load management was mentioned as an effective tool.

A. Smart Grid Technologies

Smart Grid (SG) is the evolution of currently existing power electric system as by the increase of energy renewable distributed system. In power grid the cable and wireless technology is being applied as communication technology. Further, the SG enables sensors to produce reliability, security and efficiency. SG also has capability of advance sensing and storage eligibility of electricity in distributed locations [11]. For assuring the quality of power supply, it can get valuable performance with enough reliability and quality to be hosted wind energy system of wide range [10]. For having a pure concept of Smart Grid, it is realized in intelligence monitoring and fashionable information and technical communication in a control system [12]. In SG wind supplied management is controlled with load shifting by the means of energy systems and demand response [13].

The solutions of WSAN are readymade to give backbone to the requirements of Smart Grid [14]. The power quality will be affected by the sharing of power producing in renewable energy system, electricity interrupts may occur as if demand is increased and power stations can't supply it for the time being. The power quality is being disturbed by penetrating the wind energy's system of conversion, the power generating a wind turbine are more valuable as compared to convention producers [15]. The concept of SG is introduced to solve the problems of existing electric grid and to have the desirable functionalities of SG such as high reliability, extra power quality, self-healing and the one and only distributed genera ration of electricity and storage [16]. Wireless communication is involved in security concerns when information is very sensitive in addition wireless grid focused on different distributed devices to be connected and their data to be collected and sensors to be sampled and measured [17].

B. Microgrid Technologies

Paper [6] presented a general overview of MGSC/EMS related with definitions, methodologies and functions where on the basis of classical hierarchical control structure, a detailed definition of possible objectives and roles of MGSC/EMS were given in a MG system. for real time power regulation the methodologies that was applied in MGSC/EMS and for short-/long-term energy management were reviewed emphasizing on representative research work. Further Section generalized the agent based EMS applications and research. This paper took standardized from conventional power systems and comprised three principal levels; Tertiary level, primary level and secondary. MGSC/EMS realizing phenomena can be centralized or decentralized. Both types of strategies up-to-date applications were reviewed, also for different sorts of Microgrids with indicating their suitability. This research provided many possibilities and solutions for achieving the objectives in several different areas while the integration, development and project-based study demonstrated the practicability and suitability of different methods.

The authors in [1] proposed an energy scheduling algorithm for a small-scale Microgrid served to commercial buildings from small to medium sized, known as Microgrid which includes energy storage renewable and conventional and renewable generation resources and both no-linear and linear loads. For mitigating power quality issues coordinating with scheduling algorithms of sensitive devices in Microgrids, was the main objectives of that research. Power quality requirement were modeled in the constraints formulating as a mixed integer programming problem. That algorithm was involved in validation with dynamic and harmonics event simulation. For verifying the performance of the algorithm, the case study of paper [1] was performed with realistic model parameters which further demonstrated in managing frequency and voltage, the effectiveness of the algorithm and harmonic distortions. The proposed framework could be used in the transaction-based control framework for facilitating buildings-to-grid integration and aggregating device transaction bids. The study there had proposed MIP-based energy scheduling algorithm where on frequency, harmonic distortions and voltage, the power quality requirements were enforced as constraints. Building Microgrids could effectively fulfill the functional role in the transaction-based framework for facilitating building to grid integration of end-use site. Before communicating to the upper tier level energy management, the proposed algorithm could serve for aggregating the energy transaction bids of the building [1].

Authors in [2] presented the integration of photo voltaic inverter and battery based energy storage system in a micro grid network, to achieve efficient energy management using interleaved boost converter with Maximum Power Point Tracking (MPPT) controller. The regulation of battery operations i.e. battery hold, discharge and charge actions depending on the requisite of load were achieved using a bi-directional DC-DC converter. The performance of interleaved boost converter and a simple boost converter with MPPT control that had been analyzed and compared with two-level inverter and Three-level NPC inverter for the scenarios like the PV source completely catering to the load demand & charging battery, PV source catering only to load demand, Battery storage system catering to load demand and finally PV source & battery storage system both together caters to the load demand. The output Voltage, Current and Power waveforms were analyzed for all the above mentioned scenarios and the results are compared for arriving at better performance. The proposed micro grid energy management system has been modeled and analyzed using MATLAB/Simulink tool.

For finding the energy scheduling in Microgrid, researchers in [3] proposed in this paper, an algorithm for EMS based on multilayer ant colony optimization was presented. For figuring out the optimum operation of micro sources, the aim of study was to decrease the electricity production cost by hourly real time and day-ahead scheduling. Here the proposed algorithm was based on Ant Colony

Optimization (ACO) method and was able for analyzing the economic and technical time dependent constraints. The algorithm attempted for meeting in a local energy market structure the required load demand with minimum energy cost. Performance of this technique was compared with particle swarm optimization based EMS and modified conventional EMS (MCEMS). Obtained results demonstrated that the system performance had improved the energy cost, reduced about 20% and 5% by applying this technique. In addition the plug and play capability was investigated by using different scenarios in real time applications and the system adequate performance was experimentally validated. This algorithm used short term forecast data (DAS, HDAS and FMRTS). The case study provided a better response than particle swarm optimization algorithm because of having less computational time using less iterations and for converging [3].

Microgrids had emerged an alternative to alleviate increasing energy demands. However; Microgrids were based on nonconventional energy sources (NCES) in addition in their operation there was high uncertainty involved. For formulating a robust EMS, was the aim of paper [4] that used as mathematical framework uses model predictive control theory for a Microgrid. The robust EMS (REMS) as the prediction model was formulated using a fuzzy prediction interval model that allowed us for representing both uncertainty and the nonlinear dynamic behavior in the available energy from NCES. Specifically the uncertainty could be represented in wind-based energy sources. Thereby for the trajectories of the available energy an upper and lower boundaries were obtained hence the boundaries were used to derive a robust formulation of the EMS. The results indicated, in comparison with a non-robust approach that, the uncertainty was adequately integrated in the proposed formulation into the EMS, with increasing the robustness by using the diesel generator of the Microgrid as spinning reserve. However; the operating costs also increased because of the additional reserves. These results indicated that proposed REMS to improve the robustness was an appropriate alternative in the operation of Microgrids against the wind power variations [4].

Moreover, NCES uncertainty could be eventually included in the formulation of EMS and hence dispatched in the unit. These completeness extended for the Huatacondo Microgrid in a sense as the prediction model in the EMS that, a more reliable operation was possible in addition it extended with a more complex topology, the applicability of scenario-based formulations to Microgrids and with more NCES in the sense and with a reduced number of scenarios in a Microgrid. in Microgrids or specially in wind-diesel-based Microgrids for real-Microgrid implementations, the resulting REMS was suitable where the main source of uncertainty was wind-based energy sources [4].

The EMS depends over the energy system type and system's components. Different techniques and approaches were developed for a successful energy management strategy.
In that paper, a comprehensive review of various approaches had been taken. These techniques included the grid-connected hybrid renewable systems and standalone hybrid renewable energy systems. For addressing the features of each system, an attention was purely focused over popular techniques used in smart grid. Fuzzy logic systems energy management strategies were also discussed in that paper to achieve an operational efficiency and a high level of system reliability It also helped to increase the life span of hybrid components, to reduce the cost of energy generated and energy storage device. For the hybrid connection, the need for robust energy management and real-time approaches became very important of these resources with the energy storage devices [5].

III. Motivation

Intermittency and Variability are the features that characterize renewable energy sources. Intermittency usually includes both predictable and unpredictable variations. Drawbacks of intermittency of renewable sources can be overcome by considering special design considerations. Integrating more than one renewable energy source and including backup sources and storage systems can be few of them. These design considerations may increase the overall cost of the renewable system. Also, presence of more than one energy supply/storage system requires the control of energy flow among them. Hence, optimizing size of the components and adopting an EMS are essential for decreasing the cost of system and limiting its negative effects. EMSs are commonly integrated with optimization to ensure the continuity of load supply and to decrease the cost of energy production. There are several techniques have been developed nowadays for Microgrid just to enhance the electricity in an efficient way with no losses in a medium from energy producer to energy consumer. We have selected different techniques suggested by many authors in this research in order to enhance the efficiency and ignoring the wasted energy and to propose our own new technique with preventing from losses in the medium and providing energy in a distributed way.

IV. Microgrid Techniques

A lot of different techniques and algorithms have been defined in recent years for an effective use of energy in Microgrid for the smart grid scenario which are as followed:

A. UODSM using Cooperation [7]

In paper [7], authors exploited the benefits of Direct Current (DC) Microgrids for improving existing load performance and with the help of battery storage, DSM program had been shifted in addition DSM solutions had been proposed in the presence of DC Microgrid for overall distribution system with battery storage. By using Mixed-Integer Non Linear Programming (MINLP) Solver, the results were obtained in General Algebraic Modelling System (GAMS) software for DSM problem of industrial loads optimally by generic algorithm for solving the load shifting problem. According to [7], for reducing the peak demand of overall distribution system., researchers proposed a load scheduling DSM strategy for shifting all Alternative Current (AC) controllable loads of industrial customer while DC loads continuously receiving power from DC Microgrid at different hours of the day.

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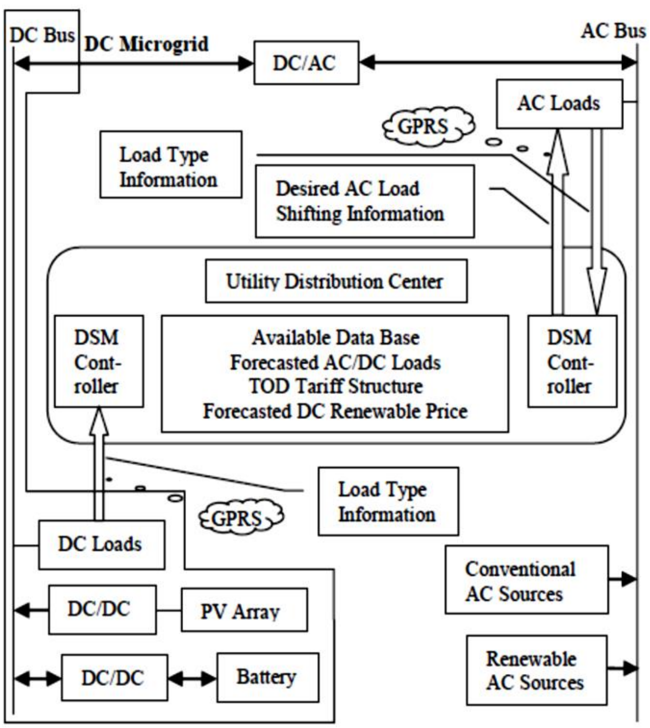

Figure 2. Architecture of proposed DSM [7]

To maximize the use of renewable DC sources, to reduce system peak load demand and to minimize the power taken by an existing AC distribution grid were the objectives of DSM. For scheduling as per time of day tariff AC loads were considered so as power consumption reduced during the period of peak load furthermore this energy scheduling approach was based on fixed time of day tariff. It is possible for scheduling the load during low cost period. Hence authors in that scheme proposed optimization technique for bringing the final curve as near as possible to the pre-defined target load curve which is inversely proportional to the time of day tariff of the system [7].

Utility Oriented Demand Side Management Using Smart AC and Micro DC Grid Cooperative (UODSM) was proposed in [7] where the strategy worked over shifting principle, for bringing the desired load curve more near to the target load curve of the system; of connection moment of each shift able AC device. Load shifting DSM technique for the AC distribution grid mathematically given as :

$$\text{Minimize} \sum_{t=1}^{N} (\text{ACP ac (t)} - \text{Target ac (t)})\, 2 \qquad (1)$$

where N denotes number of time steps in half hourly block

ACP $_{ac}$ (t) can be written as:

$$\text{ACP}_{ac}(t) = \text{Forecast}_{ac}(t) + \text{Connect}_{ac}(t) - \text{Disconnect}_{ac}(t) + (1+k_{lf\,(ac/dc)}).\text{Charging}_{bt}(t) - (1- K_{lf\,(dc/ac)}).\text{Discharging}_{bt}(t) \qquad (2)$$

Due to shifting of their connection instants the *Connect*$_{ac}$*(t)* having two components there dealing with the increment in the loads. At time t there was first increment in the load, due to device connection instants shifted to time t, whereas due to device connection instants, the second increment in the load was which were planned to be connected for the time steps which precede t and whose load consumption overlaps duration time period t.

B. *Real-Time MPC Scheduling [8]*

For the energy management of a renewable hydrogen-based Microgrid Real-time integration of optimal generation scheduling with MPC proposed in paper [8] intended to improve the existing control system via implementation of two control levels as discussed in literature review. A model predictive controller was entrusted by the real time management of Microgrid that has important features as obtaining the results by an optimal generation scheduling. The control strategy was tested at the University of Seville in a laboratory scale Microgrid composed of an electric source which was emulated with a battery, photovoltaic system and storage system [8]. During the charging process, battery utilization costs were related with cycling energy corresponded to a certain power via batteries and given as:

$$C_B = \frac{CC_B}{E_B N_{CYCLES} \eta_{BC} \eta_{BD}} P_B \qquad (3)$$

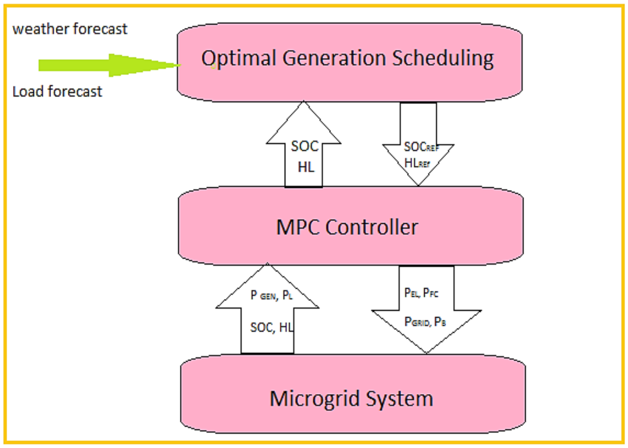

Figure 3. Control System Approach [8]

where E_B is the battery capacity (kW h), ,CC_B is the capital cost of the battery bank (€), N_{CYCLES} is the average battery lifetime in equivalent full charge/discharge cycles, P_B is the battery power , η_{BC} and η_{BD} are the battery efficiencies during charge and discharge processes respectively. To store the excess energy, the utilization costs in the hydrogen storage system were independent instead of the power, however; only operating time function given as:

$$C_{H2} = \frac{(\frac{CC_{EL}}{L_{EL}}+O\&M_{EL})+(\frac{CC_{FC}}{L_{FC}}+O\&M_{FC})}{\eta_{EL}.\eta_{FC}} \quad (4)$$

where L_{EL} and L_{FC} the electrolyzer and the fuel cell lifetimes, CC_{EL} and CC_{FC} are the electrolyzer and fuel cell acquisition costs, $O\&M_{EL}$ and $O\&M_{FC}$ the O&M costs of the electrolyzer and of the fuel cell with η_{EL} and η_{FC} were the electrolyzer and fuel cell efficiencies.

In [8], authors proposed an EMS to improve the exists control systems by two control levels of implementations; the short term energy management that considered between loads and internal sources a real time power dispatching and a long term energy management including load forecast and production whereas disconnection of controllable loads and maintenance intervals were entrusted to the optimal generation scheduling algorithm. Here a novel control strategy was presented of Microgrids for optimal management with high penetration of different energy storage systems and of renewable energy sources. This control strategy was scheduled with a predictive control model for achieving both short and long term optimal planning. After adapting an optimal generation scheduling, long-term optimization of the various Microgrid components were obtained where a statistical approach was used taking into an account uncertainties of weather or load forecasting.

C. TPS Devices for PDR in Microgrid [9]

In [9] time Programmable Smart Devices for Peak Demand Reduction in a Microgrid of Smart Homes (TPS devices for PDR) technique was proposed with an efficient electricity use plan based on improvement on DSM load shifting and appliance working principle technique for peak demand reduction in a rural Microgrid. For programming its ON/OFF working states, the knowledge of an appliance working principle was used. Time-of-use of shiftable devices could be adjusted without affecting the end user's comfort for short periods of time. As desired by the customer the TPS Devices was expected to be a smart home appliance for programmable times of operation with built-in capacity. The consumer determined the TPS devices off- states and on-states. The devices will have incorporated a display unit from where the desired on and off-states could be set by customer.

The TPS Devices technique did not require customers for setting daily appliances, however; the devices according to their programmed time table rather switch on/off. Since it was an automated switching operation, there were no issues of human inadequacies such as absence from home or forgetting to switch on or off the devices.

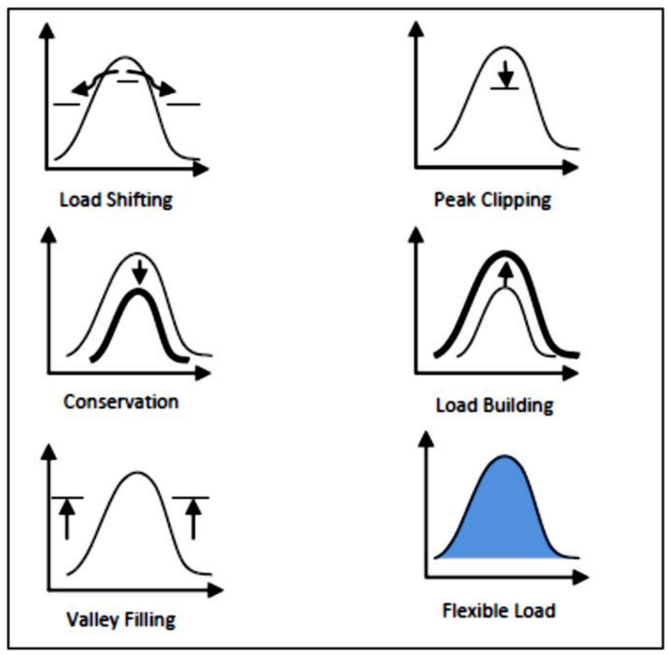

Figure 4. Demand Side Management Technique [9]

The room heater, refrigerator and water heater were shiftable loads in the TPS devices load profile simulation whereas electric stove, television, bulbs, electric kitten, fan, electric iron, phone and radio were the non-shiftable loads. The total consumed energy; E_T by a household was given as:

$$E_T = \sum_{i=1}^{m} nP_iT_i = E_1 + E_2 + E_3 + \cdots . E_m \quad (5)$$

Where n showed the total number of the appliance i used in a household, T_i is the duration of appliance i usage per household and P_i is the power rating of appliance I as shown in (1).

Load	Power, P (KW)	Qty, n	Usage, T (hours)		Electricity Consumption, E (KWh)	
			ND LP	TPSD LP	ND LP	TPSD LP
Radio	0.015	1	10	10	0.15	0.15
Television	0.040	1	6	6	0.24	0.24
Stove	1.000	1	3	3	3	3
Phone	0.010	2	2	2	0.04	0.04
Bulbs (inside and outside)	0.010	4	12	12	0.48	0.48
Iron	1.000	1	1	1	1	1
Kettle	1.000	1	2	2	2	2
Fan*	0.080	1	9	9	0.72	0.72
Refrigerator	0.350	1	24	15	0.84	0.525
Water heater	3.000	1	15	5	45	15
Room heater*	1.000	1	15	8	15	8

*Seasonal loads NS – Non-shiftable load S – Shiftable load

Table 1. Households Electric Load [9]

The numbers of households considered were about 100. For both traditional Normal Devices (ND) LP and TPSD LP in that model, the consumption typical household was shown in table 1. The proposed TPS device technique did not only producing a reduced peak demand in addition it also resulting in lower peak-to-peak difference. This will further lead to lower capital cost for more financial savings for the consumers, better environmental safety and to incur peaker plants by the utility provider. In terms of morning peak demands, energy savings; *PDm* is given as:

$$Em_s = PDm_{ND} - PDm_{TPSD} \qquad (6)$$

Where PDm_{ND} was morning peak demand with normal, and PDm_{TPSD} was morning peak demand with TPS devices' included loads.

D. Real time implementation of optimum EMS [3]

Ant Colony Optimization (ACO) algorithm was implemented based on the behavior of ants which can search

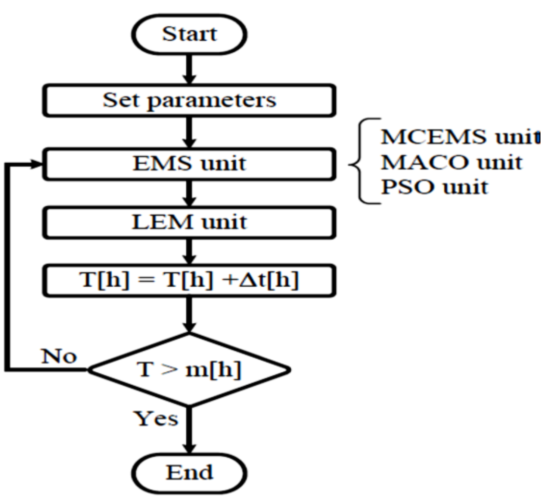

Figure 5. Proposed algorithm for EMS [3]

the shortest route to a food source from the nest. This technique was the common methods to optimize various problems where they further presented some advantages in comparison with gravitational search algorithm, artificial bee colony and competition in dynamic applications including usefulness, positive feedback that leads algorithm for rapid discovery of good solutions and in order to avoid premature convergence distributed computation got in action. The efficiency of that algorithm solved problems related with performance optimization in addition distributed energy resource scheduling improvement and also with cost reduction of system performance was shown in Microgrid.

This method did not have any special algorithm while a paper design had been done. The presented algorithm in that paper had adequate fast response and flexibility in the system to any incident.

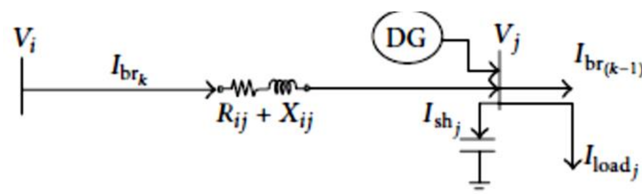

Figure 6: Steady State Representation [10]

The sources timing schedule in the presented methodology with the time intervals day ahead, hour ahead and 5 minutes ahead were considered. Short term scheduling of energy sources considered intensive penetration of distributed energy resource's load curtailment by using plug and play capability and demand response were specific features of that paper. Furthermore the proposed algorithm was tested experimentally and implemented over the IREC's Microgrid system where the experimental results stated in handling different scenarios, the proper performance of the algorithm occurred in the system. Moreover it's comparison with other EMS algorithms showed better performance.

According to the following objective function, the optimization problem was defined as:

z min C_{TOT}

$$\sum_{t1}^{m} C_t^g \, C_t^{tg} C_t^{ES} - C_t^l - C_t^{ES} \Omega_t \times \Delta \boldsymbol{t} \qquad (7)$$

Where *m* the number of time periods represented by m in the scheduling time horizon T; C_t^g and C_t^{tg} Were the cost of energy produced by non dispatchable and dispatchable generation units in period t; C_t^{ES} and C_t^{ES} were also cost of energy produced that by ES units respectively during charging and discharging operation mode in period t; C_t^l stated cost of energy which was consumed by Responsive Load Demand (RLD) and Ω_t justified for depicting the penalty cost during the time period t , resulted from Undelivered Power (UP).

E. Computational LFA Technique[10]

To suit the load flow analysis, the basic backward forward sweep technique was modified of a sustainable autonomous Microgrid.

The above figure 6 represents steady-state representation of a branch "k" between jth and ith buses of a Microgrid. The steady stated equivalent circuit representation of "k" branch between the buses "j" and "i" of Microgrid was considered as shown in Figure 3 and the currents were computed by using the following:

$$I_{\mathrm{br}_k} = I_{\mathrm{br}_{k-1}} - I_j, \qquad (8)$$

where

$$I_j = I_{g_j} - \left(I_{sh_j} + I_{load_j} \right), \qquad (9)$$

$$I_{load_j} = Conj\left(\frac{S_{load_j}}{V_j} \right). \qquad (10)$$

In each of the iterations all node and branch currents were computed using (8)–(10). In distributed systems, the effect to introduce generators was incorporated in (9) and where positive sign was assigned to the injected generator current in addition negative sign for the current components drawn by compensating devices and load. This assignment polarity incorporated the effect of DGs penetrated in that system named as the net current injected at any Jth bus with a DG attained a positive sign and without DG attained a negative sign which is automatically computed in the forward sweep reflected in bus voltages in addition the modifications incorporated in the conventional backward sweep technique was reflected in (10).

V. Conclusion and Future work

Different approaches and reviews implemented for energy management in both grid connected hybrid renewable systems and standalone hybrid systems were conducted in this study. Particularly attention has been given in this paper for management strategies in Microgrids. Only a few studies has been taken in this review paper according to which most work has been done over stand-alone hybrid systems. Therefore to develop an EMS which controls energy flow of both electrical and heat between hybrid system's sources, the load is recommended connecting to grid or with directly to these resources. For measuring energy of heat generated by load or distributed generation systems, in this case must be specified. Future work will be directed to develop a strategy for their on-line computation and to determine that how to select the values of the weighting factors based on the available historical data.

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