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Renewable Energy Based Load Management in Micro-Grid

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Abstract:- **Operational controls are designed to support the integration of wind and solar power within micro grids.An aggregated model of renewable wind and solar power generation forecast is proposed to support the quantification of the operational reserve for day-ahead and real-time scheduling. The use of a single power processing stage to interface multiple power inputs integrates power conversion for a hybrid power source. This structure removes redundant power stages that would exist in the conventional approach that uses multiple converters. The controls are implemented for the special case of a dc micro-grid that is vertically integrated within a high-rise host building of an urban area and load share control method of droop control is employed.**

Further more, demand response implementation reduced the peak of consumed have been modeled mathematically within frame work of the mixed integer linear programming method. The optimation program has been performed by HOMER software together with GAMS software via the CPLEX solver

INTRODUCTION:-

Electrical energy is the most efficient and popular form of energy and the modern society is heavily dependent on the electric supply .At the same time the quality of the electric power supplied is also very important for the efficient functioning of the end user equipment. Electricity for remote areas that are located close to a main grid can be supplied by extending the existing grid relatively cheaply.

However, in the newly formed rural areas including islands, the cost of supplying electricity to every new customer has increased. Further, the income levels of dwellers in remote locations are relatively low and tend to purchase less electricity which will lead to reduced financial returns to the utilities.

These factors do not help promotion of grid-based rural electrification schemes as the first choice to serve rural communities.

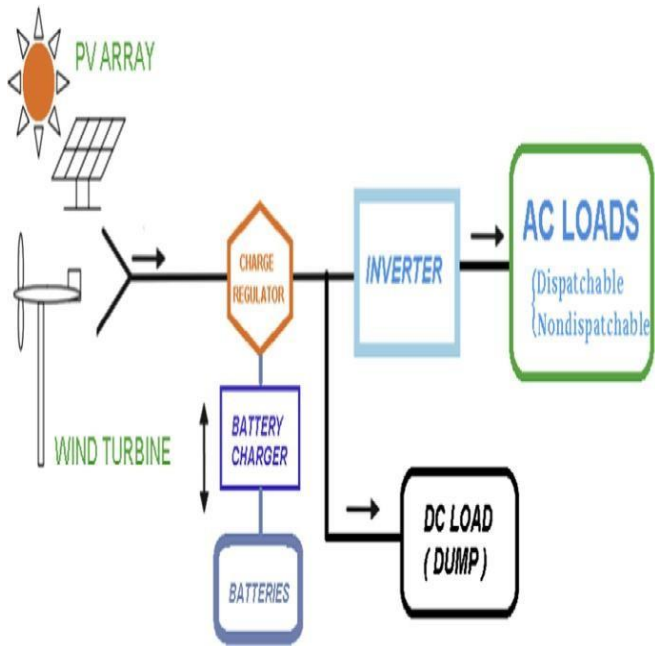
Instead, locality and de-centrality based generation schemes are considered as viable methods in supplying electricity to remote customers. The micro-grid components have been modeled mathematically within the the frame work of the mixed integer linear programming method. The applied software for modeling, simulating and optimizing the studied microgrid are GAMS and HOMER.

The framework of the mixed integer linear method. regarding the importance of size optimation of micro-grid this paper seeks to examine energy generation stand alone micro-grid using DR programming due to be deficiency or unavailability of dispatchale energy recourses in the present study,only the available nondispatchable renewable energy resources(wind and solar energy) are consider to supply the desired energy (it must noted that power management with Nondispatchable energy resources is more complicated then dispatchable ones).

For the realistic modeling, consumed loads where considerd as statistical normal distribustion with mix of hourly and daily veration of loads . The studied micro grid is a forestry cam located in the north west of iran at longitiude 45°; 5' and latitude of 37°;2'. Consumed loads comprise dispatchable and nondispatchable loads. Applied strategy for effective component size optimization is implemented by reducing or eliminating the mismatch between the generation and consumption profiles by time shifting and schedule of dispatchable loads. In addition, the effect of applying this program on reducing the loss of generated energy is studied.

Recently, many studies have addressed the DR strategy for optimum power management in on-grid network. A new approach for solving the multi-area electricity resource allo- cation problem with considering both intermittent renewable and DR was proposed. Babonneauetal introduced a linear programming framework to model distributed generation, flexible loads.

EXSISTING SYSTEM BLOCK DIAGRAM:-



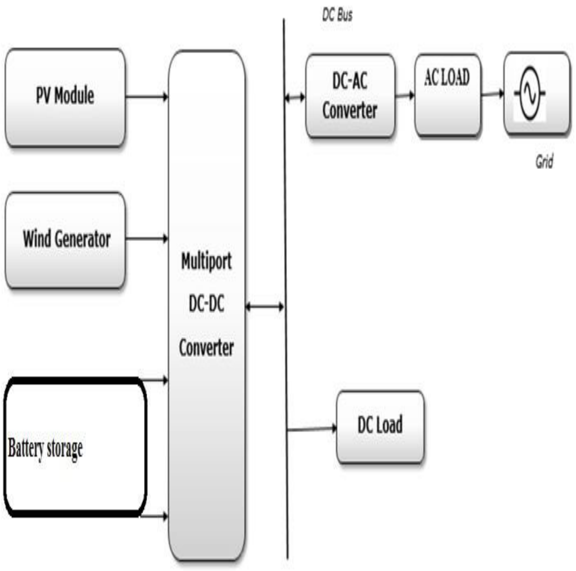
EXISTING SYSTEM DESCRIPTION:-

This system comprised of the Renewable hybrid power generation system consist of solar and wind, then the multilevel energy storage system, which is comprised of the Battery Energy Storage system(BESS) and the super/ultra capacitor. Power produced from hybrid source is transferred based on load demand to load as well as energy storage system through converter and inverter.

The solar pv power is connected to the DC bus through the DC-DC converter, likewise the multilevel energy storage is also connected to the DC bus through the DC-DC converter. Excessive power generated from wind generator during high wind speed is transferred to dump load.

Limitations of existing system description. There will be some losses due to the use of the dump load and multiple converters. There are more number of converters used here in the process of connecting the produced power to the DC bus, the losses will be more and the usage of the components also high.

PROPOSED SYSTEM BLOCK DIAGRAM:-



PROPOSAL SYSTEM DESCRIPTION :- The proposed DC Micro grid consists of PV module, wind generator, BESS,, Multi-port DC-DC Converter, DC Load, DC-AC Converter and Grid. Brushless DC wind generator is used to produce DC power directly on wind conversion which would avoid losses during rectification.

Battery Energy Storage System (BESS) Energy Storage System to store the energy produced by the renewable sources. The energy stored in the BESS can be utilized for future use during demand in DC bus through Multiport DC-DC Converter.

Multiport DC-DC converter is used instead of having separate DC-DC converter for every source which connects to grid, this would avoid losses and reduce the size. The DC bus which connects the produced DC power and DC load and DC-AC converter to give the excess power to grid. The constraints of the issue include the operational and physical limitations of the components, energy balancing, and ESS constraints

HYBRID SYSTEM:-

It shows a schematic view of the studied isolated micro- grid. In this micro-grid, energy is generated using PV and WT. As shown in this figure, the micro-grid has an energy storage system (battery) to store energy generated in excess of consumption. Furthermore, the micro-grid has a smart system to manage dispatchable loads. The smart system uses DR to reduce or elimi- nate the mismatch between the generation and consumption pro- files. The dump load is used to dissipate power generated in excess of consumption and storage. The characteristics and equations related to each of the above components

Mathematical model of the system

A solar panel directly converts sunlight into electricity. The out- put DC power of the PV panel (P_{PV} t) depends on solar radiant intensity, absorption capacity, panel area, and cell temperature, and is described.

Wind turbine:- The output power of a wind turbine (PWT t) is a function of the wind speed at turbine hub altitude.

This predicts that v (m/s), vr, vcut—in, and vcut—out represent, respectively, the wind speed at turbine hub altitude, nominal speed, cut- in speed, and cut-out speed for the wind turbine. P_r represents the output power at rated speed (vr). It shows output power versus wind speed for a wind turbine.The wind speed at turbine hub altitude can be obtained as a function of the reference speed

Energy storage system (battery)

Energy storage is used to simultaneous balance of supply and demand. In a micro-grid, a battery bank can be used as a storage system. It can be charged or discharged depending on the genera- tion power and consumption power. The input power of the batterT ies can be either positive or negative depending on whether the battery bank is being charged or discharged

Ebatmin 6 Ebatðtþ*6 Ebatmax SOCmin ¼ Nbat

*Ebatmin SOCmax ¼ Nbat * Ebatmax

where E_{bat}ðtþ represents the energy stored in each battery,E_{batmax},E_{batmin}, SOC_{max} and SOC_{min} represent, respectively, the maximum and minimum allowable amounts of energy for storage in each battery and battery bank, and N_{bat} is the number of batteries, which the maximum and minimum allowable capacity level of each battery are related to each other.

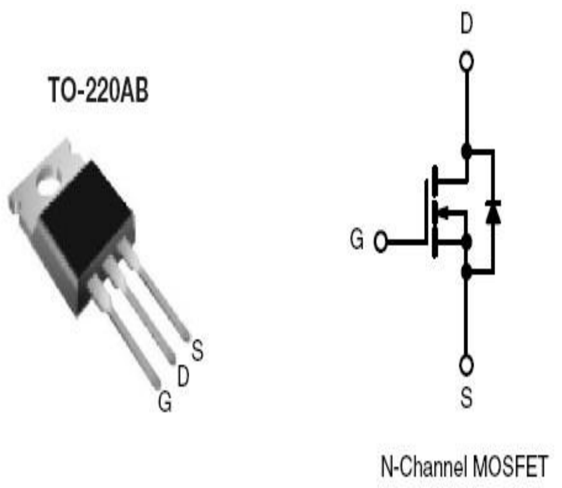
Energy balancing:-

In order for a power system to be stable, total consumption power should be equal to total generation power. In other words, during each time period, the electric energy consumed by nondis- patchable and dispatchable appliances plus the energy charged into the storage system should be equal to the energy supplied by PV and WT plus the energy discharged from the storage system. Perfect balancing during each time interval is not possible. This is due to the restriction on the charge and discharge rates of the storage system, the restriction on the capacity of dispatchable loads, and the uncontrollability of the amount of power generated by renewable energy sources.

Hardware requirement

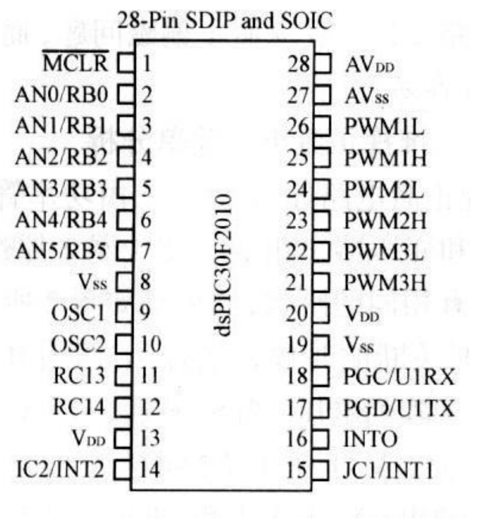
- MOSFET IRF840
- MOSFET IRF460
- TLP250 driver
- dsPIC30f2010
- 1ph VSI

Power MOSFET IRF840



- TLP250 is suitable for gate driving circuit of IGBT or power MOS FET.
- Input threshold current: 5mA(max)
- Supply current : 11mA(max)
- Supply voltage : 10-35V
- Output current : ±1.5A (max)
- Isolation voltage: 2500Vrms(min)

dsPIC controller

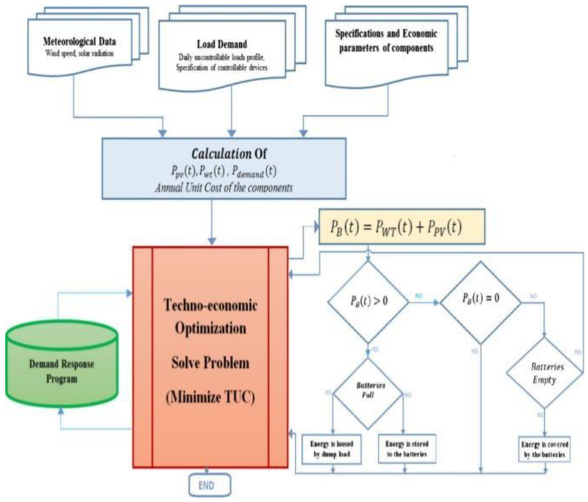


Optimizion problem

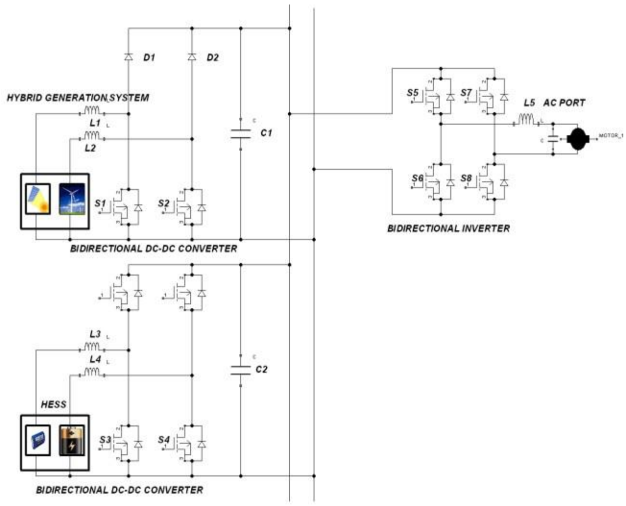
Optimization procedure consists of input data (such as meterology, loads, and specification and economic parameters of components) and is conceived as a MILP model that is performed by the EMS to jointly schedule appliances power consumption and the energy. The objective of minimizing the amount total net present cost of the micro-grid over its life time. Schematic view of this procedure is depicted .

Electric appliances divided into two categories: (i) shiftable appliances (including Water electro-pump, Clothes dryer, Clothes washer, and Dish washer), which can be run at flexible time sched- ule in scope of a day (by energy management system (EMS)), or (ii) non-shiftable appliances, which are

schematic view of optimization procedure of the micro-grid



SIMULATION DIAGRAM



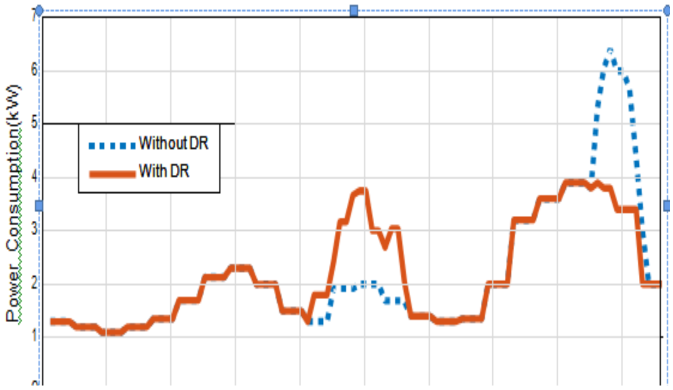
Simulation, results and discussion

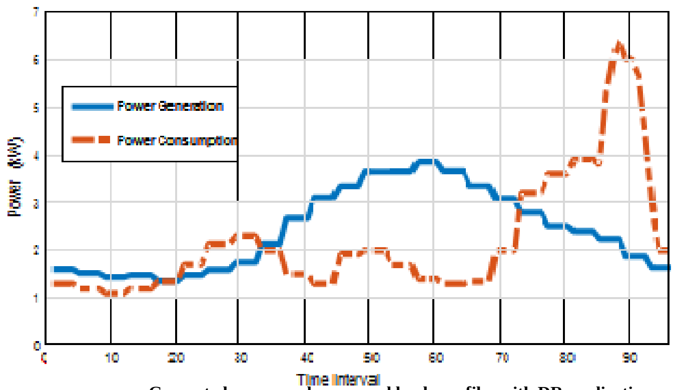
In this paper, obtained results of size optimization of the micro-grid with and without DR implementation are presented. In current study, the issue is modeled as mixed integer linear pro- graming. GAMS 23.6 software with CPIEX solver [52] along with HOMER [53], which is a useful software for programing of micro- grid are applied for size optimization.

Size optimization of the micro-grid is accomplished for 2 cases: with and without DR.Here it presents essence of size optimization results for these cases.

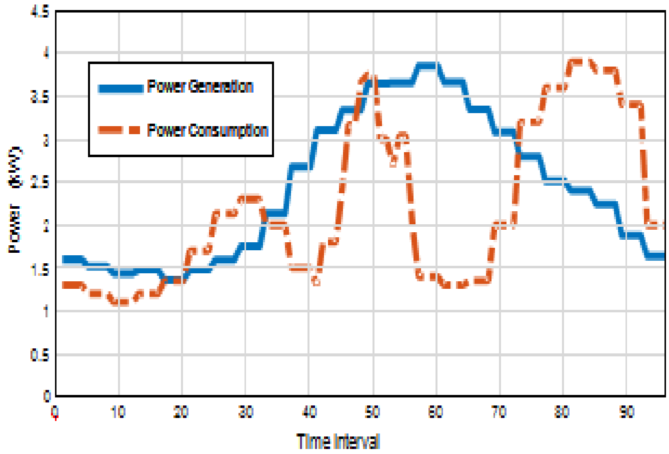
Consumed power is equal for two cases. Part of generated power is wasted in charge and discharge processes. Origin of this slight difference in the number of photovoltaic panels is this waste.

OUTPUT WAVEFORMS

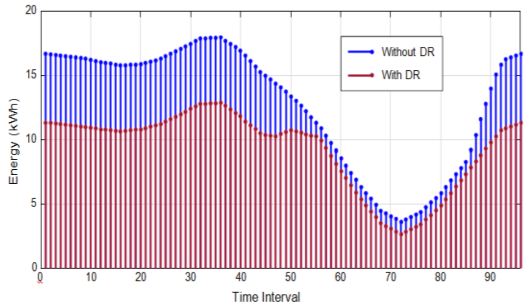




Generated power and consumed loads profiles with DR application.



Generated power and consumed loads profiles with DR application.



Charge and discharge states of batteries

CONCLUSION

In spite of many studies in the case of DR programming for opti- mal management and operation cost reduction of the micro-grids, and attention to importance of size optimization of micro-grids, this paper was devoted to examine of ability of DR programming in the case of component size optimization of a micro-grid. Due to deficiency or unavailability of dispatchable energy recourses, only the nondispatchable renewable energy resources (wind and solar energy) were considered to supply the required energy.

For size optimization, DR scheduling program was employed to provide a better coincide between the generated power and con- sumed energy profiles and also to minimize the components size of micro-grid as well as the relevant costs. The micro-grid components were mathematically modeled within the framework of the integer linear programming method. The optimum program for controllable appliances was performed by GAMS software via the CPLEX solver. And optimization results (using HOMER software) for two cases, with and without applying the DR program were extracted and compared with each other. For each case, the optimum configuration was determined. Obtained results indicated that application of the DR program, significantly reduced the number of required batteries by 35.6%, the inverter capacity by 35%, PV panels by 1.8% and, consequently, the net present costs by 17.1% (including investment, repair and maintenance, and replacement costs). As a result, compared to the case of with- out DR applying, the storage system, the inventers and the total costs were reduced by 35%, 35.6% and 17.2% respectively. Further- more, DR implementation reduced the peak of consumed loads and DF index by 36.8% and 26.3% respectively. Also increased the con- sumed load factor and correlation factor by 57.9% and 368%, respectively.

This paper showed good ability of DR programming in the case of component size optimization of a stand-alone micro-grid for only 7.5% dispatchable loads. It is obvious that for higher percentage, ability of DR for size optimization increased.

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