Optimization of Renewable Energy Sources for DC Microgrid

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***Abstract**: For a century, people have made this finite resource available in a very inefficient way. This increase in fossil reserve energy consumption has led to financial instability, climate change, a significant depletion of reserves and political unrest in the world. Initially, the generation of electricity by large power plants was promoted; because it was considered more efficient than a large number of small scattered power plants. Due to this trend in development, together with the depletion of fossil fuel reserves and the associated environmental pollution, it is urgent to find energy alternatives that are profitable, sustainable and respectful of the environment. Renewable energy sources such as wind, sun, hydropower and biomass provide energy security and will play an important role in the future to meet the growing global demand for energy. Research and development of renewable energy technologies confirm that renewable energy sources are undoubtedly sustainable and that green technologies can reduce global dependence on fossil fuels.*

Keywords

Microgrid, Optimization, Solar, Wind.

1. INTRODUCTION

Saving the earth's energy has become an important issue in this century, because energy hunger will occur after a few decades. The interest in solar energy has grown rapidly due to the advantages that this entails.

- Direct electric power;
- Low maintenance;
- There is no sound;
- No pollution

The energy system proposed in this project aims to address the problems of electricity and transport. One possible solution is a micro-network that can be vertically integrated with a large height, as is often found in urban areas. The collection of renewable wind and solar energy is done in the upper part of the building. The generation system on the roof is connected to ground level through a micro-network where charging points for electric vehicles (EV) are supplied and a battery supports the balance of supply and demand.

The potential value of an urban integration in buildings as considered here comes from the sources where the power generation in the roof is used, the storage of the latter to offer EV fast loading in the ground floor, the joint location and the integration of the production, the contribution to the transport of EV without emissions in urban areas and the load in urban areas, and the integration of the network-friendly micro-network with the rest of the main network. The combination of wind and solar energy leads to fewer local storage requirements and this has been verified.

The combination of several but complementary storage technologies can in turn form multilevel energy storage, with a supercapacitor or handwheel that provides cache control to compensate for rapid energy fluctuations and to mitigate the transients found by a battery with a higher capacity. of energy. Microgrids or hybrid energy systems have proven to be an effective structure for the local coupling of distributed renewable energy generation, taxes and storage.

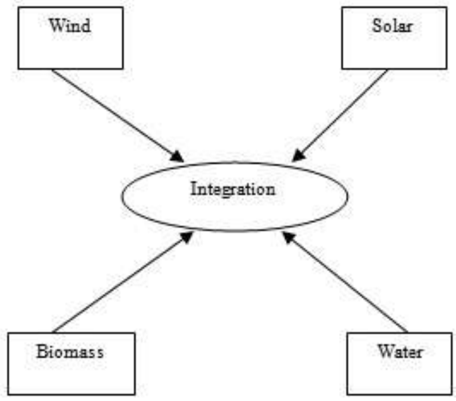

Fig. 1 Renewable energy integration

Research Objectives:

- To optimize the cost and efficiency of microgrid using renewable sources.
- Comparison of hybrid (Wind and solar) with other system.
- Mathematical modelling of an optimization of microgrid and implementation.
- Comparison of results (Modelling and Simulation).

2. PROPOSED WORK

The proposed operating strategy is mainly determined by the use of adequate energy management and control strategies to improve the operation of a DC micro grid, formed by the use of photovoltaic (PV) and wind energy, batteries and loads.

This control strategy is used to implement the decentralized energy management of a hybrid photovoltaic unit / battery in a micro-network with tilt control. Operational arrangements have been designed to support the integration of wind and solar energy in micro grids. To support the quantification of the operational reserve for daily programming and in real time, an aggregated forecast model for renewable solar and wind energy is proposed.

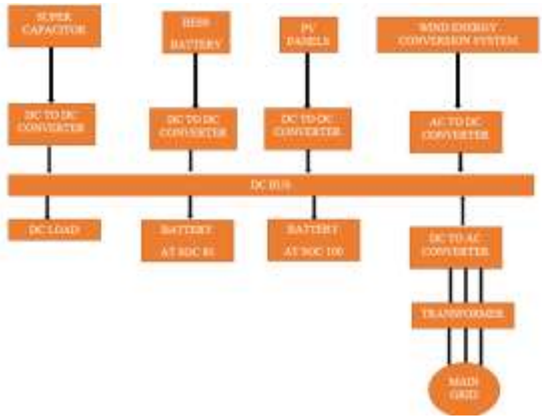

Fig.2 Proposed System Flow Chart

The proposed power / frequency characteristics of the combined wind and solar energy unit and the entire micro grid are autonomously adjusted to the operating conditions of the micro network, so that this unit can provide the maximum photovoltaic energy with the charge and / or charge the battery while maintaining the power balance in the microgrid and complying with the SOC limits of the battery. In comparison with the existing fall controls, it is distinguished by the fact that the fall lines are determined as a function of the storage status (SOC) of the storage and can become asymmetrical. The slope adjustment ensures that the power output is compatible with the terminal voltage and at the same time maintains the SOC within a target range of the desired operational reserve.

3. WIND POWER INTEGRATION

The idea of integrating network connected systems to generate wind turbines have been developed in recent decades for power generation units of MW size with advanced control. The output power is not only based on the incoming wind speed, but also in the system requirements. In contrast to the past, technological developments WTGS [1] allow wind farms to be operated in accordance with the concept of the Virtual Power Plant (VPP), providing the necessary support for the primary activities.

Communication systems basic tool that transmits the measured data and control signals between wind farms and power installations. A suitable communication system can explore the potential of wind and be controlled by the company, help with maximum rest voltage and support power systems. Figure 3 shows the integration of the wind farm network. It can be seen that a modern electrical system consists of communication networks. Energy flows through the grid to customer demand, while the information flow within the communication system to check the status of the system, the control of the dynamic energy flows presented in the network and the transfer of the collected information from an Internet intelligent devices detecting and controlling the electricity grid. As the wind farm, the data is delivered to the plant via SCADA communication, where the control, monitoring, operation and connection to the transmission system are carried out.

Wind energy is becoming an increasingly important part of the production mix. Large-scale wind farms are usually integrated into the transmission power so that the energy generated can be delivered to the load in remote locations, while small-scale wind farms can be integrated into power distribution networks to meet local requirements.

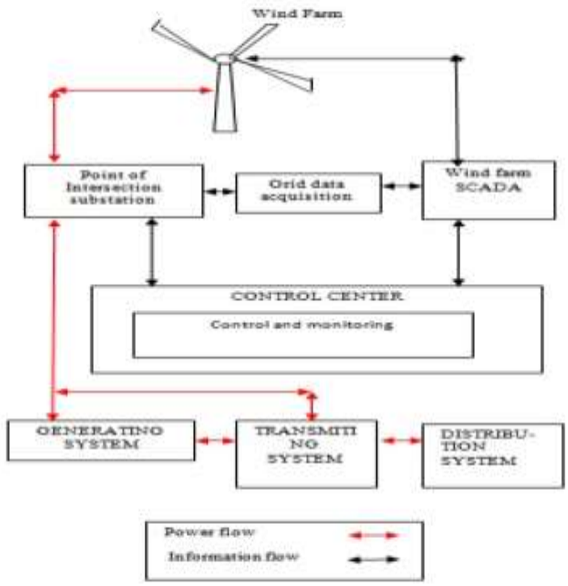

Fig. 3. Grid integration of a wind farm

4. GRID CODES OF WIND INTEGRATION

Network operators, both in transmission and distribution, have developed network codes to connect WTGS and wind turbine manufacturers have met these requirements by developing advanced functions in the field of WTGS control and electrical system design. The essential requirements of the network code are explained below.

A. Frequency control

Various network codes require the participation of wind farms in primary and secondary frequency control, including the frequency response capacity and the limitation of slope percentages and active power. The requirements are expected to become stricter at higher levels of wind energy integration to prevent the power gradients of conventional power stations responsible for primary and secondary frequency control from being exceeded. Some operators also require WTGS to stay connected and operate in a wider frequency band to contribute to frequency restoration and stable operation of power systems.

B. Voltage control

Individual WTGS must control their own terminal voltage at a constant value by means of an automatic voltage regulator, which gives modern wind farms the option of transferring the voltage at the common coupling point (PCC) to a preset network voltage set point. The extensive reactive capacities can offer benefits to system administrators because they offer the possibility to better balance the demand for reactive power.

C. Fault Ride-Through capability

WTGS must remain connected during and after major network failures, ensuring a rapid recovery of the active power to the failure level as soon as the error is corrected and reactive power injected to support the network voltage during failures and ensuring a quick recovery stress after clear failure.

5. SOLAR ENERGY INTEGRATION

The first application of photovoltaic energy was as an energy source for space satellites. Most photovoltaic modules are used to generate interactive power. Solar systems that are connected to the grid are generally classified into three categories: residential, commercial and public scales. The residential scale is the smallest type of installation and refers to all installations of less than 10 kW that can usually be found on private property.

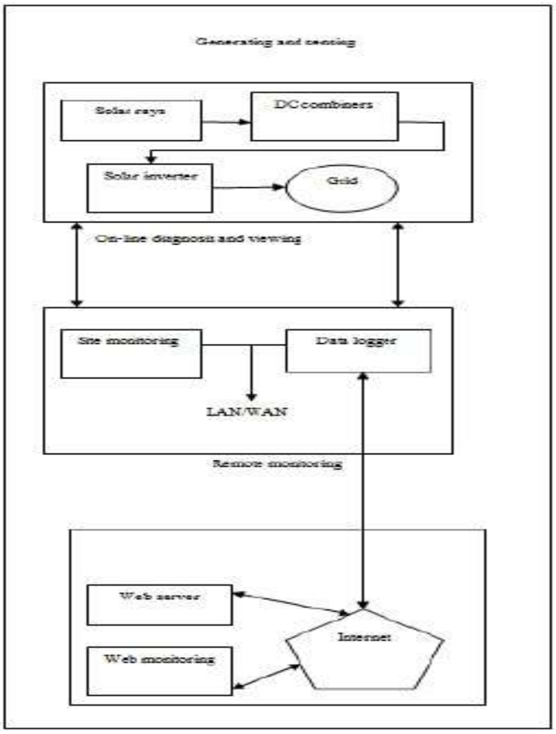

Fig. 4. Three-level monitoring of photovoltaic Power systems

The commercial capacity varies from 10 kW to 100 kW, which are often found on the roof of a commercial building. The utility scale is designed for installations of more than 100 kW, which are traditionally field-bound in fields.

In this technique, which uses integrated communication systems [4]: the photovoltaic panel, voltage, current and temperature of each module were collected and the information was sent to the monitoring interface.

Solar energy monitoring [3] can be divided into three categories: system level, chain level and module level. FIG. 4 shows the monitoring of three levels based on wireless communication systems. The system will monitor the status of solar modules, solar panels and solar inverters based on the IEEE 802.15.4-2003 ZigBee standard. A star or mesh topology can be used. With this wireless monitoring function, the status of each solar module is visible.

6. WIND AND SOLAR ENERGY INTERGRATION

The combination of wind and solar energy reduces the requirements for local storage. The combination of multi-level and complementary energy storage technologies, where a super capacitor or handwheel provides cache control to compensate for rapid energy fluctuations and for smooth transitions found by a higher-capacity battery.

Microgrids or hybrid power systems have proven to be an effective structure for the local coupling of distributed renewable energy generation, charging and storage. Recent research has considered the optimization of the operation and the use of DC to link resources on the other side. Figure 5 presents a diagram of the DC network with the conventions used for feeding.

The DC bus connects the wind energy conversion system (WECS), the photovoltaic panels, the multilevel energy storage that includes the battery energy storage system (BESS) and the super capacitor. The WECS is connected to the DC bus via an AC to DC converter. The photovoltaic panels are connected to the DC bus via a DC to DC converter. The BESS can be realized by means of the current battery technology that is connected to the DC bus via a DC / DC converter. It is connected in the vicinity of the LV - MV transformer to reduce losses and voltage loss and is connected to the main network.

7. ADVANTAGE OF WIND AND SOLAR – HYBRID SYSTEM

The main advantage of the system is that it meets the basic energy needs of non-electrified remote areas, where the power of the network has not yet been achieved. The energy generated by the wind and solar energy components is stored in a battery bank for use if necessary. A hybrid renewable energy system uses two or more methods for energy production, usually solar and wind energy. The big advantage of the hybrid solar / wind system is that when the production of solar and wind energy is used together, the reliability of the system is improved.

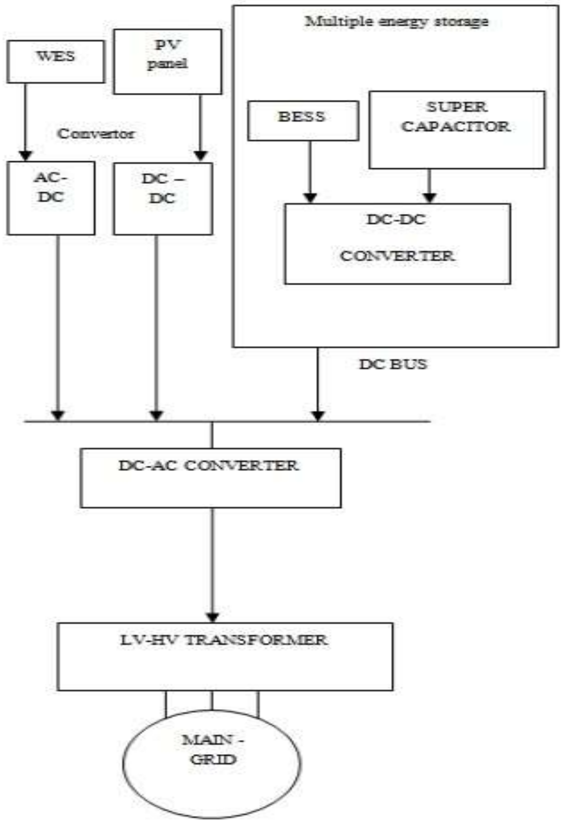

Fig. 5. Wind and Solar Integration

Moreover, the storage capacity of the battery can be reduced somewhat, because there is less dependence on an energy production method. Wind speeds are often low in periods (summer, ultimately) when the sun's sources are at their best. On the other hand, the wind tends to be stronger in the seasons when there are fewer solar sources. Even on the same day, in many regions of the world or in some periods of the year, there are different and opposite patterns in terms of wind and solar sources. And those different patterns can make hybrid systems the best choice.

A hybrid wind-solar electrical system requires a higher initial investment than larger systems: large photovoltaic wind and solar energy systems are cheaper than smaller systems. But the hybrid solution is the best option as long as there is a significant improvement in terms of performance and performance, which happens when the sun and wind sources have opposite cycles and intensities on the same day or in some seasons.

8. GRID CONGESTION

Congestion of the electricity grid is a situation where the existing transmission and / or distribution lines are not suitable for all loads that are required during periods of high demand or during emergency loads, such as when an adjacent line is decommissioned or damaged by a storm. , also reflects a decrease in efficiency.

Under high load conditions, line losses increase exponentially. If the lines are overloaded and operate at or near their thermal limits, they would also show significant losses on the line under high loads.

There have been cases where wind farms have been forced to close, even when the wind is blowing, because there is no available capacity in the pipes for the electricity they generate. Without adequate energy transfer from rich "renewable" areas (such as Arizona) to densely populated areas, it is only cost-effective to use renewable resources in certain areas of the country. While building a new infrastructure would help, smart grid technologies can also help utility companies to alleviate network congestion and maximize the potential of our current infrastructure.

Smart grid technologies [2] can help deliver real-time measurements of the high-voltage line, so that utilities can maximize the flow through those lines and help alleviate congestion. As smart grid technologies become more widespread, the electricity grid [5] will become more efficient, which will reduce congestion problems. The sensors and controls help to intelligently divert the energy to other lines when needed, by absorbing the energy from renewable sources so that the energy can be transported at greater distances, exactly where needed. Reducing network congestion can be achieved in different ways:

- Add new transmission lines.
- Construction of new capacity for power generation in the vicinity of charging centers.
- By reducing the demand for electricity in overloaded areas by making greater use of energy efficiency and conservation.

9. BATTERY ENERGY STORAGE FOR GRID STABILIZATION

Current and future electricity networks are characterized by a high share of renewable energy sources. This leads to an enormous fluctuating energy injection, which must be balanced with the energy storage of the battery, which offers network stabilization and a higher power quality: operation with four quadrants (active and reactive energy control), shaving of peaks and load balancing, daily shift of renewable energy photovoltaic energy, reliable photovoltaic energy supply through rolling clouds and providing control power to participate in this market. The additional benefit of the new energy storage of the battery is the ability to control the harmonic emissions of the electronic power equipment connected to the same busbar by using the active damping function or active filtering.

Fig: - 6 Schematic Diagram of Wind and Solar Integration.

10. SIMULATION RESULTS

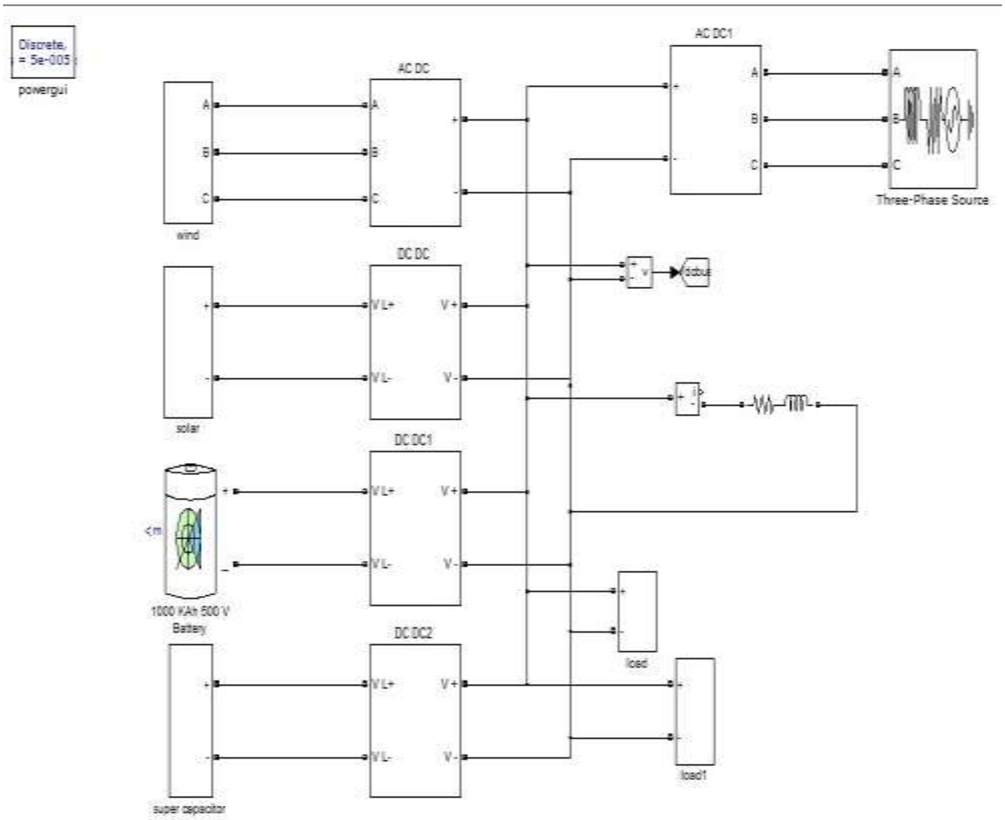

Fig: - 7 Simulink Model of Integration of Wind and Solar Power

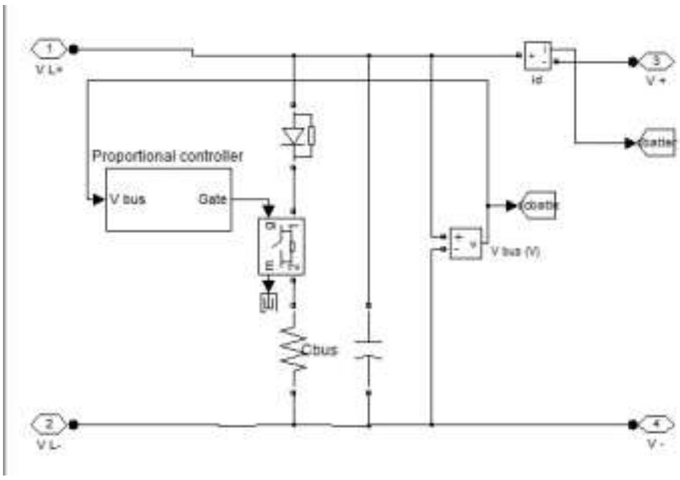

Fig:- 8 Controller of Above Simulink Model

GRID CONNECTED OUT PUTS

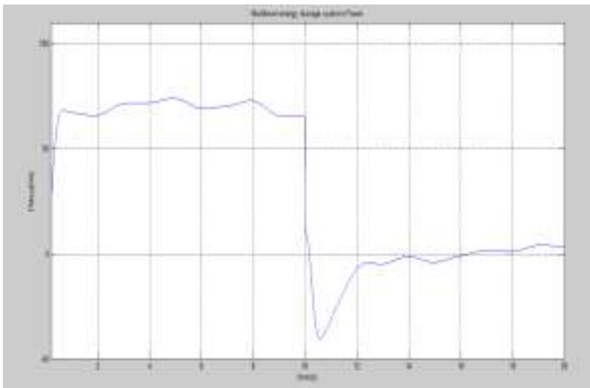

Fig:- (a)

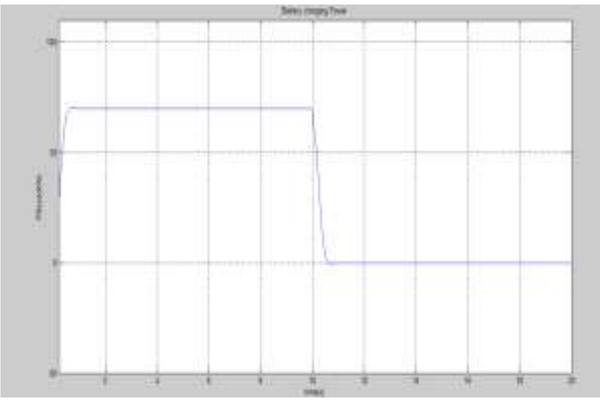

Fig:- (b)

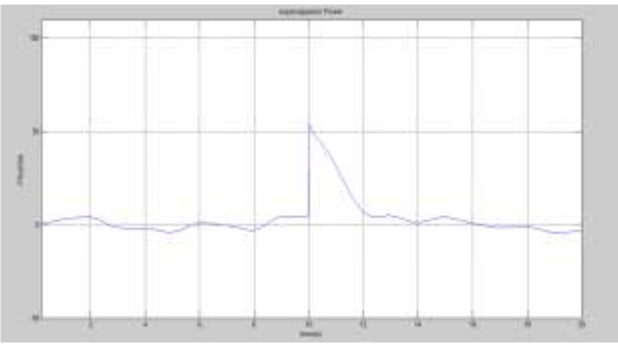

Fig:- (c)

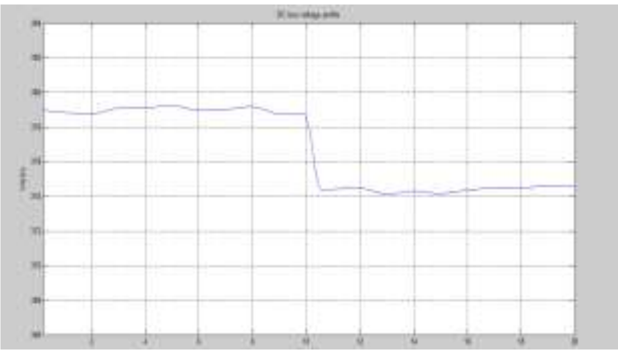

Fig:- (d)

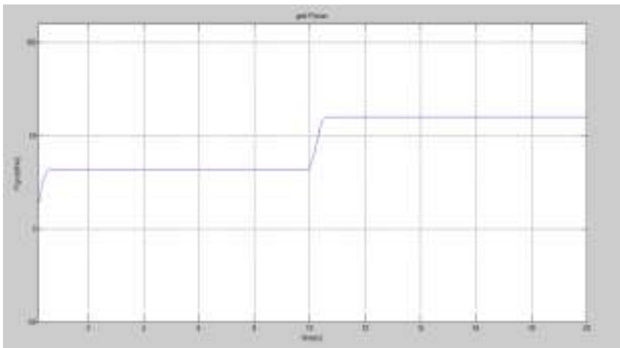

Fig:- (e)

Fig. 9. Droop-control-based responses to wind fluctuation and fast charging when SOC of battery is lower than scheduled. (a) Multilevel energy storage system (MES) charging power from the dc bus. (b) Battery charging power from the dc bus. (c) Super capacitor discharging power to the dc bus. (d) dc bus voltage profile. (e) Grid power to the dc bus.

11. OPERATIONAL OPTIMIZATION OF MICROGRID FOR RENEWABLE ENERGY INTEGRATION

In the proposed system, wind and solar energy will be used as sources of distributed generation for the Microgrid. The resulting power must be smoothed using the smoothing control unit that contains a super capacitor to reduce power fluctuations.

This flattened power after conversion to the required level must be allocated to the energy storage system of the battery to meet the demand and the supply of the loads. From the energy storage system of the battery, the energy for DC and AC users will be available for use. In this way the efficiency of the system will increase with the reduction of the various losses.

11. OPERATIONAL OVERVIEW

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13. EXPECTED OUTCOME

The expected output of the proposed system must be more smoothed with a low current fluctuation. Moreover, the efficiency will be increased and losses will be reduced. The improvement of the efficient integration of wind and solar energy in combination with the extension of the battery life of the battery energy storage system.

14. REFERENCES

[1]. M. A. Mahmud, H. R. Pota, and M. J. Hossain, “Dynamic stability of three-phase grid-connected photovoltaic system using zero dynamic design approach,” IEEE J. Photovoltaics, vol. 2, no. 4, pp. 564–571, Oct. 2012.

[2]. M. A. Mahmud, H. R. Pota, and M. J. Hossain, “Dynamic stability of three-phase grid-connected photovoltaic system using zero dynamic design approach,” IEEE J. Photovoltaics, vol. 2, no. 4, pp. 564–571, Oct. 2012

[3]. C.-H. Lin, W.-L. Hsieh, C.-S. Chen, C.-T. Hsu, T.-T. Ku, and C.-T. Tsai, "Financial analysis of a large-scale photovoltaic system and its impact on distribution feeders," IEEE Trans. Ind. Applicat., vol. 47,no. 4, pp. 1884–1891, Jul./Aug. 2011.

[4]. M. Cheng, S. Kato, H. Sumitani, and R. Shimada, "Flywheel-based AC cache power for stand-alone power systems," IEEJ Trans. Electr. Electron. Eng., vol. 8, no. 3, pp. 290–296, May 2013.

[5]. R. Majumder, B. Chaudhuri, A. Ghosh, R. Majumder, G. Ledwich, and F. Zare, "Improvement of stability and load sharing in an autonomous microgrid using supplementary droop control loop," IEEE Trans. Power Syst., vol. 25, no. 2, pp. 796–808, May 2010.

[6]. A. Chaouachi, R. M. Kamel, R. Andoulsi, and K. Nagasaka, "Multiobjective intelligent energy management for a microgrid," IEEE Trans. Ind. Electron., vol. 60, no. 4, pp. 1688–1699, Apr. 2013.

[7]. R. Dai and M. Mesbahi, "Optimal power generation and load management for off-grid hybrid power systems with renewable sources via mixed-integer programming," Energy Convers. Manag., vol. 73, pp. 234–244, Sep. 2013.

[8]. G. Madureira and J. A. Pecas Lopes, "Coordinated voltage support indistribution networks with distributed generation and microgrids," IET Renew. Power Generat., vol. 3, no. 4, pp. 439–454, Dec. 2009.

[9]. MMPT &Flywheel M. H. Nehrir, C. Wang, K. Strunz, H. Aki, R. Ramakumar, J. Bing, et al., "A review of hybrid renewable/alternative energy systems for electric power generation: Configurations, control, and applications," IEEE Trans. Sustain. Energy, vol. 2, no. 4, pp. 392–403, Oct. 2011.

[10]. Simulinkdaykira F. Giraud and Z. M. Salameh, "Steady-state performance of a gridconnected rooftop hybrid wind-photovoltaic power system with battery storage," IEEE Trans. Energy Convers., vol. 16, no. 1, pp. 1–7, Mar. 2001.

[11]. T. B. Johansson et al. "Renewable fuels and electricity for a growing world economy: Defining and achieving the potential," in Renewable Energy: Sources for Fuels and Electricity, Washington, D.C.: Island Press, 1993, pp. 1-7

[12]. Holm, "Renewable energy future for the developing world," International Solar Energy Society, ISES Headquarters, Freiburg, Germany, White Paper, 2005.