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# Energy Management Strategy of Ac/Dc Hybrid Microgrid Based On Solid-State Transformer

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***ABSTRACT:***
*This project describes the energy management scheme for ac/dc microgrid system for microgrid applications. Home energy management scheme is employed for design of power management scheme for building automation system. The predicted building load power (BLP) and renewable energy of the system reduce the build cost of the system. An ems is proposed for the developed reconfigurable grid-tied HMG architecture, which consists of a two-stage control strategy control and minimization of cost of the system. The proposed EMS for a reconfigurable grid-tied HMG architecture. Through numerical simulation studies, it is shown that the proposed EMS is capable of reducing BEC and increasing RI by concurrently enabling MMC of a reconfigurable grid-tied HMG architecture.*

***Index Terms—****Artificial neural network, building electricity*.

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## I. INTRODUCTION

Buildings are accountable for 39% of the energy consumption and also is considered one of the primary energy consumers compared with other sectors, i.e. industrial and transportation. In the building construction sector, commercial buildings (CB) account for 19% of energy consumption. In particular, commercial buildings dedicate the largest share of their building electricity cost (BEC) for maximum reliability index (RI), i.e. reliable power supply rate. In this context, a reconfigurable grid-tied hybrid ac/dc microgrid (HMG) is an attractive option to reduce BEC while increasing RI, and taking into consideration with renewable based distributed generators (DGs), i.e. solar photovoltaic (PV) and wind turbine (WT), energy storages (ESs), and genset. However, a CB consists of different types of loads, i.e. ac and dc, that have stochastic behaviors with respect to time. Also, the renewable-based DGs power is intermittent, which may reduce both BEC and RI.

The ESs life cycle is significantly reduced due to the inappropriate and frequent charging/discharging. Also, the genset would increase the BEC for maximum RI due to high fossil fuel cost. In this regard, one potential way to achieve BEC reduction with higher RI is through the design and development of a reconfigurable grid-tied HMG for CB applications. The HMG architecture may isolate dc loads to dc supply, ac loads to ac supply, and both ac/dc supply with multi-mode configuration (MMC). The main advantage of this architecture is the capability to reconfigure its structure based on the predicted building load power (BLP) and renewable-based DGs power. However, reducing the BEC and increasing the RI of a developed reconfigurable grid-tied HMG architecture is a challenging task due to the stochastic behavior of BLP, intermittent nature of renewable-based DGs power, limited capacity of ESs, and high fossil fuel cost. Hence, an energy management strategy (EMS) is essential for the proposed reconfigurable grid-tied HMG architecture.

A hybrid AC/DC micro-grid which consists of an AC grid and a DC grid and operates in both grid-tied and autonomous mode. Wind turbine generators (WTGs), diesel generators (DGs) and conventional AC loads are connected to the AC grid whereas photovoltaic arrays with boost converter (PVBC), fuel cell generators and DC loads are tied to the DC grid. AC bus and DC bus are coupled through a four-quadrant operating three phase converter which can act as an inverter or rectifier. Battery is connected to the DC bus through a charging/discharging converter to maintain energy requirement when the system operates in the isolated operation mode. The coordination control algorithms are proposed to balance power flow between AC and DC grids and to maintain both DC and AC voltages. Uncertainty and intermittent characteristics of wind speed, solar irradiation level, ambient temperature and load capacities are also considered in system control and operation. The simulation results show that system is stable under various load and supply conditions. Moreover, the hybrid grid has higher efficiency than individual DC or AC micro grid due to avoidance of multiple DC-AC-DC conversions.

The power management strategy adopted in this article utilize power flow control scheme that helps to maintain the State Of Charge (SOC) of batteries in appropriate limit, neglecting the over charge/over discharge of batteries and frequent transformation between charge and discharge. The major contribution of power flow control is assigning the highest and lowest values of SOC. By this the lifetime of batteries will get increase.

## II. WORKFLOW OF THE PROPOSED APPROACH

A reconfigurable grid-tied hybrid ac/dc microgrid architecture is proposed for CB application. The BLP and renewable-based DGs stochastic behaviors are modeled using an artificial neural network (ANN) approach to predict future time slot value. EMS scheme is proposed for the developed reconfigurable grid-tied HMG architecture which consists of a two stage control strategy Optimization algorithm is implemented for power flow control of grid tied and power management scheme. Measure the load demand and PV generation output. Determine whether the generator is on or off and how much power it should produce. Communicate with the BEMS of the other building for energy trading.

Hybrid grid is considered as the key solution to residential distribution grid. The hybrid is considered to be the future power structure in residential application and this will meet the energy production and distribution in residential renewable production. The local renewable energy production in residential application has a greater flexibility in energy control. The hybrid grid has an ability to buy energy from the conventional grid and to sell the energy produced from the renewable source back to the conventional this makes the system closed loop and bidirectional flow between conventional grid and energy storage systems. This makes the consumers to buy and sell energy through a dynamic or a static pricing scheme. The grid system requires a better control strategies and effective storage system. The bidirectional flow between the grid and storage unit makes the system complicated and creates more challenges which requires intelligent control strategies more control decision has to be made. A smart control system solution to the total grid creates a better energy flow in real time application this solution helps to maximize the benefits from the system. Moreover, the control strategy has to know about storage unit investment, energy flow between load, conventional grid, renewable grid and storage unit, and has to decide how much of energy to buy, sell, store. The storage unit which is the battery unit has limitations since the battery has to charge and discharge continuously the battery unit requires a better and optimized usage of it.

The main goal of this project is to study and to implement the new energy management control system with the bidirectional converter. The objectives of the project are divided in two parts: evaluation of the bidirectional converter and evaluation of the energy management control system. The first part includes a mathematical analysis and modeling of the bidirectional converter as well as performance evaluation through simulation. The second part includes implementation of the new energy management control system and evaluating its performance through simulation. An overall simulation is performed to prove the effectiveness of the energy management control system with the bidirectional converter. The simulation is performed using PSIM software and shows a grid connected hybrid PV/Storage system as shown in Fig.3.

The proposed management system is similar to the previously mentioned systems as shown in Fig.1. However, they model predictive algorithms lack the simplicity that residential application require and the instantaneous algorithms lack the forecast focus. Therefore, the proposed algorithm will combine simplicity of application and apply forecasting that suits the residential application. The proposed system will not discuss island detection techniques and will assume the state of the point of common coupling (PCC) will be given by a binary integer (one/zero). The proposed energy management algorithm is similar to the one in but power limitations and economic considerations are added. The proposed energy management algorithm is realized as follows in the next page:

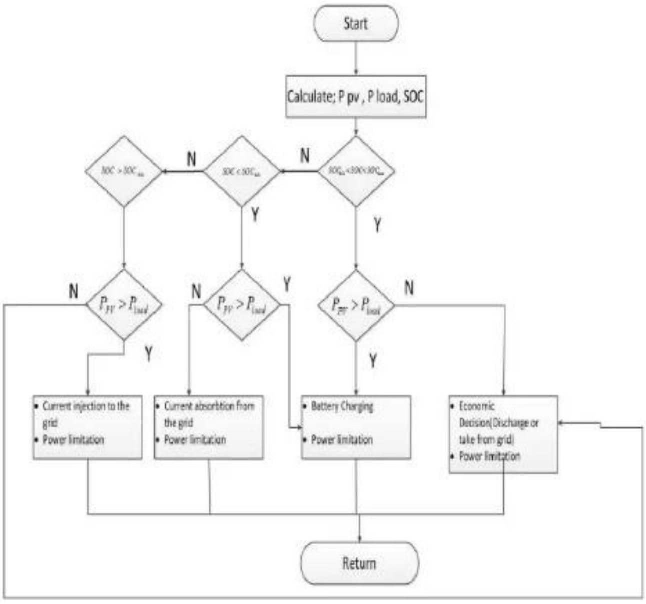


Fig.1 Proposed Energy Management Algorithm

The flowchart is similar to which consider a grid-connected mode operation as illustrated in Fig.2. However, in order to make economic decisions, load forecasting and PV forecasting must be included to make sure that the most economic state is chosen. Therefore, this algorithm will be modified to include conditions for the forecasted values and will be presented.

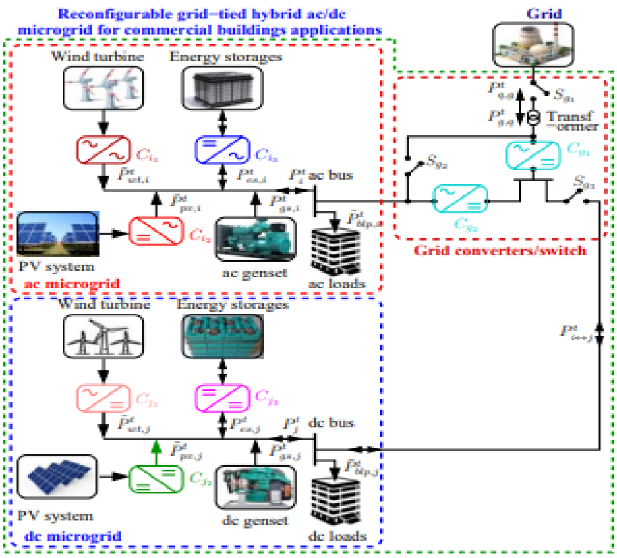


Fig.2 Building Automation

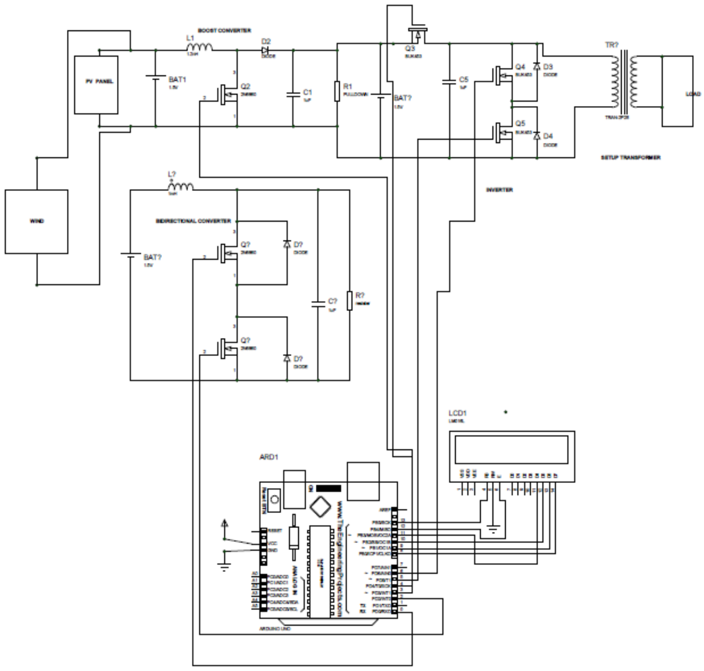

Fig.3 Simulation Block Diagram.

## IV.RESULTS AND DISCUSSION

Once the connection instructions have been followed, plug-in AC power cord, the “POWER” Red (LED) will be on, the charger will begin charging automatically and the “CHARGING” Yellow (LED) will be on during charging. When the battery is fully charged the “CHARGING” Yellow (LED) will be off and the “FULL/FLOAT” Green (LED) will be on. Float Mode allows the charger to effectively be left connected to your batteries, over the course of a season, without overcharging your batteries and maintains your battery's full charge.

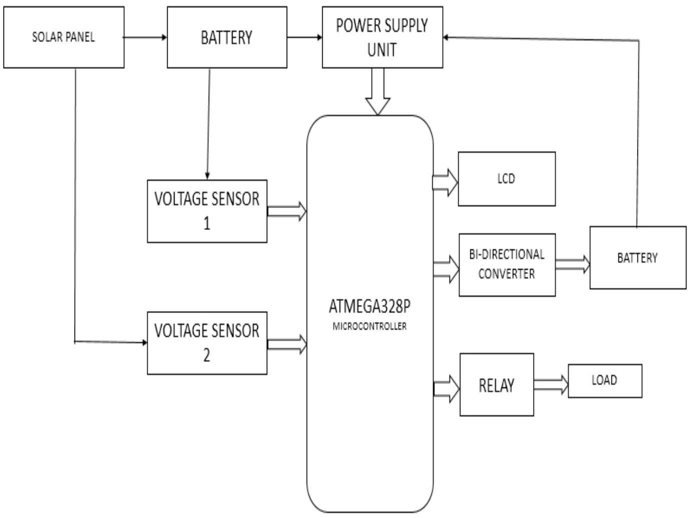


Fig.4 Hardware Block Diagram.

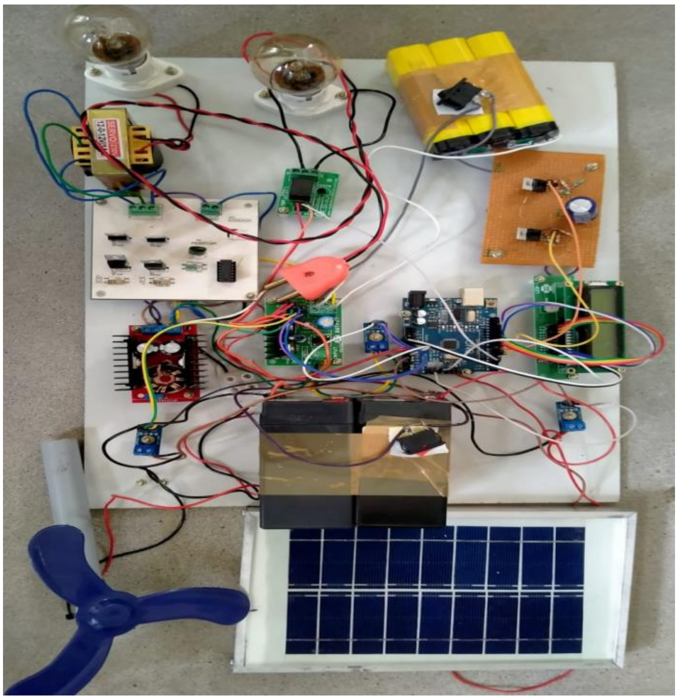

Fig.5 Implementation of Hardware Kit.

Based on the Energy Management Strategy of a Reconfigurable Grid-Tied Hybrid AC/DC Micro grid for Commercial Building Applications, it can be concluded that the use of a hybrid AC/DC micro grid system can significantly improve the energy efficiency and reliability of commercial buildings. The proposed energy management strategy allows for the optimal use of renewable energy sources such as solar panels and wind turbines while ensuring a stable power supply. The configurability of the micro grid allows for the flexibility to adapt to changes in energy demand or availability, making it a practical solution for commercial buildings with fluctuating energy requirements. The use of energy storage systems such as batteries and super capacitors further enhances the system's ability to balance power supply and demand. The implementation of a hybrid AC/DC micro grid system with an effective energy management strategy can lead to significant cost savings and environmental benefits for commercial buildings as shown in Fig.4 & Fig.5. Further research and development in this area can lead to even more efficient and sustainable energy solutions for the future.

## V.CONCLUSION

In conclusion, a power management scheme for the grid using solar and flywheel energy can provide a sustainable and reliable solution for meeting energy demands. Solar energy can be harnessed during the day and stored in batteries for later use, while flywheel energy can be used as a backup source of energy during periods of high demand or when solar energy is not available. This approach can help to reduce dependence on non-renewable sources of energy and mitigate the environmental impact of energy production. Additionally, the use of flywheels as energy storage devices offers several advantages, including high efficiency, low maintenance, and a long lifespan. Implementing this power management scheme will require significant investment in infrastructure and technology, but the benefits of a sustainable and reliable energy source for the grid can make it a worthwhile investment in the long run. Furthermore, as the technology continues to advance, the cost of solar and flywheel energy storage is expected to decrease, making it more accessible and affordable for widespread adoption.

**Future Enhancement**

There are several potential enhancements that can be made to the Energy Management Strategy of a Reconfigurable Grid-Tied Hybrid AC/DC Microgrid for Commercial Building Applications to further improve its efficiency and effectiveness.

One potential enhancement is the integration of advanced control and optimization algorithms to improve the accuracy and speed of energy management decisions. Machine learning techniques can be used to predict energy demand and supply, allowing the system to adjust proactively and optimize energy storage and distribution.

Another enhancement could be the integration of additional renewable energy sources, such as geothermal energy, which can provide a consistent and reliable source of energy for the micro grid.

Additionally, the use of smart grid technologies, such as demand response systems, can help to reduce peak demand and further optimize energy usage.

The development of more advanced energy storage systems, such as flow batteries and hydrogen fuel cells, can also enhance the micro grid's ability to store and distribute energy. Finally, the use of blockchain technology can improve the transparency and efficiency of energy transactions within the micro grid, enabling peer-to-peer energy trading and further reducing energy costs.

There are many potential enhancements that can be made to the Energy Management Strategy of a Reconfigurable Grid-Tied Hybrid AC/DC Micro grid for Commercial Building Applications, and further research and development in this area can lead to even more efficient and sustainable energy solutions for the future.

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