A Real Time Application of an Efficient Energy Management Using Renewable Energy Source

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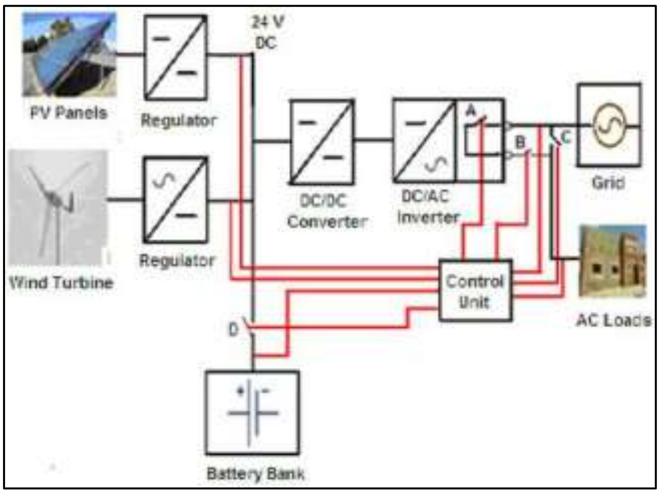
Abstract— With the event of recent technologies within the field of renewable energy and batteries, increasing range of homes are equipped with renewable energy sources (RES) and energy storage systems (ESS) to cut back home energy price. These homes sometimes have home energy management sys- tems (HEMS) to regulate and schedule each device. numerous studies are conducted on HEMS and improvement algorithms for energy price and peak-to-average magnitude relation (PAR) reduction. However, none of papers provides a spare study on the use of main grid's electricity and merchandising electricity. during this paper, firstly, we have a tendency to propose a brand new HEMS design with RES and ESS wherever we have a tendency to take utilization of the electricity of the most grid and electricity merchandising under consideration. With the projected HEMS, we have a tendency to build general mathematical formulas for energy price and PAR throughout each day. we have a tendency to then optimize these formulas mistreatment each the particle swarm improvement (PSO) and also the binary particle swarm improvement (BPSO). Results clearly show that, with our HEMS system, RES and ESS will facilitate to drop home energy price considerably to nineteen.7%, compared with the results of previous works. By increasing charge/discharge rate of ESS, energy price is weakened by four.3% for 0.6 kW and 8.5% for 0.9 kW. Moreover, by mistreatment multi-objective improvement, our system can do higher PAR with a suitable energy price.

Keywords: Home Energy Management Systems, Electricity Merchandising, Renewable Energy Sources, Energy Storage Systems, Day-Ahead Worth, Meta-Heuristic Algorithms

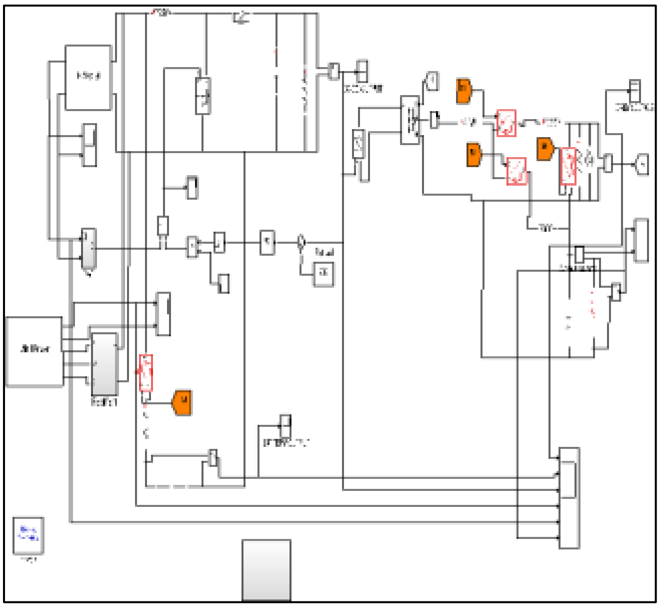
I. Introduction

In recent decades, the speed of world warming and temperature change are additional severe, inflicting world extreme events like subfigure ocean ice melting, serious flood, sturdy cyclone, and so on. one among main causes of world warming is CO2 emissions from the consumption of fuel to satisfy daily energy demand. To mitigate this prob- space vehicle, researches are conducted in 2 completely different meanss: finding additional renewable energy resources (RES) to interchange fuel and utilizing energy in a very best way with the combination of RES and energy storage systems (ESS). For the aim of utilization, sensible grid (SG) has been introduced as a replacement of the present facility that doesn't support consumer's new necessities. The SG utilizes the newest communication technologies to enhance the normal wattage system. With integration of RES and ESS, SG helps decrease the emission of carbon particulate and greenhouse gases furthermore as temperature change mitigation (CCM) [1]. 2 key integral components of SG that create it higher than ancient grids area unit advanced metering infrastructure (AMI) and demand facet management (DSM). The main functions of AMI area unit energy mensuration and data assortment. It includes of sensible meters and data and Communication Technology (ICT). The ICT permits SG to stay the customers updated regarding varied electricity costs, or events/failures thanks to devices or disasters. It additionally sends data of energy consumption measured by sensible meter to electricity operators to alter the operators to observe and analyze period of time information and create period of time selections regarding activities of power networks. DSM is a vital half within the energy management of SG. DSM provides a diversity of functionalities in various areas like electricity market management, energy management, infrastructure construction and management of suburbanized energy resources [2]. DSM, which incorporates demand response (DR) and energy improvement, encompasses a broader vary of energy demand management concepts. DSM seeks a balance between energy offer and demand on the each facet of utilities and customers whereas DR focuses on the patron facet solely. The DR is employed for the programs designed to assist end-users to scale back short- term energy demand in response to a worth signal from the electricity hourly market, or a trigger initiated by the elec- tricity grid operator [3]. DR seeks to regulate the demand for power, instead of the provision. However, it's examined within the literature that researchers thought of the DSM and DR area unit interchangeable [4]. Usually, the most objective of DSM and DR functions in SG is to encourage the customers to utilize their RES (local generators) for his or her load, particularly at peak hours, whereby decreasing the dependence on electricity suppliers. The second objective is to encourage customers to shift home load: moving the time of energy use from peak hours to off-season hours [2], [5]. These objectives additionally facilitate the customers to scale back their electricity price and energy consumption in peak hours. Moreover, with superb development electrical |of electrical} mobile devices like electric vehicles (EV) and revolution of the technologies in RES, customers area unit inspired to participate in electricity market by merchandising surplus energy. The consumers will be electrical cars, alternative homes and even electricity suppliers. To realize the on top of objectives, a home energy management system (HEMS) is needed at the patron facet. HEMS controls and optimizes RES, ESS and residential appliances in a very best means and additionally helps customers to include alternative DSM activities. Various studies have projected algorithms to optimize the operation of home appliances like linear program- Ming (LP) [6], mixed number applied mathematics (MILP) [7], [8], mixed number nonlinear programming (MINLP) [9], [10], dynamic programming (DP) [11], or hogged programming (CP) [12]. However, these techniques have terribly slow convergence rate with an oversized range of variables, and in some cases, they area unit unable to handle heaps of appliances [3], [13]. Meta-heuristic algorithms area unit utilized in HEMS to upset such shortcomings. the foremost wide used meta-heuristic algorithms area unit particle swarm improvement (PSO), binary particle swarm optimization (BPSO), genetic algorithmic program (GA), wind-driven optimization (WDO), microorganism hunting improvement (BFO) and Jaya algorithmic program [3], [13], [14], [15]. Based on the on top of background, we have a tendency to propose a replacement HEMS with integration of RES and ESS. Our HEMS is connected with electricity operator through AMI. Electricity operator sends helpful forecast data to our HEMS by exploitation AMI like valuation data and star irradiance. The projected HEMS makes the subsequent contributions. • With the combination of RES and ESS, we have a tendency to propose a novel HEMS design to scale back energy price and PAR. In our HEMS, utilizing main grid and electricity merchandising area unit stressed and delineate as follows: Our ESS will be accustomed store electricity from main grid at low worth time furthermore as electricity from RES. This electricity is reused for home load at high worth time. Moreover, our HEMS permits prosumers to sell surplus electricity at applicable time slots. • With the projected HEMS design, we have a tendency to build general mathematical formulas wherever we have a tendency to contemplate utilization of main grid and electricity merchandising furthermore because the selling worth. supported these formulas, our HEMS offers careful schedules for every device throughout on a daily basis. moreover, quantity |the quantity| the number} of electricity utilised from main grid and therefore the amount of electricity sold to the out- facet also are determined at whenever slot. • In projected HEMS, we have a tendency to mix 2 algorithms, PSO and BPSO, for improvement due to the quality of the HEMS architecture: BPSO is employed for binary variables and PSO is employed for continuous variables. • We measure the projected HEMS by activity extensive simulations. Firstly, we have a tendency to concentrate on the minimization of energy price exploitation single-objective improvement. Secondly, we have a tendency to apply multi-objective improvement to the HEMS to reduce each energy price and PAR.

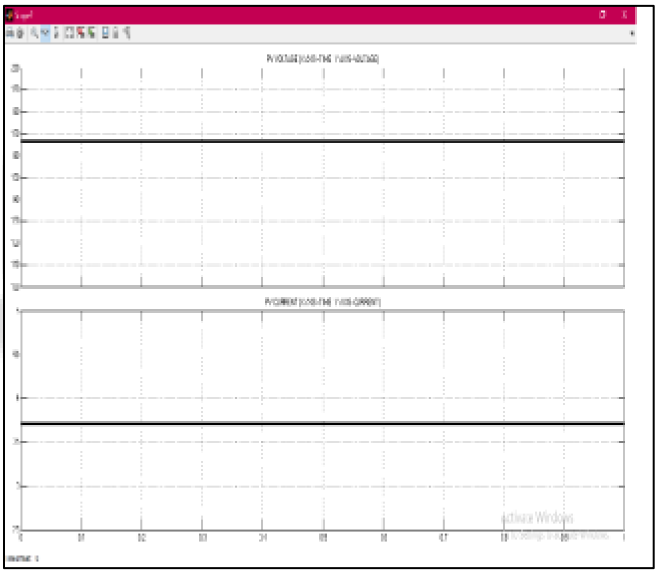


BLOCK DIAGRAM

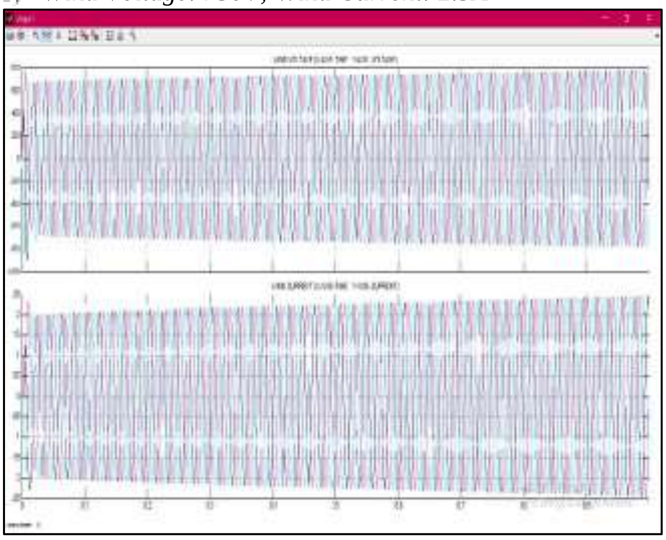
II. SIMULATION



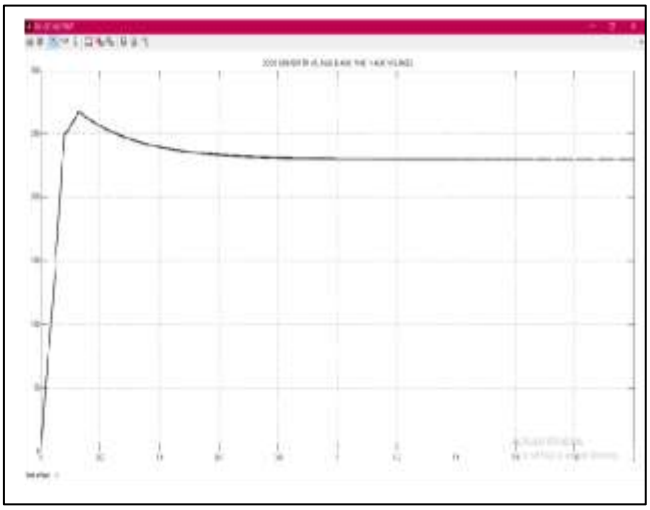
A. *Stage 1: PV Voltage: 168V; PV Current: 3.8A*



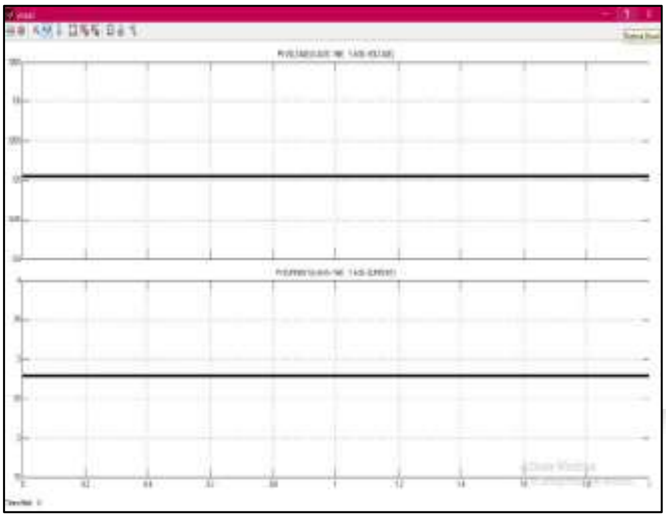
B. *Wind Voltage: 750V; Wind Current: 2.5A*



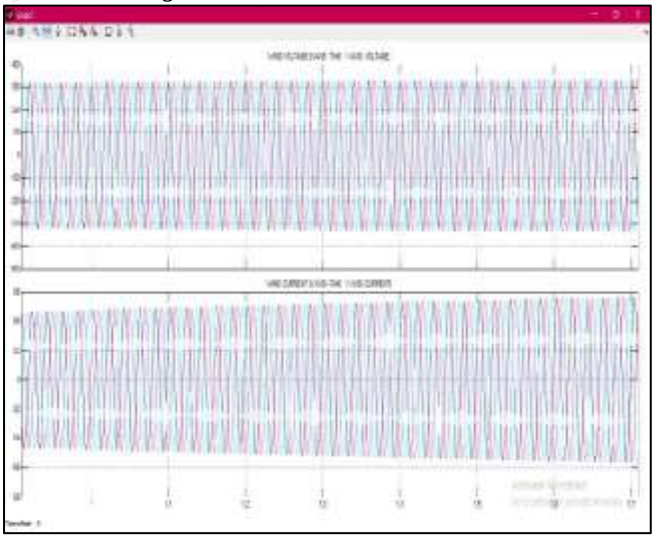
2) DC-Dcoutput Voltage(230V) AC Output Voltage-230V; Current-2.3A;



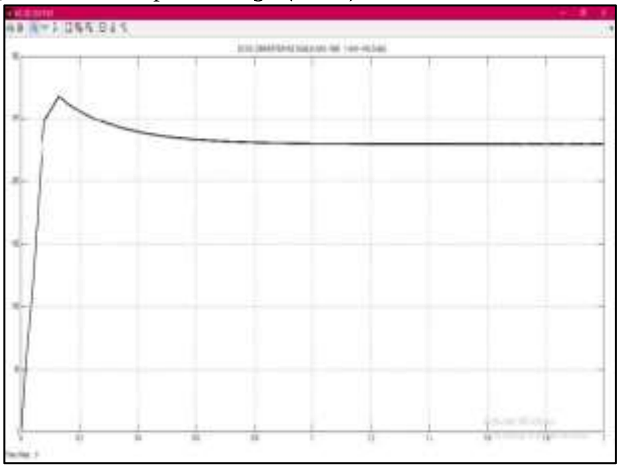
B. Stage 2: PV Voltage: 125V; PV Current: 2.8A



1) Wind Voltage: 300V; Wind Current: 0.5A



2) DC-DC Output Voltage (230V)



III. CONCLUSIONS AND FUTURE WORKS:

This study presented a new HEMS with integration of RES and ESS. Our objective was to minimize energy cost and PAR of our system during a day. The algorithms we used in our system were the combination of PSO and BPSO. Our HEMS is able to utilize electricity of the main grid at low price time to provide for home appliances at high price time with the support of ESS and RES. In addition, our HEMS support selling electricity to the outside. To achieve our objective, we built general mathematical formulas for energy cost and PAR and evaluated our HEMS by performing extensive simulations. With new functions, energy cost of our HEMS was significantly reduced to 19.7%, as compared to previous results of BPSO algorithms in [3]. However, when our system only focuses on the minimization of energy cost, PAR of our system remains very high. In order to reduce PAR, we used the weighted method of MOO to minimize both energy cost and PAR. Simulation results showed that, with appropriate values of weight constants w1, w2, energy cost and PAR of our system can be decreased to values smaller than both energy cost and PAR of BPSO algorithm in [3]. In particular, with w1 1, w2 20, both energy cost and PAR of our system were reduced by approximately 10%. In terms of ESS parameters, simulation results also show that there is considerably reduction when Chrate/Dhrate and the capacity of ESS are increased. Energy cost of our system was reduced by 4.3% and 8.5% with 0.6 kW and 0.9 kW of Chrate/Dhrate respectively and ESS must have sufficient capacity to store energy.

With development of HEMSs, user-mode energy management architecture in global scale is suggested for SG [26]. Its main responsibilities are to maintain energy efficiency and energy reliability under uncertain electricity generation and demand of prosumers. In future, our HEMS need to cooperate with this system to improve operations of SG.

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[1] In our future system, besides electricity cost and PAR, user comforts, such as thermal comfort and consecutive tasks, will also be considered. Real-time optimization is another way to improve our system. With this technology, our system can be optimized with real-time

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