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Review Paper on Consumption of Residential Electricity in a Community Micro Grid

Neha Anil Khedlekar
Prof. Santosh Kumar

Abstract: *In modern world for our day to day life we totally depends on appliances. We uses technical appliances like mobile, Ipad , Bluetooth headphones, laptops, WIFI, house hold appliances like refrigerators , washing machines, water purifiers, mixer blender and also now a days vehicles also runs on electricity . As the uses of electricity is increasing day by day Renewables are expanding quickly but not enough to satisfy a strong rebound in global electricity demand this year, resulting in a sharp rise in the use of coal power that risks pushing carbon dioxide emissions from the electricity sector to record levels. This may force residential electricity users to face the power cut problem. For this problem an application of the micro grid to provide sufficient energy sources for electricity customers. For this we proposed a model which generate electricity by using solar and thermal and provide to micro grid for fulfill the demand.*
Keywords: *Micro grid power, Renewable energy, photovoltaic system,*
Hybrid simulation, solar system.

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I. Introduction:

Energy resources are all forms of fuels used in the modern world, either for heating, generation of electrical energy, or for other forms of energy conversion processes. Energy resources can be roughly classified in three categories: renewable, fossil, and nuclear.

Fossil energy resources are obtained from dead plant and animal deposits created over the long history of the planet. These resources are vast, but limited, and are not renewable. Until recently fossil fuels have provided for the majority of humanity's energy demands. These resources mainly include coal, oil, and natural gas. Energy resources and utilization are serious societal concerns today. Energy, resources, food, water, and clean air are so intimately joined that the future of every country in the world is interminably linked; the health, economic welfare, political destiny, and national security of all peoples in the universe are at stake. Energy required to construct, maintain and operate buildings in the industrial nations account for a major portion of all energy consumed in the world, contributing to air and water pollution, capital shortage and world tension. Developing nations and those which are mainly agriculturally-based will consume their increasing just share of the world's resources as their built environment expandsHuman energy needs has always been covered by the use of RES such as wind, water power, wood burn and various other forms of biomass and have been dominated by their abundance and ease of use .

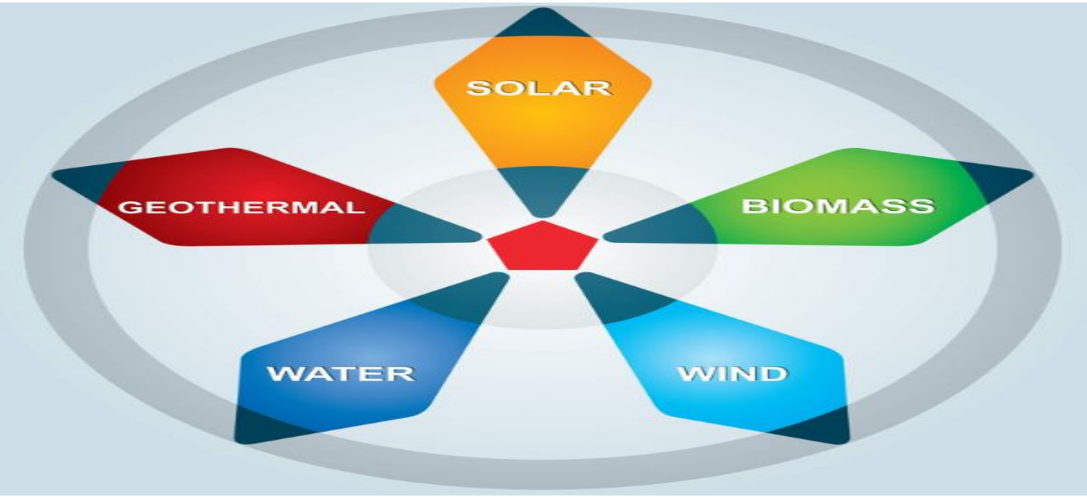

Figure 1 : Types of energy resources.

Hydro plants produce electricity using turbines and generators, where mechanical energy is created when moving water spins rotors on a turbine. This turbine is connected to an electromagnetic generator, which produce electricity when the turbine spins.

Hydro plant facilities can be categorized into three sizes: large (>30 MW), small (100 kW – 30 MW), or micro (<100 kW)[3].

Hydropower is the largest contributor of all renewable energy sources and accounts for 6.7% of worldwide electricity production [24]. Further growth of this mature technology may be possible, though many countries have already developed cost-effective sites[1].

Hydropower is an abundant, low cost source of power (where applicable), despite high upfront buidling costs[1]. It is also a flexible and reliable source of electricity compared to other renewable options, as it may be stored for use at a later time. Dammed reservoirs can also help with flood control, be a reliable water supply, and may be used for recreational purposes.

However, there are many concerns with hydropower, particularly large dam facilities. Damming a river has a significant impact on the regional ecosystem, by flooding upstream landscapes, distrupting habitats for wildlife, blocking fish passages, and often displacing local communities. In addition, dam failures can be catastrophic, further disrupting landscapes and claiming the lives of those living downstream.

Geothermal energy is heat within the earth. The word geothermal comes from the Greek words *geo* (earth) and *therme* (heat). Geothermal energy is a renewable energy source because heat is continuously produced inside the earth. People use geothermal heat for bathing, to heat buildings, and to generate electricity.

The slow decay of radioactive particles in the earth's core, a process that happens in all rocks, produces geothermal energy.

The earth has four major parts or layers:

- An inner core of solid iron that is about 1,500 miles in diameter
- An outer core of hot molten rock called magma that is about 1,500 miles thick.
- A mantle of magma and rock surrounding the outer core that is about 1,800 miles thick
- A crust of solid rock that forms the continents and ocean floors that is 15 to 35 miles thick under the continents and 3 to 5 miles thick under the oceans

Scientists have discovered that the temperature of the earth's inner core is about 10,800 degrees Fahrenheit (°F), which is as hot as the surface of the sun. Temperatures in the mantle range from about 392°F at the upper boundary with the earth's crust to approximately 7,230°F at the mantle-core boundary.

The earth's crust is broken into pieces called tectonic plates. Magma comes close to the earth's surface near the edges of these plates, which is where many volcanoes occur. The lava that erupts from volcanoes is partly magma. Rocks and water absorb heat from magma deep underground. The rocks and water found deeper underground have the highest temperatures.

Distributed energy resources are composed of energy system, controllable loads and energy storage system. Electrical energy sources such as solar PV, Wind Energy Conversion System (WECS), utility electricity grid, diesel generator, Fuel Cell System (FCS), wave energy harvester, etc. The energy storage system can be electrochemical energy storage system of various technologies, initial energy storage in a flywheel, electrostatic energy in capacitors and super capacitor, compressed air energy storage system, electromagnetic energy storage in a coil as in Superconducting Magnetic Energy Storage (SMES) system, etc... Electrical loads can be divided into critical or essential loads and non-critical or deferrable loads. Deferrable electrical loads are the type that can be switched off without causing any noticeable discomfort to the users e.g. hot water heating system or loads that can be shifted to another time of use such as dish washers, washing machines and the likes. There are some types of distributed energy resources

➢ **Diesel generator-** A diesel generator consists of a diesel engine and a synchronous generator. The synchronous generator rotor shaft is mechanically coupled to the diesel engine shaft. The diesel engines (also known as a compression-ignition), named after Rudolf Diesel, and is an internal combustion engine in which the fuel ignition is caused by the elevated temperature of the air in the cylinder due to mechanical compression. Diesel engines work by compressing only the air. This increases the air temperature inside the cylinder to such a high degree that atomized diesel fuel that is injected into the combustion chamber ignites spontaneously. The magnetically excited rotor converts the input mechanical power to electrical energy through the electromagnetic interaction between the rotor magnetic field and the stator magnetic field. The four main subsystems are the speed governor, the fuel injector, the prime mover and the synchronous generator [13]. The automatic voltage regulator (AVR) is not explicitly shown in the block which is used to regulate the output AC voltage while the governor regulates the mechanical speed for the engine. The mechanical speed of the engine is exclusively related to the frequency of the output voltage waveform.

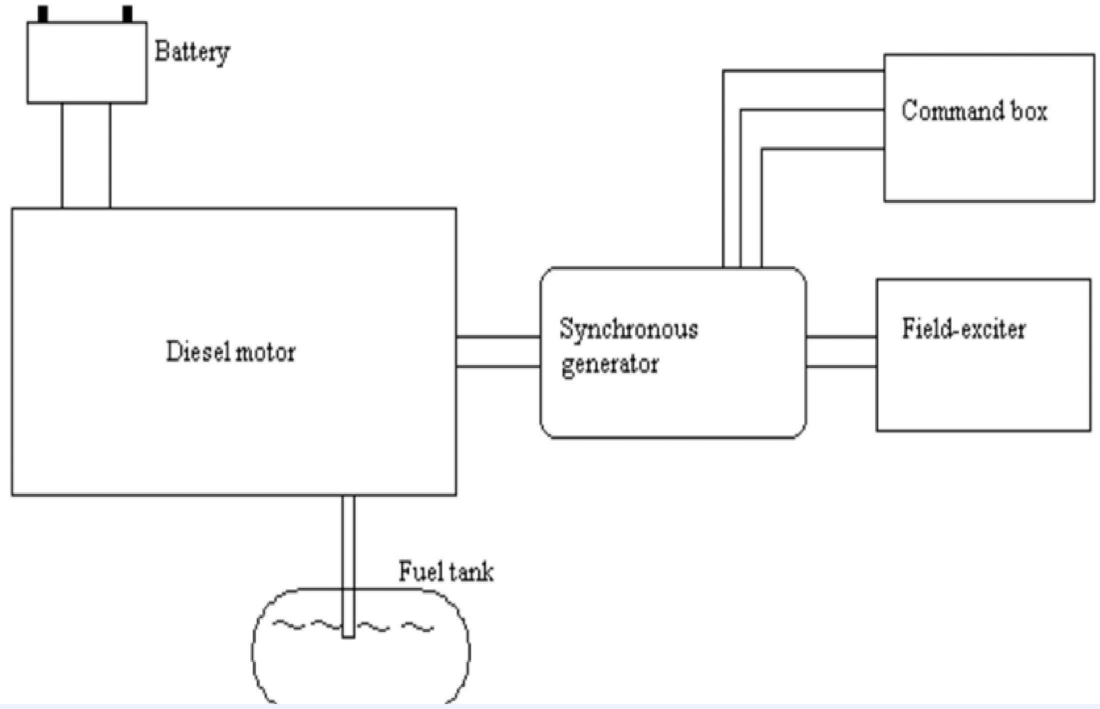

Figure 2 : Diesel generator architecture.

➢ Battery Energy Storage System: Battery energy storage system converts stored chemical energy to electrical energy. The form of the electricity is DC. A rechargeable battery is able to convert chemical energy to electrical energy and vice versa as well. The most commonly used rechargeable batteries are lead-acid batteries as they are relatively cheap, robust and reliable and have good storage density. The major disadvantage of batteries is their need for the control of charging and discharging processes. This control allows enlarging the number of charge/discharge cycles and improving the battery life. Therefore, a charge controller is always used to regulate the charge and discharge rate of a battery. An electronic charge controller is responsible for performing this function.

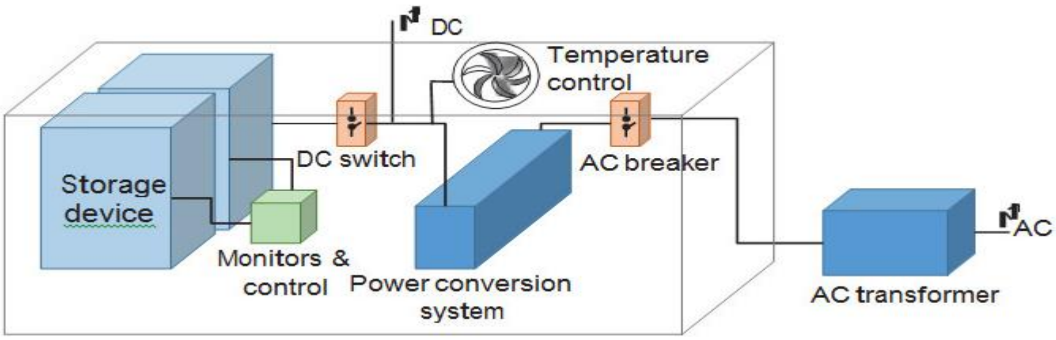

Figure 3 : Battery energy storage system architecture.

➢ Electrical Loads: Electrical loads are electronics and electrical appliances that are used in homes, offices, industries, and many other places that are supplied with electrical energy. These appliances mainly convert electrical energy into different useful energy forms such as: light energy (lighting), mechanical energy (motor), heat energy (hot water heating) etc. The use of these appliances can only be predicted and precisely unknown in terms of when and how long it can be switched on. Statistical metrics are usually used to construct the pattern of use [13]. A typical load profile is shown in Fig. 1.8.

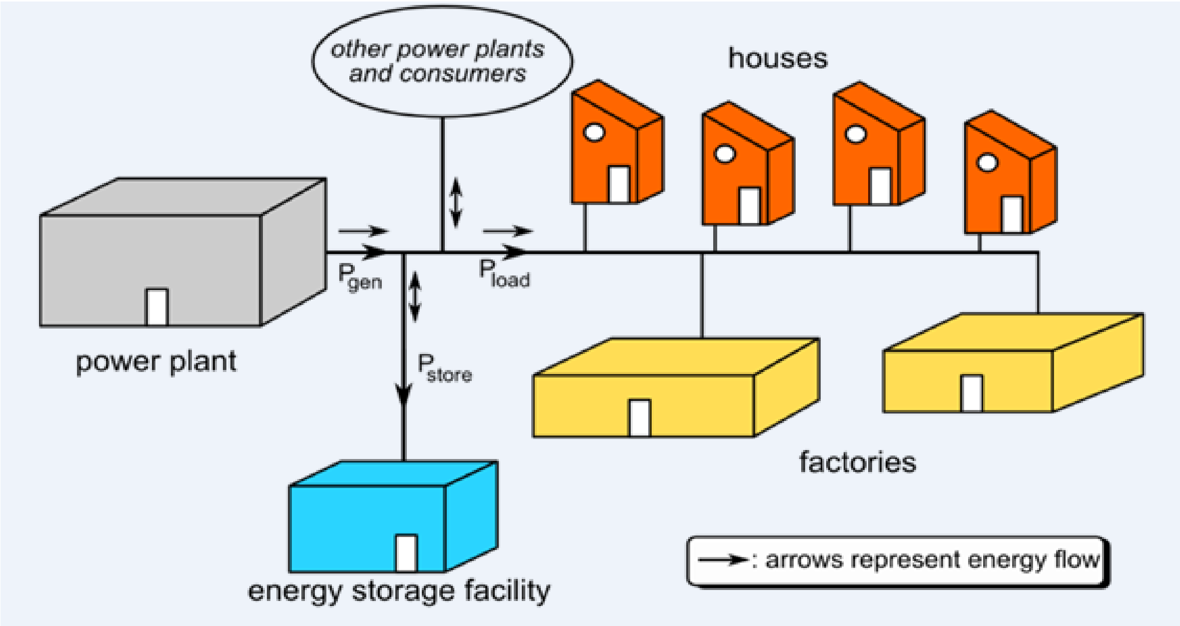

Figure 4 : Electrical loads in different places.

Green house is a structure commonly used in agriculture to grow plants with intensive care for better production. Solar energy is now used prominently to heat green house and therefore such system is labeled as solar green house where solar energy is used for both heating and lighting. The system is well to retain heat during night and cloudy days. This setup will greatly reduce the need to use fossil fuel for heating. In some green house configurations, gas or oil heater is used as backup heater to release CO_2 for better plant growth.

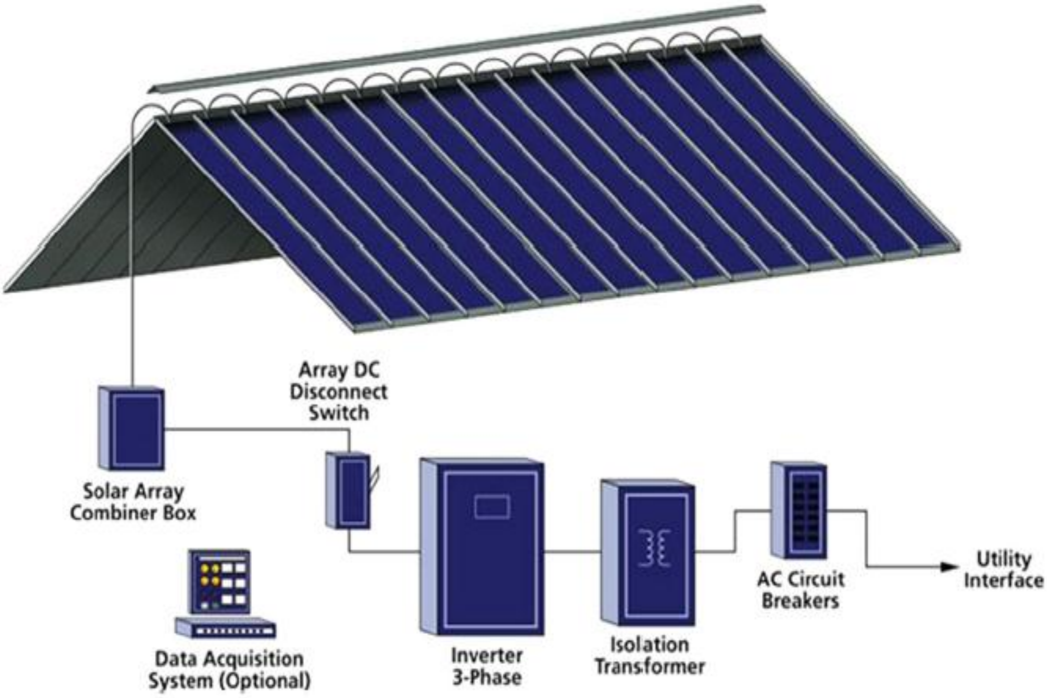

Figure 5 : Building integrated photovoltaic system.

Related work

[1] In this paper, author aimed to develop a simulation-based electricity analysis scheme for a real community microgrid configuration using a proposed modelling methodology, simulation mechanisms, and a power balancing control strategy under the MATLAB environment. Simulation results of this paper considering different weather conditions reported the observed performance of electricity analysis. Calculations of electricity

bills depending on two electricity rates are also discussed. It also represented the benefits of electricity bill reduction when electricity users accepted the power supply from community microgrid systems. This paper also presented an effective simulation mechanism under the MATLAB/Simulink environment for the electricity analysis in C-ugrid systems, and it can flexibly be modified so as to comply with different simulation requirements when faced with various system topologies.

[2] In this paper, author presents the potential role of thermal power generation in a future power system with high shares of variable generation while considering different sources of demand side flexibility such as heat pumps and heat storages in district heating, demand response from industries and electric vehicles. The research in this paper is carried out using a generation planning model combined with a unit commitment and economic dispatch model. The results from the planning model show a strong shift away from combined cycle gas turbines to open cycle gas turbines and gas engines as the share of wind power and solar photovoltaic increases. Demand side flexibility measures pushed this trend further. The results from the unit commitment and economic dispatch model of this paper demonstrate that the flexibility measures decrease the ramping frequency of thermal units, while the ramp rates of thermal units remain largely unchanged or increased. This indicates that the flexibility measures can cover smaller ramps in the net load more cost-effectively but that thermal power plants are still valuable for larger ramps. Impacts on emissions and electricity prices are also explored.

[3] In this paper, author presents a status review of the technical issues that may appear under the community grid scenario. Building upon the surveyed issues, this paper also reviews and discusses approaches to solutions, which are required in order to make the community grid highly renewable and sustainable. To achieve the de-carbonization of grid network and empowering energy citizens, a way of penetrating high renewable in the low voltage distribution network through the development of community grid is presented here. This will allow multiple integration of μGens and other DGs in a sustainable way. With all of improvements in DER based integrated energy system development and integration, maintaining the grid stability, improved power quality and efficient energy management with high penetration of renewable from a large number of micro-generation systems in the distribution network are still a matter of great concern. Therefore, a concept of community grid structure in the form of virtual microgrid embedded in the distribution network is presented in this paper. A major goal of this proposed community grid structure is to increase renewable energy usage by facilitating the consumer transition to active prosumers, and giving them a scenario to develop the solution using their existing setup.

[4] In this paper, author proposed a DSM scheme for electricity expenses and peak to average ratio (PAR) reduction using two well-known heuristic approaches, the cuckoo search algorithm (CSA) and strawberry algorithm (SA).This paper also proposed a smart home decides to buy or sell electricity from/to the commercial grid for minimizing electricity costs and PAR with earning maximization. It makes a decision on the basis of electricity prices, demand and generation from its own microgrid. The microgrid consists of a wind turbine and solar panel. Electricity generation from the solar panel and wind turbine is intermittent in nature. Therefore, an energy storage system (ESS) is also considered for stable and reliable power system operation. Author also tested their proposed scheme on a set of different case studies. The simulation results of this paper confirm author's proposed scheme in terms of electricity cost and PAR reduction with profit maximization.

[5] In this paper, author proposed design considerations to transform the Malta College of Arts, Science and Technology (MCAST) current and future planned electrical network system into an efficient micro-grid. During this study, consumption of electrical loads and photovoltaic (PV) generation has been monitored by author in real-time to define the micro-grid concept. These measurements provide the values to integrate a combined 63kWp PV system together with intelligent loads such as heating, ventilation and air conditioning systems, and lighting, highlighting the integration capabilities. The future enlargement of the MCAST micro-grid is also considered and recommendations are given on the infrastructure to complete an integral campus wide transformation. Eventually the 3DMgrid would be a blueprint for future micro-grids for training purposes. This paper also results real measurements obtained by main 400 V feeders within a realistic MCAST Pilot Micro Grid campus. The analysis of this paper is used to design the micro grid requirements and plan future expansion within the campus as well as energy storage systems and increase renewable energy and electrical energy systems. In addition, the demand and consumption curves of a real micro grid are also parameterized by the author, which is susceptible to serve as a test bench for other studies in this field.

[6] In this paper, author proposed a novel method for the microgrid energy management problem by introducing a nonlinear, continuous-time, rolling horizon formulation. The method is linearization-free and gives a global optimal solution with closed loop controls. It allows for the modelling of switches. They also formulated the energy management problem as a deterministic optimal control problem (OCP). They also solved (OCP) with two classical approaches, the direct method and Bellman's Dynamic Programming Principle (DPP).In both cases, author has used the optimal control toolbox Bocop for the numerical simulations. For the DPP approach, they implemented a semi-Lagrangian scheme adapted to handle the optimization of switching times for the on/off modes of the diesel generator. The DPP approach allows for accurate modelling and is

computationally cheap. It finds the global optimum in less than one second, a CPU time similar to the time needed with a Mixed Integer Linear Programming approach used in previous works. They achieved this result by introducing a 'trick' based on the Pontryagin Maximum Principle. The trick reduces the computation time by several orders and improves the precision of the solution. For validation purposes, authors have performed simulations on datasets from an actual isolated microgrid located in northern Chile.

[7] The main objective of this paper is to provide a comprehensive literature review to identify, classify, evaluate and analyze the performance of different methodologies, models and energy systems for isolated areas. Therefore, effective information could be provided to support decision making toward to appropriate energy models and systems for isolated areas with different scales and demands. This paper has also reviewed the forecasting techniques of energy demand and renewable energy (RE) resources, energy models, application of hybrid RE systems (HRESs), and management of energy planning for two most representative isolated areas: islands and remote villages. The uncertainty analysis of energy systems of isolated areas is also discussed. It is evident that the indigenous RE resources show great potentials for the energy system of isolated areas, especially the solar and wind resources. The various combinations of photovoltaic (PV), wind, diesel and batteries have been proven more competitive. Also, it is necessary to develop sophisticated models that are more applicable to isolated areas and that consider the distinctive characteristics, practical needs and uncertainties of isolated areas. In this paper, various forecasting techniques for both energy demand and RE were identified and classified. The developed approaches suitable for isolated areas based on conventional forecasting techniques were surveyed. The evolution of modelling approaches was also explored, and the applicability of these models for isolated areas was analyzed. The roles of RE and HRES in isolated areas were evaluated, and the application of various configuration of HRESs for different isolated areas were investigated. The management including policy effect on energy planning of isolated areas were discussed with two typical representatives: islands and remote villages.

[8] In this paper, author presents a novel modelling approach to optimize the electrical and thermal energy management of a multiple energy carrier micro-grid with the aim of minimizing the operation cost such that system constraints are satisfied. The proposed micro-grid of this paper includes a micro-turbine, a fuel cell, and rubbish burning power plant, a wind turbine generator system, a boiler, an anaerobic reactor-reformer system, an inverter, a rectifier, and some energy storage units. This model uses day-ahead forecasting (24 h) to estimate the electrical and thermal loads on a micro-grid network. A day-ahead forecast is also used to estimate electricity generation from wind turbines. Due to the uncertainty associated with day-ahead forecasts, a Monte Carlo simulation is used to estimate thermal loads, electrical loads, and wind power generation. Also, a real-time pricing demand response program is used to shift non-vital loads. The operating cost of the micro-grid is minimized through the particle swarm optimization algorithm. The simulation results demonstrate the proposed modelling framework is superior over conventional centralized optimal scheduling models widely used in the literature in terms of reducing operating cost and computational complexity. The main advantage of the proposed agent-based method of this paper is simplicity that has a key role in moving towards sustainable development of the MECMs. Numerical tests are carried out on a typical MECM. Analyses and tests have proved that the decentralized nature of the MAS distributes the computational burden and yet further optimizes the operational cost of the MECM as compared with the conventional centralized modelling frameworks. This paper also demonstrates that by using the proposed architecture, several uncertain parameters can be managed and the RTP-DRP can be implemented without facing a complex modelling scheme.

[9] In this paper, author presents a novel characterisation framework for energy services based on their relative flexibility and consumer prioritisation. Detailed survey data from 154 households across five microgrid sites in Nepal is used to test this framework, and assess the potential insights that it can provide for microgrid designers and operators seeking to reduce costs and improve reliability when serving poor rural communities. The five microgrids in this paper represents very different energy services and microgrid technology contexts, yet all would appear to have demand-side management opportunities that can trade-off cost and reliability and prioritise loads according to user preferences. Their proposed energy services characterisation framework has appeared to a useful contribution towards improving MG design and operation. It provides insights into the potential flexibility of end-users' energy service needs that can help reduce the costs and improve the reliability of MGs these communities. Their field survey of five different MGs highlights the opportunity for system designers to tailor MGs to improving energy service delivery by focusing on the relative value, and any inherent flexibility and inherent storage, of different energy service needs. The preferences of the user play a major role in the strategy and need to be identified with consideration of the socio-economic context, ideally discovered through a field-level survey.

[10] In this paper, author proposed energy management optimization problems in a future wherein an interaction with micro-grids has to be accounted for. They modelled this interaction through a set of contracts between the generation companies owning centralized assets and the micro-grids. They have also formulated a general stylized model that can, in principle, account for a variety of management questions such as unit-

commitment. The resulting model, a bi level stochastic mixed integer program will be numerically tackled through a novel pre processing procedure. This paper results the solution for the bi level (or single leader multiple follower) problem will be neither “optimistic” nor “pessimistic”. This paper numerically evaluated the difference of the resulting solution with the “optimistic” solution. They have also demonstrated the efficiency and potential of our methodology on a set of numerical instances.

[11] In this paper, author has presented a comprehensive and critical review on the developed microgrid energy management strategies and solution approaches. The main objectives of this energy management system are to optimize the operation, energy scheduling, and system reliability in both islanded and grid-connected microgrids for sustainable development. Hence, microgrid energy management system is a multi-objective topic that deals with technical, economical, and environmental issues. This extensive review addresses solutions, opportunities, and prospects to achieve the energy management objectives using various efficient methods. These methods are selected based on their suitability, practicability, and tractability, for optimal operation of microgrids. The objective types of MG EMS depend on its operation mode, its centralized or decentralized operation, economical aspects, and the intermittent and volatile nature of renewable energy sources. They also consider environmental issues of conventional generators, health status of batteries, active DR integration, system losses and reliability, and customer privacy.

Proposed work

With economic growth driving a gradual increase in electricity demand, electric power systems have recently introduced advanced grid or new energy technologies to satisfy these demands. In many advanced electric grid technologies, the microgrid (ugrid) system is one of most important applications, acting as a controllable localized electricity supplier for providing reliable energy to area demand facilities, promoting energy savings, minimizing carbon emissions, and reducing electricity bills for electricity users. The major components of ugrid systems include distributed/renewable energy resources, different types of energy storage systems (ESSs), grid-connected and islanding operation mechanisms, and various real-time monitoring and management/control methods [1]. The main purpose in the following simulations can be used to observe the home user electricity consumption under the considered scenarios by the proposed modelling methodology and simulation mechanism. The smart home is able to make decisions at every hour to shift the load, purchase, sell or store electricity. In this case, a smart home imports electricity when rates are low and in ON-peak hours the load requirement is met by the microgrid, and the excess electricity is sold back to the commercial grid against high prices. The smart home earns maximum profit with this activity.

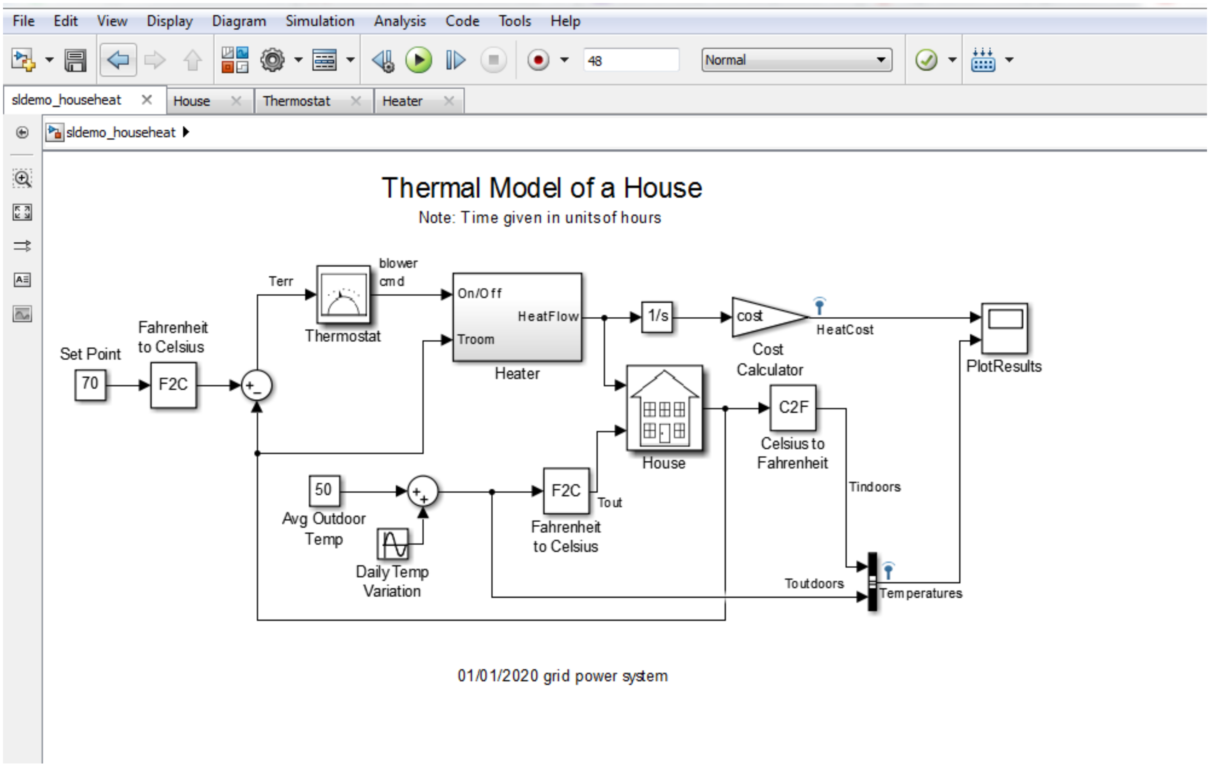

Figure 6 : This figure shows Simulation model of a domestic house.

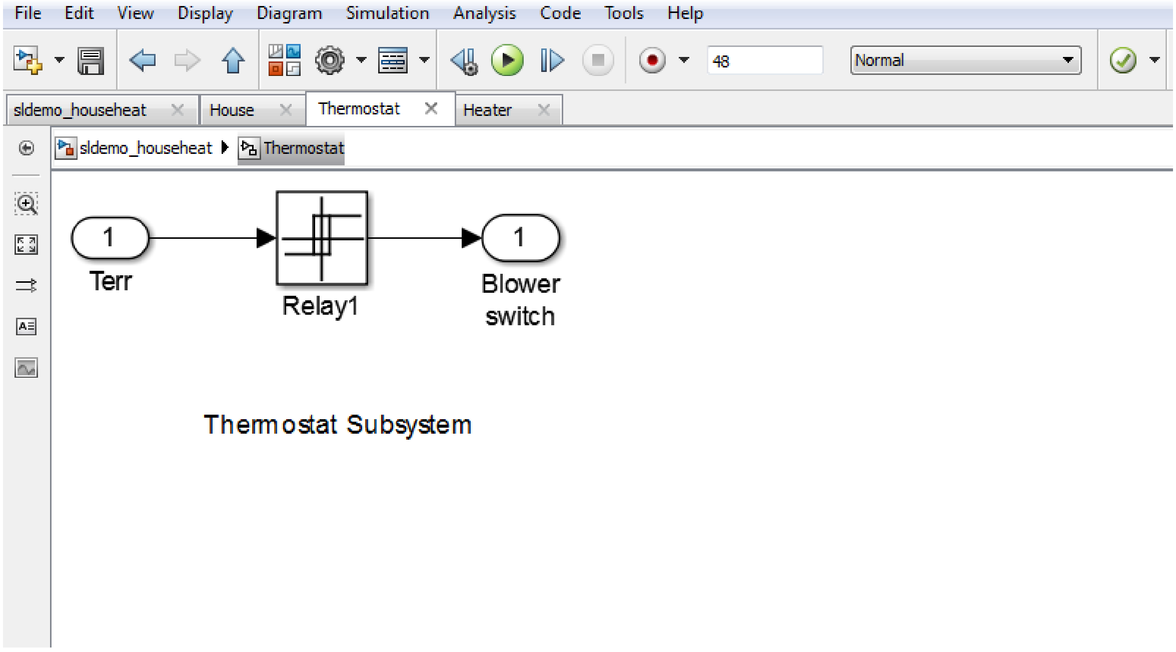

Figure 7 : This figure shows the proposed thermostat subsystem.

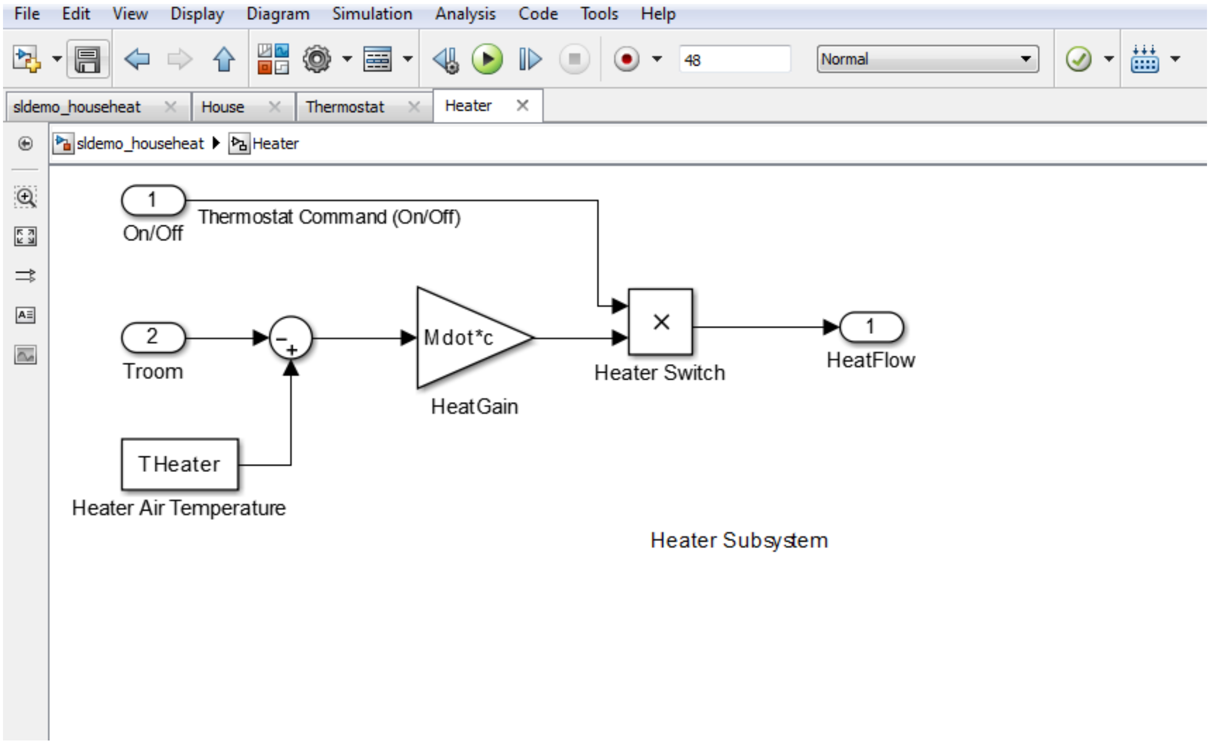

Figure 8 : This figure shows the proposed heater subsystem.

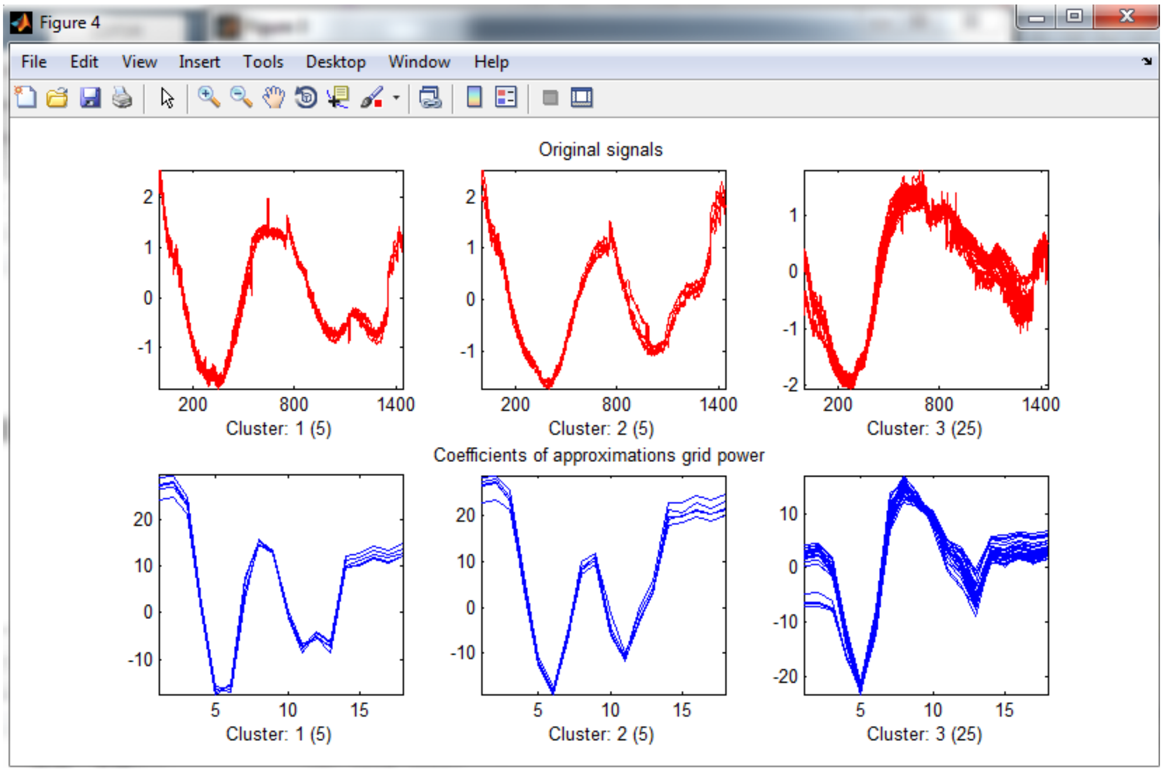

Figure 9 : This figure shows the output signals for coefficients of approximations grid power.

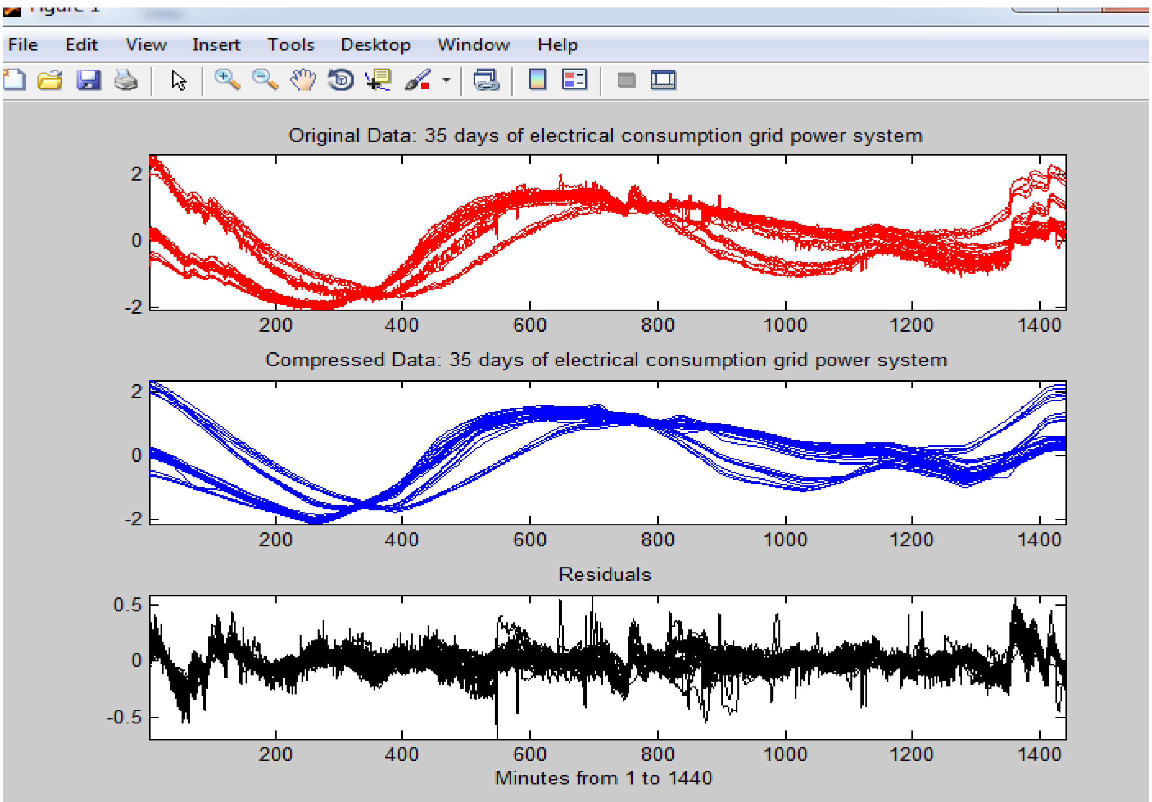

Figure 10 : This figure shows the output signal of electrical consumption for grid power system.

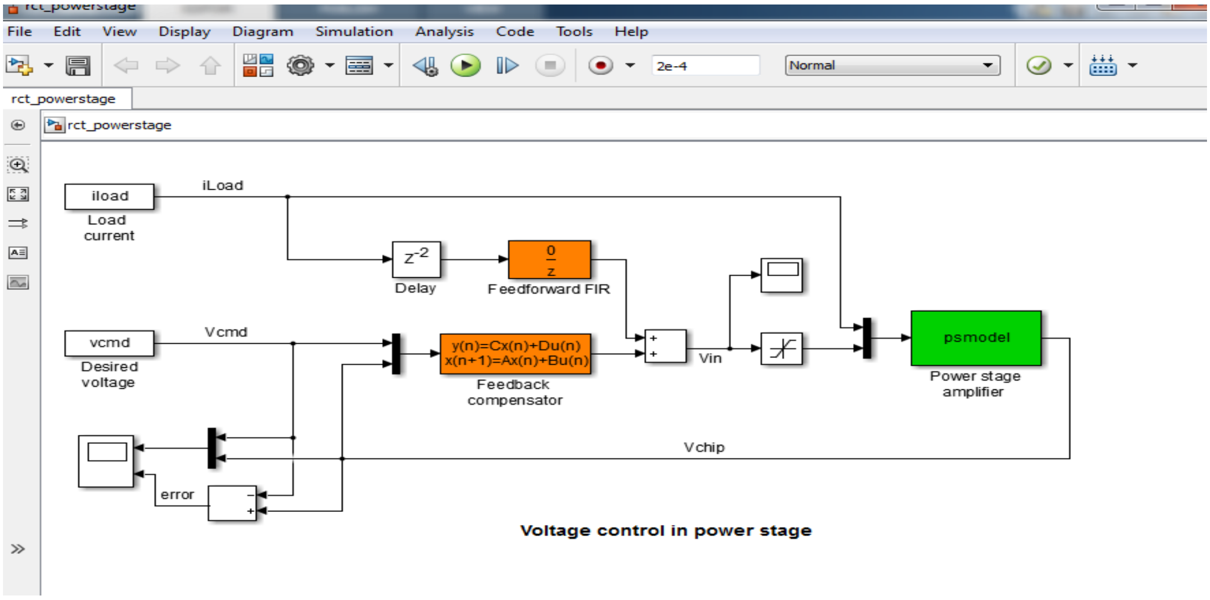

Figure 11: This figure shows the proposed voltage control in power stage.

COMPARATIVE RESULT STUDY

Time	Load Demand	GRID POWER SUPPLY	µgrid power supply	TIME	LOAD DEMAND	GRID POWER SUPPLY	µgrid power supply
0:00-01:00	4.14	4.14	0	12:0-13:00	7.58	0.01	7.57
1.00-2.00	4.19	4.19	0	13.0-14.00	6.99	0.01	6.98
2.00-3.00	4.8	3.8	0	14.0-15.00	5.45	0.01	5.44
3.00-4.00	3.71	3.71	0	15.0-16.00	3.75	0.01	3.74
4.00-5.00	3.33	3.33	0	16.0-17.00	3.43	0.01	3.42
5.00-6.00	3.68	3.68	0	17.0-18.00	4.38	0.01	4.37
6.00-7.00	4.09	3.5	0.59	18.0-19.00	4.42	0.01	4.43
7.00-8.00	3.7	0.5	3.2	19.0-20.00	5.3	0.01	5.29
8.00-9.00	3.41	0.05	3.36	20.0-21.00	5.97	0.01	5.96
9.00-10.00	3.21	0.02	3.19	21.0-22.00	5.78	3.65	2.15
10.0-11.00	3.09	0.01	4.24	22.0-23.00	5.65	5.65	0
11.0-12.00	4.25	0.01	3.07	23.0-24.00	4.72	4.72	0

LOAD DEMAND	**109.02**
GRID POWER SUPPLY	**41.06**
µ GRID POWER SUPPLY	**67**

Table 1 : Shows the comparative studies of load demand, grid power supply and µ grid power supply for Sunny day.

LOAD DEMAND	**109.02**
GRID POWER SUPPLY	**67.18**
µ GRID POWER SUPPLY	**39.25**

Table 2 : Shows the comparative studies of load demand, grid power supply and µ grid power supply for Cloudy day.

II. Conclusion and future scope

The exponential increase in global energy demand is the main cause of rapid depletion of fossil fuels and increased greenhouse gas emissions of conventional generators (CGs). To overcome these problems, the world has taken initiatives to deploy renewable energy resources (RERs) on a large scale, in order of GW, since a decade. The RERs, such as solar, wind, biomass, hydro, and tidal power are one of the most important sources in providing clean energy and mitigating greenhouse gas (GHG) emissions for sustainable development. United Nations Sustainable Development and Paris Climate Agreement goals also promote installation of RERs. RERs, micro CGs, and energy storage systems (ESSs) are often described as distributed energy resources (DERs) in the literature. DERs are on-site generation sources in distribution system. Hence, no transmission equipment is required for power transfer to load ends. In DERs, the RERs, particularly solar and wind energy are volatile and intermittent energy sources. Therefore, ESSs and micro CGs are needed to overcome these uncertainties. The integration of DERs into distribution network requires the optimal sizing, control, and scheduling of these energy resources. Understanding the use of electricity from different energy sources in a C-ugrid can be helpful for user demand management and system operation control. In this paper, a modeling and simulation methods for a C-ugrid system is developed to study electricity analysis of residential users. To study the performance of electricity analysis, proposed schemes that integrate solar and thermal modeling methodologies, implementation of real-time simulation. Two different weather scenarios, sunny and cloudy, are considered in simulations so as to observe the power supply capabilities among different energy sources to users in the C-ugrid. The major contribution of this paper is to present an effective simulation mechanism under the MATLAB/Simulink environment. In this dissertation we proposed a model which generate the electricity by suing solar and thermal and provided to micro grid for fulfill the domestic user electricity demand. In future we can also used some optimization techniques to enhance the performance of such renewable energy system.

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