Electricity Consumption Analysis in A Community Microgrid System: Survey & Discussions

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ABSTRACT
In the present life of modernization and financial development, energy is the main ingredient. Thus, the increasing energy demand is stressing the transmission and generation system capabilities leading to frequent power outages and hence developing reliability, stability, and quality problems of the power system. Security, reliability, and economy are the main basic requirements for the operation of the electric power system. 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. A microgrid is defined as a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. In this study, a community microgrid is composed of solar photovoltaic system, diesel generators, energy storage system and composite electrical loads that can be intelligently segregated.

Keywords:- Electrical Consumption, Microgrid, Energy, Renewable Energy.

INRODUCTION

Governments are under heavy pressure to achieve secure and environmentally friendly energy resources, at the same time to ensure the prosperity and the development of their communities. This pressure is transmitted to the cities, societies and industries who either; continuously research enhancements to their processes that consume energy the most or optimize their running configurations for quality, reducing reparation energy. Another option is renewable energy resources which are abundant and clean sources that have the ability to meet the demand of the countries with competitive cost However, renewable energy resources like solar and wind energy produce variable energy, which makes these systems unreliable power generation systems [10].

In recent years with the electric power system development toward the smart grid, there is an increasing interest in microgrids as they are considered flexible, intelligent, active participants, secure, environmentally friendly, and economic [5]. The concept of microgrid was first developed by R. H. Lasseter in 2002. Microgrid is a distributed generation pattern that encompasses a variety of energy sources, ranging from clean and efficient fossil-fuels technologies (such as micro-turbines), as well as from environmentally friendly renewable energy technologies such as photovoltaics, fuel cells, wind, biogas, hydro. Combination of different but complementary energy generation systems based on renewable or mixed energy (renewable energy with backup bio-fuel/diesel generator) are known as a renewable energy hybrid system. The grid formed by this system is known as a micro-grid due to its size compared to thr main grid. The renewable energy technologies generate many environmental and economic benefits. By definition, they do not use fossil fuels, which means they generate low or zero greenhouse gas emissions and less pollution. Investments in renewable technologies bring the added benefit of stimulating employment and economic growth, which move the world closer to a low-carbon economy [3].

As load demands are fluctuating with time, the variations in solar or wind energy generations do not always match frequently unable to meet the needs of customer's sufficiently and reliably due to the volatility of renewable resources. The micro grid system involving generation systems, storage units, and controllable loads can minimize the randomness nature of renewable energy sources (REs), resolve oversizing issues, and improve the reliability of the supply. Therefore, it is predictable that electricity generation, transmission, and customers demand. Thus, there is need to use storage system or other components including grid for providing incessant power supply to the load [7].

A modern microgrid is an integrated energy system consisting of localized grouping of distributed electricity generation with storage and multiple electrical loads. It can be controlled as one entity or grid, either standalone, completely separate from, or connected to, the existing utility grid. The development of the microgrid has been largely dominated by energy demand-side management, RE penetration and its integration into the utility grid. In cases where it is not possible to connect the microgrid to the utility grid for any reason such as the remote or isolated location, a stand-alone microgrid (SAM) is an answer to the power supply challenges. The authors of this research envisioned that the SAM is a good starting point to transit from the classic trend of fossil-fuelled powered systems to 100% RE powered systems [9].

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].

II DC MICRO GRID

The microgrid is usually defined as a small network of loads and distributed energy resources (DER), connected to the main grid but with the ability to operate reliably independently. The main advantages of microgrids are higher supply reliability for consumers, resiliency, and power quality and lower costs and environmental emissions. Microgrids are also becoming increasingly common in universities. The DC microgrid system is made up of mostly renewable energy sources and delivers the energy to the components of the microgrid in Direct current form. Here the components of the microgrid are connected directly to the sources through the system bus and as a result, there is no need for conversion of the power. The below figure shows the block diagram and architecture of a DC microgrid. A DC microgrid conventionally consists of the Renewable Energy Source, the DC bus, the storage system and the loads, which may be either AC or DC. As earlier mentioned the main advantage of the DC microgrid is the elimination of the high number of power conversion stages that lead to many losses.

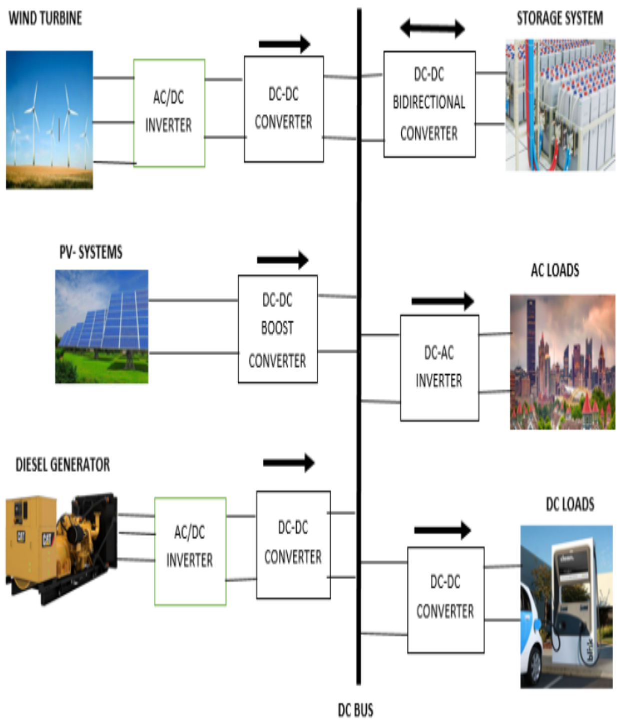

Fig 1: Schematic Diagram of a Stand-alone DC microgrid [4].

III RELATED WORK

DC microgrid is an attractive technology in modern electrical grid system because of its natural interfacing with the existing renewable energy sources [4]. The DC microgrid system is made up of mostly renewable energy sources and delivers the energy to the components of the microgrid in Direct current form. Here the components of the microgrid are connected directly to the sources through the system bus and as a result, there is no need for conversion of the power. [1] In this paper author present to study the performance of electricity analysis, proposed schemes that integrate various modelling methodologies, implementation of real-time simulation, and power balancing control strategies to manage PV and BES facilities are carried out in a real C-ugrid configuration. Meanwhile, collected data including load electricity profile and solar insolation on a real site are used as inputs of the models. 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. Results found that, with better solar insolation, users can obtain a power supply for a longer time from DERs in the C-ugrid, and also present a more noticeable benefit in electricity savings than that in poorer weather case. [2] In this paper presents a real-time energy management strategy for a BSS based smart community microgrid (SCMG), using VREs to supply EV batteries (EVBs) and conventional residential loads (RLs). A novel Lyapunov optimization framework based on queueing theory is designed to solve the proposed model. It addresses the variability of supply, demand and energy prices without assuming their forecasts or future distributions, and can also ensure the quality of service (QoS). The proposed method can simplify the complex energy scheduling and transform it into a single optimization problem, making it suitable for real-time applications, which require high computational efficiency. Simulation results found that BSS used for the dual purposes can improve the whole system economics and facilitate the utilization of renewable energy compared to isolated operation. [3] This study analyses the technical and economic performances of a microgrid system which is used to increase the electricity access in a rural area, Hutajulu village, Parmonangan district, North Tapanuli district, Indonesia. There are two types of power distributed generator used in the microgrid system, i.e., diesel generator and solar PV, and there are 20 houses in the village to be supplied electricity by the microgrid system. The results show that the generator would operate 3.754 hours per year and would supply electricity to the houses 2,456 kWh/year during the planning horizon (25 years). The levelized cost of electricity (LCOE) of the diesel generator would be US₵10.7/kWh, and the capacity factor of the diesel generator would be 14%. The average electrical efficiency of the diesel generator is found 27.2%. [4] In this paper, a solar PV powered DC microgrid is proposed and designed for Umuokpo Amumara in Nigeria with 800 households and a number of community installations which include churches, schools, shops, and a water pumping system. The appropriate sizes of system components are determined to meet the all-time load demand. A Techno-economic feasibility study was carried out in Homer Pro to determine the energy needs of the community and as well the system size and configuration that best suits the community. The energy requirement of the community was obtained to be 3.16MWh/day. The battery storage system was also seized in this work and a battery system capacity of 21,944Ah was able to meet the community energy requirement for up to a day without renewable energy supply. [5] This paper comprised of an introduction to microgrids followed by an overview of microgrids operation modes. A review in RT control and energy management is presented that consists of classification of different control and optimization approaches used in this area. A review on RT modeling and simulation approaches is also presented, including classification of simulation methods and a summary of different applications of HIL simulations in microgrids based on their technology. Finally, a detailed discussion is presented in the comparison of recent studies based on their main objectives. In this regard, it can be concluded that most studies are focused on customer-driven objectives, and few RT studies are done in energy management of microgrid from the system-wide side of view considering both economic and technical issues of the grid. [6] In this article they systematically analyze to what extent varying microgrid sizes and prosumer-consumer ratios affect local self-consumption and self-sufficiency rates. To that end, they developed a simulation model that uses real-world load profiles from 4190 residential buildings as input data. They find that the prosumer-to-consumer ratio is more important than the absolute microgrid size, for microgrids sizes greater than ten. The results also indicate that prosumer-to-consumer ratios in the range of 40%-60% have the best performance. Each simulation is also compared to the baseline scenario of a stand-alone prosumer, which shows significantly better self-consumption ratios and self sufficiency ratios for microgrids due to aggregation effects. Finally, this work may also be used as a reference to design residential microgrid communities for various prosumer-consumer compositions and various production-to-demand ratios. [7] In this study they explore the potentials of integrating microgrid as a cooperating unit in the power supply network to support further expansion of renewable energy sources (RES). The main concern and backbone of the smart grid is micro grid, which integrates different distributed generation systems, storage units and electrical loads. The main objective of this study is modelling a micro grid system from a combination of renewable energy resources such as Solar photovoltaic and wind with Storage battery which are operated in a grid-connected mode in Bahir Dar city, Ethiopia. There is a need to use storage system or grid system for providing incessant power supply to the load. The system is designed to meet the customer load demand of the city in a reliable manner and good power quality, which cannot be met using conventional system generation alone. Residential, institutional, commercial, agricultural, and small-scale industrial loads with an average electricity demand of 15,467 KWh per day are estimated. [8] This study is conducted to propose a new hybrid system (PV/Wind/Biomass) using abundant pine needle resource as a replacement of existing roof-mounted PV/wind hybrid system and analyse the feasibility using Hybrid Optimization of Multiple Energy Resources (HOMER). Biomass gasifier is integrated to meet the increased load demand of 29.5 kW from 4.3 kW at the Centre for Energy and Environment Engineering building in NIT-Hamirpur. Both cases (with and without storage) has been considered in this research study. New optimized configuration is found to be a 1kWp PV array, one wind turbine of capacity 5kW, gasifier with a 17 kW capacity, 10 numbers of 12v batteries connected in series and 10 kW converter. [9] In this research, a set of 100% renewable energy (RE)-based scenarios were defined, modelled and simulated for a proposed stand-alone microgrid (SAM) system. A battery-based, a hydrogen-based and a hybrid combination of battery-hydrogen-based Renewable Energy

Storage Systems (RESS) were evaluated and compared with the conventional DG-based SAM system. The evaluation of all proposed scenarios demonstrated that the hybrid battery-hydrogen-based RESS system (S3) is a promising innovative approach for 100% renewable energy-based SAM systems. [10] The main aim of this study is to suggest a sizing methodology for the RES components with various ESS scenarios in a microgrid through techno-economic feasibility analysis. Although the suggested methodology is flexible to include several RESs and ESSs, the methodology is demonstrated to compare the techno-economic performance of Wind and Photovoltaic (PV) energy systems under four different ESS scenarios; (i) no ESS, (ii) Pumped Hydro Storage (PHS), (iii) Hydrogen Fuel Cell (HFC), and (iv) hybrid ESS (PHS/HFC). The optimal RES configuration is determined by maximizing the RES fraction while equating the Cost of Electricity (COE) to the national utility tariff. However, in the event that there is no feasible system configuration that satisfies the mentioned criteria, the main objective becomes maximizing the RES fraction at the lowest attainable COE.

IV PROBLEM STATEMENT

For residential electricity users, the greatest electricity consumption is generally due to use of various electric appliances, like lighting devices, air conditioners, washing machines etc., for each user. With increasing use of electricity by these users, traditional fuel-type power generations may not able to provide sufficient electricity due to a lacking system upgrade. Furthermore, electricity users are not able to take initiative in participating in demand regulation under the single-direction power flow situation. This may force residential electricity users to face the risk of power outage. To overcome the problem, an application of the C-ugrid is thus introduced, integrated into electric grid to provide sustainable energy sources for electricity supporting services to multiple electricity customers within a community. When the C-ugrid operates into electric grid, the electricity can thus be observed from different locations in system, such as utility grid side, user side, and C-ugrid energy facility (i.e., inverter) output side. Meanwhile, if it can effectively monitor the electricity status on these sides, it will be able to help the electricity users in the C-ugrid carry out correct energy management and system control. Simulations, in addition, are often required for ugrid analysis purposes. Simulations can assist researchers to test different problem scenarios in a simulated domain in an economical way.

V CONCLUSION

Renewable energy (RE) generation has become a national target for all countries towards global sustainable development and greener future e.g., solar, wind, wave, bio-energy, etc. The main challenge in the integration of the RE into conventional energy systems is the vital necessity for large-scale energy storage systems to overcome the variability of renewable resources. Conventional resources are currently being used to meet the increasing demand for energy due to industrialization, population growth, improvements in technology and changing lifestyles. A shift to clean, cost-effective and reliable renewable resources for energy generation is needed. Most of the studies in the past two decades have been conducted on PV and/or the wind hybrid systems with fossil fuel. Few studies also focused on biomass-based hybrid systems in low windy areas. This study analyse how to design a microgrid to increase electricity access in a commercial and domestic application for the rural and urban area.

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