International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 6 June 2021, pp: 646-651 www.ijaem.net ISSN: 2395-5252

Energy management control on inland grid for EV charging and residential loads

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Submitted: 25-05-2021 Revised: 01-06-2021 Accepted: 05-06-2021

ABSTRACT : This paper presents power generation using renewable energy resources. The increased population will cause to increase in the power demand. The majority of our power from fossil fuels that will increase pollution and global warming. But the reduction in the availability of fuel and increased cost of the fuel will increase the cost of electricity. Most of food production unit and agricultural elements are depends only on the electricity from the government sources. Based on this reason we will introduce a design to support the government and individuals. In our design the power production from renewable energy resources like wind and solar photo voltaic systems. The generated power is used for residential use and electric vehicle charging. By the use of V2G, the residential use increases power to be drawn from Electric Vehicle batteries and fed back into the grid when the vehicle is not in use.

Key Words: Solar Photo-voltaic array, Wind, V2G, Transformer.

I. INTRODUCTION

The increased population, industries, and agricultural activities will cause to increase in the power demand. Fossil fuels are too expensive and a depleting resource. Burning fossil fuels such as coal, oil, and natural gas produces carbon dioxide (CO_2) and other greenhouse gases, which cause global warming. The high efficient RE technologies and accurate forecast models with different time horizons are inducted into the power system. Our system is renewable energy-based power generation. Moreover, Renewable Energy based power sources, which are pollution-free and abundant in nature, like wind and solar sources, are highly emerging due to their reduced cost and availability.

Solar energy can be a major source of all renewable power generation. Most renewable energy comes either directly or indirectly from the sun. The sun's heat also drives the wind, whose energy is captured with wind turbines and fed to the generator, finally produce electric power. The energy of wind can be used for the generation of electrical energy. Wind energy which is an indirect source of solar energy conversion can be utilized to run a windmill, which in turn drives a generator to produce electricity.

This paper is organized as follows: Section I presents the overall structure and related work Section II discusses the design specification of the proposed system and architecture of the system. Section III implementation of the proposed system and simulation results.

1.1. Related Work

Mellit (2007) presented a review on the sizing of a photovoltaic system. The paper aimed at portraying a summary of the alternative approach and Artificial Intelligence (AI) for sizing of various photovoltaic systems like standalone PV, grid-connected PV system, PV-wind hybrid system. The new AI technique for sizing PV systems relied mainly on conventional methods and the work indicated the wide popularity and wide application of using an AI-based sizing of a PV system is that it gives good optimization particularly in isolated areas where the data on weather conditions are not always available.

Sungwoo Bae & Alexis Kwasinski (2012) presented a dynamic modeling and control strategy for a sustainable micro grid with wind and photovoltaic resources. The system with an MI dc-dc converter in which wind energy changes, AC Wind generator, and variations in the local AC load power and dispatch power to the distribution grid have been considered for the study. The study considers both wind energy and solar irradiance changes in combination with load power variations. The proposed power system, in addition to producing electricity from renewable energy sources, also injects excess power into the utility grid during normal operation. The investigation results of the study show that the proposed power system is a

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feasible option for a sustainable micro grid application.

Forecasting wind and solar power generation are fundamental to assess the balancing and reserve requirements for reliable operation of the grid. Several forecasting methods have been reported by researchers and consultants in the recent past, and new methodologies are still being developed to improve the forecasting accuracy (Skoplaki and Palyvos, 2009).

Hetzer et al. (2008) and Shi et al. (2012), have developed new models to quantify the wind generation cost considering the intermittent and fluctuant nature of the wind power; the opportunity cost of the deficit and surplus wind power generation was also considered.

Sharma et al. (2018) presented a generalized model for determining the optimal location and rating of the Wind Energy Generators (WEGs) in a competitive electricity market. The multi-objective optimization problem has been formulated to maximize the profitability of WEG companies by minimizing the distribution losses by optimally locating the WEGs.

II. DESIGN SPECIFICATION OF THE PROPOSED CONVERTER

The three sources the proposed design is shown in figure 1.of the proposed system are 8MW PV farm, 4.5MW Wind farm, and 15MW KSEB Grid. The output of the three sources is combined and given to the transformer of input capacity 25KV and step down to 600V. Step-down output from the isolation transformer is given to the V2G 4MW and Residential load 10MW. Using the V2G we can charge 100 vehicles of 40KW each. The residential use increases decrease the number of vehicle charging after the peak residential use we can charge more number of vehicles.

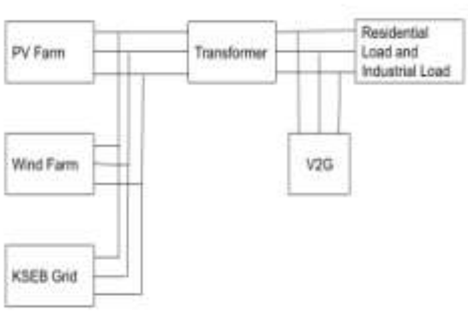

Fig -1: Block diagram of Proposed Converter

Using the renewable energy source we cannot achieve residential use without charging vehicles, connect the KSEB grid. The proposed design is shown in figure 1. The solar and wind control is shown in figure 2 and figure 3 respectively. In the solar control use P&O of MPPT technique and wind control use DC-AC converter.

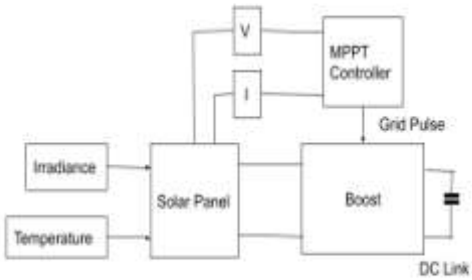

Fig -2: Solar Controller

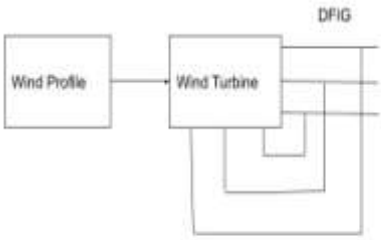

Fig -3: Wind Controller

2.1. Solar Photo-voltaic Array

Photovoltaic (PV), or solar cells as they are often referred to, are semiconductor devices that convert sunlight into direct current (DC) electricity. A typical silicon PV cell is a thin wafer consisting of a very thin layer of phosphorus-doped (N-type) silicon on top of a thicker layer of boron-doped (P-type) silicon. An electrical field is created near the top surface of the cell where these two materials are in contact (the P-N junction). When sunlight strikes the surface of a PV cell, this electrical field provides momentum and direction to light-stimulated electrons, resulting in a flow of current when the cell is connected to an electrical load. The amount of current generated by a PV cell depends on its efficiency, its size (surface area), and the intensity of sunlight striking the surface. For example, under peak sunlight conditions a typical commercial PV cell with a surface area of about 25 square watts of power. Photovoltaic cells are connected electrically in series and or parallel circuits to produce higher voltages and/or currents. Photovoltaic modules consist of PV cell circuits sealed in an environmentally protective laminate and are the fundamental building blocks of the complete PV generating unit. Photovoltaic panels include more than one PV module assembled as a pre-wired, field-installable unit. A Photovoltaic array is the complete power-generating unit, consisting of several PV panels.

A solar panel (also solar module, photovoltaic module, or photovoltaic panel) is a packaged, connected assembly of photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply the electricity in commercial and residential applications. Each panel is rated by its DC output power under standard test conditions, and typically ranges from 100 to 320 watts. Solar panels use light energy (photons) from the sun to generate electricity through the photovoltaic effect. The majority of modules use wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon. The structural (load carrying) member of a module can either be the top layer or the back layer. Cells must also be protected from mechanical damage and moisture. Most solar panels are rigid, but semi-flexible ones are available, based on thin-film cells.

2.2. Wind Farm

Wind power is one of the fastest-growing renewable energy technologies. Usage is on the rise worldwide, in part because costs are falling. The wind is used to produce electricity using the kinetic energy created by air in motion. This is transformed into electrical energy using wind turbines or wind energy conversion systems. Wind first hits a turbine�s blades, causing them to rotate and turn the turbine connected to them. A wind turbine turns wind energy into electricity using the aerodynamic force from the rotor blades, which work like an airplane wing or helicopter rotor blade. When wind flows across the blade, the air pressure on one side of the blade decreases. The difference in air pressure across the two sides of the blade creates both lift and drag. The force of the lift is stronger than the drag and this causes the rotor to spin. The rotor connects to the generator, either directly (if it�s a direct drive turbine) or through a shaft and a series of gears (a gearbox) that speed up the rotation and allow for a physically smaller generator. This translation of aerodynamic force to the rotation of a generator creates electrical energy through electromagnetism.

The amount of power that can be harvested from wind depends on the size of the turbine and the length of its blades. The output is proportional to the dimensions of the rotor and the cube of the wind speed. Theoretically, when wind speed doubles, wind power potential increases by a factor of eight.

1) Doubly-fed induction generator: The doubly-fed induction generator (DFIG) with the back-to-back converter is a system frequently used in wind turbines. Traditional wind turbines have fixed turning speeds, while DFIG enables wind turbines to operate with various ranges of speeds. The back-to-back converter is connected to the rotor of the DFIG, and its purpose is to feed the rotor with currents of varying frequency, to reach the desired rotor speeds.

2) Gear Box: The gearbox is used in wind energy systems to change low-speed high torque power coming from a rotor blade to high-speed low torque power which is used for generators. It is connected in between the main shaft and generator shaft to increase rotational speeds from about 20 to 60 rotations per 53 minute (rpm) to about 1000 to 1800 rpm. Gearboxes used for the wind turbine are made from superior quality aluminum alloys, stainless steel, cast iron, etc.

2.3. Vehicle to Grid

V2G stands for �vehicle-to-grid� and is a technology that enables energy to be pushed back to the power grid from the battery of an electric car. With vehicle-to-grid technology, a car battery can be charged and discharged based on different signals � such as energy production or consumption nearby.

Vehicle-to-grid technology involves drawing unused power from the car into the smart grid. V2G, which is also known as vehicle-grid integration (VGI), can help the energy grid supply electricity during peak hours. It can also create an extra power source when weather-dependent renewable energy sources are not available. For example, a home that uses solar power cannot generate electricity at night, but an electric vehicle could provide a secondary source of power if needed.

In the context of energy production, de-carbonization refers to the deployment of renewable energy sources, such as solar and wind power. This introduces the problem of storing energy. While fossil fuels can be seen as a form of energy storage as they release energy when burned, wind and solar power function differently. Energy should be either used where it’s produced or stored somewhere for later usage. Therefore, the growth of renewables inevitably makes our energy system more volatile, requiring new ways to balance and store energy to be used.

2.4. Transformer

Transformers are electromagnetic devices that transform alternating current (AC) electrical energy from the primary to the secondary side. The energy is transformed with equal frequency and approximately equal power using the transformer core magnetic field.

Three-phase Single core limb transformers are used in this design. In a core type three-phase transformer, the core is made up of three limbs or legs and two yokes. The magnetic path is formed between these yokes and limbs. On each limb, both primary and secondary windings are wounded concentrically. Circular cylindrical coils are used as the windings for this type of transformer. The primary and secondary windings of one phase are wounded on one leg. Under balanced conditions, the magnetic flux in each phase of the leg adds up to zero. Therefore, under normal conditions, no return leg is needed. But in case of unbalanced loads, high circulating current flows and hence it may be best to use three single-phase transformers.

III. RESULTS AND DISCUSSION

This paper will focus on power generation using renewable energy resources. The generated power is used for Electric vehicle charging, Residential and Industrial use. The amount of solar light used in this design V-I characteristics of PV array shown in figure 4 and also the grid voltage taken are shown in figure 5 and the wind profile is shown in figure 6.

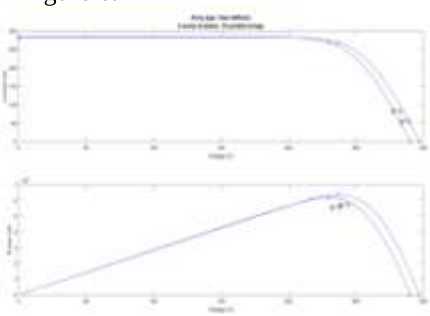

Fig -4: PV Array Characteristics

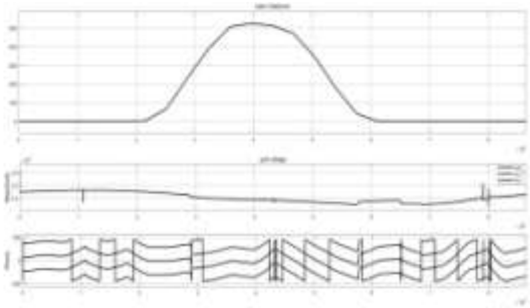

Fig -5: Solar irradiance and Grid Voltage

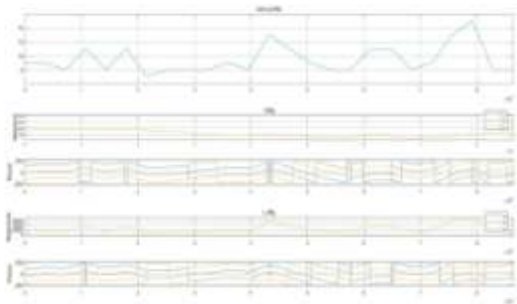

Fig -6: Wind Profile

Figure 7 will show the state of charging of connected cars, what amount of charge is present in the connected car are shown in it. Figure 8 is showing the active and reactive power of connected cars.

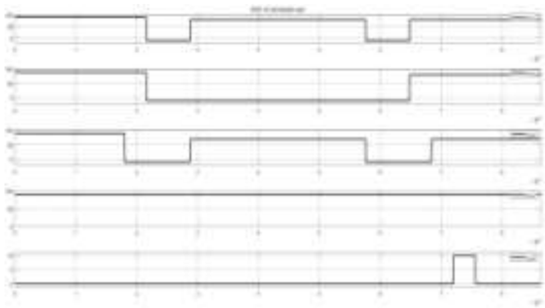

Fig -7: SOC of Connected cars

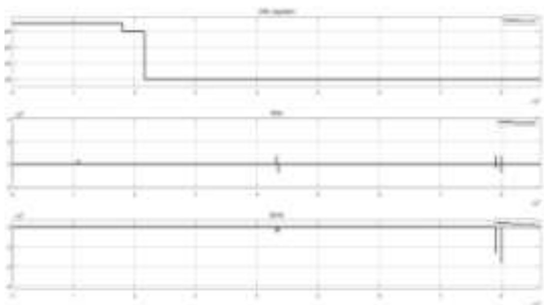

Fig -8: Active and Reactive Power of Cars

Figure 9 and Figure 10 show the active and reactive power of residential and industrial load connected. The time calculated for industrial load is taken from morning 3 AM. The final result is shown in figure 11.

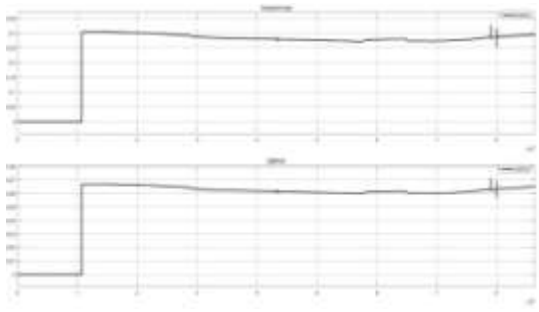

Fig -9: Active and Reactive Power of Industrial Load

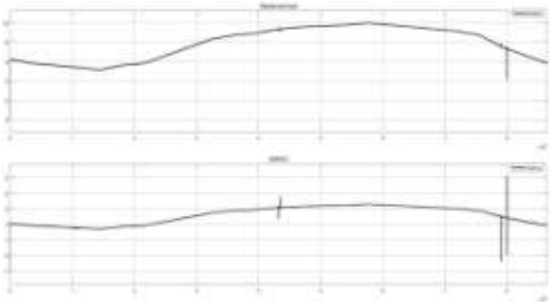

Fig -10: Active and Reactive Power of Residential Load

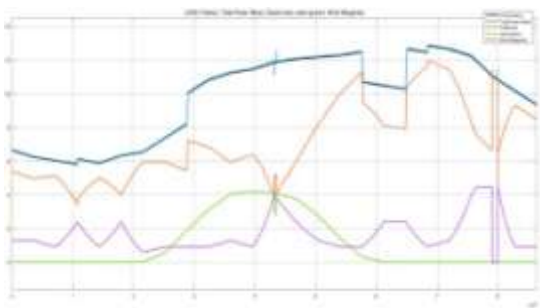

Fig -11: Total Energy Management

IV. SUMMARY

Throughout this paper will discuss power generation using renewable energy resources. The main source is solar light and wind. The solar photo-voltaic cell is used to convert solar energy to electrical energy by the use of P&O of MPPT technique. In the wind farm electricity is generated using the kinetic energy of the wind and also using a doubly-fed induction motor in it. The vehicle to grid technique is used to push back the power stored in the electric vehicle to another demand use. It is an energy management system worked based on renewable energy sources. To reduce the use of fossil fuels and also the designed system is eco-friendly, pollution-free, and cost-effective. By this design maximum industrial and residential load run using the renewable energy sources, power is not attaining the requirement we will approach the KSEB grid.

REFERENCES

[1] bbassi Rabesh Chebbie Souad 2012,a Energy management strategy fora grid-connected wind-solar hybrid system with battery storage policyfor optimizing conventional energy generationa, International Review ofElectrical Engineering , vol.7, no.2, pp. 3979- 3990

[2] ird, L, Cochran, J and Wang, X 2014,aTechnical Report on Wind andSolar Energy Curtailment: Experience and Practices in the United Statesa,National Renewable Energy Laboratory (NREL). Accessed October 28,2016

[3] Caisheng Wang Hashem Nehrir, M 2008,aPower management of a stand-alone wind /photovoltaic/fuel cell energy systema, IEEE Transactions onEnergy Conversion, vol. 23, no. 3, pp.957-967.

[4] ambasivaiah Puchalapalli and Bhim Singh, A Grid Interactive MicrogridBased on Wind Driven DFIG and Solar PV Array with Regulated PowerFlow Functionality, 978-1-5386-4996-1/18/2018 IEEE.

[5] W. Li, P. Chao, X. Liang, J. Ma, D. Xu, and X. Jin,aA practical equivalentmethod for DFIG wind farms,a IEEE Trans. Sustain. Energy, vol. 9, no.2, pp. 610-620, April 2018.

[6] S. Kumar Tiwari, B. Singh, and P. K. Goel,aDesign and control ofmicrogrid fed by renewable energy generating sources,a IEEE Trans. Ind.Applicat., vol. 54, no. 3, pp. 2041-2050, May-June 2018.

[7] ew, D, Brinkman, G, Ibanez, E, Florita, A, Heaney, M, Hodge, BM,Hummon, M and Stark, G ,aThe Western Wind and Solar IntegrationStudy Phase 2, 2013.

[8] Mohammad Ahmad, Anil Kumar Jha, Sitaram Jana, Kishore Kumar,Simulation and Performance Analysis of a Grid Connected MultilevelInverter Considering Either Battery or Solar PV as DC Input Sources ,3rd IEEE International Conference on "Computational Intelligence and Communication Technology" (IEEE-CICT 2017).

[9] Celik, A N, 2002,aThe system performance of autonomous photovoltaic-wind hybrid energy systems using synthetically generated weather dataa,Renewable Energy, vol.27, pp. 107-121.

[10] Ahmed M Hemeida, Wael A Farag Osama A Mahgoub 2011,aModellingand control of direct driven pmsgfor ultra large wind turbinesa, WorldAcademy of Science, Engineering and Technology, vol. 59 , pp. 918-924.
[11] abr, RA, and Pal, BC 2009,aIntermittent wind generation in optimalpower flow dispatchinga IET Generation, Transmission and Distributionvol. 3, no. 1, pp. 66-74.
[12] Wei Wang, Liu Liu, Jizhen Liu, and Zhe Chen, Fellow, IEEE,EnergyManagement and Optimization of Vehicle-to-grid Systems for Wind PowerIntegrationCSEE JOURNAL OF POWER AND ENERGY SYSTEMS,VOL. 7, NO. 1, JANUARY 2021
[13] Abhsan Shahid, Member IEEE,Smart Grid Integration of RenewableEnergy SystemsIEEE 2018.
[14] Zheng CHEN, Quan LIU, Xiangning XIAO, Nian LIU, XiangwuYAN,INTEGRATED MODE AND KEY ISSUES OF RENEWABLEENERGY SOURCES AND ELECTRIC VEHICLESa CHARGING ANDDISCHARGING FACILITIES IN MICROGRIDIEEE
[15] A.Marinescu,I.Serban,A Smart Residential Microgrid Based on Re-newable Energy Source with Integrated Electric Vehicle Charging Sta-tion,IEEE 2018
[16] Yu Yang, Student Member, IEEE, Qing-Shan Jia, Senior Member, IEEE,Geert Deconinck, Senior Member, IEEE, Xiaohong Guan, Fellow, IEEE,Zhifeng Qiu, Member, IEEE, and Zechun Hu, Member, IEEE,DistributedCoordination of EV Charging with Renewable Energy in a Microgrid ofBuildings,IEEE 2017.
[17] Khoucha, F., Benbouzid, M., Amirat, Y., Kheloui,Integrated EnergyManagement of a Plug-in Electric Vehicle in Residential DistributionSystems with Renewable,IEEE 2015
[18] Yazdi, L., Ahadi, R., Rezaee, B,Optimal electric vehicle charging stationplacing with integration of renewable energy,IEEE 2019.