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A Review Article Of hybrid System - Framework Which Prompts Produce Power With Reasonable Expense Without Harming The Nature Balance

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Abstract- Due to the fact that solar and wind power is intermittent and unpredictable in nature, higher penetration of their types in existing power system could cause and create high technical challenges especially to weak grids or stand-alone systems without proper and enough storage capacity. By integrating the two renewable resources into an optimum combination, the impact of the variable nature of solar and wind resources can be partially resolved and the overall system becomes more reliable and economical to run. This paper provides a review of challenges and opportunities / solutions of hybrid solar PV and wind energy integration systems. Voltage and frequency fluctuation, and harmonics are major power quality issues for both grid-connected and stand-alone systems with bigger impact in case of weak grid. This can be resolved to a large extent by having proper design, advanced fast response control facilities, and good optimization of the hybrid systems. The paper gives a review of the main research work reported in the literature with regard to optimal sizing design, power electronics topologies and control. The paper presents a review of the state of the art of both grid-connected and stand-alone hybrid solar and wind systems.

Keywords- solar energy; photovoltaic-fuel cell system; integrated energy system; power generation; hydrogen energy; hydrogen economy; zero emissions; photovoltaics; fuel cells.

I. INTRODUCTION

Energy is essential to our society to ensure our quality of life and to underpin all other elements of our economy. The escalation in cost and environmental concerns involving conventional electrical energy. Sources have increased interest in renewable energy sources. Many societies across the world in which we live have developed a large appetite for electrical energy. This appetite has been stimulated by the relative ease with which electricity can be generated, distributed, and utilized, and by the great variety of its applications. It is arguable whether the consumption of electricity should be allowed to grow unchecked, but the fact is that there is an ever-increasing demand for this energy form. Clearly, if this demand is to be met, then the world's electricity generating capacity will have to continue to grow. Presently almost all the electricity generation takes place at central power station which utilizes coal, oil, gas, water or fissile nuclear material as the primary fuel source.

There are problem facing the further development of generating methods based on any of these conventional fuels‖. Hydro-power generation is restricted to geographically suitable areas, and reserves of coal, although presently plentiful, are not renewable .The possible hazards of nuclear power have been much publicized, particularly those concerning the storage and military use of nuclear waste material. Nevertheless, to assist in maintaining electrical supply in many of our societies its seems likely that an increasing nuclear power presence, involving breeder and possibly fusion reactors, will be tolerated. To achieve this and also to aid in management of the existing fossil-fuel resources, it is essential that some part and an increasing part, of future electrical energy research and development be concerned with so called nonconventional methods of generation Wind- solar PV and fuel cell power generations are visible options for future power generation. Besides being free, they are free of recurring costs.

II. RESEARCH MOTIVATION

Globally, there is an increasing emphasis on the decarbonization of economies and a quicker transition from the use of fossil fuels to renewable energy resources to mitigate the unravelling risks posed by the anthropogenic interferences on the climatic systems from the inception of the first industrial revolution. As the political will to adopt and scale-up clean energy technologies (CETs) increases across the globe, there is an urgent need to facilitate the technological transition by developing novel CETs or optimizing the existing ones. Of all the renewable energy resources available to mankind (including solar, hydro, wind, geothermal, biomass, tidal, etc.), solar energy appears to be the most sustainable because it is inexhaustible, ubiquitous across the globe, and it is not subject to price controls, unlike fossil fuels.

Because of this, renewable energy technologies (RETs) that use solar energy as a prime mover will continue to attract research and development attention because they can be deployed across the globe. One of such RETs is integrated photovoltaic-fuel cell (IPVFC) system, which uses photovoltaics and fuel cells to majorly generate power and hydrogen, using solar energy as the prime mover.

III. LITERATURE REVIEW

D.B.Nelson, Unit sizing and cost analysis of stand-alone hybrid wind/PV/fuel cell power generation systems: An economic evaluation of a hybrid wind/photovoltaic/fuel cell (FC) generation system for a typical home in the Pacific Northwest is performed. In this configuration the combination of a FC stack, an electrolyser, and hydrogen storage tanks is used as the energy storage system. This system is compared to a traditional hybrid energy system with battery storage. A computer program has been developed to size system components in order to match the load of the site in the most cost effective way. A cost of electricity, an overall system cost, and a break-even distance analysis are also calculated for each configuration. The study was performed using a graphical user interface programmed in MATLAB.

AlirezaMaheri, Multiobjectiveoptimisation of hybrid wind-PV-battery-fuel cell-electrolyser-diesel systems: An integrated configuration-size formulation approach: A generic integrated configuration-size optimisation formulation for design of hybrid renewable energy systems (HRES) is presented in this paper. This formulation allows identifying the optimum configuration for a given site and the optimum size of each component in that configuration by solving only one optimisation problem. Single and multiobjective case studies are defined for both on-grid and standalone systems using wind turbine, PV panel, battery bank, fuel cell, electrolyser and diesel generator as potential components.

To solve the optimisation problems a genetic algorithm (GA) and a nondominated sorting GA (NSGA-II) are developed, in which the reproduction operators are designed carefully for robust exploration and exploitation at both size and configuration levels. Eight single and multiobjective case studies for a variety of renewable resources, objectives and constraints are conducted. The results show the versatility of the problem formulation in defining different HRES design problems and the robustness of the developed GA and NSGA-II in search within the design space at both configuration and size levels and finding the optimum size and configuration simultaneously.
BoualamBenlahbib, Experimental investigation of power management and control of a PV/wind/fuel cell/battery hybrid energy system microgrid: This paper presents an experimental study of a standalone hybrid microgrid system. The latter is dedicated to remote area applications. The system is a compound that utilizes renewable sources that are Wind Generator (WG), Solar Array (SA), Fuel Cell (FC) and Energy Storage System (ESS) using a battery. The power electronic converters play a very important role in the system; they optimize the control and energy management techniques of the various sources. For wind and solar subsystem, the speed and Single Input Fuzzy Logic (SIFL) controllers are used respectively to harvest the maximum power point tracking (MPPT). To maintain a balance of energy in the hybrid system, an energy management strategy based on the battery state of charge (SOC) has been developed and implemented experimentally. The AC output voltage regulation was achieved using a Proportional Integral (PI) controller to supply a resistive load with constant amplitude and frequency. According to the obtained performances, it was concluded that the proposed system is very promising for potential applications in hybrid renewable energy management systems.

ShirefA.Abdalla, Performance enhancement and power management strategy of an autonomous hybrid fuel cell/wind power system based on adaptive neuro fuzzy inference system: In this paper, a hybrid wind/fuel cell generation system which can be used for loads in remote areas as a micro grid application is considered. This micro grid mainly includes fuel cell (FC), wind generator as electrical power suppliers, resistive-inductive impedance as static load, induction motor (IM) as a dynamic load, DC/AC converter and water electrolizer for supplying hydrogen gas. The Fuel cell is used to compensate the decrease in the power generated by wind, which leads to an increase in the system efficiency.

Furthermore, an adaptive control model and achievement refinements of a micro-grid using Adaptive Neuro Fuzzy Inference System (ANFIS) controller has been utilized to regulate the load voltage and frequency. This suggested microgrid system is achieved so that the wind generation unit supplies the loads, while any additional energy needed by the loads will be offset by the fuel cell generator unit. Thus, the main objective of this work is to apply an adaptive control method for improving the proposed electrical micro grid performance. In addition, the performance of the considered system is compared with the proposed ANFIS control when applying the traditional fuzzy control. The outcomes also demonstrated a better reaction and durability to the chosen control model. The MATLAB/SIMULINK programming software tools have been used for carrying out case studies towards the evaluation and validation of the methodology developed in this work with applications. The proposed solution achieved improvement in transient performance. However, the settling time is decreased to 21% in the case of using the suggested ANFIS controller comparing with conventional fuzzy control.

Syed RaahatAra, Two-level planning approach to analyze techno-economic feasibility of hybrid offshore wind-solar pv power plants: In this paper, a two-level planning framework has been proposed to assess the techno-economic feasibility of hybrid offshore wind-solar PV power plants. In the first level, the optimal layout design of hybrid offshore wind-solar PV plants is determined to maximize the generation considering wake effect and shadow loss for wind turbines (WTs) and solar PV panels, respectively. Particle Swarm Optimization (PSO) is used to determine the optimal layout of hybrid power plants. In the second level, economic analysis has been conducted to determine the feasibility of the hybrid offshore power plants for any particular site. In this context, two scenarios have been investigated.

In scenario-1, the optimal share of wind and solar generation for an offshore hybrid plant of given capacity is determined from a techno-economic point of view. On the other hand, in scenario-2, the optimal share of solar PV panels utilizing the existing electrical infrastructure of offshore wind plants has been determined. Both cases are compared on the basis of the Levelized cost of energy (LCOE), and the best alternative has been highlighted for a site in this study. Yearly data of wind speed and solar irradiation of a site near the coast of Gujarat in India has been considered to investigate the proposed approach.

ZhanleiWang, Hydrogen fuel and electricity generation from a new hybrid energy system based on wind and solar energies and alkaline fuel cell: Excessive consumption of fossil fuels has led to depletion of reserves and environmental crises. Therefore, turning to clean energy sources is essential. However, these energy sources are intermittent in nature and have problems meeting long-term energy demand. The option suggested by the researchers is to use hybrid energy systems. The aim of this paper is provide the conceptual configuration of a novel energy cycle based on clean energy resources. The novel energy cycle is composed of a wind turbine, solar photovoltaic field (PV), an alkaline fuel cell (AFC), a Stirling engine and an electrolyzer. Solar PV and wind turbine convert solar light energy and wind kinetic energy into electricity, respectively. Then, the generated electricity is fed to water electrolyzer.

The electrolyzer decomposes water into oxygen and hydrogen gases by receiving electrical power. So the fuel cell inlets are provided. Next, the AFC converts the chemical energy contained in hydrogen into electricity during electrochemical reactions with by-product (heat). The purpose of the introduced cycle is to generate electricity and hydrogen fuel. The relationships defined for the components of the proposed cycle are novel and is examined for the first time. Results showed that the output of the introduced cycle is 10.5 kW of electricity and its electrical efficiency is 56.9%. In addition, the electrolyzer uses 9.9 kW of electricity to produce 221.3 grams per hour of hydrogen fuel. The share of the Stirling engine in the output power of the cycle is 9.85% (1033.7 W) which is obtained from the dissipated heat of the fuel cell. In addition, wind turbine is capable of generating an average of 4.1 kW of electricity. However, 238.6 kW of cycle exergy is destroyed. Two different scenarios are presented for solar field design.

M.M.Samy, Optimal economic study of hybrid PV-wind-fuel cell system integrated to unreliable electric utility using hybrid search optimization technique: This study addresses the problem of power outages in distant districts by taking advantage of the available renewable energy resources in the surrounding environment.

This was done by proposing connecting the utility to a hybrid system constituting from photovoltaic (PV), wind turbine (WT), and fuel cell (FC) systems where this hybrid system is considered as a backup system that works when the grid is unavailable. This hybrid system proposed is used for feeding the load to a tourist resort in Hurghada, Egypt.The design of the introduced system has taken into consideration the cost of purchasing electric energy and the profit from selling it to the utility network. Component scaling was implemented to improve the net present cost of the proposed system using two grouped meta-heuristic techniques, which are the Hybrid Firefly and Harmony Search optimization technique (HFA/HS) and compared to the particle swarm optimization (PSO) technique.

AmmarAlkhalidi, Cantilever Wind Turbines Installation to harvest accelerated wind in dams (Hybrid floating PV – Wind System): Lack of fossil fuel creates a need to search for unique innovations to produce renewable energy within the country. Large inland water bodies, Dams as an example, provides an opportunity to utilize both solar and wind energy for this purpose. The flat, large water surface of dams with high solar radiation in the MENA region makes it a favorable location for a floating PV system. The high temperature in the MENA region causes a high evaporation rate from inland water bodies. Thus, floating PV panels serve dual purposes, power generation and reduction in water evaporation.

On the dry side of the water Dam, there is a significant amount of space available to build a wind farm, especially with this area being between two mountains, which creates a wind tunnel effect that increases the wind speed and unifies wind direction. This paper presents a case study to install the wind turbines horizontally hanging over the dry side of dam to determine the ability to utilize dam space to build a hybrid PV wind system in the MENA region. Wadi Al Mujib dam located in Jordan was chosen as a location for this study. Cantilever wind turbines hanging horizontally facing the dry side of the Dam combined with floating PV was found capable of producing up to three GWh per year.

AnisaEmrani, Optimal sizing and deployment of gravity energy storage system in hybrid PV-Wind power plant: The world today is continuously tending toward clean energy technologies. Renewable energy sources are receiving more and more attention. Furthermore, there is an increasing interest in the development of energy storage systems which meet some specific design requirements such as structural rigidity, cost effectiveness, life-cycle impact, and increased energy capacity. Gravity energy storage (GES) is one of those innovative storage technologies that is still under development.

Hence, this study proposes a new methodology which aims to optimally design and deploy a large-scale GES system in a hybrid PV-Wind plant to make it more competitive technically and economically. The objective of this study is to minimize GES construction cost restricted by handling mechanical load applied on the system's structure. The sizing methodology is based on genetic optimization algorithm which aims to determine the optimum dimensions of GES components. A case study has been used to verify the effectiveness of the proposed model.

MahdiFasihi, Global potential of green ammonia based on hybrid PV-wind power plants: Ammonia is one of the most commonly used feedstock chemicals globally. Therefore, decarbonisation of ammonia production is of high relevance towards achieving a carbon neutral energy system. This study investigates the global potential of green ammonia production from semi-flexible ammonia plants utilising a cost-optimised configuration of hybrid PV-wind power plants, as well as conversion and balancing technologies.

The global weather data used is on an hourly time scale and 0.45° × 0.45° spatial resolution. The results show that, by 2030, solar PV would be the dominating electricity generation technology in most parts of the world, and the role of batteries would be limited, while no significant role is found for hydrogen-fuelled gas turbines. Green ammonia could be generated at the best sites in the world for a cost range of 440–630, 345–420, 300–330 and 260–290 €/t_{NH3} in 2020, 2030, 2040 and 2050, respectively, for a weighted average capital cost of 7%. Comparing this to the decade-average fossil-based ammonia cost of 300–350 €/t, green ammonia could become cost-competitive in niche markets by 2030, and substitute fossil-based ammonia globally at current cost levels.

A possible cost decline of natural gas and consequently fossil-based ammonia could be fully neutralised by greenhouse gas emissions cost of about 75 €/t_{CO2} by 2040. By 2040, green ammonia in China would be lower in cost than ammonia from new coal-based plants, even at the lowest coal prices and no greenhouse gas emissions cost. The difference in green ammonia production at the least-cost sites in the world's nine major regions is less than 50 €/t_{NH3} by 2040. Thus, ammonia shipping cost could limit intercontinental trading and favour local or regional production beyond 2040.

Benyoh Emmanuel KighaNsafon, Optimization and sustainability analysis of PV/wind/diesel hybrid energy system for decentralized energy generation: This paper focuses on the techno-economic feasibility and sustainability of a PV/wind/diesel hybrid system designed for decentralized power supply. Several designs have been studied for the hybrid system by varying the PV slope and wind turbine hub height under different dispatch strategies to supply the load. For each design, the power system has been optimized to determine the maximum electrical output at a low cost. Sensitivity analyses have been performed to evaluate operational risk in the actual operation as well as the cost-effectiveness of the proposed system.

As a final remark, the sustainability of the proposed hybrid energy system has been analyzed based on some key indicators to understand the implications of a design choice on electrical production, CO_2 emission and cost of energy. Our results show that for a projected period of 25 years, the selected hybrid power system for electrification of a housing estate will cost 10.2 million USD for a daily load of 4876.5 kWh, and the cost for every kWh of electricity generated is $0.4574. Results also show that the hybridization of the standard diesel generating system increased the reliability and cost-effectiveness of the power system, saving $0.316 for every kWh of electricity generated, with about 1,521,310 kg of CO_2 emission avoided annually.

Ahmed F.Bendary, Battery Charge Management for Hybrid PV/Wind/Fuel Cell with Storage Battery: Hybrid renewable electric energy generation system become essential to the most of electric networks and the stand-alone systems like the water pumping and telecommunication systems. The renewable sources usually required storage system due to change in the power outputs during the day. Due to increase in demand of using batteries, the charging process of battery system needed to be well managed through an adaptive controlled energy managing system.

In this paper a standalone system using photovoltaic, wind generation, fuel cell and storage batteries are contributed in supplying the desired load and the charging balance of batteries is achieved by using AI techniques to enhance battery charging controller performance. The main goal of this paper is to design and implement an integrated smart artificial controller, this controller is responsible for controlling both the battery charge voltage using the boost converter and the other controller is to control the charging current of the battery through DC to DC converter using (ANFIS) and (GA) techniques. This study is implemented using MATLAB /Simulink and the results are presented to

show the applicability and effieciency of the proposed technique.

PikasoPal, Viability analysis of direct current (DC) standalone hybrid photovoltaic (PV)/ hydrogen fuel cell (HFC) energy system: A techno-economic approach: The renewable energy sector in a developing country can play a vital role in socio-economic development. With proper utilization of renewable energy resources (RESs) such as photovoltaic (PV) energy system, wind energy system, hydrogen fuel cell (HFC) energy system, etc. may be accepted for renewable electricity generation for urban or rural populations. In this present work, the techno-economic analysis was carried out for the viability of a direct current (DC) based standalone hybrid PV/HFC energy system with hydrogen storage. The PV panel used for the study is monocrystalline silicon (mono-Si) with 13.5% efficiency and the study site considered for analysis the hybrid energy system is Madanapalle (13° 33′ N and 78° 30′ E), Andhra Pradesh, India. The connected electrical load to the hybrid PV/HFC system assumed to be 14 kW. The optimal size obtained for the energy system is 80 kW PV system, 20 kW fuel cell, 50 kW electrolyzer and hydrogen tank of 20 Kg. It is found that the cost of energy (COE) of considered hybrid energy system obtained is 0.161$/kWh.

HadiTaghavifar, Techno-economic viability of on grid micro-hybrid PV/wind/Gen system for an educational building in Iran: In this research, a highly potential campus site for solar/wind energy production is identified with the purpose of micro-hybrid system installation in on-grid mode to sellback the excess electricity and hence economize the building as a source of income. A PV/wind/grid and PV/wind/grid/gen system are surveyed techno-economic wise. For case1, the net present cost (NPC) equals to $49,022, renewable fraction (RF) of 85.5%, and cost of energy (COE) $0.0024 is achieved at an inflation rate of 10% and wind speed of 6.8 m/s. While for the best feasible design of case2 (case2d), the NPC = $224,430, COE = $0.0272, RF = 63.6% are obtained. The results indicated that for a low inflation rate a simple PV/grid is appropriate and with the increase of inflation, more equipment incorporation to the system is a preferable choice.

Increasing the number of wind turbine cause NPC reduction and the wind speed increase leads to COE reduction. The results indicated that the case1 with 10 XL10R and 76.0 kW generator capacity could generate 315000 kWh electricity which means 69.2% expenditure decline compared to when one turbine is used (maximum annual electricity production and minimum NPC). Increment of inflation rate from 10% to 15% at $0.35 biodiesel price, increases the RF from 14% to about 50%. This implies that when the fuel price is low together with the high inflation rate, the renewability of the system is more significant.

CerenCeylan, Design and simulation of the PV/PEM fuel cell based hybrid energy system using MATLAB/Simulink for greenhouse application:

In this study, design and optimization of the hybrid renewable energy system consisting of Photovoltaic (PV) / Electrolyzer / Proton Exchange Membrane Fuel Cell (PEMFC) was investigated to provide electricity and heat for Greenhouse in Şanlıurfa (Turkey). The coupling of a photovoltaic system with PEMFC was preferred to supply continuous production of electric energy throughout the year. Additionally, produced heat from PEMFC was used to heating of the greenhouse by micro cogeneration application.

The MATLAB/Simulink was applied to the design and optimization of the proposed hybrid system. In the designed system, solar energy was selected to produce the Hydrogen (H_2) required to run the electrolyzer. In cases where the solar energy is not sufficient and cannot meet the electricity requirement for the electrolyzer; the H_2 requirement for the operation of the PEMFC was met from the H_2 storage tanks and energy continuity was ensured. The electrolyzer was designed for H_2 demand of the 3 kW PEMFC which were met the greenhouse energy requirement. PEMFC based hybrid system has 48% electrical and 45% thermal efficiencies. According to optimization results obtained for the proposed hybrid system, the levelized cost of energy was found 0.117 $/kWh. The obtained results show the proposed PV/Electrolyzer/PEMFC hybrid power system provides an applicable option for powering stand-alone application in a self-sustainable expedient.

IV. CONCLUSION

The paper presents a utility interactive hybrid WEC/PV/FC power system with MPPT and dc bus voltage regulation. The proposed hybrid system is able to provide almost continuous electric power with better reliability than a single power source. The controller of wind and PV has the function of MPPT control while the controller of FC has the function of load power fluctuation compensator. A simple control method tracks the MPP of the wind and PV is proposed without measuring the wind speed or solar irradiance, which is very useful for actual small size wind turbines and PV systems. The FC is thus controlled to provide the deficit power when the primary combined PV and wind energy sources cannot meet the net grid or load power demand.

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