Implementation and Control System For a Hybrid Wind-PV Battery Energy System Via PLC

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Abstract- *Electric utilities are continuously increasing the quantity of intelligent field devices deployed on distribution feeders to improve service reliability, efficiency and capacity with the help of hybridization of solar PV and wind power plant. The hybrid power plant or integrated power plant is design to run simultaneously with the help of programmable logic controller (PLC). Solar panels along with wind power plant can be used to generate energy or power in different areas of this country.*

The aim of this paper is to check the feasibility of an innovative concept of automatic and continuously electrical supply units with a larger power output. According to this, system is capable of performing real time measurement of electrical data.

Keywords- Solar PV, Wind Energy System, Power System Control, Hybrid Power Plant, PLC, SCADA.

I. INTRODUCTION

The world is facing its great energy crisis. The reason behind energy crisis is localized shortage, wars and market manipulations. Electricity is produced from Non-renewable and Renewable energy resources. Most non-renewable energy resources are fossil fuels, petroleum, coal and natural gas.
Renewable energy is energy that produces from renewable energy resources. According to today's scenario total installed capacity of power station in India is 3,30,860.58 MW.

About 18.37% consumption of total energy is comes from renewable energy resources and that is 60.98 GW without including large hydro power plant generation. If we include large hydro power plant electricity generation then standalone generation from large hydro power plant is 44.41 GW and contribution of hydro power plant is 13.6% of the total power generation capacity.

Contribution of solar energy in India is 20GW according to February 2018 survey and this solar energy used from produce electricity from sunlight energy. Total installed capacity of wind power is 32.72GW mainly spread across the south, west and north region, 10% of all energy from traditional biomass, mainly used for heating, and 13.5% from hydroelectricity. New renewable (small hydro, modern biomass, solar, geothermal, and bio-fuels) account for another 3% and are growing rapidly. At the national level, at least 30 nations around the world already have renewable energy contributing more than 20% of energy supply.

National renewable energy markets are projected to continue to grow strongly in the coming decade and beyond. Wind power.

Renewable energy resources exist over broad geographical areas in comparison to other energy sources, which are
available in a limited number of countries.

Today's main problem is the shortage of energy and environment pollution because of using non-renewable energy sources.

In order to provide continuous and sustained load demands during varying natural conditions, different renewable energy sources need to be integrated with each other like : solar ,wind ,biomass/biogas, geothermal ,ocean ,Bio diesel ,small hydro , fuel cell technologies ,waste of energy municipal waste/ liquid waste/Industrial waste ,wave energy. Thus we have seen that solar and wind is a promising tool for employment generation energy self sufficiency and reduction of green house gases and recover global warming effect. Energy, Environment & Economy is the three inter-connected areas having direct correlation for development of any country. Per capita energy consumption is an index for development of any country so we are tries to increase per capita energy consumption in India with use of renewable energy source.

In the framework, the yield of the inexhaustible sources can't sustain the heap specifically on the grounds that their voltage changes are large to the point that they will harm the concerned load. So first it should be molded, for that by and large dc-dc/air conditioning dc converters are utilized.

Accordingly the changing voltage can be brought to required esteem and determined varieties confines by differing the obligation proportion of the converters, and afterward associated with DC transport.

II. UNIIFIED AND DISTRIBUTED INTELLIGENCE

The capacity to deal with the potential across the board presentation of DER will require an inventive way to deal with conveyance lattice tasks. This will include introducion of new age of data and equipment innovations to deal with these difficulties including Integrated Distribution Management Systems (IDMS) and Distribution Automation (DA) gadgets and frameworks.

The IDMS stage incorporates SCADA, conveyance network investigation and advancement, exchanging administration and blackout administration, all sharing a solitary dynamic system availability show and a solitary far reaching dispatcher UI, i.e. a solitary coordinated stage. IDMS is intended to enhance the execution of the appropriation dispatchers, improve their capacities and enable them to deal with the system all the more successfully, especially under tempest conditions which regularly display a critical number of spontaneous blackouts.

Distribution automation automatically reconfigures the distribution system after a fault and quickly restores service to segments of the feeder which aren't affected by the fault. Advanced DA systems leverage the distributed intelligence of field devices and peer-to-peer communications to facilitate very fast restoration times. The DA system uses the excess capacity available from any alternate source including conventional utility sources, wind power, distributed energy resources, and battery storage to restore service in seconds to unfaulted line segments, thus substantially reducing the number of customers that experience either a momentary or sustained outage, and markedly reducing the Customer Minutes of Interruption (CMI), thereby improving the utility's reliability ratings.

III. INTEGRATED SYSTEM

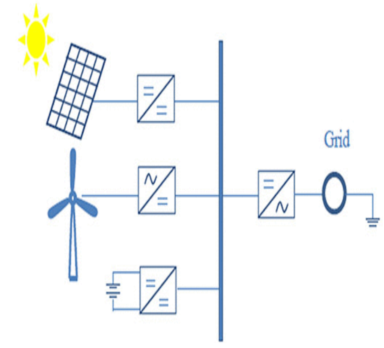

Fig. 1 Grid-connected hybrid system at common DC bus

According to upper shown figure two different types of renewable energy resources are connected to a DC bus and a battery is also connected with this DC bus. Here we are using DC bus because when we use DC bus then losses are reduced. A DC-DC converter is connected between solar system and DC bus and a AC-DC converter is connected between wind energy system and DC bus. In this hybrid power system a battery bank is connected with DC-DC converter. This battery bank two way charge flowing battery so this type of battery perform charging and discharging operation. After that an inverter is connected between DC bus and grid because inverter convert DC supply into AC supply.

In a great part of the United States, wind speeds are low in the late spring when the sun sparkles brightest and longest. The breeze is solid in the winter when less daylight is accessible. Since the pinnacle working circumstances for wind and heavenly bodies happen at various circumstances of the day and year, cross breed frameworks will probably deliver control when you require it.

IV. VISIBILITY OF SYSTEM PERFORMANCE METRICS

Propelled circulation gear, for example, blame intruding on gadgets that have broad estimation abilities, and dispersion frameworks that perform activities, for example, programmed self-recuperating capacities, are intended to react to continuous occasions in the field. Every gadget has an arrangement of DNP indicates that might be mapped the SCADA framework to report certain occasions to the framework administrators. Generally, this sort of data has been centered around ongoing status, for example, open or close switch positions, and voltage and current estimation reports.

V. EQUATIONS

5.1 Objective Function:-

Below shown equation is shows our objective function, which we aim to minimize. It comprises of our aggregate costs (wind and sun powered), including upkeep expenses and capital expenses, and considers the loan cost over the task lifetime. The cost capacities are expounded on in Section 5.4.

$$Cost\ (Wind) + Cost\ (Solar) \qquad (1)$$

5.2 Demand Constraint:-

Condition (2) guarantees that our model meets the power request of the heap, utilizing the power produced from the half and half framework – from both breeze turbines and sun based exhibits. The power produced by the two sources is considered over a year time frame under various climate conditions (e.g. higher sun oriented radiation in summer, high breeze in the winter).

$$Po(Wind) + Po(Solar) \geq Pdemand \qquad (2)$$

5.3 Height And Radius Constraints:-

Condition (3) restricts the tallness of the breeze turbine to 130 meters, while Equation (4) constrains the rotor range to 30 percent of the pinnacle stature.

$h <= 100$ (3)

$r <= 0.3*h$ (4)

5.4 Overall Cost:-

Condition (5) gives the cost brought about from working and keeping up the breeze turbines; this condition consolidates the expenses of expanding the tallness of the breeze turbine and the rotor distance across. These expenses are a numerous of the number of wind turbines introduced, Nw.

$$Cost\ (Wind) = NwCwm+[0.1(h/10-1)+1]Nw(2.449r*2.7+Cwf)\ [i*(1+i)\text{^}Yproj\ /\ (i+1)\text{^}Yproj-1] \qquad (5)$$

Equation (6) gives the cost incurred as a function of the design and placement of the solar arrays, where the cost is comprised of the capital and maintenance costs. This cost is a multiple of the optimal number of solar arrays Ns.

$$Cost\ (Solar) = NsCsm + NsCsc\ [i*(1+i)\text{^}Yproj\ /\ (i+1)\text{^}\ Yproj-1] \qquad (6)$$

5.5 System Generated Power Output:-

Condition (7) demonstrates the normal aggregate yield control produced by the aggregate number of twist turbines in the plan; this condition consolidates the impact of the turbine tallness and measurement.

$$Po\ (Wind) = Nw(1+0.814\ln(h)-1.92)*(0.5\times rho\times \pi r2cpVw\ 3NgNb) \qquad (7)$$

VI. ENERGY MANAGEMENT AND CONTROL SYSTEM

The energy management system (EMS) switches the method of energy supply, and controls the heap share as per the state of wind control, sun oriented radiation, Fuel cell power and load necessity. When all is said in done breeze speed and sunlight based radiation changes indiscriminately, in that conditions vitality administration assumes essential part. Created energy of half breed framework is contrast and the heap. In the event that created control surpasses the heap, at that point overabundance power will be gathered by the electrolyzer. The electrolyzer can create H_2 gas and is put away in H_2 store tank. Vitality administration unit screens the H_2 store tank. In the event that H_2 repository tank is full, and consequently overabundance control is utilized to charge the battery. The capacity batteries remunerate the heap supply at the point when the yield control from the breeze control generator, Solar and power device is insufficient. What's more, its charging status is likewise observed by the EMS on- time. In the event that the load is more than the produced power, at that point the load is associated with the framework. All things considered the EMS checks for the recurrence and controls it.

In the generally low limit of the microgird control frameworks, there are adaptable decisions for request side to expand the productivity of the framework activity and financial matters. In this way, utilizing request side administration to advantageously control stack, would diminish the need of age limit and increment the usage of inexhaustible age gadgets and as needs be increment the effectiveness of age speculation. Mix of the all pieces by utilizing EMS can give adaptable energy utilization administration answer for enhancing power nature of the sustainable power source half and half miniaturized scale matrix control framework. The half and half power framework depends on multi agents hypothesis, so the control subsystem is viewed as a specialist. It is made out of programmable rationale controller (PLC), human machine interface (HMI), matrix associated control module, AC multi-work electric power meters, what's more, DC electric power meters, RS485/TCP converter and so forth., to control and deal with the task of multi-source, for example, control matrix, wind turbine age, sunlight based photovoltaic, stockpiling batteries and loads, likewise to get information and speak with others.

VII. CONCLUSION

Our study focused on planning a model that would enable us to locate the ideal framework plan parameters of a crossover sun oriented breeze framework USING PLC, thinking about the number of sun powered exhibits and twist turbines, and in addition the wind turbine rotor distance across and tallness. The target was to meet the heap of various applications utilizing our outlined cross breed framework, while limiting expenses.

Utilizing produced climate information ordinary of Middle Eastern deserts, our model needed to test the for the nearness of a potential correlative connection amongst wind and sunlight based vitality frameworks under comparable climate conditions. A wide range of uses were considered, and the ideal outline parameters for every application were discovered, which means the ideal number of sun powered clusters and twist turbines, and in addition the ideal rotor width and tallness.

After the tests were completed, a correlative connection between both individual designing was obvious in our outcomes. In mid year, when sunlight based radiation is inexhaustible and there is little breeze vitality, the sunlight based clusters supply the vast majority of the required vitality. In wintertime, when wind speeds are higher and there is less sunlight based radiation, it is the breeze turbines that supply a large portion of the required vitality, therefore giving clear proof of a corresponding connection between the two sources.

REFERENCES

[1] **A**. Jayantilal “Smarter Fault Location, Isolation, and Service Restoration using Integrated Distribution Management Systems and Distribution Automation” IEEE, 2012.

[2] Kazi Mohammad Arfatul Islam “Design and Performance Analysis of a Hybrid Solar PV and Biogas Power Plant using PLC” IEEE, 2015.

[3] Giovanni Artale “Measurement and Communication Interfaces for Distributed Generation in Smart Grids” IEEE, 2013.

[4] Egon Ortjohann “Simulation and Implementation of an Expandable Hybrid Power System” IEEE, 2007.

[5] Syed Zulqadar Hassan “Design and Control of wind/supercapacitor/battery/diesel engine power plant” IEEE, 2017.

[6] Yusuf DEBBAG “Internet Based Monitoring and Control of a Wind Turbine via PLC” IEEE, 2012.

[7] 7. F. Salvadori “Smart Grid Infrastructure Using a Hybrid Network Architecture” IEEE transactions on smart grid, vol. 4, no. 3, September 2013.

[8] A. Cataliotti “Experimental Evaluation of an Hybrid Communication System Architecture for Smart Grid Applications” IEEE, 2015.

[9] Hakan Terziolu “The Designing of an Educational Solar Panel That Can Be Controlled in different Ways” 2015 2nd International Conference on Information Science and Control Engineering.