SECURITY CONCERN TO SIMULATE THE SMARTGRID

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ABSTRACT-Performance optimization, system reliability and operational efficiency are key characteristics of smart grid systems. In this paper a novel model of smart grid-connected PV/WT hybrid system is developed. It comprises photovoltaic array, wind turbine, asynchronous (induction) generator, controller and converters. In this paper, a Smart Grid has been designed by MATLAB/SIMULINK approach for analysis of Active Power. Analysis of active power gives the exact idea to know the range of maximum permissible loads that can be connected to their relevant bus bars. This paper presents the change in the value of Active Power with varying load angle in context with small signal analysis. The Smart Grid, regarded as the next generation power grid, uses two-way flow of electricity and information to create a widely distributed automated energy delivery network. Perturb and observe (P&O) algorithm is used for maximizing the generated power based on maximum power point tracker (MPPT) implementation. The dynamic behavior of the proposed model is examined under different operating conditions. The proposed model and its control strategy offer a proper tool for smart grid performance optimization.

INTRODUCTION

Thelimitations of global resources of fossil and nuclear fuel, has necessitated an urgent search for alternative sources of energy. Therefore, a new way has to be found to balance the supply and demand without resorting to coal and gas fuelled generators. Smart grid is a system that would enable the integration of renewable energy sources and shift from reliance on fossil fuels, while maintaining the balance between supply and demand. The key characteristics of smart grid include:

Grid optimization: system reliability and operational efficiency. Distributed generation: not only traditional large power stations, but also individual PV panels, micro-wind, etc. Advanced metering infrastructure (AMI): smart meters. Grid-scale storage. Demand response.Plug-in hybrid electric vehicles (PHEVs) and vehicle to grid (V2G). This paper focuses mainly on the smart grid integration of PV/WT hybrid system (grid optimization and distribution generation). Over recent years several research and investment has been carried out in hybrid power system, such as Yang, who recommended an optimal design model for hybrid solar–wind system, which employs battery banks to calculate the system's optimum configurations in China. Dihrab , presented a hybrid solar-wind system as a renewable source of power generation for grid connected application in three cities in Iraq. Reichling , modeled a hybrid solar wind power plant in south western Minnesota for a two year period, using hourly solar irradiation and wind speed data. Ekren , showed an optimum sizing procedure of PV/wind hybrid system in Turkey. Several modeling studies on PV/WT power system have been conducted.

Among them, Kim, developed a grid-connected photovoltaic model using PSCAD/EMTDC for electromagnetic transient analysis. Tsai, implemented an insulation-oriented PV model using MATLAB/SIMULINK software package. Gow [8], developed a general PV model which can be implemented on simulation platforms such as PSPICE or SABER. Khan, presented the model of a small wind-fuel cell hybrid energy system and analyzed life cycle of a wind-fuel cell integrated system. Chayawatto, developed a mathematical model of a dc/ac full-bridge switching converter with current control for PV gridconnected system under islanding phenomena; this phenomena occur when the grid system is disconnected for any reason and the distributed generation still supplies to any section of local loads. Onar, modeled a hybrid wind/FC/ ultra-capacitor (UC) power system for a grid-independent user with appropriate power flow controllers. In this study, a detailed dynamic model, control an

d simulation of a smart grid-connected PV/WT hybrid power generation system is proposed. Modeling and simulation are implemented using MATLAB/SIMULINK and SimPower Systems software packages to verify the effectiveness of the proposed system.

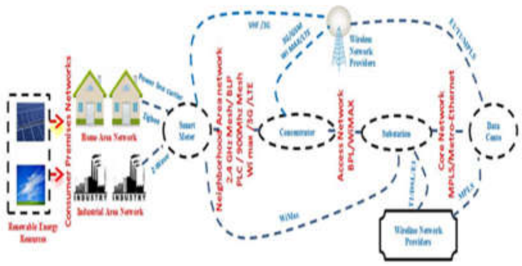

Figure 1. Smart grid communications protocols

MATERIAL AND METHOD
SYSTEM DESCRIPTION AND MODELING

A. Modeling and design of a wind turbine

A few investigations have been accounted for with respect to Wind Turbine and wind generators [8]. In this examination, the proposed Wind Turbine show is based on the wind speed versus Wind Turbine output power qualities. The output power of the wind turbine is given by [9]:

$$P_m = C_p(\lambda,\beta)\frac{\rho A}{2}V^3{}_{wind} \qquad (1)$$

A V_{wind} (1) where: Pm =the mechanical output power of the turbine, Cp= the performance coefficient of the turbine, λ= the tip speed ratio of the rotor blade, β= the blade pitch angle, ρ= the air density, A = the turbine swept area, Vwind= the wind speed. The performance coefficient model $C_p(\lambda,\beta)$used in this paper is taken from [9] and given by:

Where: Pm =the mechanical output power of the turbine, Cp= the performance coefficient of the turbine, λ= the tip speed ratio of the rotor blade, β= the blade pitch angle, ρ= the air density, A = the turbine swept area, V_{wind}= the wind speed. The performance coefficient model $C_p(\lambda,\beta)$ used in this paper is taken from [9] and given by:

$$C_p(\lambda,\beta) = C_1\left(\frac{C_1}{\lambda_1} - C_2\beta - C_4\right)e^{\left(\frac{-C_5}{\lambda_i}\right)} + C_6\lambda \qquad (2)$$

Where constants C1 to C6 are the parameters that depend the wind turbine rotor and the blade design. λ_i is a parameter given in (3).

$$\frac{1}{\lambda_i} = \frac{1}{\lambda+0.08\beta} - \frac{0.035}{\beta^2+1} \qquad (3)$$

Furthermore, Equality (1) can be normalized and simplified for specific values of A and ρ, as in (4):

$$P_{m-pu} = K_p C_{p-pu} V^3{}_{wind-pu} \qquad (4)$$

Where: Pm-pu=the power in per unit of nominal power for particular values of A and ρ, Cp pu=the performance coefficient Cp, Kp =the power gain Vwind-pu of the base wind speed. The based wind speed is the mean value of the expected wind speed in m/s.

B.Modeling and Design of a Photovoltaic Module

The general mathematical model for the solar cell has been considered in the course of recent decades [10]. The circuit of the solar cell display, which comprises of a photocurrent, diode, parallel resistor (leakage current) and a series resistor; is appeared in Figure. 2. As per both the PV cell circuit and Kirchhoff's circuit laws, the photovoltaic current can be displayed as pursues:

$$I_{pv} = I_{GC} - I_O\left[exp^{\left(\frac{eV_d}{KFT_c}\right)} - 1\right] - \frac{V_d}{R_p} \qquad (5)$$

Where: I_{pv} =the photovoltaic current, IGC=the light generated current, Io =the dark saturation current dependant on the cell temperature, e=the electric charge e=1.6*10-19C, K=Boltzmann's constant, K=1.38*10-23 J/K, F=the cell idealizing factor, T_c=the cell's absolute temperature, V_d=the diode voltage, R_p=the parallel resistance.

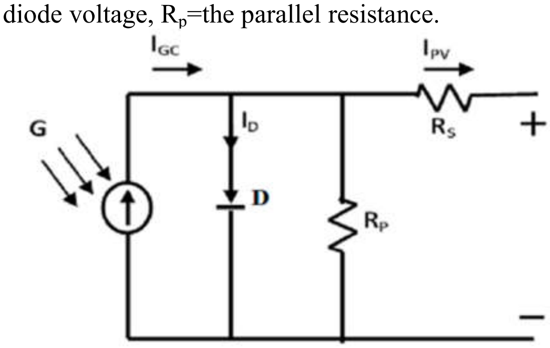

Figure 2. Single diode PV cell equivalent circuit

The photocurrent IGC mainly depends on the solar irradiation and cell temperature, which is described as [11]:

$$I_{GC} = [\mu_{sc}(T_c - T_r) + I_{sc}]G \qquad (6)$$

Where: μ_{sc}=the temperature coefficient of the cell's short circuit current, T_r =the cell'sreference temperature, ISC=the cell's short circuit current at a 25˚C and 1 KW/m2, G=the solar irradiation in KW/m2, Rs=the series resistance, D=the diode, ID=the current flowing in the diode. Furthermore, the cell's saturation current (Io) varies with the cell temperature, which is described as [11]:

$$I_O = I_{O\alpha}\left(\frac{T_c}{T_r}\right)^3 exp^{\left[\frac{eV_g}{KF}\left(\frac{1}{T_r} - \frac{1}{T_c}\right)\right]} \qquad (7)$$

$$I_{O\alpha} = \frac{I_{sc}}{exp^{\left(\frac{eV_{OC}}{KFT_c}\right)}} \qquad (8)$$

Where: $I_{o\alpha}$ =the cell's reverse saturation current at a solar radiation and reference temperature, V_g=the band-gap energy of the semiconductor used in the cell, V_{oc} =the cells open circuit voltage.

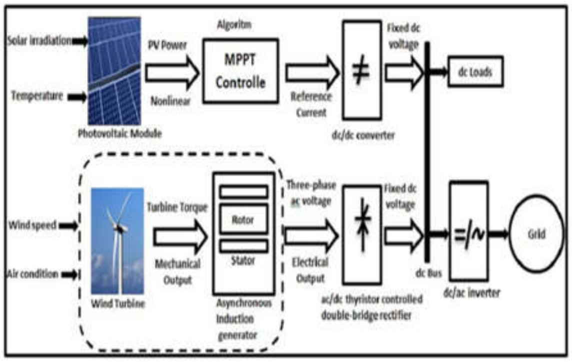

Figure 3. Block diagram of the proposed system

DESCRIPTION SMART GRID SYSTEM

There are four Major parts of smart system, which will cooperate to beat every one of those issues which are disadvantages of past systems, these are:

1. Smart House System
2. Smart Meter
3. Town Server
4. Main Server

A) Smart house system

Smart house is a client house which comprises of smart apparatuses. Devices are smart because of establishment of smart remote card. The diagram of smart remote card it comprise of

1. Digital meter
2. Microcontroller
3. Sensor
4. Simple wireless card

Utilizing the smart machines, correspondence among gadget and smart metering will be finished utilizing little attachment (SM). To detect power utilization sensor is utilized. It additionally chooses current status while advanced meter is the gadget which indicates devoured power and its cost. Microcontroller is gadget which controls the flow of power. What's more, machines required power is likewise known to microcontroller and send this data to SM through basic remote card.

B) Smart meter system (SM)

The basic purposes of SM system are.

(i) Power management and measuring
(ii) (ii) Unit measurement and price
(iii) (iii) Communication

Power management and measuring

SM is a canny gadget which has data about the total power required by smart machines and disseminates power taken from smart grid/power station likewise. On the off chance that the given power from the two sources isn't adequate it will endeavor to satisfy necessity by separating power from RS. Furthermore, if RS can't fulfill power necessity, SM will send a signal to TS to give distinction of required power and accessible power. Along these lines, in the event that it is the situation, required power is not exactly given power by town server it communicate a message to TS that TS given power is more than require so TS can lessen power which is more than require power by SH.

I.Price and unit measurement

In this piece of operation, SM estimates power utilization unit of 3 levels.

Power units given by specialist organization

Power units removed from RS.

Those which are used by specialist organization by utilizing previously mentioned readings, SM compute cost up to that time and it will be unmistakable to custome.

ii Communication

To send and getting the message signal, TS is domain to convey for SM. This is finished by nearby open exchanged phone network (PSTN). The usage of PSTN innovation evacuates the powerful radiations which are available in SM correspondence [17] utilizing this correspondence way, SM just send those number of units and cost to TS which is to at long last paid by the client to specialist co-op. While for power transmission, SM is associated with TS by means of power line moreover. All TSs are additionally associated with main server utilizing PSTN.

C) Town sever (TS)

A town server (TS) is essential unit of smart system for administration. Truth be told, it is the focal PC and a total server which can take choice for its whole client. The TS is associated with MS for correspondence just by utilizing PSTN. As town server send computed power units up to that time to MS after every hour with the goal that every one of the information remain spare at MS. while TS keeps information of current month as it were. It is for proficient filling in as long as present month passes, TS expels its information since MS have every one of the information of earlier month and of present month up to that time. The sending of information after every hour is intended to evacuate the likelihood of over troubling of bandwidth and furthermore to lessen the bandwidth to significantly low level than past smart system.

$$BPS = BWlog2(1 + \frac{s}{n}) \quad (9)$$

Where: BPS=bits per second, BW=channel bandwidth, s/n: Signal to noise ratio. This is a real power ratio and not a db ratio. And bit per second is given by equation:

$$BPS = R_s log2N_s \quad (10)$$

Where: Rs: image rate (likewise bandwidth for QAM), Ns =number of images in the group of stars Now starting from first point, SM makes an impression on TS that its SH needs as much measure of power. In such away such messages will be gotten by TS from the majority of its SMs. At whatever point the required power of SH reduction or increment, it will be educated to TS. Presently in the event that it is the situation, ASM need to lessen its power and other SM need to build its power, both broadcast a message signal to TS then TS diminishes the recommended power of initial one and appointed required made reference to power to other one. In the event that no SH can give or SH's power is less then it broadcast a message to its closest TS to give power see Figure 4. In the event that closest TS does not have power to give from its very own circle/grid then it will get from next TS for the first. In the event that any issue happen at MS or any/few TSs, the various TSs will remain filling in as working before observe Figure 5. This is an impressive substantial preferred standpoint over every single other system. TS could possibly be associated directly to smart grid or conventional power station or both. It fluctuates from one territory to region based on shoddy and solid creation of power around there.

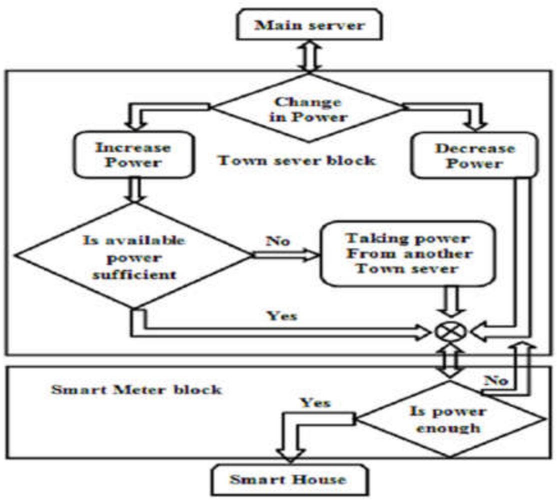

Figure 4. Flow chart of smart system

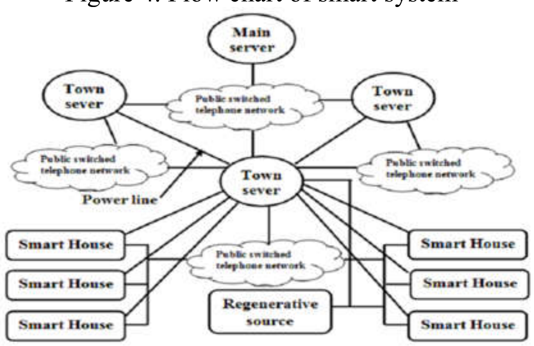

Figure 5. Topology of smart system ; upper part shows way of connection between TS and also with MS while lower part shows the way of connection of SH to TS through local PNST

D) Main server

The main server (MS) is the focal gadget around which all the system works. It keeps estimations, charges, records, client records, topology of division of all the power of smart grid/power stations for its town servers and so forth every TS is associated with MS through PSTN as it were. MS is directly worked by head office of specialist organization. What's more, MS is can begin or stop all the functionality and working of a specific SH/TS by utilizing some kind of directions or passwords. In the event that distinctive distribution organizations are working under single umbrella of smart system, because of any reason, specialist co-op Company can stop the working of any TS under extreme conditions.

RESULTS AND DISCUSSION

To comprehend the working of the keen network, we will think about the accompanying circumstance. Our whole system comprises of two houses, two light businesses and whatever remains of the electrical network. The arrangement of the system was demonstrated for a simulation. Figure 6 represents the simulation block of the system under the Mat lab/Simulink condition.

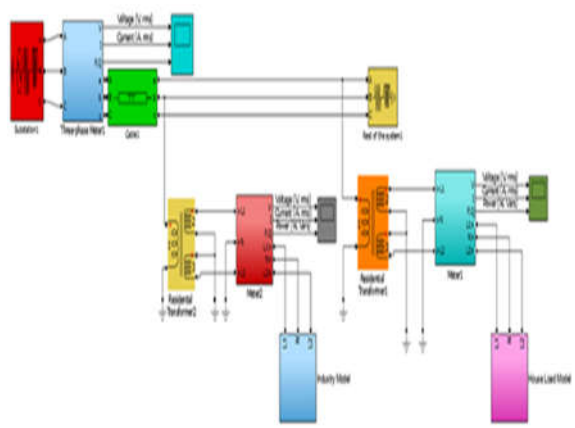

Figure 6. Bloc simulation for smart grid system after running the simulation, we have the following results.

The primary house, appeared by Figure 7, is powered by two energies, wind energy of 4KW and the other of the general power network GEN. Its load bend is depicted by the accompanying project: from 0:00 to 7:00 early in the day, the house devours a constant electric power of 1KW provided by the wind turbine. At 7:00 am, there is a pinnacle of load achieving an estimation of 3KW, additionally provided by the wind turbine.

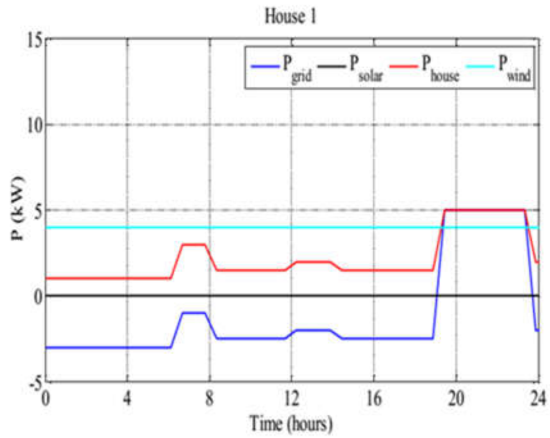

Figure 7. First house simulation results

For the second house, appeared by Figure 8, its load bend is given by the accompanying project: from 00h to 06:00, it expends a power of 1KW provided by the GEN. A pinnacle of power utilization of 3KW is observed and which should last 1h30mn. This power is constantly provided by the GEN then the utilization will be decreased to 1.5KW after the presence of the day when the solar energy intervenes. In this manner, the GEN will be released of this distinction until 19:00. So the GEN deals with the utilization of the second house until 24:00. In contrast to houses, ventures have vital posts of creation and utilization.

The principal business, appeared by Figure 9, contains a 5MW wind turbine and is associated with the GEN, so it is powered by both energy sources. Its load bend is depicted by the accompanying distribution: from 00h00 to 7h00 it devours a constant power of 2MW given by the wind turbine. At 7:30 am the landing of the specialists and the start-up of the machines of the business, a first pinnacle of power utilization is observed and achieves an estimation of 7MW. The last must be met by GEN help until the point when 10.00 am; at that point the load is diminished to 5MW.

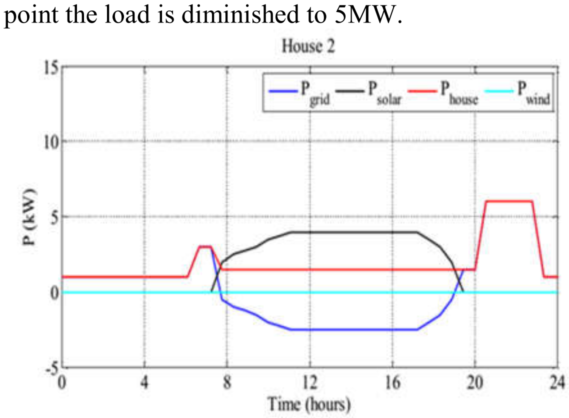

Figure 8. Second house simulation results

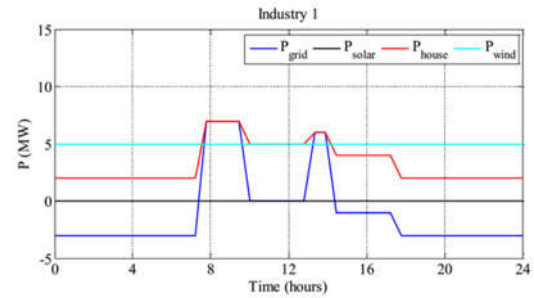

Figure 9. First industry simulation results

The second business, appeared by Figure 10, contains a solar stop with a limit of 5MW and is associated with GEN, so it is powered by both energy sources. Its load bend is depicted by the accompanying distribution: from 00h00 to 6h00 it devours a constant power of 2MW given by the GEN. With the entry of the laborers and the start-up of the machines of the business, a pinnacle of 7MW power is observed and just the GEN deals with it.

At 8:00 am the place the solar energy shows up and starts to give energy, both energy are operational yet solar energy can't fulfill this interest alone, and the pinnacle will last until 10:00. Following a decrease in power of 5MW, the GEN is discharged and just the solar stop encourages the plant. A second pinnacle of 6MW is observed at 15h00 and proceeds until 16h00, which again includes the GEN. At 5 pm, with the conclusion of the business, utilization is lessened to 2MW. The last is given by the solar stop until 19:00 with the nightfall, the GEN is utilized again until the day's end.

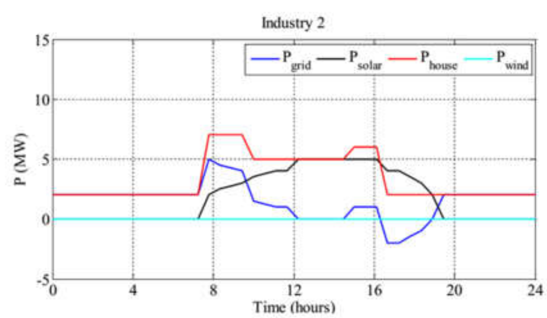

Figure 10. Second industry simulation results

CONCLUSION

In this paper, a novel PV/WT hybrid power system is designed and modeled for smart grid applications. The developed algorithm comprises system components and an appropriate power flow controller. The model has been implemented using the MATLAB/SIMULINK software package, and designed with a dialog box like those used in the SIMULINK block libraries. The available power from the PV system is highly dependent on solar radiation. To overcome this deficiency of the PV system, the PV module was integrated with the wind turbine system. The dynamic behavior of the proposed model is examined under different operating conditions. The developed system and its control strategy exhibit excellent performance for the simulation of a complete day. The proposed model offers a proper tool for smart grid performance optimization.

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