Solar power converter for water pumping system engineering essay

Abstraction

The paper presents development of a public-service corporation interface solar power convertor to supplement shortage in Grid power supply for a H2O pumping system used in rural place of Indian small towns. The power supply system comprises of solar (PV) array, PWM convertor integrating PWM control scheme, energy storage battery devices, submergible pump and H2O storage armored combat vehicle (s) etc. The theoretical account of the system has been designed for its optimum operation and a paradigm solar power convertor unit has been developed to drive a ? horsepower pump motor. The Life rhythm cost rating of the solar power convertor has been done and compared with conventional DG set. This has resulted in a cost effectual system with a 60 % - 70 % grid power economy.

Keywords: Photovoltaic ; solar pump ; PWM inverter ; Diesel Generator.

1. Introduction

Water is the basic demand of all life being. Approximately 30 % of universe population deficiency entree to H2O for imbibing, farm animal and irrigation. Traditional engineering used to entree the H2O from available beginnings like bore good or open good employ H2O pump to raise H2O and shop it in an overhead armored combat vehicle (s) . These pumps are either powered by conventional grid supply or alternate Diesel Generating (DG) set etc. but higher cost of fuel consumed by DG set and non handiness of equal grid supply have forced scientist and applied scientist to believe for either a auxiliary or alternate renewable energy beginning to bring forth electrical power [1, 2, 3, 4, 5, 6,] . Solar photovoltaic energy is one of the possible beginning is preferred due to handiness of free Sun fuel, directly frontward engineering, lower care with dependable operation etc. Though the solar faculties (cells) are expensive but attempts are being made to utilize it non merely for power transition but besides for constructing the exterior wall or covering the roof of pump farm houses or H2O pump Houses.

Further, the demand of electricity is increasing twenty-four hours by twenty-four hours by the turning population where as grid supply extension has about become standstill due to its limited resources like fossil fuel etc. and its farther enlargement is non possible due to assorted proficient and economic grounds. This has motivated the research workers to develop public-service corporation interface solar power convertor to bring forth power which can run into the increasing energy demand of houses located specially in rural sector of the state connected to weak grid supply beginnings. The system can work even as a standalone device in the grid less village countries. Data acquisition of demand based burden profile were accessed. The computational analysis for optimum design of the constituent has been done and prototype Inverter theoretical account has been developed and tested for its dynamic Performance. The proposed system is able to convey an energy salvaging up to a maximal value of 60-80 % of power drawn from public-service corporation supply in these rural houses.

The mold and design of constituents of H2O pumping system include the undermentioned faculties

i,· PV cell

i,· Battery back-up beginning

i,· PWM Inverter

i,· Intelligent power accountant

i,· Pump for H2O storage in an overhead armored combat vehicle etc.

The present survey highlights the followers:

i,· Study of user demand of pump and buoy uping burden profile in a rural house of Indian small towns.

i,· Optimal design of solar power convertor faculty dwelling of PV array, Battery, PWM Inverter and Pump-Motor etc.

i,· Prototype development of public-service corporation interface solar adaptative Power convertor unit.

i,· Life Cycle Cost Analysis of the paradigm solar convertor system and its cost comparing with DG set.

i,· Social Impact of usage of solar powered convertor on rural development in Indian Villages.

The solar energy is harnessed through photovoltaic cell and converted into public-service corporation class AC power utilizing PWM inverter. The system adapts to run into the changing burden profile under two manners of its operation. The conventional diagram of the proposed strategy is shown on Figure (1) .

Bore well/Open well

Figure (1) : Model of Solar Power Converter and Pump Motor

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Figure (2) : Block and Circuit Model of public-service corporation interface

Solar Power Converter System

The convertor works in bidirectional manner and performs both under charging and inverter manner of operation. The push pull configured Centre tapped converter unit is switched ON and OFF instead in push pull manner by transistorised exchanging Power devices to bring forth ac power from the DC beginning.

i,· Mode 1: High Insolation / low Insolation with more than 50 % province of charge (SOC) of the Battery: The PV charges the battery bank every bit good as provender illuming burden through PWM inverter. (S2 remain ON)

i,· Mode 2: Low battery status (less than 50 % SOC) : Grid or DG (in absence of Grid) is connected to lade and charges the Battery boulder clay it becomes to the full charged (S1 or S3 become ON)

The shift of these power devices are controlled through PWM base thrust pulsations and therefore minimizes the power loss. The intelligent accountants monitor and control the system parametric quantities and execute the assorted power direction control undertakings like:

i,· PV power direction

i,· Battery direction

i,· Load power direction

2. OPTIMAL DESIGN OF SYSTEM COMPONENTS

2. 1 PV Sizing

The empirical expression based on energy balance equation has been used to calculate the optimum size of PV faculty for critical bound of burden as stated below:

(1) S. F * Hour Sun P evaluation Cell PV avg iˆ?

(Where sun hr = 6. 2 for country under survey, S. F. = 1. 2 for cloudy conditions)

(2) hour 24/ P P 24hr 0hr L avg i?? iˆ?

The mean burden power (Pavg) is computed over 24 hour taking the burden value as changeless for every 1 hr interval.

The optimum figure of PV faculty = (3) Module PV Standard Rating PV

2. 2 Battery Sizing

Battery shops the energy to a maximal value as per norm burden power demand.

The battery capacity = (4) SOC* 12V Power Load Average

Where SOC (State of Charge) of Battery = 50 %

2. 3 Pump Motor

The pump is driven by ac motor whose optimum value can be computed by the undermentioned look

Motor Power = (5) i?? P H

Where HP = Hydraulic power of pump [W]

i?? = Efficiency of pump

The hydraulic power HP can be computed by the undermentioned look

HP = Q i?? g H (6)

Where, Q = discharge rate, i?? = denseness of H2O 1000kg/m3, g = acceleration due to gravity 9. 81 m/s2,

H = dynamic Head (m)

2. 4 Inverter Module

The inverter produces AC power end product with DC power input. The efficiency of Inverter depends on harmonic content in Ac end product power which depends on the figure of PWM exchanging pulsations i. e. N approximated to a sine moving ridge in both the half rhythm of end product AC moving ridge. The PWM pulsations are generated through Microprocessor/computer package plan embedded in individual bit of incorporate circuit.

3. PWM CONTROL ALGORITHM OF PV CONVERTER

The PV convertor produces PWM sinusoidal pulses utilizing Direct PWM transition control scheme. The pulse breadth (Pi) of PWM pulsations come closing to an tantamount sine moving ridge is computed from the control algorithm (equation 7) as stated below:

(7) 2N 1) - I (2 Sin * 22N 180 P I & A ; deg ; iˆ?

Where, Pi = PWM pulse breadth of one Thursday pulsations

N = figure of PWM Pulses within one half rhythm come closing to a sine moving ridge

I = 1, 2... . N

The fake PWM pulsations for a typical representative value of N= 3 is shown on Figure (3) .

Figure (3) : Simulated Direct modulated Sinusoidal PWM pulses for N = 3 in one half rhythms (10ms= 180 Deg) ,

Frequency = 50 Hz (Scale X = Degree ; Y= Pulse Voltage x 5V)

4. HARDWARE IMPLEMENTATION

The algorithm of package plan for coevals of N figure of PWM pulsations has been implemented through 16 spot Microprocessor (8086) . The pulse breadth and Notch width timings are computed from the exchanging angles of PWM pulsations and are loaded in the timer (peripheral device) unit of

Microprocessor and outputted through ports interfaced with Microprocessor.

The plans flow-chart (Figure (4)) is as depicted below:

Figure (4) : Flow Chart of PWM Pulse Generation Program

5. TECHNICAL Specification

A paradigm solar convertor unit of the system has been designed and developed as depicted in Table (1) .

Table (1) : Technical Specification of Prototype Sample of Solar Converter system PV Cell

12V, 75Wp @ STP

Battery (Lead Acid)

12V, 150Ah

PWM Inverter

500VA, 220V, 50Hz PWM Sine Wave

Load

Pump (Self priming ? HP submergible pump for dynamic caput of 10 metres, CFL etc.

Grid Power

220V i,±10 % , 50Hz

Duty Ratio

User Demand