ISSN (Online) 2321-2004
ISSN (Print) 2321-5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROLENGINEERING
Vol. 3, Issue 6, June 2015

Solar Irrigation System using Brush less DC Motor

Renu Singh[1], Ahmed Sharique Anees[2], Devang Tyagi[3]

Electrical and Electronics Eng, Galgotia's College of Eng and Tech, Gr. Noida, UP, India[1,3]

Asst. Professor, Electrical and Electronics Eng, Galgotia's College of Eng and Tech, Gr. Noida, UP, India[2]

Abstract: The paper presents an idea of solar based after pumping system. To fulfill the need of water requirement of an educational institute for different purposes such as drinking, irrigation and other daily requirement the idea is to replace the grid power supply by the solar array system resulting in a huge power saving. The attempts are made to recover the minimum cost of the whole system in minimum years and after that a calculation of revenue is discussed in the work.

Keyword: SPV system, DC driven System, AC driven system, Decentralized Application, Environmental benefit.

I. INTRODUCTION

Solar irrigation system using BLDC is an idea to replace the grid power by the solar power and existing submersible pump by the BLDC motor. Currently in India the power for irrigation purpose is taken from the grid but due to vast gap between demand and the supply of electric power, farmers are suffering a lot. In the paper we are presenting an idea to use the sun light for irrigation purpose, it will fulfill all the demands for irrigation purposes as well as creates an additional wealth to the farmers under the schemes such as surya raitha scheme . The model is very simple to install and almost operated at zero maintenance cost as well as project is economically friendly and can be installed at remote locations where it is very difficult to fulfill the need with the grid power [1]. By the implementation of solar irrigation system we can use the solar power efficiently by converting the sun energy into electrical energy. For irrigation a great percentage of the water is required during the day time, solar water pumping system can easily fulfill this requirement because the sun is in its brightest position during the day time .The main advantages of using the solar powered pumps includes saving of grid energy, no fuel cost as it uses the free sunlight, reliable operation, reduction in dependency on rain and one of the most important advantage is creating an additional wealth to the farmer as they can supply some energy back to the grid. Experiments says that a solar panel of 10 KW operating from 9 Am to 4 pm for a land of 4 Acers is sufficient to give a profit of amount of 60,000/- per year to the farmer (surya raitha scheme)[2]In India There is a vast gap between demand and supply of electric power. The shortage of electric

In the paper a case study of our educational institute "Galgotia's college of engineering and technology" is carried out. All the information regarding the college water pumping system is collected. The information consist an overview about various motors, their locations, their rating along with timing of operation. In college water pumping system 4 submersible pumps are used to fulfill the water demand with a total of 16hp power, which means we have to apply a solar array system approximately of 11.936 KW nearly equal to 12KW for power results in economically backwardness of the country. (surya raitha scheme)[2]In India There is a vast gap between demand and supply of electric power. The shortage of electric power results in economically backwardness of the country no fuel cost as it uses the free sunlight, reliable operation, reduction in dependency on rain and one of the most important advantage is creating an additional wealth to the farmer as they can supply some energy back to the grid. Experiments says that a solar panel of 10 KW operating from 9 Am to 4 pm for a land of 4 Acers is sufficient to give a profit of amount of 60,000/- per year to the farmer (surya raitha scheme)[2]

In India There is a vast gap between demand and supply of electric power. The shortage of electric power results in economically backwardness of the country.In India per capita energy consumption is about 917.2 kWh which is much lesser than European country where it is around 2600kWh [3], to fulfill the demand of power renewable resources plays an important role. Solar power is one of the most important type of renewable energy resources used in India, now a day solar power is contributing to a large amount of power in the total energy production by various methods[4]. This is the reason why Indian government is supporting incentive method of irrigations. Solar irrigation is one of the most popular method of irrigation. Gujarat government recently promised to distribute more than 1,000 devices to its poor farmers, Maharashtra government promised to distribute 5 lakh solar pumps by the end of this year.

Daily water requirement by our proposal we can save 2948.25 units of energy per month which is almost 7% of the total energy consumption per month of the institute. In a Solar water system PV array plays most important part, PV array is a semiconductor device, which converts sunlight into electricity but this technology costs more than other electricity generation methods although there is a hope that the cost will be down with the technical advancement in few year .The second most important component is motor- pump set ,a number of combination

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROLENGINEERING
Vol. 3, Issue 6, June 2015

can be used for this, solar pump can be categorized in 3 types (according to the depth from where they can pump the water) submersible pump used. submersible pump is of two type :- surface pump and floating pump and depending upon the working they are of two type: centrifugal and helical type pump[6]. The motor can be either AC or DC motor since the output from the PV array is direct in nature so dc motor is widely used in solar system. In our project we are using BLDC motor. In BLDC motor there is absence Absence of carbon brushes makes the operation free from noise and spark which makes the life of motor long. The working function of BLDC is achieved by electronically controlled switches or by solid state switches. The operation of BLDC is much more reliable in comparison to a conventional motor. Other benefits of using BLDC motor is reliable operation, much more efficient in comparison to conventional motor, longer life due to the elimination of spark at brushes, less noise as well as less electromagnetic interference[7].

Our idea is to replace the currently grid connected system by solar powered system either with the help of already existing AC operated system or by replacing the whole system by the BLDC motor. For the analysis and calculation purpose we use all the information including motor rating, total timing of operation of each individual motor, various purposes, various storage pumps ,their capacity, locations, college operating power factor, college tariff plans and operating power factor at last we collected information about previous year tariff plan to compare the final results.

The study in the paper can be categorized in following sections

Section 1:- introduction
Section2:-Description of existing water-pumping system.
Section3:- proposed models.
Section4:-techno-economic analysis of various models
Section5:-result evaluation
Section 6:- conclusion

II DESCRIPTION OF EXISTING SYSTEM

Existing water pumping system is consisting 4 submersible pumps, two of them is 5hp pump while the other two is of 3 hp power. The motors are 3 phase operated with a power factor of 0.982(lagging). The pumps are used to supply a number of different tanks located in different sections of campus. These sections are Different blocks, as block A, B, C, D and block E, college canteen, boy and girl hostel and 5 parks located in the college campus.

The total water requirement of the college campus is around 187500 liter per day excluding the water requirement for park purpose. Total Capacity of tanks in various blocks is 101000 liters which is for drinking and washroom of the Brushes so the losses and the noise will be negligible sectionintheollegetotal capacity of tanks is 3000 liters which is used for drinking and washroom purposes.

TABLE 1

Rating and Location of Motors

S.No	Location	Rating	Total time of operation	Timing of operation	Purposes
1	GBS road	5 HP	9:30 hrs	6:00am-12:00pm & 2:30pm-6:00pm	Boys hostel, GBS Building, block –B,C,D &E
2	Big hut	5 HP	8 hrs	9:00 am- 1:00pm & 2:00- 6:00 pm	Girl hostel & fountain
3	Behind Boys hostel	3 HP	8 hrs	9:00 am-1:00 pm & 2:00 -6:00pm	For park
4	Small hut	3 HP	3 hrs	5to 6 time in a day	Block A & Canteen

TABLE 2

various storage tank in different blocks

S.no	Location	Number of tanks	Tank capacity(in liter)
1	Block A	4	16,000
2	Block B	4	20,000
3	Block C	4	20,000
4	Block D	3	15,000
5	Block E	2	36,000
6	Boys hostel	6	30,000
7	GBS building	3	30,000
8	Girl Hostel	2	18,000
9	Canteen	1	500

DOI10.17148/IJIREEICE.2015.3634

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROLENGINEERING
Vol. 3, Issue 6, June 2015

The existing system takes the supply from the grid. After that the 3 phase operated submersible system operates which is used to fulfill the water requirement tanks. The block diagram of current system can be as

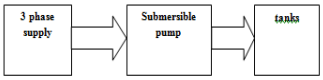

Fig 1 Block Diagram of Existing System

II. PROPOSED MODEL

a. Inverter interfaced solar connected system

To use the existing AC motor pump set we need only an inverter interfacing as well as instead of using the grid supply we connect our motor pump set with the solar panel after the inverter circuit. Since the output of the solar panel is DC and the inverter converts the DC output in AC [8] so it can easily drive the existing AC operated pump. The connection can be explained by the block diagram as:-

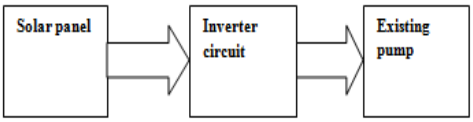

Fig 2 Block Diagram of Inverter Interfaced model

With the help of this system we can reduce the heavy establishment cost by eliminating the cost required for new motor pump set but this will cost a high running and maintenance cost of the system.

b. DC operated system with solar panel and BLDC motor

The next proposal is to replace the whole system. In this proposal all the components along with the grid and motor pump set is replaced. Since the output from the solar panel is DC in nature so it is very easy to fed the output of the solar panel directly to the dc motor, in our project we are not using conventional dc motor .We are going to use a BLDC motor. In a BLDC motor there is an absence of the carbon brushes and commutator which increase the life of the motor by reducing the spark at the brushes. A BLDC motor has a number of advantage over conventional motor as reliability of operation, low maintenance and many more. Although there are lots of advantage there are some disadvantage of the motor also such as high cost, need of the electronically controlled sensors etc. The block diagram of our proposed model can be as follow:-

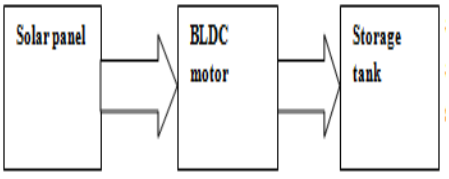

Fig 3 Block Diagram of BLDC model

III. TECHNO ECONOMIC ANALYSIS OF VARIOUS PROPOSAL

our prime motive of the project is to reduce the energy bill down by the efficient use of sun energy so to prove that our proposed model is much better than the existing system a cost comparison is necessary collected all the information regarding the college tariff plan to calculate the energy bill in water pumping system as well as we establish our small working project and by integrating the cost of 1 unit to the current requirement we can estimate a near cost of the proposal including the running, maintaining and establishment cost of the system. The cost analysis of the work can also classify in to the various stages which can be as follow:

- Existing grid connected water system

The existing system is already established in the college so we are not in need to establish the whole system. Hence the system eliminate the cost of establishment. As we know that for calculating the electricity bill we need to have the energy requirement of per day which can be described in table 3 Also by the college electricity bill we know that college power factor is 0.982 (lagging) and we also have different tariff plans of electricity bill .these different plan will help us to compare the price that is increase within two years. In our project we assume that the price are not increasing per day, while there is a continuous price hike in the electricity. we compare the cost for the same water pumping system under two different plan. On the basis of the above data we can also draw the load cycle of the system. The peak of the load cycle decide about the rating of the connection and with the help of above data we will see that peak of the system is at 21hp. In the cost analysis of the existing system we have two tariff plans. We all know that the price of electricity is increasing day by day, there is an increment of almost 10 % per annum, we will ignore per annum increment in the rate and compare the cost of the existing system for two different tariff plan AC Current.

- Driven with inverter interfacing

In AC driven system with inverter as an interfacing we required the installation cost of the system. For installation of the system we required the cost of solar array, inverter interfacing and also the accessories cost .This system is similar to the conventional grid connected method with the only difference is that the power is fed from the solar array and for the matching between the DC output of the solar panel and the AC motor pump set the inverter is used as an interfacing circuit. Since the peak is 21 hp so to fulfill the requirement ,we need to design the whole circuit according to the peak demand which is approximately equal to the 15.667KW , It is only the approximated cost by considering the 60% capacity factor we required a whole of 26.11kw SPV plant , which would be very costly for us so the best method is load shifting method, by load shifting means shifting the load from peak hours to non peak hours and make the curve more flat, so the peak load is reduced for this shifting of the load we need only to operate some of the submersible pumps at some different timing.

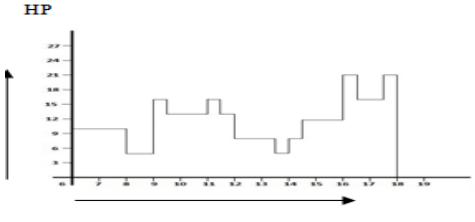

Fig 4 Load cycle

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROLENGINEERING
Vol. 3, Issue 6, June 2015

Table 3 energy consumption per month and year

S. no	Motors	Power in hp	Total time of operation	Energy required per day	Energy required per year
1	GBS road motor	5hp(3.73KW)	9 hour 30minute	35.435KWh	12.933MWh
2	Big hut motor	5hp(3.73KW)	8 hours	29.84KWh	10.891MWh
3	Boys hostel motor	3hp(2.23KW)	8 hours	24KWh	8.760MWH
4	Small hut motor	3hp(2.23KW)	3 hours	9KWh	3.285MWh

Table 4 electricity bill calculation

S.no	21 hp system at (0.982 lagging PF)	Old tariff (rates)	Cost/month	New tariff (rates)	Cost/month
1	Fixed charge (Rs /KVa)	115	3002.65/-	250	6527.5/-
2	Energy cost (Rs/ KVah)	7.25	192.766/-	5.80	154.223/-
3	TOD Surcharge on energy charges	20%	38.5532/-	20%	30.842/-
4	Surcharge on fixed charge	8%	240.212/-	8%	522.2/-
5	Surcharge on energy charge	8%	15.4212/-	8%	12.3370/-
6	Electricity tax	5%	174.480/-	5%	362.35/-
7	**cost**	**3664.082/-**		**7609.442/-**	

Table 5 Cost of the AC Driven Inverter Interfacing With 21 hp & 13hp peak

S. no	component	Unit cost in rupees	Cost(21 hp peak)	Cost(13 hp peak and)
1	Solar panel (capacity factor 60%)	400 rupees per 10 watt	436760/-	436760/-
2	inverter	450 rupees per 100 watt	44223.75/-	43641
3	Accessories	30 rupees per 10 watt	32,757/-	29094
4	*Total*		**513740.75/-**	**480,430.94/-**

Table 6 Cost of DC operated system

S. NO	component	Cost per unit	Motor (impeller)	Motor (pump)
1	Solar array	400 RS per 10 watt	436760	436760/-
2	motor	450& 400 RS per motor	6770.8	39351.85/-
3	Accessories	29094/-	29094/-	29094/-
4	Total cost		**472,624.8/-**	**505,205.85/-**

ISSN (Online) 2321-2004
ISSN (Print) 2321-5526
INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROLENGINEERING
Vol. 3, Issue 6, June 2015

Table 7 Comparitive Study Between Stages

s. no	Different methods	Equipment and installation cost	Running & maintenance cost for 1 year	Running & maintenance cost for 20year
1	Existing system(old plan)	Already installed	43,968.984/-	879379.68/-
2	Existing system (new)	already	91312.8	1826256/-
3	Ac driven with inverter	480430.8	25000/-	980430/-
4	Motor with impeller	472624	5000/-	572624/-
5	Motor with pump	505205	5000/-	605205/-

Table 7- Cost Recovery

s.no	Proposed model	Recovery in years New tariff
1	Ac driven system with inverter interface	10 years
2	Dc system motor with impeller	6 years
3	DC system motor with pump	6.6 years

IV. CONCLUSION

The various table's shows that our proposal is much more cost effective and it start to give revenue in a very short time. The proposal is also environment friendly, reduces transmission losses and electrical hazards also. the project is very advantageous for agricultural purpose.

V. ACKNOWLEDGEMENT

The work and all the studies are supported by galgotia's college of enginnering and technology. so we would like to thank the college administration.

REFRENCES

[1] Clinton slabbert, Michel malengre "Grid connected solar water pump for rular area"
[2] "Agricultural department of india, agricultural schemes in Andhra Pradesh".
[3] Majid Jamil, Ahmed Sharique Anees, M. Rizwan "SPV based water pumping system for an academic institution"
[4] Anantha "Solar photovoltaic as an energy source for India".
[5] Majid Jamil, Ahmed Sharique Anees, M. Rizwan"SPV based water pumping system for an academic institution".
[6] CV Nayar, E Vasu and SJ Philips.."Inverter Interfacing Induction Motor."
[7] T. S. Surendra and S. V. V. Subbaraman "Solar PV water pumping comes of age in India", Twenty-Ninth IEEE Conferenceon Photovoltaic Specialists, pp. 1485–1488, 19-24,May 2002.
[8] R. E. Katan, V. G. Agelidis and C. V. Nayar "Performance analysis of a solar water pumping system", International Conference on PowerElectronics, Drives and Energy Systems for Industrial Growth, pp. 81 – 87, vol.1, 8-11 Jan 1996.
[9] http://www.lorentz.de/en/products/submersible_solarpumps/ps1800.html.
[10]Delhi Electricity regulatory commission.http:// www.derc.gov.in /ordersPetitions/orders/Tariff/Tariff%20Order/201213/Press%20Release_26.06.2012/BRPL.pdf
[11]A. Mukherji, Photovoltaic Analysis and Design, PHI publication,New Delhi,2011.
[12] B. H. Khan, Non Conventional Energy Resources, 2nd edition,Tata McGraw-Hill pg no. 424.