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A Decision Support Technique to Design Solar Power System for Sindh Agriculture University Tandojam

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Abstract: *Pakistan's energy requirements are increasing day by day and not only economic growth but political stability is linked with the availability of energy resources. At present the total generation installed capacity is 21,000 MW. The peak demand is 15,000 MW, but the production is only 9,000-10,000 MW, resulting in 10-12 hours of load shedding. The root cause of the faulty fuel mix is the use of furnace oil as the main fuel to produce thermal electricity. This energy crisis has destroyed at least 50 percent of the industrial sector that has led to increase in the rate of unemployment. It has badly affected the fixed income group because costs of goods and services have increased. Due to the electricity crises a common man look to the available short term alternatives such as generators and Uninterrupted Power Supply (UPS) units but they are not environmental friendly nor have enough storing capacity to provide continuous energy. Due to above problems, the report has been formulated which divert the attention of the policy makers of Sindh Agriculture University Tandojam for bringing the university to the solar system. This process was done using both software and manual analysis, to determine the tilt angle, azimuth degrees, Photovoltaic module size, size of the inverters, batteries and charge controller. At the other hand we also estimated the cost efficiency of solar power system as compare to HESCO in which we analyze the basic appliances like tube lights, savers, fans and computers. The total load of the all faculties and departments are 3, 51,498 Watts per month and the monthly expenditure are paid by university is Rs.11,59,943. But as compare to solar power system the monthly expenditure for same load is just Rs.2, 68,504 and it has a 25 years life as well. If we compare the HESCO and solar power system we would save approximately 76.8% monthly cost. The result of this study can be referred by the policy makers and decision takers of Government and as well as private sectors. We all are causing the problem of pollution, but we need to realize that there are many other power sources for running appliances, and that these options need to be taken advantages.*

I. Introduction

Energy crises Scenario of Pakistan

Pakistan has been facing an energy crisis since 2007. The main reason for the current crisis is that in the past no efforts were made to ensure increase in power generation capacity along with increase in population growth. An energy crisis is any great shortfall in the supply of energy resources to an economy. Electricity is the basic need of human life. It has great importance as it is directly related to every country's economy.

Pakistan's energy requirements are increasing day by day and not only economic growth but political stability is linked with the availability of energy resources. At present the total generation installed capacity is 21,000 MW. The peak demand is 15,000 MW, but the production is only 9,000-10,000 MW, resulting in 10-12 hours of load shedding. The root cause of the faulty fuel mix is the use of furnace oil as the main fuel to produce thermal electricity. The months of January to May have very low hydropower available since reservoirs are empty and snow melt will not, start till June. The Tarbela reservoir receives about 95 percent of its water through snow melt. The natural gas is in short supply and is available only to produce 29 percent MW of electricity. As over 50 percent of current generation is dependent on furnace oil, it is not viable for the government to purchase and provide oil at such high price. Therefore, many plants are either shut or transfer the cost to consumer. When the price of electricity is raised, the whole economy gets disturbed as a result of producing much below their capacity. Wapda and KESC purchase expensive oil and inflation and increase in the price of items of everyday use.

Energy crisis has destroyed at least 50 percent of the industrial sector that has led to increase in the rate of unemployment. It has badly affected the fixed income group because costs of goods and services have increased.

The current shortage of electricity of Pakistan clearly implies failure on the part of the government to tackle it. Corruption is another major reason. The government should have developed electricity through alternative resources of energy like nuclear energy, natural gas exploration, natural gas import, solar energy, coal and wind energy.

Due to the electricity crises a common man looked to the available short term alternatives such as generators and Uninterrupted Power Supply (UPS) units. Generators are expensive to buy (average cost Rs 37,500 and per year average for five years comes out to Rs 7,500) and expensive to operate, at an average of Rs 5,882 per month and an annual cost of Rs 70,560. The noise and air pollution they cause is damaging to health and buyer don't like to visit market when there is no light.

The UPS on the other hand is cheaper at Rs 15,000 for five years but the cost of the battery is 15000 and its life is 12 months and per year average comes out to 4,000 but with an average running and maintenance cost of Rs 12,240. Moreover, it has a running cost of Rs 1,000 per month.

However, UPS does not store enough energy to meet the long hours of load shedding and also consumes a considerable amount of energy from the grid. In addition, its acid batteries cause immense air pollution which is difficult to tolerate for a long period of time.

Due to above problems, different people conducted surveys in which they wanted to know the real diversion of people to the reliable alternative system. Ninety percent of the people were showed their willing to adopt a solar energy option because they understand it's environmental and sustainability advantage. People expressed their concerns as well. Interestingly, they believe that the constraints in providing alternative energy to their units are not of a financial or technical nature but have more concerned with governance issues.

Minimum 10km/hr wind velocity is required for the installation of wind mill at that site but here at Tandojam i.e. 2 km/hr velocity of wind there for wind mill is not recommended. Pakistan, has capacity of producing 350,000 MW, 2.9 million MW, 2500 MW wind energy in coastal areas, solar Energy and Geo-thermal respectively. **(source: Alternative Energy Development Board Ministry of Water and Power Government of Pakistan**

Due to above facts the report has been formulated which divert the attention of the policy makers of Sindh Agriculture University Tandojam for bringing the university to the solar system. Further this project get more advantage when government provide subsidy on the import of silica based glass solar panels and frequent trainings must be provide regarding the assembly and the maintenance of solar panels/products.

Objective of the study

To help the decision makers for bringing the Sindh Agriculture University Tandojam from HESCO to Solar Power System.

Estimation tool

For the estimation of electric load, solar panel array sizing, solar charge controller sizing, and battery bank seizing for SAU Tandojam electric load calculator has been used.

Diagram-1 Electric lo ad Calculator

connected

Load Calculator

Us t know what your power consumption (kilowatt-hours) is.

more info

Name: Date 7/31/2012

	Appliance*	Qty	Watts (Volts x Amps)	Hrs/Day	Watt Hrs/Day
1	TUBELIGHTS	546	40	10	218400
2	SAVERS	36	14	10	5040
3	FANS	183	100	10	183000
4	COMPUTERS	49	100	10	49000
5					0
6					0
7					0
8					0
9					0
10					0
11					0
12					0
13					0
14					0
15					0
16					0
17					0
18					0
19					0
20					0

Total Watt Hrs Per Day: 455,440

Total Kilowatt Hrs Per Month (30 Days): 13,663

(write down this value and enter it into Step 1 of solar panel sizing calculator)

Diagram-2 Solar Panel Array Sizing

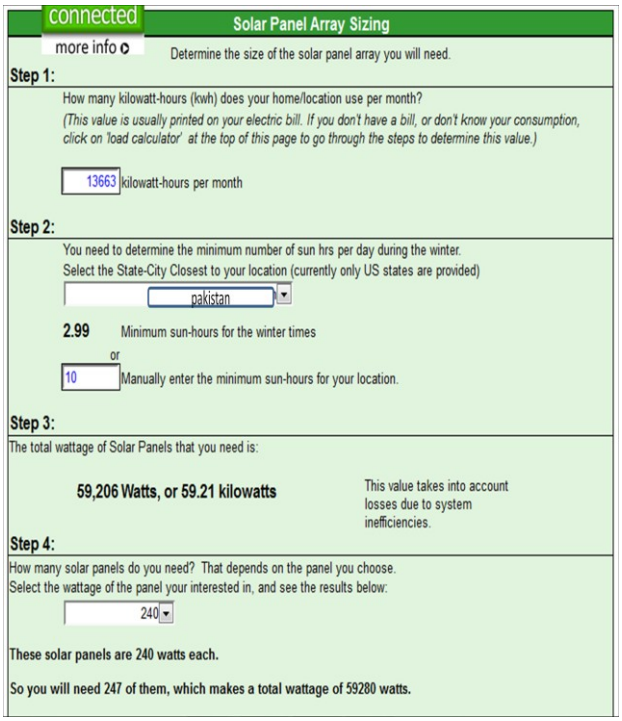


Diagram-3 Solar Charge Controller Sizing

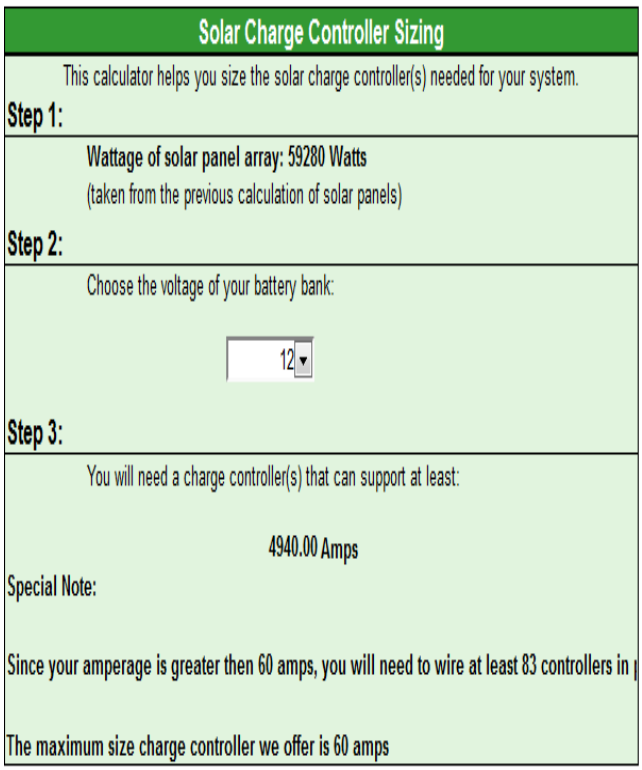
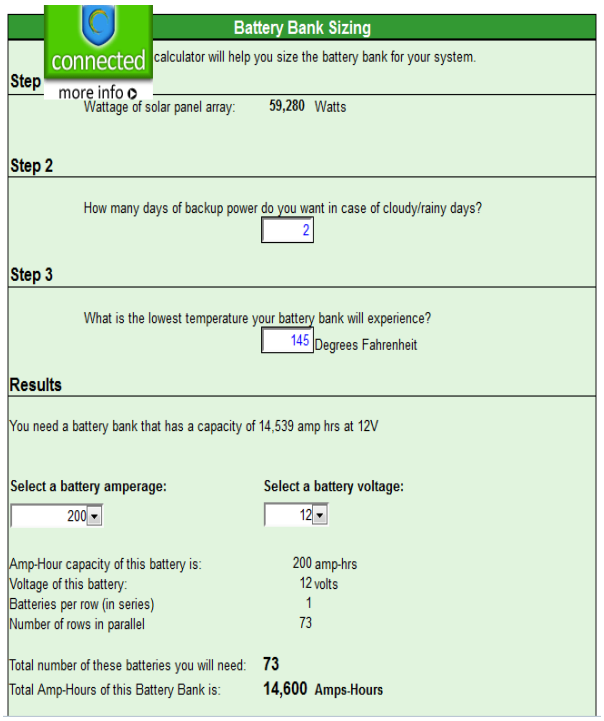


Diagram-4 Battery Bank Sizing



Design of PV System for SAU Tandojam

First time an Agriculture College associated with Agriculture Research Institute was established at Sakrand in District Nawabshah in 1939-40, and named as the King George-V Institute of Agriculture and This college paved the way for raising the status of the college to the full-fledged university on 1st March, 1977, named as Sindh Agriculture University, Tando Jam established under Act of 1977. Now the following faculties are prevailed in the university.

- **Faculties of the University**

Faculty of Agricultural Engineering
Faculty of Agricultural Social Science
Faculty of Crop Production
Faculty of Animal Husbandry and Veterinary Sciences
Faculty of Crop Protection

- **Institutes of the University**

Information technology Center
Institute of Food Sciences and Technology

- Farm Power Machinary Workshop
- Central Library
- Administration Block

II. Faculty of Agriculture Engineering

A total electric load of 45544 Watts was consumed by Faculty of Agricultural Engineering comprises of 22344 Watts in lights, 18300 Watts in fans and 4900 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	247 N0
Capacity of single solar panel	240 Watts
Solar panel produce	59280 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 88,92,000
Charge Controller	

One charge controller of 4940 amps is required	
Cost	RS:350,000
Batteries	
Required Amp:s	15000 AMP/HRS
Battery Capacity	2OO AMP/HRS
No of batteries for system	75 OF 12Volt each
Batteries cost	75*13000(Cost)= 9,75,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	10
Total capacity	10 * 6000= 60,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 8,79,840
Total cost	RS:1,08,49,840
	Or 10.85 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty= 45544 Watts	For Solar =59280 Watts
Current of Faculty 101.87 Amp	Monthly cost of solar system RS:35,670/=
Monthly bill is Rs:1,50,295	
Difference is Rs: 1,14,624/=	
77 percent cost will be saved per month	

Faculty of Agriculture Social Science

A total electric load of 21716 Watts was consumed by Faculty of Agricultural Social Science comprises of 14416 Watts in lights, 6800 Watts in fans and 500 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	118N0
Capacity of single solar panel	240 Watts
Solar panel produce	28320 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 42,48,000
Charge Controller	
One charge controller of 2360 amps is required	
Cost	RS: 250,000
Batteries	
Required amp:s	7200 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	36 OF 12Volt each
Batteries cost	36*13000(Cost)= 4,68,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 WATTS
Required no	5
Total capacity	5 * 6000 = 30,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 4,39,920
Total cost	RS: 52,87,920
	Or 5.287 million

Cost benefit statement

Hydropower System	Solar Power System
Power of Faculty= 21716 Watts	For Solar =28320 Watts
Current of Faculty 48.57 Amp	Monthly cost of solar system RS:17,385/=
Monthly bill is RS: 71,665/=	
Difference is Rs: 54,281/=	
76 percent cost will be saved per month	

Faculty of Crop Production

A total electric load of 48876 Watts was consumed by Faculty of Agricultural Crop Production comprises of 21416 Watts in lights, 25000 Watts in fans and 3800 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	265 N0
Capacity of single solar panel	240 Watts
Solar panel produce	63600 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 95,40,000
Charge Controller	
One charge controller of 5300 amps is required	
Cost	RS:4,00,000
Batteries	
Required amp:s	16000 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	80 OF 12Volt each
Batteries cost	80*13000(COST)= 10,40,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	11
Total capacity	11 * 6000 = 66,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 9,67,824
Total cost	RS:1,19,47,824
	Or 11.947 million

Cost benefit statement

Hydropower System	Solar Power System
Power of Faculty= 48876 Watts	For Solar =63600 Watts
Current of Faculty 112.32 A	Monthly cost of solar system RS:39,280/=
Monthly bill is RS: 1,65,715/=	
Difference is Rs: 1,26,435/=	
77 percent cost will be saved per month	

Faculty of Animal Husbandry and Veterinary Sciences

A total electric load of 79692 Watts was consumed by Faculty of Animal Husbandry and Veterinary Sciences comprises of 41334 Watts in lights, 34200 Watts in fans and 5000 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	432 N0
Capacity of single solar panel	240 Watts
Solar panel produce	103680 Watts

Cost of each panel	36000
Total cost of solar panel	RS: 1,55,52,000
Charge Controller	
One charge controller of 8640amps is required	
Cost	RS:6,00,000
Batteries	
Required amp:s	26000 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	130 OF 12Volt each
Batteries cost	130*13000(Cost)= 16,90,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	17
Total capacity	17 *6000= 1,02,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 14,95,728
Total cost	RS:1,93,37,728
	Or 19.34 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty=80534 Watts	For Solar =103680 Watts
Current of Faculty 180.14A	Monthly cost of solar system RS:63,576/=
Monthly bill is RS: 2,65,760/=	
Difference is Rs: 2,02,184/=	
76 Percent cost will be saved per month	

Faculty of Crop Protection

A total electric load of 24230 Watts was consumed by Faculty of Crop Protection comprises of 11530 Watts in lights, 11200 Watts in fans and 1500 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	132 N0
Capacity of single solar panel	240 Watts
Solar panel produce	31680 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 47,52,000
Charge Controller	
One charge controller of 2640amps is required	
Cost	RS:2,00,000
Batteries	
Required amp:s	7800 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	39 OF 12Volt each
Batteries cost	39*13000(Cost)= 5,07,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	3
Total capacity	3 * 6000 = 18000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 2,63,952
Total cost	RS:57,22,952
	Or 5.723 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty= 24,230 Watts	For Solar =31,680 Watts
Current of Faculty 54.19 A	Monthly cost of solar system RS:18,815/=
Monthly bill is RS: 79,959/=	
Difference is Rs 61,144/=	
76.4 Percent cost will be saved per month	

III. Institute of Food Sciences and Technology

A total electric load of 27714 Watts was consumed by Institute of Food Sciences and Technology comprises of 15114 Watts in lights, 9200 Watts in fans and 3400 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	115 N0
Capacity of single solar panel	240 Watts
Solar panel produce	27600 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 41,40,000
Charge Controller	
One charge controller of 2300 amps is required	
Cost	RS:1,80,000
Batteries	
Required amp:s	6800 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	34 OF 12Volt each
Batteries cost	34*13000(Cost)= 4,42,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	5
Total capacity	5* 6000 = 30,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 4,39,920
Total cost	RS:48,05,992
	Or 4.806 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty= 16752 Watts	For Solar =21840 Watts
Current of Faculty 37.47 A	Monthly cost of solar system RS:12,904/=
Monthly bill is RS: 55,286/=	
Difference is Rs: 42,382/=	
77 Percent cost will be saved per month	

Institute of Information Technology Centre (ITC)

A total electric load of 29134 Watts was consumed by Institute of Information Technology (ITC) comprises of 11634 Watts in lights, 7600 Watts in fans and 9900 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	134 N0
Capacity of single solar panel	240 Watts
Solar panel produce	3160 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 48,24,000
Charge Controller	
One charge controller of 2680amps is required	
Cost	RS:2,00,000
Batteries	
Required Amp:s	8000 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	40 OF 12Volt each
Batteries cost	40*13000(COST)= 5,20,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	5
Total capacity	5* 6000 = 30,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 4,39,920
Total cost	RS:59,83,920
	Or 5.98 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty=29134Watts	For Solar =32160 Watts
Current of Faculty 65.17Amp	Monthly cost of solar system RS:19,673/=
Monthly bill is RS:96,142/=	
Difference is Rs: 76,469/=	
80 Percent cost will be saved per month	

Farm Power Machinery Workshop

A total electric load of 7674 Watts was consumed by Farm Power Machinery Workshop comprises of 2374 Watts in lights, 5200 Watts in fans and 100 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	42 N0
Capacity of single solar panel	240 Watts
Solar panel produce	10080 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 15,12,000
Charge Controller	
One charge controller of 840 Amps is required	
Cost	RS:1,50,000
Batteries	
Required Amp:s	2600 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	13 OF 12Volt each
Batteries cost	13*13000(Cost)= 1,69,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 WATTS

Required no	2
Total capacity	2* 6000 = 12,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 1,75,968
Total cost	RS:20,06,968
	Or 2.01 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty= 7674 Watts	For Solar =10080 Watts
Current of Faculty 17.16 A	Monthly cost of solar system RS:6,600/=
Monthly bill is RS: 25,322/=	
Difference is Rs: 18,560/=	
74 percent cost will be saved per month	

Central Library

A total electric load of 12030W was consumed by Central Library comprises of 8630W in lights, 1900W in fans and 1500W in computers.

Design of Solar System

Solar Panels	
No of solar panels required	66 N0
Capacity of single solar panel	240 Watts
Solar panel produce	15840 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 23,76,000
Charge Controller	
One charge controller of 1320 amps is required	
Cost	RS:1,50,000
Batteries	
Required Amp:s	4000 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	20 OF 12Volt each
Batteries cost	20*13000(Cost)= 2,60,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	3
Total capacity	3* 6000 = 18,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 2,63,952
Total cost	RS:30,49,952
	Or 3.05 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty=12030 Watts	For Solar =15840 Watts
Current of Faculty 26.90 Amp	Monthly cost of solar system RS:10,027/=
Monthly bill is RS:39,699/=	
Difference is Rs: 29,672/=	
74.7 Percent cost will be saved per month	

Administration Block

A total electric load of 27714 Watts was consumed by Administration Block comprises of 15114 Watts in lights, 9200 Watts in fans and 3400 Watts in computers.

Design of Solar System

Solar Panels	
No of solar panels required	115 N0
Capacity of single solar panel	240 Watts
Solar panel produce	27600 Watts
Cost of each panel	36000
Total cost of solar panel	RS: 41,40,000
Charge Controller	
One charge controller of 2300 amps is required	
Cost	RS:1,80,000
Batteries	
Required Amp:s	6800 AMP/HRS
Batery Capacity	2OO AMP/HRS
No of batteries for system	34 OF 12Volt each
Batteries cost	34*13000(Cost)= 4,42,000
Batteries backup	2 Days
Inverter	
Inverter Capacity	6000 Watts
Required no	5
Total capacity	5* 6000 = 30,000
Cost of one inverter	RS: 87,984
Cost of 10 invertors	RS: 4,39,920
Total cost	RS:48,05,992
	Or 4.81 million

Cost benefit statement

Hydropower System	**Solar Power System**
Power of Faculty=27714 Watts	For Solar =27600 Watts
Current of Faculty 61.99 Amp	Monthly cost of solar system RS:15,800/=
Monthly bill is RS:91,454/=	
Difference is Rs: 75,654/=	
82.7 Percent cost will be saved per month	

IV. Conclusion

Comparison B/W HESCO & Solar Power System	**HESCO RS:**	**Solar System**
Faculty of Agricultural Engineering	150295	35671
Department of Social Science	71665	17384
Faculty of Crop Production	165715	39280
Department of Food Technology	55286	12904
Department of Form Power Machinary	25322	6762
DVM Faculty	265760	63576
Central Library	39699	10027
Faculty of Crop Protection	79959	18815
Administration Block	91454	15800
Information Technology	96142	19673
Total Charges	1041297	239892

V. Results

1. This study conclude that the solar power system is 76.96% is more economical than the HESCO.
2. Total electric bill paid by Sindh Agriculture University Tandojam monthly is RS. 1041297 for above faculties and departments.
3. Here in the solar power system for the same capacity the monthly bill will be RS. 239892/= the solar power system having 25 years warranty.

4. The total bill of 25 years in HESCO will be RS.312389100/=
5. In the solar power system for 25 years it will be RS.71967600/=
6. The saving for 25 years will be RS.20421500/=

VI. Suggestions

We suggest to the high command/policy makers of Sindh Agriculture University Tandojam to install the solar power system in Sindh Agriculture University Tandojam and use the saving amount in projects beneficial for the University.

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