

A STUDY OF SOLAR PV SYSTEM AT DISTRICT LEVEL & ITS IMPLICATIONS

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Abstract

India's economy is on a fast track in the past decade & is one of the fastest growing in the world. With this growth rate the energy demand is only going to increase multiple folds in the coming years. The electricity demand during the period 1997-2019 grew by 5.7% per year and from 2020-2047 it is expected to grow by 3.9% per year. Major electricity demand in an urban scenario is from educational institutions, hospitals, banks, government buildings etc. apart from residential buildings. So the installation of rooftop solar PV systems on these buildings will not only reduce the electricity demand from the supplier also solar being eco friendly will reduce the carbon footprint of the country. In this paper we have studied the feasibility of installing solar PV systems on educational institutions, hospitals, banks, government buildings etc. Along with investment cost, returns, payback period, breakeven point & the environmental impact.

Keywords Electricity demand, Solar PV system, Eco friendly, investment cost, returns, payback period, environmental impact.

Introduction

In India electricity demand during the period 1997-2019 grew by 5.7% per year and from 2020-2047 it is expected to grow by 3.9% per year[1]. Electricity generation for the FY 2017-18[2] by type of source is as shown in Fig 1

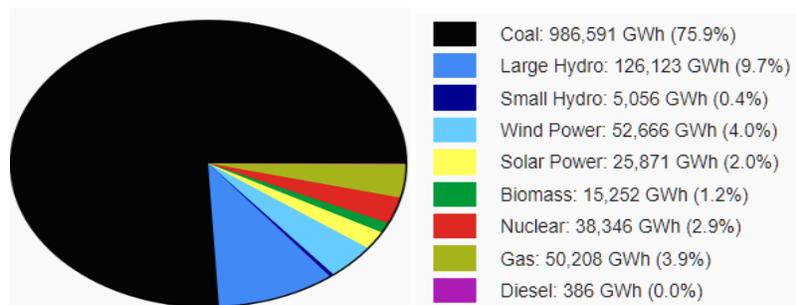


Fig.1 Electricity generation in India for the FY 2017-18 by type of source

From Fig.1 it can be noted that nearly 76% of our electricity demand is being met by burning coal. Burning of coal releases toxins into the environment which include lead, mercury , sulfur & nitrous oxides which can have serious effect on health even death. Long term impact of burning of coal is the climatic change resulting in global warming whose consequences are drought, rise of the sea level , extreme weather even loss of species[3]

With the electricity demand constantly on the rise we need to find sources of energy which pollute less. With the market penetration of wind energy in the past 2 decades the dependence on conventional sources has reduced to some extent. Solar technology at that time was considered too costly to compete with conventional sources, but with the advent of technology now the solar technology is on par with any other renewable source & is more relevant especially in a country like India which lies in the solar belt receiving a bright sunshine for more than 300 days in a year. Solar potential in India around **750 GW**[4]. Installed capacity as on 19th September 2018 is **25 GW**[5] which is just 3% of the available potential hence there is a lot of potential yet to be realized.

Major electricity demand apart from industries is in the urban areas comprising of educational institutions, hospitals, banks, government buildings, bus stations, railway station etc. which usually have a big open space on top the buildings which can be utilized to install solar PV system to harness solar energy which is available aplenty. The outcome of this effort can be analyzed by taking example of a district considering the potential loads in the city, taluks & villages.

For instance let’s consider Davangere district located at the heart of Karnataka, which is around 265 kilometers from the state capital Bengaluru along NH-4 (Bengaluru-Pune highway). The total area of the Davangere district is 5924 Sq km , has 6 taluks , 932 villages & a total population of 19.45 Lakhs as shown in Fig.2

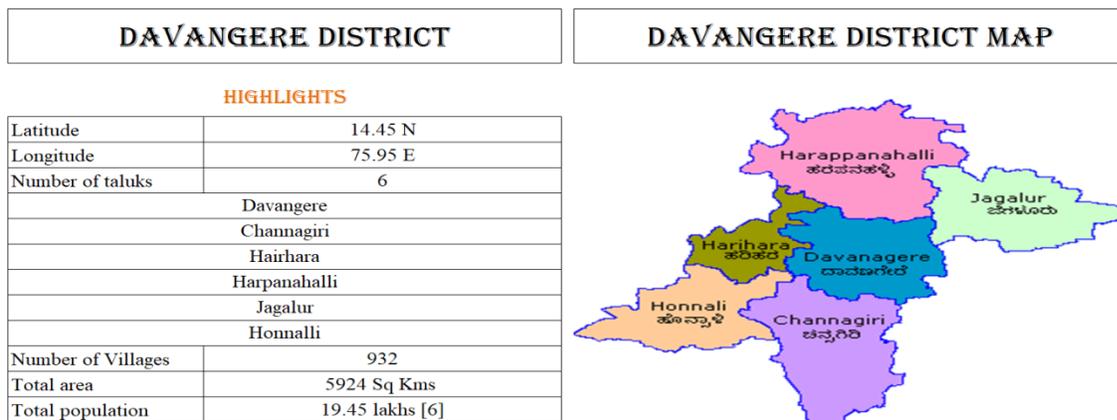


Fig. 2 Demographic data of Davangere district [6]

Davanagere has moderate weather throughout the year summers will see temperatures in high 30s where as winters it will in around 14-18. The location receives annual average insolation of 6.07 Kwh/m2/day , highest insolation received will be in Feb & March of about 7.09 Kwh/m2/day & the lowest received is during Aug of about 5.0 Kwh/m2/day as seen in Fig, 3[7]

Approach for calculating the approximate total sanctioned for the district

1. Find the approximate total sanctioned load for city considering all possible educational institutions, hospitals, banks, government buildings, bus stations, railway station etc.
2. Find the approximate total sanctioned load for a taluk considering all possible educational institutions, hospitals, banks, government buildings, bus stations, railway station etc.
3. For simplicity multiply the value arrived at step 2 by No. of taluks to find the approximate total sanctioned load for all 6 taluks in the district.
4. Each village is assumed to have 300 KVA demand & later multiplied by No. of villages to arrive at approximate total sanctioned load for all 932 villages.

CALCULATION OF APPROXIMATE TOTAL SANCTIONED LOAD FOR DAVANGERE CITY

SI No.	Name of the building	No.	Govt. / Private	Approximate Sanctioned load in KW	Approximate Total load in KW
Government Offices					
1	DC Office	1	G	100	100
	SP Office	1	G	25	25
	Taluk office	1	G	6	6
	Corporation Office	1	G	25	25
	Court	1	G	25	25
	BSNL Office	3	G	6	18
	POST Office	7	G	6	42
	ZP office	1	G	25	25
	Sub registrar office	1	G	8	8
	Irrigation department	1	G	8	8
	Sericulture department	1	G	8	8
	Horticulture department	1	G	8	8

	Police Stations	6	G	10	60
	PWD Office	1	G	8	8
	RTO office	1	G	8	8
	ESCOM Office	4	G	6	24
	Libraries	7	G	6	42
	Quarters	10	G	100	1000
2	Important Hospitals				
	Chigateri Hospital	1	G	2000	2000
	Bapuji Hospital	1	P	1500	1500
	S S High tech Hospital	1	P	1500	1500
3	Schools/Colleges				
	Polytechnic Colleges				
	DRR Govt polytechnic	1	G	75	75
	Bapuji Polytechnic	1	P	75	75
	Jain Polytechnic	1	P	75	75
	Engg. Colleges				
	UBDT	1	G	250	250
	BIET	1	P	250	250
	GMIT	1	P	250	250
	Jain	1	P	250	250
	ITI Colleges				
	Government	1	G	30	30
	Chamundeshwari ITI	1	P	30	30
	Degree colleges				
	Government/Aided	4	G	5	20
	Private	3	P	5	15
	PU Colleges				
	Government	3	G	5	15
	Private	7	G	10	70
	Important Schools				
	Government	10	G	5	50
	Private	6	P	20	120
Davangere University	1	G	250	250	
4	Hostels				
	Government	10	G	20	200
	Private	20	P	20	400
5	Banks				
	SBI	6	G	14	84
	Canara Bank	2	G	14	28
	Syndicate Bank	2	G	14	28

	Corporation Bank	2	G	14	28
	HDFC Bank	2	G	14	28
	AXIS Bank	2	G	14	28
	Other co-operative societies	10	G	10	100
	Bus Stations				
6	KSRTC	1	G	250	250
	Private	1	P	100	100
7	Railway Station	1	G	250	250
Approximate total Sanctioned load for Davangere City in KW					9789

CALCULATION OF APPROXIMATE TOTAL SANCTIONED LOAD FOR HARIHARA TALUK

Sl no	Name of the building	No.	Govt. / Private	Approximate Sanctioned load in KW	Approximate Total load in KW
	Government Offices				
1	Taluk office	1	G	6	6
	Court	1	G	25	25
	BSNL Office	1	G	6	6
	POST Office	1	G	6	6
	Sub registrar office	1	G	8	8
	Irrigation department	1	G	8	8
	Sericulture department	1	G	8	8
	Horticulture department	1	G	8	8
	Police Stations	2	G	10	20
	PWD Office	1	G	8	8
	RTO office	1	G	8	8
	ESCOM Office	1	G	6	6
	Libraries	2	G	6	12

	Quarters	5	G	100	500
2	Important Hospitals				
	Government	1	G	1500	1500
	Private	2	P	800	1600
3	Schools/Colleges				
	Polytechnic Colleges				
	Government	1	G	75	75
	Private	1	P	75	75
	ITI Colleges				
	Government	1	G	30	30
	Private	1	P	30	30
	Degree colleges				
	Government/Aided	2	G	5	10
	Private	2	P	5	10
	PU Colleges				
	Government	2	G	5	10
	Private	3	G	10	30
	Important Schools				
	Government	5	G	5	25
	Private	5	P	20	100
	4	Hostels			
Government		5	G	20	100
Private		5	P	20	100
5	Banks				
	SBI	2	G	14	28
	Canara Bank	1	G	14	14
	Syndicate Bank	1	G	14	14
	Corporation Bank	1	G	14	14
	HDFC Bank	1	G	14	14
	AXIS Bank	1	G	14	14
	Other co-operative societies	5	G	10	50
6	Bus Stations				
	KSRTC	1	G	150	150
	Private	1	P	100	100
7	Railway Station	1	G	150	150
Approximate total Sanctioned load for Harihara Taluk in KW					4872

SOLAR PV SYSTEM FOR DAVANGERE DISTRICT

Total Power demand for the district				
	Particulars	No	Individual demand in KW	Total demand in KW
1	City	1	9789	9789.00
	Taluk	6	4872	29232.00
	Villages	932	300	279600.00
	Approximate total power demand for the district			318621.00

2	assuming power factor as 0.8 , total power demand in MW	398.28
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Investment cost	
No of MW	Cost in Crores
1	3.25
398.27625	₹ 1294.397813

Area Required			
On Land		On Roof Top	
MW	Acres	KW	Sq Ft
1.00	4.00	1.00	100.00
398.28	1593.11	398276.25	39827625.00

Generation for an installed capacity of 398.28 MW			
5	Module type	Standard	Tilt Angle 14.45 Degree
	Array type	Fixed	
	System loss	14.08%	

Data collected from https://pvwatts.nrel.gov/pvwatts.php		
Per Year	631417408.00	Kwh
Per month	52618117.33	Kwh
Per day	1729910.71	Kwh

Operations and maintenance	
Operation cost	Nil
Maintenance cost	Once every 7 to 10 days depending upon dust accumulated PV panels need to be cleaned, which will be carried out by the personnel working in that individual building. So maintenance cost is considered as Nil

Revenue generated			
	Units	Rs/Unit	Total revenue in Crores
Per day	1729910.707	8	₹ 1.383
per month	52618117.33	8	₹ 42.094
per year	631417408	8	₹ 505.133

Payback period including installation , O&M charges		
Total investment	₹ 1,294.40	Crores
Total revenue generated per year	₹ 505.13	Crores
payback period	2.562484412	Years
	30.24	Months

Environmental impact			
Particulars	At consumer point	Units	At generation point
Total conventional energy savings	631417408.00	KWh/Yr	1262834816.00
Total coal saved (1 kG / Unit)	631417408.00	Tonnes / Yr	1262834.816
Total water saved (3.3 Ltrs / Unit)	2083677446.40	Million Ltrs / Yr	237.539
Total CO ₂ & other Green House Gases not added to the atmosphere @ 1KG/Unit generation	631417408.00	Tonnes / Yr	1262834.816

PVWatts Calculator

RESULTS**631,417,408 kWh/Year***

Month	Solar Radiation (kWh / m ² / day)	AC Energy (kWh)	Value (\$)
January	6.70	58,691,704	N/A
February	7.09	53,683,452	N/A
March	7.09	58,665,296	N/A
April	6.91	55,493,232	N/A
May	6.22	54,354,456	N/A
June	5.14	46,102,448	N/A
July	4.85	45,554,052	N/A
August	5.00	46,843,592	N/A
September	5.93	52,251,584	N/A
October	5.74	51,500,716	N/A
November	6.07	53,065,648	N/A
December	6.13	55,211,156	N/A
Annual	6.07	631,417,336	0

Fig. 3 Annual AC energy generated at Davangere according to PVWatts® calculator

PVWatts® Calculator is an online calculator developed by NREL (National Renewable Energy Laboratory) of the USA. That estimates the energy production and cost of energy of grid-connected photovoltaic (PV) systems using solar resource data for locations throughout the world. It allows homeowners, small building owners, installers and manufacturers to develop preliminary estimates of the cost and performance of potential PV installations.

Since the energy generated is directly uploaded to the grid battery backup is not required. Hence the operation cost is negligible. Solar PV system doesn't require any maintenance as such other than dusting the surface once in a while depending on the accumulation of dust on the surface.

Conclusion

With the growing demand for the electricity & diminishing conventional sources the energy gap can be bridged by utilizing the renewable energy sources like solar energy which is abundantly available in a country like India. Also burning of fossil fuels adds pollutants to the atmosphere. India along with other developing countries is the major contributor of green house gases into the atmosphere. Switching to green energy like solar can help in reducing the CO₂ & other green house gases addition to atmosphere by about 1262834.816 Tonnes per Year. Solar energy will also help save water when compared to conventional sources like thermal & nuclear of about 237.539 Million Liters per Year. In a country like India which generated 76% of its energy requirement by coal solar energy can help reduce coal consumption by about 1262834.816 Tonnes per Year. All the above mentioned numbers are for the chosen loads & the district. The total investment cost is ₹ 1294.39 Crores & the income generated per year considering tariff at ₹ 8/- per unit generated is ₹ 505.13 Crores, assuming no changes in units generated & tariff the breakeven point is achieved around 2.5 years or 30th month & income generated later will be the profit. Even though the investment cost is high, it gives quick returns & comes with benefits which go beyond monetary context. All these numbers are for just one district when the whole country is considered they will be huge & play a major role in preserving the environment for generations to come, make the whole world a happy, safe & healthy place to live.

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