

Analysis of solar irradiation and modeling of large scale PV power plant implementation in South Tamil Nadu

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ABSTRACT

Now a day the PV power generation plays a major role for generation of electricity. The Fossil Fuel based power generation is very harmful for environment and cause of climate changes. In this study we have been selected south Tamil Nadu for Implement huge PV Power Plant. The solar irradiation for South Tamil Nadu has been calculated From National Renewable Energy Laboratory (NREL) in US. The PV Power Plant rating has been choosing based on solar irradiation report. The proposal system has been developed in MATLAB simulation Software and analysis the result. Finally the proposed PV Power system is recommended to south Tamil Nadu.

KEY WORDS: Solar, Photovoltaic, irradiance, South Tamil Nadu.

1. INTRODUCTION

Solar energy is an important, clean, cheap and abundantly available renewable energy. The sun radiates heat and light received from sun support the environment on the earth through the following well-known natural effect. Solar energy is received on earth in cyclic (Anderson, 2016; Ssekulima, 2016). The direction of solar rays changes during the day and with season. Solar radiation-energy radiated by sun. Solar irradiation-radiated energy received on earth surface. The sun radiates about 3.8×10^{26} watts of power in all directions out of this about 1.7×10^{17} watts power is intercepted by earth. Solar radiation received on earth's surface has, Daily variation; Seasonal variation; Variation with atmospheric clarity; Variation with latitude of the location; Variation with the tilt angle.

So that's why we selected PV power plant. PV system does not release any harmful air or water pollution into environment photovoltaic system with this PV power plant we can implement large scale in South Tamil Nadu. In district wise we selected four cities to measure solar irradiation by using NREL (Cervantes, 2016; Chai, 2016; Rajput, 2015; Silva, 2015; Ceylan, 2015).

2. METHODS & MATERIALS

Methodology: The main objective of this work is to analysis the solar irradiation for South Tamil Nadu (Iqbal, 2016). We have selected 11 District and 53 Locations. The solar irradiation has been calculated using NREL PV/Watt Software for the above selected areas.

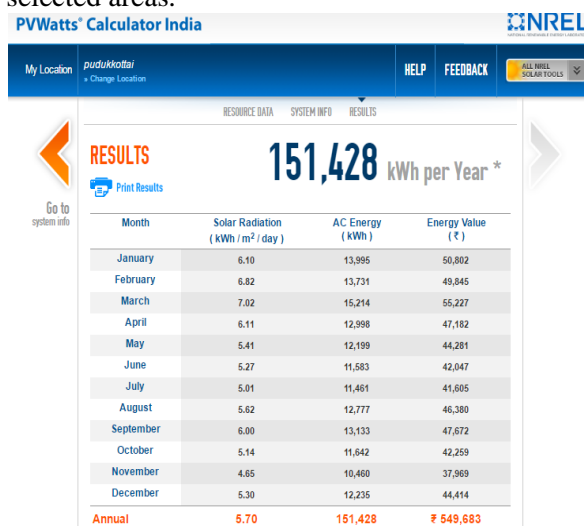


Figure.1. Pv Watt Software



Figure.2. Pudukkottai District Map

Table.1. Pudukkottai and Pudukkottai District

Month	Pudukkottai	Poovatrakkudi	Karambakkudi	Ennai	Kalamavur
January	6.10	6.28	6.03	6.13	6.17
February	6.82	6.63	6.61	6.89	6.84
March	7.02	6.83	6.79	6.92	6.87
April	6.11	6.07	5.99	6.33	6.19
May	5.41	5.44	5.50	5.56	5.59
June	5.27	5.36	5.36	5.27	5.29
July	5.01	5.13	5.28	5.19	5.09
August	5.62	5.68	5.56	5.55	5.67
September	6.00	6.18	6.02	6.20	6.22
October	5.14	5.22	5.36	5.64	5.48
November	4.65	4.69	4.51	4.70	5.01
December	5.30	5.34	5.25	5.50	5.45
Annual	5.70	5.74	5.69	5.82	5.82

Average: 5.75

District: Pudukkottai: The solar irradiation has been calculated for Pudukkottai district as shown in figure. We have selected 5 locations such as Pudukkottai, Poovatrakkudi, Karambakkudi, Ennai, Kalamavur. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.1. The average solar irradiation for this district is 5.75kwh/m².

**Figure.3. Dindigul District Map****Table.2. Dindigul And Dindigul District Solar Radiation (kWh / m² / day)**

Month	Dindigul	Sendurai	Thoppanayakkanour	Sirugudi	Lingavadi
January	6.14	6.18	6.49	5.68	6.26
February	7.07	6.96	7.09	6.60	7.02
March	7.04	6.93	7.03	6.66	6.80
April	6.19	6.37	6.34	6.32	5.97
May	5.56	5.88	5.76	6.14	5.74
June	5.06	5.29	5.30	6.11	5.16
July	4.93	5.19	5.18	6.12	4.92
August	5.37	5.47	5.62	6.43	5.34
September	5.97	6.01	6.22	6.09	5.91
October	5.53	5.42	5.38	5.10	5.27
November	4.85	4.58	4.99	4.49	4.84
December	5.27	5.22	4.97	5.17	5.36
Annual	5.75	5.79	5.86	5.91	5.72

Average: 5.81

District: Dindigul: The solar irradiation has been calculated for Dindigul district as shown in figure. We have selected 5 locations such as Dindigul, Sendurai, Thoppanayakkanour, Sirugudi, Lingavadi. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.2. The average solar irradiation for this district is 5.81 kwh/m².

**Figure.4. Theni District Map**

Table.3. Theni And Theni District Solar Radiation (kWh / m² / day)

Month	Theni	Varusanadu	Gudalur	Cumbum	Devadhanapatti
January	6.47	6.53	6.58	6.53	6.59
February	6.49	6.90	7.05	6.90	7.22
March	6.73	6.79	7.12	6.79	6.85
April	6.18	5.80	6.22	5.80	6.32
May	5.58	5.09	5.49	5.09	5.51
June	5.00	4.30	4.95	4.30	5.21
July	4.65	4.60	4.70	4.60	4.82
August	4.97	5.16	5.02	5.16	5.30
September	5.29	5.71	5.80	5.71	5.60
October	5.27	5.68	5.25	5.68	5.42
November	4.63	5.51	5.13	5.51	5.06
December	5.53	6.03	5.75	6.03	5.43
Annual	5.57	5.68	5.76	5.68	5.78

Average: 5.69

District: Theni: The solar irradiation has been calculated for Theni district as shown in figure. We have selected 5 locations such as Theni, Varusanadu, Gudalur, Cumbum, Devadhanapatti. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table 3. The average solar irradiation for this district is 5.69 kwh/m².

**Figure.5. Madurai District Map****Table.4. Madurai and Madurai District Solar Radiation (kWh / m² / day)**

Month	Madurai	Mallapuram	Purandippatti	Vadipatti	Palamedu
January	5.68	6.70	6.22	6.65	6.26
February	6.60	7.16	6.96	7.14	7.02
March	6.66	6.69	6.87	7.12	6.80
April	6.32	5.83	6.13	6.19	5.97
May	6.14	5.17	5.55	5.49	5.74
June	6.11	3.98	5.27	5.25	5.16
July	6.12	3.84	5.19	4.99	4.92
August	6.43	4.58	5.61	5.61	5.34
September	6.09	5.30	6.01	5.82	5.91
October	5.10	5.23	5.67	5.81	5.27
November	4.49	5.78	4.87	5.07	4.84
December	5.17	6.47	5.45	5.48	5.36
Annual	5.91	5.56	5.82	5.89	5.72

Average: 5.78

District: Madurai: The solar irradiation has been calculated for Madurai district as shown in figure. We have selected 5 locations such as Madurai, Mallapuram, Purandippatti, Vadipatti, Palamedu. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.4. The average solar irradiation for this district is 5.78 kwh/m².

**Figure.6. Thoothukudi District Map**

Table.5. Thoothukudi and Thoothukudi District Solar Radiation (kWh / m² / day)

Month	Thoothukudi	Mullakadu	Jahir Hussain Nagar	Davis Puram	Pandarampatti
January	6.53	6.53	6.53	6.53	6.53
February	6.90	6.90	6.90	6.90	6.90
March	6.79	6.79	6.79	6.79	6.79
April	5.80	5.80	5.80	5.80	5.80
May	5.09	5.09	5.09	5.09	5.09
June	4.30	4.30	4.30	4.30	4.30
July	4.60	4.60	4.60	4.60	4.60
August	5.16	5.16	5.16	5.16	5.16
September	5.71	5.71	5.71	5.71	5.71
October	5.68	5.68	5.68	5.68	5.68
November	5.51	5.51	5.51	5.51	5.51
December	6.03	6.03	6.03	6.03	6.03
Annual	5.68	5.68	5.68	5.68	5.68

Average: 5.68

District: Thoothukudi: The solar irradiation has been calculated for Thoothukudi district as shown in figure. We have selected 5 locations such as Thoothukudi, Mullakadu, Jahir Hussain Nagar, Davis Puram, Pandarampatti. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.5. The average solar irradiation for this district is 5.68 kwh/m².

**Figure.7. Thirunelveli District Map****Table.6. Thirunelveli and Thirunelveli District Solar Radiation (kWh / m² / day)**

Month	Thirunelveli	Anandapuram	Kurichi	Thirumal Nagar	Melakulam
January	6.53	6.06	6.71	6.53	6.53
February	6.90	6.82	7.27	6.90	6.90
March	6.79	7.01	6.94	6.79	6.79
April	5.80	6.70	6.29	5.80	5.80
May	5.09	5.80	5.65	5.09	5.09
June	4.30	4.82	4.90	4.30	4.30
July	4.60	4.52	4.72	4.60	4.60
August	5.16	4.61	5.40	5.16	5.16
September	5.71	4.88	6.18	5.71	5.71
October	5.68	5.37	5.63	5.68	5.68
November	5.51	6.34	5.27	5.51	5.51
December	6.03	5.66	5.83	6.03	6.03
Annual	5.68	5.72	5.90	5.68	5.68

Average: 5.73

District: Thirunelveli: The solar irradiation has been calculated for Thirunelveli district as shown in figure. We have selected 5 locations such as Thirunelveli, Anandapuram, Kurichi, Thirumal Nagar, Melakulam. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.6. The average solar irradiation for this district is 5.73 kwh/m².

**Figure.8. Nagercoil District Map**

Table.7. Nagercoil and Nagercoil District Solar Radiation (kWh / m² / day)

Month	Nagercoil	Muhilanvilai	Kottar	MelatheruKarai	West Kalungady
January	6.53	6.53	6.53	6.53	6.53
February	6.90	6.90	6.90	6.90	6.90
March	6.79	6.79	6.79	6.79	6.79
April	5.80	5.80	5.80	5.80	5.80
May	5.09	5.09	5.09	5.09	5.09
June	4.30	4.30	4.30	4.30	4.30
July	4.60	4.60	4.60	4.60	4.60
August	5.16	5.16	5.16	5.16	5.16
September	5.71	5.71	5.71	5.71	5.71
October	5.68	5.68	5.68	5.68	5.68
November	5.51	5.51	5.51	5.51	5.51
December	6.03	6.03	6.03	6.03	6.03
Annual	5.68	5.68	5.68	5.68	5.68

Average: 5.68

District: Nagercoil: The solar irradiation has been calculated for Nagercoil district as shown in figure. We have selected 5 locations such as Nagercoil, Muhilanvilai, Kottar, Melatheru Karai, Westkalungady. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.7. The average solar irradiation for this district is 5.68 kwh/m².



Figure.9. Virudunagar District Map

Table.8. Virudunagar and Virudunagar District

Month	Virudunagar	Voc Nagar	Allampatti	Pelampatti	Kattayapuram
January	5.68	6.45	5.68	6.76	5.68
February	6.60	7.01	6.60	7.41	6.60
March	6.66	7.22	6.66	7.19	6.66
April	6.32	6.60	6.32	6.45	6.32
May	6.14	5.74	6.14	5.87	6.14
June	6.11	5.21	6.11	5.25	6.11
July	6.12	4.97	6.12	5.09	6.12
August	6.43	5.22	6.43	5.42	6.43
September	6.09	5.67	6.09	5.81	6.09
October	5.10	5.50	5.10	5.58	5.10
November	4.49	4.83	4.49	5.96	4.49
December	5.17	5.76	5.17	5.76	5.17
Annual	5.91	5.85	5.91	6.05	5.91

Average: 5.92

District: Virudunagar: The solar irradiation has been calculated for Virudunagar district as shown in figure. We have selected 5 locations such as Virudunagar, Voc Nagar, Allampatti, Pelampatti, Kattayapuram. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.8. The average solar irradiation for this district is 5.92 kwh/m².



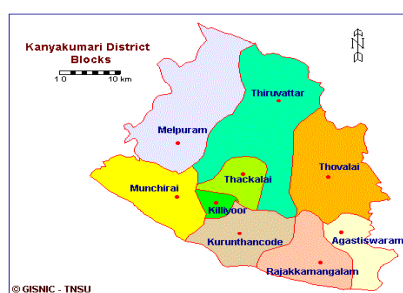
Figure.10. Ramanathapuram District Map

Table 9: Ramanathapuram And Ramanathapuram District Solar Radiation (kWh / m² / day)

Month	Ramanathapuram	Kottai puram	Velipattinam	Krishnanagar	Pattinamkattan
January	6.71	5.68	5.68	4.32	5.68
February	7.27	6.60	6.60	5.62	6.60
March	6.94	6.66	6.66	6.43	6.66
April	6.29	6.32	6.32	6.42	6.32
May	5.65	6.14	6.14	5.57	6.14
June	4.90	6.11	6.11	4.80	6.11
July	4.72	6.12	6.12	4.46	6.12
August	5.40	6.43	6.43	4.85	6.43
September	6.18	6.09	6.09	4.82	6.09
October	5.63	5.10	5.10	5.48	5.10
November	5.27	4.49	4.49	5.31	4.49
December	5.83	5.17	5.17	4.85	5.17
Annual	5.90	5.91	5.91	5.24	5.91

Average: 5.77

District: Ramanathapuram: The solar irradiation has been calculated for Ramanathapuram district as shown in figure. We have selected 5 locations such as Ramanathapuram, Kottai Puram, Velipattinam, Krishnanagar, and Pattinamkattan .The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.9. The average solar irradiation for this district is 5.77 kwh/m².

**Figure.11. Kanyakumari District Map****Table.10. Kanyakumari And Kanyakumari District Solar Radiation (kWh / m² / day)**

Month	Kanyakumari	Vivekananda kenda	Baywatch park
January	6.53	4.62	2.73
February	6.90	5.24	4.05
March	6.79	4.78	4.55
April	5.80	4.56	5.54
May	5.09	4.54	6.04
June	4.30	4.71	6.42
July	4.60	4.31	6.99
August	5.16	4.76	6.11
September	5.71	5.21	5.01
October	5.68	5.29	3.98
November	5.51	5.09	2.56
December	6.03	4.87	2.24
Annual	5.68	4.83	4.69

Average: 5.0

District: Kanyakumari: The solar irradiation has been calculated for Kanyakumari district as shown in figure. We have selected 3 locations such as Kanyakumari, Vivekananda Kenda, and Baywatchpark. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table 10.The average solar irradiation for this district is 5.0 kwh/m².



Figure.12. Sivaganga District Map

Table.11. Sivaganga And Sivaganga District Solar Radiation ($\text{kWh} / \text{m}^2 / \text{day}$)

Month	Sivaganga	Karaikudi	Devakottai	Manamadurai	Tiruppuvanam
January	5.68	6.01	5.68	5.68	5.68
February	6.60	6.77	6.60	6.60	6.60
March	6.66	6.77	6.66	6.66	6.66
April	6.32	6.09	6.32	6.32	6.32
May	6.14	5.51	6.14	6.14	6.14
June	6.11	5.34	6.11	6.11	6.11
July	6.12	5.30	6.12	6.12	6.12
August	6.43	5.82	6.43	6.43	6.43
September	6.09	6.20	6.09	6.09	6.09
October	5.10	5.32	5.10	5.10	5.10
November	4.49	4.88	4.49	4.49	4.49
December	5.17	5.35	5.17	5.17	5.17
Annual	5.91	5.78	5.91	5.91	5.91

Average: 5.9

District: Sivaganga: The solar irradiation has been calculated for Sivaganga district as shown in figure. We have selected 5 locations such as Sivaganga, Karaikudi, Devakottai, Manamadurai, and Tiruppuvanam. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation values is presented in table.11. The average solar irradiation for this district is 5.9 kwh/m².

Table.12. South TamilNadu Solar irradiation district wise

S.NO	City	Average
1	Pudukkottai	5.75
2	Dindugul	5.81
3	Theni	5.69
4	Madurai	5.78
5	Thoothukudi	5.68
6	Thirunelveli	5.73
7	Nagercoil	5.68
8	Virudunagar	5.92
9	Ramanathapuram	5.77
10	Kanyakumari	5.0
11	Sivaganga	5.9

3. RESULTS

In this paper we have analysed solar irradiance at 53 locations in 11 districts of North Tamil Nadu. Based on the above analysed result the Virudunagar district is recommended to install large scale PV power plants.

4. CONCLUSION

In this paper we have studied and analysed solar irradiation of south Tamil Nadu for implementation for large scale photovoltaic power plant. We have been selected 53 location from 11 different district in south Tamil Nadu for calculate the solar irradiation availability data by using NREL PV /Watt software from UNITED STATES. The 53 location solar irradiation availability of throughout year data is presented in this paper. Based on analyses of solar irradiation availability data Virudunagar district is selected as a best location for implementing large scale Photovoltaic power plant among 11 districts. The other districts are recommended.

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