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Analysis of Solar Irradiation and Modeling of Large Scale PV Power Plant Implementation in North Tamil Nadu

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ABSTRACT

In last decade, environmentally mining of coal results in destruction of wide areas of land .fossil fuel is also difficult and may endanger the lives of miners, it is known fact that greenhouse gases released when fossil fuel based power generation, on the primary gas responsible for global warming, rise in temperature of earth has resulted in melting polar ice caps, flooding of low lying area, if such attitude continues, our earth will face a major problem based on environment. So, to stop this attitude, we planned to use solar energy based on power generation. Now a day's solar energy plays a very important role to meet power demand in our modern society. The proposed PV power plant has been modelled based on North Tamil Nadu solar irradiation report from NREL in US. Finally the proposed system has been recommended to implement in North Tamil Nadu.

KEY WORDS: Solar, irradiance, PV, Tamil Nadu.

1. INTRODUCTION

As of today, fossil fuels are being extracted at an exorbitant between demand and supply. It is estimated that will be available in next 30-40 years. Since they are non-renewable, it is more likely that fuel expenses will face a steep hike in near future (Anderson, 2016; Sekulima, 2016). Coal mining results in destruction of ecosystems and also endangers the lives of mineworker. The coal mining destroys wide areas of land and results in ecological imbalance. Though the fossil fuels meet our energy and fuel needs, still it's a high time to look forward for the alternative renewable energy source such as wind turbines, solar panels, tidal generators and compost (Bae, 2016; Cervantes, 2016; Chai, 2016; Shinozaki, 2016). As our non-renewable resources are set to decline in the years to come, it is important for us to move toward renewable source of energy like solar , wind, hydropower, biomass and tidal. Solar energy not only benefits individual owners, but also benefit environment as well. Solar energy is one of the most widely used renewable energy source (Masral, 2015; Lynch, 2015). In this paper we have concentrate analyses and study of the solar energy and availability in north Tamil Nadu.

2. METHODS & MATERIALS

Methodology: The main objective of this work is to analysis the solar irradiation for South Tamil Nadu (Lynch, 2015). We have selected 9 District and 45 Locations. The solar irradiation has been calculated using NREL PV/Watt Software for the above selected areas as shown in fig.1.

Figure.1. PV Watt Software - NREL

Table.1. Chennai

Month	Chennai	Thambaram	Gundy	Thiruvottiyur	Adyar
January	6.45	6.04	5.88	5.85	6.45
February	7.01	6.97	5.05	6.74	7.01
March	7.22	7.16	3.73	7.18	7.22
April	6.60	6.60	2.97	6.56	6.60
May	5.74	5.69	1.85	5.73	5.74
June	5.21	5.23	1.42	5.21	5.21
July	4.97	4.98	1.55	4.92	4.97
August	5.22	5.34	2.41	5.18	5.22
September	5.67	5.69	3.58	5.65	5.67
October	5.50	5.34	5.04	4.83	5.50
November	4.83	4.78	5.77	4.84	4.83
December	5.76	5.40	6.34	5.49	5.76
Annual	**5.85**	**5.77**	**3.80**	**5.68**	**5.85**

Average: 5.39

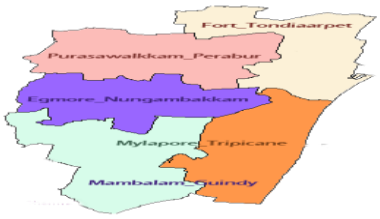

Figure.2. Chennai district map

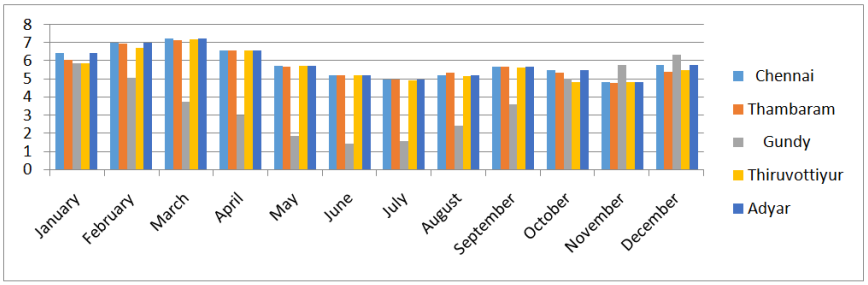

Figure.2a. Chennai district solar irradiation graph

District: Chennai: The solar irradiation has been calculated for Chennai district as shown in figure.2. We have selected 5 locations such as Chennai, Thambaram, Gundy, Thiruvottiyur, Adyar. 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 and solar irradiance graph as shown in fig.2a. The average solar irradiation for this district is 5.39 kwh/m^2.

Figure.3. Erode District Map

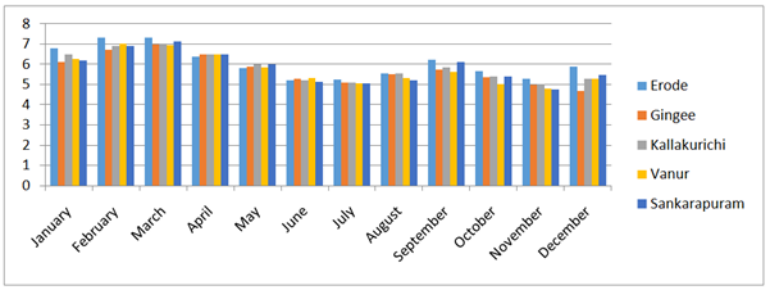

Figure.3a. Erode District Solar irradiance graph

Table.2. Erode

Month	Erode	Gingee	Kallakurichi	Vanur	Sankarapuram
January	6.78	6.11	6.49	6.26	6.20
February	7.33	6.71	6.92	7.03	6.90
March	7.33	6.98	7.03	6.93	7.15
April	6.39	6.50	6.50	6.50	6.50
May	5.83	5.88	6.00	5.84	6.00
June	5.21	5.27	5.19	5.32	5.15
July	5.25	5.08	5.11	5.07	5.05
August	5.54	5.50	5.53	5.33	5.22
September	6.21	5.72	5.84	5.62	6.12
October	5.66	5.37	5.38	5.03	5.40
November	5.28	4.97	5.01	4.81	4.76
December	5.90	4.67	5.27	5.29	5.46
Annual	**6.06**	**5.73**	**5.86**	**5.75**	**5.83**

Average: 5.8

District: Erode: The solar irradiation has been calculated for Erode district as shown in figure.3. We have selected 5 locations such as Erode, Gingee, Kallakurichi, Vanur, Sankarapuram. 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 solar irradiance graph as shown in fig.3a. The average solar irradiation for this district is 5.8 kwh/m^2.

Figure.4. Kancheepuram District Map

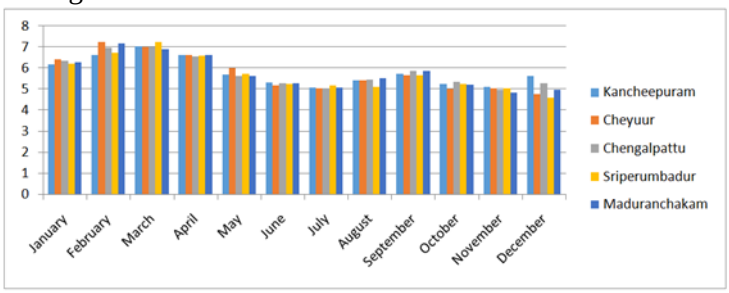

Figure.4a. Kancheepuram District Solar irradiance graph

Table.3. Kancheepuram- Average: 5.772

Month	Kancheepuram	Cheyuur	Chengalpattu	Sriperumbadur	Maduranchakam
January	6.17	6.43	6.34	6.21	6.27
February	6.62	7.23	6.95	6.73	7.16
March	7.04	7.01	7.00	7.24	6.88
April	6.61	6.63	6.56	6.59	6.61
May	5.70	6.01	5.63	5.72	5.63
June	5.30	5.16	5.28	5.23	5.27
July	5.08	5.03	5.02	5.18	5.06
August	5.42	5.41	5.44	5.11	5.52
September	5.74	5.65	5.85	5.64	5.85
October	5.24	5.01	5.34	5.24	5.21
November	5.09	5.03	4.96	5.05	4.82
December	5.61	4.76	5.28	4.58	4.98
Annual	**5.80**	**5.78**	**5.80**	**5.71**	**5.77**

District: Kancheepuram: The solar irradiation has been calculated for Kancheepuram district as shown in figure.4. We have selected 5 locations such as kancheepuram, cheyuur, chengalpattu, sriperumbadur, and maduranchakam. 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 solar irradiance graph as shown in fig.4a. The average solar irradiation for this district is 5.77 kwh/m^2.

Figure.5. Krishnagiri District Map

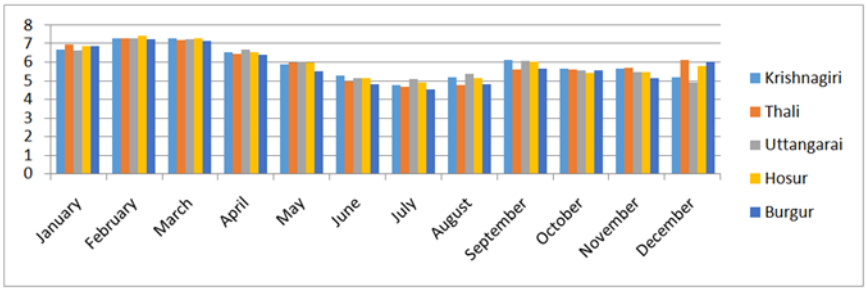

Figure.5a. Krishnagiri District solar irradiance graph

Table.4. Krishnagiri

Month	Krishnagiri	Thali	Uttangarai	Hosur	Burgur
January	6.68	6.97	6.63	6.89	6.87
February	7.30	7.31	7.32	7.42	7.23
March	7.30	7.19	7.23	7.30	7.14
April	6.55	6.45	6.68	6.56	6.39
May	5.88	6.01	6.02	5.97	5.54
June	5.33	4.97	5.18	5.18	4.85
July	4.80	4.69	5.12	4.95	4.55
August	5.21	4.80	5.39	5.20	4.85
September	6.13	5.62	6.09	6.05	5.66
October	5.65	5.60	5.58	5.45	5.56
November	5.66	5.72	5.49	5.48	5.17
December	5.24	6.12	4.93	5.80	6.03
Annual	**5.98**	**5.95**	**5.97**	**6.02**	**5.82**

Average: 5.948

District: Krishnagiri: The solar irradiation has been calculated for Krishnagiri district as shown in figure.5. We have selected 5 locations such as Krishnagiri, Thali, Uttangarai, Hosur, Burgur. 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 and solar irradiance graph is presented in figure.5a. The average solar irradiation for this district is 5.77 kwh/m^2.

Figure.6. Namakkal District Map

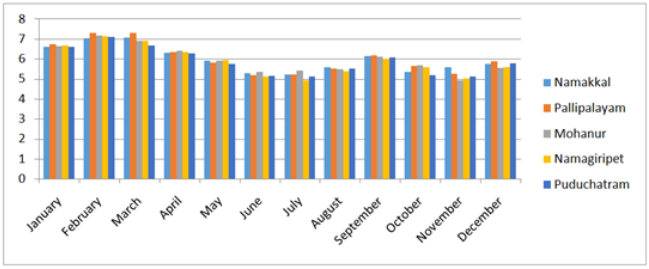

Figure.6a. Namakkal District Solar irradiance graph

Table.5. Namakkal

Month	Namakkal	Pallipalayam	Mohanur	Namagiripet	Puduchatram
January	6.64	6.78	6.66	6.70	6.63
February	7.08	7.33	7.20	7.16	7.15
March	7.09	7.33	6.94	6.95	6.72
April	6.34	6.39	6.44	6.37	6.31
May	5.95	5.83	5.95	5.97	5.78
June	5.30	5.21	5.37	5.14	5.19
July	5.24	5.25	5.45	4.96	5.16
August	5.61	5.54	5.52	5.40	5.55
September	6.19	6.21	6.15	6.03	6.10
October	5.38	5.66	5.70	5.62	5.21
November	5.62	5.28	4.95	5.05	5.13
December	5.77	5.90	5.59	5.61	5.82
Annual	**6.02**	**6.06**	**5.99**	**5.91**	**5.90**

Average: 5.97

District: Namakkal: The solar irradiation has been calculated for Namakkal district as shown in figure.6. We have selected 5 locations such as Namakkal, Pallipalayam, Mohanur, Namagiripet, Puduchatram. 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 solar irradiance graph is presented in figure.6a. The average solar irradiation for this district is 5.97 kwh/m^2.

Figure.7. Salem District Map

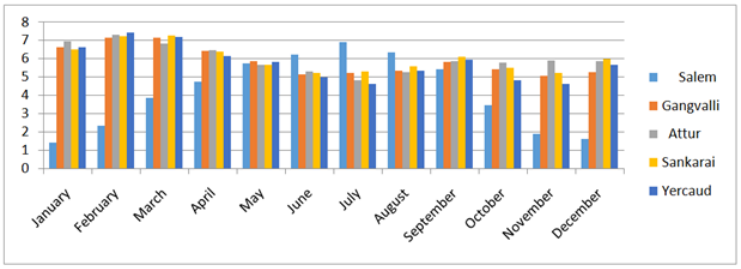

Figure.7a. Salem District Solar irradiance graph

Table.6. Salem

Month	Salem	Gangvalli	Attur	Sankarai	Yercaud
January	1.42	6.65	6.94	6.51	6.65
February	2.32	7.16	7.33	7.25	7.42
March	3.87	7.14	6.84	7.27	7.21
April	4.74	6.44	6.48	6.38	6.15
May	5.73	5.87	5.67	5.65	5.84
June	6.23	5.16	5.30	5.21	5.00
July	6.91	5.21	4.84	5.31	4.63
August	6.36	5.33	5.27	5.58	5.33
September	5.41	5.84	5.85	6.10	5.94
October	3.46	5.44	5.77	5.52	4.83
November	1.88	5.06	5.90	5.22	4.62
December	1.60	5.25	5.88	5.98	5.67
Annual	**4.16**	**5.88**	**6.01**	**6.00**	**5.77**

Average: 5.564

District: Salem: The solar irradiation has been calculated for Salem district as shown in figure.7. We have selected 5 locations such as Salem, Gangvalli, Attur, Sankarai, Yercaud. 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 solar irradiance graph is presented in fig.7a. The average solar irradiation for this district is 5.564 kwh/m^2.

Figure.8. Thiruvallur District Map

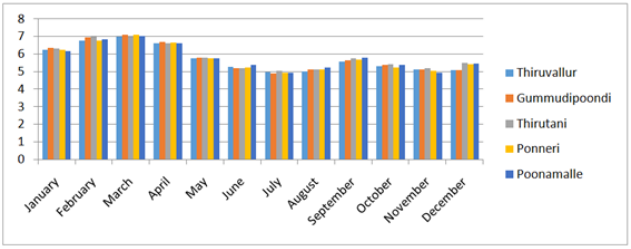

Figure.8a. Thiruvallur District Solar irradiance graph

Table.7. Thiruvallur

Month	Thiruvallur	Gummudipoondi	Thirutani	Ponneri	Poonamalle
January	6.25	6.37	6.30	6.23	6.17
February	6.75	6.95	7.00	6.77	6.84
March	7.00	7.09	7.00	7.12	7.03
April	6.60	6.68	6.63	6.64	6.61
May	5.75	5.79	5.81	5.74	5.74
June	5.26	5.21	5.20	5.25	5.37
July	4.98	4.90	5.04	4.92	4.92
August	5.02	5.12	5.12	5.11	5.25
September	5.57	5.64	5.75	5.67	5.81
October	5.31	5.40	5.41	5.23	5.37
November	5.14	5.14	5.20	5.03	4.94
December	5.09	5.08	5.48	5.41	5.46
Annual	5.73	5.78	5.83	5.76	5.79

Average: 5.778

District: Thiruvallur: The solar irradiation has been calculated for Thiruvallur district as shown in figure 8. We have selected 5 locations such as Thiruvallur, Gummudipoondi, Thirutani, Ponneri, Poonamalle. The solar irradiation has been measured throughout year for the above location using NREL PV/Watts Software. The solar irradiation value is presented in table.7 and solar irradiance graph is presented in figure.8a. The average solar irradiation for this district is 5.77 kwh/m^2.

Figure.9. Thiruvannamalai District Map

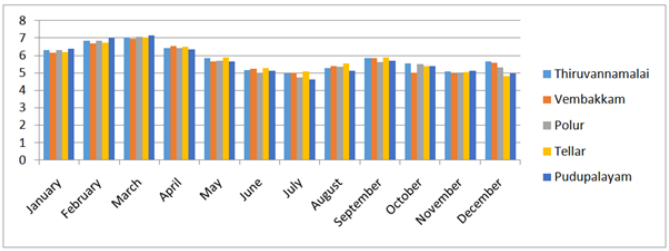

Figure.9a. Thiruvannamalai District solar irradiance graph

Table.8. Thiruvannamalai

Month	**Thiruvannamalai**	**Vembakkam**	**Polur**	**Tellar**	**Pudupalayam**
January	6.33	6.20	6.33	6.23	6.43
February	6.85	6.71	6.85	6.74	6.99
March	7.04	6.95	7.07	7.04	7.15
April	6.48	6.56	6.45	6.55	6.40
May	5.89	5.70	5.73	5.93	5.70
June	5.21	5.25	5.04	5.31	5.16
July	5.00	5.05	4.78	5.11	4.67
August	5.29	5.43	5.38	5.58	5.15
September	5.88	5.87	5.64	5.92	5.72
October	5.58	5.02	5.55	5.43	5.43
November	5.12	4.99	4.99	5.08	5.15
December	5.71	5.61	5.35	4.86	5.00
Annual	**5.87**	**5.78**	**5.76**	**5.82**	**5.75**

Average: 5.796

District: Thiruvannamalai: The solar irradiation has been calculated for Thiruvannamalai district as shown in figure 9. We have selected 5 locations such as Vembakkam, Polur, Thirutani, Tellar, Pudupalayam. 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 and solar irradiance graph is presented in figure.9a.The average solar irradiation for this district is 5.78 kwh/m^2.

Figure.10. Vellore District Map

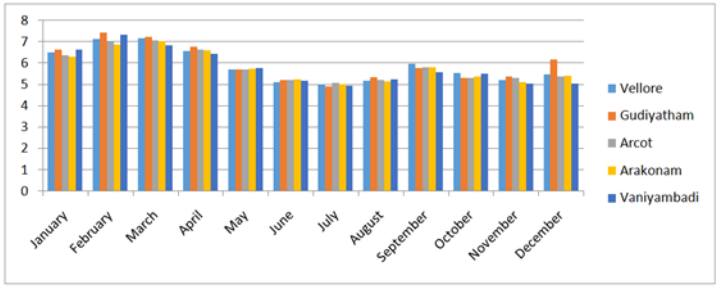

Figure.10a. Vellore District Solar irradiance graph

Table.9. Vellore

Month	Vellore	Gudiyatham	Arcot	Arakonam	Vaniyambadi
January	6.49	6.63	6.39	6.31	6.64
February	7.14	7.42	7.02	6.86	7.34
March	7.18	7.25	7.06	7.04	6.84
April	6.58	6.76	6.65	6.61	6.43
May	5.74	5.74	5.73	5.75	5.79
June	5.13	5.25	5.25	5.27	5.21
July	5.03	4.93	5.09	5.04	4.95
August	5.20	5.36	5.22	5.16	5.26
September	5.96	5.79	5.84	5.84	5.59
October	5.55	5.32	5.34	5.39	5.54
November	5.22	5.39	5.35	5.12	5.07
December	5.51	6.16	5.40	5.42	5.06
Annual	**5.89**	**6.00**	**5.86**	**5.82**	**5.81**

Average: 5.876

District: Vellore: The solar irradiation has been calculated for Vellore district as shown in figure.10. We have selected 5 locations such as Vellore, Gudiyatham, Arcot, Arakonam, and Vaniyambadi. 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 and solar irradiance graph is presented in figure.10a. The average solar irradiation for this district is 5.87 kwh/m^2.

Table.10. North Tamil Nadu average solar Irradiation in kW/m^2 / day

S.No	Name of the District	Average Solar Irradiation in kW/m^2 / day
1	Chennai	5.39
2	Erode	5.8
3	Kancheepuram	5.77
4	Krishnagiri	5.94
5	Namakkal	5.97
6	Salem	5.564
7	Thiruvallur	5.77
8	Thiruvannamalai	5.78
9	Vellore	5.87

3. RESULTS

In this paper we have analysed solar irradiance at 45 locations in 9 districts of North Tamil Nadu. Based on the above analysed result the Namakkal district is recommended to install large scale PV power plants.

4. CONCLUSION

In this paper we have studied and analysed solar irradiation of North Tamil Nadu for implementation for large scale photovoltaic power plant. We have been selected 45 location from 9 different district in south Tamil Nadu for calculate the solar irradiation availability data by using NREL PV /Watt software from UNITED STATES. The 45 location solar irradiation availability of throughout year data is presented in this paper. Based on analyses of solar irradiation availability data Namakkal district is selected as a best location for implementing large

scale Photovoltaic power plant among 9 districts. The other districts are recommended to implement Photovoltaic power system based solar irradiation availability.

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