IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 04, Issue 09 (September. 2014), ||V1|| PP 01-08

A Realistic Estimate of Annual Typical Daily Solar Photovoltaic Power in Urban Armidale NSW, Australia

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Abstract: - Solar energy is one of the common sources of renewable and clean energy. It is really difficult to know exactly the solar radiation at any specific moment at a specific location as clouds are moving simultaneously. Clouds decays solar radiation dramatically. It is astonishingly that in different solar radiation observations are recorded in the same location or town or city due, at the same moment of time, due to the clouds' effect. Such effect has a great influence on solar photovoltaic energy can be generated at any place during the daytime. Generally, manufacturers and suppliers of solar photovoltaic energy system considers the global solar radiation known and published for each town or city as metrological data. However, this led to and overestimation of the solar photovoltaic produced energy and represents a misleading to customers as such estimate it doesn't consider cloudy days.
Armidale is a regional city in New South Wales (NSW) in Australia, as well it is the highest town all over Australia. This study aims to provide a justified realistic/creditable/ reliable estimate of annual typical daily solar photovoltaic power. The reason of this justification that this study depends on an accurate estimate of cloudy global solar radiation**f**or urban Armidale. Such estimate would be a great benefit of solar energy specialists and non-specialists households to obtain an estimate of daily potential solar photovoltaic power would likely be generated in Armidale.

Keywords: *- Armidale NSW, solar Photovoltaic power, test meteorological year, test reference year, solar radiation, micro-scale energy generation*

I. INTRODUCTION

Solar energy is a renewable inexhaustible clean source of energy which was used to meet residential needs of hot water, space heating and cooling, industrial needs of process heat, and agricultural needs of irrigation, drying and cooking. In general, solar energy resource is versatile and does make a significant contribution to the global energy requirements and has the premise of being one of the few, future, clean and reliable energy sources available to mankind [1, 2 & 3].
There are two main categories of solar collection options –direct and indirect. The direct delivery options do not normally require storage or fossil fuel support for small-scale applications but they would for large-scale isolated applications. Such back-up or storage could take any of several forms depending on the application, e.g. batteries, electric network or, if the desired output is heat, internal energy stored in a thermal mass to which heat can be transferred for use at a less favorable time [4 & 5].
There are various solar energy technologies such as Passive thermal systems for comfort conditions, stationary solar collector systems, solar ponds, tracking collectors, photovoltaic generators (terrestrial) and satellite power systems [6].
This study focuses on the generation of photovoltaic energy in urban Armidale NSW, Australia as a sample of regional Australian cities. This scope is selected mainly to provide micro-scale photovoltaic energy generation systems' designers an annual realistic mean daily photovoltaic power.

II. DATA AND LOCATION

A previous study generated the typical meteorological year for global solar radiation [7]. This study was based on daily global solar radiations recorded during the period 1980–2012 are utilized to generate the typical solar radiation data. In Australia, meteorological observations are recorded by the Australian Bureau of Meteorology (BOM) weather stations are widely spreader in lots of cities and towns around Australia. In this study, the global solar radiation data recorded by Armidale Airport Weather Automatic Station and published on the BOM's website where it was collected. The missing and invalid measurements account for approximately 0.01% of the whole database of global solar radiation; those were replaced with the values of preceding or subsequent days by interpolation. During the calculations process, any year found with more than ten days in any month observations not available was excluded. "Table 1" provides geographical information for Armidale town and the periods of the relevant global solar radiation data. Another previous study considered the effect of cloudy

days on the annual typical meteorological solar Radiation for Armidale NSW, Australia was developed which is more realistic [8].
Figure 1 shows the location of Armidale city in New South Wales in Australia.

Table 1 Geographical and solar radiation database information of Armidale NSW, Australia

	Longitude (†E)	Latitude(†S)	Elevation (m)	Daily Global Solar Radiation Data	
				Period	Total years
Armidale	151.67	30.52	970-1070	1990—2012	23

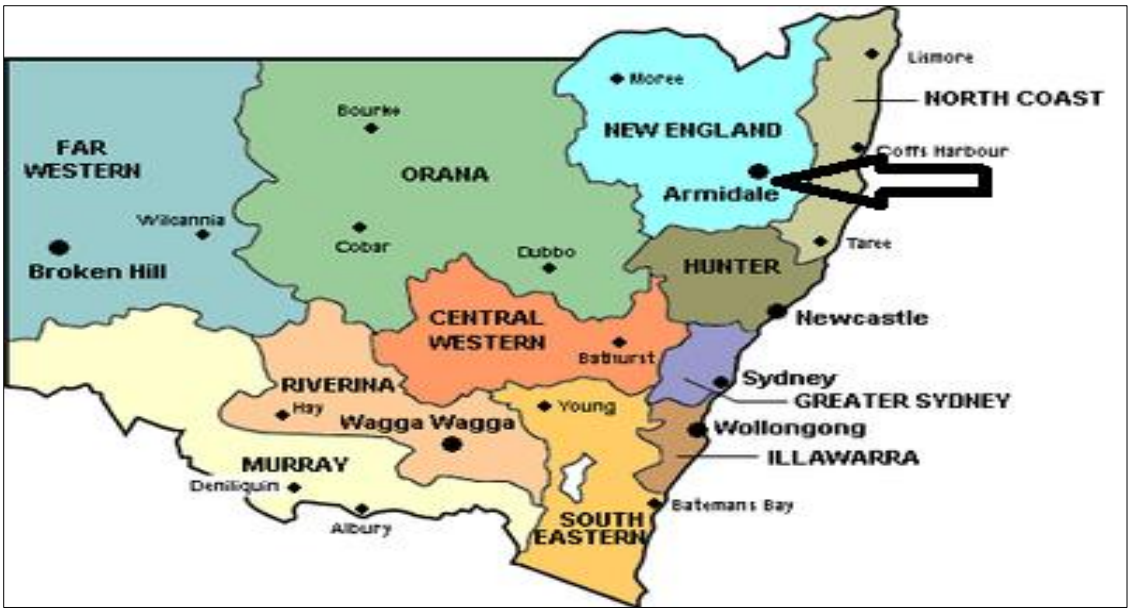

Figure1 Armidale NSW, Australia location

III. METHODOLOGY

The power of solar photovoltaic can be estimated by using the following equations [9]:

$$E = 365 P_k r_p H_{hi} \quad (1)$$

Where E is the yearly potential for electricity generation in kilowatt hours (kWh), Pk is the peak power of the equipment installed in kilowatts (kW), rp is the system performance ration or dating factor, and Hhi is the monthly or yearly average of daily global radiation in watt-hours (Wh). In the development of the r.sun based PVGIS web calculator, the system performance ratio (r_p) utilized for mono- and polycrystalline silicon panels was 0.75.

$$O_{ut} = A_e E_e G \quad (2)$$

Where Eout is the annual electricity production in kWh, Ae is the total surface area of solar cells in square meters (m2), Ee is the annual mean power conversion efficiency coefficient for each PV technology, and G is the annual total global irradiation (Wh/m^2).

$$TC = T_{amb} + (T_0 - 20°C)\, E/800 Wm^{-2} \quad (3)$$

Where T_C is the photovoltaic panel temperature °C, T_{amb} is ambient temperature in degrees Celsius (°C), T_0 is the nominal operating cell temperature at ideal conditions °C and E is the incident radiation in W/m^2 at each time step.

IV. GENERATION OF A TYPICAL ANNUAL MEAN SOLAR PHOTOVOLTAIC POWER

"Tables2&3" shows the test meteorological year for global solar radiation and the modified one considered cloudy days in Armidale
Applying the above methodology to "table 3"modified test reference year values it resulted in annual mean daily global solar radiation on a Horizontal Surface in "table 4", peak sunshine sours per day (PSH) in table "5" and

Power in (kWh) per day for a 200w nominal monocrystalline panel of 1.25 m2 area in "table 6".For simplification, "table 7" shows Power in (kWh) for a 10m2 surface area of 200w nominal monocrystalline panel of 1.25 m2 area each of total 8 panels with a nominal system capacity 1600 W.

Table 2 Daily global solar radiation values (MJ/m^{2}day) obtained from Test Reference Year data for Armidale

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.4	18.1	19.1	18.8	13.5	10.8	10.0	14.5	16.4	20.5	22.3	24.6
2	27.0	22.5	21.8	18.9	12.6	10.6	10.4	14.2	16.3	19.4	22.9	25.0
3	27.2	23.2	21.1	17.8	13.9	9.00	11.2	13.6	16.1	19.3	23.4	26.0
4	26.1	26.1	22.0	19.0	13.0	10.7	10.0	13.2	17.5	20.9	23.1	25.7
5	23.2	25.5	19.8	16.8	12.0	10.9	12.0	13.3	15.8	21.2	21.3	25.4
6	23.2	23.5	21.3	19.5	14.7	11.6	11.2	14.3	18.7	19.9	22.3	23.8
7	26.6	21.5	19.4	18.8	14.5	9.70	10.8	13.7	17.0	21.4	24.1	26.1
8	25.1	23.2	20.3	16.4	12.8	10.3	10.7	14.9	17.0	21.6	22.0	26.8
9	24.9	23.2	19.5	16.2	13.4	10.6	9.60	14.9	15.7	22.3	23.2	24.8
10	26.4	24.1	21.0	17.4	12.9	10.7	11.2	15.4	18.7	21.5	24.7	22.7
11	26.4	24.3	21.4	16.3	12.8	10.1	11.4	15.1	18.3	22.4	24.2	24.7
12	26.7	21.4	20.2	16.5	12.6	11.6	10.3	15.2	18.4	22.8	25.3	26.3
13	26.1	22.4	21.0	16.4	12.5	9.80	9.90	15.7	20.4	23.7	24.4	28.3
14	25.6	20.2	21.1	14.9	12.7	10.2	10.2	15.6	19.7	21.9	26.9	25.8
15	25.7	19.7	21.9	16.7	12.9	10.5	11.6	15.6	19.3	23.2	23.8	25.2
16	26.6	20.3	21.9	15.7	12.2	10.5	12.4	14.3	19.7	23.6	22.5	27.0
17	25.1	23.9	19.3	15.4	11.5	11.2	12.1	14.4	19.2	22.5	21.3	28.3
18	25.1	22.2	20.7	16.2	11.1	10.6	10.7	14.0	19.7	23.0	21.5	26.0
19	22.1	21.8	20.9	15.2	12.4	9.50	12.2	14.6	20.0	21.8	25.5	27.1
20	28.4	22.8	20.5	15.4	12.4	9.90	12.4	13.9	19.9	23.6	24.2	26.8
21	27.3	23.4	19.8	16.2	11.3	10.6	12.4	15.5	19.9	22.9	21.3	28.1
22	25.0	21.3	17.8	15.7	11.9	10.6	12.2	14.3	21.2	24.3	24.2	26.4
23	23.5	23.2	18.8	16.2	12.2	10.4	12.7	12.8	21.8	24.4	23.7	27.9
24	25.6	23.3	20.3	14.6	12.0	11.1	11.6	16.1	20.2	21.3	25.6	24.3
25	20.8	19.0	19.5	14.6	12.2	11.0	10.8	16.8	21.5	22.9	25.3	26.2
26	25.4	21.5	17.8	14.9	11.9	10.3	9.60	16.2	20.5	20.0	26.3	26.3
27	25.2	21.5	19.4	13.7	12.2	9.80	11.4	15.5	21.5	21.3	26.1	19.8
28	27.2	25.5	17.9	13.1	11.7	10.6	11.7	15.3	21.6	26.9	26.5	26.2
29	26.8	18.3	18.5	15.1	11.4	11.2	13.6	14.9	22.1	25.5	25.7	28.3
30	27.4		15.8	14.9	11.5	9.70	13.3	14.0	23.7	21.3	26.0	26.1
31	22.8		18.7		11.0		12.8	15.9		22.6		28.4

Extracted from [7]

Table 3 A Modified test reference year of global solar radiation considering cloudy days (MJ/m^{2}day) for Armidale

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	29.4	1.1	5.2	18.8	0.2	10.8	6.5	14.5	16.4	2.5	22.3	2.9
2	3.9	1.6	2.8	18.9	12.6	4.4	10.4	14.2	3	2.4	22.9	9.1
3	27.2	7.1	7.6	17.8	13.9	4.1	11.2	13.6	16.1	19.3	1.5	10.8
4	7.5	3.1	7.2	19	5.6	4.8	10	2.7	17.5	4.2	1.4	25.7
5	7.4	3.9	19.8	0.7	12	10.9	12	13.3	15.8	21.2	1.8	25.4
6	23.2	7.1	21.3	7.3	14.7	2.5	6.7	14.3	18.7	0.5	10.4	6.4
7	26.6	4.5	19.4	18.8	14.5	2.5	10.8	9.1	17	1.7	7.7	0.3
8	25.1	3.4	20.3	16.4	12.8	10.3	2.9	2.4	3	21.6	8.7	26.8
9	24.9	11.5	1.9	6.7	4.9	1.6	3.2	9.6	1.4	22.3	23.2	9.6
10	26.4	24.1	21	17.4	12.9	0.2	2.3	15.4	2.5	21.5	24.7	22.7
11	26.4	4.9	21.4	2.9	2.6	10.1	2.7	3.6	2.8	22.4	24.2	2.3
12	26.7	5.5	20.2	16.5	4.1	11.6	2.8	15.2	5.1	22.8	7.6	2.4

13	26.1	2	21	7.9	1.6	3.2	9.9	5.2	2.2	23.7	3.8	11.1
14	5.4	6.1	12.6	14.9	12.7	2.4	3.4	15.6	19.7	21.9	3.4	7.1
15	4.7	2.1	21.9	6.9	2.8	2.2	0.5	15.6	2	4	23.8	10
16	7.8	2.2	21.9	1.1	3.8	3.7	0.8	14.3	4.9	4.3	22.5	27
17	3.8	7.6	6.1	6.1	1.9	3.8	12.1	3	5	22.5	3	5.6
18	1.9	22.2	7.2	16.2	1.4	1.3	3.3	1.3	4.1	2.2	6.7	3.6
19	4	2.1	20.9	15.2	12.4	3.5	1.5	14.6	2.9	4	25.5	27.1
20	28.4	22.8	20.5	15.4	12.4	9.9	4.3	3.6	1.9	23.6	2.7	26.8
21	27.3	7	1.6	16.2	3.5	10.6	4.6	15.5	19.9	22.9	2	28.1
22	25	0.4	17.8	3.2	1.4	3.1	3.1	4.4	21.2	24.3	2.8	10.3
23	1.2	23.2	18.8	2.9	12.2	10.4	12.7	3	21.8	4.5	3.7	27.9
24	25.6	23.3	20.3	14.6	4.9	11.1	5.9	5.4	1.9	1.9	25.6	24.3
25	6.2	3.3	8.1	14.6	2.5	11	2.8	6.6	21.5	22.9	10	3.6
26	6.7	21.5	4.5	4.9	1.7	2.9	0.5	4.2	20.5	4.5	0.3	7.4
27	25.2	21.5	8	4.4	2.4	9.8	0.9	2.5	21.5	21.3	26.1	4.4
28	27.2	25.5	4.9	2.9	11.7	3.9	2	2	21.6	26.9	26.5	26.2
29	1.6	18.3	18.5	6.1	2.9	2.5	2.4	4	22.1	25.5	25.7	28.3
30	2.5		3.5	3.3	11.5	1.7	13.3	7.6	23.7	2.3	26	10.7
31	6.8		18.7		11		12.8	1		22.6		28.4

Extracted from [8]

Table 4 Global Solar Radiation on a Horizontal Surface (MJ/m^{2}day) for Armidale

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	8170	310	1440	5220	60	3000	1810	4030	4560	690	6190	810
2	1080	440	780	5250	3500	1220	2890	3940	830	670	6360	2530
3	7560	1970	2110	4940	3860	1140	3110	3780	4470	5360	420	3000
4	2080	860	2000	5280	1560	1330	2780	750	4860	1170	390	7140
5	2060	1080	5500	190	3330	3030	3330	3690	4390	5890	500	7060
6	6440	1970	5920	2030	4080	690	1860	3970	5190	140	2890	1780
7	7390	1250	5390	5220	4030	690	3000	2530	4720	470	2140	80
8	6970	940	5640	4560	3560	2860	810	670	830	6000	2420	7440
9	6920	3190	530	1860	1360	440	890	2670	390	6190	6440	2670
10	7330	6690	5830	4830	3580	60	640	4280	690	5970	6860	6310
11	7330	1360	5940	810	720	2810	750	1000	780	6220	6720	640
12	7420	1530	5610	4580	1140	3220	780	4220	1420	6330	2110	670
13	7250	560	5830	2190	440	890	2750	1440	610	6580	1060	3080
14	1500	1690	3500	4140	3530	670	940	4330	5470	6080	940	1970
15	1310	580	6080	1920	780	610	140	4330	560	1110	6610	2780
16	2170	610	6080	310	1060	1030	220	3970	1360	1190	6250	7500
17	1060	2110	1690	1690	530	1060	3360	830	1390	6250	830	1560
18	530	6170	2000	4500	390	360	920	360	1140	610	1860	1000
19	1110	580	5810	4220	3440	970	420	4060	810	1110	7080	7530
20	7890	6330	5690	4280	3440	2750	1190	1000	530	6560	750	7440
21	7580	1940	440	4500	970	2940	1280	4310	5530	6360	560	7810
22	6940	110	4940	890	390	860	860	1220	5890	6750	780	2860
23	330	6440	5220	810	3390	2890	3530	830	6060	1250	1030	7750

24	7110	6470	5640	4060	1360	3080	1640	1500	530	530	7110	6750
25	1720	920	2250	4060	690	3060	780	1830	5970	6360	2780	1000
26	1860	5970	1250	1360	470	810	140	1170	5690	1250	80	2060
27	7000	5970	2220	1220	670	2720	250	690	5970	5920	7250	1220
28	7560	7080	1360	810	3250	1080	560	560	6000	7470	7360	7280
29	440	5080	5140	1690	810	690	670	1110	6140	7080	7140	7860
30	690		970	920	3190	470	3690	2110	6580	640	7220	2970
31	1890		5190		3060		3560	280		6280		7890

Table 5 Peak sunshine sours per day (PSH) for Armidale

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	8.17	0.31	1.44	5.22	0.06	3	1.81	4.03	4.56	0.69	6.19	0.81
2	1.08	0.44	0.78	5.25	3.5	1.22	2.89	3.94	0.83	0.67	6.36	2.53
3	7.56	1.97	2.11	4.94	3.86	1.14	3.11	3.78	4.47	5.36	0.42	3
4	2.08	0.86	2	5.28	1.56	1.33	2.78	0.75	4.86	1.17	0.39	7.14
5	2.06	1.08	5.5	0.19	3.33	3.03	3.33	3.69	4.39	5.89	0.5	7.06
6	6.44	1.97	5.92	2.03	4.08	0.69	1.86	3.97	5.19	0.14	2.89	1.78
7	7.39	1.25	5.39	5.22	4.03	0.69	3	2.53	4.72	0.47	2.14	0.08
8	6.97	0.94	5.64	4.56	3.56	2.86	0.81	0.67	0.83	6	2.42	7.44
9	6.92	3.19	0.53	1.86	1.36	0.44	0.89	2.67	0.39	6.19	6.44	2.67
10	7.33	6.69	5.83	4.83	3.58	0.06	0.64	4.28	0.69	5.97	6.86	6.31
11	7.33	1.36	5.94	0.81	0.72	2.81	0.75	1	0.78	6.22	6.72	0.64
12	7.42	1.53	5.61	4.58	1.14	3.22	0.78	4.22	1.42	6.33	2.11	0.67
13	7.25	0.56	5.83	2.19	0.44	0.89	2.75	1.44	0.61	6.58	1.06	3.08
14	1.5	1.69	3.5	4.14	3.53	0.67	0.94	4.33	5.47	6.08	0.94	1.97
15	1.31	0.58	6.08	1.92	0.78	0.61	0.14	4.33	0.56	1.11	6.61	2.78
16	2.17	0.61	6.08	0.31	1.06	1.03	0.22	3.97	1.36	1.19	6.25	7.5
17	1.06	2.11	1.69	1.69	0.53	1.06	3.36	0.83	1.39	6.25	0.83	1.56
18	0.53	6.17	2	4.5	0.39	0.36	0.92	0.36	1.14	0.61	1.86	1
19	1.11	0.58	5.81	4.22	3.44	0.97	0.42	4.06	0.81	1.11	7.08	7.53
20	7.89	6.33	5.69	4.28	3.44	2.75	1.19	1	0.53	6.56	0.75	7.44
21	7.58	1.94	0.44	4.5	0.97	2.94	1.28	4.31	5.53	6.36	0.56	7.81
22	6.94	0.11	4.94	0.89	0.39	0.86	0.86	1.22	5.89	6.75	0.78	2.86
23	0.33	6.44	5.22	0.81	3.39	2.89	3.53	0.83	6.06	1.25	1.03	7.75
24	7.11	6.47	5.64	4.06	1.36	3.08	1.64	1.5	0.53	0.53	7.11	6.75
25	1.72	0.92	2.25	4.06	0.69	3.06	0.78	1.83	5.97	6.36	2.78	1
26	1.86	5.97	1.25	1.36	0.47	0.81	0.14	1.17	5.69	1.25	0.08	2.06
27	7	5.97	2.22	1.22	0.67	2.72	0.25	0.69	5.97	5.92	7.25	1.22
28	7.56	7.08	1.36	0.81	3.25	1.08	0.56	0.56	6	7.47	7.36	7.28
29	0.44	5.08	5.14	1.69	0.81	0.69	0.67	1.11	6.14	7.08	7.14	7.86
30	0.69		0.97	0.92	3.19	0.47	3.69	2.11	6.58	0.64	7.22	2.97
31	1.89		5.19		3.06		3.56	0.28		6.28		7.89

Table 6 Power in (kWh) per day for a 200w nominal monocrystalline panel of 1.25 m^2 area approximately

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.242	0.047	0.219	0.793	0.009	0.456	0.275	0.613	0.693	0.105	0.941	0.123
2	0.164	0.067	0.119	0.798	0.532	0.185	0.439	0.599	0.126	0.102	0.967	0.385
3	1.149	0.299	0.321	0.751	0.587	0.173	0.473	0.575	0.679	0.815	0.064	0.456
4	0.316	0.131	0.304	0.803	0.237	0.202	0.423	0.114	0.739	0.178	0.059	1.085
5	0.313	0.164	0.836	0.029	0.506	0.461	0.506	0.561	0.667	0.895	0.076	1.073
6	0.979	0.299	0.9	0.309	0.62	0.105	0.283	0.603	0.789	0.021	0.439	0.271
7	1.123	0.19	0.819	0.793	0.613	0.105	0.456	0.385	0.717	0.071	0.325	0.012
8	1.059	0.143	0.857	0.693	0.541	0.435	0.123	0.102	0.126	0.912	0.368	1.131
9	1.052	0.485	0.081	0.283	0.207	0.067	0.135	0.406	0.059	0.941	0.979	0.406
10	1.114	1.017	0.886	0.734	0.544	0.009	0.097	0.651	0.105	0.907	1.043	0.959
11	1.114	0.207	0.903	0.123	0.109	0.427	0.114	0.152	0.119	0.945	1.021	0.097
12	1.128	0.233	0.853	0.696	0.173	0.489	0.119	0.641	0.216	0.962	0.321	0.102
13	1.102	0.085	0.886	0.333	0.067	0.135	0.418	0.219	0.093	1	0.161	0.468
14	0.228	0.257	0.532	0.629	0.537	0.102	0.143	0.658	0.831	0.924	0.143	0.299
15	0.199	0.088	0.924	0.292	0.119	0.093	0.021	0.658	0.085	0.169	1.005	0.423
16	0.33	0.093	0.924	0.047	0.161	0.157	0.033	0.603	0.207	0.181	0.95	1.14
17	0.161	0.321	0.257	0.257	0.081	0.161	0.511	0.126	0.211	0.95	0.126	0.237
18	0.081	0.938	0.304	0.684	0.059	0.055	0.14	0.055	0.173	0.093	0.283	0.152
19	0.169	0.088	0.883	0.641	0.523	0.147	0.064	0.617	0.123	0.169	1.076	1.145
20	1.199	0.962	0.865	0.651	0.523	0.418	0.181	0.152	0.081	0.997	0.114	1.131
21	1.152	0.295	0.067	0.684	0.147	0.447	0.195	0.655	0.841	0.967	0.085	1.187
22	1.055	0.017	0.751	0.135	0.059	0.131	0.131	0.185	0.895	1.026	0.119	0.435
23	0.05	0.979	0.793	0.123	0.515	0.439	0.537	0.126	0.921	0.19	0.157	1.178
24	1.081	0.983	0.857	0.617	0.207	0.468	0.249	0.228	0.081	0.081	1.081	1.026
25	0.261	0.14	0.342	0.617	0.105	0.465	0.119	0.278	0.907	0.967	0.423	0.152
26	0.283	0.907	0.19	0.207	0.071	0.123	0.021	0.178	0.865	0.19	0.012	0.313
27	1.064	0.907	0.337	0.185	0.102	0.413	0.038	0.105	0.907	0.9	1.102	0.185
28	1.149	1.076	0.207	0.123	0.494	0.164	0.085	0.085	0.912	1.135	1.119	1.107
29	0.067	0.772	0.781	0.257	0.123	0.105	0.102	0.169	0.933	1.076	1.085	1.195
30	0.105		0.147	0.14	0.485	0.071	0.561	0.321	1	0.097	1.097	0.451
31	0.287		0.789		0.465		0.541	0.043		0.955		1.199

Table 7 Power in (kWh) for a 10m2 surface area of 200w nominal monocrystalline panel of 1.25 m2 area each - total panels 8 - Nominal System Capacity 1600 w

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	9.936	0.376	1.752	6.344	0.072	3.648	2.2	4.904	5.544	0.84	7.528	0.984
2	1.312	0.536	0.952	6.384	4.256	1.48	3.512	4.792	1.008	0.816	7.736	3.08
3	9.192	2.392	2.568	6.008	4.696	1.384	3.784	4.6	5.432	6.52	0.512	3.648
4	2.528	1.048	2.432	6.424	1.896	1.616	3.384	0.912	5.912	1.424	0.472	8.68
5	2.504	1.312	6.688	0.232	4.048	3.688	4.048	4.488	5.336	7.16	0.608	8.584
6	7.832	2.392	7.2	2.472	4.96	0.84	2.264	4.824	6.312	0.168	3.512	2.168
7	8.984	1.52	6.552	6.344	4.904	0.84	3.648	3.08	5.736	0.568	2.6	0.096
8	8.472	1.144	6.856	5.544	4.328	3.48	0.984	0.816	1.008	7.296	2.944	9.048
9	8.416	3.88	0.648	2.264	1.656	0.536	1.08	3.248	0.472	7.528	7.832	3.248

10	8.912	8.136	7.088	5.872	4.352	0.072	0.776	5.208	0.84	7.256	8.344	7.672
11	8.912	1.656	7.224	0.984	0.872	3.416	0.912	1.216	0.952	7.56	8.168	0.776
12	9.024	1.864	6.824	5.568	1.384	3.912	0.952	5.128	1.728	7.696	2.568	0.816
13	8.816	0.68	7.088	2.664	0.536	1.08	3.344	1.752	0.744	8	1.288	3.744
14	1.824	2.056	4.256	5.032	4.296	0.816	1.144	5.264	6.648	7.392	1.144	2.392
15	1.592	0.704	7.392	2.336	0.952	0.744	0.168	5.264	0.68	1.352	8.04	3.384
16	2.64	0.744	7.392	0.376	1.288	1.256	0.264	4.824	1.656	1.448	7.6	9.12
17	1.288	2.568	2.056	2.056	0.648	1.288	4.088	1.008	1.688	7.6	1.008	1.896
18	0.648	7.504	2.432	5.472	0.472	0.44	1.12	0.44	1.384	0.744	2.264	1.216
19	1.352	0.704	7.064	5.128	4.184	1.176	0.512	4.936	0.984	1.352	8.608	9.16
20	9.592	7.696	6.92	5.208	4.184	3.344	1.448	1.216	0.648	7.976	0.912	9.048
21	9.216	2.36	0.536	5.472	1.176	3.576	1.56	5.24	6.728	7.736	0.68	9.496
22	8.44	0.136	6.008	1.08	0.472	1.048	1.048	1.48	7.16	8.208	0.952	3.48
23	0.4	7.832	6.344	0.984	4.12	3.512	4.296	1.008	7.368	1.52	1.256	9.424
24	8.648	7.864	6.856	4.936	1.656	3.744	1.992	1.824	0.648	0.648	8.648	8.208
25	2.088	1.12	2.736	4.936	0.84	3.72	0.952	2.224	7.256	7.736	3.384	1.216
26	2.264	7.256	1.52	1.656	0.568	0.984	0.168	1.424	6.92	1.52	0.096	2.504
27	8.512	7.256	2.696	1.48	0.816	3.304	0.304	0.84	7.256	7.2	8.816	1.48
28	9.192	8.608	1.656	0.984	3.952	1.312	0.68	0.68	7.296	9.08	8.952	8.856
29	0.536	6.176	6.248	2.056	0.984	0.84	0.816	1.352	7.464	8.608	8.68	9.56
30	0.84		1.176	1.12	3.88	0.568	4.488	2.568	8	0.776	8.776	3.608
31	2.296		6.312		3.72		4.328	0.344		7.64		9.592
Total	166.21	97.52	143.47	107.42	76.19	57.66	60.26	86.90	120.81	151.37	133.93	156.18

V. CONCLUSION AND RECOMMENDATIONS

Predicting solar photovoltaic power could be generated is a sophisticated task. As clouds directly affects the solar radiation and can decay it during the daytime. This paper considered developing a realistic/reliable/creditable database of annual mead daily typical solar photovoltaic typical daily power database based on previously published generated solar radiation test reference year considering cloudy days in urban Armidale. Such consequent calculations justifies and enhance the reliability of generated solar photovoltaic power. It is a common issue that mostly new photovoltaic systems 'users gets disappointed of their solar systems' under-performance, although the fact that they have overestimated the available solar radiation, actually, there are misled by overestimated meteorological historically recorded solar radiation at their towns or cities. This paper considered Armidale, the highest city in Australia, as a sample of Australian regional cities

Therefore, it is highly urged to base any solar photovoltaic power calculations or modelling on test reference years considering cloudy days. This would reflect the real picture of solar photovoltaic potential and would save any disappointment of not reaching the expected energy generation which is usually misled by any sort of overestimation.

It is worth mentioning that, there is a recently published study provided a realistic estimate of annual typical daily wind power for urban Armidale at heights (8, 9 & 10) meters above ground which suit micro-scale wind turbine installations [10]. Such study, in addition to this one, would provide annual typical daily generated power do both solar and wind energies which is highly recommended to be utilised while studying and designing hybrid solar and wind systems for Armidale NSW. As well, a more specialised study providing an estimate of solar radiation on tilted surfaces of angles (15°, 30°, 45°, 60°& 75°) is recommended to be used by solar photovoltaic specialists and designers when considering solar systems with sun tracking devices [11].

REFERENCES

[1] Natural Resources Canada, 2001). Photovoltaics for Buildings: Opportunities for Canada. Catalogue Number M39-76/2001E, ISBN 0-662-30106-4.

[2] W. Schmidt, B. Woesten, 2000. *Proceedings of the 16th European PV Solar Energy Conference, Glasgow*, 1083.

[3] H. Sakata, T. Nakai, T. Baba, M. Taguchi, 2000. *Proceedings of IEEE Photovoltaic Specialists*

'Conference, 7–12.
[4] J. Szlufcik, S. Sivoththaman, J. Nijs, R. Mertens, R., Van Overstraeten, 1997. *Low-cost Industrial Technologies of Crystalline Silicon Solar Cells. Proceedings of the IEEE* 85:711–730.
[5] R. Kawamura, K. Sasatani, T. Onizuka, K. Kameko, 1996. *Proceedings of the International PVSEC-9, Miyazaki, Japan*, 75–78.
[6] B. Ponomaryov, R. Ward., 1982. Layman's Guide to New and Renewable Sources Energy. *International Journal of Solar Energy*, 1(5), 379-397.
[7] Y. Maklad, 2014. Generation of an Annual Typical Meteorological Solar Radiation for Armidale NSW Australia. *IOSR Journal of Engineering (IOSRJEN*): 4(4), 2014, 41-45.
[8] Y. Maklad, 2014. The Effect of Cloudy Days on the Annual Typical Meteorological Solar Radiation for Armidale NSW, Australia. *IOSR Journal of Engineering (IOSRJEN*): 4(8), 2014, 14-20.
[9] C. Carl., 2014. Calculating Solar Photovoltaic Potential on Residential Rooftops in Kailua Kona, Hawaii. Master of Science Thesis. University of Southern California. USA.
[10] Y. Makald, 2014. A Realistic Estimate of Annual Typical Daily Wind Power of different heights in Urban Armidale NSW, Australia. *IOSR Journal of Engineering (IOSRJEN*): 4(9).
[11] Y. Maklad, 2014. Generation of an Annual Typical Meteorological Solar Irradiance on Tilted Surfaces for Armidale NSW, Australia. *IOSR Journal of Engineering (IOSRJEN*): 4(7), 2014, 24-40.