Iranica Journal of Energy & Environment 5 (1): 78-86, 2014
ISSN 2079-2115
IJEE an Official Peer Reviewed Journal of Babol Noshirvani University of Technology
DOI: 10.5829/idosi.ijee.2014.05.01.12

BUT

Creation Typical Meteorological Year Data for Baghdad Province, Iraq

Ali M. AL-Salihi

Department of Atmospheric Sciences, College of Science, AL-Mustansiriyah University, Baghdad, Iraq

(Received: December 20, 2013; Accepted in Revised Form: March 8, 2014)

Abstract: Weather data can vary significantly from year to other, so there is a need to create a Typical Meteorological Year (TMY) data to represent the long-term typical weather data sets which are very important as inputs in modeling, designing and performance evaluation of energy balance calculations. In present study Finkelstein-Schafer statistical method was employed to analyze the long-term measured weather data of a 30-year period (1971-2000) for Baghdad province, which included six major meteorological parameter (Global solar Radiation, Sunshine Duration, Maximum, Minimum and Mean Temperature, Relative Humidity) Typical meteorological months from the period of considered years were selected by choosing the smallest (FS) deviation from the long-term of a TMY for Baghdad province.

Key words: Typical Meteorological Year · Finkelstein-Schafer · Meteorology · Baghdad

INTRODUCTION

Weather is the main exterior factor that governs the construction and structure of building designs, especially solar radiation, sunshine duration, air temperature and relative humidity. In order to have a suitable indoor temperature in the buildings, we need to know the energy balance of building and then we can calculate the required power for devices of heating and cooling, which are used to regulate the indoor temperature on a desired value. One year time series of meteorological variables, which serve as an input into the model of the energy balance, is needed for this purpose. Testing the energy response of a building on specific weather types usually requires the so called Typical Meteorological Year (TMY) [1].

The modern simulation software for evaluating the performance of solar energy systems requires accurate and high-resolution meteorological data series [2]. Information concerning solar irradiation and meteorological variables; such as air temperature, relative humidity, necessary for the analysis of renewable energy systems and to simulate the evaluation of heating and cooling loads in buildings and the performance of solar thermal and photovoltaic systems. The analysis of renewable solar energy systems can be carried out using multiyear hourly data that involve additional and expensive computational efforts or creating a year of representative data, called long-term average measured data series from many years of available data series. Long-term average measured data are a feasible series with the drawback that the values are averaged and do not take directly into account the extreme meteorological values reached in the year [3].

Typical Meteorological Year (TMY) which is a dataset of hourly meteorological variables throughout the year, with the advantage of representing reference rather than extreme conditions in the region. TMYs data series can simplify the work with weather data in energy studies. They also have the property of facilitating performance comparisons of different types of energy systems and installers of energy systems could use them more easily.

The need for such appropriate weather data led to development of methodologies for generating the Typical Meteorological Year. In last two decades many researchers have been made attempts to generate a climatic database for different areas around the world employing different approaches [4-18]. One of the most common methodologies for generating TMY is the one proposed by Hall [4] using the Filkenstein-Schafer (FS) statistical method [19].

Corresponding Author: Ali M. AL-Salihi, Department of Atmospheric Sciences, College of Science, AL-Mustansiriyah University, Baghdad, Iraq.

The real recorded data from past weather observations are selected for generation of representative weather data. A representative database for one-year duration is known as test reference year (TRY) or typical meteorological year (TMY). TMY or TRY consists of the months selected from the individual years and concatenated to form a complete year. Many attempts have been made to produce such weather databases for different locations around the world [15, 18].

An accurate knowledge of the meteorological data at a particular geographical location is of vital importance for the development of meteorological elements measuring devices and for estimates of their performances [20]. In this study, an attempt is made to generate a representative weather database for Baghdad province by using Filkenstein-Schafer (FS) statistical method. The TMY will created using available weather data, which recorded by the Iraqi Meteorological Organization and Seismology (IMOS) covering the period 1971 to 2000. This restriction on the length of time series is related to the availability of the data in electronic form. It is hope that in a near future the generation of a TMY will became feasible for other provinces of Iraq, especially when solar radiation records will be available.

TMY Generation Method: Thirty years of meteorological data collected by Iraqi Meteorological Organization and Seismology (IMOS) at Baghdad station were used as a data base for selecting Typical meteorological year (TMY) by using the common methodology for creating typical weather data is Filkenstein-Schafer (FS) static's [19], It were used by many researcher such as; [5, 6, 9-12, 16]. According to these static's (FS), if a number (n) of observations of a variable (X) are available and have been sorted into an increasing order $X_1, X_2, \ldots, X_n$, the Cumulative Distribution Function (CDF) of this variable is given by a function S_n (X) which is defined as flows:

$$0 \text{ for } X < X_1 \quad (1)$$

$$S_n(X) = (k-0.5)/n \text{ for } X_k < X < X_{(k+1)}, \quad (1)$$
$$1 \text{ for } X > X_{(n)},$$

where Sn (X) is value of the CDF at X; n, the total number of elements; k, ranked order number (k=1, 2, 3,…..n-1). The FS by which comparison between the long-term CDF of each month and the CDF for each individual year of the month was done is given by the equation:

$$FS_x(y,m) = \frac{1}{N}\sum_{i=1}^{N}\left|CDF_m(x_i) - CDF_{y,m}(x_i)\right| \quad (2)$$

$$WS(y,m) = \frac{1}{M}\sum_{x=1}^{M} WF_x . FS_x(y,m) \quad (3)$$

$$\sum_{x=1}^{M} WF_x = 1 \quad (4)$$

where CDFm is the long term and CDFy,m is the short term cumulative distribution function of the daily index x for month m and WFx are the weighting factors, one for each daily index. N is the number of bins and M is the number of considered meteorological parameters in the present study [19]. Finally, the typical year for each month of the data set was determined on the basis, that the typical year is that of the minimum values of FS through the year.

RESULT AND DISCUSSION

The intensity of solar radiation received by the earth's surface varies from location to other owing the attenuating properties of the atmosphere and the diverse geographical characteristic of the earth surface. Generally from the daily global solar radiation data as well as sunshine duration which employed in present study illustrated in Figures 1 and 2, respectively. It is a clear that the daily solar radiation are higher from late February early September and lower from October to late January with maximum values during June (8 kwh/m^2.day). But for temperature group there are about one month and half shift between the distribution of solar radiation and air temperature group, where the mean air temperature shows higher values late April and mid September with maximum values in July (about 40°C in average) and the minimum and maximum value reaches to 28 and 48 °C, respectively. The mean temperature records are illustrated in Figures 3, 4 and 5. While, the annual behavior of relative humidity show an opposite distribution against the previously mentioned meteorological parameters (solar radiation and air temperature parameters), where the relative humidity presents lower values during May, June, July and Augustus months and higher during other months of the year as shown in Figure 6. The representative year for each month for each meteorological parameter was determined on the basis that the representative year is that concluded the smallest values of FS as presented in previous section (TMY Generation Method).

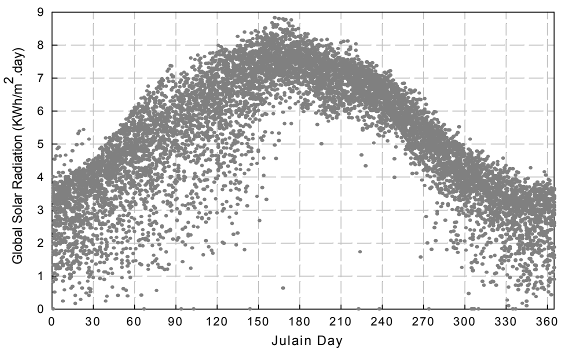

Fig. 1: Variation of long term measured daily global solar radiation data for Baghdad city

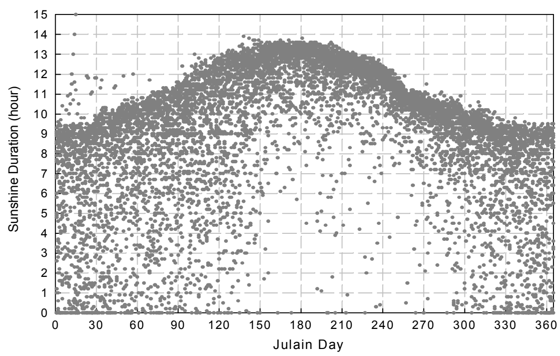

Fig. 2: Variation of long term measured sunshine duration data for Baghdad City.

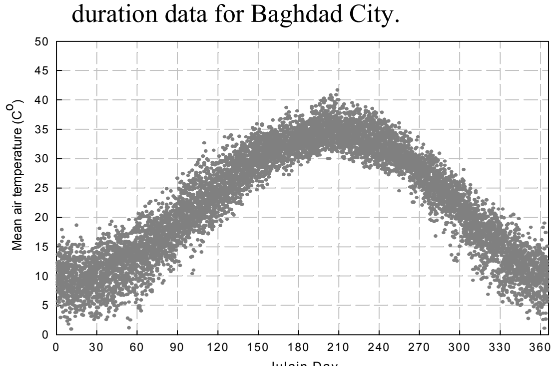

Fig. 3: Variation of long term measured mean air temperature data for Baghdad city

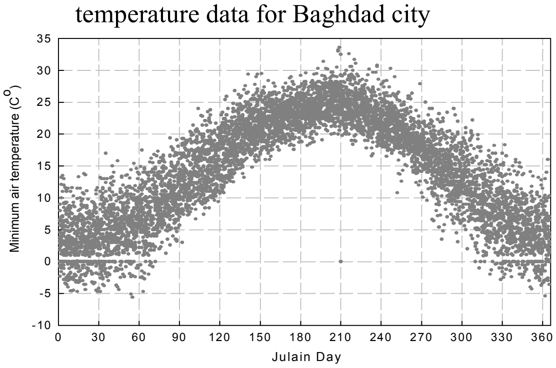

Fig. 4: Variation of long term measured minimum air temperature data for Baghdad city.

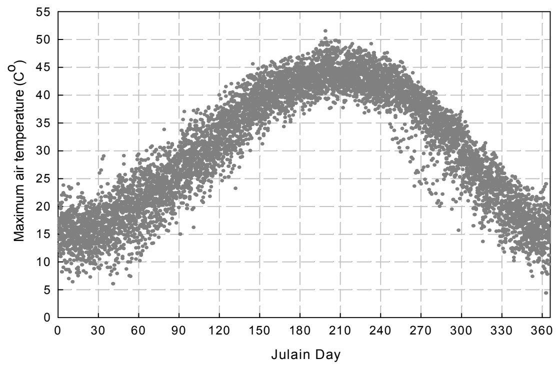

Fig. 5: Variation of long term measured maximum air temperature data for Baghdad city.

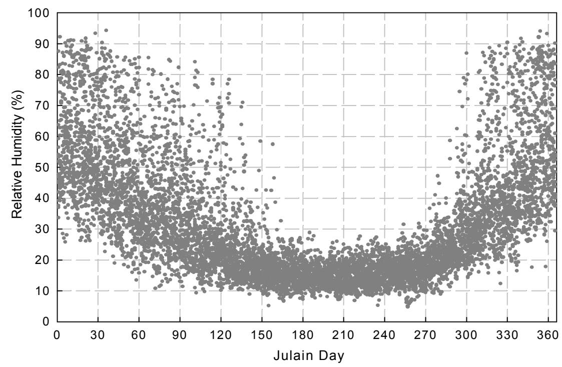

Fig. 6: Variation of long term measured relative humidity data for Baghdad city

There are six TMY resulted from different years to carry out the weighted FS for each meteorological element. Daily measured data (derived from hourly measurements) for years (1971-2000) for all the considered meteorological elements except of solar radiation the data represented by the years (1971-1987) and (1989-1999), sun shine duration (1971-1990) and (1992-2000) and relative humidity for the period (1975- 2000) are shown in Figures 1 to 6. In present study, the function FS was computed for each month of every year for all the considered data set shown in Tables 1-6.

The abdicated months for each element with lowest FS values are shown in underline in Tables 1-6 for solar radiation (kwh/m^2.day), sunshine duration (h), mean air temperature (°C), minimum air temperature (°C), Maximum air temperature (°C) and relative humidity (%), respectively. Usually the sunshine duration not concluded in TMY and replaced by solar radiation which is represented. But in our case we have a very big shortage in solar radiation measurements in most meteorological stations in Iraqi provinces and its available in a few stations in main provinces, so that we conclude this additional parameter to use it instead of solar

Table 1: Weighted sum of the FS statistics of global solar radiation for Baghdad. (The candidate months of each year are underlined)

	Month											
Year	Jan	Feb	Mar	Aprl	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1971	0.0785	0.1012	0.0779	0.0083	0.0653	0.1071	0.0027	0.0171	0.0434	0.0942	0.0751	0.0960
1972	0.0361	0.1000	0.0442	0.0308	0.1274	0.1707	0.1224	0.1145	0.0050	0.0178	0.1365	0.1366
1973	0.1207	0.0472	0.1284	0.0649	0.1822	0.1060	0.0227	0.0036	0.0046	0.1340	0.0942	0.1704
1974	0.0957	0.1039	0.0514	0.1797	0.1863	0.007	0.0420	0.0329	0.1050	0.0548	0.1462	0.0050
1975	0.2314	0.0903	0.0175	0.1743	0.1645	0.0074	0.0368	0.1066	0.0368	0.0359	0.0691	0.0827
1976	0.0409	0.0463	0.1028	0.0458	0.1560	0.3380	0.0023	0.0390	0.0039	0.0552	0.0491	0.0580
1977	0.0829	0.0780	0.0343	0.1022	0.1161	0.0341	0.0081	0.3214	0.0080	0.0332	0.0492	0.0772
1978	0.0560	0.0353	0.1125	0.0941	0.0921	0.0145	0.0038	0.0628	0.0313	0.0054	0.1598	0.1543
1979	0.0557	0.1086	0.0812	0.0335	0.0613	0.1199	0.1507	0.1061	0.1701	0.0844	0.1177	0.1088
1980	0.1143	0.0703	0.1125	0.0668	0.1845	0.2672	0.2550	0.0547	0.2027	0.1729	0.1291	0.0508
1981	0.0962	0.1164	0.1124	0.1011	0.1039	0.2142	0.0449	0.0977	0.0053	0.0328	0.1554	0.1296
1982	0.0115	0.1065	0.0813	0.1093	0.0879	0.0354	0.0929	0.2015	0.2483	0.1405	0.1088	0.0613
1983	0.0979	0.1208	0.0692	0.0652	0.0510	0.1483	0.0853	0.0028	0.3535	0.0519	0.1247	0.1015
1984	0.0653	0.0345	0.0194	0.0630	0.1216	0.0057	0.1993	0.0474	0.0197	0.0859	0.0896	0.1194
1985	0.0558	0.0606	0.0861	0.1115	0.1356	0.0516	0.0083	0.0190	0.0065	0.1949	0.0491	0.1035
1986	0.1331	0.0698	0.0801	0.1300	0.1357	0.0941	0.0432	0.1691	0.0402	0.0545	0.1592	0.0392
1987	0.0265	0.0209	0.1145	0.0752	0.1098	0.2003	0.2280	0.2294	0.1707	0.1221	0.1057	0.0123
1989	0.0979	0.1408	0.0425	0.0868	0.1294	0.1567	0.0151	0.0398	0.0301	0.0120	0.1113	0.0471
1990	0.1263	0.0329	0.1130	0.0784	0.0802	0.0828	0.0072	0.0083	0.0596	0.1287	0.1102	0.0574
1992	0.0226	0.0007	0.0677	0.1292	0.0747	0.0012	0.0386	0.0332	0.0315	0.0169	0.1078	0.0275
1993	0.0441	0.1149	0.1092	0.0964	0.0948	0.0209	0.0505	0.0567	0.0524	0.0314	0.0524	0.0814
1994	0.0682	0.0094	0.0189	0.1350	0.0423	0.0244	0.0533	0.0384	0.0226	0.0594	0.0114	0.1002
1995	0.0697	0.1213	0.1260	0.1136	0.0596	0.1063	0.0639	0.1774	0.0853	0.1011	0.0369	0.1204
1996	0.0942	0.0558	0.0570	0.1288	0.0790	0.0669	0.1125	0.0669	0.0003	0.0318	0.1804	0.0834
1997	0.0297	0.0955	0.0195	0.0701	0.1044	0.1961	0.0212	0.0090	0.0376	0.1032	0.1319	0.1056
1998	0.0750	0.0876	0.0807	0.0392	0.0081	0.008	0.0295	0.0382	0.0445	0.0254	0.1758	0.1259
1999	0.0967	0.0771	0.0907	0.1883	0.1715	0.1615	0.0604	0.0185	0.1211	0.1318	0.0379	0.0673

Table 2: Weighted sum of the FS statistics of Sun shine duration for Baghdad. (The candidate months of each year are underlined)

	Month											
Year	Jan	Feb	Mar	Aprl	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1971	0.1271	0.0626	0.0655	0.0654	0.0430	0.1199	0.1654	0.0055	0.0101	0.0658	0.0939	0.0115
1972	0.0847	0.1541	0.0469	0.0053	0.0446	0.1425	0.1491	0.2337	0.1114	0.1092	0.1490	0.1371
1973	0.0843	0.1088	0.1389	0.0434	0.1763	0.1108	0.0291	0.0031	0.0020	0.0989	0.1499	0.0804
1974	0.0270	0.1442	0.0379	0.0873	0.1035	0.1115	0.0427	0.0704	0.1822	0.0700	0.1407	0.0337
1975	0.0698	0.0684	0.1958	0.0529	0.0848	0.1132	0.0103	0.0564	0.0915	0.2476	0.1218	0.0214
1976	0.0381	0.0673	0.0646	0.0816	0.1350	0.1490	0.1006	0.0045	0.0877	0.1126	0.0620	0.0247
1977	0.0282	0.1079	0.0187	0.0828	0.0869	0.1237	0.0162	0.0283	0.0044	0.0938	0.1158	0.0512
1978	0.0984	0.1515	0.0591	0.1080	0.1190	0.1241	0.0008	0.0853	0.0123	0.0074	0.1516	0.1339
1979	0.1322	0.1308	0.0592	0.0102	0.0251	0.1273	0.1429	0.0928	0.1031	0.1065	0.1230	0.0881
1980	0.1224	0.0504	0.0833	0.0725	0.1838	0.1090	0.1034	0.0707	0.1493	0.1544	0.1072	0.0782
1981	0.0554	0.0968	0.1442	0.0698	0.0847	0.2437	0.1121	0.0645	0.0446	0.0888	0.1268	0.0775
1982	0.0105	0.0683	0.0878	0.0481	0.0381	0.0529	0.0204	0.0147	0.0203	0.1167	0.1378	0.0730
1983	0.1317	0.0920	0.0563	0.0720	0.0585	0.1933	0.0749	0.1360	0.2278	0.1186	0.0896	0.0832
1984	0.1230	0.0859	0.0381	0.0719	0.0747	0.1985	0.1488	0.0559	0.0150	0.0961	0.0597	0.1201
1985	0.1150	0.1533	0.0974	0.1332	0.0811	0.0980	0.0205	0.0366	0.0090	0.1393	0.1442	0.1115
1986	0.1361	0.0678	0.1253	0.0070	0.1416	0.1466	0.0534	0.0241	0.0065	0.0880	0.0690	0.0825
1987	0.0995	0.0216	0.0412	0.0343	0.0484	0.0916	0.1453	0.0778	0.1078	0.0792	0.1276	0.0560
1988	0.1349	0.0873	0.0183	0.0893	0.1095	0.0466	0.0848	0.1363	0.1412	0.0595	0.1993	0.0998
1989	0.1308	0.0877	0.0943	0.2437	0.0873	0.1400	0.0328	0.00035	0.0507	0.0897	0.1113	0.0182
1990	0.0254	0.0231	0.0764	0.0509	0.0707	0.0166	0.0173	0.0016	0.0213	0.1455	0.0474	0.0262
1992	0.0180	0.0026	0.0952	0.0778	0.0559	0.0682	0.0837	0.0968	0.0644	0.0954	0.0279	0.0654
1993	0.1958	0.1266	0.1333	0.0594	0.0124	0.0079	0.1453	0.0266	0.0431	0.1806	0.1574	0.0698
1994	0.1175	0.0701	0.0909	0.1350	0.1965	0.1247	0.2769	0.3113	0.1577	0.0700	0.0645	0.1450
1995	0.1668	0.1381	0.0651	0.0223	0.1008	0.2393	0.0607	0.0304	0.0225	0.2393	0.1753	0.1282
1996	0.0225	0.0305	0.0063	0.1217	0.0527	0.2446	0.1870	0.0190	0.0617	0.3202	0.1617	0.0015
1997	0.1040	0.2094	0.0471	0.0927	0.1025	0.2437	0.0838	0.0073	0.0911	0.0936	0.1116	0.1389
1998	0.0655	0.0763	0.0939	0.0852	0.0642	0.0307	0.0527	0.0793	0.0365	0.0857	0.1573	0.0561
1999	0.0784	0.1113	0.0374	0.1322	0.1707	0.1412	0.1505	0.0816	0.2485	0.0682	0.1201	0.0044
2000	0.0889	0.1799	0.1146	0.0159	0.1095	0.0850	0.0523	0.0535	0.1293	0.1396	0.0908	0.0420

Table 3: Weighted sum of the FS statistics of Mean air temperature for Baghdad. (The candidate months of each year are underlined)

	Month											
Year	Jan	Feb	Mar	Aprl	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1971	0.0152	0.0048	0.0276	0.0465	0.0343	0.0177	0.0078	0.0044	0.0311	0.0523	0.0055	0.0360
1972	0.0299	0.0159	0.0207	0.0135	0.0017	0.0048	0.0120	0.0162	0.0407	0.0401	0.0820	0.0321
1973	0.0094	0.0314	0.0069	0.0016	0.0137	0.0198	0.0164	0.0083	0.0059	0.0153	0.0462	0.0156
1974	0.0373	0.0050	0.0225	0.0201	0.0471	0.0235	0.0111	0.0327	0.0189	0.0172	0.0031	0.0023
1975	0.0076	0.0137	0.0488	0.0196	0.0287	0.0134	0.0092	0.0129	0.0466	0.0236	0.0305	0.0021
1976	0.0258	0.0629	0.0354	0.0085	0.0317	0.0133	0.0373	0.0439	0.0172	0.0427	0.0499	0.0098
1977	0.0017	0.0140	0.0174	0.0515	0.0019	0.0199	0.0170	0.0804	0.0130	0.0079	0.0155	0.0245
1978	0.0132	0.0232	0.0203	0.0435	0.0052	0.0145	0.0047	0.0208	0.0371	0.0370	0.0272	0.0318
1979	0.0374	0.0485	0.0322	0.0196	0.0067	0.0101	0.0159	0.0161	0.0286	0.0255	0.0413	0.0326
1980	0.0277	0.0609	0.0013	0.0226	0.0103	0.0164	0.0326	0.0213	0.0184	0.0020	0.0351	0.0119
1981	0.0113	0.0260	0.0955	0.0013	0.0012	0.0293	0.0200	0.1595	0.0281	0.0368	0.0012	0.0051
1982	0.0295	0.0108	0.0146	0.0536	0.0108	0.0134	0.0034	0.0397	0.0033	0.0146	0.0390	0.0257
1983	0.0108	0.0360	0.0212	0.0249	0.0066	0.0076	0.0227	0.0447	0.0173	0.0384	0.0349	0.0475
1984	0.0221	0.0250	0.0227	0.0048	0.0552	0.0614	0.0019	0.0362	0.0076	0.0456	0.0372	0.0059
1985	0.0305	0.0485	0.1219	0.0219	0.0200	0.0225	0.0189	0.0110	0.0122	0.0344	0.0362	0.0151
1986	0.0427	0.0145	0.0229	0.0210	0.0166	0.0839	0.0050	0.0371	0.0073	0.0114	0.0427	0.0441
1987	0.0629	0.0293	0.0815	0.0099	0.0051	0.0009	0.1099	0.0390	0.0327	0.0136	0.0329	0.0390
1988	0.0140	0.0179	0.0246	0.0345	0.0247	0.0549	0.1415	0.2129	0.1466	0.0444	0.0148	0.0809
1989	0.0317	0.0166	0.0199	0.0466	0.0370	0.0170	0.0031	0.0504	0.0524	0.0062	0.0056	0.0420
1990	0.0019	0.0243	0.0025	0.0268	0.0555	0.0237	0.0130	0.0293	0.0079	0.0037	0.0667	0.0410
1991	0.0439	0.0213	0.0136	0.0134	0.0804	0.0290	0.0255	0.0467	0.0139	0.0429	0.0178	0.0129
1992	0.0562	0.0182	0.0417	0.0234	0.0672	0.0185	0.0232	0.0076	0.0059	0.0290	0.0879	0.0621
1993	0.0401	0.0293	0.0804	0.0274	0.0529	0.0066	0.0256	0.0131	0.0037	0.1062	0.0027	0.0293
1994	0.0214	0.0418	0.0083	0.0391	0.0080	0.0174	0.0452	0.0342	0.0366	0.0016	0.0248	0.0109
1995	0.0393	0.0707	0.0635	0.0137	0.0055	0.0452	0.0141	0.0426	0.0297	0.0561	0.0342	0.0175
1996	0.0542	0.0475	0.0444	0.0104	0.0060	0.0094	0.0254	0.0075	0.0131	0.0149	0.0415	0.0185
1997	0.0115	0.0147	0.0312	0.0081	0.0348	0.0073	0.0372	0.0038	0.0118	0.0175	0.0461	0.0352
1998	0.0404	0.0353	0.0414	0.0081	0.0100	0.0179	0.0100	0.0360	0.0181	0.0053	0.0393	0.0382
1999	0.0039	0.0356	0.0123	0.0490	0.0018	0.0368	0.0148	0.0062	0.0235	0.0121	0.1860	0.0243
2000	0.0443	0.0229	0.0196	0.0351	0.0674	0.0323	0.0605	0.0492	0.2648	0.0336	0.0244	0.0369

Table 4: Weighted sum of the FS statistics of Minimum Temperature for Baghdad. (The candidate months of each year are underlined)

	Month											
Year	Jan	Feb	Mar	Aprl	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1971	0.8046	0.8238	0.8178	0.8244	0.8664	0.8463	0.8415	0.8565	0.8639	0.8094	0.8889	0.8260
1972	0.8859	0.8168	0.8968	0.8297	0.8502	0.8485	0.8408	0.8309	0.8799	0.8545	0.7725	0.8517
1973	0.1060	0.0167	0.0202	0.0116	0.0386	0.0110	0.0007	0.0439	0.0275	0.0007	0.0689	0.0103
1974	0.0622	0.0028	0.0858	0.0907	0.0015	0.0512	0.0081	0.0538	0.0459	0.0226	0.0714	0.0852
1975	0.0788	0.0145	0.0121	0.0232	0.0092	0.0052	0.0393	0.0139	0.0245	0.0054	0.0206	0.0583
1976	0.0579	0.0884	0.0081	0.0529	0.0001	0.0255	0.0847	0.0004	0.0061	0.0011	0.0014	0.0187
1977	0.0324	0.0326	0.0437	0.0249	0.0139	0.0384	0.0137	0.0289	0.0514	0.0424	0.0162	0.0237
1978	0.0014	0.1384	0.0809	0.0389	0.0387	0.0185	0.0433	0.0622	0.0505	0.0905	0.0905	0.0254
1979	0.0172	0.0035	0.0206	0.0163	0.0004	0.0554	0.0234	0.0303	0.0037	0.0260	0.0198	0.0851
1980	0.0717	0.0237	0.0140	0.0223	0.0127	0.0269	0.0247	0.0418	0.0038	0.0637	0.0016	0.0981
1981	0.0970	0.0068	0.0132	0.0806	0.0098	0.0770	0.0560	0.1375	0.0754	0.0503	0.0710	0.0649
1982	0.0183	0.0150	0.0181	0.0036	0.0088	0.0169	0.0315	0.0409	0.0283	0.0029	0.0064	0.0019
1983	0.0459	0.0034	0.0063	0.0643	0.0272	0.0182	0.0014	0.0013	0.0160	0.0630	0.0300	0.0192
1984	0.0596	0.0202	0.0470	0.0011	0.0619	0.1209	0.0127	0.0348	0.0607	0.0549	0.0320	0.0351
1985	0.0569	0.0112	0.0348	0.0213	0.0388	0.0310	0.0270	0.0317	0.0130	0.0115	0.0126	0.0506
1986	0.0176	0.0035	0.0051	0.0168	0.0569	0.0283	0.0233	0.0602	0.0388	0.0042	0.0525	0.0569
1987	0.0446	0.0046	0.0012	0.0325	0.0017	0.0571	0.2337	0.0061	0.0320	0.0956	0.0409	0.0809
1988	0.0861	0.0796	0.0186	0.0384	0.0629	0.0144	0.0413	0.0165	0.0464	0.0239	0.0395	0.0695
1989	0.8799	0.0956	0.0549	0.0380	0.0202	0.0414	0.0509	0.0215	0.0468	0.0034	0.0112	0.0339
1990	0.0248	0.0469	0.0268	0.0809	0.0092	0.0591	0.0003	0.1167	0.0225	0.0102	0.0102	0.0185
1991	0.0550	0.0319	0.0488	0.0151	0.0145	0.0227	0.0180	0.0415	0.0260	0.0213	0.0569	0.0247
1992	0.0222	0.0330	0.0173	0.0373	0.0176	0.0019	0.0277	0.0034	0.0024	0.0079	0.0364	0.0037
1993	0.0619	0.0418	0.0637	0.0160	0.0404	0.0298	0.0284	0.0166	0.0242	0.0431	0.0199	0.0569
1994	0.0103	0.0254	0.0058	0.0337	0.0131	0.0287	0.0097	0.0029	0.0305	0.0202	0.0392	0.0640
1995	0.0209	0.0089	0.0076	0.0005	0.0161	0.0163	0.0245	0.0574	0.0467	0.0183	0.0115	0.0015
1996	0.0746	0.0056	0.0051	0.0722	0.0878	0.0672	0.0015	0.0171	0.0197	0.0027	0.1115	0.0515
1997	0.0335	0.0359	0.0170	0.0388	0.0144	0.0478	0.0168	0.0116	0.0070	0.0380	0.0807	0.0672
1998	0.0066	0.0159	0.0289	0.0243	0.0226	0.0084	0.0472	0.0652	0.0550	0.0450	0.0915	0.0450
1999	0.0365	0.0035	0.0157	0.0634	0.0114	0.0304	0.0038	0.0339	0.0374	0.0414	0.0140	0.0314
2000	0.0340	0.0106	0.0269	0.0301	0.0266	0.0986	0.0514	0.0931	0.0551	0.0049	0.0539	0.0201

Table 5: Weighted sum of the FS statistics of Maximum Temperature for Baghdad. (The candidate months of each year are underlined)

	Month											
Year	Jan	Feb	Mar	Aprl	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1971	0.0291	0.0136	0.0174	0.0487	0.0214	0.0706	0.0065	0.0175	0.0457	0.0042	0.0480	0.0143
1972	0.0071	0.0351	0.0383	0.0354	0.0374	0.0186	0.0289	0.0022	0.0040	0.0848	0.0884	0.0129
1973	0.0389	0.0250	0.0248	0.0088	0.0037	0.0482	0.0393	0.0247	0.0145	0.0311	0.0428	0.0077
1974	0.0057	0.0138	0.0352	0.0178	0.0422	0.0467	0.0081	0.0056	0.0086	0.0500	0.0545	0.0131
1975	0.0842	0.0511	0.0143	0.0224	0.0003	0.0690	0.0172	0.0200	0.0271	0.0660	0.1148	0.0008
1976	0.0391	0.0035	0.0140	0.0031	0.0028	0.0057	0.0375	0.0541	0.0159	0.0509	0.0919	0.0154
1977	0.0243	0.0548	0.0013	0.0193	0.0117	0.0220	0.0878	0.0356	0.0029	0.0262	0.0804	0.0300
1978	0.0338	0.0277	0.0534	0.0282	0.0213	0.0157	0.0033	0.0061	0.0855	0.0098	0.0249	0.0341
1979	0.0218	0.0139	0.0182	0.0086	0.0179	0.0021	0.0100	0.0383	0.0200	0.0338	0.0689	0.0267
1980	0.0277	0.0609	0.0004	0.0226	0.0103	0.0164	0.0326	0.0213	0.0184	0.0020	0.0351	0.0119
1981	0.0174	0.0075	0.0986	0.0068	0.0303	0.0569	0.0225	0.0984	0.0531	0.0534	0.0586	0.0619
1982	0.0427	0.0318	0.0361	0.0377	0.0182	0.0044	0.0044	0.0445	0.0204	0.0134	0.0233	0.0269
1983	0.0183	0.0072	0.0347	0.0016	0.0103	0.0108	0.0437	0.0380	0.0073	0.0177	0.0410	0.0449
1984	0.0312	0.0392	0.0522	0.0520	0.0077	0.0408	0.0369	0.0354	0.0236	0.0394	0.0267	0.0054
1985	0.0096	0.0169	0.0157	0.0291	0.0044	0.0468	0.0462	0.0282	0.0059	0.0165	0.0160	0.0511
1986	0.1240	0.0041	0.0192	0.0071	0.0102	0.0387	0.0325	0.0002	0.0334	0.0393	0.0082	0.0545
1987	0.0396	0.0158	0.0018	0.0166	0.0236	0.0279	0.0392	0.0203	0.0322	0.0134	0.0213	0.0175
1988	0.0182	0.0117	0.0073	0.0541	0.0348	0.0134	0.0233	0.0983	0.0271	0.0983	0.0241	0.0241
1989	0.0140	0.0250	0.0509	0.0482	0.0408	0.0915	0.0434	0.0315	0.0410	0.0298	0.0343	0.0455
1990	0.0406	0.0096	0.0470	0.0385	0.0305	0.0062	0.0382	0.0376	0.0142	0.0166	0.0066	0.0085
1991	0.0892	0.0110	0.0278	0.0489	0.0231	0.0496	0.0162	0.0166	0.0482	0.0226	0.0367	0.0109
1992	0.0034	0.0412	0.0566	0.0395	0.0180	0.0465	0.0142	0.0328	0.0218	0.0015	0.0606	0.0326
1993	0.0375	0.0534	0.0383	0.0656	0.0273	0.0069	0.0448	0.0313	0.0109	0.1324	0.0823	0.0025
1994	0.0088	0.0253	0.0123	0.0138	0.0423	0.0241	0.0201	0.0271	0.0983	0.0237	0.0136	0.0094
1995	0.0106	0.0279	0.0302	0.0116	0.0085	0.0296	0.0292	0.0104	0.0070	0.0348	0.0810	0.0338
1996	0.0061	0.0031	0.0193	0.0105	0.0291	0.0581	0.0125	0.0010	0.0108	0.0050	0.0420	0.0062
1997	0.0787	0.0234	0.0211	0.0329	0.0243	0.0167	0.0283	0.0094	0.0360	0.0174	0.0387	0.0326
1998	0.0098	0.0123	0.0327	0.0110	0.0515	0.0472	0.0057	0.0054	0.0221	0.0323	0.0359	0.0241
1999	0.0535	0.0351	0.0183	0.0240	0.00821	0.0061	0.0482	0.0252	0.0816	0.0419	0.0917	0.0207
2000	0.0645	0.0024	0.0101	0.0561	0.0587	0.0374	0.0736	0.1319	0.3634	0.0060	0.0861	0.0028

Table 6: Weighted sum of the FS statistics of Relative humidity for Baghdad. (The candidate months of each year are underlined)

	Month											
Year	Jan	Feb	Mar	Aprl	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1975	0.0589	0.0078	0.0380	0.0466	0.0301	0.0451	0.0419	0.0459	0.0576	0.0107	0.0499	0.0409
1976	0.0275	0.0087	0.0108	0.0475	0.1181	0.0106	0.0083	0.0501	0.0011	0.0092	0.0357	0.1043
1977	0.0790	0.0290	0.0263	0.0046	0.0176	0.0141	0.0105	0.0596	0.0424	0.0832	0.0490	0.0404
1978	0.0553	0.0515	0.0174	0.0753	0.0158	0.0469	0.0749	0.0279	0.0450	0.0171	0.0578	0.0218
1979	0.0311	0.0147	0.0068	0.0412	0.0224	0.0125	0.0478	0.0905	0.0475	0.0512	0.0643	0.0160
1980	0.0488	0.0532	0.0634	0.0426	0.0629	0.0149	0.0081	0.0303	0.0238	0.0863	0.1087	0.0501
1981	0.0861	0.0796	0.0186	0.0384	0.0049	0.0144	0.0413	0.0069	0.0064	0.0239	0.0395	0.0695
1982	0.0563	0.0840	0.0161	0.0359	0.0354	0.0818	0.0107	0.0927	0.0244	0.1073	0.0224	0.0623
1983	0.0099	0.0288	0.0288	0.0085	0.0908	0.0363	0.0873	0.0093	0.0210	0.1179	0.0423	0.0371
1984	0.0520	0.0558	0.0138	0.0398	0.0306	0.0256	0.0315	0.0227	0.0505	0.0462	0.0292	0.0549
1985	0.0194	0.0057	0.0734	0.0481	0.0063	0.0835	0.0388	0.0739	0.0173	0.0170	0.0262	0.0098
1986	0.0089	0.0636	0.0032	0.0690	0.0422	0.0351	0.0134	0.0291	0.0179	0.0307	0.0348	0.0315
1987	0.0501	0.0181	0.0107	0.0087	0.0130	0.0490	0.0148	0.0158	0.0298	0.0841	0.0842	0.1201
1988	0.0327	0.0275	0.0359	0.0237	0.0362	0.0174	0.0073	0.0057	0.0705	0.0261	0.0491	0.0548
1989	0.0095	0.0146	0.0152	0.0298	0.1489	0.0371	0.0405	0.0084	0.0006	0.0415	0.0126	0.1169
1990	0.0566	0.0420	0.0356	0.0475	0.0344	0.0590	0.0605	0.0721	0.0402	0.0921	0.1179	0.0353
1991	0.0052	0.0307	0.0733	0.0812	0.0645	0.0341	0.0423	0.0021	0.0036	0.0750	0.0077	0.0439
1992	0.0291	0.0356	0.0657	0.0038	0.0516	0.0698	0.0605	0.0323	0.0630	0.0832	0.0275	0.0414
1993	0.0249	0.0776	0.0024	0.0290	0.0164	0.0036	0.0523	0.0031	0.0177	0.0391	0.1006	0.0160
1994	0.0154	0.0126	0.0816	0.0062	0.0536	0.0947	0.0408	0.0557	0.0460	0.0460	0.0396	0.0601
1995	0.0589	0.0078	0.0379	0.0466	0.0301	0.0451	0.0420	0.0458	0.0577	0.0107	0.0499	0.0408
1996	0.0275	0.0087	0.0108	0.0475	0.1181	0.0106	0.0083	0.0501	0.0011	0.0199	0.0357	0.1043
1997	0.0790	0.0290	0.0263	0.0079	0.0176	0.0141	0.0105	0.0596	0.0424	0.0832	0.0490	0.0404
1998	0.0553	0.0515	0.0174	0.0753	0.0158	0.0469	0.0749	0.0279	0.0450	0.0171	0.0578	0.0218
1999	0.0312	0.0147	0.0078	0.0412	0.0224	0.0126	0.0478	0.0905	0.0474	0.0512	0.0643	0.0160
2000	0.0488	0.0532	0.0634	0.0426	0.0026	0.0149	0.0081	0.0303	0.0238	0.0863	0.1087	0.0501

Table 7: The weight factors for each meteorological parameter considered in present study

Parameter	Solar Radiation	Sun Shine Duration	Mean Air Temperature	Maximum Air Temperature	Minimum Air Temperature	Relative Humidity
Weights	0.276	0.248	0.085	0.098	0.186	0.107

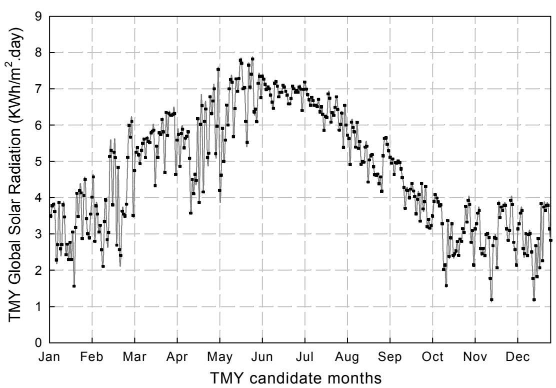

Fig. 7: Annual variation of TMY values of global solar radiation for the whole period of 27 years.

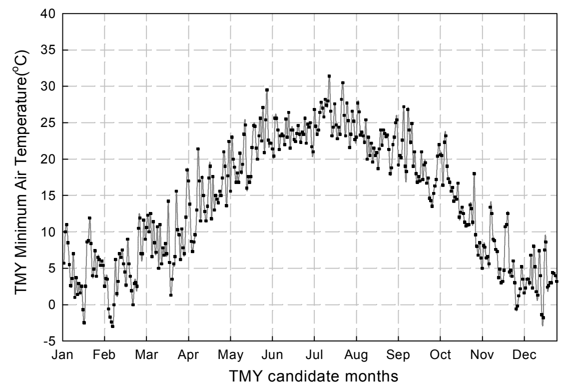

Fig. 10: Annual variation of TMY values of minimum air temperature for the whole period of 30 years.

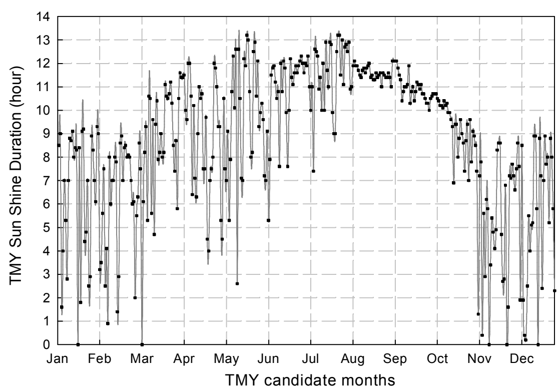

Fig. 8: Annual variation of TMY values of sunshine duration for the whole period of 29 years.

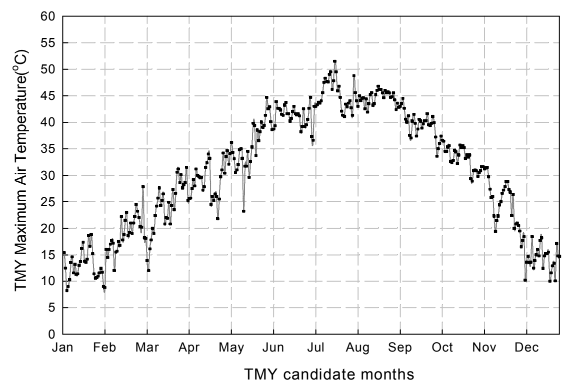

Fig. 11: Annual variation of TMY values of maximum air temperature for the whole period of 30 years.

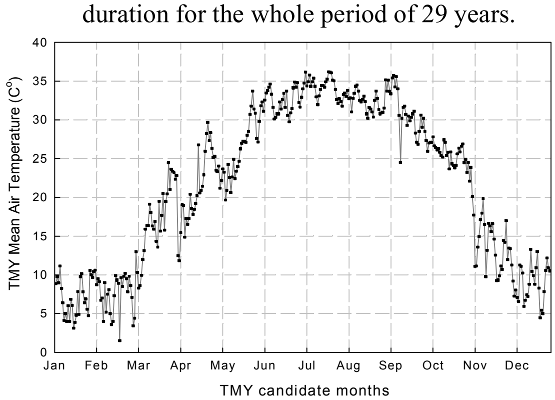

Fig. 9: Annual variation of TMY values of mean air temperature for the whole period of 30 years.

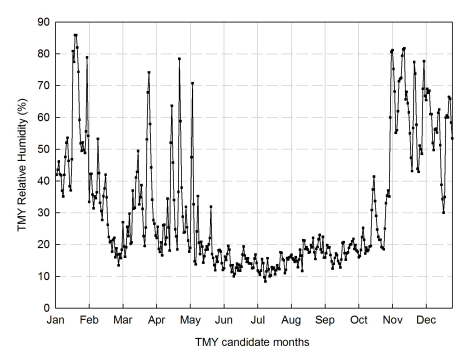

Fig. 12: Annual variation of TMY values of relative humidity for the whole period 26 years.

radiation in other stations which there are no solar radiation measurements available. The resulted TMY data for the solar radiation (kwh/m^2.day), sunshine duration (h), mean air temperature (°C), minimum air temperature (°C), Maximum air temperature (°C) and relative humidity (%) are presented in Figures 7-12, respectively.

Finally the values of month of the 30 years period where calculated to conform the weights for each meteorological elements and the results are shown in Table 7. It was seen that with TMY using Filkenstein-Schafer (FS) static's the solar radiation and sunshine duration have the heights score among the considered meteorological parameters (0.276 kwh/m^2.day for solar radiation and 0.248 h for sunshine duration) and this result indicated that the solar radiation and sunshine duration became the key parameter while the mean, minimum, maximum air temperature and relative humidity became less priority parameters.

CONCLUSION

The generation of the TMY for any location is very important for the solar energy calculation, many applications of thermal engineering and building energy analysis. In present study, a Typical Meteorological Year for six previously mentioned parameters for Baghdad province using at least 26 years measured data and presented throughout year in a graphical form, the solar radiation and sunshine duration play the dominant role in the general situation of the weather.

It is expected that the presented TMY data set for Baghdad will be useful to the designers of solar energy systems, Architects, Urban planning specialist and energy experts.

REFERENCES

1. Ecevit, A., B. Akinoglu and B. Aksoy, 2002. Generation of a typical meteorological year using sunshine duration data. Energy, 27(10): 947-954.
2. Crawley, D.B. and Y.J. Huang, 1997. Does it matter which weather data you use in energy simulations. User News, 18(1): 2-12.
3. Rahman, I.A. and J. Dewsbury, 2007. Selection of typical weather data (test reference years) for Subang, Malaysia. Building and Environment, 42(10): 3636-3641.
4. Hall, I.J., R.R. Prairie, H.E. Anderson and E.C. Boes, 1978. Generation of Typical Meteorological Years for 26 SOLMET stations. Sandia Laboratories Report, Albuquerque, New Mexico,. SAND, pp: 78-1601.
5. Pissimanis, D., G. Karras, V. Notaridou and K. Gavra, 1988. The generation of a "typical meteorological year" for the city of Athens. Solar Energy, 40(5): 405-411.
6. Said, S. and H. Kadry, 1994. Generation of representative weather-year data for Saudi Arabia. Applied Energy, 48(2): 131-136.
7. Al-Hinai, H. and S. Al-Alawi, 1995. Typical solar radiation data for Oman. Applied Energy, 52(2): 153-163.
8. Petrakis, M., S. Lykoudis and P. Kassomenos, 1996. A software tool for the creation of a typical meteorological year. Environmental Software, 11(4): 221-227.
9. Petrakis, M., H. Kambezidis, S. Lykoudis, A. Adamopoulos, P. Kassomenos, I. Michaelides, S. Kalogirou, G. Roditis, I. Chrysis and A. Hadjigianni, 1998. Generation of a "typical meteorological year" for Nicosia, Cyprus. Renewable Energy, 13(3): 381-388.
10. Argiriou, A., S. Lykoudis, S. Kontoyiannidis, C.A. Balaras, D. Asimakopoulos, M. Petrakis and P. Kassomenos, 1999. Comparison of methodologies for TMY generation using 20 years data for Athens, Greece. Solar Energy, 66(1): 33-45.
11. Bulut, H., 2003. Generation of typical solar radiation data for Istanbul, Turkey. International Journal of Energy Research, 27(9): 847-855.
12. Kalogirou, S.A., 2003. Generation of typical meteorological year (TMY-2) for Nicosia, Cyprus. Renewable Energy, 28(15): 2317-2334.
13. Bulut, H., 2004. Typical solar radiation year for southeastern Anatolia. Renewable Energy, 29(9): 1477-1488.
14. Skeiker, K., 2004. Generation of a typical meteorological year for Damascus zone using the Filkenstein–Schafer statistical method. Energy Conversion and Management, 45(1): 99-112.
15. Bilbao, J., A. Miguel, J.A. Franco and A. Ayuso, 2004. Test Reference Year Generation and Evaluation Methods in the Continental Mediterranean Area. Journal of Applied Meteorology, 43(2): 390-400.
16. Zhang, Q., 2006. Development of the typical meteorological database for Chinese locations. Energy and Buildings, 38(11): 1320-1326.
17. Skeiker, K., 2007. Comparison of methodologies for TMY generation using 10 years data for Damascus, Syria. Energy conversion and Management, 48(7): 2090-2102.
18. Chaiyapinunt, S. and K. Mangkornsaksit, 2001. Standard meteorological data for Bangkok. Journal of Energy Heat and Mass Transfer, 23(1): 23-38.
19. Finkelstein, J.M. and R.E. Schafer, 1971. Improved goodness-of-fit tests. Biometrika, 58(3): 641-645.
20. Townsend, T.U., 1989. A method for estimating the long-term performance of direct-coupled photovoltaic systems, 1989, UNIVERSITY OF WISCONSIN.

Persian Abstract

DOI: 10.5829/idosi.ijee.2014.05.01.12

چکیده

اطلاعات هواشناسی سال به سال در حال تغییر می باشد، بنابر این ایجاد اطلاعات یک سال هواسنجی نوعی (TMY) برای نمایش مجموع اطلاعات هواشناسی بلند مدت ضروری می باشد که بعنوان ورودی در مدلسازی، طراحی و ارزیابی عملکرد و محاسبات موازنه انرژی بسیار مهم می باشد. در مطالعه حاضر روش آماری فینکلشتاین-شافر برای آنالیز اطلاعات هواشناسی جمع آوری شده در یک دوره ۳۰ ساله (۲۰۰۰-۱۹۷۱) برای استان بغداد به کار گرفته شد، که شامل ۶ پارامتر هواسنجی اساسی (تشعشع خورشیدی جهانی، مدت تابش آفتاب، حداکثر، حداقل و میانگین دما، رطوبت نسبی) می باشد. ماههای هواسنجی نوعی از دوره سالهای در نظر گرفته شده با استفاده از کمترین انحراف (FS) نسبت به بلند مدت یک TMY برای استان بغداد انتخاب شدند.