Methodology for Assessment of the Potential of Photovoltaic Electricity Production in the Non-residential Areas of Tunisia

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Abstract

For large projects, further analysis of the solar resource is needed to better assess the production of electricity. This in-depth analysis must take into account seasonal variations that alter the average monthly values of sunshine. We use the ArcGIS software to map the solar energy potential of each region of Tunisia to know the solar potential very specifically of each location, we study the solar potential in 1300 different points from the map of Tunisia. The sunshine data comes from the European program PVGISF. The places in which we can install photovoltaic solar panels, there is no consensus method to estimate this value. In this paper, new method proposed to estimate the virgin spaces in each region of Tunisia. the proposed method is to study the geographical characteristics of Tunisia. After estimating the areas. Using PVsol, we simulated and calculated the total electrical potential that aims to produce from all of the estimated areas.

Key words: Tunisia, Non-residential Areas, PV Electricity Production, regions, solar potential

1. Introduction

The photovoltaic (PV) effect used in solar cells used to directly convert light energy of sunlight into electricity. Depending on geographic location and equipment performance solar energy appears to be the energy of the future, given the role it can play in countries like Tunisia, receiving a relatively strong insolation, about 3000 hours of sunshine per year [1] and an average daily global radiation of 5 kWh / m2. [2]

A significant portion of Tunisia's electricity can be produced either by large utility-scale solar power stations or with small, distributed solar power systems. In 2010, the Tunisian government launched the program "PROSOL-Elec" to support the development of solar PV grid connected in the residential sector. This program is based on financial incentives supplemented by a credit rate improved. Production of photovoltaic system reduces household energy bills. Surplus production is injected into the network. Since the implementation of the program, the installed capacity of 2.6 MWp. [3]

In this connection and to help support this project and its development the purpose of our study is to estimate the potential of photovoltaic electricity production in the non-residential areas of Tunisia. For large projects, further analysis of the solar resource is needed to better assess the production of electricity. This in-depth analysis must take into account seasonal variations that alter the average monthly values of sunshine. Seasonal fluctuations mainly reflected the following mechanisms: the inclination of the sun, albedo, climate effects, attenuation of light rays by the atmosphere, temperature ... In this context, we use the ArcGIS software to map the solar energy potential of each region of Tunisia (24 regions) to know the solar potential of each location and calculate very

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specifically the amount of energy that can be produced. The sunshine and temperature data for meteorological basis come from the European program PVGIS (Photovoltaic Geographical Information System).

The places in which we can install photovoltaic solar panels, there is no consensus method to estimate this value. In this analysis, we present a new method to estimate the virgin spaces in each region of Tunisia, which can supporter of photovoltaic stations. This method is to study the geographical characteristics of Tunisia and in each region we should eliminate the agricultural areas, the mountainous terrain, Natural Reserves, Lakes and rivers, private property, the border areas and All that contrasts with the land laws of Tunisia. After estimating the areas in which we would like to install the photovoltaic station. with the assistance of PVsol program, we calculated the total electrical potential that aims to produce from all of the estimated areas.

2. Solar energy potential of Tunisia

In order to know the solar output from one place, to calculate very specific amount of energy that can be produced, to simplify the production of feasibility study and planning of photovoltaic systems. We presented a mapping of solar energy potential of Tunisia.

2.1. Methodologies and Tools

The work of the cartographer is a work consisting of several stages. The first step, we obtained the map of Tunisia with the help of GADMEI (Global Administrative Areas) [4] is a spatial database of the rental of the world's administrative areas that it provides us spatial data of Tunisia beneath the form of a digital map, usable by the programs in the field of GIS (geographic information Systems). the maps are free and downloadable from the internet.
The second stage, in the ArcGIS interface we created a map of points (1300 points) on the X and Y fields contains the coordinates of latitude and longitude respectively. At first we chose a spread points with interval of 12 minutes of X and Y. Then, we added a random set of points in the empty spaces as shown in Figure 1.

The third phase, in order to compile the data of sunshine (Hh: Irradiation on a horizontal plane, Hopt: Irradiation of a plan with the optimal tilt, DNI: direct normal irradiation and Iopt: optimal tilt) we adopted the values given by PVGIS online [5]. It must first locate each point (X: longitude, Y: latitude) on Google Maps interface already built into the program and fill in a number of technical information. In the late, a report containing the results is available in three formats (web page, text, or PDF). The results are Compiled in the time interval of 3 to 10 March, 2016.
Finally, the data processing is done with ArcGIS to map all the cards of; the Irradiation on horizontal plane, the Irradiation on optimally inclined plane and the Direct normal irradiation. ArcGIS is able to dispose the variables of Hh, Hopt and DNI in any place of the map of Tunisia not only on the points that we have chosen. This generalization will be through a spatial interpolation "IDW".

2.2. Interpretation of results

The Figures 1 shows respectively the realized mapping of the Tunisian solar energy potential of: The

annual Irradiation on optimally inclined plane (Iop), the annual Irradiation on horizontal plane (Hh) and the annual direct normal irradiation (DNI).

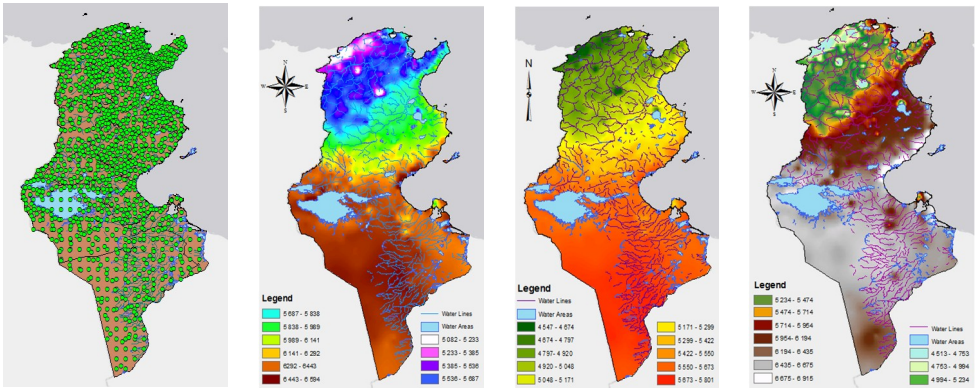

Figure1: The Realized Mapping of the Tunisian Solar Energy Potential

As shown in Figure 1 in connection with Figure 2, the distribution of the Solar energy potential of Tunisia on the various governorates of the region reveals some disparities showing a concentration in the southern governorates. Tunisia has a significant solar resources conducive to the operation of this energy source. Indeed, benefit an Annual Irradiation On Horizontal Plane (Wh/m2/day) exceeding 5700 (Wh/m2/day). Similarly, Tunisia she has an annual irradiation on a plan with the optimal inclination (Hopt) exceeding the 6400 (Wh/m2/day).

Direct normal irradiation is the component of solar irradiation that reaches a surface of the Earth (normal to the direction of the sun) without any atmospheric losses due to scattering or absorption. Tunisia receive annual direct normal irradiation exceeding to 6500 (Wh/m2/day). Regarding the distribution of all potential on the various governorates of the country, it presented in the figure 1:

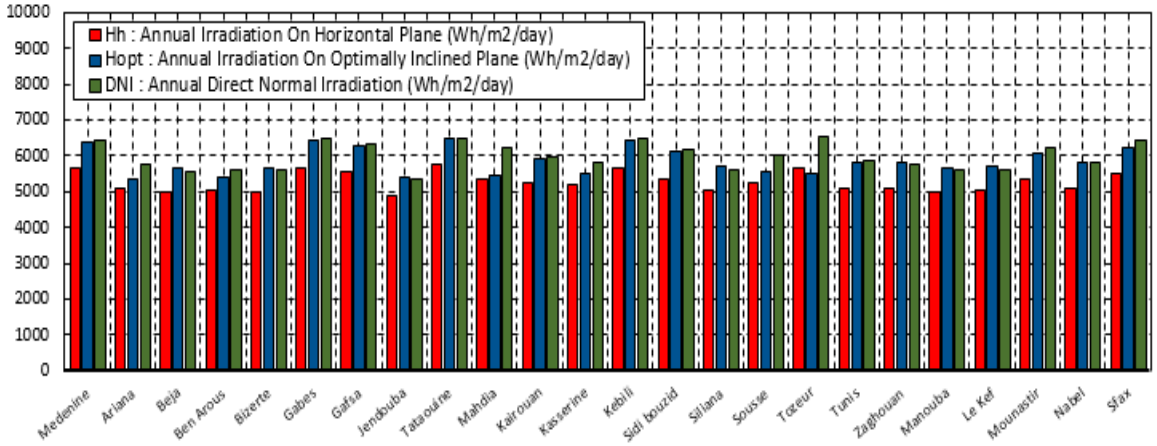

Figure 1: The Distribution of All Potential On the Various Governorates

Optimum angle refers to the angle at which PV modules should be oriented in order to generate maximum electricity. The main parameter influencing optimum angle is latitude. we have provided the Table 1 that grouped: The Monthly Optimum Tilt Angle, the Seasonal Optimum Tilt Angle and

the Annual Optimal Tilt Angle of all Cities of Tunisia.

Table 1: Optimum Angle on the Various Governorates

Cities	Monthly Optimum Tilt Angle (deg)							Seasonal Optimum Tilt Angle (deg)									Annual Optimal Tilt Angle (deg)
	Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Winter*	*Spring*	*Summer*	*Autumn*	
Medenine	58,8	50,8	37,4	21,4	7	0,5	3,1	15,1	31,4	45,8	56,6	60,9	56,8	21,9	5,9	44,6	32,3
Ariana	60,3	52,4	40	24,7	11,9	3,2	7	19	35	48,8	58,7	63	58,5	25,5	9,7	47,5	35,3
Beja	59,7	51,6	39,4	24,1	11,4	3,5	7,2	19	34,5	48,2	58,1	62,1	57,8	24,9	9,9	46,9	34,9
Ben Arous	59,8	51,7	39,4	24	11	3,2	7,1	19	34,3	48,3	58,3	62,3	57,9	24,8	9,7	46,9	34,8
Bizerte	60	52,1	39,9	24,7	11,8	3,9	7,4	19,1	35	48,8	58,4	62,6	58,2	25,4	10,1	47,4	35,3
Gabes	59	51	37,9	22,1	8,2	0,6	4,3	15,9	32	46,4	56,9	61,4	57,1	22,7	6,9	45,1	32,9
Gafsa	59,6	51,7	38,2	22,9	9	1,4	5	16,7	32,8	46,9	57,3	61,8	57,7	23,3	7,7	45,6	33,6
Jendouba	59,2	51,2	39	23,9	11,1	3,5	7,2	19	34,2	47,9	57,6	61,4	57,2	24,6	9,9	46,5	34,6
Tataouine	58,3	50,2	36,5	20,4	5,5	1,5	1,9	14,2	30,4	45	55,8	60,3	56,2	20,8	4,8	43,7	31,4
Mahdia	60	52	39	23,1	9,9	2	5,8	17,4	33,6	47,8	58	62,9	58,3	24	8,4	46,4	34,2
Kairouan	60	51,9	39	23,6	10,4	2,4	6	17,9	33,8	47,8	58	62,7	58,2	24,3	8,7	46,5	34,4
Kasserine	59,6	51,5	38,8	23	10	2,5	6,1	17,4	33,1	47	57,8	61,6	57,5	23,9	8,6	45,9	34
Kebili	58,9	50,9	37,7	21,6	7,5	0	3,5	15,5	31,6	46,1	56,8	61	56,9	22,2	6,3	44,8	32,5
Sidi bouzid	59,8	51,7	38,7	23,1	9,6	2	5,6	17,1	33	47	57,8	61,9	57,8	23,8	8,2	45,9	33,9
Siliana	59,7	51,5	38,9	23,8	10,8	3,2	6,8	18,2	33,9	47,8	57,9	61,9	57,7	24,5	9,4	46,5	34,5
sousse	60,3	52,2	39,4	23,8	10,5	2,5	6,1	18	34	48	58,6	62,9	58,4	24,5	8,8	46,8	34,6
Tozeur	59,6	51,8	38	22,4	8,4	0,8	4,3	16,1	32,1	46,7	57,07	61,9	57,7	22,9	7	45,2	33,2
Tunis	60,4	52,4	40	24,5	11,2	3	7	19	34,9	48,7	58,6	63,2	58,6	25,2	9,6	47,4	35,2
Zaghouan	60	51,9	39	24	10,9	3,1	6,8	18,4	34	48,1	58,5	62,6	58,1	24,6	9,4	46,8	34,7
Manouba	59,8	51,8	39,8	24	12	3,2	7	19	34,7	48,4	58,4	62,8	58,1	25,2	9,7	47,1	35
Le Kef	59	51,7	39	23,9	10,8	3	6,7	18,1	34	48	58	61,9	57,5	24,5	9,2	46,6	34,5
Mounastir	60,2	52,2	39,3	23,8	9,5	2	6	18	34	48	58,4	63	58,4	24,2	8,6	46,8	34,5
Nabel	60,1	52,1	39,7	24,4	11,4	3,4	7	19	34,5	48,3	58,6	62,7	58,3	25,1	9,8	47,1	35,1
Sfax	60	51,9	38,9	23,2	9,5	1,5	5,1	16,9	33	47,1	57,9	62,2	58	23,8	7,8	46	33,9

2.1. Regulatory Aspects and Incentives

Tunisia has established a Tunisian Solar Plan, which integrates all domains of energy efficiency and renewable energy. It has set up since the early 1990s, a specific regulatory framework for energy management. Today, there are several regulations for energy efficiency, for example:

• Law N°: 2009-7 of 9 February 2009 which allows the production of electricity from renewable energies connected to the grid for own consumption [6].

• Decree N°: 2009-362 of 9 February 2009 which sets the bonuses granted by the State to the actions of energy management [7].

• Decree N°: 2009-2773 of 28 September 2009 laying down the conditions of transportation and sale of surpluses to STEG and upper limits of these surpluses. Prices of these sales are set by decision of the Minister in charge of energy [8].

3. Implantation Site Selection

Looking for the best implementation a photovoltaic installation to the ground will still reconcile or harmonize the economic requirements, energetic, technical with the natural issues and the legal controls.

3.1. Site Estimate

The selection of a suitable site is decisive for the installation of photovoltaic systems on the ground. If selection site is good, the likelihood of a lasting negative impact will be minimized. Afterwards, we have indicated the nature of the surfaces of interest for the establishment of a photovoltaic system in Tunisia.

3.1.1. Industrial Park

An industrial park is an area zoned and planned for the purpose of industrial development. Tunisia has a total of 5856,18ha from the industrial areas (existing or planned) distributed by governorate as shown; Ariana: 141ha, Tunis: 495ha, Ben Arous: 1316ha, Zaghouan: 475ha, Manouba: 266,1ha, Nabel: 289,5ha, Bizerte: 154,8ha, Beja: 106ha, Le Kef: 34,5ha, Jendouba: 173,5ha, Siliana: 98ha, Kairouan: 132ha, Mahdia: 94ha, Mounastir: 105ha, Sfax: 188,8ha, Sousse: 256ha, Gabes: 864ha, Medenine: 111ha, Tataouine: 30ha, Sidi Bouzid: 40ha, Gafsa: 241ha, Kassrine: 119ha, Kebili: 31,28ha, Tozeur: 94,7ha [13,14,15,19,21].
The industrial zones currently being marketed; these are the most favorable areas for establishment a photovoltaic system. has bare surfaces to adopt the industrial projects. Tunisia has a total of 306,5ha from The industrial zones currently being marketed. distributed by governorate as shown in Tablo 2.

Table 2: The Industrial Zones Currently Being Marketed

Governorates	Areas (ha)	Prize(DT/m²)
Zaghouan	29	60
Bizerte	8,5	40
Siliana	20	32
Kairouan	8	22
Mahdia	31	35
Sfax	32	45
Sousse	8	30
Gabes	170	30

3.1.2. Bare Soils

Bare Soils in our definition of bare areas, are the untapped zones by the state or by the private sectors. Zones are not classified as: agricultural areas, protected areas or areas with a specific constraint. Using ArcGis and with the help of Atlas geographical maps for all regions of Tunisia [13,14,15,19,21], we measured the total area for the bare areas in Tunisia, distributed by governorate as shown in Table 3. The distribution in the different governorates reveals some disparities showing a concentration of the bare Soils in the governorates of Tataouine, Kebili, Gafsa and Tozeur with a rate of about 98,99% from the total bare soils in Tunisia.

Table 3: The Distribution of the Bare Soils in The Different Governorates

Governorates	Bare Soils (ha)	Governorates	Bare Soils (ha)
Kebili	670000	Medenine	4186
Sidi bouzid	9620	Ariana	200
Siliana	10	Beja	1270
Sousse	0	Ben Arous	0
Tozeur	44100	Bizerte	Unknown
Tunis	560	Gabes	2400
Zaghouan	Unknown	Gafsa	17000
Manouba	10	Jendouba	20
Le Kef	0	Tataouine	2240500
Mounastir	0	Mahdia	40
Nabel	Unknown	Kairouan	18000
Sfax	948	Kasserine	150
Tunisia		3009014	

Other areas are also interest for the development of photovoltaic installations to the ground. These The Military Lands, The Protected Areas and the agricultural land areas, which Present specific constraints.

3.1.3. The Military Lands

Mount Abdel Adhim, Mount Eddouleb, Mount Khchem El Kalb, Mount Tom smida + Dernaya, Mount Teyoucha, Mount Birinou + Lajred, Mount Echaâmbi, Mount Essalloum, Mount Essammama and Mount Mghila of the governorate of Kasserine and Mount Kassar El Glel and Mount Wergha of the governorate of Kef. These areas are identified by the first Article of the presidential decree N°: 2015-120 in 6 July 2015 [9], in the military operations zones and military operations areas fenced up to the end of operations. With the help of ArcGIS program, we can have determined the approximate area of the fenced military zones, it close to 106713ha.

3.1.4. The Protected Areas

Tunisia has a total of 633384ha from the protected areas (17 National Parks and Protected Natural Sites 27) distributed by governorate as shown in Figure 3; Ariana: 300ha, Tunis: 603ha, Ben Arous: 1939ha, Zaghouan: 2024ha, Manouba 0ha, Nabel: 6264, Bizerte, Beja: 23307ha, Le Kef: 3807ha, Jendouba: 11871ha, Siliana, Kairouan: 6415ha, Mahdia 0ha , Mounastir: 0ha, Sfax: 471ha, Sousse: 8000ha, Gabes: 5022ha, Medenine: 6315ha, Tataouine 292750ha, Sidi Bouzid, Gafsa-Kassrine: 47619ha, Kebili: 150000ha, Tozeur: 8000ha [10-11]. National parks covering an area of 541105ha, 85.43% from the total of protected areas in tunisia, against the protected natural sites cover only a 92279ha area with a rate of about 14.56%

The third chapter (Articles 218 and 221) from the Tunisian Forest Code, as remade in 1988 [12], takes into account the first definition of the National Parks, Nature Reserves and recreational drills given by the IUCN (International Union for Conservation Nature) in 1969 during the general assembly in New Delhi [11], where it was territory in which the country's highest authority has taken measures to prevent or eliminate as early as possible any exploitation or occupation.

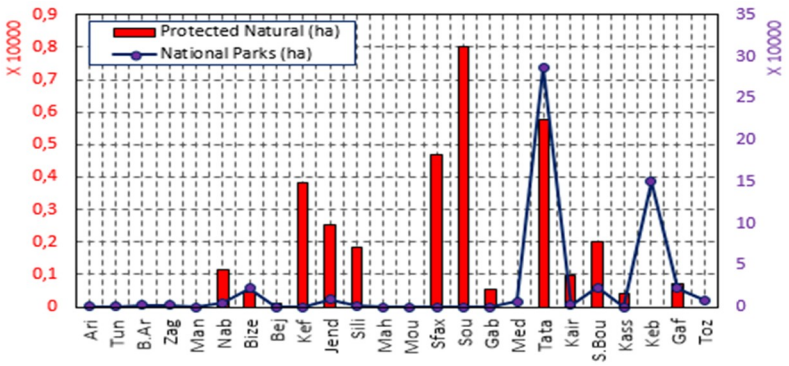

Figure 3: The Distribution of the Protected Areas in The Different Governorates

3.1.5. Agricultural Lands

Tunisia has 24 governorates divided into 6 major regions: The North East, the North West, the Central West, the Center East, the South West and the South East.

- The region North-East of Tunisia occupying an area of 1285500ha spans seven governorates: The governorates of Tunis, Ben Arous, Ariana, Manouba, Bizerte, Nabeul and Zaghouan. The region has a 1101076ha of the useful agricultural land, in which 784085ha is agricultural land (plowed and not plowed) 77182ha are of cours and 239809ha of forests. The distribution of agricultural area (ha) on the various governorates is as follows; Tunis: 8700, Ben Arous: 67000, Ariana: 31670, Manouba: 113700, Bizerte: 351606, Nabeul: 246400 and Zaghouan: 282000 [13].

As indicated in Figure 4 The distribution of this potential in the various governorates of the region reveals some disparities showing a concentration of agricultural areas in the governorates of Nabeul, Bizerte and Zaghouan. The Northeast region accounts for only 8% of the National territory,10.52% of the utilized agricultural area of the country, 1.8% of Cours and 20.27% of Tunisian forest wealth.

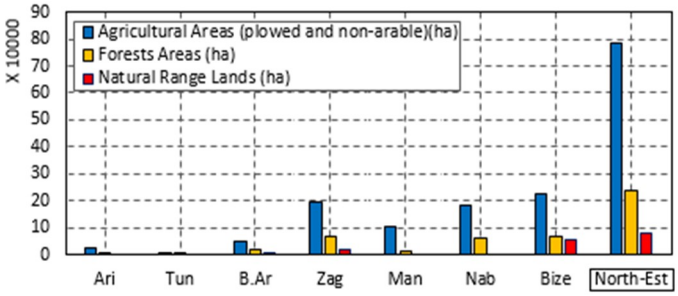

Figure 4: The Distribution of the Agricultural Lands in the Different Governorates

The region of northwestern Tunisia, covers a territory of 1656500ha occupying four governorates: The governorates of Jendouba, Beja, Siliana and Kef. The region has s 1622209ha of the agricultural land, in in which 1129157ha are agricultural plowed 75368ha are course and 417684ha are Forestry. The distribution of agricultural area (ha) on the various governorates is as follows; Tunis: 8700, Ben Arous: 67000, Ariana: 31670, Manouba: 113700, Bizerte: 351606, Nabeul: 246400 and Zaghouan: 282000 [14]. The Figure 5 present the distribution of this potential in the various governorates of the region reveals some disparities showing a concentration of agricultural areas in the Governorates of Manouba, Bizerte, Nabeul and Zaghouan. The Northwest region represents 10.21% of the national territory, the region has significant potential in soil, representing 15.51% of agricultural land, the best forest resource 35.31% and 1.75% of courses in the country.

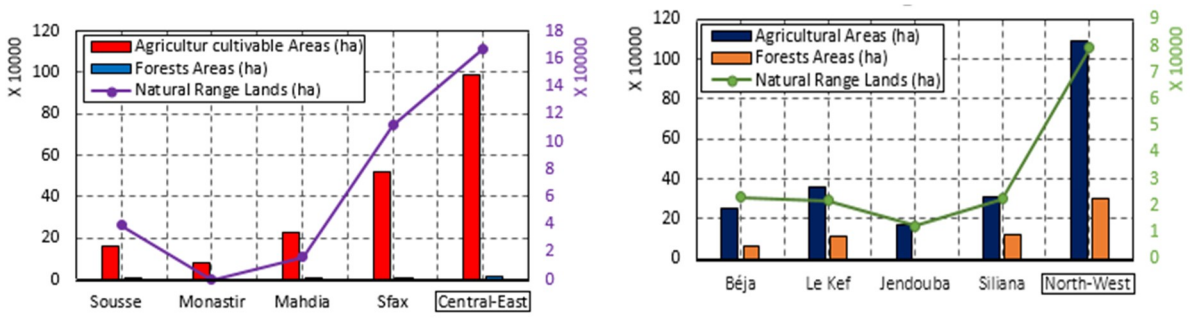

Figure 5: The Distribution of the Agricultural Lands in northwestern and the east-central of tunisia

- The region of east central Tunisia, covers an area of 1421300ha covers the entire territory

of the four governorates: The governorates of Sousse, Monastir, Mahdia and Sfax. The total agricultural area of the region covers approximately 1,358,800 hectares of which are 988577ha of agricultural land plowed 186848ha non-arable agricultural land, 167179 ha of course and 16200ha Forests. The distribution of agricultural area (ha) on the various governorates is as follows; Sousse; 264619 Monastir; 102385, Mahdia; 287800 and Sfax; 704000 [15]. The distribution of the total agricultural area by governorate as shown in Figure 5 shows that 52% of the areas are located in Sfax, Mahdia 21% to 19% in Sousse, Monastir and 8%. The Central East region covers 8.76% of the national territory, 13% of the utilized agricultural area of the country, 3.90% and 1.36% course of Tunisian forest wealth.

- The Central West region of Tunisia, extends over an area of 2237700ha covers the entire territory of the three governorates: Governorates of Kairouan, Sidi Bouzid and Kasserine. The total agricultural area in the region which covers about 1729300ha are; 893200ha of agricultural land are plowed, 432500ha of course and 380600ha Forestry lands. The distribution of agricultural area (ha) on the various governorates is as follows: Kairouan; 347900 Sidi Bouzid; 592,200 and Kasserine; 789 200 [16-17-118]. The distribution of the total agricultural area by governorate (Figure 6) shows that 45.63% of the areas are located in Kasserine, Kairouan and 20.11% to 34.24% in Sidi Bouzid. The Central West region covers 13.79% from the national territory, 16.53% of the utilized agricultural area of the country, 10% of course and 32.17% of the Tunisian forest wealth.

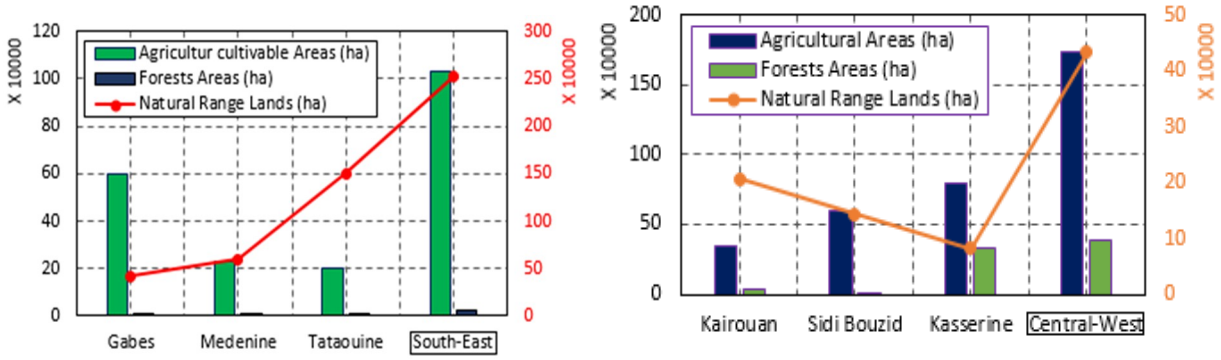

Figure 6: The Distribution of the Agricultural Lands in the Central West and the South-East of tunisia

- The region of South-East of Tunisia, extends over an area of 5586300ha covers the entire territory of the three governorates: The governorate of Medenine, Gabes and Tataouine. The total agricultural area of the region covers about 3571972 ha wish are 1028980ha dependable agricultural land, 2 517340ha of course and 25652ha Forestry. The distribution of agricultural area (ha) on the various governorates is as follows: Medenine; 834,798, Gabes; 1028924 and Tataouine; 1708250 [19]. The distribution of the total agricultural area by governorate (Figure 6) shows that 47.82% of the areas are located in Tataouine, 28.80% to Gabes and 23.37% in Medenine. The Southeast region covers 34.45% of the national territory, 20.61% of the arable agricultural surface of the country, 58.76% of course and 2.16% of the Tunisian forest wealth.
- The region southwestern of Tunisia, extends over an area of 3585400ha covers administratively three governorates of Gafsa, Tozeur and Kebili. The total agricultural area of the

region covers about 1544348ha which 297562ha are agricultural land, 1236820ha of course and 10571ha Forestry [20] [21]. The distribution of agricultural area (ha) on the various governorates is as follows: Gafsa; 577690, Tozeur; 326061 and Kebili; 641202. The distribution of the total agricultural area by governorate presented in Figure 7 shows that 47.82% of the areas are located in Gafsa, 21.11% inTozeur and 41.51% in Kebili. The South West region covers 21.91% of the country, 14.76% of the agricultural area of the country, 28.87% Course and 0.9% of Tunisian forest wealth.

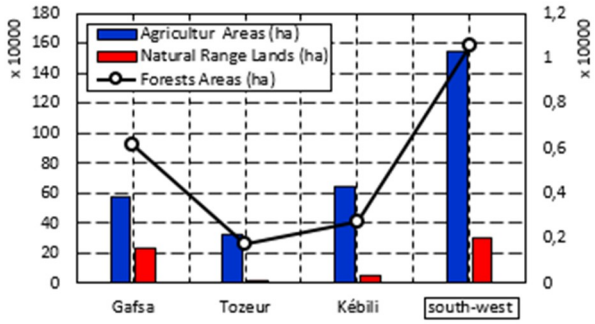

Figure 7: The Distribution of the Agricultural Lands in The region southwestern of Tunisia

3.2. Site Selection

In this paper; The military land, mentioned above are to be avoided as a potential site for solar parks to the absence of a presidential decree defines the duration of military operations. The cultivable areas to be avoided as a potential site for solar parks from the perspective of the protection of species and habitat, due to their sensitivity to soil protection, it is recommended to plan cropland regionally based their agronomic potential and reserving the most fertile areas for agricultural use. Furthermore, the Tunisian forest law It is strictly prohibited to change the formula these lands to industrial zones [12]. The industrial zones currently being marketed (ZIM); these are the most favorable areas for establishment a photovoltaic system by reason of its availability for operating a solar park. To a lesser extent, we find arid areas that represent a large reservoir of spaces capable of containing a enormous solar power stations.

In the case of a photovoltaic installation, the three most used for design criteria are: electricity consumption, the available area and budget. In the case study of a photovoltaic potential, the minimum number of panels for installation is dependent on the surface can be covered. the Figure 4 indicate the distribution the areas that can exploit in the various governorates.

Table 4: The Distribution of the Areas That Can Exploit in the Various Governorates

Governorates	ZIM+Bare Soils (ha)	Governorates	ZIM+Bare Soils (ha)
Kebili	670000	Medenine	4186
Sidi bouzid	9620	Ariana	200
Siliana	30	Beja	1270
Sousse	8	Ben Arous	0
Tozeur	44100	Bizerte	8,5 + Unknown
Tunis	560	Gabes	2570
Zaghouan	29 + Unknown	Gafsa	17000
Manouba	10	Jendouba	20
Le Kef	0	Tataouine	2240500
Mounastir	0	Mahdia	71
Nabel	0 + Unknown	Kairouan	18008
Sfax	980	Kasserine	150
Tunisia		3009320,5	

4. Electrical Potential Estimation

4.1. Implantation facilities to the surfaces

The total surface area of a PV plant floor corresponds to industrial land, which includes access roads, addictions, mounting surface of the modules, and other open areas. This area depends on various factors (yields, techniques used, space between rows). Site characteristics (slope of the terrain, location), the nature of the mounting medium and height of the modules determine, among others, the interval required between the module rows. The area required for technical installations (including inverter) is generally insignificant compared to the total area.
Used the "premium PVSOL" software to identify the general structure of installation of photovoltaic modules. The Figure 23. Presented our proposed implementation of photovoltaic fields in an area of 1ha.

Remember that the main characteristics of installation of photovoltaic modules are:

- Solar Panels (3454 panels) type: SPR-X20-250-BLK, SunPower,250W
- Inverter (12 inverter) type: Lsg100Kw-B,Shanghai Macsolar Power
- Installed Power: 863.5 KWc

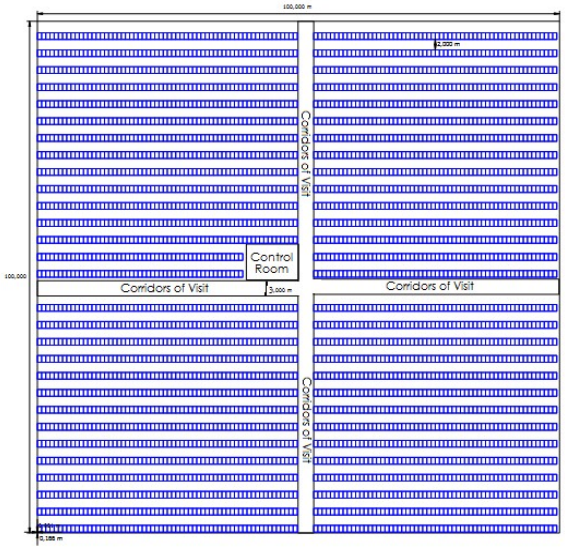

Figure 8: proposed implementation of photovoltaic fields in an area of 1ha

4.2. The Potential of Photovoltaic Electricity Production

Used the "premium PVSOL" software to calculate the potential of PV electricity for all Areas of Tunisia. The table 23. Presented the distribution of this potential in the various governorates.

Table 4: The Distribution of the Potential of Photovoltaic Electricity Production in the Various Governorates of Tunisia.

Governorates	Potential Of Pv Electricity For 1 Ha (KWh/Y)	Coefficient Of Performance Of The Installation (%)	CO2 Emissions Avoided (Kg/Y)	Potential Of Pv Electricity For all areas (GWh/Y)
Kebili	1752773	87.2	10124912	1174357,91
Sidi bouzid	1357136	86.7	813656	13055,64832
Siliana	1557707	87.1	934001	46,73121
Sousse	1582530	87.6	948851	12,66024
Tozeur	1752272	86.6	1050745	77275,1952
Tunis	1562390	87.3	936812	874,9384
Zaghouan	1562410	87.4	936534	45,30989
Manouba	1562380	87.3	936822	15,6238
Le Kef	1535621	87.0	936547	0
Mounastir	1582689	87.8	948991	0
Nabel	1505194	88.0	902494	0
Sfax	1526320	87.5	948832	1495,7936
Medenine	1675869	84.7	10004901	7015,187634
Ariana	1562389	87.4	936798	312,4778
Beja	1433336	87.6	859375	1820,33672

Ben Arous	1562399	87.3	936568	0
Bizerte	1483788	87.6	889648	12,612198
Gabes	1675868	84.9	10003210	4306,98076
Gafsa	1726627	87.1	1035357	29352,659
Jendouba	1479294	87.1	886953	29,58588
Tataouine	1763215	83.6	10003210	3950483,208
Mahdia	1515325	87.2	948792	107,588075
Kairouan	1599895	87.0	959317	28810,90916
Kasserine	1586023	87.2	945617	237,90345

5. Conclusion

In order to know the solar output from one place, to calculate very specific amount of energy that can be produced, to simplify the production of feasibility study and planning of photovoltaic systems. We presented a mapping of solar energy potential of Tunisia. The country benefits an Annual Irradiation On Horizontal Plane exceeding 5700 Wh/m2/day, an annual irradiation on a plan with the optimal inclination (Hopt) exceeding the 6400Wh/m2/day and an Annual Direct normal irradiation exceeding to 6500 Wh/m2/day. Tunisia cover 24 governorates divided into 6 major regions, extends over an area of 16 361 000ha, has a 3009320,5ha of the areas that can exploit for the solar park. As indicated in Table 4, the total electrical potential that aims to produce from all of the Non-residential areas exceeding to 5289669,259 GWh/y.

For solar power, the prognosis for the future are rather favorable and even very promising. The nuclear disaster and the oil spill will have a long term impact on the development of solar energy. Governments are therefore given in the urgency of strengthening their energy policies to promote solar energy.

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