

Happy Life Region
West Mediterranean



SOLAR ENERGY SECTOR REPORT

WEST MEDITERRANEAN DEVELOPMENT AGENCY
February, 2011

FOREWORD

Regional development agencies whose history dates back to old times in developed countries are the models newly adopted in Turkey. These agencies aim to accelerate regional development, ensure sustainability and reduce interregional development disparities in accordance with the principles and policies set in the development plans and programs, through a cooperative networking between local authorities, private sector and civil society.

One of the tasks given to agencies to achieve their aim is whether to do research on determining the resources and opportunities of the region, accelerating economic and social development and enhancing the competitiveness or to support the researches done by other individuals, organizations and institutions.

West Mediterranean Development Agency which largely completed its process of establishment and institutionalization is responsible for providing free consulting services to investors in Antalya, Isparta and Burdur. In addition, through a one-stop shop approach, the agency offers an extensive range of services including coordinating and following-up the permits, licensing procedures and other administrative works within the scope of public institutions and organizations of investors. Furthermore, the agency promotes the investment opportunities of the region both at national and international level in cooperation with relevant organizations.

In line with the mentioned task above, the sector reports were prepared to guide the investors willing to invest in the region and promote the investment opportunities of the region.

At first, Marble, Milk and Dairy Products, Solar Energy, Golf Tourism and Health Tourism Sector Reports of West Mediterranean Region, Tourism Potential of Egirdir Report and Antalya – Konya High Speed Rail-Line Report have been prepared. Over time, many sector reports related with the region will be prepared and investment opportunities of the region will continue to be promoted. Being helpful with these sector reports to investors and all other institutions operating in the region is our greatest wish.

Tuncay ENGIN
Secretary General of WMDA

Dr. Ahmet ALTIPARMAK
Governor of Antalya
Chairman of WMDA



INTRODUCTION

The competition in economics between countries started with industrial revolution, technological developments, population growth, people's desire for a more comfortable life are the main reasons of the increase of energy consumption rapidly in the last 50 years.

Nowadays, approximately 90% of the energy consumption is being extracted from coal, oil, natural gas and fossil resources. Countries started new researches and projects based on producing energy from clean and renewable energy sources because of limited reserves of fossil resources, global warming, acid rain etc. after especially the petrol crisis in 1973. Solar, wind, hydraulic, geothermal and biomass energies are the main renewable energy types.





1. SOLAR ENERGY

Solar energy is the general given name of solar heat and light energy emitted from Sun. This energy is being used by humanity with different type of technologies since ancient times.

Solar energy, wind and wave energy, hydroelectric energy and biomass energy constitute the largest part of renewable energy sources.

One minute of solar energy comes from Sun meets our world's energy consumption need for a year, despite today's technologies are insufficient to use this energy efficiently. Uses of solar energy and detailed information of solar panels is as follows.





1.1. Solar Energy Basics



The total energy that comes directly from the Sun is 174 petawatt (10^{15} watt), but 10 PW of this energy reflects back into space from the atmosphere, 35 PW from clouds and 7 PW from Earth's surface. The remaining energy is absorbed by the atmosphere with 33 PW, land and seas with 89 PW.

The atmosphere heated by the sun causes waters to evaporate both on lands and seas. The red arrows indicated at below show how the sun's rays cause the evaporation. In other terms, sun rays come to earth, and the energy reflects back to space again.

“Nowadays, approximately 90% of the energy consumption is being extracted from coal, oil, natural gas and fossil resources.”





EFFECT OF SOLAR ENERGY TO THE WORLD





“Many countries consider solar energy as the only solution of dependence on foreign energy.”

1.2. Importance of Solar Energy

The amount of solar energy falling on the world in a year is 516 times more than known oil reserves and 157 times more than coal reserves on Earth.

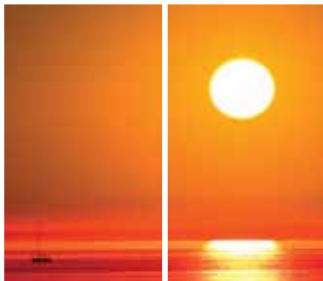
With an easy calculation it is very clear that the solar energy is infinite with millions of year's life of Sun. In addition, it is a huge advantage of having this energy for free.

Compared to fossil fuel energy; solar energy can be obtained at every point on earth, it does not need mechanical power and it is a source with zero carbon dioxide emissions in the expenditure.

With the increase of fossil fuel consumption, atmospheric carbon dioxide rate increased by 1.3 times in the last century. It is expected to increase 1.4 times more in the next 50 years.

Global average temperature increase comes with the production of energy is another issue on this matter. Melting glaciers, rising seas, drying lakes and





agricultural drought seem to be important problems in the near future. Life of petroleum and natural gas sources are considered to be 43 and 67 years respectively, according to usage rate of today. Regarding the current conditions and the amount of per capita energy consumption has increased rapidly in last years; it is inevitable for humanity to use the renewable energy sources instead of fuel sources.

Electricity generation, hot water production, natural ventilation and lighting by using solar energy is not known very well by consumers, but it becomes a new business line and a new research area for scientists and business men.

Despite having less sunlight than Turkey, even European Countries use solar energy systems in their buildings and they receive grants from their governments. Many countries consider solar energy as the only solution of dependence on foreign energy.

“It is a huge advantage of having solar energy for free.”

1.3. Solar Energy as of Today



The biggest advances in technology began after the discovery of electricity. The knowledge and usage of echnology and consumption increase dependent on electricity.

Electrical energy is needed for heating, lighting, equipment operations and in other areas of our lives. Rapid progress of technology and increase consumption per capita has pushed nations to produce more energy.

Government policies are taking shape as not being dependent on foreign countries, meeting energy demand in the domestic market and selling energy to other countries. Starting with 1950s strong thermal solar plants, solar thermal electric power stations began to be established in the late 1970s. Solar One with 10 MV is one of the first solar thermal stations established on California Mojave Desert.

Nowadays, solar power plant projects leaded by Germany and Spain have been accepted by all countries in the world. Solar energy technology became a rapidly evolving industrial field.

With the Act 5346-Use of Renewable Energy Sources for Electricity Generation use of renewable energy sources has been organized. Some provisions of the Act were changed with Act 6094.

The law aims at the promotion of electricity generation based on renewable resources. Determining, grading and using of the resources of renewable energy are being held with principles and procedures with relevant institutions and organizations by Law. The permits of designated renewable energy areas are subject to be processed by the Department of Energy in order to notify the relevant authorities.

The determined prices for the facilities which are producing electricity by renewable energy sources (RES) is as follows.





\$7.3 cents/kW for hydroelectric generation facilities, \$7.3 cents/kW based on wind energy generation, \$10.5/Kw based on geothermal energy generation, \$13.3/kW based on biomass, including landfill gas generation, \$13.3/kW based on solar energy generation facilities.

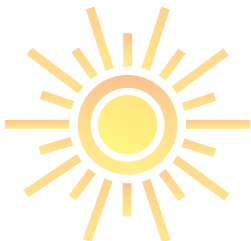


These prices are subject to applied for 10 years for the license holders relevant to RES support mechanism which are entered into operation and production from 18 May 2005 until 31 December 2015.



For the companies which will be operational after 31 December 2015, the prices will be determined by the Council of Ministers and will not exceed the current prices.

Development of new energy sources will eliminate the energy dependence on foreign countries as well as help fighting the global warming and rapid climate changes. Clean Energy Fund will provide efficiency in energy use and renewable energy sources in Turkey. This fact is being expressed by U.S. officials and they consider Turkey as a partner country to act together on this matter.



Turkey is referred as energy corridor due to its geopolitical position, natural resources and the amount of solar energy falling throughout the year.

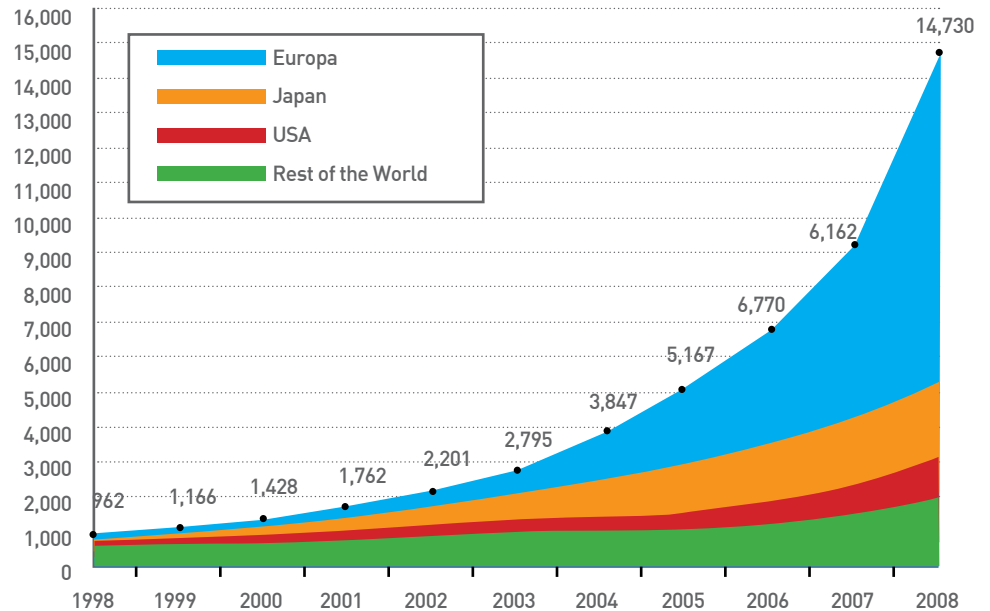
By the end of the 2005 World Renewable Energy Sources Production Capacity

| | Added in 2005 | End of 2005 | Growth Rate of 2005 |
|--|------------------|-------------|------------------------|
| POWER PRODUCTION | | | |
| Large Hydroelectric Power Plants (GW) | 12-14 | 750 | %1,5-2 |
| Small Hydroelectric Power Plants (GW) | 5 | 66 | %8 |
| Wind Turbines (GW) | 11,5 | 59 | %24 |
| Biomass Power Plants (GW) | 2-3 | 44 | %4,8-7,1 |
| Geothermal Power Plants (GW) | 0,3 | 9,3 | %3 |
| Solar, Photovoltaic (GW) | 1,1 | 3,1 | %55 |
| (network connection) | | | |
| domestic | 200,000 | 650,000 | %44,4 |
| Solar, Photovoltaic (GW) | 0,3 | 2,3 | %15 |
| (network disconnected) | | | |
| Solar Thermal Power Plants (GW) | -0 | 0,4 | - |
| Wave (tidal) Power Plants (GW) | -0 | 0,3 | - |
| PRODUCTION OF HEAT / HEATING | | | |
| Biomass Heating (GW _{th}) | n/a | 220 | - |
| Heating with Solar Collector (GW _{th}) | 13 | 88 | %17,3 |
| Power and Area Warmers (m ²) | 19 million | 125 million | %17,9 |
| domestic | 7 million | 46 million | %17,9 |
| Geothermal Heating | 2,6 GW | 28 GW | %10 |
| TRANSPORTATION | | | |
| Ethanol for Furnaces (liter/year) | 2,5 billion | 33 billion | %8 |
| Biomass Utilization | 1,8 billion | 3,9 billion | %85 |
| ENERGY FOR RURAL AREAS | | | |
| PFfor Cooking Furnaces (Total, all types) | n/a | 570 million | - |
| Biomass Utilization (improved types) | n/a | 220 million | - |
| Use of Biogas (m ³) | n/a | 21 million | - |
| Use of Solar Collector (m ²) | 270,000 | 2,4 million | - |





Power Change of Installed Global Cumulative PV by Years



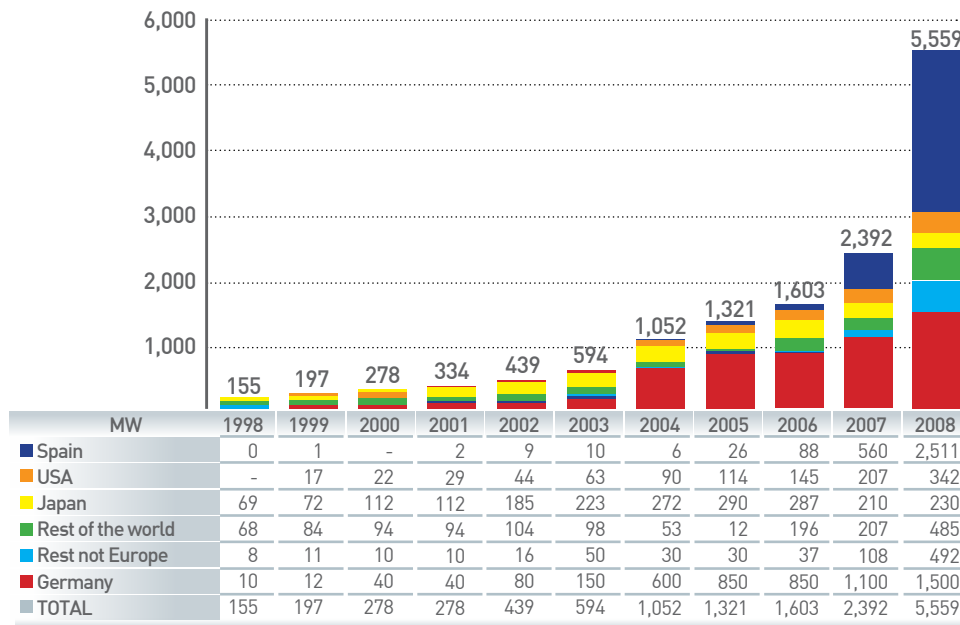
Global photovoltaic market has been growing very quickly. Between 1998 and 2007 the annual market growth rate is around 35%. In 2000, the world's installed capacity of 1,200 MW is increased to 9,200 MW at the end of 2007 and 14,730 MW at the end of 2008. In 2008 PV market value has reached to 13 billion Euros. With new manufacturers entering the market, this value is increasing day by day.

According to the study made in 2008 by European Photovoltaic Industry Association the state of the global cumulative photovoltaic installed capacity reached 15 GW. In this sense, European countries hold a share over 65% with 9 GW. Japan and USA follows Europe with respectively 15% (2.1 GW), and 8% (1.2 GW) shares.



“The knowledge and usage of technology is completely dependent on electricity.”

Global Cumulative PV Installed Capacity by Year



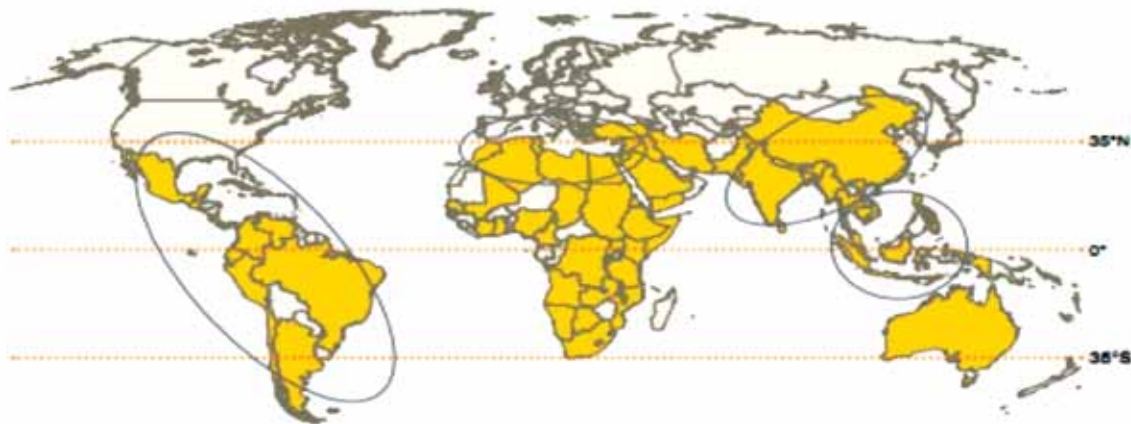
Installed capacity of PV systems founded in 2008 was more than twice powerful the systems was established in 2007. As shown in the chart above, the PV systems founded in Spain in 2008 have an installed capacity more than all other PV systems in the world. By the end of 2008, Spain holds 45% of total PV systems capacity with 2,511 MW. Spain is respectively followed by Germany, USA and Japan in this sector.





The other countries making investments in PV systems are as follows; Italy with 258 MW, South Korea with 274 MW, France with 105 MW, Portugal with 50 MW and Belgium with 48 MW.

Selected Focus Regions in the World



LATIN AMERICA

- PV potential of 13 GW by 2020 and 48 GW by 2030 in the Accelerated scenario.
- Current development driven by off-grid applications in remote areas.

MEDITERRANEAN & NORTHERN AFRICA

- PV potential of 7 GW by 2020 and 27 GW by 2030 in the Accelerated scenario.
- Large scale solar projects are announced; openness for PV increasing.

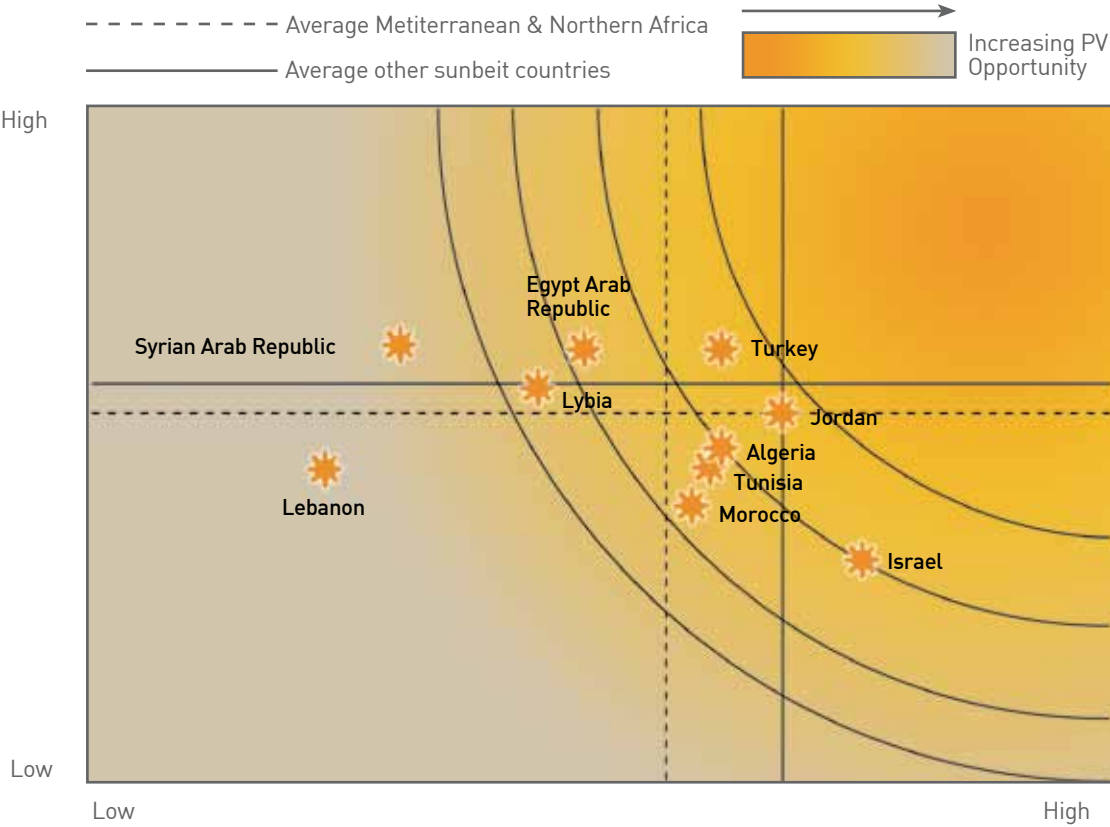
CHINA & INDIA

- PV potential of 53 GW by 2020 and 228 GW by 2030 in the Accelerated scenario.
- Surging electricity demand and existing manufacturing base drive PV potential.

SOUTH EAST ASIA

- PV potential of 10 GW by 2020 and 46 GW by 2030 in the Accelerated scenario.
- Existing manufacturing base drives PV growth in the region.

Solar Energy attractiveness for Average Mediterranean and Northern Africa



Source: A.T. Kearney analysis



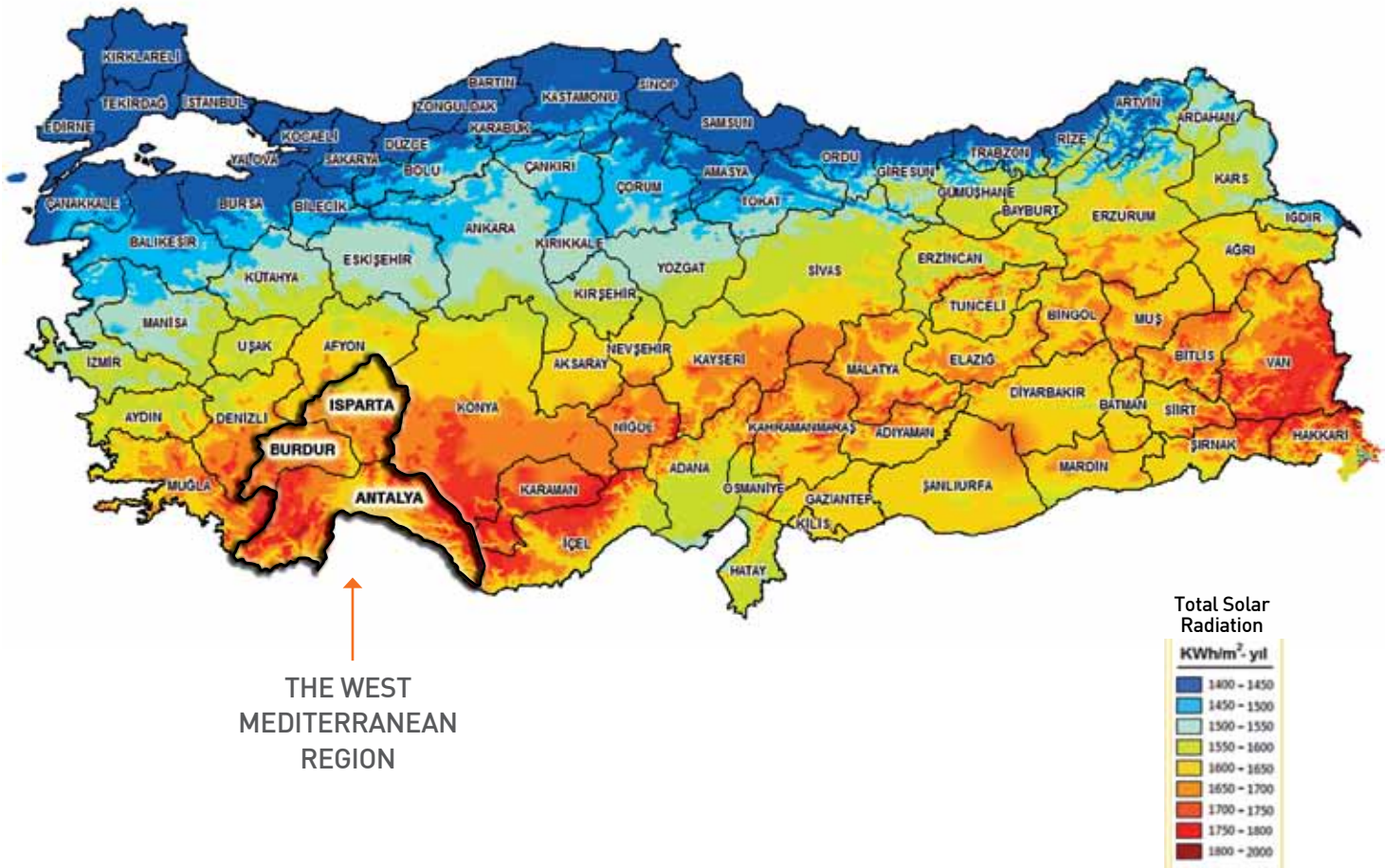


2. SOLAR ENERGY IN TURKEY

Turkey is considerable lucky compared to many countries in terms of solar energy potential due to its geographical location. Approximately 170 million MW of energy comes to the earth from sun every second. The solar energy meets the surface of Earth every second is 1700 times larger than Turkey's annual energy production which is only 100 million MW. According to Electrical Power Resources Survey and Development Administration with cooperation of State Meteorology Affairs General Directorate, Turkey's average annual total sunshine duration is 2640 hours; a total of 7.2 hours per day, the average total radiation intensity of 1,311 kWh / m² -years, daily total 3.6 kWh / m² were found. Turkey has a great potential of producing 1,100 kWh on average from a square meter area if necessary investments can be made on solar energy plants. On table 1; the solar energy potential of Turkey and the distribution of sunshine duration values are given by months.

“The knowledge and usage of technology is completely dependent on electricity.”

MAP OF SOLAR ENERGY IN TURKEY



↑
THE WEST
MEDITERRANEAN
REGION



Monthly average solar energy values in Turkey

| MONTHS | MONTHLY TOTAL SOLAR RADIATION | | SUNSHINE DURATION (Hour/Month) |
|----------------|-------------------------------------|----------------------------------|-----------------------------------|
| | (kcal/cm ² -Month) | (kWh/m ² -Month) | |
| January | 4,45 | 51,75 | 103 |
| February | 5,44 | 63,27 | 115 |
| March | 8,31 | 96,65 | 165 |
| April | 10,51 | 122,23 | 197 |
| May | 13,23 | 153,86 | 273 |
| June | 14,51 | 168,75 | 325 |
| July | 15,08 | 175,38 | 365 |
| August | 13,62 | 158,40 | 343 |
| September | 10,0 | 123,28 | 280 |
| October | 7,73 | 89,90 | 214 |
| November | 5,23 | 60,82 | 157 |
| December | 4,03 | 46,87 | 103 |
| Total | 112,74 | 1311,00 | 2640 |
| Average | 308,0 cal/cm²-day | 3,6 kWh/m²-day | 7,2 hours/day |

Source: General Directorate of EIE

Regional Distribution of Solar Energy Potential of Turkey

| REGION | TOTAL SOLAR RADIATION | SUNSHINE DURATION |
|-----------------------|-----------------------|-------------------|
| Southeastern Anatolia | 1460 | 2993 |
| Mediterranean | 1390 | 2956 |
| East Anatolia | 1365 | 2664 |
| Central Anatolia | 1314 | 2628 |
| Aegean | 1304 | 2738 |
| Marmara | 1168 | 2109 |
| Black Sea | 1120 | 1971 |

Source: General Directorate of EIE

Accordingly, in general, Turkey's most and least efficient months in order to produce solar energy are June and December, respectively. In terms of solar energy potential, Southeastern Anatolia and West Mediterranean Coasts come first in Turkey. If we exclude the Black Sea Region, Turkey can produce 1,100 kWh on a square meter with its 2640 hours of sun light on average. Accordingly, the total amount of energy is taken as the year is about 1015 kW hours.



3. POTENTIAL OF SOLAR ENERGY IN WEST MEDITERRANEAN REGION

According to the solar energy evaluations South Eastern Anatolia Region has the highest solar energy potential and Mediterranean Region has the second highest solar energy potential in Turkey. Three provinces in West Mediterranean Region have very appropriate values in terms of solar energy investments.

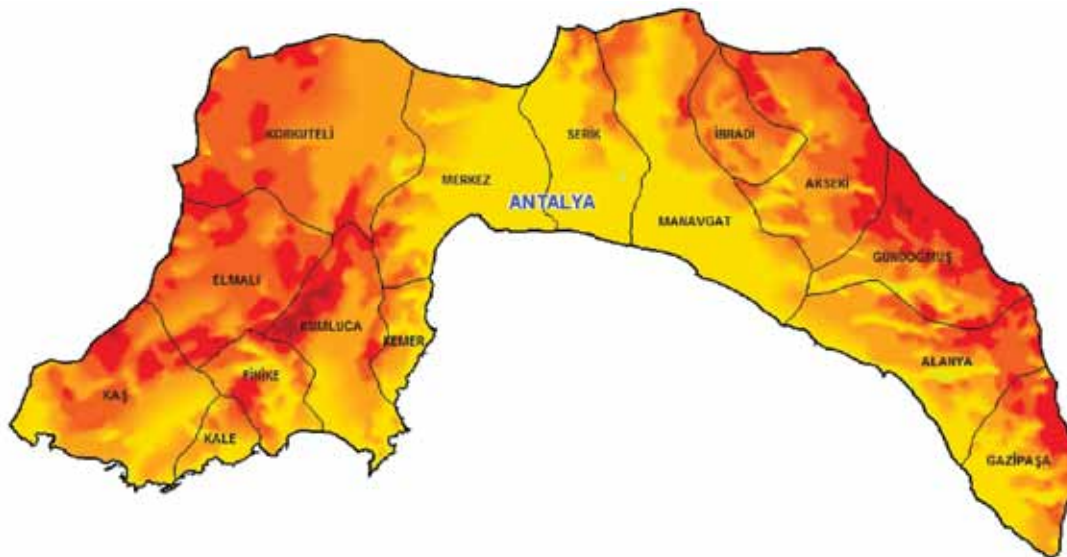


“Turkey is considerable lucky compared to many countries in terms of solar energy potential due to its geographical location.”

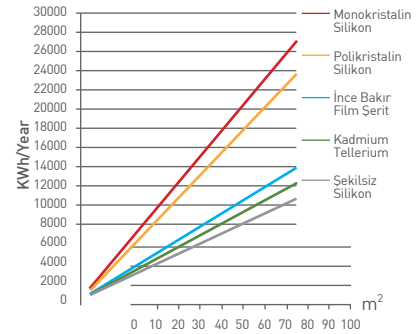
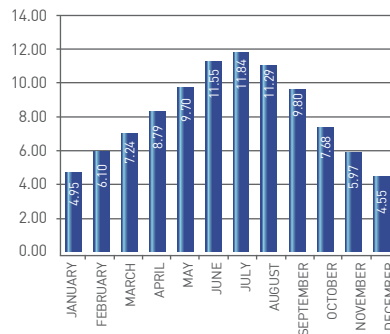
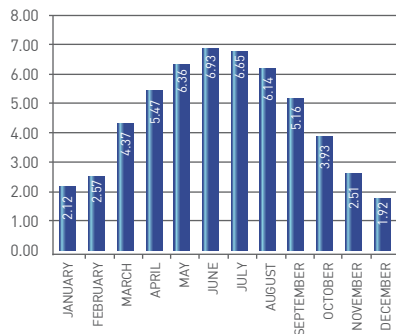




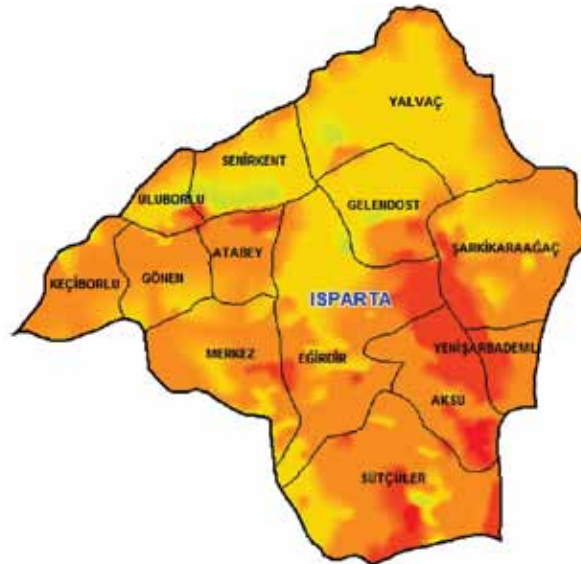
POTENTIAL MAP OF SOLAR ENERGY IN ANTALYA



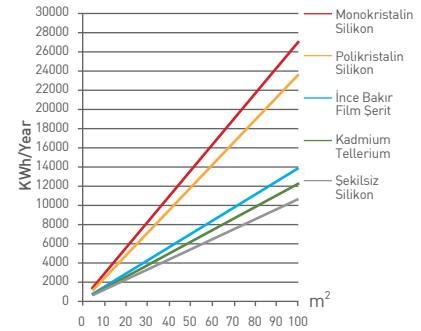
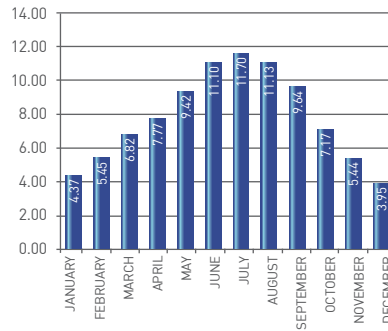
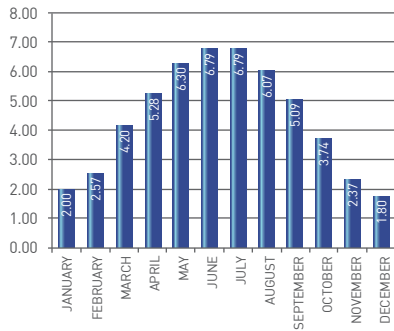
Sunshine Duration and Total Solar Radiation of Antalya



POTENTIAL MAP OF SOLAR ENERGY IN ISPARTA



Sunshine Duration and Total Solar Radiation of Isparta

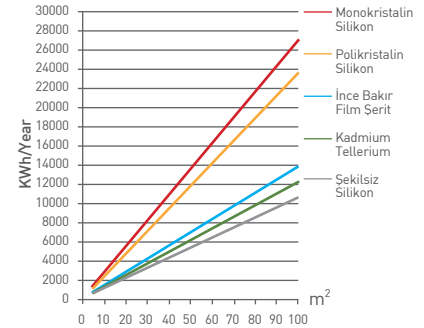
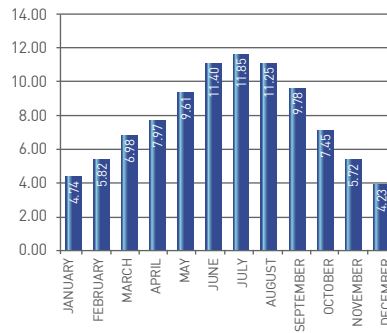
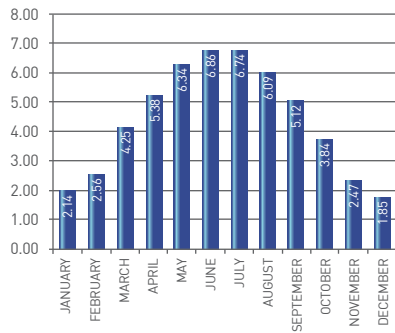




POTENTIAL MAP OF SOLAR ENERGY IN BURDUR



Sunshine Duration and Total Solar Radiation of Burdur



Especially in recent years, countries began to invest in alternative energy production methods due to climatic changes, narrow straits of energy and oil crises. The leading renewable energy sources are wind and solar energy. With the signing of the protocols, such as the Kyoto Protocol countries began to be put quotas on certain amount of greenhouse gases they produce. Quota exceeding countries are being cited.

4. CONCLUSION

- Western Mediterranean Region is the second region after Southeastern Anatolia Region with the potential of getting the most solar energy
- Having Renewable Energy Resources Research Center at Suleyman Demirel University
- The presence of a strong organization in Antalya for the use of clean energy sources
- The presence of a strong industry in Isparta which already produce hot water by using solar energy
- Appropriate reflection of the sun's rays for energy-producing capacity of Isparta
- Guidance of our agency and many foreign investors who want to set up solar farms in the area
- Renewable Energy Sources Act has been approved

