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Turkey's Solar Energy Market Study and Potential Economic Benefits

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Özet

Enerji, özellikle elektirik enerjisi tüketimi ekonomik gelişmenin temel aracıdır. Türkiye'de elektirik üretimi kömür, linyit, doğalgaz, petrol, hidrolik ve jeotermal kaynaklı santraller aracılığı ile gerçekleştirilmektedir. Türkiye; sınırlı petrol ve doğalgaz kaynaklarına sahip olmasına karşın güneş enerji kaynağı açısından zengindir. Güneş enerjisi, sadece Türkiye için değil Dünya için de sonsuz ve anahtar enerji kaynağı olarak kabul edilmektedir. Bu sebeple, sürdürülebilir ekonomik büyüme için güneş enerjisi teknolojilerindeki ve kullanımındaki gelişmeler hayati önem arzetmektedir. Bu çalışmanın amacı; Türkiye'de elektirik üretimindeki güneş enerjisi pazarını, yasal düzenlemeleri, ekonomiye ve işgücüne etkisini analiz etmektir. Bu çalışmada; Türkiye'nin güneş enerji potansiyeli, enerji politikalarında destekleme ve fiyatlandırma mekanizmalarının etkisi ile araştırma ve geliştirme çalışmaları ve desteklerinin yıllar içerisindeki gelişimi ve işgücüne yapacağı etki değerlendirilmektedir. İlk bölümde; Dünya'daki elektirik üretimindeki güneş enerjisi teknolojileri ve pazarındaki gelişmeler ve ekonomik etkileri değerlendirilmektedir. Yasal düzenlemelerin ve güneş enerjisine uygulanan desteklerin, araştırma ve geliştirmeye ayrılan kaynakların etkisi incelenmektedir. Çalışmanın ikinci bölümünde ise, Türkiye'de ki elektirik üretimindeki güneş enerjisi pazarı ve yasal düzenlemelerin etkileri, sektördeki önemli oyuncular ile yapılan derinlemesine görüşmelerle analiz edilmektedir. Kamu kurumları, üniversiteler ve özel sektörde ilgili kuruluşlar ile anket çalışması yapılmış, enerji alanında ve özelde güneş enerjisi alanında araştırma ve geliştirme bütçeleri yıllar bazında tespit edilmiş ve Dünya'daki bu alandaki önemli ülkelerin göstergeleri ile karşılaştırmalı değerlendirilmiştir. Sürdürülebilir kalkınma ve güneş enerjisinin ilişkisini göstermek için istihdama olası katkısı literatürdeki çalışmalar baz alınarak hesaplanmıştır. Bulgularımıza göre; Türkiye'de güneş enerjisi; yasal destekleme mekanizmaları ve araştırma-geliştirme fonlarının arttırılması ile enerji talebinin temel kaynağı olacak ve yüksek istihdam sağlayacaktır.

Keywords:
Renewable energy, solar energy, solar power plant, PV and CSP plant, Turkey,
Employement impacts, solar energy reserach and development budgets, economics effects, legislation and supporting mechanism of renewable energy

Abstract

Energy -especially electricity- consumption is considered a prime agent in economic development. Electricity is mainly produced by thermal power plants via coal, lignite, natural gas, fuel oil and geothermal energy, hydro power plants in Turkey. Turkey has no sufficient large oil and gas reserves but has a considerably high level of solar energy resources. Solar energy is considered a key energy source for the future, not only for Turkey, but also for the world. For these reasons, the development and use of solar energy technologies are increasingly becoming vital for sustainable economic development. The objective in doing this study is to investigate the solar energy market in electricity production and legislations and to analyze economic and employment impacts of the solar energy industry in Turkey. In this concept, the solar energy potential of Turkey, the energy politics and related incentive, pricing and trade mechanisms, research and development studies and funds, employment impacts for development of solar energy in the electricity production are investigated in this study. In the first phase, development of solar energy technology and market and the effects of economic development in the world has been discussed. The impacts of regularity framework and government incentives for solar technologies and allocated budgets of research and development for solar energy technology in the world has been examined. In the second phase, the structure of power market and regularity framework, relevant solar energy pioneers and projects in Turkey have been analyzed with depth interview of main stakeholders. Energy and specially solar related research development budgets data of Turkey within the years has been collected from governmental agencies, universities and companies with survey study, which has been evaluated by indicators of world's primary countries. The possible employment impacts of solar technology has been estimated, hence the intimate connection between solar energy and sustainable development. As a result; solar energy in Turkey would be the primary source of energy demand and would have big employment effects on the economics. This can only be achieved with the support of governmental feed-in tariff policies of solar energy and by increasing research-developments funds.

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Governmental organizations: TUBİTAK- Scientific and Technical Research Council of Turkey, TTGV - Faundation of Technology Development, DPT - State Planning Organization, KOSGEB – Small and medium Enterprise Development Coprporation , The Ministry of Industry, TEIAS- Turkish Electricity Transmission Company, EUAS-Turkish Electricity Generation Company, TETAS - Turkish Electricity Trading and Contractor Company, TPAO - Turkish Petroleum Company, EIE - Electric Power Resources Survey and Development Administration, TAEK - Türkiye Atom Enerjisi Kurumu, ETİ - Maden İşletmeleri Genel Md, TEMSAN - Türkiye Elekromekanik Sanayi, BOTAŞ-Petroleum Pipeline Corporation, MTA – General Directorate of Mineral and Exploration

Universities and Reserach and Devolopment Centers: The Solar Energy Institute - Ege University/Izmir, Muğla University and Temiz Enerji kaynakları AR-GE Merkezi, GUNAM / ODTU (Midle East Technical University), Hacettepe University YETAM, Harran University – HÜGEM, Kocaeli University, Pamukkale University, Niğde University, Sabancı University, Yaşar University, Özyeğin University, Işık University, Yeditepe University

Non profit organizations: ICAT - International Center for Applied Thermodynamics, UFTP – National Technology Platform for Photovoltaic , thanks to GENSED - Solar Energy Industry Association for sending the questionnaire to the members of the GENSED and collaborative approach for in-depth interviews, thanks to TEMEV - Clean Energy Foundation for sharing information of the foundation's projects clearly and kindly, thanks to ÇEDBİK, ISKID, ISKAV, IMSAD, IZODER for sending the questionnaire to members for increasing participation

Private companies: TANSUĞ Makina, SIEMENS Türkiye, THERMOFLEX, PROENERJİ, SOLARİS

Claim of Orginality

This is the first holistic study in Turkey which includes subjects from city based location selection for PV and CSP plants to major economical effects of electricity generation from solar energy with an exclusive roadmap study;

The thesis is comprised of five original features:

1. Identification of the city based most prominent locations for solar PV and CSP installations in Turkey which is critical to optimizing both the physical and economic outcomes of solar projects.

2. Cost and availability of solar PV and CSP technology in Turkey including major players of private firms and Universities and Non-governmental organizations (NGO) and primary components of this technology and approximate cost figures.

3. Solar roadmap study in order to set a strategic vision and target for solar energy development in Turkey which includes PV, CSP and solar heating and cooling.

4. Research and development (R&D) project numbers and budgets and ratio of R&D funds to Gross Domestic Product for energy and solar energy subjects according to the years via questionnaire with major players in governmental organizations and universities, which have been compared with EU, Japan and USA figures.

5. Assessment of economics and employment impacts of solar energy in Turkey.

These five features are aimed to creating a basis for NGO's for planning their activities on publicity of solar energy, for local and foreign companies who plan to invest and for governmental organizations who are preparing energy politics and strategy studies in Turkey that they can use in later projects.

3 May, 2010 Müjgan ÇETİN Prof. Dr. Nilüfer EĞRİCAN

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Abbreviations

ARRA The American Recovery and Reinvestment Act
BMU Nature Conservation and Nuclear Safety (Germany)
BMBF Federal Ministry of Education and Research (Germany)
BOO Build, Own, Operate
BOT Build, Operate, Transfer
BOTAŞ Petroleum Pipeline Corporation
CEC California Energy Commision
CPV Concentrating Photovoltaic
CSP Concentrating Solar Power
DMI Turkish State Meteorological Service
DNI Direct Normal Insolation
DPT State Planning Organization
DBU The Länder and the Federal German Environmental Foundation
EC European Commission
EEG Renewable Energy Act (Germany)
EIE General Directorate of Electric Power Resources Survey and Development Administration Turkey
EN European Standards
EMRA Electricity Market Regulatory Authority
EPDK Energy Market Regulatory Authority
EPIA European Photovoltaic Industry Association
ETKB Ministry of Energy and Natural Resources
EU European Union
EURO Euro (currency)
FIT Feed-In Tariff
GENSED Solar Energy producers and Investors Association
GERD Gross Domestic Expenditure on Research and Development
GNP Gross National Product
GTs Green tags
GWh Gigawatt hour
Hydro Hydro-electric
ICAT International Center of Applied Thermodynamics
IEC International Electrotechnical Commission
IEA International Energy Agency
ISO International Organization for Standardization
ISPAT Prime Ministry Investment Support and Promotion Agency
ITC Federal Investment tax credit
I-O Input Output model
KEP Kg of oil equivalent
km2 Square kilometer
Ktoe Kiloton of oil equivalent
kcal kilocalorie
kWh kilowatt hour
kWp kilowatt peak
KOSGEB Small and medium Enterprise Development Corporation
LCOE Levelized Cost of Energy
MCuM Million Cubic Meters
METI The Ministry of Economy
Mtoe Million ton of oil equivalent
MTA General Directorate of Mineral and Exploration
MWh Megawatt hour
MWp Megawatt power
NGO Non-governmental organization
NREL The National Renewable Energy Laboratory
O&M Operation and Maintenance

OECD	Organisation for Economic Co-operation and Development
PIER	The energy Commision's Public Interest Energy Research
PV	Photovoltaic
RES	Renewable Energy Sources
REIPI	Renewable Energy Incentive program
R&D	Research and development
RPS	Renewable portfolio standards
RSI	Renewable System Interconnection
SEI	Solar Energy Onstitute
SET-Plan	The Europan Strategic Energy technology Plan
SAI	Solar American Inititative
SRA	The Strategic research Agenda
SCST	The Supreme Council for Science and Technology
TEDAS	Turkish Electricity Distribution Company
TEIAS	Turkish Electricity Transmission Company
TETAS	Turkish Electricity Trading and Contractor Company
TEUAS	Turkish Electricity Generation Company
TOOR	Transfer of Operation Rights
TPAO	Turkish Petroleum Corporation
TPES	Total Primary Energy Supply
TUBITAK	Scientific and Technical Research Council of Turkey
TTGV	Faundation of Technology Development
TWh	Terawatt hour
UFTP	National PV Technology Platform in Turkey
USD	US Dollars
UNDP	United Nations Development Programme
VAT	Value Added Tax
WEC	World Energy Council
WBGU	The German Advisory Council on Global Change

1. Introduction

Energy is important since it has been one of the major inputs for the industry, as a prerequisite for sustainable development. It is also prominent for social development that it fairly facilitates life through heating, lighting, transportation while it contributes to education and scientific studies. The fossil fuels (oil, natural gas, coal, lignite etc), hydraulics and nuclear energy are traditional sources of energy, which supplies 90% of the world's primary energy need by 2007 and meets 97,5% of the world's electricity production by 2007. According to the world Energy outlook 2009 report, the fossil fuels remain the dominant source for primary energy worldwide in 2007 which is 81% of total energy consumption. The global and the local climates may change faster than natural and social systems can adapt. The use of fossil fuels, which enabling human civilization to develop and to function, has now become a threat to our natural living conditions.

The world's energy system is at a crossroads. Current global trends in energy supply and consumption are environmentally, economically and socially unsustainable. A possible solution is the diversification of supply countries, as well as the diversification of energy sources including renewable energies. Because of these reasons, many countries have focused on solar energy. The benefits of solar power are compelling: environmental protection, economic growth, providing employment, diversity of fuel supply and rapid deployment, as well as the global potential for technology transfer and innovation. The underlying advantage of solar energy is that the fuel is free, abundant and inexhaustible. The total amount of energy irradiated from the sun to the earth's surface is equivalent to 7500 times of the world's energy demand.

This study proceeds in the following phases;in Chapter 1, solar energy technologies for electricity generation, major solar energy markets, regulatory framework and government incentives, research-development budget/activities, economics and employment impacts of solar energy in the world are discussed in order to illuminate the crucial factors behind the transformation in Turkish energy sector. Chapter 2 concentrates on Turkey's energy situation using appropriate quantitative and qualitative data. Turkey has always been a net-importer of primary energy resources, and thus has always been in a fragile energy situation. Firstly, recent data of primary energy consumption, production and energy demand of Turkey are illustrated by tables and figures. Furthermore, a set of policies carried out by the government and the recent enactment of the laws in the energy sector are analyzed in order to highlight the basic vulnerabilities within the envisagement of these laws. Chapter 3 is reserved for a case study; it contains main topics for solar energy potential in Turkey. Firstly; most appropriate locations for requirements of solar plants and project development risks of solar technology in the local market are evaluated. In order to set a strategic vision and target for solar energy development in Turkey, International Center of Applied Thermodynamics (ICAT) has felt the need to prepare a roadmap of solar energy. Therefore ICAT has formed a task team to conduct a solar roadmap with related stakeholders which are universities, research and development centers, private companies and non-profit organizations. The roadmap points out major areas for long term, including main fields. It represents a collaborative process whereby stakeholders identify the future technical developments, market barriers, and policy mechanisms on the following phases. The Delphi method was used for the preparation of the roadmap and the roadmap has been prepared together with the stakeholders. Additionally, research and development budget for solar energy of Turkey -which is thought to be very important for solar energy technology in every country- has been evaluated with the survey of government corporations and universities and private companies. The government corporations as well as the level of participation of the other actors such as the universities and non-profit organizations and private companies in the energy sector are questioned for research and development budgets and projects numbers between before 2005 and every year up to 2010 in order to evaluate tendency and to compare with the European Union and United State of America rates. Finally; economics and employment impacts of solar energy has been estimated according to the world's experience in this thesis.

In conclusion, In order to grow a successful and sustainable solar market, stable and supportive policies and regulations are needed for extended period of time. It is hoped that this study tries to contribute to the vision of the other researchers to handle deeper analysis of Turkish solar energy and to the politicians for setting strategic visions and targets for solar energy and for organizing supportive policies and research and developme

2. Solar Energy in The World

The sun, sits at the center of the solar system and emits energy as electromagnetic radiation at an extremely large and relatively constant rate, 24 hours per day, 365 days of the year. The Sun emits energy at a rate of 3.8x1023 kW. Of this total, only a tiny fraction, approximately 1.8x1014 kW is intercepted by the earth, which is located about 150 million km from the sun. [1] About 60% of this amount or 1.08x1014 reaches the surface of the earth. The rest is reflected back into space and absorbed by the atmosphere. Even if only 0.1% of this energy could be converted at an efficiency of only 10% it would be four times the world's total generating capacity of about 3 000 GWp. Looking at it another way, the total annual solar radiation falling on the earth is more than 7 500 times the world's total annual primary energy consumption. However, 80% of the present worldwide energy use is based on fossil fuels. Several risks are associated with their use. Energy infrastructures - power plants, transmission lines and substations, and gas and oil pipelines – are all potentially vulnerable to adverse weather conditions or human acts. World demand for fossil fuels (starting with oil) is expected to exceed annual production, probably within the next two decades. Shortages of oil or gas can initiate international economic and political crises and conflicts. Moreover, burning fossil fuels releases emissions such as carbon dioxide, nitrogen oxides, aerosols, etc. [2]The global financial crisis and ensuring recession have had a dramatic impact on the enegry outlook market, particularly in the next few years. As the leading of greanhouse gas emmisions, energy is at the heart of the problem and so must be integral to the solution. The policy and regularory frameworks established at national and international levels will determine whether investment and consumption decisons are steered towards low carbon options. Many countries have established a virtuous circle of improvements in energy infrastructure and economic growth, nonetheless today 1.5 billion people are still denied access to electricity. As shown **Figure 0.1;** 35 Billion USD per year more investment than in the Reference Scenario would be needed to 2030.[3]

[1] Stine, W. B., Geyer, Michael, 'Power From the Sun', http://www.powerfromthesun.net/book.htm
[2] World Energy Council (WEC), 2007 Survey of Energy Resources , 2007
[3] World Energy Outlook, IEA-International Energy Agency, 2009

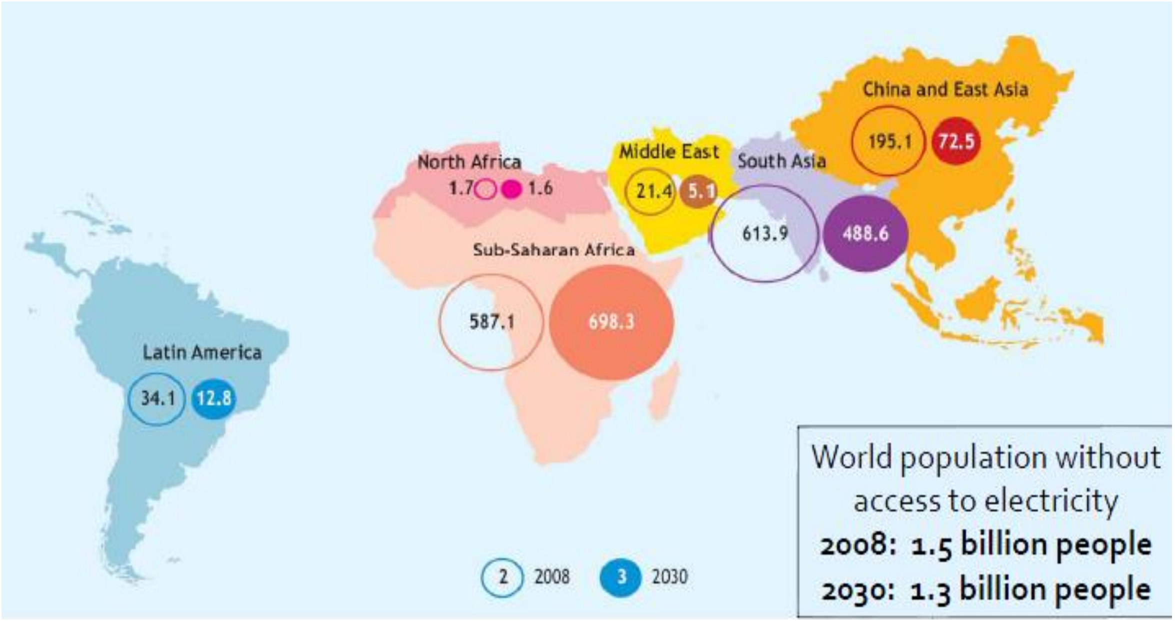

Figure 0.1: Number of people without access to electricity in the Reference Scenario

World energy demand expands by 40% between now and 2030. China and India are main drivers of growth. Demand for fossil fuels peaks by 2020 and by 2030 zero carbon fuels make up a third of the world's primary source of energy demand. (**Figure** 0.2)

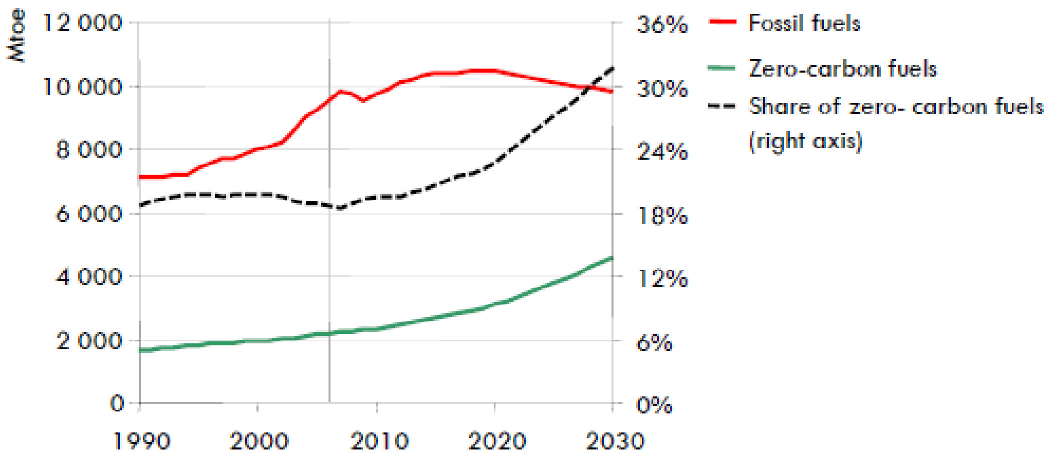

Figure 0.2 : Energy demand characteristics up to 2030

According to the world energy outlook 2009 report, as shown distribution of resources **Figure 0.3** electricty generation from solar energy will grow up 402 TWh in 2030 from 5 TWh in 2007 as 80 times bigger from 2007.

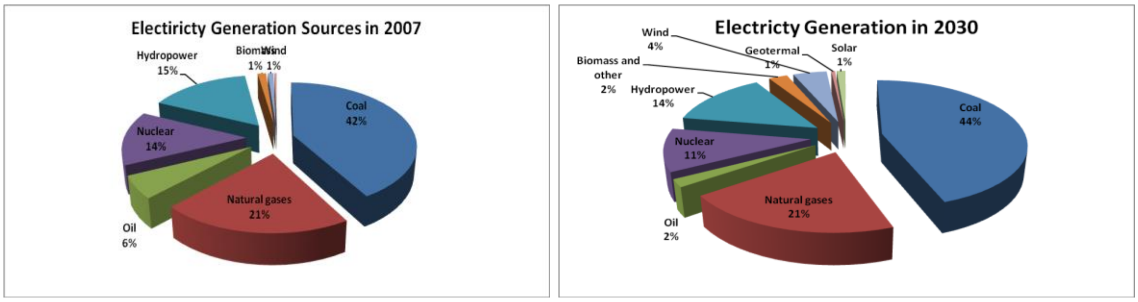

Figure 0.3 : Electricity generation sources in 2007 and 2030

The generation of electricity in the world increases nearly from 15 500 TWh/year today to 60 000 TWh/year by 2050. [4] Generation from solar sources increases strongly, 1 Twh in 2001 to 1493 Twh in 2050. [5] The German Advisory Council on Global Change (WBGU) recently conducted an analysis of energy needs and resources in the future to the years 2050 and 2100**.** By 2100 oil, gas, coal and nuclear, as shown in **Figure 0.4**, will provide less than 15% of world energy consumption while solar thermal and photovoltaic will supply about 70%. [6]

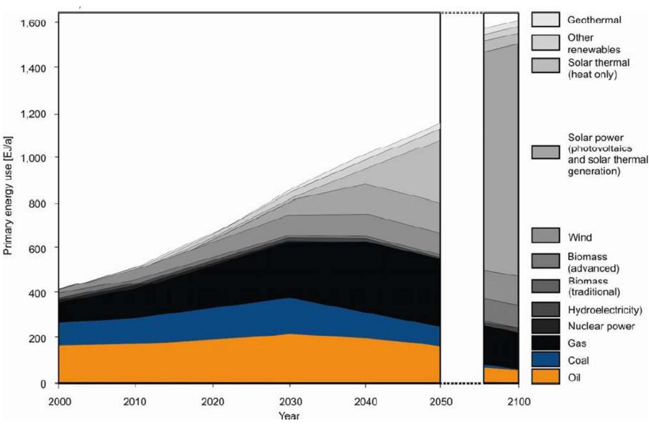

Figure 0.4: Transforming The Global Energy

[4] MED-CSP, German Aerospace Center (DLR), Concentrating Solar Power for the Mediterranean Region Final Report, Institute of Technical Thermodynamics Section Systems Analysis and Technology Assessment, 2005

[5] EU, World Energy Technology Outlook 2050, 2006

2.1. Solar Energy Technologies

The energy in solar radiation can be used directly or indirectly for all of our energy needs in daily life, including heating, cooling, lighting, electrical power, transportation and even environmental cleanup. Many such applications are already cost-competitive with conventional Energy sources. Solar collectors convert solar radiation into heat. Typical applications are swimming pools, domestic or Industrial hot water, space heating, or process heat. There are many different types of solar energy systems that will convert the solar resource into a useful form of energy. One method is by collecting solar energy as heat and converting it into electricity using a typical power plant or engine; the other method is by using photovoltaic cells to convert solar energy directly into electricity. [7] The two main options for generating electricity from solar energy are photovoltaic cells (PV cells) and solar thermal power plants. In the thesis; technologies will be focused on the electricity generation by solar as shown **Figure 0.5** solar technologies for electirictiy generation will be analyzed.

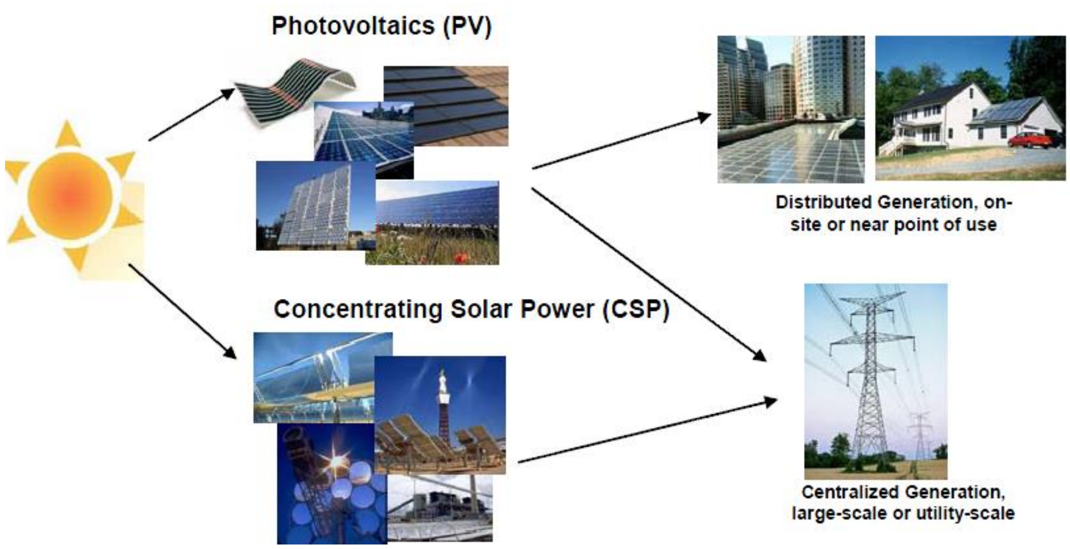

Figure 0.5: Solar technologies for electricity generation

[6] WBGU, 'World in Transition, Towards Sustainable energy system', EARTHSCAN, 2003
7 Stine, W. B., and Geyer, M., 'Power From The Sun', http://www.powerfromthesun.net/chapter2/Chapter2.htm

2.1.1 Photovoltaic system (PV) :

The direct conversion of sunlight into electricity is a very elegant process to generate environmentally friendly, renewable energy. This branch of science is known as ’’photovoltaics” or “PV”. PV technology is modular, operates silently and is therefore suited to a broad range of applications and can contribute substantially to our future energy needs. Photovoltaic modules can be connected to module arrays and connected to consumer loads or to the grid via suitable electronics. A storage element (e.g. rechargeable battery) is usually integrated in systems that are not connected to the grid. Because of this advantage the demand for photovoltaics is increasing every year. Since solar cells are connected to modules, which in turn can be combined to systems of any size, photovoltaics offers a wide range of possible applications.

Photovoltaic (PV) systems are currently based predominantly on crystalline silicon technology and are mature for a wide range of applications. Today the average turn key price of a small to medium size (3 to 20 kWp) PV system is 5 EURO/Wp and for large systems in the multi MWp ranges about 3 -4 EURO/Wp. The efficiency of commercial flat plate modules and of commercial concentrator modules is up to 15% and 25%, respectively. Crystalline siliconbased systems are expected to remain the dominant PV technology in the short term. In the medium term, thin films will be introduced as integral parts of new and retrofitted buildings. Finally, in the long term, new and emerging technologies will come to the market, such as high concentration devices that are better suited for large grid connected multi MWp systems, and compact concentrating PV systems for integration in buildings. The cost of a typical turn key system is expected to be halved to 2.5 EURO/Wp in 2015, and reach 1 EURO/Wp in 2030 and 0.5 EURO/Wp in the longer term. Simultaneously, module efficiencies will also increase. Flat panel module efficiencies will reach 20% in 2015 and up to 40% in the long term, while concentrator module efficiencies will reach 30% and 60% in 2015 and in the long term respectively. [8] For long-term global strategies, in addition to efficiency and price, the availability of raw materials should also be considered in the assessment of solar cell technologies. A further consideration is the energy payback period of the systems. The biggest advantage of solar

[8] EUROGIA +, A EUREKA initiative, For Low Carbon Energy Technologies, WHITE BOOK PART 2 Version 1, 2008

PV systems is that they can provide from a few watts to hundreds of megawatts. The energy payback period has been reduced to about 2-4 years, depending on the location of use, while panel lifetime has increased to over 25 years. The energy payback period of multijunction thin-film Concentrating PV is projected to be less than one year. [9]

2.1.2. Concentrated solar power (CSP) system:

Solar thermal power uses direct sunlight, so it must be sited in regions with high direct solar radiation that can be concentrated and collected by a range of Concentrating Solar Power (CSP) technologies to provide medium to high temperature heat. This heat is then used to operate a conventional power cycle, for example through a steam or gas turbine or a Stirling engine. Solar heat collected during the day can also be stored in liquid, solid or phase changing media like molten salts, ceramics, concrete, or in the future, phase changing salt mixtures. At night, it can be extracted from the storage medium to run the steam turbine. Four main elements are required to produce electricity from solar thermal power: a concentrator, a receiver, some form of a heat transport, storage and power conversion equipment much the same as for a fossil fuel-based plant. The three most promising solar thermal technologies are the parabolic trough, the central receiver or solar tower, and the parabolic dish. Three different technologies have already been realized [10]:

- **Parabolic trough power plants:** Solar radiation is focussed onto tubular light absorbers, usually containing special oil as heat transfer medium, in linear reflectors with parabolic shape that track the sun around one axis. The oil is heated to approximately 350–400°C and subsequently generates steam in a heat exchanger for a largely conventional steam turbine. Such systems can be designed for relatively large capacities, currently between 30 and 80MWp. Further significant cost reductions could be achieved through direct vaporization of water within the absorber tubes.

- **Solar power towers:** A large array of movable mirrors focuses the sunlight onto a receiver installed on a tower, where the heat transfer medium (water, salt, air) is heated to 500–1,000°C. Due to the high temperatures, the energy can, in principle,

[9] World Energy Council (WEC)¸ 2007 Survey of Energy Resources , 2007

be coupled directly into a gas turbine or a modern combined cycle plant. Capacities of around 200MWp have been proposed for solar power towers, which is approximately 10 times the capacity of current pilot plants.

- **Parabolic dish power plants:** This system uses parabolic mirrors to track the sun. A heat transfer medium at the focus of the mirror can be heated to 600–1,200°C. Such systems are usually rather small (some 10kWp of nominal capacity). They therefore lend themselves for decentralized applications. Engines are used to convert the heat energy into mechanical energy and subsequently into electrical energy. The technology is currently at an experimental stage.

Capital investment for solar only reference systems of 50 MWp are currently of the order of 3.300 to 4.500 EURO/kWp. Depending on the Direct Normal Insolation (DNI), the cost of electricity production is currently in the order of 20 EURO cent/kWh. For a given DNI, cost reduction of the order of 25% to 35% is achievable due to technological innovations and process scaling up to 50 MWp. Facility scaling up to 400 MWp will result in cost reduction of the order of 14%. [11] In the future, hybrid technology would be used to generate electiricty. The close relationship between solar thermal systems and conventional power plants enables the integration of fossil heating and solar thermal technology in so-called hybrid power plants. Another possibility is the combination of solar thermal power plants with thermal biomass utilization. The level of dispatching from CSP technologies can be augmented and secured with thermal storage or with hybridized or combined cycle schemes with natural gas, an important attribute for connection with the conventional grid. Several Integrated Solar Combined Cycle projects using solar and natural gas are under development, for instance, in Algeria, Egypt, India, Italy and Morocco.[12]

2.2. Major Solar Energy Markets

According to investment analysts and industry prognoses, solar energy will continue to

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[10] WBGU, 'World in Transition, Towards Sustainable energy system', EARTHSCAN, 2003

[11] EUROGIA +, A EUREKA initiative, For Low Carbon Energy Technologies, WHITE BOOK PART 2 Version 1, May 2008

[12] ICAT, Yerel ve Küresel bakış Işığında Türkiye İçin bir Yol haritası önerisi, Solar Future 2010 Congress 2010

grow at high rates in the coming years. Worldwide, more than USD 148 billion (EURO 102 billion) in new funding entered the renewable energy and energy efficiency sectors in 2007, up 60% from 2006.[13] Global investment in sustainable energy again reached record levels in the year 2008, with new investment of USD 155 billion. Solar continues to be the fastest-growing sector for new investment (see **Figure 0.6**). [14]

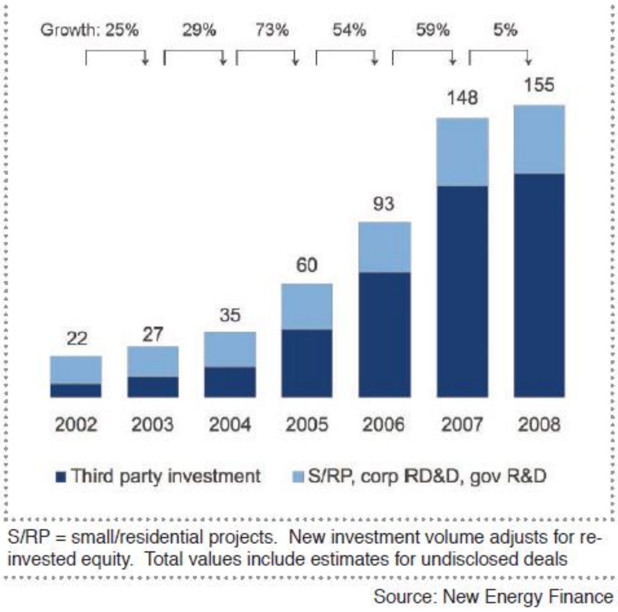


Figure 0.6 : Global new investment in sustainable energy, 2002-2008, USD billions

According to the New Finance report, around the world, investment (145 Billion USD) has decreased in 2009 according to the 2008 because of global crises as shown **Figure 0.7**.[15]

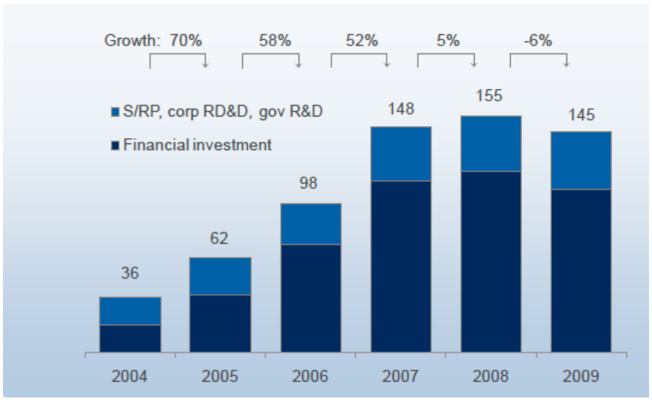


Figure 0.7 : Annual clean energy growth (Billion USD)

[13] JRC, PV Status Report, 2008
[14] UNEP, SEFİ, New Energy Finance, Global Trends in Sustainable Energy Investment2009 Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency, 2009
[15] Bloomberg, 'New Energy Finance, Presentation 2010', http://www.newenergyfinance.com/free-publications/presentations/

The installed concentrating solar power capacity by 2050 is as large as that of wind, PV, biomass and geothermal plants together, but due to their built-in solar thermal storage capability, as shown **Figure 0.8**, CSP plants deliver twice as much electricity per year as those resources.[16]

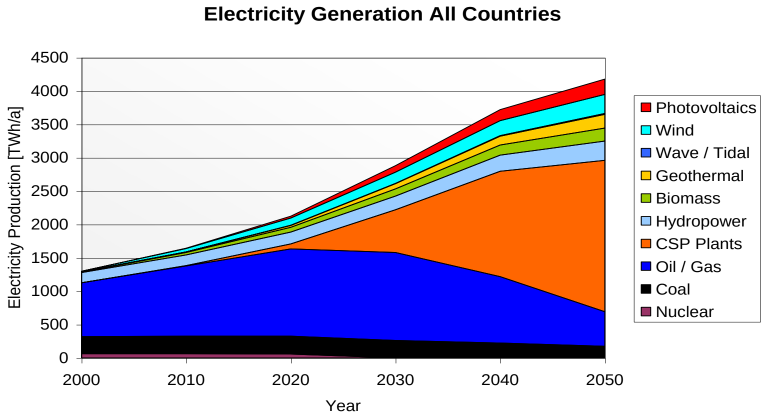


Figure 0.8 : Annual electricity demand and generation within the countries

Production data for the global cell production in 2008 vary between 6.9 GWp and 8 GWp. **Figure 0.9**, shows PV production capacity of world up to 7.35 GWp that representing a production growth of about 80% compared to 2007. The worldwide production capacity for solar cells would exceed 38 GWp at the end of in 2010. This indicates that even with the most optimistic market growth expectations, the planned capacity increases are way above the market growth. [17]

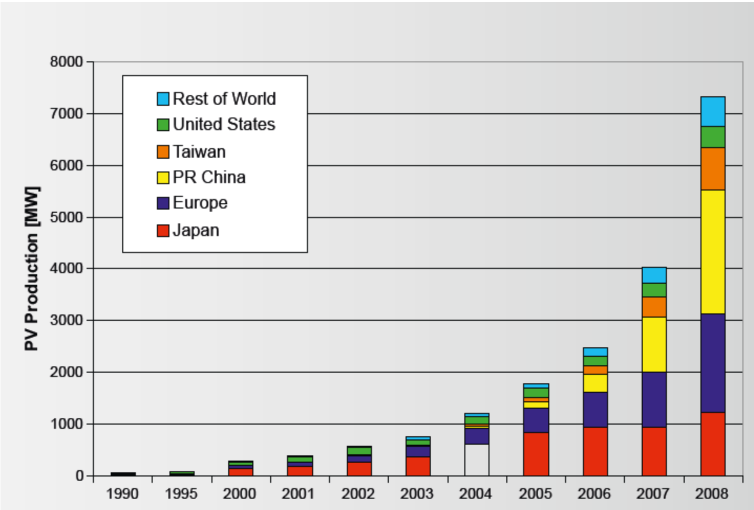


Figure 0.9 : World PV cell/module production from 1990 to 2008

[16] MED-CSP, German Aerospace Center (DLR), Concentrating Solar Power for the Mediterranean Region Final Report, Institute of Technical Thermodynamics Section Systems Analysis and Technology Assessment, 2005

PV is beginning to play a role as a significant source of new generation capacity in certain Countries; this role is further differentiated in the varying regional markets of the United States. Markets in Germany, Spain, and Japan have exploded over the past several years, and consultancies and public equity analysts believe this trend will continue and expand. The most optimistic of these forecasts calls for a 51% compound annual growth rate in worldwide solar installations through 2011. The International Energy Agency estimates that worldwide investments in energy supply will total approximately USD 22 trillion by 2030. [18]

Acording to the EPIA reports, as shown **Figure 0.10**, By the end of 2012 a global cumulative capacity of 44 GWp could be achieved. This is equivalent to the power capacity of 44 nuclear reactors. Germany is expected to remain the market leader and even increase its market size considerably over the next years. The biggest growth is foreseen for the rest Europe in particular in countries such as Spain, Italy, France and Greece. The USA will also be able to use its vast solar potential and will challenge Germany as the Number 1 PV country. PV development in Japan will, to a large extent, depend on the decision of the Japanese government to reintroduce, or not, a support program. Also the Rest of Asia, in particular India and South Korea, will face increasing demand for PV. [19]

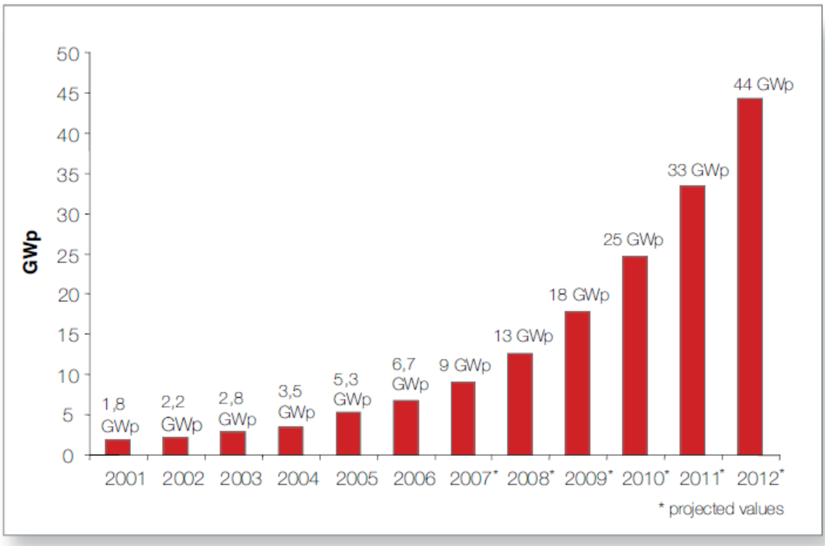
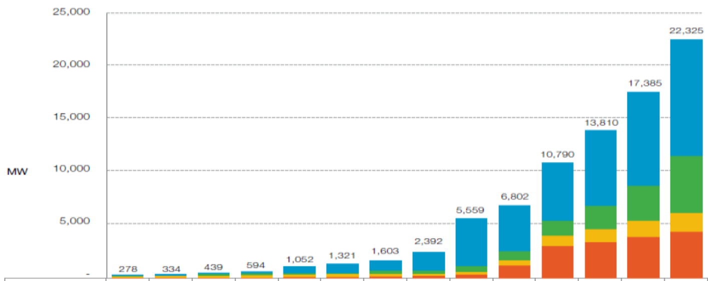


Figure 0.10 : Global cumulative PV capacity (Policy Driven Scenario)

[17] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009
[18] US Department of Energy, Solar Energy Technologies Program, Multi year Program Plan 2008-2012, 2008

According to the JRC PV Status report; Investment in May 2009 just amounted to USD 185 billion (EURO 135 billion), including USD 22.1 billion (EURO 15.8 billion) for research and development (R&D), spread until 2013. The draft of the new Chinese Energy Revitalisation Plan, foresees EURO 309 billion investments into new energy, including solar, and more than EURO 436 billion into smart-grids. This development clearly indicates that China is strongly supporting its renewable energy industry and will emerge even stronger after the current financial crisis. More than 150 companies are involved in the thin-tilm solar cell production process, ranging from R&D activities to major manufacturing plants. [20]

The EPIA/Greenpeace Advanced Scenario shows that by the year 2030 PV systems cumulative capacity will be 1.864 Gwp, Employment potential will be 10 million jobs, cost of solar electricity 7–13 Eurocent/kwh depending on location and PV systems could be generating approximately 2,600 TWh of electricity around the world. This means that, assuming a serious commitment is made to energy efficiency, enough solar power would be produced globally in twenty-five years' time to satisfy the electricity needs of almost 14% of the world's population.[21] The solar PV market has been booming over the last decade and is forecast to confirm this trend in the coming years. Spain represented almost half of the new installations in 2008 with about 2,5 GWp of new capacities, followed by Germany with 1,5 GWp of additional connected. Japan (2,1 GWp) and the USA (1,2 GWp) are following behind, representing 15% and 8%, respectively, of the Global cumulative PV power installed. (**Figure 0.11)** [22]



MW	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009E	2010E	2011E	2012E	2013E
Europe	50	96	106	210	637	906	975	1,768	4,503	4,302	5,490	7,110	8,785	10,925
Rest of the world	94	75	104	98	53	12	196	207	485	800	1,300	2,100	3,200	5,200
Japan	112	135	185	223	272	290	287	210	230	500	1,000	1,200	1,500	1,700
USA	22	29	44	63	90	114	145	207	342	1,200	3,000	3,400	3,900	4,500
TOTAL	278	334	439	594	1,052	1,321	1,603	2,392	5,559	6,802	10,790	13,810	17,385	22,325

Figure 0.11 : Global annual PV market outlook per region

[19] EPIA, Global Market Outlook for Photovoltaics until 2012, 2008

[20] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009

[21] EPIA, Greenpeace Solar Generation V – 2008 Solar electricity for over one billion people and two million jobs by 2020, 2008

[22] EPIA, Golabal Market Outlook for Photovoltaics Until 2013

Because of this reason, in the thesis following country and region will be evaluated detailed.

2.2.1. European Union (EU)

European Council Meeting in Brussels on 8–9 March 2007, the Council endorsed a binding target of a 20% share of renewable energies in the overall Europian Union (EU) energy consumption by 2020. In order to meet the new targets, the European Council called for an overall coherent framework for renewable energies, which resulted in the Directive on the “Promotion of the Use of Energy from Renewable Sources’’. This new Directive 2009/28/EC, which went into force on 25 June 2009 amends and subsequently repeals the Directives 2001/77/EC and 2003/30/EC. The market conditions for Photovoltaics differ substantially from country to country. [23] Germany’s commitment to renewables and supportive governmental polices have helped grow its domestic industry, created many skilled jobs (approximately 280,000 in 2008, a growth of nearly 75% from 2004) and have made the country a global leader in the renewable energy market. It is estimated that Germany’s solar energy market has grown from USD 600 million to USD 6,5 billion in this supportive environment.[24]

For the CSP component, the objective is to demonstrate the competitiveness and readiness for mass deployment of advanced CSP plants, through scaling-up of the most promising technologies to pre-commercial or commercial level in order to contribute to around 3% of European electricity supply by 2020 with a potential of at least 10% by 2030 if the DESERTEC vision. Achieving large-scale, sustainable deployment of advanced CSP plants with better technical and environmental performance and lower costs requires addressing the system efficiency, together with increasing power availability through better storage systems and hybridisation and reducing water consumption by developing new thermal cycles and dry cooling systems. The cost of the solar programme is estimated at EURO 16 Billion over the next ten years, of which EURO 9 billion are for the PV and

[23] JRC, Instutute of Energy, Renewable Energy Unit, ‘PV Status Report 2009’, August 2009
[24] IFC Knowledge Management Market Study Report: Turkey, Bulgaria, the Balkans and the Czech Republic, 2010

EURO 7 billion for the CSP.[25] In 2008, European Union was the main powerhouse in the world market with over 80% of the world's installed capacity. [26]

2.2.2. United State of America (USA)

In 2008, the USA was the third largest market with 342 MWp of PV installations, 292 MWp grid connected. California, New Jersey and Colorado account for more than 75% of the USA grid-connected PV market. The American Recovery and Reinvestment Act (ARRA) of 2009 expanded funding to USA 2,4 billion (EURO 1.7 billion) of new allocations. On 27 May 2009, President Obama announced to spend over USD 467 million (EURO 333,6 million) from the ARRA to expand and accelerate the development, deployment, and use of geothermal and solar energy throughout the United States. The Department of Energy of USA will provide USD 117,6 million (EURO 84 million) in Recovery Act funding to accelerate the widespread commercialisation of solar energy technologies across America. USD 51,5 million (EURO 36,8 million) will go directly for Photovoltaic Technology Development and USD 40,5 million (EURO 28,9 million) will be spent on Solar Energy Deployment, where projects will focus on non-technical barriers to solar energy deployment. Increase R&D investment to USD 250 million per year by 2010. [27] CSP Current capacity in 2007 is 418,8 MWp and a 500 MWp tower project is being planned in USA The long-term future of the CSP industry in the USA also appears robust. [28]

2.2.3. Asian Countries

Japan : The long-term Japanese PV research and development programmes, as well as the measures for market implementation which started in 1994, have ensured that Japan has become a leading PV nation world-wide. The principles of Japan's Energy Policy are the 3Es:

- Security of Japanese **E**nergy Supply (Alternatives to oil)
- **E**conomic Efficiency (Market mechanisms)

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[25] EU Comission, SET PLAN, Technology Roadmap, COM(2009) 519 final, 2009
[26] Observ'ER, THE STATE OF RENEWABLE ENERGIES IN EUROPE, 9th EurObserv'ER Report, 2009
[27] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009

- Harmony with **E**nvironment (Cutting CO2 emissions on line with the Kyoto Targets)

A new investment subsidy system was introduced and started in January 2009 under a supplementary budget for 2008 and a volume of EURO 69 million. For 2009 the programme has a budget volume of EURO154 million. [29]

China: The production of solar cells and the announcements of planned new production capacities in the People's Republic of China, have sky-rocketed since 2001. Production rose from just 3 MWp in 2001 to 124 MWp in 2005 and 1070 MWp in 2007. For 2008 capacity increases to 5.7 GWp are announced, whereas the figure stands at 10.5 GWp for 2010. This development presents a reason to press for additional government policies supporting the introduction of energy efficiency measures and renewable energy sources.[30] China have announced EURO 22 billion for green energy programmes in early March 2009. Analysts believe that these measures will accelerate the Chinese domestic market. For 2009 a doubling, or even tripling of the market seems possible as a starting point for the development of a GWp size market from 2012 on. China is now aiming for 2 GWp solar capacity in 2011 and in July 2009 under the new energy stimulus plan China revised its 2020 targets for installed solar capacity to 20 GWp. [31]

2.3. Regulatory Framework and Government Incentives for Solar Technologies

In order to grow a successful and sustainable solar market, stable and supportive policies and regulations are needed over an extended period of time. Fluctuating or short-term policies do not provide the support needed for investment in large-scale solar power projects which, depending on the technology, take 1- 5 years to place in service.

Policies to promote renewables have mushroomed in recent years. At least 60 countries—37 developed and transition countries and 23 developing countries—have some type of policy to promote renewable power generation. The most common policy is the feed-in

[28] US Department of Energy, Solar Energy technologies, Task plan 2008-2012,2008
[29] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009
[30] JRC, PV Status Report, 2008

tariff (FIT). By 2007, at least 37 countries and 9 states/provinces had adopted feed-in policies, more than half of which have been enacted since 2002. Strong momentum for FIT continues around the world as countries enact new feed-in policies or revise existing ones. At least 44 states, provinces, and countries have enacted renewable portfolio standards (RPS), also called renewable obligations or quota policies. There are many other forms of policy support for renewable power generation, including capital investment subsidies or rebates, tax incentives and credits, sales tax and value-added tax exemptions, energy production payments or tax credits, net metering, public investment or financing, and public competitive bidding. [32]

The four large current PV markets (Germany, Japan, Spain and California) can be observed in **Figure 0.12** and which represent the cumulative and yearly installed capacity over time respectively. The effect of the new Renewable Energy Law, which came into force in January 2004 in Germany and the effect of the Japanese Residential PV Dissemination program, stands out. The start of the Spanish feed-in tariff in 2004 corresponds with the increase of installed capacity after 2006. [33]

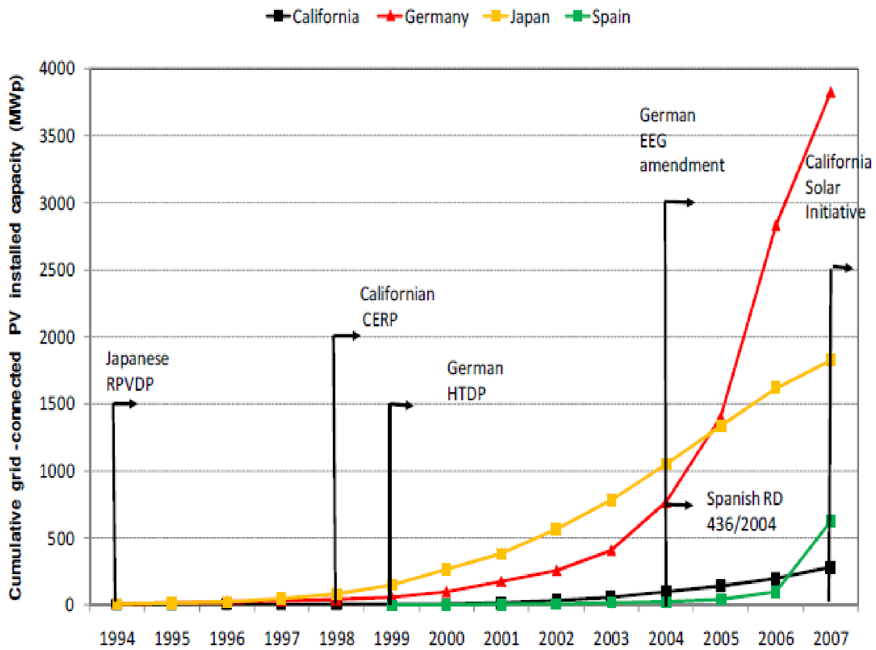

Figure 0.12: Cumulative capacity with important milestones in the largest grid-connected markets

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[31] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009
[32] EPIA, Renewables 2007, Global Status report, 2008

2.3.1. European Union (EU)

In the early 1980s, financial incentives in the form of capital grants (i.e. investment subsidies), loans or reduced taxes, were a common way of encouraging investments. In the mid-1990s, in various European countries, promotional programs based on regulated tariffs for the purchase of electricity from specified renewable sources became more common. The most important models in this context were (fixed) feed-in tariffs and fixed premium systems. In recent years, another type of instrument emerged, at least in the political discussion process. [34] In 2001, the EU has officially recognized the need of promoting renewable energy sources as a priority measure since their exploitation contributes to environmental protection and sustainable development and makes it possible to meet Kyoto targets more quickly (Directive 2001/77/EC, 2001). The latest evidence of the diligence of the European countries in promoting the use of Renewable Energy Sources (RES) is the European Council act 7224/1/07, 2007 targeting an objective of 20% as contribution of the RES on the total European energetic production in 2020. **Table 0-1** show the different financing strategies activated in the 25 countries of the EU, for PV systems, respectively. [35]

Table 0-1: Financing Strategies for PV systems in the EU-27

					2010 Renewable Energy target *	
EU country	Feed-in tariffs	Net metering	Capital subsidies, grants or rebates	Green tags	1997 Target (%)	2010 Target (%)
Austria	*		*	*	70	78,1
Belgium		*	*	*	1,1	6
Cyprus	*		*			
Czech Republic	*	*	*	*		
Denmark	*	*		*	8,7	29,0
Estonia	*					
Finland			*		24,7	31,5
France	*				15	21,0
Germany	*				4,5	12,5
Greece	*		*		8,6	20,0
Hungary	*			*		
Ireland	*		*	*	3,6	13,2

33 International Energy Agency (IEA), Promotional Drivers for PV , Photopoltaic System Programme, IEA-PVPS-TASK 10-05,2009

34 EU Directorate-General Energy and Transport, Support Schemes for Renewable Energy, 2005

35 Campoccia, A., Dusonchet, L., Telaretti, E., Zizzo, G., ‘ Comparative analysis of different supporting measures for the production of electrical energy by solar PV and Wind systems: Four representative European cases’, Solar Energy, ELSEVİER, August 2008, PP: 287–297

Italy	*	*			16	25,0
Latvia	*					
Lithuania	*		*			
Luxembourg	*		*		2,1	5,7
Malta			*			
Netherlands	*			*	3,5	9,0
Poland			*			
Portugal	*		*		38,5	39,0
Slovak Republic	*					
Slovenia	*					
Spain	*		*		19,9	29,4
Sweden	*		*	*	49,1	60,0
United Kingdom			*	*	1,7	10,0

Green tags :Green tags (GTs) are the property rights to the environmental benefits from generating electric energy from RES. GTs can be sold and traded and their owners can legally demonstrate1 to have purchased renewable energy. An energy producer is credited with one GT for every 50 MWh of electricity produced from RES. A certifying agency gives to each GT a unique identification number to assure that it does not get double-counted. The energy is then injected into the electrical grid, and the accompanying GT is sold on the open market.

Feed-in tariffs : FITs mechanism involves the obligation on the part of an Utility to purchase electricity generated by renewable energy producers in its service area paying a tariff determined by Public Authorities and guaranteed for a specific time period. A FIT’s value represents the full price received by an independent producer for any kWh of electric energy produced by a RES-based system, including a premium above or additional to the market price, but excluding tax rebates or other production subsidies paid by the government.

Net-metering: Net-metering was born to answer the request of a simple standardized protocol for the exchange of the electric energy produced by residential customers that install renewable energy systems in their houses.

Though Germany does not have an ideal solar resource and climate, PV is well-supported by long-term policies. CSP does not work well in this wet climate with limited direct solar insolation. Germany continues to occupy the leading position for installed capacity amongst the European members of the IEA-PVPS. The Länder and the Federal German Environmental Foundation (DBU) have their own incentive programmes to support the implementation of PV but it is the Renewable Energy Act (EEG) with its feed-in tariffs which continues to be the driver behind the strong growth in Germany. The principle of the EEG is to stimulate lower prices in the market by reducing the feed-in tariff (guaranteed over a period of 20 years) which, since 2004, has dropped by 5% per annum for roof-top modules (6.5% for ground modules). A modification was made to the EEG during 2008 so that the degression rate is reduced more rapidly from 2009 onwards. The new feed-in tariff was set at 8% for up to 100 kWp and 10% for over 100 kWp in 2009/2010. In the period 2011/2012 the rate will become 9%. [36] Current Germany renewable energy policy targets (supported most recently by the new version of the Renewable Energy Sources Act (EEG) of 2009) include 30% renewable energy consumption by 2020, increasing after that to 50% by 2050. [37]

Table 0-2 shows the guaranteed rates in 2004, 2007 and 2009. [38] Long-term, stable policy has created a good environment for investment and manufacturing.

Table 0-2 : Overview of German Feed-in Tariffs in 2004, 2007 and 2009 in EUR-ct/kWh

Share of capacity	***2009 EEG***	***EEG Progress Report (7.11.2007)***	***2004 EEG***
Roof mounted facilities			
Up to 30 kW	43,01	42,48	44,41
30 kW – 100kW	40,91	40,37	42,26
Over 100 kW	39,58	39,91	41,79
Over 1000 kW	33.00	34,48	41,79
Electricity produced is used within building/facility			
Up to 30 kW	25,01	-	-
Freestanding facilities			
All	31,94	32,01	33,18
Bonuses for facades facilities			
All	-	+ 5	+5
Degression for freestanding facilities			
	Basic fee and bonuses: 2010: 10% from 2011: 9%	Basic fee From 2009: 7% From 2011: 8%	Basic fee 5% Freestanding facilities 6,5%
Degression for Roof systems			
	Basic fee and bonuses: Up to 100 kW 2010: 8% From 2011: 9% Over 100 kW 2010: 10% From 2011: 9.0 %	Basic fee: From 2009: 7% From 2011: 8%	Basic fee 5% Freestanding facilities 6,5%

The most recent renewable energy law (EEG 2009) includes higher prices for energy and introduced a reduction in tariff prices for new projects. New PV plants receive a set FIT

[36] WEC, World Energy Council, Survey of Energy Resources,İnterim Update 2009, 2009

[37] "Renewable Energy Sources in Figures, National and International Development", German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, June 2009

for 20 years after the start of operation [39] In 2008, Germany has spent approximately 3.2 billion EURO on the FIT. This equates to approximately 3–4 Euros per month for electricity customers. [40]

Spain is located in what is referred to as the "solar belt" (the equatorial band that circles the world and has the best solar resource in the world). Spain has adopted a Feed-In Tariff (FIT) has helped produce energy domestically and grow its domestic industry. More importantly, in 2008 Spain accounted for half of the world's new solar installations in large part due to generous government subsidies. Spain's incentives have proven successful in motivating the domestic renewable energy market and significantly increasing the use of electricity generated by renewable energy sources. [41] The government specifically increased the FIT for solar to increase its use and make it a more attractive resource option. As a result of this increase, in 2008 Spain's solar capacity grew from 695 MWp to 3,342 MWp and the corresponding subsidy costs grew from 214 million EURO (2007) to 1,1 billion EURO in 2008 [42]. The government set the FIT at 44 Euro cent/kWh for all projects that were connected to the transmission grid by September 2008. The unexpectedly large number of developers who acted on this FIT, especially coinciding with the global economic crisis, resulted in the incentive being revised to sustainable levels. The Spanish government has moved to the new tariff that is set at 32 Euro cent/kWh for solar plants (34 Euro cent/kWh for roof-top systems).[43] The lesson learned from Spain is that long-term, stable and sustainable incentives are the key to successful growing and maintaining the market.

Feet-in Tariff of France, Greece and Portugal are as follows; In France; rooptop and ground base 32,6 Eurocent/kWh in 2009, In Greece; for <100 kWp FIT is 45,28

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[38] International Energy Agency (IEA), Promotional Drivers for PV , Photopoltaic System Programme, IEA-PVPS-TASK 10-05,2009
[39] "Act Revising the Legislation on Renewable Energy Sources in the Electricity Sector and Amending Related Provisions", EEG 2009, the Federal Law Gazette No. 49, October 2008.
[40] "Let the Solar Shine In", Bruce Stokes, the National Journal, April 2009
[41] "Spain's Solar-Power Collapse Dims Subsidy Model", Gonzalez, Angel and Johnson, Keith, the Wall Street Journal, 8 September 2009.
[42] "Spain's Solar Market Crash Offers a Cautionary Tale about Feed-In Tariffs", Voosen, Paul, New York Times, 2009.
[43] " Spain Kicks Of New Solar Feed-In Tariffs", Wang, Ucilia, Greentech Media, 20 February, 2009

Eurocent/kWh in 2008, for >100 kWp is 40,28 Eurocent/kWh in 2008, In Portugal, 65 Eurocent/kWh in 2008 [44]

2.3.2. United States of America (USA)

Policy developments at the federal and state level have the capability to increase demand substantially, creating a much more receptive U.S. market. In 2007, the Departmant Of Energy of USA commissioned the Renewable Systems Interconnection (RSI) reports that analyzed the three main policies that would have the largest positive impact on solar demand in the USA:[45]

- Lifting net metering caps and establishing net metering in areas currently lacking these policies led the projected cumulative installed PV in 2015 to increase by about 4 GWp;
- Extension of the federal investment tax credit (ITC) led projected cumulative installed PV in 2015 to increase from 12 GWp under a partial extension of the ITC to 17 GWp under a full extension of the ITC; and
- Improved interconnection standards had a significant effect on PV market development, leading to a projected cumulative demand increase of another 7 GWp.

As shown in **Figure 0.13**, combining all three policies is projected to result in a cumulative installed base of about 24 GWp of PV in the USA by 2015.

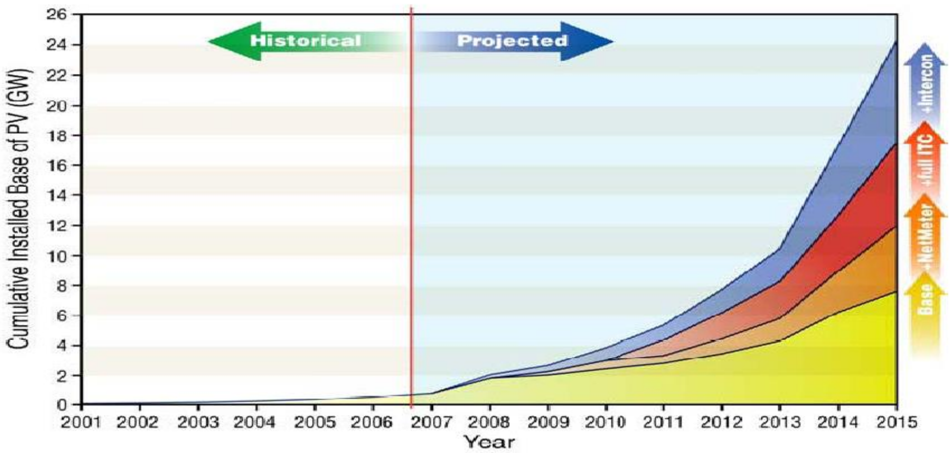

Figure 0.13 : USA PV Installations and policy projections

[44] Barometre Photovoltaic, EUROBSERVER, 2009
[45] US Department of Energy, Solar Energy Technologies, Task Plan 2008-2012, 2008

More than thirty State governments have set requirements for utilities to generate a percentage of electricity from renewable energy during the coming years and several States have set ambitious goals. For example the California Solar Initiative has a goal of 1.940 MWp installed PV by end–2016. In June 2007, 13 USA cities were selected by the USA Department of Energy to be inaugural members of solar America Cities. In March 2008, an additional 12 cities joined the programme. The 25 cities now involved are located in 16 States and six are among the 10 largest cities in the USA. [46] A cumulative 550 MWp of solar capacity may be required by these policies by 2010, growing to approximately 2,200 MWp by 2015, 5,300 MWp by 2020, and 6,700 MWp by 2025. [47] California's Emerging Renewables Program was managed by the California Energy Commission (CEC) and started accepting applications in March 1998. The Renewable Energy Incentive Program (REIPI) started in 2009 that includes a federal tax credit of 30 percent of total system cost of a solar system. By October 2008, 40 states had statewide net metering rules. This incentive is highly variable due to the varying costs for retail electricity in the states. In 2006, The New Jersey Board of Public Utilities (NJBPU) approved a requirement that each supplier/provider must include 22,5% of renewable electricity in the electricity it sells to retail customers by 2021. [48]

2.3.3. Asian Countries

Most Asian economies are dynamic and their impact on the global energy market is considerable, especially with rapidly growing energy demand in japan, China, India and the other Asian "tiger" economies. The Asian region is diverse geographically, economically, and socially and its energy issues and concerns vary greatly from sub-region to sub-region.

Japan had the second largest installed PV capacity in the group of 19 participating members of the International Energy Agengy (IEA). The Japanese Residential PV System Dissemination Program was launched in 1994. The program was combined with low-

[46] WEC, World Energy Council, Survey of Energy Resources,İnterim Update 2009, 2009
[47] Wiser, R. and Barbose, G., Renewables Portfolio Standarts in The Unideted States, A Status Report with data through 2007, Lawerence Berkeley National Laboratory, April 2008
[48] International Energy Agency (IEA), Promotional Drivers for PV , Photopoltaic System Programme, IEA-PVPS-TASK 10-05,2009

interest consumer loans and comprehensive education and awareness activities for PV. The subsidy was given in three categories: a) individuals installing PV systems to their own house, b) suppliers of housing development complexes or suppliers of houses built for sale, and c) local public organizations that introduce PV systems to public buildings. [49] The ending of government funding for residential PV systems in March 2006 resulted in a levelling off of the market for privately-installed systems during 2007. The Ministry of Economy, Trade and Industry (METI) began instead to support nonresidential facilities through its Field Test Project on New Photovoltaic Power Generation Technology. During 2007 the Project applied to systems with a capacity of 10 kWp or more but during 2008 it was extended to systems of 4 kWp or more where they demonstrated new module types, building material integration and new control methods. In 2007 METI revised the Renewables Portfolio Standard (RPS) Law, whereby new and renewable energy will account for 16 billion kWh in 2014. In July 2008 the Japanese Cabinet approved the Government's Action Plan for Achieving a Low-Carbon Society. The Action Plan includes a target for increasing solar power generation capacity by tenfold by 2020 (about 14 GWp) and 40-fold by 2030 (about 50 GWp).[50]

The Standing Committee of the National People's Congress of China endorsed the Renewable Energy Law on 28 February 2005. Although the Renewable Energy Law went into effect on 1 January 2006, the impact on Photovoltaic installations in China is however still limited, due to the fact that no tariff has yet been set for PV. Under 2006 Renewable Energy Law includes that both building-integrated PV systems and largescale desert PV power plants will be subject to the 'feed-in-tariff' policy. For off-grid central PV power plants in villages, the initial investment will be paid by the government, and the portion of the cost of subsequent operation and maintenance that exceeds the revenue from electricity fees will be apportioned to the nationwide electricity network by increasing the electricity tariff. End-users, whether grid-connected or off-grid, will pay for their electricity according to the 'same network, same price' principle: in other words, the electricity tariff

[49] International Energy Agency (IEA), Promotional Drivers for PV , Photopoltaic System Programme, IEA-PVPS-TASK 10-05,2009

[50] WEC, World Energy Council, Survey of Energy Resources,İnterim Update 2009, 2009

paid by PV power users will be the same as the electricity tariff paid by grid-connected power users in the same area.[51]

Government of India in early 2005, to provide access to electricity for all households within five years, has continued and gained approval for financing under the Eleventh Five Year Plan (2007–2012). By end–2007 some 110 MWp of solar PV had been installed under the Programmes, including just under 70.000 solar street lighting systems, in excess of 360.000 home lighting systems, nearly 600 000 solar lanterns and a 2.18 MWp power plant. Additionally, 7 068 solar PV pumps were active and in total some 4 200 villages and hamlets had become electrified. Under the solar Thermal programme 2.15 million m2 of solar water heating systems and over 600.000 solar cookers had been installed. The Government announced in January 2008 a new initiative to harness the solar potential of the country, that tariffs for developing and demonstrating grid interactive generation would come into effect. In the 11th Plan Period, 60 cities will attain the status of solar City with each State having at least one, with a maximum of 5. Each city's Master Plan will set out how renewable energy and energy efficiency measures will supply at least 10% of its 5-year forecast conventional energy demand.[52]

In 2002, the Renewable Energy Development Plan of **Tawian,** was approved by the Executive Yuan and it aimed for 10% or more of Taiwan's total electricity generation by 2010. This plan led to concerted efforts by all levels of the Government, as well as the general public, to develop renewable energy and to aggressively adopt its use. In 2004, Taiwan enacted "Measures for Subsidising Photovoltaic Demonstration Systems", as part of its National Development Plan by 2008. This programme provides subsidies that cover up to 50 percent of the installation costs for Photovoltaic systems. To promote the solar energy industry the Government subsidises manufacturers engaging in R&D and offers incentives to consumers that use solar energy. [53]

In Korean between end–2006 and end–2007, installed PV capacity rose by 123% to 77,6 MWp. Of the large number of support measures driving 2007's strong growth, the feed-in

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[51] EPIA, GREENPEACE, Solar generation V-2008, Solar electricity for over one billion people and two million jobs by 2020, 2008

[52] WEC, World Energy Council, Survey of Energy Resources,İnterim Update 2009, 2009

tariff and the 100.000 rooftop programme were particularly successful. The General Deployment Progamme, the Public Building Obligation Programme and the Local Deployment Programme are designed to promote the increased use of solar PV in the public sector and to raise the awareness of solar PV within the population. In September 2008 the Ministry of Knowledge Economy presented its long-term strategy, Korea goes for "Green Growth": sustainable development in a low carbon society. [54]

2.4. Research and Development for Solar Energy Technology

Research and Development - "R&D" - is crucial for the advancement of solar energy technology. In general, the government should guarantee an attractive environment for the research activities by both the private and public sector. Public research initiatives are necessary where the actions by the private sector are insufficient. The role of the public sector in energy-related research is twofold. A first role of the governments is to stimulate R&D in new energy technologies ("technology push"). This will help in resolving technical problems and reducing the costs that are typically above those of existing technologies. A second role for the governments is to create favourable conditions for deploying the new energy technologies ("demand pull"). Such market pull instruments contribute to the maturing of new technologies through "learning". There is a common believe that renewable energies are expensive. However, they are continuously becoming cheaper by technology learning and by economies of scale in contrary to fuel-based power technologies that are submitted to highly fluctuating and slowly increasing fuel prices. The investment cost of almost every technology becomes lower with mass production and technical development. The research and development studies focused on competitive prices and improving efficiency, tapping new fields of application and reducing environmental and social impacts. As an emerging industry, the renewable energy sector needs a supportive political and legal framework to reach its full potential, which includes strong public investment in research and development and better incentives for private-sector research spending.

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[53] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009

[54] WEC, World Energy Council, Survey of Energy Resources, Interim Report, 2009

In the EPIA reports, PV is expected to allow a 50% price reduction at a system level by 2020 with further future improvement potential as shown **Figure 0.14.** [55]

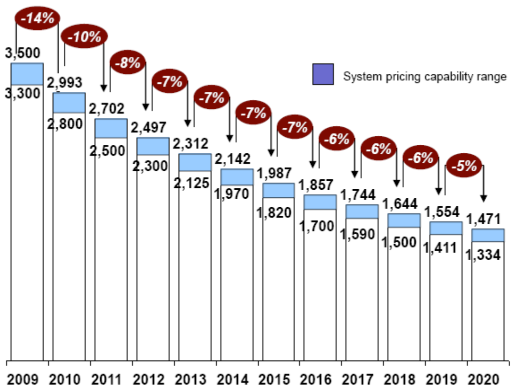

Figure 0.14 : Pricing range for larger systems (EURO/Kwp)

These figures are supported by the historic learning curve for PV modules, which shows a 20% price reduction for every doubling of the accumulated sales (see **Figure 0.15**) Cost reduction can only be achieved by continued market growth in combination with focused research efforts, and with cross-fertilisation and spin-offs from other high-tech industry sectors like flat panel displays, micro-electronics, nanotechnology, the automotive industry and the space sector. [56]

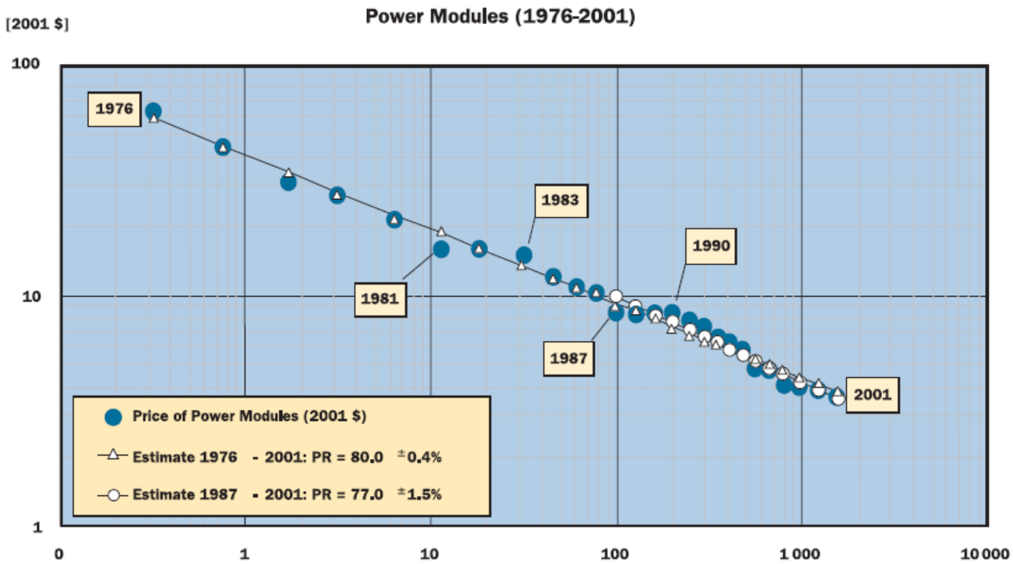

Figure 0.15 : Learning curve – PV module prices /Watt against cumulative shipment (in MW)

Learning curves have been used for several decades to analyse the cost reduction of new

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[55] EPIA, EUPV TP AGM 2009 –Vienna Presentation, 19 June2009

[56] European Comission, A Vision for Photovoltaic Technology, 2005

technologies. The concept of learning curves have been used to analyse the reduction in man-hours (or cost) per unit of a standardised product produced by an individual company. The historical trend in cost reductions expressed by learning curves has been extrapolated and used to analyse future cost reductions. [57]

2.4.1. Europian Union (EU)

The European Union has been funding research and demonstration projects with the Research Framework Programmes since 1980. In Frame Program FP4 (1994 – 1998) 85 projects were supported with a budget of 84 Million EURO. During the next Framework Programme FP5 (1998 to 2002) the budget was increased to around 120 Million EURO and was divided into research projects and demonstration projects. In the 6th Framework Programme (2002 to 2006) 810 Million EURO were foreseen for the topic "Sustainable Energy Systems", split into two equal parts for "short to medium" and "medium to long" term research, which includes PV. However, no specific budget was earmarked, especially for PV. About 107,5 Million EURO were allocated to Photovoltaic projects. The CONCERTO initiative launched by the European Commission was a Europe wide initiative proactively addressing the challenges of creating a more sustainable future for Europe's energy needs. CONCERTO is supervised by DG Energy and Transport and made available 14 Million EURO for solar related projects. During the 6th Framework Programme, the PV Technology Platform was established. The aim of the Platform is to mobilise all the actors sharing a long-term European vision for Photovoltaics. The Platform developed the European Strategic Research Agenda for PV for the next decade(s) and gives recommendations for its implementation to ensure that Europe maintains industrial leadership. For the first time, the **7th EU Framework Programme** for Research, Technological Development has a duration of 7 years and runs from 2007 to 2013. The first call for projects has allocated 237,3 Million EURO budget, 239,67 Million EURO in the second call. Research and development should lead to reduced material consumption, higher efficienciesand improved manufacturing processes, based on environmentally sound processes and cycles.[58] The Strategic Reserach Agenda (SRA) indicates that the

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[57] NEEDS RS1a, WP3, Project no: 502687, Cost development – an analysis based on experience curves, 2006
[58] JRC, PV Status Report, 2009

folowing targets **(Table 0-3)** for FP7. To reach these targets, the SRA details the R&D issues related to materials, conversion principles and devices, processing and assembly (incl. equipment), system components and installation, materials installation, operation and maintenance, concentrator systems, environmental quality, applicability, socio-economic aspects of PV. The European Union is convinced of the potential of CSP technology and currently supports the implementation of three demonstration solar thermal power plants in Europe (PS10, ANDASOL, SOLAR TRES) with a total sum of 15 million EURO with the target to reduce levelised electricity costs below 8 EUROcent/kWh by 2015. [59]

Table 0-3: Strategic research Agenda Targets

	1980	1995	2009	2015	2030	Long term potential
Typical turn-key system price (2006 €/Wp, excl. VAT)	>30	10	3-4,5	2,5	1	0,5
Typical electricity generation costs southern Europe (2006 €/kWh)	>2	0,7	0,2-0,3	0,15 (competitive with retail electricity)	0,06 (competitive with wholesale electricity)	0,03
Typical commercial flat-plate module efficiencies	up to 8%	up to %12	up to 20%	up to 20%	up to 25%	up to 40%
Typical commercial concentrator module efficiencies	(~10%)	Up to %20	up to 30%	up to 30%	up to 40%	up to 60%
Typical system energy pay-back time southern Europe (years)	>10	>5	<2	1	0,5	0,25

The European Strategic Energy Technology Plan (SET-Plan) is the EU's response to the challenge of accelerating the development of low carbon technologies, leading to their widespread market take-up. It sets out a vision of a Europe with world leadership in a diverse portfolio of clean, efficient and low-carbon energy technologies as a motor for prosperity and a key contributor to growth and jobs. Working together with stakeholders, the Commission has drawn up Technology Roadmaps 2010-2020 for the implementation of the SET-Plan. [60]

According to the SET-Plan documents; total research and devolopment investment are 470 million EURO in 2007 with an uncertainty of 25%. The required additional investment will

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[59] EU 6 Frame Program Technology Platform, A Strategic Research Agenda for Photovoltaic Solar Energy Technology, European Communities, 2007

be 6 Billion EURO towards the SET-Plan objectives. The stability of the regulatory system remains an important factor in this regard for the consolidation of investor confidence.[61]

The technology roadmaps put forward concrete action plans aimed at raising the maturity of the technologies to a level that will enable them to achieve large market shares during the period up to 2050. The main solar energy target is up to 15% of the EU electricity will be generated by **solar energy** in 2020. This European research, development and demonstration programme on low carbon energy technologies has been estimated by the Commission together with the industry to cost between 58,5 to 71,5 Billion EURO over the next 10 years, divided to solar energy with PV and CSP 16 billion EURO. The European Industrial Initiative on solar energy focuses on photovoltaics (PV) and concentrating solar power (CSP) technologies. The objective of the PV as a competitive and sustainable energy technology contributing up to 12% of European electricity demand by 2020. For the CSP component, the objective is to demonstrate the competitiveness and readiness for mass deployment of advanced CSP plants, through scaling-up of the most promising technologies to pre-commercial or commercial level in order to contribute to around 3% of European electricity supply by 2020 with a potential of at least 10% by 2030 if the DESERTEC vision is achieved. Achieving this objective for solar energy requires a substantial reduction of costs, the improvement of device efficiencies, and at the same time, the demonstration of innovative technological solutions for large scale deployment of PV and CSP and the integration of large scale PV-CSP generated electricity into the European grid, together with increasing power availability through better storage systems and hybridisation and reducing water consumption by developing new thermal cycles and dry cooling systems for CSP. The cost of the solar the programme is estimated at 16 Billon EURO over the next ten years, of which 9 EURO billion are for the PV and 7 Billion EURO for the CSP. [62] According to thise program; key performance indicators has been set as follows;

For PV;

- Reduced conventional turnkey PV system cost to <1.5 EURO/Wp by 2020
- Reduced concentrated PV system cost to <2 EURO/Wp by 2020

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[60] EU, Investing in the Development of Low Carbon Technologies (SET-Plan), COM(2009) 519 final, 2009
[61] EU, SET-Plan, Impact assessment, SEC(2009) 1297, 2009
[62] EU, SET-Plan, Technology Roadmap, SEC(2009) 1295, 2009

- Increased PV (module) conversion efficiency to > 23% by 2020
- Increased conversion efficiency of concentrated PV to > 35% by 2020
- Increased crystalline silicon and thin film modules lifetime to 40 years
- Increased inverter lifetime to >25 years by 2020
- Battery storage cost < 0.06 EURO/kWh and life > 25 years

For CSP;

- Increased solar to electricity conversion efficiency by at least 20% (relative)
- Reduce cost of installed products and O&M by at least 20% compared with state of the art in commercial plants in 2009
- Increased performance of storage and hybridisation by at least 20%
- Substantial reduction of water consumption with only minor loss of performance
- Substantial reduction in land use per MW installed

An increase to an average of 250 Million EURO per year for EU-funded renewable energy R&D would help ensure that sectors that have received less attention in recent years are also able to undertake research important to the continuing development of their technology and thereby provide the EU with the scientific knowledge necessary to maintain its leading international position across the full spectrum of renewable energy technologies. [63]

By 2005, government budget appropriations dedicated to energy R&D amounted to 2.139 Million EURO in the EU–15 and 2.194 Million EURO in the EU–27. Relative to GDP, the budget for production and utilisation of energy amount to in-between 0.01% to 0.03% in most Member States, with only Hungary, Finland and France reaching 0,04–0,05%. The government budgets for the energy sector are shown in **Figure 0.16**. [64]

[63] EURAC Agency, FP7 Research Priorities for the Renewable Energy Sector, 2005

[64] EU Commision, A European Strategic Energy Technology Plan (SET-Plan), CAPACITIES MAP, {COM(2007) 723 final}, 2007

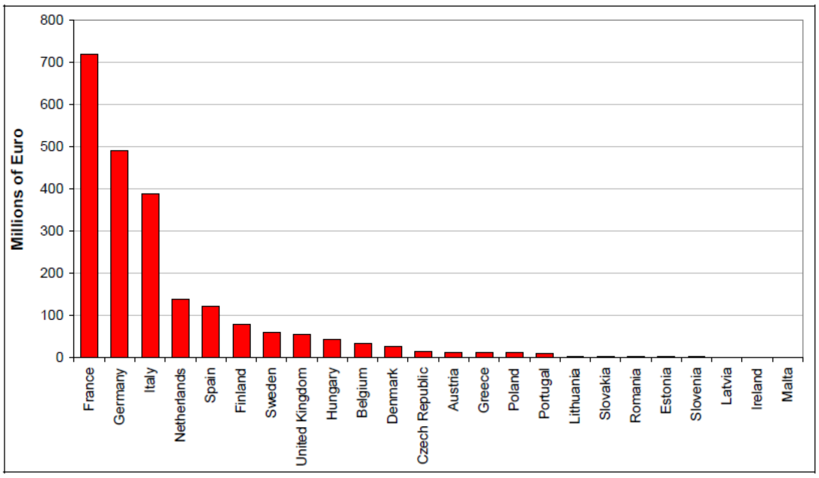

Figure 0.16 : Absolute government budget appropriations for production, distribution and rational utilisation of energy, 2005

2005, public spending for energy R&D in Japan was 60% above the aggregated spending of 17 EU Member States. (see **Figure 0.17**) The respective figures in the USA and Japan are 2429 Million EURO (nuclear 15%) and 3144 Million EURO (nuclear 64%). This corresponds to 0.086% and 0.024% of GDP for Japan and USA in 2005, respectively. [65]

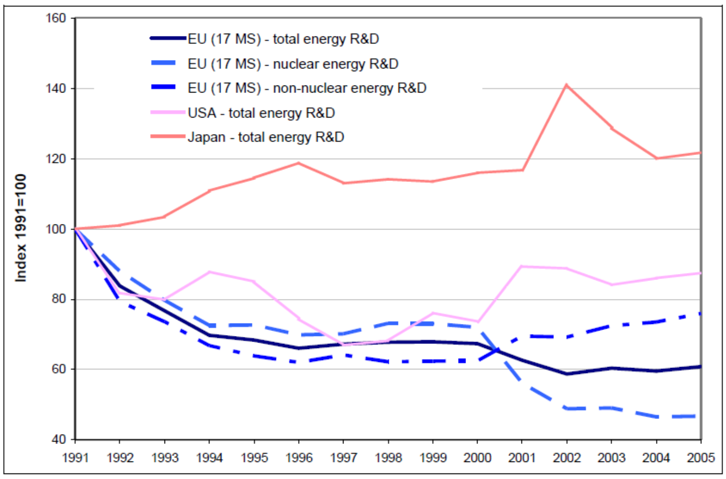

Figure 0.17 : Development of public spending on energy R&D in selected EU Member States, the USA and Japan

To improve the competitiveness and ensure the sustainability of the technology and to facilitate its large-scale penetration in urban areas and as free-field production units, as well as its integration into the electricity grid, EU has parapared a PV, CSP roadmaps as shown **Figure 0.18**. [66]

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[65] EU Commision, A European Strategic Energy Technology Plan (SET-Plan), CAPACITIES MAP, {COM(2007) 723 final}, 2007

[66] EU Comission, SET PLAN, Technology Roadmap, COM(2009) 519 final, 2009

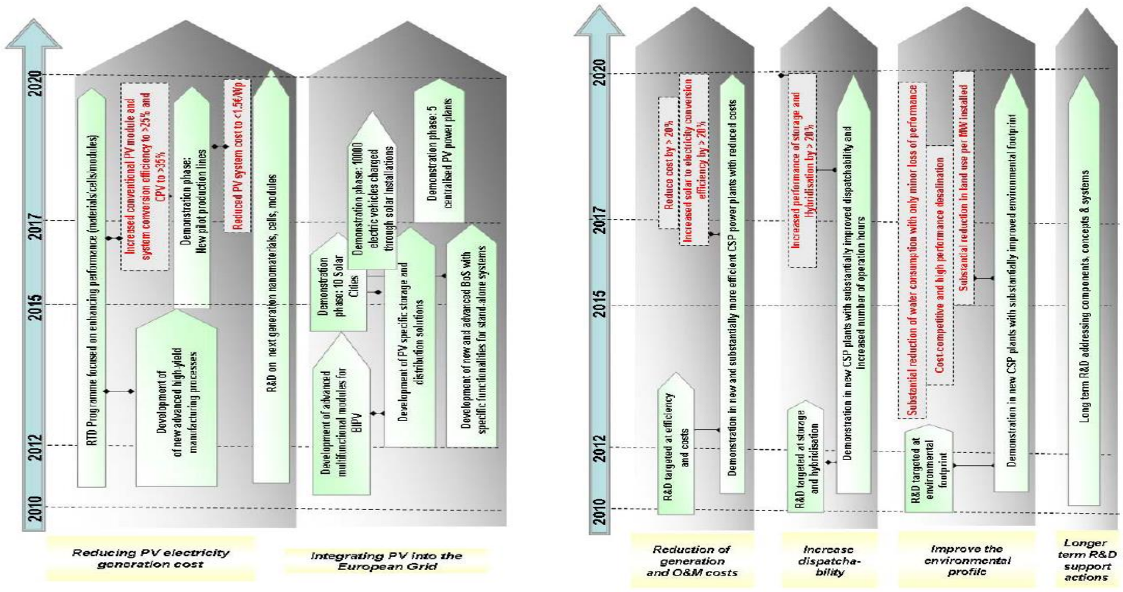

Figure 0.18 : PV and CSP roadmap

In Germany, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) takes the responsibility for the renewable energies within the Federal Government. In 2008, the BMU support for R&D projects on PV amounted to about 39,9 Million EURO shared by 130 projects in total. BMBF (Federal Ministry of Education and Research) support R&D on different aspects of PV. In 2008, 8 cooperative R&D projects were granted in total. The funds amount to a total of 19,5 Million EURO. With ındustrial R&D investments was up 190,0 Million EURO.[67] Results of the Germany PV R&D Program in 2008 ranged from new, highly-efficient solar cell designs to new processes for high-volume manufacturing of solar materials. R&D expenditure in Germany should rise to 224 million EURO in 2010.[68]

2.4.2. United State of America (USA)

The USA allocated a research and development (R&D) budget of 136,7 Million USD in 2008. These funds financed R&D and technology acceptance activities in partnership with national laboratories, universities, and private industry. [69] USA Department of Energy's Solar Energy Technologies Program (Solar Program is responsible for carrying out the

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[67] IEC, CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS, National Survey Report of PV Power Applications in Germany 2008
[68] Photovoltaic barometer, 2009

Federal role in researching, developing, demonstrating and deploying solar energy technologies) is driven by the Solar America Initiative (SAI), a Presidential initiative launched in 2007 with the goal of achieving grid-parity for solar electricity produced by photovoltaic (PV) systems across the nation by 2015 - making the SAI a nine-year effort. During the first year of the SAI, the solar Program was able to lay the initial foundation for success through aggressive research and development (R&D) efforts in collaboration with private industry and national laboratories, and expanded that effort to universities in early 2008. Simultaneously, the program launched a groundbreaking market transformation effort to help commercialize solar technologies by targeting and eliminating market barriers to solar energy, as well as promoting deployment opportunities, through partnerships with cities, companies, non-profits, and universities. The Solar Program's economic targets, as shown in **Table 0-4** were determined by an analysis of key markets and were set based on assessments of the Levelized Cost Of Energy (LCOE) for solar technologies to be competitive in these markets. Meeting the solar market cost goals will result in 5-10 GWp of PV installed by 2015 in the U.S. and 70-100 GWp by 2030. For CSP, satisfaction of these cost targets is expected to lead to installation of between 16 and 35 GWp of new generating capacity by 2030. [70]

Table 0-4 : Solar Program Cost Targets by Market Sector

Market Sector	Current U.S. Market Price Range for Conventional Electricity (¢/kWh)	Technology	Levelized Cost of Energy (¢/kWh)		
			Benchmark	Target	
			2005	2010	2015
Utility	4-0-7.6	CSP[a]	12-14	10-12	8-10[b]
		PV	13-22	13-18	5-7
Commercial[c]	5.4-15.0	PV	16-22	9-12	6-8
Residential	5.8-16.7	PV	23-32	13-18	8-10

a) Utility CSP includes up to 12 hours of thermal storage in 2020, thereby competing effectively as base load power.
b) CSP target for 2020 is 5-7 ¢/kWh; more aggressive funding will shorten that timeframe.
c) In many commercial applications, utility costs are tax deductible. In these cases, the cost of solar energy should be compared to the effective market price, considering tax effects.

The National Renewable Energy Laboratory (NREL)'s National Centre for Photovoltaics (NCPV) conducts research to support the USA Department of Energy's goal to reduce the average cost of all grid-connected PV systems from 6.25 USD/Wp to 3.30 USD/Wp for end users. Increase R&D investment to USD 250 million per year by 2010. Their targets are strengthen investments in crystalline silicon, thin film, and balance-of-systems

[69] U.S. Department of Energy by the National Renewable Energy Laboratory, National Survey Report of PV Power Applications in the United States 2008, 2009

components, as well as new system concepts that are critical to the industry now – reducing the gap between their current cost and performance and their technical potential.[71] The USA Department Of Energy allocated a research and development (R&D) budget of 136,7 Million USD in 2008. These funds financed R&D and technology acceptance activities in partnership with national laboratories, universities, and private industry.[72] USA Department of Energy solar energy research and developments budget was reached 156,12 Million USD in 2009. [73] In December 2005, the Energy Commission's Public Interest Energy Research (PIER) Program began an effort to develop a Renewable Energy research, development, and demonstration (R&D) roadmap (as shown) to provide a planning mechanism and communication tool that establishes a clear link between the priorities of the Public Interest Energy Research program in renewable energy and the key California state renewable energy policy goals.[74]

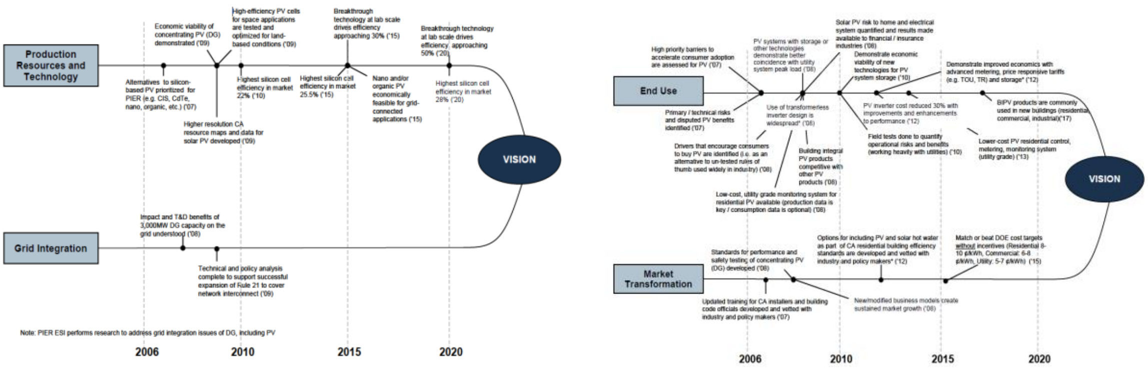

Figure 0.19: California Energy Commission PV Roadmap

2.4.3. Asian Countries

The PV industry of today looks very different to the industry of five years ago in Asian countries. Production has increased and new producers like China and Taiwan have taken major shares of the production market. Meanwhile, an increasing number of emerging

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[70] US Department of Energy, Solar Energy Technologies Program, Multi Year Program Plan 2008-2012, 2008
[71] JRC, PV Status report, 2008
[72] IEA, CO-OPERATIVE PROGRAMME ON PHOTOVOLTAIC POWER SYSTEMS, National Survey Report of PV Power Applications in the United States 2008
[73] Department of Energy, FY 2009 Congressional Budget Request, 2008
[73] California Energy Commision, PIER RENEWABLE ENERGY, TECHNOLOGIES PROGRAM, RESEARCH DEVELOPMENT AND DEMONSTRATION ROADMAP, 2007

players like India, Korea, Singapore and Malaysia are strengthening their R&D base in PV to support the growth of their own PV industry.

India's first National Action Plan to tackle climate change was published in 2008, identifying eight 'National Missions' to develop and use new technologies. In April 2009, the National Solar Mission was finalised. The actions it calls for for PV are R&D collaboration, technology transfer and capacity building. The overall mission is to make India a global leader in solar energy and to install a solar generation capacity of 20 GWp by 2020, 100 GWp by 2030 and 200 GWp by 2050. So far, R&D has aimed at the development of materials for solar cells and modules, different types of device structures, module designs and components, and systems and sub-systems, with the overall aim of reducing the costs and improving system efficiency. Production-oriented research is financed by the emerging PV industry rather than publicly. India has an excellent research base in materials science and semiconductors. [75]

Japan explores many different technology options in parallel without picking winners and losers such as solar, wind, jeothermal and others. The country's 'industrial policy' aims at creating viable, independent and sustainable businesses along the whole length of the PV value chain, from raw material production to cell, module and component manufacturing and distribution line. In 2004, Japanese organizations drafted and then revized the "PV Roadmap towards 2030" **(Figure 0.20).** [76] The Japanese Council for "Science and Technology Policy", on the "Third Science and Technology Basic Plan" (FY 2006 to 2010) planned to spend 172 Billion EURO for "Technology for innovative efficiency improvement and cost reduction to disseminate Photovoltaic power generation to the world". [77]

[75] EU PhotoVoltaic Technology Platform, 'Today's Actions for Tomorrow's PV technology - An Implementation Plan for the Strategic Research Agenda of the European Photovoltaic Technology Platform', 2009
[76] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009
[77] JRC, PV Status Report, 2008

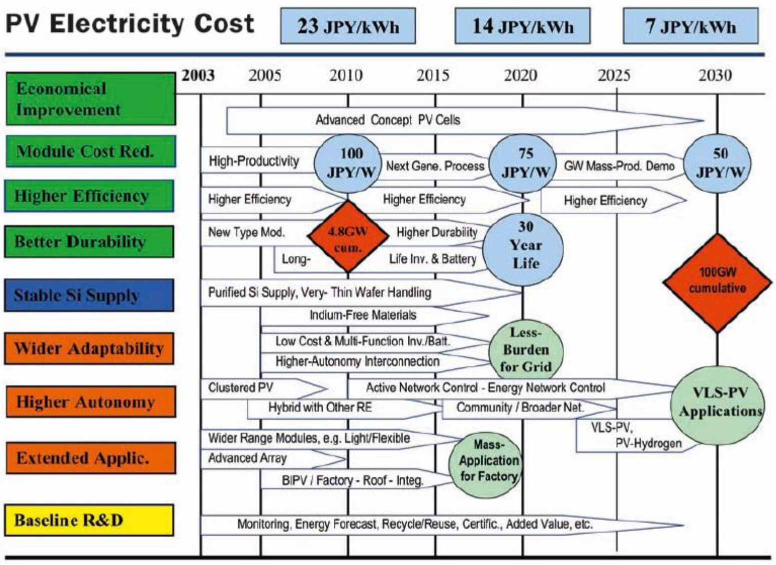

Figure 0.20: Japanese roadmap for PV R&D and market implementation

Following

TABLE 0-5 shows summary of R&D budgets of japan. As a total 138,48 Million Euro has assigned for solar related technologies in 2007. [78]

Table 0-5: Research and Development budgets for solar projects of Japan

Research Program Name	Project name	2007 Budget *	Explanation
Photovoltaic and Wind Power	Field Test Project on New Photovoltaic Power Generation Technology	7.86 billion JYN (87,246 Million USD) (61,308 Million Euro)	To further promote the introduction of PV systems to install them at public facilities, residential housing complexes, and in the industrial sector, such as at factories.
	Development of Technology to Accelerate the Practical Application of Photovoltaic Power Generation Systems	230 million JYN (2,553 million USD) (1,794 Million Euro)	in order to fully disseminate photovoltaic power generation and make the photovoltaic industry selfsustaining
	Research and Development of Next-generationPV Generation System Technologies	2.38 billion JYN (26,418 Million USD) (18 Million Euro)	their cost-effectiveness, per-formance, function, appli-cability, and usability must be drastically improved to facilitate the promotion and New Energy Technology Development
	Research and Development of Common Fundamental Technologies for Photovoltaic Generation Systems	470 million JYN (5,217 Million USD) (3,666 Million Euro)	to develop and incorporate commonly-used fundamental technologies and to reduce the cost of solar cells
	Research and Development of Technologies for New Solar Energy Utilization Systems	170 million JYN (1,887 Million USD) (1,326 Million Euro)	the objective of enhancing their practical application in new areas, such as public facilities, housing complexes, and industrial facilities
	Advanced Solar Heat Utilization Field Test Project	1 billion JYN (11,1 million USD) (7,8 Million Euro)	to promote their use in applications beyond detached houses, such as in the public sector, housing complexes, and within various industrial sectors
Grid-connected Systems	Demonstrative Project of Regional Power Grids with Various New Energies	1.15 billion JYN (12,765 Million USD) 8,97 Million Euro)	With fluctuating output power sources like solar photovoltaics, wind and other new energy-based dispersed power sources, there is a need to address the potential impact these sources could have on power grids
	Demonstrative Project on Grid-interconnection of	640 million JYN (7,104 Million USD)	As PV systems become increasingly common, they are expected to be

[78] NEDO, Energy and Environment Technology, 2007

	Clustered Photovoltaic Power Generation Systems	(4,99 Million Euro)	connected to power grids in local concentrations (concentrated connections). In such cases, however, both output restraints caused by voltage surges and the impact on grid lines will probably limit the dissemination of these systems.
	Verification of Grid Stabilization with Large-scale PV Power Generation Systems	3.5 billion JYN (38,85 Million USD) (27,3 Million Euro)	When a number of such large-scale PV systems are connected to power grids, there is a concern that the fluctuating output inherent to PV systems could affect the voltage and frequency of power on utility power grids, and result in restrictions that limit the dissemination and practical application of PV systems.
Public Solicitations	Project to Support Innovative New Energy Technology Ventures	420 million JYN (4,662 Million USD) (3,276 Million EURO)	to promote the technological development of fields related to untapped energies, including new sources/technologies such as photovoltaic power generation, biomass, wind energy and unutilized energy sources.
TOTAL SOLAR RELATED PROJECT BUDGETS		197,802 Million USD 138,43 Million EURO	

* JYN = 0,0078 Euro, 0,0111 USD

The National Basic Research Program (also called 973 Program) is China's on-going national keystone basic research program, which was approved by the Chinese government in June 1997 and is organized and implemented by the Ministry of Science and Technology. There is support for research into ‘large-area, low-cost and long-life solar cells with the support of national ministries and commissions, China has reached a PV cell efficiency of 21% in the laboratory. Commercial PV components (modules) and normal commercialised cells have respective efficiencies of 10 – 13% and 14 – 15%. The price of Chinese cells has gradually fallen from 4.40 EURO/Wp in 2000 to 2.57 EURO/Wp in 2004, which is not only crucial to the growth and maturity of China’s domestic solar energy market but also significant in connection with the international PV market. It is estimated that by 2010, the electricity generation cost with solar PV systems will decline to some 0.089 EUR/kWh, reaching or approaching the price of power on electricity markets. [79]

In Taiwan, the solar energy industry may see its output reach 9.68 Billion USD by 2015. The Industrial Technology Research Institute (ITRI), a Government- backed research organisation, has drawn up an R&D Strategy for Taiwan with the aim to lower module costs to around 1 $/Wp between 2015 and 2020. The research topics identified range from efficiency increase in the various wafer based and thin-film solar cells to concentrator concepts and novel devices. Despite the fact that the national R&D budget should be

[79] See the website of the China National Basic Research Program http://www.973.gov.cn/English/AreaItem.aspx?catid=02

doubled within the next four years, it is visible that the main focus is on the industry support to increase production capacities and improved manufacturing technologies. [80]

In South Korea, In January 2009, the Korean government announced its third national renewable energy plan, under which renewable energy sources will steadily increase their share of the energy mix to 4.3% in 2015, 6.1% in 2020 and 11% in 2030. The plan covers such areas as investment, infrastructure, technology development and programs to promote renewable energy. The Korea Institute of Energy and Resources Technology Evaluation and Planning' (KETEP) manages energy R&D. The focus of R&D has recently shifted away from development work on interconnections, electrical standards, mounting systems and other know-how related to PV installations and towards improving manufacturing technology. This research ranges from cost reduction and efficiency improvement in c-Si cells to novel thin-film solar cells and high-efficiency concentrating cells. A parallel adjustment has been made in power generation system research, away from the pursuit of high performance and towards the pursuit of cost effectiveness. [81]

2.5. Economics and Employment Effects for Solar System

Solar energy has provided millions of households with incomes, livelihood activities and employment. Avoiding Carbon emissions, environment protection, security of energy supply on a national level or other 'big issues' are for local communities an added bonus, but the primary driving force are much more likely employment or job creation, contribution to regional economy and income improvement. Consequently, such benefits will result in increased social cohesion and stability that stem from the introduction of an employment and income-generating source.

Solar energy contribute to all important elements of country or region development: economic growth through business expansion (earnings) and employment; import substitution (direct and indirect economic effects on Gross Domestic Product and trade balance); security of energy supply and diversification. Other benefits include support of

[80] JRC, Instutute of Energy, Renewable Energy Unit, 'PV Status Report 2009', August 2009
[81] EU PhotoVoltaic Technology Platform, 'Today's Actions for Tomorrow's PV technology - An Implementation Plan for the Strategic Research Agenda of the European Photovoltaic Technology Platform', 2009

traditional industries, rural diversification, rural depopulation mitigation, community empowerment, etc. The renewable energy sector provides employment to large numbers of people and will generate more jobs as it grows. They will range from highly-skilled, research-related jobs in the design and manufacture of renewable energy products to jobs requiring a lower level of skill, for instance in the maintenance of renewable energy systems and operations.

Table 0-6 contains a list of the studies reviewed about employement impacts of solar energy. Studies that focus on calculating the employment impacts of the renewables industry can be divided into two main types that are direct and indirect jobs. Direct employment includes those jobs created in the manufacturing, delivery, construction/installation, project management and operation and maintenance (O&M) of the different components of the technology, or power plant, under consideration. İndirect employment includes jobs in the supply chain such as manufacturing of steel and other supplies. Most studies report jobs in the amount of labor required to manufacture equipment or build a power plant which can deliver a maximum of one megawatt of power. As you can see

Table 0-6, The different methods, assumptions, time horizons and unique countries of focus make it difficult if not impossible to accurately compare the results of the different studies.

Table 0-6 : Employment and Economics Impacts in Different Studies for Countries

No	Year	Author	Study	Countries	Contents and Time horizon	Funding/ Investment	Job /employee effects
1	2010	Bloomberg, New Energy Finance,	Presentation 2010, http://www.newenergyfinance.com/free-publications/presentations/	World wide	Clean energy 2009	USD 145 Billion	
2	2009	EREC	Renewable Energy Technology Roadmap 20% by 2020	Europa Union	Solar thermal 2009		20,000 full time jobs
				World wide	PV 2007	EURO 14 billion	119,000 people , For CSP Power Plants, every 100 MW installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs, and 30 annual jobs in O&M.
3	2009	EU	Investing in the Development of Low Carbon Technologies (SET-Plan), COM(2009) 519 final	Europa Union	Solar power electiricity , 2020	EURO16 billion	200 000 skilled jobs
4	2009	JRC	PV Status Report	Tawian	PV, 2010	EURO 645 million	10.000 jobs created after law in 2009
5	2009	Bezdek, R.H.	American's Solar Energy Societies Estimating the Jobs Impacts of Tackling Climate Change	USA	Renewable energy and energy efficiency, 2007	USD100 billion	9 million jobs, $100 billion in corporate profit, and more than $150 billion in federal, state, and local government tax revenue.
					2030	USD 4.3 trillion Sales	37 million jobs
6	2009	O'Sullivan, M., Edler, D., Ottmüller,	Gross Employment from Renewable Energy in Germany in the Year 2008	Germany	PV	EURO 5.2 billion	57,000 jobs. In total the turnover from the German PV industry is estimated at €5.2 billion. Taking into account operations and maintenance

		M., Lehr, U.,			CSP, 2008	EURO 1.2 billion	17,400 jobs
7	2009	RWI	Economic impacts from the promotion of renewable energies: The German experience	Germany	Solar Industry, 2008		74,000 jobs
8	2009	Universidad rey Juan carlos	Study of the effects on employment of public aid to renewable energy sources	spain	PV, 2008		14.500 direct jobs 1.112517241 Investment (in Million EURO)/job
9	2008	EPIA, Greenpeace	Solar Generation V – 2008, Solar electricity for over one billion people and two million jobs by 2020	world wide	PV, 2030		by 2030, around 10 million full-time jobs it has been assumed that 10 jobs are created per MW during production and about 33 jobs per MW during the process of installation. Wholesaling of the systems and indirect supply (for example in the production process) each create 3-4 jobs per MW. Research adds another 1-2 jobs per MW.
10	2008	JRC	PV Status Report	world wide	Renewable energy and energy efficiency, 2008	USD 148 billion	
				Europa Union	PV, 2010		59,000 PV related jobs , a figure of 100,000 jobs would be realistic if export opportunities are exploited
				world wide	PV		10 jobs per MW of capacity, 36 additional jobs per MW installed capacity in the wholesale, retail, installation and maintenance services sector
11	2008	US Department of Energy	Solar Energy Technologies Program, Multi year Program Plan 2008-2012	world wide	Energy supply, 2011	USD 22 trillion	
12	2008	EUROGIA +, EUREKA Initiative,	White book, part 1, version 1	Europa Union	Renewable energy, 2008		500.000 direct and indirect employees, 900.000 new jobs by 2020 in Industry, Service and Universities and research Laboratories.
13	2008	UNEP, SEF ALLIANCE	Why Clean Energy Public Investment Makes Economic Sense -The Evidence Base	USA - California	Green Energy and PV, 2007		450.000 new jobs, 15.000 new jobs generated per billion dollars of expenditure on Photovoltaics . The estimates of jobs generated by PV differ by a factor of 8, from as few as 7.4/MW to as many as 51/MW
14	2007	Federal Ministry for The Environment, Nature Conservation and Nuclear safety, ZWs and DLR	International Workshop “Renewable Energy: Employment Effects” Models, Discussions and Results, 2007		PV		34.6 jobs/MWp for insatllation 2.7 jobs/MWp operation and maintanace
15	2006	Stoddard, L. , Abiecunas, J., and O'Connell, R. NREL	‘Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California’,	USA	CSP, 2006	USD 628 Million /100 MW capacity	94 + 13 jobs /100 MW
16	2006	Bremer Energy Institute	Renewable energies – environmental benefits, economic growth and job	Germany	Renewable energy, 1996-2006	EURO 10 billion	100.000 new jobs
17	2006	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety	Renewable Energy Employment Effect; Impact of the Expansion of Renewable Energy on the German Labour Market	Germany	renewable energy, 2020		300,000 (gross employment) by 2020
18	2005	MED-CSP, German Aerospace	Concentrating Solar Power for the Mediterranean Region Final Report, Institute of Technical	MEDA Countries	Renewable energy, 2050		2 million direct and indirect jobs

		Center (DLR),	Thermodynamics Section Systems Analysis and Technology Assessment		PV		19 direct jobs / year during construction26 direct jobs during operation (20 years)
					CSP		20 direct jobs / year during construction, 20 direct jobs / year during construction
19	2004	Kammen, D. M., Kapadia, K., Fripp, Matthias, UNIVERSITY OF CALIFORNIA BERKELEY	Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?, REPORT OF THE RENEWABLE AND APPROPRIATE ENERGY LABORATORY	USA	PV, 2020		5.65 person-yrs of employment per million dollars in investment (over 10 years)
20	2004	Boira-Segarra, I. (Mott McDonald)	Renewable Supply Chain Gap Analysis, Study on behalf of the Department of Trade and Industry, January 2004.	UK	renewable energy, 2020		£15 billion to £19 billion capital expenditure, 17,000 to 35,000 jobs could be sustained by the industry
21	2003	Environment California Research and Policy Center,	Renewable Energy and Jobs Employment Impacts of Developing Markets for Renewables in California	USA , california	PV , 2001		7.14 jobs/MW for PV for construction, 0.12 jobs/MW for opration

These studies employ a wide range of methods, which adds credence to the findings, but at the same time makes a direct comparison of the numbers difficult. Some of studies, authors have been used interview models with important players and projects in the industry. Some studies that focus on calculating the employment impacts of the renewables industry have been used input-output models (I-O). I-O models calculate direct employment but also account for *indirect jobs* that are induced through multiplier effects of the industry under consideration. I-O Analyses that consider the complete value chain and the interdependence of the different economic sectors in most of studies. For the analysis of the aspects of gross and net employment, I-O Analysis provides a very comprehensive tool. To improve the modeling of the behavior of the economy over time, I-O tables can be combined with macro-economic and macro-econometric models. Within these models, labor models, tax models and other macroeconomic aspects are incorporated. Paying attention to the types of jobs created is especially important for regional and state-level policy.

The level of employment sustained by the industry varies significantly across the technologies. This is illustrated in **Figure 0.21** for all phases of a project. **Figure 0.21** give a breakdown of the employment per MW at each level of the supply chain for construction and operation respectively. [82]

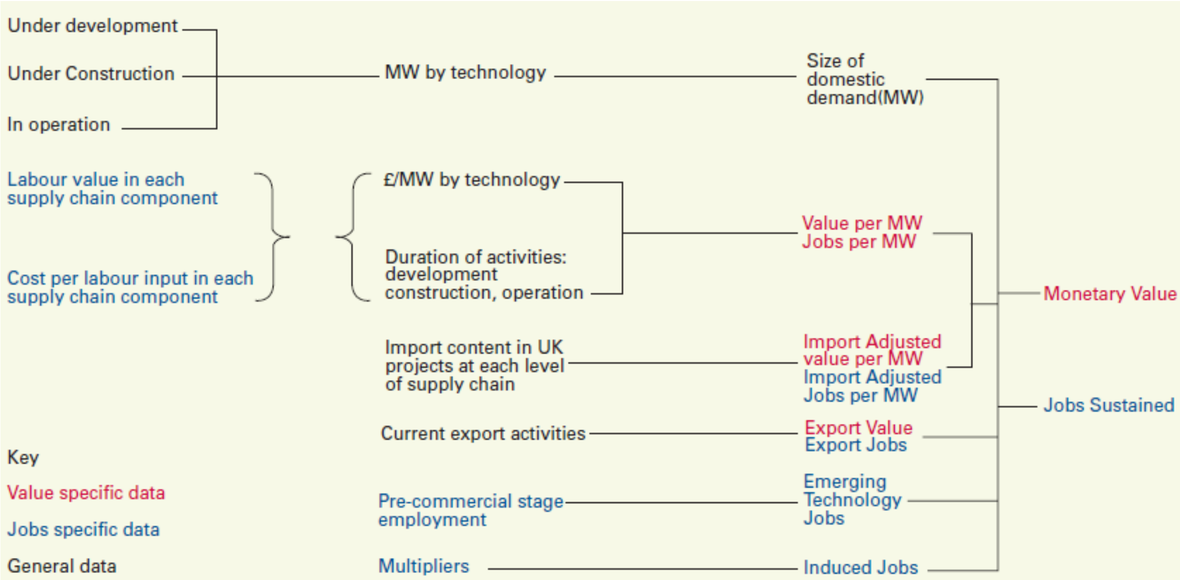

Figure 0.21 : Estimation of industry value and jobs sustained

According to the EPIA-greenpeace studies, more jobs are created in the installation and servicing of PV systems than in their manufacture, the result is that by 2030, around 10 million full-time jobs would have been created by the development of solar power around the world. As shown **Table 0-7, t**he majority of those would be in installation and marketing. Based on information provided by the industry, it has been assumed that 10 jobs are created per MWp during production and about 33 jobs per MWp during the process of installation. Wholesaling of the systems and indirect supply (for example in the production process) each create 3-4 jobs per MWp. Research adds another 1-2 jobs per MWp.[83]

[82] Boira-Segarra, I. (Mott McDonald), Renewable Supply Chain Gap Analysis, Study on behalf of the Department of Trade and Industry, January 2004.
[83] EPIA, Greenpeace, Solar Generation V – 2008, Solar electricity for over one billion people and two million jobs by 2020, 2008

Table 0-7 : Worldwide employment in PV-related jobs under Solar Generation Scenarios

year	Installation	Production	Wholesaler	Research	Supply	Total
Advanced Scenario						
2007	77,688	22,968	6,890	2,986	8,613	119,145
2010	220,162	62,546	18,764	8,131	23,455	333,058
2015	559,282	147,373	44,212	19,159	55,265	825,292
2020	1,632,586	393,530	118,059	51,159	147,574	2,342,907
2025	3,877,742	839,338	251,801	109,114	314,752	5,392,747
2030	7,428,118	1,406,841	422,052	182,889	527,565	9,967,466
Moderate Scenario						
2007	77,688	22,968	6,890	2,986	8,613	119,145
2010	166,518	47,306	14,192	6,150	17,740	251,906
2015	486,219	128,121	38,436	16,656	48,045	717,478
2020	1,018,552	245,519	73,656	31,917	92,070	1,461,713
2025	1,806,321	390,978	117,294	50,827	146,617	2,512,037
2030	2,770,569	524,729	157,419	68,215	196,773	3,717,705

According to the EREC Report; employment in the European solar thermal sector already exceeds 20,000 full time jobs. With the expected growth of solar thermal, more than half a million people will be employed in the solar thermal sector in just a few decades. In 2007, a world-wide production volume of 3 GWp of PV modules was reached, and with a turnover of more than EURO 14 billion, the PV industry employs over 119,000 people. For CSP Power Plants, every 100 MWp installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs, and 30 annual jobs in O&M. [84]

Table 0-8 allows for a simple comparison between the jobs created per unit of power delivered from each energy technology in USA. In scenarios, assumptions that a 20 percent Renewable Portfolio Standard (RPS) will be achieved by 2020. The mix of renewables (exclusive of hydro) used to meet the RPS in these scenarios. The results show that that in all cases, the RPS produces more jobs in manufacturing, construction and installation, as well as in O&M and fuel production and processing, than the corresponding fossil-fuel scenarios. Investment in renewables also generates more jobs per dollar invested than the fossil fuel energy sector. The solar PV industry generates 5.65 person-yrs of employment per million dollars in investment (over 10 years) and the wind energy industry generates 5.7 person-yrs of employment per million dollars in investment (over 10 years). In contrast, every million dollars invested in the coal industry generates only 3.96 person-

[84] EREC, Renewable Energy Technology Roadmap 20% by 2020, 2009

yrs of employment, over the same time period. Supporting the renewable energy industry will benefit sectors of the economy and states that currently suffer from high unemployment.[85]

Table 0-8 : Jobs in the renewables

Scenarios	Average employment associated with each scenario (jobs)		
	Construction, Manufacturing, Installation	O&M and Fuel Processing	Total Employment
Scenario 1: 20% Renewable Portfolio Standard (RPS) by 2020 (85% biomass, 14% wind energy, 1% solar PV)	52,533	111,136	163,669
Scenario 2: 20% Renewable Portfolio Standard (RPS) by 2020 (60% biomass, 37% wind energy, 3% solar PV)	85,008	91,436	176,444
Scenario 3: 20% Renewable Portfolio Standard (RPS) by 2020 (40% biomass, 55% wind energy, 5% solar PV)	111,879	76,139	188,018
Scenario 4: Fossil Fuels as Usual to 2020 (50% coal and 50% natural gas)	22,711	63,657	86,369
Scenario 5: 20% Gas Intensive by 2020 (100% natural gas)	22,023	61,964	83,987

According to the International Energy Agency report about PV, as shown **Table** 0-9, approx 17 Billion USD revenue and 100.000 direct employment has been created in 2007. [86]

Table 0-9: Economics benefits of PV

Year	2006	**2007**	growth
Total value of business	~10 Bill. USD	**~ 17 Bill. USD**	70 %
Total direct employment	70,000	**100,000**	40%
Annual installed capacity	1.5GW	**2.3GW**	53%

Job creation impact of CSP development information that is given by the Abengoa Solar in Solucar Platform-Sevilla for 500 MWp is as follows; [87]

- 2000 jobs for manufacturing of some components (assuming 50% local sourcing)
- More than 1500 jobs during construction

[85] Kammen, D. M., Kapadia, K., Fripp, Matthias, Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?, REPORT OF THE RENEWABLE AND APPROPRIATE ENERGY LABORATORY, UNIVERSITY OF CALIFORNIA BERKELEY, 2004

[86] IEA, PVPS, Trends in photovoltaic applications, 2008

[87] Abengoa Solar Letter to the Minister of Energy and Natural Sources – Turkey, 16 March 2010

- Around 100 highly qualified staff will be needed during the plants lifetime
- More than 300 jobs for operation and maintance during the entire life of the plant

Greenpaece report demonstrates that the solar thermal industry is capable of becoming a dynamic, innovative 15 Billion EURO annual business within 20 years, unlocking a new global era of economic, technological and environmental progress. A scenario prepared by Greenpeace International and the European Solar Thermal Power Industry Association projects what could be achieved by the year 2020 given the right market conditions. It is based on expected advances in solar thermal technology coupled with the growing number of countries which are supporting projects in order to achieve both climate change and power supply objectives as following numbers. [88]

Capacity of solar Thermal Power in 2020	21,540 MWp
Electricity Production in 2020	54.600.000 MWh (54,6 TWh)
Cumulative Investment	USD 41,8 billion
Employment Generated	200,000 jobs
Carbon Emissions Avoided 2002 – 2020	154 million tonnes CO2
Annual Carbon Emissions Avoided in 2020	32,7 million tonnes CO2
Capacity of solar Thermal Power in 2040	630,000 MWp
Electricity Production in 2040	1573 TWh
Percentage of Global Demand	5%

In most countries, the dependency on energy imports is reduced, opening new business opportunities for industrial development. Renewable energies require a lot of labour on all industrial levels from base materials like steel, glass and concrete to civil engineering and high tech-applications. Increased industrial activities will create **job opportunities named Green jobs**. Green jobs are defined as work in agricultural, manufacturing, research & development, administrative and service activities that contribute substantially to

[88] Greenpeace, Solar Thermal Power 2020, EXPLOITING THE HEAT FROM THE SUN TO COMBAT CLIMATE CHANGE, 2009

preserving or restoring environmental quality.[89] "Green jobs" and "green-collar jobs" are evocative and potentially galvanizing terms; they are also notoriously ambiguous. [90] Solar panel installers, wind tower mechanics, biofuel technicians etc will be middle-skill jobs requiring more than high school, but less than a four-year degree many PhDs, financial analysts, and engineers hold green jobs and directly contribute to the building of a green economy to high-wage jobs in a multitude of industries, including renewable energy, energy efficiency, and biofuels can be significantly affected by state policy and meaningfully supported by established workforce development systems The green jobs requires a wide range of skills including:

- professional project development skills associated with the exploitation of business opportunities (e.g. financial management, business planning, project management legal skills, marketing and sales & services).
- technical skills associated with the manufacture, construction and installation of renewable energy projects (e.g. electrical, mechanical, civil, combustion, process, electronics, software and environmental engineering).
- specialist technical skills in engineering, environmental and planning at a professional level associated with consultancy services, project development and R&D activities.
- specialist knowledge of complex form manufacturing, such as gear profile manipulations, modelling and design.
- heavy engineering and specialist skills in marine offshore technology associated with the design, development and installation of offshore wind, wave and tidal projects.
- skills necessary to develop and maintain a fuel supply system for energy crops.
- power system design and engineering which includes specialist software and hardware
- control skills to allow for monitoring more complex networks that result from increased renewable projects.

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[89] UNEP Green Jobs: Towards decent work in a sustainable, Low-Carbon world

[90] Center on Wisconsin Strategy, The Workforce Alliance , The Apollo Alliance, Greener pathways, Jobs and Workforce Development in the Clean Energy Economy, 2008

New environmental and energy laws and policies will create of tens of thousands of new jobs in the world. Green jobs especially solar have been defined Green Jobs Guide. Some of them have been given as following **Figure 0.22**. [91]

Solar power design, project management, sales & marketing

Solar Energy Engineer

Description: Perform site-specific engineering analysis and evaluation of energy efficiency and solar projects involving residential, commercial and industrial customers by utilizing building simulation software

Salary: $75,000 - $80,000/year

Min. Educational Req.: Bachelor's Degree in an Engineering discipline

Recommended College Coursework: Engineering, Physics

Certification: Professional Engineer, Engineer-In-Training, and/or Certified Energy Manager (CEM) are desired

Experience Needed: High Level
3-10 years related experience/training
3-5 years of facility-related engineering experience
2-5 years of experience within the green building, energy efficiency, building science or related field.

Desired Education: Master's degree a plus

Growth Potential: Current growth rates show California will provide over ½ of national solar energy by 2011

Employer Type: Private Firms

Related Careers:
1. Electrical Engineer

PV Power Systems Engineer

Description: Drive the development and implementation of highly efficient grid-connected systems for Concentrated PV technologies

Salary: $76,000 - $88,000/year

Min. Educational Req.: Master's in Electric Power Engineering or Energy Efficiency OR Bachelor's with strong work experience.

Recommended College Coursework: Electrical Engineering, Renewable Energies, Physics

Experience Needed: High Level
3-8 years experience including large-scale grid interconnect systems experience

Growth Potential: High growth alongside the rest of the solar energy sector

Employer Type: Private Firms, Government, Power Plants/Facilities

Related Careers:
1. Solar Systems Designer
2. Photovoltaic Engineer
3. Energy Engineer

Residential/Commercial Solar Sales Consultant

Description: Establish sales plans, prepare proposals and close client deals

Salary: $45,000 - $85,000/year – range due to commission

Min. Educational Req.: Bachelor's Degree

Recommended College Coursework: Marketing, Sales, Sciences

Experience Needed: Mid-Level
2-5 years experience in commercial and/or in-home sales.

Growth Potential: Grows with, and helps propel, the solar industry

Employer Type: Private Firms

Related Careers:
1. Energy Conservation Representative

PV Fabrication & Testing Technician

Description: Device fabrication, and testing of flexible, translucent plastic solar cells which generate energy from the sun

Salary: $22-$27/hour

Min. Educational Req.: Associate's Degree in Electronics/ Electrical Engineering, Material Science, Physics, Chemistry or related discipline OR equivalent training and work experience

Recommended College Coursework: Electronics, Electrical Engineering, Chemistry, Solar, Physics, Material Science

Experience Needed: Entry Level
2 years work experience in a laboratory environment is highly desirable

Growth Potential: High growth alongside the rest of the solar energy sector

Employer Type: Private consulting, Government, Power Plants/Facilities

Related Careers:
1. Solar Lab Technician
2. Solar Energy Systems Designer

Solar Lab Technician

Description: Performs a variety of tests on solar devices, examines test samples and reads blueprints, diagrams, instruments and operational instructions.

Salary: $19-$25/hour

Min. Educational Req.: Associate's Degree in related field

Recommended College Coursework: Physics, Chemistry, Mechanical/Electrical Engineering, Solar

Experience Needed: Entry Level
Demonstrate ability to perform all common laboratory tests, record lab results, and provide feedback

Growth Potential: High growth alongside the rest of the solar energy sector

Employer Type: Private Firms, Government, Power Plants/Facilities

Related Careers:
1. Solar Energy Systems Designer
2. PV Power Systems Designer

Solar Fabrication Technician

Description: Fabricates and assembles solar panels and arrays using machine shop tools and equipment

Salary: $10-$15/hour

Min. Educational Req.: HS Diploma/GED

Experience Needed: Entry Level
A combination of 3 – 6 months of directly related training and/or experience is typically required

Growth Potential: Current growth rates show California will provide over ½ of national solar energy by 2011

Employer Type: Private Firms, Government, Power Plants/Facilities

Related Careers:
1. Solar Energy System Installer
2. Solar and PV installation: Roofer

Green Jobs Guidebook Page 8

Figure 0.22: JOB Description of green jobs

2008 UNEP ILO study on Green Jobs conducted in collaboration with the WorldWatch Institute reports that there are 170.000 jobs in PV, 624.000 jobs in CSP sector in the world by 2008. UNEP estimates that if the sustainable energy sector grows to 630 Billion USD by 2030, this could translate into at least 20 million additional direct and indirect jobs, including 2 million in wind and 6 million in solar. Investment in improved building efficiency alone could generate an additional 2–3 million green jobs in Europe and the United States by 2030. Energy efficiency in the buildings and construction sector could both reduce carbon emissions and create jobs in the process, namely by greening its 110

[91] Green Job Guidebook, 2008–2009, http://www.edf.org/article.cfm?contentid=8466&redirect=cagreenjobs

million existing jobs. The job potential will be higher in developing than in industrialized countries mainly due to lower labour costs.[92]

2.5.1. European Union (EU)

The european oil and gas service and supply industry largely contributes to the economy by providing many jobs, estimated as being over 500.000 direct and indirect employees. The european renewable energy has the potential to create over 900.000 new jobs by 2020 in Industry, Service and Universities and research Laboratories. [93] According to the SET-Plan of EU; The total public and private investment needed in Europe over the next 10 years is estimated as 16 Billion EURO. Up to 15% of EU electricity could be generated by solar power in 2020 as a result of such a programme coupled with market-based incentives. More than 200 000 skilled jobs could be created.[94] The PV industry can be of great importance to Europe in terms of wealth and employment, with 59,000 PV related jobs in the EU in 2010 if the targets are met, and a figure of 100,000 jobs would be realistic if export opportunities are exploited." According to EPIA, new PV production facilities create about 10 jobs per MW of capacity, adding about 36 additional jobs per MW installed capacity in the wholesale, retail, installation and maintenance services sector.[95]

More than 100.000 new jobs that have been created in the German renewable energy industry during the last 10 years raise hope that the renewable energy industry could be a job motor for many countries in the EU. Thus, it seems at first sight that renewable energies can guarantee both – protection of the environment and economic growth and job creation. Therefore, the deployment of renewable energies seems to be the ideal solution to achieve the goals set in the Lisbon Agenda - i.e. environment, economic growth and job creation. Recent studies state that the present investment in RES amounts to more than 10 Billion EURO and that over 200.000 jobs have been created in the renewable energy

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[92] UNEP, SEFİ, New Energy Finance, Global Trends in Sustainable Energy Investment2009 Analysis of Trends and Issues in the Financing of Renewable Energy and Energy Efficiency, 2009
[93] EUROGIA +, EUREKA Initiative, White book, part 1, version 1, May 2008
[94] EU, Investing in the Development of Low Carbon Technologies (SET-Plan), COM(2009) 519 final, 2009
[95] JRC, PV Status report, 2008

industry in the EU (EREC a 2004), among them more than 100.000 in Germany. [96] For the Photovoltaic (PV) sector the past year was a great success. In total the turnover from the German PV industry is estimated at 5.2 Billion EURO. Taking into account operations and maintenance this adds up to 57,000 jobs. From 2007 to 2008 the German Solar thermal market almost doubled and thus recovered from its slump. A first estimate of the total turnover in this sector amounts to approx. 1.2 Billion EURO. Including operations and maintenance this adds up to 17,400 jobs.[97]

Over the time period from 2005 to 2020, cumulative investments of 130 Billion EURO (all data given in prices from 2000) in systems for using renewable energy (electricity, heat) are associated with this development. The annual domestic turnover in the sector, including system operation, will increase to nearly 15 Billion EURO/annually by 2020. Under these conditions the number of jobs in the German renewable energy sector could increase to over 300,000 (gross employment) by 2020. As shown **FIGURE 0.23** Continuing this development, more than 330,000 jobs by 2030 are realistically conceivable.[98]

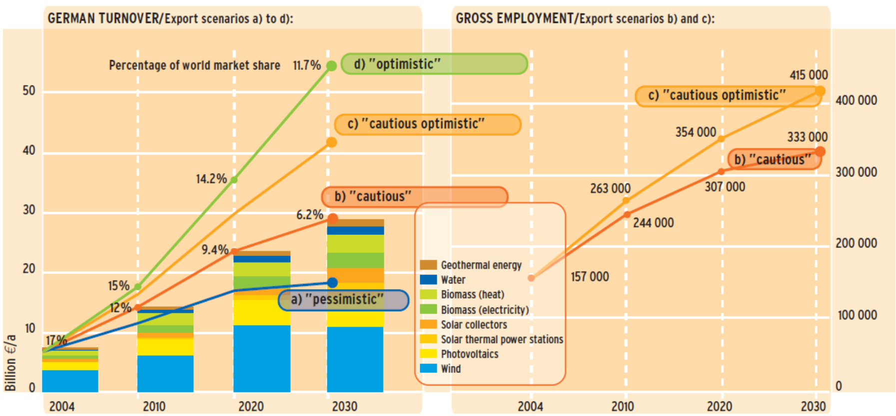

FIGURE 0.23 : Turnover of German businesses domestically and abroad, as well as the corresponding grosses employment effects until 2030

As shown **Figure 0.24** In total, gross employment from private activity is around 273,700 for the year 2008. Including employment from the use of public and commonuse funds this number rises to 278,000 representing an increase of 12% compared to 2007. Solar energy

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96 Bremer Energy Institute, Renewable energies – environmental benefits, economic growth and job creation, Case Study Paper, 2006

97 O'Sullivan, M. (DLR), Edler, D., (DIW), Ottmüller, M.,(ZSW), Lehr, U., (GWS), 2009, 'Gross Employment from Renewable Energy in Germany in the Year 2008'

98 Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Renewable Energy Employment Effect; Impact of the Expansion of Renewable Energy on the German Labour Market, 2006

demonstrated the largest growth and added approximately 27% to total employment. For the Photovoltaic (PV) sector the past year was a great success. Others renewables has small growth according to the prior year. But jobs in solar energy has jumped to 74.000 jobs in 2008 from 25.000 jobs in 2004 (3 times in 4 year).[99]

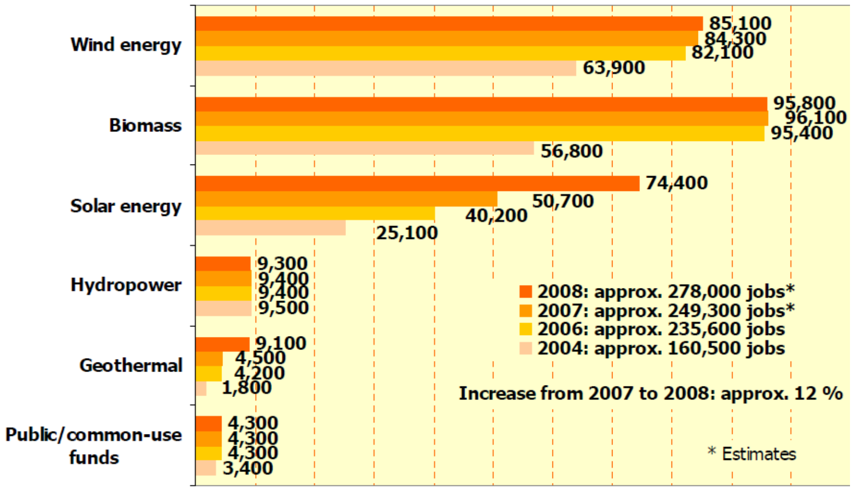


Figure 0.24 : Development of gross employment from renewable energy in Germany

2.5.2. United State of America (USA)

According to the NREL-CA Solar Benefits reports; ın terms of economic return, for each 100 MWp of installed capacity, the CSP plant was estimated to create about USD 628 million in impact to gross state output. For each 100 MWp of generating capacity, CSP was estimated to generate 94 permanent jobs and 13 jobs for combined cycle and simple cycle plants, respectively. Each dollar spent on CSP contributes approximately USD 1.40 to California's Gross State Product; each dollar spent on natural gas plants contributes about USD 0.90 – 1.00 to Gross State Product. **Table 0-10** shows that constructing one 100 MWp CSP plant has a direct impact to Gross State Output of over USD 150 million and an indirect impact of over USD 470 million. The table also shows that about 455 job-years of direct employment are created during the construction of the facility, which equates to over USD 51 million in direct earnings. The table also shows that the plant results in about 38 permanent jobs directly

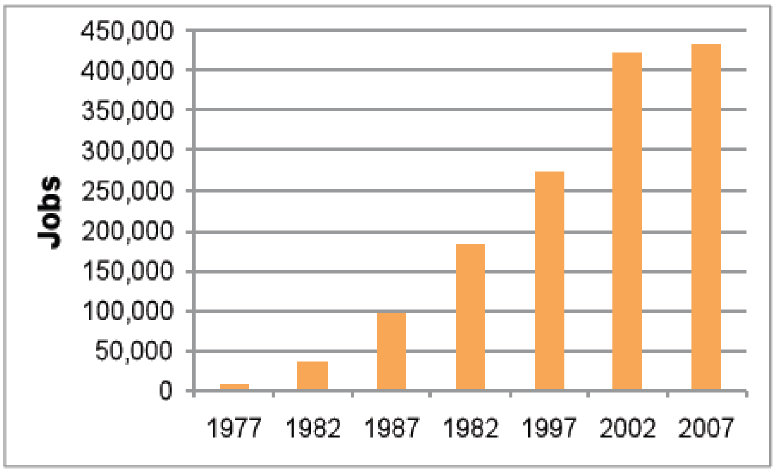
[99] Marlene , O., (DLR), Dietmar , E.,(DIW), Marion , O.,(ZSW), Ulrike, L., (GWS), 2009, 'Gross Employment from Renewable Energy in Germany in the Year 2008'

created by the operation of the plant; another 56 jobs are indirectly created by the operation of the plant. [100]

Table 0-10 : Economics Impacts of solar energy technology

Construction phase	Direct Impact	Indirect Impact
Gross State output (Million USD)	151	470
Earnings (Million USD)	51	144
Employment – job-years	455	3500
Production phase	**Direct Impact**	**Indirect Impact**
Gross State output (Million USD)	2,4	10,4
Earnings (Million USD)	3,14	2,54
Employment – job-years	38	56

FIGURE 0.25 shows the net job creation in the USA state of California over the past three decades from investments in green energy programs – total job gains in excess of the jobs lost in the fossil fuel industries and the carbon fuel supply chain. By 2007, annual net job creation totalled nearly 450,000 in the state and 15.000 new jobs generated per billion dollars of expenditure on Photovoltaics. [101]



Source: University Of California and Management Information Services, Inc., 2009

FIGURE 0.25: Job creation in USA

[100] Stoddard, L. , Abiecunas, J., and O'Connell, R., 2006, 'Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California', NREL

[101] UNEP, SEF ALLIANCE, Why Clean Energy Public Investment Makes Economic Sense -The Evidence Base, 2008

The Electric Power Research Institute (EPRI) report includes estimates of job creation from renewable energy that construction employment rate is 7.14 jobs/MWp for PV, operating employment rate is 0.12 jobs/MWp for PV.[102] The Solar Energy Research Education Foundation (SEREF) has produced maps illustrating the growth of jobs likely to result from growth in the solar energy industry for the USA. They got help from Google Earth Outreach and Google.org to produce the maps using Google Earth technology. The maps show over 400,000 new jobs due to solar energy industry growth by the year 2016.[103]

[102] Environment California Research and Policy Center, Renewable Energy and Jobs Employment Impacts of Developing Markets for Renewables in California, 2003
[103] http://www.gearthblog.com/blog/archives/2009/03/us_solar_jobs_map.html

3. Solar Energy In Turkey

Electricity has been one of the most important energy inputs for industrial development in Turkey. In addition to the industrialization process, Turkish daily life met the benefits of using energy for satisfying basic needs, such as heating, transportation, etc. The rapid improvements in technology, changing environmental concerns, financial contingencies, differentiation in the composition of the energy resources used, and indigenous and exogenous factors, all have shaped Turkey's energy polices throughout the 20th century. Nevertheless, there have been certain parameters for the implementation of the energy strategy. The main objective of the energy policy is to meet the energy needs of an increasing population and a growing economy in a continuous, quality and secure manner at a minimum cost in a competitive free market environment. Within this framework; use of domestic and renewable resources in electricity production will be expedited to reduce the overdependence on imported natural gas. Natural gas usage will be expanded through a competitive process and natural gas supply security, taking the seasonal demand variations into account, will be ensured at a national level. Due studies will be continued to make Turkey a transit country and a hub for the transportation of energy (oil, gas and electricity) resources in our region to the world markets.[104]

3.1. The Structure of the Power Market in Turkey

The Republic of Turkey (Turkey) is located between Europe and Asia. Its surface area is 783,562 km2 of which approximately 97% is in Asia and 3% is in Europe. Turkey's geographical location makes it a natural land bridge connecting Europe to Asia. Therefore, it has an increasingly important role to play as an 'energy corridor' and 'energy hub' from the major oil and natural gas producing countries in the Middle East and Caspian Sea to Europe. In addition, Turkey, with its young population, growing energy demand per person, fastest growing urbanization, and economic development, has been one of the fast growing power markets in the world for the last two decades. The table below depicts the

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[104] DPT, Medium Term Program 2010-2012, September 2009

historical and projected relationship between population, economic output and energy demand.[105]

Table 3-1: POPULATION, ECONOMY AND ENERGY IN TURKEY

Year	Population (000s)	GNP* /Capita	Total GNP (USD)	Electiricity Demand (tWh)	Electiricity demand per capita Kwh/capita
1973	38,072	1,194	75,915,568	12,4	326
1990	56,098	2,674	150,006,052	56,8	1013
1995	62,171	2,861	177,871,231	85,6	1376
2000	67,618	3,303	223,342,254	128,3	1,892
2010	78,459	5,366	421,010,994	286,6	3,653
2020	87,759	9,261	812,736,099	566,5	6,455

(Source : TUBİTAK 2023 Vision Documents in Energy, 2003)

With the social and economic development of the country, the demand for energy and particularly for electricity is growing rapidly. Primary energy consumption of Turkey is increasing at an average rate of 2.8% or 107,625 million ton of oil equivalent (Mtoe) per year. By the end of 2007, the annual electricity consumption reached a total 191.6 terawatt hours (TWh). As shown in **Table 3-2**, 53.1% of primary energy production is derived from coal, 15.4% from renewable energy sources. Wood and plants and oil are also important components of energy consumption with natural gas providing the smallest percent contribution. .[106]

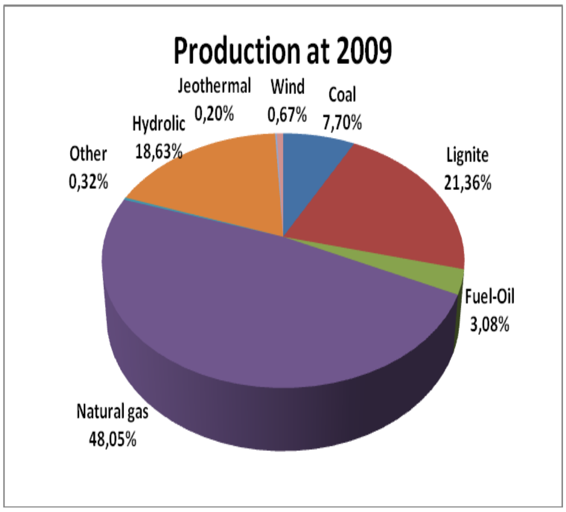
Table 3-2: Annual Primary Energy and Demand for Turkey, 2008 (1,000 ton oil equivalent**)**

Resources	Coal	Wood & Plant	Oil	Natural Gas	Renewable	Electricity (import/export)	Total
Primary energy production	16.674	4.813	2.268	931	4,592	0	29.192
Ratio of production (%)	57,1	16,5	7,8	3,2	15,4	0,0	100,0
Primary energy demand	31.391	4.813	31.784	33.807	4.506	-29	106,273
Ratio of demand %	29,5	4,5	29,9	31,8	4,3	0,0o	100,0
Rate of production compared to demand %	53,1	100,0	7,1	2,8	100,0	0,0	27,5

(Source: ETKB, 2009)

[105] Koyun, Ahmet, Regional Activity Centre, March 2007, “Mediterranean and National Strategies for Sustainable Development Priority Field of Action 2: Energy and Climate Change, Energy Efficiency and Renewable Energy Turkey” - Summary, Plan Bleu

As shown in **Figure 3.1** and TABLE 3-3, 48.05% electricity production derived from natural gas, 29.06% from coal-lignite and 19,5% from renewable energy sources (hydro, wind and geothermal).[107] Due to insufficient domestic resources, 97% of natural gas, 93% of fuel oil, 20% of coal-lignite demand for elecricty generation has been imported.[108]



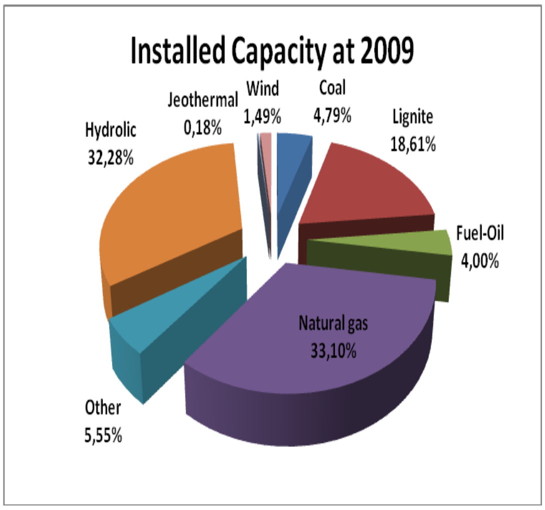


Figure 3.1: Electric production in Turkey, by resource type and installed capacity at 2009
Source : DPT, 2010 Orta Vadeli program

Table 3-3: Installed power and electircty productıon accordıng to the resources

	2008		2009		2010	
	Installed Capacity (MW)	**Production (GWh)**	**Installed Capacity (MW)**	**Production (GWh)**	**Installed Capacity (MW)**	**Production (GWh)**
Coal	**1.986**	**15.858**	**2.121**	**15.000**	**2.170**	**16.700**
Lignite	**8.109**	**41.858**	**8.245**	**41.600**	**8.250**	**40.700**
Fuel-Oil	**1.745**	**7.209**	**1.772**	**6.000**	**1.840**	**6.300**
Natural gas	**13.428**	**98.685**	**14.662**	**93.600**	**15.428**	**99.500**
Other	**2.327**	**530**	**2.460**	**620**	**2.482**	**700**
Hydrolic	**13.829**	**33.270**	**14.302**	**36.300**	**14.800**	**36.000**
Jeothermal	**30**	**162**	**80**	**380**	**80**	**450**
Wind	**364**	**847**	**658**	**1.300**	**950**	**2.150**
TOTAL	**41.818**	**198.419**	**44.300**	**194.800**	**46.000**	**202.500**

Source : DPT, 2010 Orta Vadeli Program

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[106] World Energy Council, "Effects of Global Crises on Energy Sector in Turkey", DEK-TMK Publication No: 0012/2009, June 2009.
[107] DPT, 2010 Orta vadeli program, 2009
[108] TEÜAŞ, Elektirik Üretim Sektör Raporu, 2008

The Turkish Electricity Transmission Corporation (TEIAS) published its capacity projection report in October 2009. The study period for the generation capacity projection is 10 years and it covers the period from 2009 to 2018. The gross electricity consumption (equal to gross generation + imports – exports) has expected to reach to 194 TWh in 2009. The reduction in gross electricity consumption from 198 TWh in 2008 to 194 TWh in 2009 is a two percent reduction attributable to the global economic crisis. A base and a low demand forecast have been prepared by the Ministry of Energy and Natural Resources (ETKB). Base demand is calculated by the State Planning Organization (DPT) and is based on the contribution to GDP by agriculture, mining, manufacturing, energy, construction, transportation and other service sectors up to 2030. Low demand is calculated with the assumption of a 4.5% yearly increase in GDP starting from the year 2009. The base demand scenario projects a 7.4% yearly increase in demand will occur between 2016-2018 and in the low demand scenario, the projection is an increase of 6.6%. The projections have been adjusted to reflect the economic crisis which began at the end of 2008, and its effect on the demand of electricity. As a result, in 2009, a 2% contraction in demand for electrical energy will be included. **Table 3-4** shows the actual value of peak load and electricity consumption between 1999-2008 and projections of the base demand scenario [109].

Table 3-4: Peak Load and Electricity Consumption in the Turkish Electricity System (1999-2008)

Year	Peak Load (MW)	Rate Increase (%)	Electricity Consumption (GWh)	Rate Increase (%)
1999	18,938	6.4	118,485	3.9
2000	19,390	2.4	128,276	8.3
2001	19,612	1.1	126,871	-1.1
2002	21,006	7.1	132,553	4.5
2003	21,729	3.4	141,151	6.5
2004	23,485	8.1	150,018	6.3
2005	25,174	7.2	160,794	7.2
2006	27,594	9.6	174,637	8.6
2007	29,249	6	190,000	8.8
2008	30,517	4.3	198,085	4.2
2009	29,900	-2.0	194,000	-2.1
2010	31,246	4.5	202,730	4.5
2011	33,276	6.5	215,907	6.5
2012	35,772	7.5	232,101	7.5

[109] "Turkish Electrical Energy 10-Year Generatıon Capacıty Projectıon (2009-2018)", TEIAS Official web page, http://www.teias.gov.tr/eng/

2013	38,455	7.5	249,508	7.5
2014	41,339	7.5	268,221	7.5
2015	44,440	7.5	288,338	7.5
2016	47,728	7.4	309,675	7.4
2017	51,260	7.4	332,591	7.4
2018	55,053	7.4	357,202	7.4

Source : TEİAŞ

By the end of 2008, Turkey had a total installed electricity capacity of 41,800 MWp. Power plants under construction (including those granted license and with an expected in-service date from EPDK) are listed with a breakdown of the installed capacities by primary resources using the base demand scenario and will add up to 14,864 MW to this capacity through 2016 as shown **Table 3-5** below.[110]

Table 3-5: Installed Capacity of Private Sector Power Plants and State-Owned Power Plants under Construction (by primary resources)

	Installed Capacity (MW) by Year								
Resource	2009	2010	2011	2012	2013	2014	2015	2016	Total
Private Sector Power Plants Granted by License and Expected In-Service on Proposed Date									
Biogas	2.6								2.6
Waste Gas (LFG)		11.4	7.8						19.2
Other – Low Grade Lignite	187.1		410.3	1,215.8	1213.3				3,026.5
Natural Gas	91.9	145.6	805.9	1,911.9					2,955.3
Fuel Oil	67								67
Lignite	1.7								1.7
Geothermal	54.9								54.9
Hydro	562	1,024.7	1,007.5	1,818.7					4,412.9
Wind	205.8	173.3	269.5						648.6
TOTAL	1,173	1,355	2,501	4,946.4	1,213.3	0	0	0	11,188.7
State-Owned Power plants Under Construction									
Thermal					840				840
Hydro	495.3	470.4	670					1200	2835.7
TOTAL	495.3	470.4	670	0	840	0	0	1200	3675.7
Combined Totals									
Thermal	347.7	145.6	1,216.3	3,127.7	2,053.3				6,890.6
Hydro	1,057.3	1,495.1	1,677.5	1,818.7				1,200	7,248.6
Wind+Renwabable	263.3	184.7	277.3						725.3
TOTAL	1,668.3	1,825.4	3,171.1	4,946.4	2,053.3	0	0	1,200	14,864.5

Source : TEİAŞ

[110] "Turkısh Electrıcal Energy 10-Year Generatıon Capacıty Projectıon (2009-2018)", TEIAS Offical web page, http://www.teias.gov.tr/eng/

As summarized in **Table 3-6**, the government estimates electricity generation from renewable sources is expected to increase from 35.5 TWh in 2003 to 62 TWh by 2010 and 118 TWh by 2020 but most of this growth is from hydro**.** [111]

Table 3-6: Current and Projected Renewable Energy Projects in Turkey

Resource Type and Percentages of Total	2003	2005	2010	2015	2020
Hydro (GWh)	35,330	47,287	57,009	82,095	109,524
Geothermal, solar and wind (GWh)	150	490	5,274	7,020	8,766
Renewable Energy Generation (GWh)	35,480	47,777	62,283	89,115	118,290
Share of total generation of renewable (%)	25	29	26	25	25

Source : IEA

As shown **Figure 3.2** ratio of renewable energy installed capacity of total power is decreasing after 2000. [112]

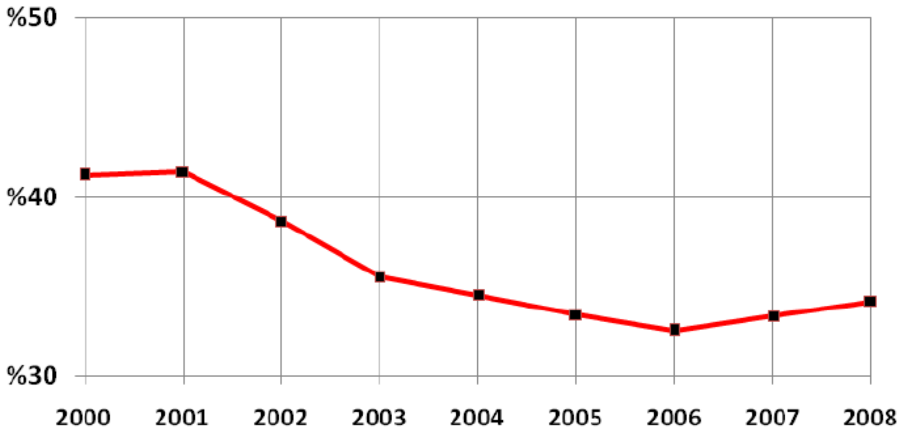

Figure 3.2 : The ratio of total power installed capacity of renewable energy
Source : ETKB

The Turkish government has developed an energy policy aimed at diversifying energy sources and suppliers and attracting private capital. Special attention in the government's energy policy is paid to the development of international cooperation. State owned installed capacity and generation amounts have grown approximately 3.5 times between 1984 and 2007. On the other hand, the increase of private sector installed capacity has grown 13 times and the generation amount has grown 25 times in the same period.[113]
The total investment needed for power plants and distribution lines up to 2010 is estimated to be approximately USD 45 billion, USD 19 billion of which will be developed using

[111] OECD/International Energy Agency (IEA), "Energy Policies of IEA Countries", Turkey 2005 Review, 2005.
[112] ETKB, Strateji Belgesi 2010-2014, 2009

either the build-operate-transfer (BOT) or build-own-operate (BOO) models. The huge size of this investment makes it impossible to lay the burden entirely on public finances. Private capital has to be introduced into Turkey's electricity sector to meet these requirements [114]. At current projections, the energy sector of 2023 will require USD 130 billion of investment and electricity demand by 2020 will be 420,000 GWh. In 2007, Turkey spent a total of USD 33.9 billion and in 2008, USD 48.2 billion importing energy supplies and related materials. Following table **Table 3-7** shows imported recources ratio across in the years [115]. As shown **Figure 3.3**, External dependency ratio is around 73%-75% at last 5 years [116]. According to the DPT reports, energy imported will be forcasted around 34,5 Million USD in 2010.

Table 3-7 : Turkey's energy ımport

	Total Import	Coal	Crude fuel oil and natural gas	Processed coal and fuel products	Total energy	Ratio of energy %	Coal %	Fuel and natural gas %
2000	54.303	615	6.196	2587	9.398	17,3	6,5	65,9
2001	41.055	300	6.076	1799	8.175	19,9	3,7	74,3
2002	50.954	689	6.193	2191	9.074	17,8	7,6	68,3
2003	68.874	929	7.766	2833	11.528	16,7	8,1	67,4
2004	97.047	1.222	9.366	3797	14.384	14,8	8,5	65,1
2005	116.207	1.579	14.140	5507	21.226	18,3	7,4	66,6
2006	139.069	1.978	19.220	7631	28.828	20,7	6,9	66,7
2007	169.388	2.570	21.784	9492	33.846	20	7,6	64,4
2008	201.257	3.315	31.109	13829	48.252	24	6,9	64,5
2009(9ay)	100.142	2.194	11.854	7.394	21.443	21,4	10,2	55,3

Source : TMMOB

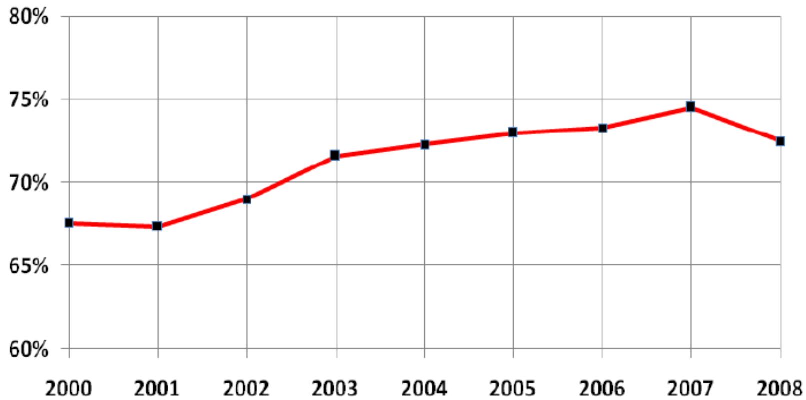

Figure 3.3:: External depedency ratio in Turkey between 2000-2008
Source : EPDK

[113] "Turkısh Electrıcal Energy 10-Year Generatıon Capacıty Projectıon", (2009-2018), TEIAS Offical web page, http://www.teias.gov.tr/eng/
[114] "Mediterranean and National Strategies for Sustainable Development Priority Field of Action 2: Energy and Climate Change, Energy Efficiency and Renewable Energy Turkey" (Summary), Koyun, A., March 2007.
[115] Türkyılmaz, O, 'Türkiye'nin Enerji Görünümü', TMMOB, 2010
[116] EPDK, Strateji belgesi 2010-2014, 2009

In Turkey's announced development plans, the main objectives of its energy policy are to ensure sufficient, reliable and economical energy supplies in order to maintain economic and social development, to meet the growing energy demand, reform and liberalize the energy sector to increase productivity and efficiency and to advance transparency. However, specific strategic plans, and targets focusing on solar energy have not yet been announced and published by the government. Fortunately, non-profit organizations and research networks are continuing their efforts on a solar energy roadmap for Turkey. One of these, UFTP (the National PV Technology Platform in Turkey) has completed a PV roadmap for Turkey (October 2009). The objectives are:[117]

- Contribute and support new legislation for solar energy by first quarter of 2010.
- Establish the first solar energy plant with a capacity of 20 MWp by second quarter of 2012, and
- Reach the following capacities by 2017. Complete the following solar objectives by year and MWp.

Year	MWp
2012	20
2013	30
2014	50
2015	200
2016	400
2017	600
2018	800
2019	900
2020	1,000
Total	4,000

Installed power target of 4 GWp by 2020, locally produce 50% of panels, cells and inverters by 2020.

[117] "Roadmap for PV in Turkey", UFTP, October 2009, http://www.trpvplatform.org/index_eng.html.

Academicians and industry representatives have been working on roadmap for solar energy in Turkey at the conference Solar Future 2010[118] organized by ICAT (the International Center of Applied Thermodynamics) and Yeditepe University. In the case study section, this roadmap preparation study has been written detailed.

3.2. Regulatory Framework and Government Incentives for Solar Technologies

Turkey's strategic plan prepared by Ministry of Environment and Forest, was announced in Copenhagen According to that document 'Turkey has set a goal to produce 25% of its total energy consumption from renewable energy sources (RES) in 2020.'In order to meet this, and other objectives, Turkey is working on legislation to support its renewable energy market. Energy development in Turkey has been dominated by public investment and management since independence in 1923. In 1971, the Turkish Electricity Authority became responsible for all electricity generation and distribution in the country. Since 1983 several waves of liberalization have been launched leading to a gradual opening and improvement of the Turkish energy market. Within the context of the restructuring efforts in the energy sector in the country parallel to the developments in the world, some arrangements have been made for transition to the liberal market system and for providing a competitive environment. As a result of these arrangements, in year of 1994 as per 12.08.1993 dated and 93/4789 numbered Decree of Ministry, Turkish Electricity Authority (TEK) had been restructured into Turkish Electricity Generation, Transmission Company (TEAŞ) and Turkish Electricity Distribution Company (TEDAŞ) as shown **Figure 3.4** and later, it has been restructured as three separated State Economic Enterprises on February 05, 2001 by 2001/2026 dated Cabinet Decree; there are 4 Government owned following companies (EUAS, TEIAS,TETAS and TEDAS) operating in each area. [119]:

- Electricity Trade: TETAS, Turkish Electricity Trading and Contracting Co. Inc.
- Electricity Generation: EUAS, the Turkish Electricity Generation Company
- Electricity Transmission: TEIAS, the Turkish Electricity Transmission Company
- Electricity Distribution: TEDAS, the Turkish Electricity Distribution Company.

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[118] The Solar 2010 conference, 11-12 February 2010, Istanbul Turkey.
[119] TETAS, Sektör Raporu, 2009

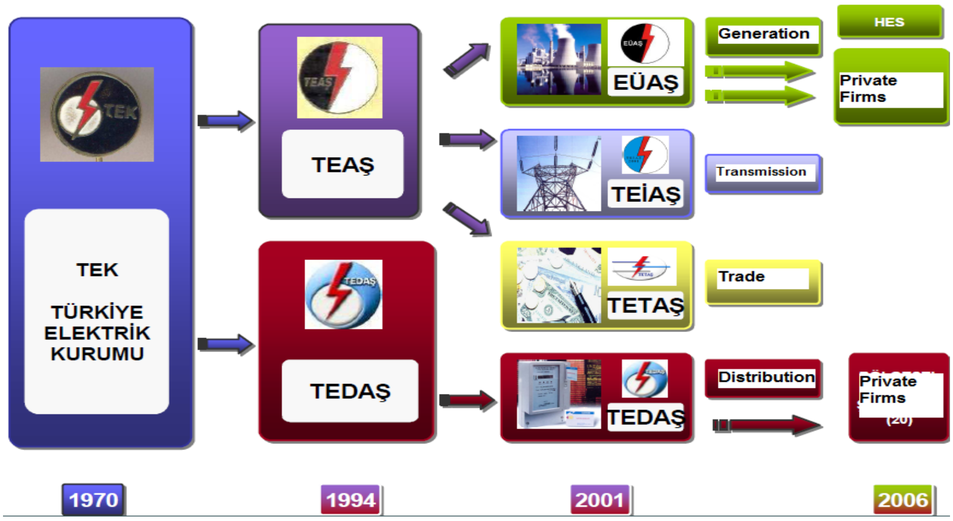

FIGURE 3.4 : ELECTIRCTY authority transformation in Turkey

Legislation was adopted in February 2001 to allow competition in the electricity market and adapt Turkey's legislation for European Union (EU) membership. Turkey established EPDK (the Energy Market Regulatory Authority), which has issued most of the necessary secondary legislation. The original legislation was supplemented by the 2004 Electricity Strategy. Laws introduced in 2003 and 2005 expanded the duties of the market to direct, to monitor, to regulate and to supervise the petroleum and liquefied petroleum gases market.[120]

Working with the framework developed over the last decade, the Turkish government has tried to create an attractive environment for capital investments and trade through: incentives, loans, tax/investment reduction and exemption. The administrative and financially autonomous regulatory authorities regulate the market activities in a stable, transparent and non-discriminatory manner to ensure the stability of the investors. In principle, if these aspects are applied to solar energy, they should help facilitate the development of that energy resource.Turkey has made early and extensive use of development models for new power plants such as:

- Build, Own and Operate (BOO) with ownership remaining with the private company during and after the power purchase agreement (PPA) term expires;

[120] "Energy Policies of IEA Countries", Turkey 2005 Review, International Energy Agency

- Build, Operate and Transfer (BOT) with private companies building the plant with contracts to operate the plant under a negotiated PPA for a period of time (usually 20 years) before ownership reverts to the state utility; and
- Transfer of Operation Rights (TOOR) with the operational rights of an existing state-owned plant being transferred to private companies for a period of 20-30 years.

The state agencies, shown in **Table 3-8**, have responsibility for planning and implementing energy policy in Turkey.

Table 3-8: Energy Policy Planning and Implementation Organizations in Turkey

Main Organization	Specific Office or Agency
Responsible for Energy Policy Planning	
Prime Minister	DPT, State Planning Organization
	TUBITAK, Scientific and Technical Research Council of Turkey
Ministry of Energy and Natural Resources	Research, Planning and Co-ordination Board
	Directorate-General for Energy Affairs
	Directorate-General of Mineral Affairs
	Directorate-General of Petroleum Affairs
Responsible for Energy Policy Implementation	
Ministry of Energy and Natural Resources	Directorate-General for Energy Affairs
	TEIAS, Turkish Electricity Transmission Company
	TEUAS, Turkish Electricity Generation Company
	TEDAS, Turkish Electricity Distribution Company
	TETAS, Turkish Electricity Trading and Contractor Company
	DSI, Directorate-General of State Hydraulic Works
	TPAO, Turkish Petroleum Company
	Directorate-General of Petroleum Affairs
	Directorate-General for Mining Affairs
	EIE, Electric Power Resources Survey and Development Administration
	BOTAS, Turkish Pipeline Corporation
	TKI, Turkish Coal Enterprises
	TTK, Turkish Hard Coal Enterprises

Turkey is taking steps to respond to the threat of climate change and is a signatory to the United Nations Framework Convention on Climate Change (May 2004). In February 2007, the Turkish Grand National Assembly adopted a decision to set up its own Research Commission on the causes and effects of global warming in the country. In addition, Turkey signed the Kyoto Protocol in February 2009. As a result of these climate change efforts, the use of renewable energy sources is being encouraged by the Ministry of Environment. The encouragement and support of the universities and this increased NGO awareness will accelerate the implementation of renewable energy policies and legislation. The main objectives of the of Turkey's energy policies (including renewable energy) are to:

- Meet demand using domestic energy resources (highest priority). In the middle to long-term this will be accomplished via a mix of public, private and foreign capital.
- Develop existing energy sources while accelerating the deployment of new and renewable sources.
- Diversify energy sources and avoid dependence on energy imports from a single source or country.
- Encourage private sector investment and accelerate capacity construction and privatization of the power industry.
- Improve the reliability of the electricity supply through upgrades to the transmission and distribution system.
- Improve energy efficiency including transmission losses.
- Protect the environment and public health.

Below is an overview of the development of energy legislation in Turkey from 2001 to present as it relates to large-scale solar.[121]

Electricity Market Law (No: 4628) 3 March 2001 : The scope of this law covers generation, transmission, distribution, wholesale, retailing and retailing services, import, export of electricity; rights and obligations of all real persons and legal entities directly involved in these activities; establishment of Electricity Market Regulatory Authority (EPDK) and determination of operating principles of this authority; and the methods to be

[121] Source: EPDK official web page, http://www.epdk.gov.tr/.

employed for privatization of electricity generation and distribution assets. The privatization of electricity generation, distribution and transmission will lead to the growth of the solar energy market, regulate all related processes at all stages of development and will reduce outstanding legal and bureaucratic issues. In abolishing the monopolistic structure of the electricity sector with this new legal framework, the government intended to open the sectors of the electricity market to competition. The sectors operate under the supervision of Energy Market Regulatory Authority (EPDK) and natural monopolies are regulated by EPDK [122]. The Law is based on bilateral market agreements for balancing the market and imbalances will be corrected through the bid and offer process of market participants. The operation of this market started 1 August 2006 and, from that date, prices have been determined by the market. Under no condition can licenses be transferred. Licenses are issued for a period of up to 49 years, with a minimum term for generation, transmission and distribution licenses of 10 years. The facilities, records of accounts must be made available for EPDK's inspection and audit, and licensees must provide any information and documents to EPDK upon its request. Within the framework of Electricity Market Law and the related secondary legislation, generation plants that generate electricity based on renewable energy sources are supported by the following mechanisms:

- **Discounted licensing fee.** The legal entities applying for licenses for the construction of facilities based on domestic natural resources and renewable energy resources pay only one percent of the total licensing fee.
- **Annual license fee waiver.** The generation facilities based on domestic natural resources and renewable energy resources do not pay annual license fees for the first eight years following the facility completion date inserted in their respective licenses.
- **Priority connection.** The Turkish Electricity Transmission Company (TEIAS) and/or distribution licensees are obliged to assign priority for system connection of generation facilities based on domestic natural resources and renewable energy resources.

- **Buying requirement for non-eligible consumers.** Applicable for sales to non eligible consumers; if the price of electricity generated at generation facilities based on renewable energy resources is equal to or lower than the sales price of TETAŞ and if there is no cheaper alternative, the retail licensees are obliged to purchase such energy for the purposes of re-sale to the non-eligible consumers.
- **RES private wholesale electricity purchase.** The electricity production firm which uses renewable energy could purchase electricity in the calender year with the permission of their licences limit.

As shown

FIGURE 3.5 after electiricty market law, private sector's share has been increased in electricity production in Turkey. [123]

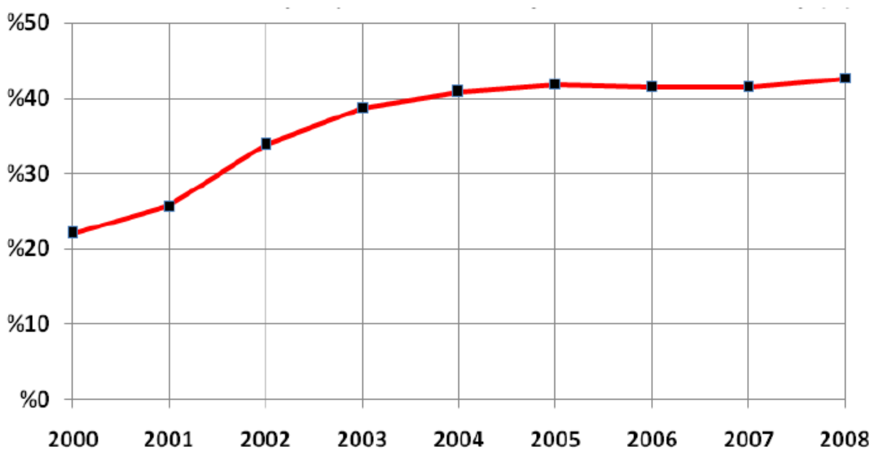

Figure 3.5 : Private sector's share in the production of electric energy

The Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (No: 5346) 18 May 2005 : The purpose of this Law is to expand the utilization of renewable energy resources for generating electricity, to benefit from these resources in secure, economic and qualified manner, to increase the diversification of energy resources, to reduce greenhouse gas emissions, to protect the environment and to develop the related manufacturing sector for realizing these objectives. Under the scope of this Law, other secondary legislation was issued in the Official Gazette [124] including:

[123] ETKB, Strateji Belgesi 2010-2014, 2009

[124] Source: Official Gazette, 4 October 2008, numbers 27049 and 25956

- Technical evaluation of wind energy license applications
- Renewable energy certificate (REC) procedures

BY-LAWS REGARDING CHANGES TO THE REC PROCEDURES WERE PUBLISHED MOST RECENTLY ON 21 OCTOBER 2009 AND SET THE GOVERNMENT PRICE FOR THE WIND AND HYDRO ENERGY CERTIFICATES AT A FIXED PRICE OF BETWEEN 5 AND 5.5 EURO CENT/KWH FOR 10 YEARS. THE PRICE IS VALID FOR PLANTS INSTALLED UNTIL END OF 2011, THOUGH THE GOVERNMENT CAN EXTEND THIS DATE FOR TWO YEARS. FOLLOWING THIS LAW, THE WIND ENERGY LICENSING ACTIVITIES INCREASED RAPIDLY. WIND LICENSE APPLICATIONS RECEIVED HAVE REACHED APPROXIMATELY 32,000 MWP. SOLAR ENERGY LICENSING IS EXPECTED TO SIMILARLY INCREASE WITH THE NEW LAW. AS SHOWN
FIGURE 3.6 installation power of wind resources has been boomed. [125]

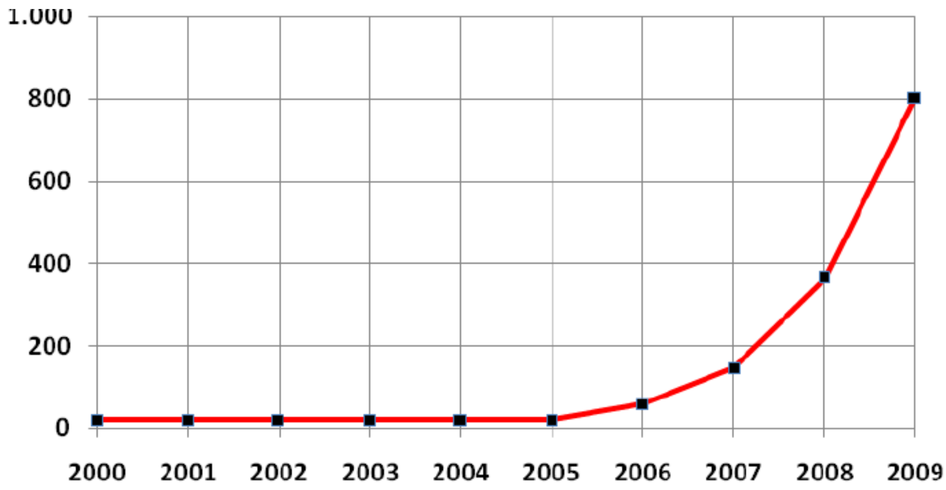

Figure 3.6 : Wind installation power after renewable energy sources law
Source : EPDK

Licensing Procedures: Below are the main principles and legal procedures required for license applications for wind projects, and must be fulfilled by companies wanting to be active in the energy market. It is expected that a similar approach will be used for large-scale solar plants. The license procedures are usually completed within 30-90 days. To receive a license, legal entities apply to Energy Market Regulatory Authority (EPDK) by submitting an Application Form. EPDK seeks an opinion regarding the interconnection and usage of the proposed plant(s) to the transmission and/or distribution system from the Turkish Electricity Transmission Company (TEIAS). A license will be granted to the company that fulfills the aforementioned obligations via a decision of the EPDK. Licenses are granted for a maximum of 49 years. The minimum period for production, transmission and distribution licenses is 10 years. Legal entities who obtain a license from the EPDK must notify the General Directorate of the start of construction 30 days prior to beginning.

[125] EPDK, Strateji belgesi 2010-2014, 2009

The principles and procedures regarding financial settlement by the EPDK are different according to the energy purchase and sales quantities. It is mandatory for participants to be registered with the EPDK. For registration, participants will submit the documents to be announced on the EPDK website following completion of legislation, along with the relevant forms and notarized authorization documents for the persons who sign the forms.[126] The required documents will be similar to those for wind projects. The documents are expected to include:

- Application letter,
- Written engagement confirming the relevant legislation,
- Certificate of authority and related official company documents (trade register, information about investors and managers, a bank letter of guarantee, etc), and
- Information about the project (an information form, investment schedule, distribution and transmission line diagram, 1/25,000 scale map, 1/5,000 scale plant layout, etc.)

If local natural resources are used by the production facility, then an agreement with DSI, the General Directorate of State Hydraulic Works, and other related permissions with the related governmental agencies are required. The land acquisition process for project investments is executed by the Turkish Electricity Transmission Company, General Directorate (TEIAS) under the authorization of EPDK. Use of private of land is recommended by EPDK. The following **Figure 3.7** shows the land appropriation process for energy projects.[127]

[126] "Operational Procedures Document for Land Acquisition and Expropriation in World Bank Financed Projects, TEIAS, http://www.teias.gov.tr/eng/ December 2005
[127] "Appropriation of Land for Energy Projects", Leblebici, N, EPDK, WEC Congress, October 2009

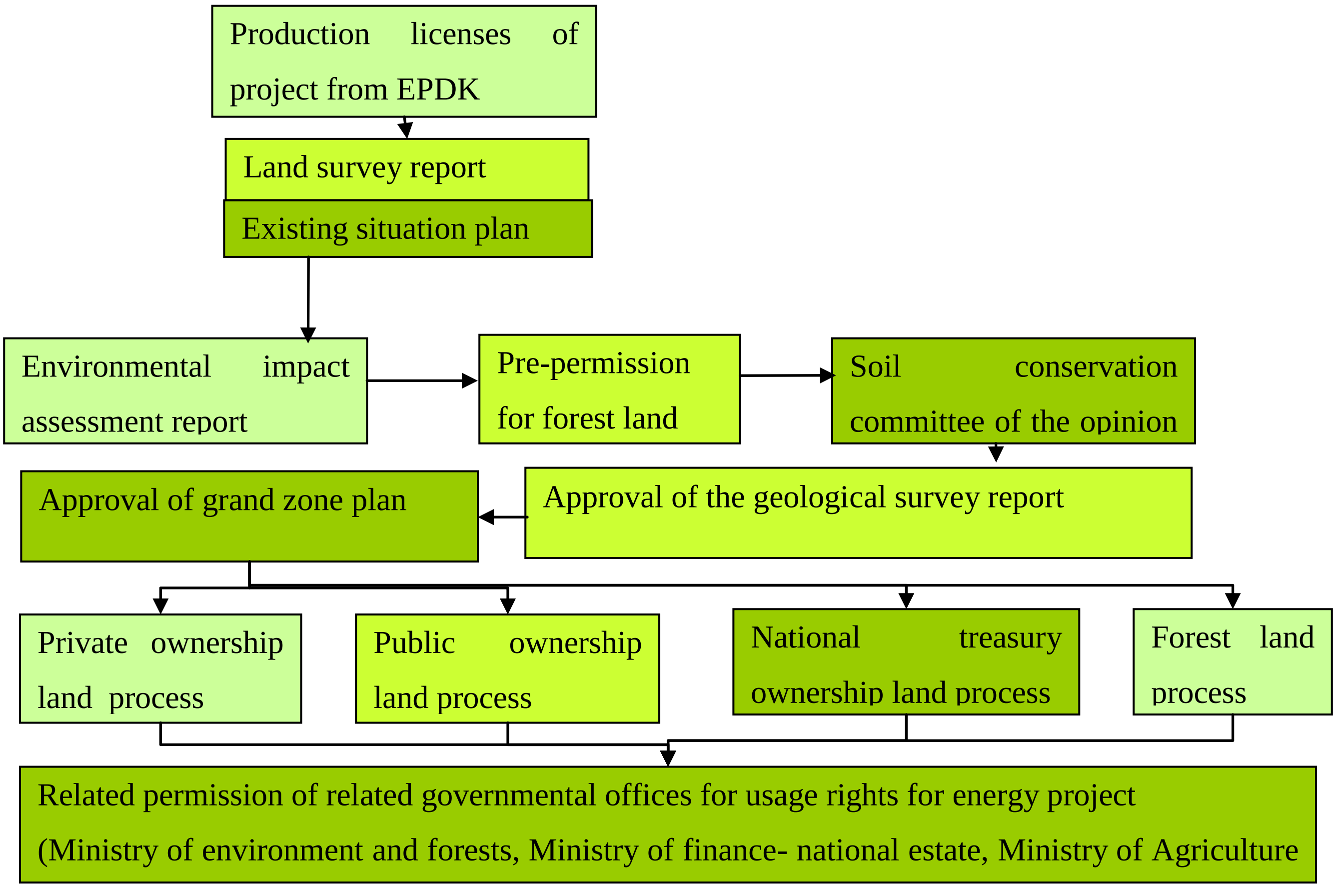

Figure 3.7 : Flowchart for the land appropriation process for energy projects

Licensing and Permitting Timeline: The licensing process is completed within 30-90 days. After licensing, the completion date of the facility is approved by EPDK according to the project plan (and with consideration for the EPDK recommendation decision number 1855 dated 20 November 2008). A 16-month reference period is taken into consideration in determining the period of before construction. If the estimated period provided by the developer in the project plan is longer than 16 months, the request will be evaluated by EPDK according to the need to expropriate the site. As a result of this review, a longer determination period may be anticipated for the approval of the Board. After all approval processes are completed the construction period of power plant must follow this schedule:

Installed Power (MW)	Months
Less than 10	16
Between 10 and 50	24
Greater than 50	30

With the experience of wind project licensing procedures, improvements are being made to the licensing process for solar projects. Inter-governmental agency protocols are being prepared to help avoid delays in process. Turkey continues significant efforts to liberalize the energy markets and diversify their energy sources with renewable energy and focusing on security of supply. It is positive that the Energy Market Regulatory Authority (EPDK) has been given considerable authority including setting the third-party access tariffs, providing licenses and making decisions that cannot be overruled by the government. At the same time, it is important that EPDK consults the different stakeholders and benefits from their experience in energy markets when preparing the upcoming regulations. EPDK is studying simplifications of the regulations, in order to accelerate and encourage energy investments.

Construction Permitting Procedure: After the license has been granted, the other application process begins. Again, using wind as an example of what is likely to be used for solar, the main steps for the application for a construction permit reflects the differences in wind power plant projects.

Necessary documentation: At the beginning of the applications, developers must obtain documents such as an Approved Site Plan, the Environmental Impact Assessment ("EIA") or Reporter Legal Decision not to prepare EIA Report.Then it is necessary to submit a request to the Ministry of Forestry and to be granted a Forestry Permit. There may be some additional procedures in the Forestry Permit process depending on the project location and site features. A **Grid Connection Agreement** must be signed with the authorized Transmission or Distribution Companies, such as Turkish Electricity Transmission Company ("TEIAŞ") or the Turkish Electricity Distribution Company ("TEDAŞ"). After a Zoning Plan approval and Project Implementation submission, developers will obtain the Construction Permit. [128]

The Energy Efficiency Law (EE Law) (No: 5627) Ratification dated 2 May 2007 Enactment Dated 18/4/2007 : The purpose of this Law is to increase efficiency in the utilization of energy resources and electricity in order to use energy effectively, avoid waste, ease the burden of energy costs on the economy and protect the environment. The By-Law on Improving Energy Efficiency for the Utilization of Energy Resources and Energy, limits the annual energy consumption of buildings to the amount stated on the

"Energy Identity Certificate" and will be enforced starting 5 December 2009. The law will also encourage the use of renewable energy resources in the design of new buildings of 1,000 m2 or larger. These regulations will begin the use of solar energy in buildings.

Upcoming Legislation: Feed-In Tariff (FIT) - Proposed Change to Law Number 5346

A newly proposed law titled the "Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy" includes additional incentives for solar energy. The law proposes a FIT for licensed solar plants. The following proposed (and still under study and review) FIT will be applied to licensed solar plants that start operation prior to December 2015:

Solar Technology Type	Years 1 - 10 (Euro cent/kWh)	Years 11 – 20 (Euro cent/kWh)
PV Plant	25	20
CSP Plant	20	18

If other licensed small solar energy producers (private individuals or companies) produce electricity that exceeds their own demand and want to supply the distribution line, they will be given a special price of 35 Euro cent/kWh for up to 3,000 kWh and 30 Euro cent/kWh for between 3,000-6,000 KWh/year. This exception is made for distributed generation that produces excess energy delivered to the grid.

Incentive for local producers – If plant is in operation before 2015 and is built with mechanical and electronic parts produced locally, the following additional proposed price incentives will be applied for 5 years, in addition to the FIT incentive.

Table 3-9: Additional Tariff Incentive for Domestic Production in Turkey

Solar Technology	Locally Produced Components	Additional Value (Euro cent/kWh)
Photovoltaic Plants		
1	Panel Integration & Structure (including tracking systems)	0.6
2	Modules	1.0
3	PV Cells	3.0
4	Inverters	0.5
5	Solar Focal Point Material	0.4
Concentrating Solar Power Plants		

[128] EPDK website, http://www.epdk.gov.tr/english/default.asp.

1	Receiver Tubes	2.0
2	Parabolic Trough Mirrors	0.5
3	Tracking System	0.5
4	Thermal Storage System	1.0
5	Steam Power Plant	2.0
6	Stirling Engine	1.0
7	Panel Integration & Structure	0.5

The government has been working on revising the law during the last few months but, unfortunately, the revised law did not make the agenda of the last legislative session. International and national investors, various organizations and academia are pushing the government to increase the FIT and additional incentives. It is expected that this solar energy legislation will be covered in the next legislative session to be after the second quarter of 2010.

Because of the great potential of electricity production of solar energy in Turkey, when the FIT is published, the solar energy market in Turkey will grow exponentially. The most important issue is the inclusion of the FITs in the upcoming renewable energy law and any related secondary legislation. In addition, governmental policies and agencies aimed at stimulating and developing the large scale solar market in Turkey should:

- Ensure legislation is ratified and implemented quickly,
- Streamline and simplify licensing, permitting, interconnection, approval and land acquisition process, including a database to assist with site determination.
- Set clear standards for design, construction and operation of facilities.
- Support the solar development and deployment via R&D incentives, local manufacturing, etc. and
- Create a free carbon market and promote low carbon programs and establish a green technology fund.

Licensing for solar energy plants has not yet begun as the legislation has not yet been completed. In the meantime, some large companies have completed their work and projects while awaiting the legislation. Approximately 12 procedures will be prepared once the legislation is in place. The table **Table 3-10** shows the status of the licensing process for other renewable energy sources. The table is available on the web and updated lastly at 16 November 2009.

Table 3-10: Licenses for Renewable Energy in Turkey

	Licensing Application		Evaluation Process		Accepted Licenses		Approved Licenses		Cancelled Licenses		Terminated Licenses	
	Unit	MW	Unit	MW	Unit	MW	Unit	MW	Unit	MW	Unit	MW
Wind	3	39.60	724	31,918.00	12	850.90	93	3,386.4	13	537.81	9	378.90
Geothermal							7	103.7			1	15.00
Biogases			1	3.48			13	54.68	1	15.00		
Biomass			1	4.00			1	5,80	1	10.00		
Total	3	39.60	726	31,925.48	12	850.90	114	3,550.58	15	562.81	10	393.90

(Source : http://www.epdk.org.tr/lisans/elektrik/yek/yek.html)

3.3. Financial and Non-Financial Barriers that Impede Solar Project Developers

There are a number of barriers that can negatively impact and impede solar project developers. If barriers are too severe, developers will seek greener pastures elsewhere and the solar market in these countries will stagnate without meeting their potential. In addition, a lack of legislative development and policy implementation can complicate an already challenging project development landscape. This section of the report will describe the barriers specific to Turkey. In Turkey, there remain a number of barriers to expanding the large-scale grid-connected solar market. The following barriers are ongoing and can be divided into the categories:

Financial Barriers

- Lack of proper financial products (ex. long term financial credits)
- High investment costs for developers
- Lack of proper finance opportunities
- Credit is supplied from foreign finance agencies and very few local finance opportunities are available.
- The current higher cost of capital, and the more stringent loan policies of the banks as a result of the financial crisis
- Problems in realizing financial incentives while waiting for approval of related legislation

- Lack of experience with solar technologies among banks or investors
- Long time required for securing financing
- Lack of standard financial products makes valuation difficult.

Non-Financial Barriers

Legislative Barriers

- Regulatory processes are not yet completed thus financing will be difficult with increased risk
- A large number of different permits and documents are required makes the process slow and risky
- A large number of authorities are involved in the licensing, permitting and approval processes which also delays development and increases risk.
- Many regulations and governmental agencies are involved in the land appropriation process (environmental, construction, national forest, cultural and natural minerals law, etc.)
- Complicated legal requirements for installation and interconnection
- Long lead time required for the environmental impact assessment documentation

Strategic Planning and Financing Barriers

- Reliable and detailed solar information is critical and ground stations are needed
- Lack of legislation and information causes delays and adds risk for developers

Project Implementation Barriers

- Lack of professional institutions. There is a lack of established companies locally and lack of know how and experience by the professional sectors.
- Lack of R&D grants for studies on solar at universities
- Lack of variety of locally available components. There are few companies manufacturing components, competition is weak for those components that are available such as cells, inverters, etc.
- Long delivery time for some components

The Energy Market Regulatory Authority (EPDK) is focusing on some of the legislative barriers (listed above) and is conducting studies to improve the situation. The studies are examining the difficulty of more than one institution being engaged in permitting and licensing; the long lead time required for the environmental impact assessment process; the complicated land appropriation process. To create a successful market for solar energy in Turkey, legal and regulatory policies must be completed and implemented. Renewable energy experience has been attained from wind energy projects and new legislation is being prepared. After resolving the barriers and problems that are complicating issues (including the financial resource shortages, the need for infrastructure investments, length of licensing process, a lack of set standards) Turkey's solar energy market will grow.

3.4. Solar Industry and Projects in Turkey

About 750 kWp of roof-top and building integrated PV were installed in Turkey during 2008, with the annual market increasing slightly from the stable level of the previous four years. Off-grid applications account for around 94 % of Turkey's cumulative installed PV Capacity of approximately 4 MW.[129] The recent historical development of the solar energy sector in Turkey can be summarized (by year) as follows:[130]

2001

- The Solar Energy Institute of Ege University began R&D studies on organic dye-sensitized solar cells to: realize, simplify production processes and lower the cost.
- 14 kWp PV "power plant" installed for start-up energy of some units in Berke Dam.

2002

- Installation of the largest grid-connected PV power plant to date in Mugla University with a 10.4 kWp capacity.

2004

- Mugla University increased the total capacity to 54 kWp and by 2010 up to 110 kWp that means 4% of electricity consumption from solar. [131]

[129] "Trends in Photovoltaic Applications, Survey Report of Selected IEA Countries betwwen 1992-2008", IEA, 2008
[130] "PVPS Annual Report 2007", "Turkey PV Technology Status And Prospects", IEA, 2007
[131] Eke, R., Muğla University presentation, 12 March 2010, 3 rd Solar Energy Fair

2005

- The Solar Energy Institute of Ege University installed a 22.2 kWp PV grid-connected plant in Izmir.
- TUBITAK (The Scientific and Technological Research Council of Turkey) initiated the first Formula-G solar car race between the Turkish universities. The TUBITAK plans to continue these solar car races in the next years in order to introduce solar electricity energy to the university students.

2006

- The Solar Energy Institute of Ege University set up a PV module production laboratory which is the first of its kind in a university.
- A Turkish company (Akkanat Technologies A.S.) began to produce PV modules with a 5 MWp/year production capacity in Istanbul, but has not continued panel production.

2007

- The first PV-wind-diesel hybrid power system was installed by Girasolar Ltd. Ege University Solar Energy Institute contributed to the project, as well. The project was built on an island (Fethiye-Kizilada) which doesn't have any utility grid connection (17.5 kWp multi-crystalline solar modules, 15 kWp wind turbine, 35 kVA diesel generator, 48 V 3,000 Ah battery capacity).
- In March 2007, the Energy Minister of Turkey opened a "Clean Energy House" in Pamukkale University, Denizli-Turkey. The house has a 5kWp PV system, which will also be used for hydrogen production.
- 30 kWp grid-connected PV power systems were installed in the TESCO-KIPA supermarkets in Marmaris and Kusadasi by Enisolar Ltd. Some attractive small PV applications were also performed by Enisolar Ltd. in 2007
- TUBITAK-Marmara Research Center (MRC) installed a stand alone renewable hydrogen demonstration park in Gebze. Ege University Solar Energy Institute was a participant of TUBITAK-MRC in the project. The autonomous system includes PV-wind-fuel cell hybrid power components

- Turk Telecom installed a 250 kWp photovoltaic power system for telecommunication systems. Aneltech Ltd. installed these systems in 2007. Some small PV systems were also installed for GSM telecommunication systems

2008-2009 New electricity production projects with solar:[132]

- A proposed project for charging the boats in Antalya would be approximately 470 Kwp and would be undertaken by the Middle East Technical University and the Environmental Protection Association.
- Antalya's proposed Solar City project 2 MWp would include hotel, school and municipality buildings.
- Burdur Technical University and Muğla University have a proposed 5 MWp PV plant project to be located in Burdur.
- Currently being contracted is an EU-funded project in Kibris with a capacity of 1.25 MWp.
- A 20 MWp PV plant in Karaman by Anel Enerji-İnci Holding Consortium is currently on hold awaiting the completion of the licensing and permitting procedures.

2009 New PV production plant projects:

- 13.5 MWp capacity for the production of crystalline silicon by Aneltech with an Italian company started in October 2009.
- Gira Solar and Saran Holding has a PV production plant project, costing approximately 500 Million USD that is currently in the contracting phase.
- Construction started on 7 October 2009 on a 280 MW capacity PV (mono-crystal, thin film, poly-crystal) production plant in Kütahya-Tavsanli by AYT with a 300 Million Euro investment and as a part of a joint venture with the German Company SITIZN.
- Tera Solar is planning to build a 5 MWp panel production plant in Bursa.

[132] Source: GENSED (Solar Energy producers and Investors Assosiation)

2009	Other Projects

- First residential project with the energy-generating solar electricity in Turkey is the 560 kWp capacity in Solar City
- High Buildings in solar has a 1 MWp capacity project by Varyap Meridian that was awarded the title of "Europe's best real estate project."

According to the survey of UFTP in 2009, installed power of the network connection is 198,2 kWp, off-gird power is 383,59 kWp, as totally **581,79 kWp**.[133]

CSP Projects

Zorlu Holding, through subsidiary companies in Izmir, is launching a CSP project. In addition, Zorlu Energy is planning to be the sole investor in a 50 MWp of CSP plant located in the Konya-Karaman region, once legislation has been completed. Zorlu Energy Group properties currently include an installed capacity of 603 MWp electricity and 192 tons/hour steam via 7 hydraulic, 5 natural gas, 1 geothermal and 1 diesel plant. They also have wind energy power plants with a combined capacity of 135 MWp located in various regions of Turkey. In addition they also operate in gas distribution and production in addition to their electricity production.

Hittite Solar Energy, located in Istanbul, Turkey, (http://hititsolarenerji.com/) is a technology developer and producer of CSP systems using steam to supplement oil. A 120 kWp project is now being implemented at Denizli, in the Aegean region of Turkey. This project is still in the performance testing phase. As a result of research and development studies, 98% of domestic production has been achieved and 40% in cost improvements have been made.

Other Thermal Solar Applications

Main solar energy utilization in Turkey is the flat plate collectors in the domestic hot water systems. Turkey is one of the leading countries in the world with a total installed capacity of 8.2 million m² collector area as of 2001. The systems are mostly used in Aegean and Mediterranean regions. Total energy production equals to 290,000 TOE (ton oil

[133] UFTP, Survey report, 2009

equivalent).[134] The industry, represented by more than 100 companies, is well developed with high quality manufacturing and export capacity.

TABLE 13-11: Contribution of Solar Collectors to Energy Production

Year	Solar Energy Contribution (thousand TOE)
1998	210
1999	236
2000	262
2001	290
2004	375
2007	420

The amount of annual production by solar collectors in Turkey is currently 750,000 m2.[135] This capacity is attractive to solar project investors partially because of the existing local manufacturers and also because of the additional market for small solar applications.

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[134] Source: EIE Official web page, http://www.eie.gov.tr/english/solar/solarTurkey_e.html

[135] 'Solar Energy in the World and Turkey', p. 123, WEC, June 2009

4. Case Studies for Turkey

After evaluation of the world and Turkey's situation; following case studies have been evaluated. Firstly, most promınent locations for solar power plant installations have been evaluated, then typical project development risks and mitigation startegies and cost and avaliability of solar technology in the local market have been analyzed by depth interview with main players in Turkey. Solar ROADMAPS have been prepared with ICAT and by using results of the roadmaps (targets of installed power and cost of installation etc) economics and employment impacts have been estimated. The trend of research and development budget of solar energy in country -that is important issue for development- have been surveyed with related governmental agencies, non-profit organizations, universities and private firms.

4.1 Identification of the Most Prominent locations for Solar Installations

Good site selection is critical to optimizing both the physical and economic outcomes of a solar project. This section looks at some of the ideal siting specifications for both CSP and PV projects. Though there are some similarities between these two solar technologies, they have different needs and requirements in order to maximize the impact of careful project siting. In addition to undeveloped project sites for PV project development, medium – large buildings and industrial areas may also be good locations for projects, especially if this allows siting near demand centers or in areas near transmission. In addition, PV is modular so there are very few constraints on how it can be configured to meet the shape of the available terrain or building structure. The elements listed in the **Table 4-1** and **Table 4-2** below describe the ideal conditions for siting a PV and CSP plant. [136]

[136] IFC, The Market Outlook for Solar Energy in Turkey, Bulgaria, the Balkans and the Czech Republic, A Knowledge Management Market Study Report, 2010

Table 4-1: Ideal Specifications for Siting a PV Plant

Characteristics	Ideal Specifications for PV Plant Siting
Solar and Climatic Resources	
Average annual solar irradiance	> 1,200 kWh/m^2/year is good for PV plants
Production losses from shading	< 1%
Wind speed for panel cooling	> 1 m/s average wind speed
Rain fall for panel self cleaning	Regular rainfall
Location Specific	
Transmission access	< 500 m distant from grid-connection point
Value of alternative land use	Arid land, not used for agriculture or other commercial uses
Land or roof inclination and orientation	< 10% south slope, only small deviation from south
Available land area for using different Technologies	> 10,000 m^2
Available land area for capacity Expansion	> 20,000 m^2
Permit requirements	Easy procedures to receive necessary permits
Module dirt due to dust and air pollution	Clean air
Distance to towns/cities for personnel	Closer is better
Risk of theft and vandalism (site security)	Prefer operational personnel onsite and/or a remote plant location
Area/perimeter ratio	Square shape preferred. Elongated, rectangular shapes result in reduced electricity production
Site replication ability	Availability to use project as model for future projects.
Planning & Construction	
Ease & simplicity of construction	Flat land or with a slight south slope
Site preparation	Solid ground with rocks or dry gravel
Transportation of materials to site	Road access for heavy vehicles
Operation & Maintenance	
Periodic panel cleaning	Available water and easy site access
Access for operational personnel	Reasonable distance from towns and cities.
Vegetation control	Dry and arid ground is preferable to fertile soil – though sand can cause increase in cleaning efforts.
Other maintenance	Easy accessibility for replacement parts and repair work.

Source : IFC Report

Table 4-2: Ideal Specifications for Siting a CSP Plant

Site Characteristics	Desired Attribute for CSP Plant Siting
Size	6 - 7 acres/MWp (assuming 3 or 6 hours Thermal Energy Storage)
Expandability	Acquirable adjacent land
Configuration	- 1 mile N/S by 3 miles E/W
	- Contiguous
	- Rectangular
Solar Insolation	- $\geq$ 7.25 kWh/m2/day
	- Low # cloud days during peak periods
	- Latitude
Grade	$\leq$ 1% slope, low site preparation costs
Encumbrances	No easements, deeds, liens, judgments
Land Use History	Previously disturbed, graded, agricultural
Adjacent Land Use	Compatible current and proposed use
Generator Intertie and Transmission	- Proximate ($\leq$ 10 miles)
	- Current and future capacity
	- Avoided wheeling
	- Power swap flexibility

	- Delivery point near load center(s)
	- Low/no anticipated upgrades
	- Low substation costs
Water	- +3,000 acre-feet availability per year (per 250 MW plant)
	- Certifiable surface or groundwater rights
	- Low industrial-use tariff, pumping costs
	- Sufficient water quality
	- Sustainability of supply
Transportation	- Proximate highway
	- Proximate railway
	- Feasible access road construction
Other Infrastructure	Proximate natural gas source
Work Force	Feasible work force attraction (location)
Environmental	- No hazardous materials history or presence
	- No known biological resource issues
	- No known cultural resource issues
	- No known visual, aesthetic, noise concerns
Stakeholders	No known stakeholder opposition, support of key influencers
Community Benefit	Rural development, alignment with state community development goals
Land Ownership	Private or leasable, acquirable, able to offload at profit
Land Cost/Value	Within sales comparable range, historical appreciation and expected growth
Purchase Terms	- Optionable or long due diligence period
	- Flexible Seller terms

Source : IFC Report

Turkey is situated between 36 and 42 N latitude and is geographically well situated for solar energy power production. Solar energy seems one of the most promising renewable energy sources because of the country's climate and has the potential to provide a significant portion of future energy needs of Turkey. The total solar energy potential of Turkey is calculated as 35 Mtoe per year. (1 Mtoe/yr = approx 1,3 GWp, 35 Mtoe/yr * 1,3 = 45,5 GWp Which is close enough to 41,8 GW.) Though large-scale grid-connected solar is not yet a source of power in Turkey, in 2001, an estimated 287,000 tons of oil equivalent (toe) for solar heating were produced, especially in the southern and western regions and in both the residential and commercial sectors.[137] Monthly solar energy potential of Turkey is given in **Table 4-3.** Solar energy potential according to the geographical regions is given in **Table 4-4.** It is recognized, however, that the existing meteorological data is lower than the actual solar energy data of Turkey. The General Directorate of Electrical Power Resources Survey and Development Administration (EIE) and the Turkish State Meteorological Services (DMI)[138] have been recording new measurements since 1992 to

[137] ETKB official web page, http://www.enerji.gov.tr
[138] EIE Official web page, http://www.eie.gov.tr/english/solar/solarTurkey_e.html

collect more accurate solar energy data. Although the measurements have not yet been completed, the collected data indicates that the actual solar energy radiation values are 20-25% higher than the existing data.

A model was developed with the data from the 8 measurement stations of EIE and with the data from the DMI measurement stations. As a result, the solar radiation and insolation values were calculated for 57 cities of Turkey.[139] Daily information is available to purchase for eight cities (İsparta, KonyaYalova, Diyarbakır, Adana, Kayseri, Antalya, and Aydın). However this data is not reliable. In 2010, additional data will be collected as part of a new tender for continuous and reliable information. Monthly Average information is available free of charge.

Table 4-3: Monthly Solar Average of Turkey (Source: General Directorate of EIE)

Month	Monthly Total Solar Energy ($kWh/m^2/month$)	Sunlight Duration (hours / month)
January	51.75	103.0
February	63.27	115.0
March	96.65	165.0
April	122.23	197.0
May	153.86	273.0
June	168.75	325.0
July	175.38	365.0
August	158.40	343.0
September	123.28	280.0
October	89.90	214.0
November	60.82	157.0
December	46.87	103.0
Total	1,311	2,640
Average	3.6 kWh/m^2-day	7.2 hours/day

Source : EİE

Table 4-4: Regional Distribution of Solar Energy in Turkey (Source: General Directorate of EIE)

Region	Total Solar Radiation (kWh / m^2 – year)	Sunlight Duration (hours / year)
Southeastern Anatolia	1,460	2,993
Mediterranean	1,390	2,956
East Anatolia	1,365	2,664
Central Anatolia	1,314	2,628
Aegean	1,304	2,738
Marmara	1,168	2,409
Black Sea	1,120	1971

Source : EİE

EIE has prepared a solar atlas for Turkey which is shown in **Figure 4.1** below.

[139] Source: http://www.eie.gov.tr/english/solar/solarrad_e.html

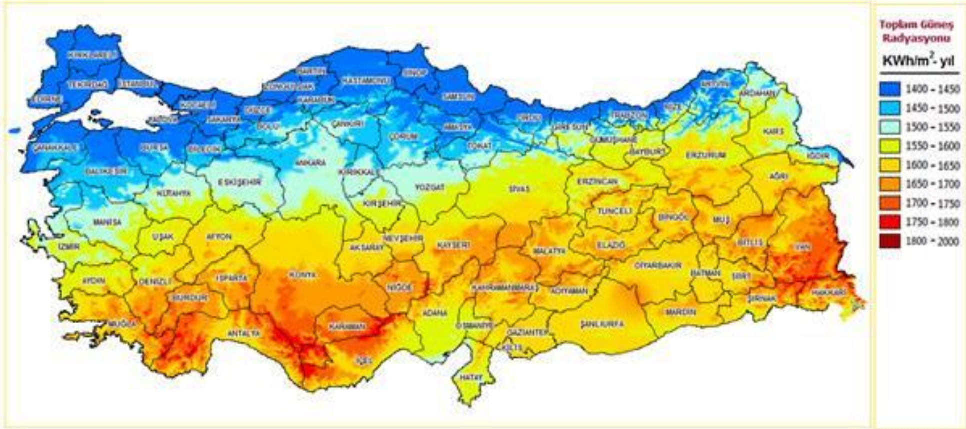

Figure 4.1 : Solar map of Turkey
SOURCE: http://repa.eie.gov.tr/MyCalculator/Default.aspx

According to studies in Turkey[140], the sum of the 8,200 km2 area is suitable for solar energy plant investment with approximately 70% of this area suitable for CSP plant development. If half of this land (4,100 km2) is used with 10% efficiency and 25% network loss, 196.8 TWh of electric energy can be obtained. This value is equivalent to Turkey's current total annual electricity consumption. Major areas in Turkey from EIE documents are shown in the **Figure 4.2** below. The circled portion of the figure shows available land sites of 4,600 km2 and a radiation value is more than 1,650 KWh/m2/year. With an effective land usage rate of 25%, and an efficiency ratio of 20% from the solar energy, the thermal solar energy potential is 380 TWh/year.[141]

Figure 4.2: Recommended areas for solar plant siting in Turkey (with a global radiation larger than 1,650 KWh/m2/year)
Source : EİE

[140] WEC, Turkish National Comitee, 'Solar Energy in the World and Turkey', Haziran 2009, Ankara, pp: 199-201
[141] EIE Presentation 9 May 2008

The southeast Anatolia region of Turkey has the best solar energy potential for Turkey, followed by the Mediterranean region as followed **Figure 4.3**. [142]

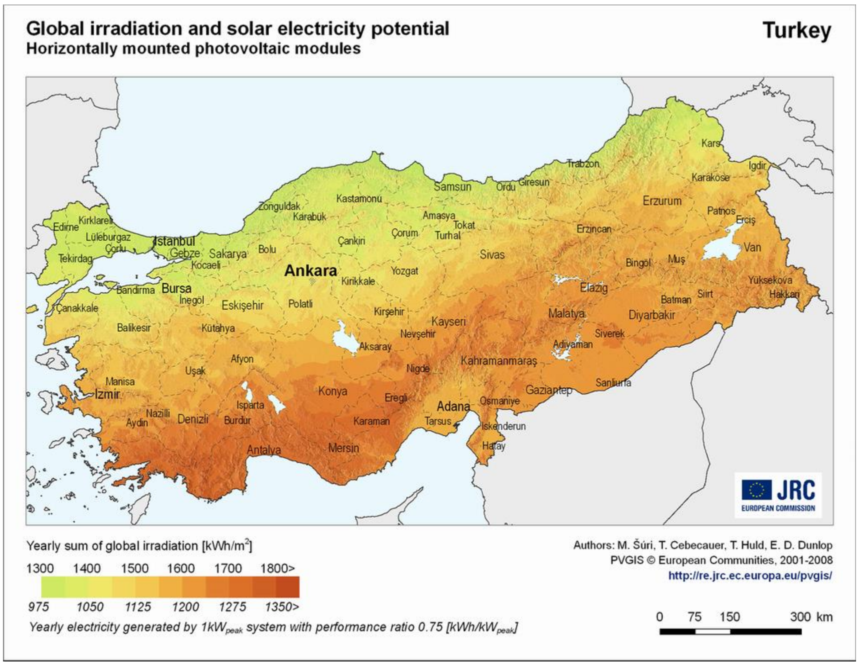

Figure 4.3: Global horizontal irradiation data for PV
Source : EU, JRC

Additional maps and calculations for the cities: Antalya, Mardin, Urfa, Konya and Karaman, may be found at using the links provided in the below.

http://repa.eie.govtr/MyCalculator/pages/7.aspx Antalya
http://repa.eie.gov.tr/MyCalculator/pages/47.aspx Mardin
http://repa.eie.gov.tr/MyCalculator/pages/63.aspx Urfa
http://repa.eie.gov.tr/MyCalculator/pages/42.aspx Konya
http://repa.eie.gov.tr/MyCalculator/pages/70.aspx Karaman

In order to determine if the ideal specifications for sitting CSP and PV plant, detailed analysis and measurements must be made. General evaluation for these cities are shown in the two tables below which show the ideal specifications listed in **Table 4-1** (PV) and **Table 4-2** (CSP) and uses those specifications to evaluate specific geographical areas in Turkey.

[142] EU, JRC, http://re.jrc.ec.europa.eu/pvgis/countries/europe.htm

Table 4-5: Evaluation of 5 Geographical areas in Turkey based on Ideal PV Siting Specifications

Characteristics	Ideal Specifications	Geographical Region				
Region/cities	Region	Mediterranean	South-East		Middle	
	Cities	Antalya	Mardin	Urfa	Konya	Karaman
Solar and Climatic Resources						
Average annual solar irradiance	> 1,200kWh/m^2/year is good for PV plants	✓	✓	✓	✓	✓
Production losses from shading	< 1%	Suitable locations possible, detailed measurements must be recorded at specific sites.				
Wind speed for panel cooling	> 1 m/s average wind speed	2.1 m/s	3 m/s	1.6 m/s	1.8 m/s	2.3 m/s
Rain fall for panel self cleaning	Regular rainfall (Lowest and highest value by month)	228.6 kg/m^2 2.0 kg/m^2	145.9 kg/m^2 0.4 kg/m^2	64.7 kg/m2 0.8 kg/m^2	64.5 kg/m^2 5.2 kg/m^2	60.7 kg/m^2 5.4 kg/m^2
Water availability to clean modules	> 0.0005 m^3 water per m^2 PV array per month	Water is available in all regions but detailed analysis is required after a site has been selected.				
Transmission access	< 500 m distant from grid-connection point	In general, transmission access is available but, again, specific analysis must be undertaken after a site is selected.				
Location Specific						
Value of alternative land use	Arid land, not used for agriculture or other commercial uses	Depending on the site selected				
Land or roof inclination and orientation	< 10% south slope, only small deviation from south	Suitable sites possible	Suitable sites possible	Suitable sites possible	Best of the five areas	Best of the five areas
Available land are for using different Technologies	> 10,000 m^2	Depending on the site selected				
Available land area for capacity Expansion	> 20,000 m^2	Depending on the site selected				
Permit requirements	Easy procedures to receive necessary permits	Permitting requirements are easier for private land than for public land. Currently, expropriation procedures for public land are long and complicated, but they will be improved.				
Module dirt due to dust and air pollution	Clean air	Low	Medium	Medium	Medium	Medium
Distance to towns/cities for personnel	Closer is better	Yes, depending on the site selected				
Risk of theft and vandalism (site security)	Prefer operational personnel onsite and/or a remote plant location	No risk	Low risk	Low risk	No risk	No risk
Area/perimeter ratio	Square shape preferred. Elongated, rectangular shapes result in reduced electricity production	Can be addressed in site selection				
Site replication ability	Availability to use project as model for future projects.	Suitable	Suitable	Suitable	Suitable	Suitable
Planning & Construction						

Ease & simplicity of construction	Flat land or with a slight south slope	Slight slope	Flat	Flat	Flat	Flat
Site preparation	Solid ground with rocks or dry gravel	Site dependent				
Transportation of materials to site	Road access for heavy vehicles	Yes, depending on the site selected				
Operation & Maintenance						
Periodic panel cleaning	Available water and easy site access	Water is available in all regions but detailed analysis is required after site selection.				
Access for operational personnel	Reasonable distance from towns and cities.	Likely, dependent on site selected.				
Vegetation control	Dry and arid ground is preferable to fertile soil	Green	Very dry	Very dry	Dry	Dry
Other maintenance	Easy accessibility for replacement parts and repair work.	Yes, depending on the site selected				

Table 4-6: Evaluation of 5 Geographical areas in Turkey based on Ideal CSP Siting Specifications

Site Characteristics	Desired Attribute	Geographical Region				
		Mediterranean	South-East		Middle	
		Antalya	Mardin	Urfa	Konya	Karaman
Size	6 - 7 acres/MWp (assuming 3 or 6 hours Thermal Energy Storage)	Depending on site selected				
Expandability	Acquirable adjacent land	Depending on site selected				
Configuration	1 mile N/S by 3 miles E/W	Possible, depending on site selected				
	Contiguous					
	Rectangular					
Solar Insolation	≥ 7.25 kWh/m2/day	✓ (Mar – Nov)	✓ (Apr-Nov)	✓ (Apr-Nov)	✓ (Apr-Nov)	✓ (Mar – Nov)
	Low # cloud days during peak periods	1 day/month	0	0	2 days /month	2 days /month
	Latitude	36N	37N	37N	37N	37N
Grade	≤ 1% slope, low site preparation costs	Possible, depending on site selected	Good	Good	Best	Best
Encumbrances	No easements, deeds, liens, judgments	Site-dependent				
Land Use History	Previously disturbed, graded, agricultural	Site-dependent				
Adjacent Land Use	Compatible current and proposed use	Detailed analysis required.				
Generator Interconnection & Transmission [143]	Proximate (≤ 10 miles)	Depends on site [144]	Depends on Site			
	Current and future capacity	17 units of generator	6 units of generator	20 units of generators at different	17 units of generators in different power [146]	2 units

143 www.teias.gov.tr/haritatasra.htm

144 www.teiasantalya.gov.tr/trafomer.html

				capacity [145]		
	Avoided wheeling	A detailed study should be made.				
	Power swap flexibility					
	Delivery point near load center(s)					
	Low/no anticipated upgrades					
	Low substation costs					
Water	+1,200 acre-feet availability per year (per 100 MW plant)	Site dependent. Water is available for all cities but detailed analysis must be made after site selection.				
	Certifiable surface or groundwater rights					
	Low industrial-use tariff, pumping costs					
	Sufficient water quality					
	Sustainability of supply					
Transportation	Proximate highway	Road access available for all cities				
	Proximate railway	Site-dependent				
	Feasible access road construction	Site-dependent				
Other Infrastructure	Proximate natural gas source	Site dependent				
Work Force	Feasible work force attraction (location)	Possible, depending on the site selected				
Environmental	No hazardous materials history or presence	Yes, depending on the site selected				
	No known biological resource issues	A detailed evaluation of the site must be conducted.				
	No known cultural resource issues [147]	High	Medium high	Medium	Low	Low
	No known visual, aesthetic, noise concerns	Yes, depending on the site selected				
Stakeholders	No known stakeholder opposition, support of key influencers	A detailed evaluation of the site must be conducted.				
Community Benefit	Rural development, alignment with state community development goals	✓	✓ Most significant	✓ Most significan t	✓	✓
Land Ownership	Private or leasable, acquirable, able to offload at profit	Site-dependent				
Land Cost/Value	Within sales comparable range, historical appreciation and expected growth	A detailed evaluation of the site must be conducted.				
Purchase Terms	Optionable or long due diligence period	Site-dependent				
	Flexible Seller terms					

146 www.teias.gov.tr/Gr9/index.htm
145 www.teiasgaziantep.gov.tr/
147 http://gis2.cevreorman.gov.tr/mp/

4.2 Cost and Availability of Solar Technology in Turkey

The primary components of a CSP parabolic trough system and PV are shown in **Table 4-7** and **Table 4-8**:[148]

Table 4-7: CSP Trough System Components

Component	Description
Parabolic Trough Mirror	Reflects direct solar radiation and concentrates it onto the focal point. The reflective parabolic surface, either a silver film deposited on glass, or a reflective metallic surface, creates a focal point for concentrating the solar radiation.
Receiver Tubes	The parabolic mirrors focus the solar radiation on a receiver tube. This component is made of two concentric tubes: an outer tube (of glass) separated from an inner tube (of metal) by a vacuum, to reduce heat lost and make the absorption more efficient. A heat transfer fluid flows through the inner tube, absorbing the heat from the solar energy.
Heat Transfer Fluid	A synthetic oil which absorbs the solar energy heat as it circulates throughout the solar field, via the receiver tubes and system piping.
Solar Tracking System	This system allows the troughs to track the sun throughout the day, thereby maximizing the solar radiation absorbed and the energy produced by the CSP system.
Support Structure	The rigid metal framework that supports the parabolic troughs.
Generator	The heated transfer fluid is used to produce steam which powers a generator that transforms the steam into electricity.
Hybrid (optional)	CSP systems may be used in a hybrid capacity with natural gas or other fuels, as the same steam generators may be used with the different energy sources.
Thermal Storage (optional)	May be included in a plant and allows the plant to produce power during times with poor solar radiation and into the evening hours.

Table 4-8: PV System Components

Component	Description
PV Modules	The smallest complete environmentally protected assembly of interconnected solar cells.
Inverter	The system component that converts the electrical power delivered by the PV array into the appropriate frequency and/or voltage values to be injected into the electricity grid based on alternating current.
Framework	Mounting structure for the PV modules, cables and cable ducts, inverter housing, switching devices, electrical grid interconnection and other installations to facilitate safe and reliable operation.
Tracking System (optional)	An alternative mounting structure which moves the PV modules in order to maximize the incoming solar radiation.
Monitoring	PV power plants are equipped with monitoring devices in order to measure and guarantee expected output.
Hybrid (optional)	PV power plants can be co-located or added to hydro-electric (or other) power sources as a way to supplement the available power.

[148] IFC, The Market Outlook for Solar Energy in Turkey, Bulgaria, the Balkans and the Czech Republic, A Knowledge Management Market Study Report, 2010

A grid-connected PV system usually has no built-in energy storage. It feeds the generated power from sunlight directly into the electricity grid. Storage devices are used in stand-alone systems where no grid is available. The Turkish solar industry is beginning to develop. Despite the fact that some investments are awaiting legislation, the range of companies dealing with solar energy components is expanding along the whole value chain. Because of lower labor cost, it is expected that lower-priced components and lower installation costs, compared to Germany, will be realized. PV System prices comparison:

Capacity	Germany [149]	Turkey
5 - 10 kWp (usually grid connected)	3.910 €/kWp	2,500 €/kWp

GENSED (Solar Energy producers and Investors Association) was established in 19 October 2009 with 48 producers and investors as members in Turkey that have 55 members. Summary information about the components of PV plants is given below **Table 4-9** is taken from members of GENSED and other producers.

Table 4-9: Summary of PV Components Available in Turkey

Cost Components	Local	Imported
Products	%	%
Modules	60	40
Inverter / Monitoring System / Data Logger	50	50
Transformer / Measurement Unit	100	
Mounting Structure	100	
AC/DC Cables, Busbar / Cable Trenches	100	
DC Signal Cabling	100	
Metering Unit / Meter / Scada / Vacuum Circuit Breaker		100
Cabinets	100	
Ground Work		
Site Preparation	100	
Installation / Buildings	100	
Spare Parts		
Spare Modules, Inverters, Circuit Breakers, etc.	50	50
Services		
Project Preparation, Site Visits	100	

The following **Table 4-10** shows large firms with production facilities for PV and CSP modules and system installers. The installation and project development companies are reviewing and waiting for the new legislation to set up production facilities.

[149] IEA Co-Operative Programme on Photovoltaic Power Systems, "National Survey Report of PV Power Applications in Germany, 2008", Task 1, Exchange and dissemination of information on PV power systems, May 2009

Table 4-10: TURKEY: Solar Manufacturing and Development Overview

Company	Company Web Site	Details
AnEl Telekomünikasyon Elektronik Sis. San. Ve Tic. A.Ş	http://www.aneltech.com/icerik.aspx?id=21&dil=tr	Production of crystalline silicon and PV panel and systems with a capacity of 13.5 MW in Istanbul
SOLİTEM Solar Energy technologies Co.Ltd	www.solitem.com.tr	Technology developer and producer of parabolic CSP systems and installation
Hittite Solar Energy	http://hititsolarenerji.com	Technology developer and producer of CSP systems and installation
AYT Group Enerji	http://www.aytgrupenerji.com/	PV (mono-crystal, thin film, poly-crystal) production plant has started construction in Kütahya-Tavsanli in October 2009 and is a joint venture with German investors.
SUNSET Enerji Sistemleri San.Tic.Ltd.Şti	www.sunsetenerji.com.tr	PV system installation
Tera Solar	http://tera-solar.com/	PV system installation
Form Temiz Enerji Sistemleri SanTic A.Ş.	www.formgroup.com	System installation, preparation stage of production for PV panel not started yet
SOLİMPEKS Solar Energy Systems Co.	http://www.solimpeks.com/photovoltaics.php	PV-T panel production and system installation

In-depth interview was conducted with GENSED, PROJENERJİ, ZORLU ENERJİ and ANALTECH for analyzing the view of solar industry in Turkey. The following questions were asked but because of commericial secrets some questions couldn’t answered.

- What is the installed capacity of the project in the solar energy?
- What is the cost of installation of the project?
- What is the cost of electricity production after solar plant installation in Turkey?
- What are your predictions for solar market?
- After the new law wherever market trends?
- Which parts can be produced locally?
- How much local produce in the future be?
- How to change the installation costs?
- Where are you going to guess the state of art of solar energy?

In the depth interview; the production companies have declared that 60% of PV modules and 98% of CSP components can be manufactured locally. All other parts (transformers, measuring devices, mounting structures, cabinets and cables, etc.) can be produced domestically in Turkey. Many companies (approximately 30) are active in solar system importation, installation and retail sales in the market. Additionally, there are many domestic producers specifically for domestic hot water systems and other distributors and installers which are not included here as they are outside the scope of this study.

In addition, there is rapidly growing interest in solar energy in universities in Turkey (see the **Table 4-11**). PV system installations have increased research and development (R&D) projects and studies. These R&D efforts are expected to achieve high efficiency and low cost results within 3-5 years and are expected to increase domestic production.

Table 4-11: Turkey: Solar R&D Institutions

Institution	**Website**	**Solar R&D Efforts**
The Solar Energy Institute - Ege University/Izmir	http://eusolar.ege.edu.tr	Organic dye-sensitized solar cells, PV module production laboratory
TUBİTAK - MAM (Marmara Research Center) Energy Instutite	www.mam.gov.tr/ee	Energy Technologies and Environmental Technologies
Muğla University	http://mutek.mu.edu.tr	Organic and inorganic solar dye-sensitized solar cells
UNAM-Bilkent University	http://www.nano.org.tr/index.html	Photovoltaic (optic concentrated system)
GUNAM / ODTU (Midle East Technical University)	http://www.gunam.metu.edu.tr/	Establishing period (R&D of high capacity solar plant (10-100 MW))
Akdeniz University	http://www.akdeniz.edu.tr/english/international	Solar energy applications for self-use and industry. Some special R&D projects on the solar energy
Gazi University	http://www.gazi.edu.tr/english.php	Some special R&D projects on the solar energy. [150]
Hacettepe University YETAM	http://www.yetam.hacettepe.edu.tr/giris.htm	
Harran University - HÜGEM	http://hugem.harran.edu.tr/	
Istanbul Technical University	http://www.itu.edu.tr/en/	
Karadeniz Technical University	http://ofinaf.ktu.edu.tr/en/	
Kocaeli University	http://www.kocaeli.edu.tr/	
Pamukkale Universty	http://www.pamukkale.edu.tr/	
Sakarya University	http://www.sakarya.edu.tr/en/	
Yıldız technical University	http://www.yildiz.edu.tr/en/index.php	
Yeditepe University	http://yeditepe.edu.tr	

[150] WEC,'Solar Energy in the World and Turkey', June 2009

Many NGOs have been established to participate in this development. The increases in NGO activities are leading to increases in social awareness in Turkey and in the legislative process. **Table 4-12** shows the list of NGO related solar.

Table 4-12: Turkey: Non-Profit Organizations

Organization	**Website**	**Areas of Interest**
GENSED (Solar Energy Industry Association)	www.gensed.org	55 producer members
ICAT (International Center for Applied Thermodynamics)	http://www.icatweb.org/giris.asp	Efficiency, Cost, Optimization, Simulation and Environmental Impact of Energy Systems
GUNESE (Electricity from solar photovoltaics Producers and Businessmen's Association)	www.gunese.org	10 producers
GED Global Energy Association	http://www.ged.org.tr/	Organizing workshop and congress for solutions of problems in energy
EED (Energy Economy Association)	http://www.traee.org/traee/index_eng.htm	Development of Renewable energy
GÜNDER (International Solar Energy Society)	http://www.gunder.org.tr/index_en.asp	Member of ISES (International Solar Energy Society), 99 personal member some of them governmental organization
TEMEV (Clean Energy Foundation)	http://www.temev.org.tr/site/eski/giris-ing.htm	To promote and widen the usage of clean and renewable energies
GETSİD (Industrialists' and Businessmen's Association of Solar Energy Technologies)	http://translate.google.com/translate?hl=tr&sl=tr&tl=en&u=http://www.getsid.com/index.htm&rurl=translate.google.com	To widen of solar energy applications
TEMİZ DÜNYA (Clean World Association)	http://www.temizdunya.org/	To promote and widen the usage of clean and renewable energies
TTMD	http://www.ttmd.org.tr/	Different Foundations and Associations are showing activity promoting usage of clean and renewable energies
ÇEDBİK	http://www.cedbik.org/	
ISKID	http://www.iskid.org.tr/index.php	
ISKAV	http://www.iskav.org.tr/Content/Default.aspx	
IMSAD	http://www.imsad.org/eng/index.asp	
IZODER	http://www.izoder.org.tr/	

Turkey’s diversified economy, proximity to Europe, the Middle East, North Africa and Eurasia, its integration with European markets, young and vibrant work force, experienced businessmen and economy management make it one of the most powerful economies in the region. Investors and businessmen in Turkey, for reasons including the location of this energy-corridor/hub country and the potential for solar energy are working to grow this market.

Turkey is an industrialized country. The major export items are automotive (18.3 billion USD, 13.8% of total export) and iron and steel (14.95 billion USD, 1.32% total export) which totaled 132 billion USD in 2008. When evaluating the of total import amount of 202 billion USD in 2008, oil and natural gas (48.2 billion USD, 24% of total import) are major import items.[151] These figures are significant and will attract investors interested in developing the solar energy market in Turkey. Fluctuating energy prices and tightened energy supplies may help stimulate the development of the processes necessary to improve market growth. Additionally, in recent years, rapidly growing NGO activities and university research centers are adding to the market growth rate. As a result of these various influences, the solar energy sector in Turkey seems primed for rapid development. Of the system components anticipated for large-scale solar projects in Turkey, many (60% for PV and 98% for CSP) can be manufactured locally.

[151] DEIK, 'How to Do Businnes Investors Guide in Turkey ', April 2009

4.3 Solar Roadmap For Turkey

Roadmapping is just good planning for all the areas that contribute to a successful development. The roadmapping process leads a cross-functional planning team to fully examine potential competitive strategies and ways to implement those strategies. Additionally, roadmaps have following advantages;

- Roadmaps link business strategy and market data with product and technology decisions.
- Roadmaps reveal gaps in product and technology plans. Areas where plans are needed to achieve objectives become immediately apparent, and can be filled before they become problems.
- Roadmaps prioritize investments based on drivers.
- Roadmapping helps set more competitive and realistic targets. Product performance targets are set in terms of the industry competitive landscape.
- A roadmap gives customers information they can use in their own planning, and can be used to solicit their reaction and guidance. With suppliers, a roadmap is a framework for partnership and directions setting.
- The roadmapping process builds a common understanding and shared ownership of the plan, incorporating ideas and insights from team members representing the many functions involved in a successful development process.

In order to set a strategic vision and target for solar energy development in Turkey, International Center of Applied Thermodynamics (ICAT) has felt the need to prepare a roadmap of solar energy for Turkey. Therefore ICAT has formed a task team which consists of Prof Dr. Nilüfer Eğrican - President of ICAT and Lemi Tuncer - coordinator of ICAT and Müjgan ÇETİN to conduct a solar roadmap with related stakeholders. The preparation of the roadmap is an interactive and ongoing process. It points out major areas for long term, including main fields. It represents a collaborative process whereby stakeholders identify the future technical developments, market barriers, and policy mechanisms on the following phases.

Phase 1: Preliminary phase

Firstly; the task team has identified the following purpose and guidelines of the development of the solar roadmap.

Purpose — Solar roadmap of Turkey is essential for all stakeholders in energy sectors. The objective of the roadmap is to identify key areas of focus (called milestones) for future research and development, installation and demonstration of Solar Energy Application that will help achieve the all groups of Turkey (Universities, Research and Development Associations and Industry) solar energy policy goals.

Guidelines — The Delphi method has been used for the preparation of the roadmap.

Secondly, direct involvement of a broad range of stakeholders has been determined which are enterprises, academic and research organisations, and other relevant actors in the solar energy such as TUBİTAK – MAM – Institute of Energy, GENSED – Solar Energy Industry Association, Türk Demir Döküm A.Ş, UFTP – National Photovolatic Technology Platform, Muğla University.

Phase 2: Development phase

The second phase, which is the development of the technology roadmap phase consists of 3 main steps.

- **Specifying the areas and critical system requirements that will be the focus of the roadmap :** This step ensures that the context for the roadmap has been specified. The major issues of solar energy in Turkey for solar roadmap and related subjects of each main area have been determined as follows.

PV

  - Total power installed capacity
  - Domestic production
  - Reduced module component costs
  - System installation costs
  - Power generation costs
  - Standards and certification
  - R&D and improvement of efficiency
  - Public and educational aspects
  - State subsidies and feed in tariffs

CSP

- CSP power generation plant capacities
- Domestic production facilities
- System installation costs
- Power generation costs
- R&D and technological developments
- State subsidies and feed in tariffs

Solar Heating and Cooling

- Energy gain of solar collectors
- Inland production of combined systems
- Increasing total capacity of applications in SH&C
- R&D and technological developments

- **Determining the survey table and nececssary information of the roadmap documents:** Survey tables that include vision statement for 2020 and 2030 with related key performance indicators for each main technology area and related activities and resources proposals has been prepared as shown

TABLE 4-13 must be filled by participants of stakeholders for each subjects of main areas and their timelines.

Table 4-13 : Survey tables of solar roadmap

Name of Participants and Organization			
	2020		**2030**
Vision Statement			
Key performance Indicators			
	Subjects :		
	2010-2011	**2012-2014**	**2015-2020**
Activities for related subjects			
Resources for related subjects			
Related organizations for this subject			

For roadmap booklets that has been distributed to the participants of Solar Future 2010 Congress, documents contents have been prepared and announced to the participants to collect related information and papers in order to be analyzed and covered. These booklets would include:

- The identification and description of each technology in the world and its current status.
- Vision, strategic targets and indicators
- Roadmap proposals and assumptions
- Conclusion and Recommendations.

During the development of the Roadmap, all participants paid close attention to the existing situation and related activities of solar energy of Turkey. The solar energy documents and scientific papers were carefully reviewed by participants in order to determine which solar energy roadmap elements would support the desired outcomes. The task team has collected and compiled all information from participants and has written the roadmap reports.

- **Conducting the survey and collecting the proposals of pariticipants and preperation of final report:** The Delphi method is a well-known intuitive method. Every participant has filled out the table independently and sent to the coordinator of ICAT. Delphi Research Process has continued as following:

  - Collect input: Round One
  - Revise definition and attributes
  - Collect input: Round Two and three
  - Analyze data for convergence and reconcile
  - Roadmap workshop sessions as 5 times for reconciliation of figures
  - Conclusions and recommendations
  - Roadmap drafting
  - Draft roadmap circulated to stakeholders
  - Roadmap released

The vision for the roadmap is to provide at least 30 percent of the electricity of Turkey's energy by 2020, providing consumers and energy providers with affordable, reliable, secure, and diverse solar energy.

The following assumptions are valid through the roadmap study and report:

- The related legislation of solar energy is issued within the first three months of 2010
- Licence application results will be announced by the end of 2010 by the Turkish Energy Marketing and Regulation Board (EPDK)
- The applications will be evaluated spread into a few years.
- For every year, issue of licenses for a minimum of 1000 MWp will take place
- Total energy demand for the country is assumed to be 450 TWh in 2023 and 600 TWh in 2030.
- For the calculations of cost of energy production using PV, radiance value is taken as Turkey's average of 1,527 kWh/m^2.
- Figures for total PV Capacity installed, are taken from report issued by UFTP in 2–3 October 2009
- It is assumed that photovoltaic systems are to be installed over the area of 4,600 km2 where yearly radiance is above the value of 1,650 kWh/m^2

Some of the definitions used in the roadmap are explained bellow in detail.

- **Domestic production** is used to define the total contribution of components used in a module that are produced inland.
- **Grid connection system components** consist of transformers, inverters, mounting cables, mechanical parts and engineering.
- **FIT or Feed in Tariff** is used for the incentive paid by the state for the electricity produced through solar systems and fed back into the national grid.

As for this goal as follows, individual objectives and activities are planned for PV, CSP, and solar heating and cooling . Market, research and devlopment, installed capacity targets and related important issue has been included by roadmap for PV, CSP and Solar heating and Cooling.

PV: activities and targets on the basis of topics and goals are determined as follows and shown as **Figure 4.4**

- **Reducing of module component cost target is 20% at 2020, 40% at 2030**
    - Developed production methods and component architecture,
    - Increased production volumes
- **Standards and certification**
    - Establishment of a centre with international certification
    - Classification and issue of standards by TSE
    - Revision of existing norms and definition of new standards, harmonization to EU and international norms
- **Domestic production: Target is Total contribution of domestic production to PV installation will be 30% in 2020, 60% in 2030 and grid connection systems used in domestic markets produced inland will be 60% in 2020, 90% in 2030**
    - Increased domestic contribution
    - Subsidized domestic procurement
    - Emerging regional markets and increased market share -> higher production ->exports
    - Learning curves and increased investments
    - Increased market share in the region; higher quality and higher volumes of production
- **System installation costs target is 1,7 EURO/Wp in 2020 and 1 EURO/Wp**
- **Total power installed capacity target is 4,8 GWp in 2020 and 7 GWp in 2030**
- **R&D and improvement of efficiency**
    - Increased efficiency in PV c-SI will be 18-20% in 2020 and 22-24% in 2030
    - Increased efficiency in PV thin film will be 16-18% in 2020 and 20-22% in 2030
    - Organic PV R&D study will be started and efficeincy will be 2-5% in 2020 and 13-15 in 2030

- State incentives for R&D in PV modules will be increased to 100% up to 2020
- R&D investment as a higher percentage of GDP*
- After 2020, the new technologies will be developed
- The new technologies in orgaic PV will be developed after 2014

- **Public and educational aspects**
  - Introduction of PV related subjects to national curriculum of middle or higher education
  - Apprentice and engineer training
  - Perform projects and applications by local governments and communities to increase public awareness and consciousness over pv and ecological aspects

- **Governmental subsidies and feed in tariffs**
  - Revised legislation will be finalized up to 2011
  - Governmental subsidies and incentives for PV Cell production plants will be enlarged up to 2012
  - Additional work over legislation and regulation for utilization of energy generated through PV

- **Power generation cost target is 12 EURO cent/kWh in 2020 and 6 EURO cent/kWh in 2030**

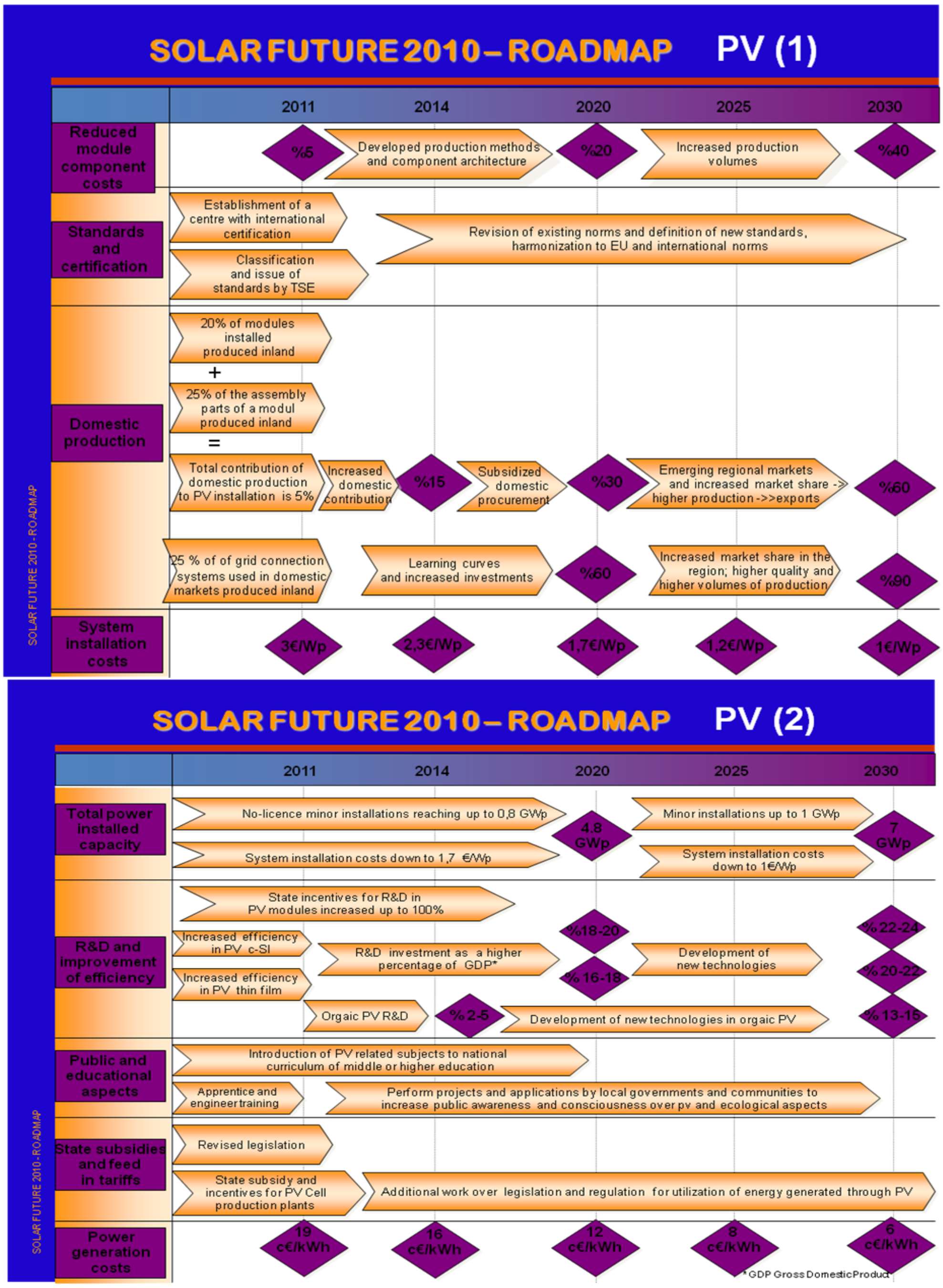

Figure 4.4: PV Roadmap for Turkey

CSP : Activities and targets on the basis of topics and goals are determined as follows and shown as **Figure 4.5**

- **R&D and technological developments**
  - Research into CSP technologies and prototyping of generation plants will be realized up to 2011

- Obtaining steam from prototypes and turbine designs for CSP Power generation and Power generation from pioneer applications will be realized up to 2014

- **Target of CSP power generation plant capacities are 200 MWp in 2020 and 1 GWp in 2030**
  - Contsruction of minimum of five installations will be reliazed up to 2020
  - Increasing the number of installations by spreading over predefined suitable locations
- **Domestic production facilities**
  - Governmental subsidies and incentives for inland production of CSP related components will be reliazed %70 in 2020 and 100% in 2030
- **Target of system installation costs is 2 EURO/Wp in 2020, 1 EURO/Wp in 2030**
- **Target of power generation costs is 6 EURO cent/kWh in 2020, 4 EURO cent/kWh**

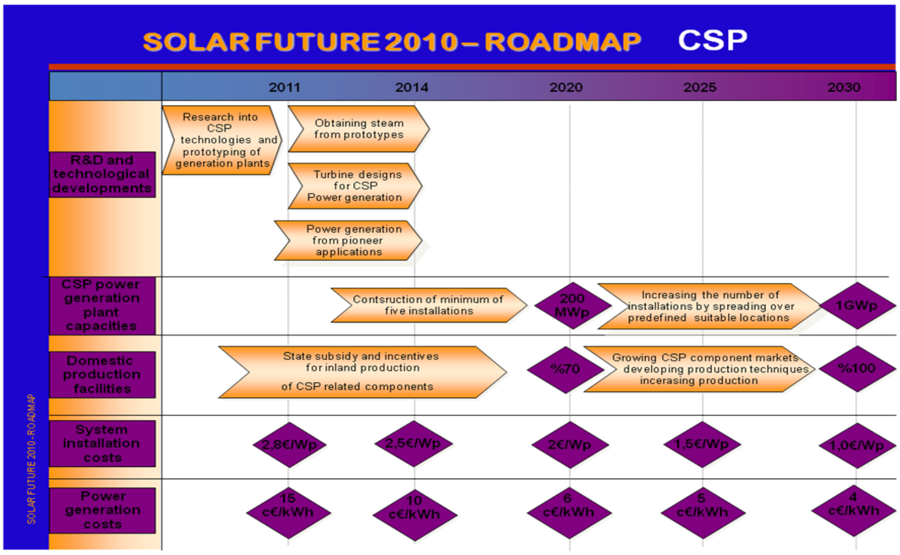

Figure 4.5 : CSP Roadmap for Turkey

Solar Heating and Cooling : Activities and targets on the basis of topics and goals are determined as follows and shown as **Figure 4.6**

- **Increasing total capacity of applications in SH&C**
  - Drop in VAT down to 15% for solar heating systems for hot water and increasing the applications of flat face glass collectors up to 2014

- 0% VAT for natural gas bills for hybrid systems where solar energy is involved up to 2014
- Enabling and encouraging production and marketing of collectors with minimum gain of 525 kWh/m2 year up to 2014

- **R&D and technological developments**
  - Mass production of vacuum high absorption flat collectors constitutes 90 % of total collector production up to 2014
  - Completing the R&D projects of systems capable of active hating and cooling with 100% R&D subidies up to 2014

- **Inland production of combined systems**
  - Commercial applications of active heating and cooling systems up to 2014
  - Enabling and encouraging production and marketing of collectors complying with EN norms, inland up to 2015
  - Domestic production of systems will be 90% in 2020
  - Increasing the utilization of systems to its natural and economical boundaries while design, development and production of heating and cooling systems done fully inland will be 80%

- **Energy gain of solar collectors**
  - R&D and developments in production methods will gain 525 kWh/m2-year
  - The result of new materials and production techniques, development of new flat face vacum constructions, energy gain will be 700 kWh/m2-year

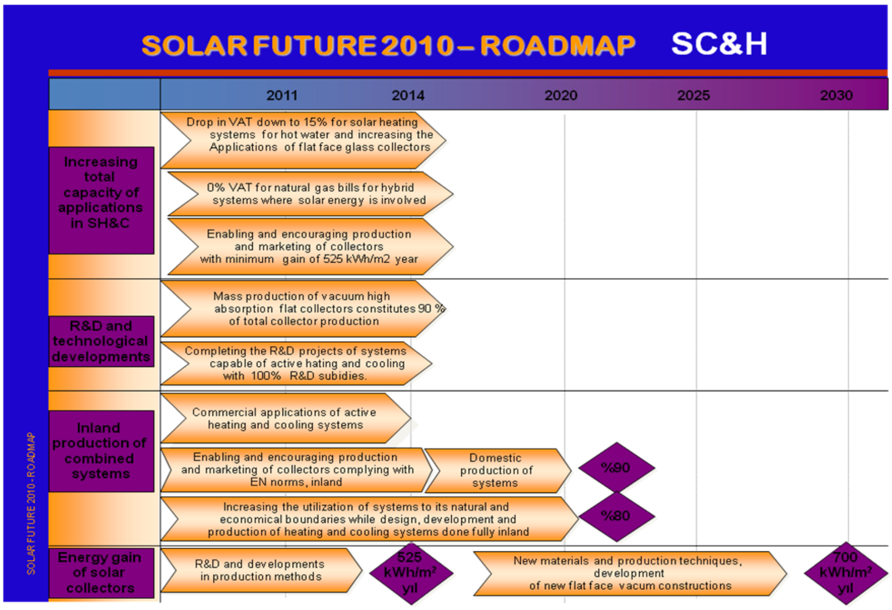

Figure 4.6 : Solar heating and cooling roadmap

All of this study has been summarized as a roadmap figure and presented in Solar Future Congress 2010 at 11-12 Feb 2010 and printed as a booklet and distrubuted to all participitant and governmental organizations.

The Roadmap is designed as a living document to incorporate policy modifications as well as additions. Existing solar energy policies in Turkey will evolve with the market and technology and new policies will be developed in the future. Because of this reason, the roadmaps could be developed and should be updated by government and all related associations.

4.4 Research and Development for Solar Energy

Public research and development plays a cricule role in the technological devlopment and economic competitiveness of a country. Skill development, generation of new knowledge, new scientific instruments and methologies, creation of new products and improved processes are benefits of public R&D accuring to society.

The Scientific and Technical Research Council of Turkey (TÜBİTAK), and the Supreme Council for Science and Technology (SCST) constitute the regulatory backbone of the national R&D system, in which the universities and public research institutions are the key players. The building blocks of the Turkish R&D system are given below

Figure 4.7: [152]

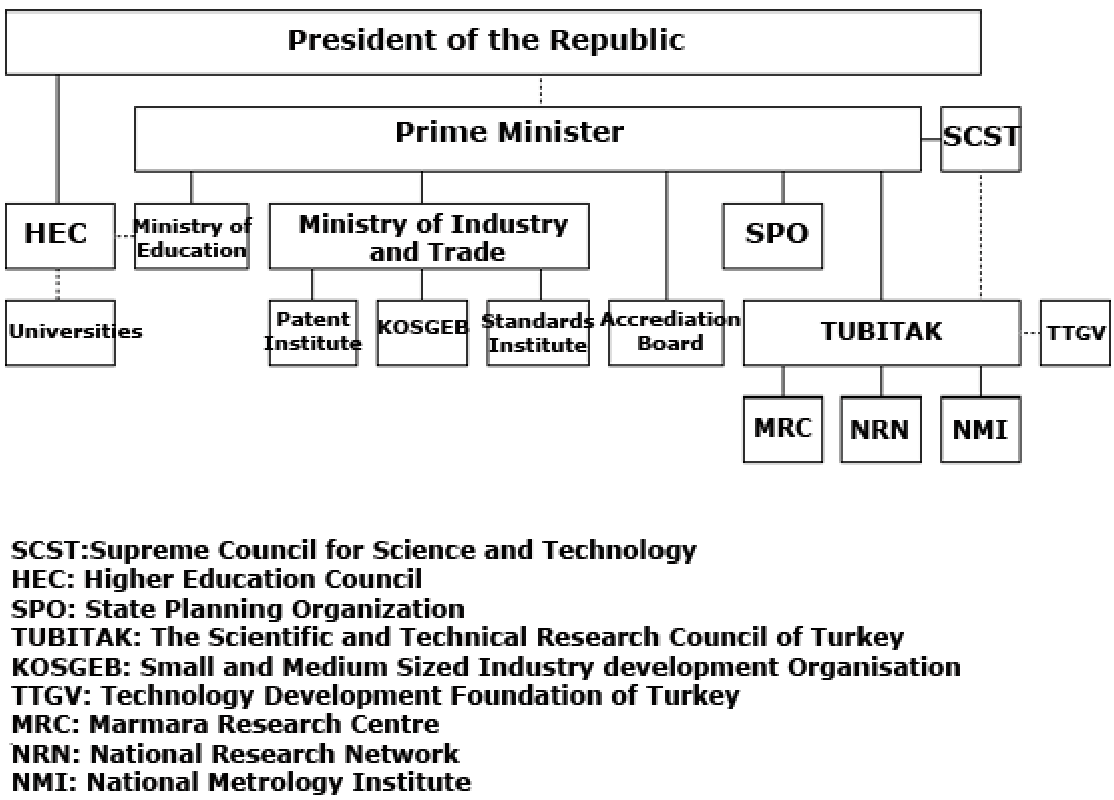

Figure 4.7: Research and technology system

Role and functions of R&D organisations has been summarized as follows;

- Established in 1983, The Supreme Council for Science and Technology (SCST) periodically establishes R&D priorities.

- The Scientific and Technical Research Council of Turkey (TÜBITAK), which is the main public R&D body, has an advisory role insetting these priorities. Founded in 1963, TÜBITAK is the principal organisation responsible for promoting, developing, organising and co-ordinating R&D in the fields of exact sciences in Turkey in line with the national targets of economic development and technical progress. It reports directly to the Prime Minister. TÜBİTAK, initiated an R&D Grant Program in 1995 for industrial R&D projects, and established a special division, TIDEB that was re-named TEYDEB, in charge of the program. The government has a R&D Assistance Programme for Industry under which TÜBITAK and the Undersecretariat of Foreign Trade can provide grants for up to 50% up to 60% of the project cost and 75% of small medium enterprise for only 2 projects. Additionally; TÜBİTAK runs its academic research support programme through Research Grant Committees, representing various areas of specialization. These researches grant committees fund and monitor national research projects, and co-finance international projects in relation with bi-lateral agreements. The Marmara Research Centre of TUBITAK (TUBITAK-MAM) is the biggest public research organisation which provides contractual research, testing, training, consultancy, analysis and certification services in its research centres, and creates an environment for the generation and growth of high-tech firms in its technopark. TUBITAK's institutes (such as Energy Instutite) are research organisations conducting research in their fields of specialisation. Until the late 1980s, solar energy and energy conservation research was carried out at the Mechanical and Energy Engineering Department (MESAB) of the Marmara Research Institute (TUBITAK-MAM) and the Building Research Institute (YAE), but these were abolished due to administrative difficulties. MAM conducted studies on low temperature applications of solar energy and modeling thermal energy requirements of Turkish process industries and assessment of the potential for solar industrial process heat between 1977 and 1985. Ankara Electronics Research and

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[152] TUBİTAK, Turkish Science, Technology and Innovation System http://traccess.tubitak.gov.tr/fp6_yeni/DefaultIframe_en.aspx?aId=914

Development Institute, Turkish Scientific and Technologic Research Center (TUBITAK) was established in 1986 and is capable of designing and manufacturing systems for photovoltaic (PV) applications. In February 1996, the Energy Systems Department located at TUBITAK Marmara Research Center became jointly affiliated with the Environmental Engineering Department, and together the two departments formed the Energy Systems and Environmental Research Institute (ESERI). Since this date, ESERI's two strategic business units - Energy Technologies and Environmental Technologies - completed several important projects, developed their infrastructure, and expanded their knowledge base, experience, and networks on an international level. On October 3, 2004, in accordance with the decision of TUBITAK's Science Committee, the two strategic business units were separated, and the Energy Technologies strategic business unit became the Energy Institute (EI).

- The State Planning Organisation (DPT), which reports directly to the Prime Minister, is responsible for overall co-ordination of national economic and social development programmes, allocation of funds to public investment projects and advising the government. It provides financing for research centres, universities and industrial organisations according to its needs and priorities.
- The Technology Development Foundation of Turkey (TTGV) was established in 1991 to raise industry's awareness of R&D and to support technology development projects of the Turkish industry through World Bank financing. TTGV is an independent non-profit organisation established jointly by the private and public sectors. It is a non-governmental organisation with a special status that has undertaken a national mission of fostering the continuous and effective technology development activities of industrial companies. TTGV supports R&D activities in the form of R&D loans. TTGV supports projects for a maximum of two years, and the support amount cannot exceed 50 percent of the project budget. R&D loans given by TTGV are extended in terms of USD without any interest, but a fee (3% of the project budget) is to be paid for administrative expenses. The loans have to be repaid over three to five years after a one-year grace period.
- Chaired by the Ministry of Industry and Trade, the Small and Medium Industry Development Organisation (*KOSGEB*) brings together the Union of Chambers of Commerce and Industry, an umbrella association for trades and professions, and

several governmental bodies, as well as TÜBITAK, in order to improve the effectiveness and expand the role of SMEs (Small and medium enterprises). KOSGEB was established by a special founding act in 1990, with the purpose of supporting innovation activities and encouraging entrepreneurship. It is a public body acting as both a consultancy service provider and a technology supplier for SMEs, to improve the performance, efficiency, and thus competitiveness by means of technical assistance programs, including training. To achieve these objectives KOSGEB introduced several instruments, like, Training Centres, Consulting and Quality Improvement Services, Common Facility Workshop and Laboratories, and Technology Development Centres.

- As for solar studies conducted by some governmental institutions and universities, The Solar Energy Institute, situated on the campus of Ege University in Izmir, was founded in 1978 for graduate education and research on solar Energy and its applications. Ege University Solar Energy Institute is still the only research institute which mainly works on solar energy research topics. The institute also supports some projects of the municipalities and the other societies to increase the PV applications in Turkey. A project which is mainly financed by United Nations with the support of the institute has been executed as a solar lighting system in Gokceada which is the biggest island of Turkey. The studies are maintained in the production of organic dye-sensitized solar cells by the solar Energy Institute of Ege University. – Ege University Solar Energy Institute increases its PV power capacity by producing the solar modules with the lamination technique of silicon solar cells The total PV capacity has reached to 24 kWp. [153]
- The new and renewable energy research and development center YETAM of Hacettepe University was esatblished in 1993.
- The Solar energy research and development center HÜGEM of Harran University was esatblished in 2003.
- Establishing of Solar Energy research and development center (GÜNAM) within the body of ODTÜ has been funded by DPT between 2009–2011.

[153] International Energy Agency (IEA), PVPS ANNUAL REPORT 2007, TURKEY PV TECHNOLOGY STATUS AND PROSPECTS, 2007

- Clean Energy Foundation TEMEV was esatablished in 1994 for aim of reserach and development and application studies, educational-information and publicity studies and compling information and documents studies. Solar Architecture in Anatolia work group was esatblished in 1996, solar cells and their applications work group was founded in 1997. Many research and development and application studies has been realized between 1994–2010 such as devloping a computer pprogram for the usage of solar collectors, the solar energy projects devloped by CEF after 199 earthquake in Marmara region, building of solar house and science museum in the eratquake region, illumunation of two bus stops at Afyon city center by solar cells, illumunating th cultural house Harran with solar energy, operating the biogas system in Çorum, illuminting of the Van cat statue with solar cells, building of a solar energy street lamp to be placed in Muğla University's new campus, illumination of a bus-stop in the city center of çorum by solar energy, solar bicycle project, participation of EU synergy projects and others [154]
- Ege University Solar Energy Institute (SEI) has initiated the "Formation of National FV Technology Platform (UFTP)'' project which will lead to a platform with the participation of the universities and the industrial companies, obtaining financial support from TÜBİTAK (The Scientific & Technological Research Council of Turkey) in 2008. The aim of the project is defining effective FV technology programs and setting the FV roadmap for Turkey.[155]
- According to the survey study of UFTP, 37 project has realized about PV technology from 1992 with funded TUBİTAK.[156]

Recently, the SCST decided that new national science and technology policies should be formulated, and priority areas should be set in order to create an innovative economy and a creative society by 2023, the hundredth anniversary of the foundation of the Turkish Republic. Consequently, the elaboration of the National Research and Technology Foresight Programme (Vision 2023 Programme) started at the beginning of 2002 under the coordination of TÜBITAK. Whereas until now most technology development has focused

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[154] TEMEV, From Its Establishment up to Today 1994-2004
[155] UFTP, http://www.trpvplatform.org/index.html
[156] UFTP, Survey Report, 2010

on short to medium-term applications, the Vision 2023 Programme covers the period 2003-2023. It has the following objectives:

- Building long-term science and technology objectives for Turkey.
- Determining strategic technologies and priority areas for R&D.
- Formulating science and technology policies for the next 20 years, while being supported by a whole spectrum of stakeholders and creating public awareness of the importance of science and technology for socioeconomic development.

Energy and natural resources is one of the areas included in the Vision 2023 Programme. The following priority topics for energy have been developed to address the energy policy goals: [157]

- Clean coal technologies.
- Fuel cells for transport, stationary and portable applications.
- Wind energy technologies.
- Hydrogen combustion technologies.
- Electricity production from solar energy.
- Energy storage technologies.
- Hydropower plants (mini and micro).
- Nuclear energy.
- Control technologies for power systems.
- Energy conservation technologies in industry.
- Reduction of energy consumption and using renewable energies in buildings

Energy-related R&D activities have focused on advanced and new energy technologies since the 1990s. Non-nuclear energy R&D activities in Turkey can be divided into two groups according to their size. The first category covers a number of small-scale clean energy R&D projects and university projects on photovoltaics, solar heating and biogas. The second category covers medium or large-size projects of an international nature. The research for these projects has mainly been focused on fuel cells, photovoltaics and biomass. The state energy R&D budget increased considerably in the mid-1990s, peaking at USD 12 million in 1997 to decline again to USD 3.3 million by 2002. In 2003, the

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[157] TUBİTAK, Vizypn 2023 Teknoloji Öngörü Projesi Enerji ve Doğal Kaynaklar Paneli Raporu, 2003

estimated budget was USD 5.5 million. 23% of the state energy R&D budget was used for renewables (principally geothermal and solar), 23% for electricity transmission and distribution, 16% for fossil fuels (principally coal), 5% for energy conservation and 2% for nuclear; 31% of the state energy R&D budget was used for “other energy R&D”, which comprises mainly hydrogen and fuel cell technologies. As compared to GDP, the Turkish state energy R&D budget is one of the smallest (together with Portugal) among the IEA member countries (see **Figure 4.8**). In 2005 the government will allocate USD 300 million to the Vision 2023 Programme with ambitious plans to increase the level to USD 8.4 billion in 2010 (2% of the GDP). [158]

[158] IEA, OECD, Energy Policies of OECD Countries, 2005 Reivew

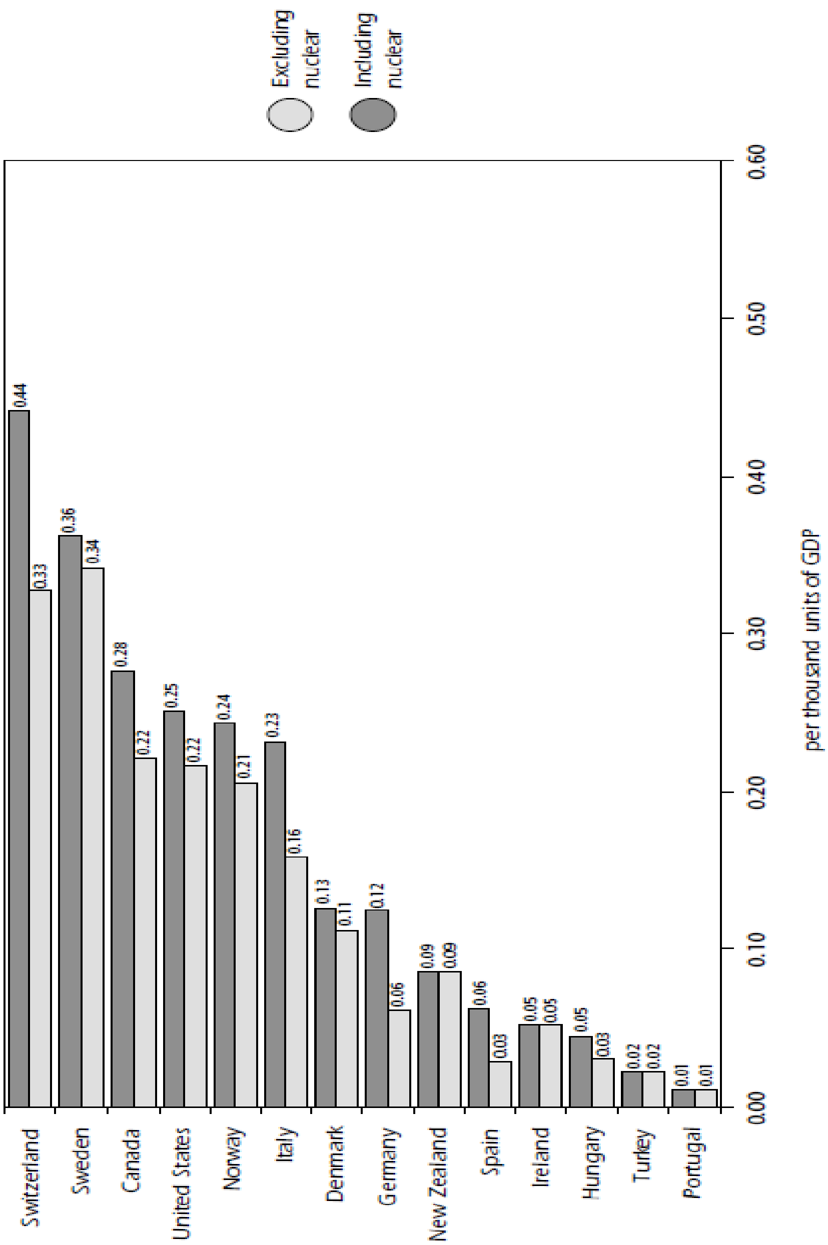

Figure 4.8: Government budgets on energy R&D per GDP, 2003
Source : IEA, OECD

Turkey continued to make good progress in science and research in the last years. Financing of R&D projects are offered via national funds by TUBITAK, TTGV, DPT (State Planning Organization), and Ministry of Industry with SAN-TEZ programs, KOSGEB, research funds of universities and owner's equity of companies. There are no uniform methodologies used to monitor and assess the energy R&D carried out in the different R&D establishments. Each funding organisation has its own management committee as well as Project monitoring committee consisting of both academia and professionals. According to the **Figure 4.9** research and devlopment funds are increasing according to the years. [159]

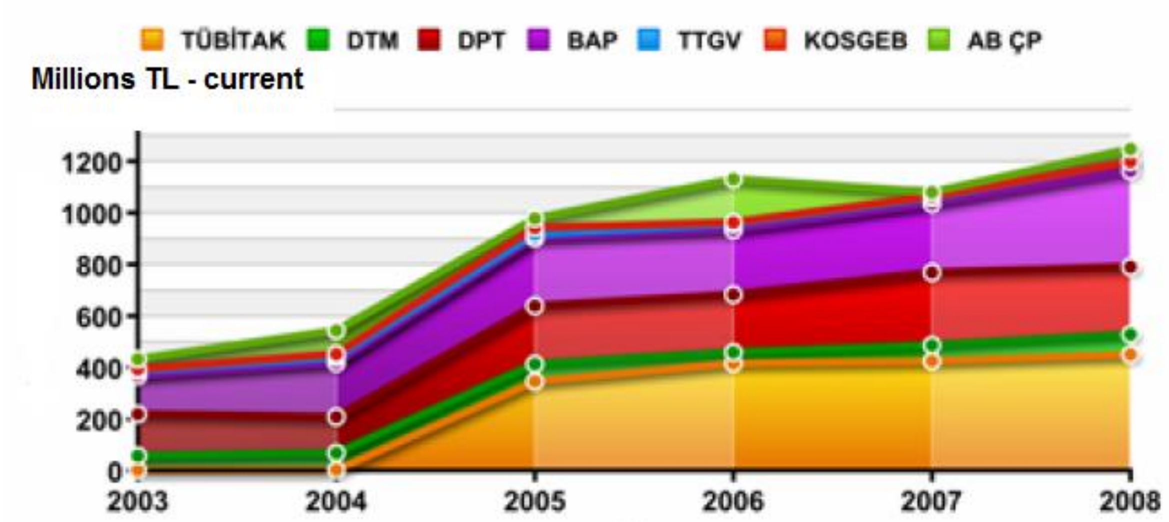

Figure 4.9 : Direct Public R&D and Innovation Funds by Source of Funds with current prices
Source : TUBİTAK

In 2008, 43.8 % of Research and Development (R&D) funds of TUBİTAK-TEYDEB (238,8 Million TL approximately 111,04 Million EURO) was performed by higher education sector, 44.2 % by business enterprises comprising state economic enterprises and private sector, and 12 % by government as shown **Figure 4.10.** [160]

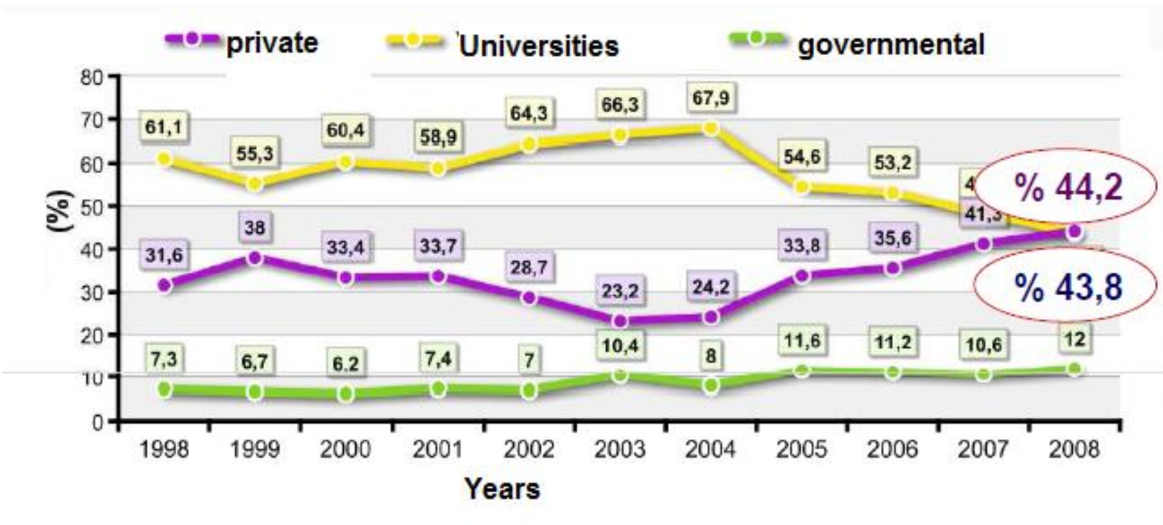

Figure 4.10: Research and Development expenditure according to the resources
Source : TUBİTAK

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159 TUBİTAK, DOĞRUDAN KAMU AR-GE FONLARININ DEĞERLENDİRİLMESİ 2008
160 TUBİTAK, 'Bilim ve Teknolojide Gelinen Nokta 2002-2009 Dönemi' Bilim ve Teknoloji Yüksek Kurulu 20. Toplantısı Presentation, 2009

According to the TUBITAK reports, university's research and devlopment expenditure and grants of The Ministry of Industry SAN-TEZ program is increasing during the years as shown following **Figure 4.11.**

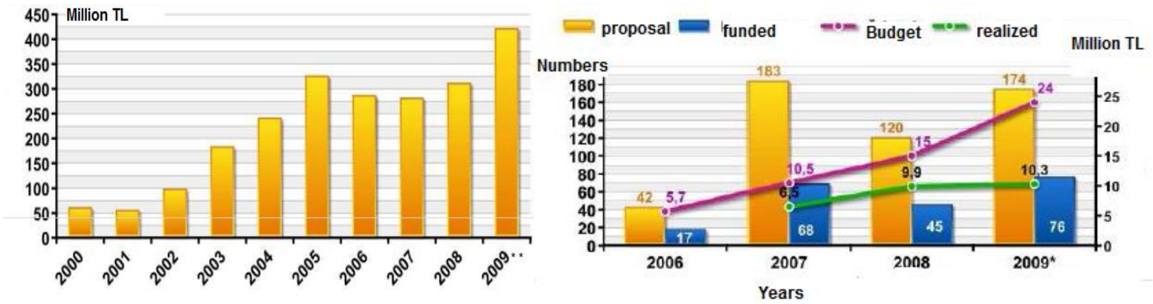
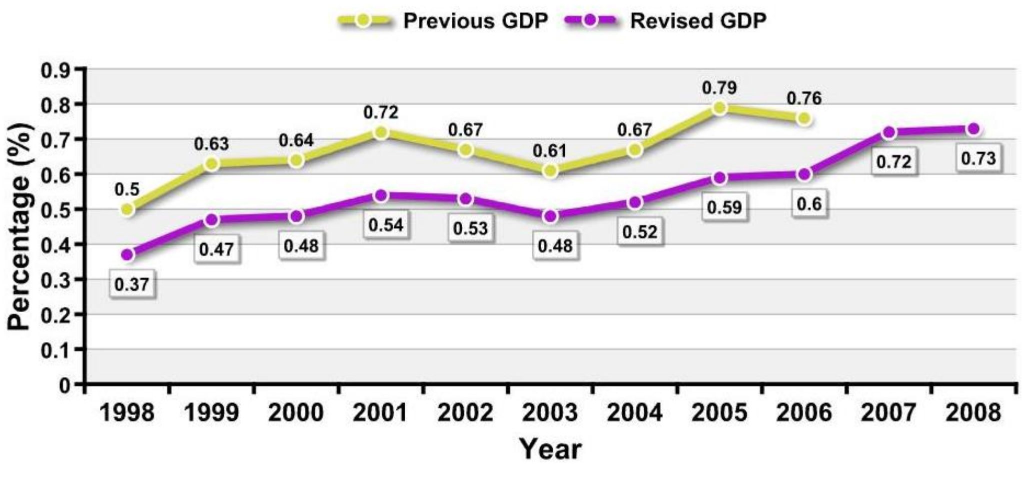


Figure 4.11 : Research and Development expenditures of universities and SAN-TEZ program

TTGV has funded USD 250 Million (347 Million EURO) to 650 projects of 500 firms from 1991 up to 2008 [161]

The results of 2008, Research and Development Activities Survey shows that share of Gross Domestic Expenditure on Research and Development (GERD) in the Gross Domestic Product (GDP) (base year 1987) was 0.76 % in 2006. As it is known, revised GDP was announced on March 08, 2008. According to the revised GDP (base year 1998), share of GERD in GDP was 0.73 % in 2008 as shown **Figure 4.12**. According to the survey results in public sector, foundation universities and business enterprise sector and calculations based on higher education sector registers for state university, GERD in Turkey was 6,892 Million YTL in 2008 (USD 5.381.410.102) as shown **Table 4-14. [**162]



161 TUBİTAK, 'DOĞRUDAN KAMU AR-GE FONLARININ DEĞERLENDİRİLMESİ' TTGV Presentation, 2008
162 TUBİTAK official web page, http://www.tubitak.gov.tr/home.do?ot=1&sid=1006&pid=547

Figure 4.12 : GERD as a percentage of GDP (Turkey)

Source: TurkStat, **Note:** Gross salaries are used for the calculation of R&D labour cost in higher education sector after the year 2006 for values based on revised GDP. (Revised GDP was announced on March 08, 2008 by TurkStat)

Analyzing the sectors financing R&D expenditure, in 2008 as shown **Table 4-14**, 47.3 % financed by business enterprises, 31.6 % by government, 16.2% by higher education, 3.6 % by other national sector and 1.3 % by foreign funds.[163]

Table 4-14 : GERD by Source of Funds* (Turkey)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Government	1022	1150	1412	1207	1188	1537	1901	2375	2643	3012	2180
Industry	800	1044	1198	965	961	976	1265	2052	2306	3100	3257
Other National Sources	87	101	147	153	170	140	159	273	243	254	251
Abroad	7	116	34	19	30	42	12	37	24	33	90
Higher Education	-	-	-	-	-	-	-	-	-	-	1114

*** 2008 Constant Prices** (Million TRY) **Source:** TurkStat **Note:** Up to the year 2008, financial resources provided by the State Universities were included in government sector and financial resources provided by the Foundation Universities sector were included in the business enterprises sector.

The Ministry of Energy and Natural Resources, within the perspective of the energy and natural resources policy of Turkey, has prepared the Strategic Plan covering the period between 2010 and 2014. In the Strategic Plan of the the Ministry, which has been prepared by considering national priorities, strategic aims and targets have been determined for the 2010-2014 in the matters of “Energy supply security”, “the regional and global effectiveness of Turkey in the field of energy” “Environment” and “Natural resources” and the strategies to be pursued have been clarified. The main target has been set to provide the energy resources to all consumers adequately, with high quality, at low costs, securely and in consideration of the sensitivities about the environmental matters as follows. [164]

Target -11 Being Innovative and Pioneering: The encouragement of the R&D studies and pioneering in the use of new technologies.

> **Target 11.1** In the year 2010, the EN-AR (Energy Researches) Program will be put into practice and by the year 2014, support worth TL 50 million will be supplied.

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[163] TUIK, statistical report, http://www.tuik.gov.tr/PreTablo.do?tb_id=8&ust_id=2

[164] ETKB, Strategic Plan 2010-2014

Target 11.2 100 percent of increase in the R&D investments conducted by the related and affiliated institutions by the year 2015, compared to the R&D investments in 2009.

Strategies

1) Priority will be given to the utilization of the national resources and different technologies in the energy production planning.
2) For the purpose of increasing efficiency and compatibility, the studies required for the designation of the R&D activities in a way to create innovation.
3) The required measures will be taken for the development of the production, manufacturing and supply industry to serve for the energy sector.
4) The mechanisms supporting the capability of designing, engineering and innovation in the developing energy sector will be improved.
5) For the purpose of developing an industry that produces energy equipment, making maximum use of the existing infrastructure and technology capability, a system based on efficiency, supply depending on R&D, acquisition of domestic technology and capability will be developed.
6) With the EN-AR Program, the development of the cooperation between universities and industry and the utilization of R&D human resource and infrastructure by the private sector will be supported.
7) The capacity of the Technology Development Centers that brings the universities and the private sector together will be utilized and their specialization in the areas of priority needed by the sector will be encouraged and supported.
8) Especially with the EU member countries, cooperation activities will be conducted with the countries authorized in science and technology for the purpose of information and technology transfer.
9) The new technology development areas such as hydrogen technology will be supported.

Budgets have been set for these strategies as follows;

	2010	2011	2012	2013	2014	TOTAL
Total Inovation and research and	**34.810**	**38.280**	**42.108**	**46.319**	**50.951**	**212.457**

development funds (Thousand TL)						
Funding of ENAR program with 50 Million TL up to 2014	20.880	22.968	25.265	27.791	30.570	127.474
İncearsing of R&D 100% from 2008 up to 2015	13.920	15.313	16843	18.528	20.380	84.983

Accordingly, the “Electricity Energy Market and Supply Security Strategy Paper”, which outlines our long-term targets in the electricity energy sector, was enforced with the resolution of the Higher Board of Planning in 2009. Within the framework of the Strategy Paper, by the year 2023, the 100th anniversary of the foundation of Turkey, the integration of entire coal and hydraulic potential into our economy, making our wind energy installed capacity reach up to 20,000 MW, and our geothermal energy installed capacity reach up to 600 MW and, additionally, supplying the 5 percent of our electricity energy production through nuclear energy have been aimed.

As shown **Table 4-15**, EU has budgeted 16 Billion Euros for PV and CSP at the period 2010-2020, USA has budgeted 250 Million USD for PV only at 2010.

Table 4-15: Research and Development Budgets in Different Studies for Different Countries

No	Year	Author	Study	Countries	Contents	Time Horizon	R&D Budget	Explanation
1	2009	PhotoVoltaic Technology Platform	Today’s actions for tomorrow’s PV technology - An Implementation Plan for the Strategic Research Agenda of the European Photovoltaic Technology Platform	Europian Union	Photo Volatic	2009-2013	Euro 6,6 Billion	55% will have to be contributed by the private sector, while 45% consists of public contributions
2	2009	JRC	PV Status Report	USA	PV and Solar	2010	USD 250 million	$ 51.5 million for PV, $ 40.5 million for solar energy,
3	2009	European Commision	SET-Plan, Technology Roadmap, SEC(2009) 1295	Europian Union	PV and CSP	2010-2020	Euro 16 Billion	R&D on low carbon energy technologies has been estimated by the Commission together with the industry to cost between 58.5 to 71.5 billion euros over the next 10 years, divided to solar energy with PV and CSP 16 billion euros which €9 billion are for the PV and €7 billion for the CSP.

4	2009	EU		Europa Union	Renewables	**2007**	Euro 16 Billion	
5	2008	JRC	PV Status Report	USA	PhotoVolatic	2010	USD 250 Million /year	
6	2008	JRC	PV Status report	japan	PhotoVolatic	2006-2010	Euro 172 Billion	
7	2008	US Department of Energy	Solar Energy Technologies Program, Multi Year Program Plan 2008-2012	USA	Photo Volatic	2010-2015		PV-produced electricity and domestic installed PV generation capacity of 5-10 GW, In 2006, installed costs for residential PV systems were baselined at \$7.97/W, resulting in an LCOE of ~30¢/kWh. 0,15 ¢/kWh in 2010, 0,10 ¢/kWh in 2015.
					CSP	2010-2015		8-10¢/kWh with 6 hours of thermal storage in 2015 , 5-7¢/kWh with 12-17 hours of thermal storage in 2020
8	2007	EU Commision,	A European Strategic Energy Technology Plan (SET-Plan), CAPACITIES MAP, {COM(2007) 723 final}	EU-15	Energy	2005	Euro 2139 Milion	energy R&D amounted to €2139 Mio in the EU-15 and €2194 Mio in the EU-27. Relative to GDP, the budget for production and utilisation of energy amount to in-between 0.04-0.05%. with only Hungary, Finland and France
				USA	Energy	2005	EURO 2429 Mllion	in the USA and Japan are €2429 Mio (nuclear 15%) and €3144 Mio (nuclear 64%)
				japan	Energy	2005	EURO 3144 Million	
9	2007	Koyun, A.	Change, Energy Efficiency and Renewable Energy Turkey Mediterranean and National Strategies for Sustainable Development Priority Field of Action 2: Energy and Climate	TR	Energy	1980-2005	US\$ 120 million	In this period, 15.6% of its total energy research and development (R&D) budget (US\$ 17.4 million) was allocated to renewable energy.
10	2007	NEDO	Energy and Environment Technologies	Japan	Solar projects	2007	EURO 138,43 Million	NEDO R&D programs budget
11	2005	EURAC Agency	FP7 Research Priorities for the Renewable Energy Sector		PV and CSP	2005-2015	EURO 16 million	€9 billion are for the PV and €7 billion for the CSP.

The main effort of research and development in the universities is directed towards reducing the production and insallation cost, increasing a efficiency of products. But there is no suffiecient consolidated information of energy and solar energy R&D projects budgets in Turkey. Because of this reason; the aim of assessing existing situation of energy and solar energy R&D projects and budgets; the survey study has been developed for **20** governmental bodies that **<u>15</u>** of them (main players) has answered the survey as shown

Table 4-16, 28 universities that **13** of them has answered the survey as shown **Table 4-17** , 15 NGO and 233 private firms .

A letter and information sheet of R&D projects and budgets for each type of organization has been prepared as shown APPENDİX (just only example for TUBİTAK) and send to each organization as officially. The list of the organizations which have answered the survey is shown below **Table 4-16.**

Table 4-16 : Governmental Organizations

Organizations	**R&D Area for Energy and Solar Energy**
TÜBİTAK	TEYDEB , Acedemia and Governmental funds, İnternational funds, EU 6th and 7th Frame and TUBİTAK research centers, MAM
TTGV	Energy grants
DPT	DPT funds for infrastructure
The Mınıstry of Industry	SAN-TEZ programs to the universities
TEIAS, Turkish Electricity Transmission Company	R&D projects
EUAS, Turkish Electricity Generation Company	R&D projects
TETAS, Turkish Electricity Trading and Contractor Company	There are no data related to R & D have been reported.
TPAO, Turkish Petroleum Company	R&D projects
EIE, Electric Power Resources Survey and Development Administration	There are no data related to R & D have been reported which exceptation of projects with funded TUBİTAK by studied univerisites.
TAEK Türkiye Atom Enerjisi Kurumu	There are no data related to R & D have been reported.
KOSGEB	KOSGEB Funds to SME
ETİ Maden İşletmeleri Genel Md	There are no data related to R & D have been reported.
TEMSAN Türkiye Elekromekanik Sanayi	R&D projects
MTA	R&D projects
BOTAŞ	There are no data related to R & D have been reported.

Table 4-17 : Universities and Research and devlopment centers

Name	**Research area related solar energy**
The Solar Energy Institute - Ege University/Izmir	organic dye-sensitized solar cells, PV module production laboratory
GUNAM / ODTU (Midle East Technical University)	establishing period (R&D of high capacity solar plant (10-100 MW)) Energy and solar energy projects
Hacettepe University YETAM	There are many R&D projects but Budget values are not reported.
Harran University - HÜGEM	R&D projects on the solar energy
Kocaeli University	R&D projects on the solar energy and

	energy subjects
Pamukkale University	R&D projects on the solar energy and energy subjects
Niğde University	R&D projects on the solar energy and energy subjects
Sabancı University	R&D projects on the energy subjects
Yaşar University	R&D projects on the solar energy
Özyeğin University	R&D projects on the solar energy
Işık University	There are no data related to R & D have been reported on energy subjects
Yeditepe University	R&D projects on the solar energy and energy subjects
Muğla University	R&D projects on the solar energy

Although they have R&D studies on energy subjects, the data of İTÜ couldn't recived. Because of this reason; their results are not included in their figures. TKİ, TTK, BOREN, PİGM, DSİ, TEDAŞ which are the Energy Ministry affiliates have not repiled to the survey. Because of this reason; their results are not included in their figures. Despite the efforts of NGO s, the participation of the private sector has been very little.

Assessment of data was made by the assumptions given by the following organizations.

- TUBITAK's reply suggested the usage of the EU Framework program for 6-7th from http://cordis.europa.eu/fp6/projects.htm and http:// cordis.europa.eu/fp7/projects_en.htm addresses. Details of the individual projects have been investigated in these web sites. Altough, a lot of organizations in the project are partners, budgets of organizations in Turkey has couldn't been reached as seperately. Therefore 20% of the total budget is assumed to be used by Turkish organizations.
- Hacettepe University – YETAM's reply suggested the use of web site which is www.yetam.hacettepe.edu.tr and related information is to be taken from this site. Because most of the R&D studies have been done via donation, there is no formal budget information for these studies. Because of this reason, this study does not include YETAM budget information.
- TEMEV has developed 16 R&D projects of solar energy since 1995. But budget information of the project couldn't be found. Because of this reason, this study does not include TEMEV budget information.
- ODTÜ's reply reported the web site which is http://bap.metu.edu.tr and related information of BAP (R&D projects with university equity) are to be taken from this

site. Additionally; there are R&D projects about energy subjects whose name is HYVOLUTION and started at 2006 has a budget 9.492.000 EURO. DPT has provided funding to the establishment of GÜNAM amounted to 11.160.000 TL (5.190.000 EURO) between 2009-2010

- DPT replied the web site which is www.dpt.gov.tr/bilTek.portal is to be used and related information of funds for R&D infrastructure of university are to be taken from this site. Data from these sites were examined individually on a year basis, energy and solar energy projects funds were collected.
- The average annual exchange rates were evaluated on the basis of taking into account as EURO that is published in the official site of the DPT, because budget data have been reported as USD and EURO and TL.
- To compare with the international value of R&D budget ratio of GDP, data were used from TUIK official site and converted to EURO.

Total budgets have been summarized as following titles as shown **Table 4-18** for energy (other energy sources) and

TABLE 4-19 for only solar energy budgets and project numbers according to the years.

- National Funds
    - TUBİTAK (All programs), TTGV (all programs), DPT, KOSGEB
    - The Ministry of Industry
    - Governmental organizations (EÜAŞ, TEİAŞ, TEMSAN, TPAO, MTA)
- İnternational Funds (EU 6th and 7th Frame)
- Universities (Ege Üniversity-GEE, ODTÜ, Nigde University, Pamukkale University, Harran University, Kocaeli University, Sabancı University, Özyeğin University, Yaşar University, Yeditepe University, Muğla University)
- Private Firms (Proenerji, Thermoflex Yalıtım, Tansuğ Makine)
- NGO (UFTP)

Turkey has been spent up to 2010 **3.298,38 Million EURO for energy** (other energy) R&D projects as shown in the **Table 4-18** and **160,41 Million EURO for only solar energy** R&D as shown in the

TABLE 4-19 and totally **3.458,80 Million EURO** shown in **Table 4-20.**

Table 4-18 : Research and Development FUNDS for Energy Projects

Funds	2005 and before years		2006		2007		2008		2009		2010		TOTAL	
	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)
National funds (Project numbers and Million EURO)	**227**	**3.044**	**95**	**30,2**	**80**	**47,22**	**126**	**57,02**	**139**	**71,55**	**40**	**17,87**	**707**	**3.268,54**
TUBİTAK	108	14,3	40	10,87	29	17,47	61	6,60	61	11,10	4	0,62	303	61,03
TTGV	32	8,4	9	0,79	7	1,17	10	0,95	18	2,51			76	13,90
DPT	42	3.017,6	14	13,1	12	18,43	11	36,29	11	43,70		0,02	90	3.129,20
KOSGEB	12	0,6	2	0,06	2	0,10	5	0,14	10	0,19			31	1,14
The Ministry of Industry						0,10		11,50		0,27				1,89
Governmental organizations	33	3,5	30	5,37	30	9,93	39	1,15	39	13,75	36	17,23	207	61,35
İnternational Funds (EU 6Th and 7 Th Frame)	**1**	**0,1**	**-**	**-**	**3**	**1,54**	**3**	**6,69**	**8**	**4,56**	**4**	**0,21**	**19**	**13,11**
Universities	**24**	**0,9**	**23**	**10,81**	**5**	**1,16**	**13**	**1,08**	**17**	**0,81**	**1**	**0,20**	**83**	**14,97**
Private Firms	**4**	**1,6**	**-**	**-**	**-**	**-**	**1**	**0,03**	**1**	**0,07**	**-**	**-**	**6**	**1,76**
TOTAL Funds (Project numbers and Million EURO)	**256**	**3.047**	**118**	**41,01**	**87**	**49,92**	**142**	**64,82**	**165**	**76,99**	**45**	**18,29**	**815**	**3.298,38**

Table 4-19 : Research and Development FUNDS for Solar Energy Projects

Funds	2005 and before years		2006		2007		2008		2009		2010		TOTAL	
	Project number (unit)	**Budget (Euro)**	**Project number (unit)**	**Budget (Euro)**	**Project number (unit)**	**Budget (Euro)**	**Project number (unit)**	**Budget (Euro)**	**Project number (unit)**	**Budget (Euro)**	**Project number (unit)**	**Budget (Euro)**	**Projct number (unit)**	**Budget (Euro)**
National funds (Project numbers and Million EURO)	**18**	**124,12**	**8**	**0.41**	**17**	**8,10**	**25**	**2,33**	**15**	**4,69**	**8**	**10,20**	**91**	**149,87**
TUBİTAK	11	0,10	6	0,26	15	7,44	19	1,83	10	0,78	5	2,81	66	13,26
TTGV			1	0,01		0,02	2	0,006	1	0,43			4	0,48
DPT	5	123,93	1	0,13	2	0,62	1	0,04	1	2,39	1	2,86	11	129,98
KOSGEB	2	0,09					3	0,03	3	0,62			8	0,75
The Ministry of Industry								0,41		0,45				0,86
Governmental organizations											2	4,52	2	4,52
İnternational Funds (EU 6Th and 7 Th Frame)							**1**	**0,58**	**1**	**1,10**	**1**	**0,39**	**3**	**2,07**
Universities	**50**	**0,51**	**29**	**3,13**	**17**	**1,16**	**24**	**0,95**	**31**	**1,35**	**10**	**0,33**	**161**	**7,46**
NGO (UFTP)			**-**	**-**	**-**	**-**	**2**	**0,03**	**2**	**0,05**	**2**	**0,21**	**6**	**0,30**
Private Firms	**1**	**0,35**			**1**	**0,02**	**2**	**0,05**	**2**	**0,11**	**3**	**0,15**	**9**	**0,69**
TOTAL Funds (Project numbers and Million EURO)	**69**	**124,99**	**37**	**3,55**	**34**	**9,28**	**54**	**3,95**	**51**	**7,32**	**24**	**11,30**	**270**	**160,41**

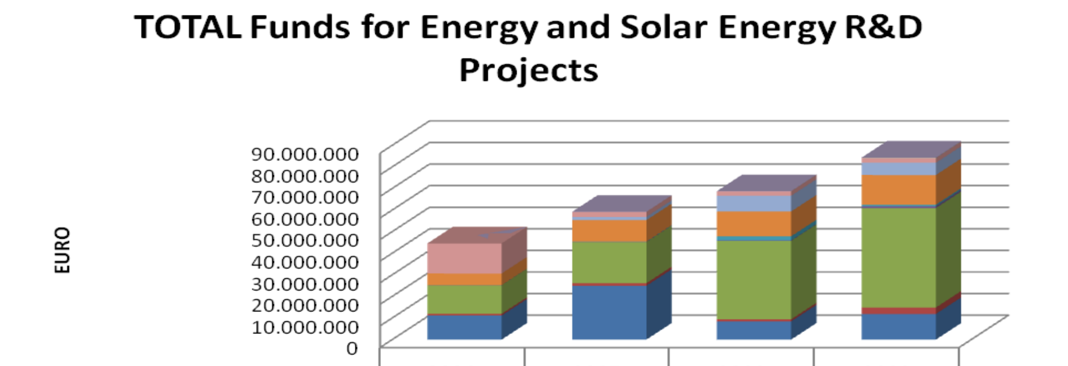
Table 4-20 : Research and Development FUNDS for TOTAL Energy Projects

Funds	2005 and before years		2006		2007		2008		2009		2010		TOTAL	
	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)	Project number (unit)	Budget (Euro)
National funds (Project numbers and Million EURO)	**245**	**3.168,78**	**103**	**30,61**	**97**	**55,32**	**151**	**59,35**	**154**	**76,24**	**48**	**28,08**	**798**	**3.418,4**
TUBİTAK	119	14,45	46	*11,14*	44	24,92	80	8,43	71	11,89	9	3,44	369	74,29
TTGV	32	8,46	10	*0,81*	7	1,20	12	0,96	19	2,95			80	14,39
DPT	47	3.141,59	15	13,22	14	19,05	12	36,34	12	46,10	1	2,88	101	3.259,19
KOSGEB	14	0,72	2	0,06	2	0,10	8	0,17	13	0,82			39	1,89
The Ministry of Industry						0,10		1,92		0,73				2,75
Governmental organizations	33	3,54	30	5,37	30	9,93	39	11,50	39	13,75	38	21,76	209	65,87
İnternational Funds	**1**	**0,10**			**3**	**1,54**	**4**	**7,27**	**9**	**5,66**	**5**	**0,61**	**22**	**15,18**
Universities	**74**	**1,43**	**52**	**13,95**	**22**	**2,32**	**37**	**2,04**	**48**	**2,16**	**11**	**0,53**	**244**	**22,43**
NGO (UFTP)							**2**	**0,03**	**2**	**0,05**	**2**	**0,22**	**6**	**0,30**
Private Firms	**5**	**2,00**			**1**	**0,02**	**3**	**0,09**	**3**	**0,19**	**3**	**0,15**	**15**	**2,45**
TOTAL Funds (Project numbers and Million EURO)	**325**	**3.172,3**	**155**	**44,56**	**123**	**59,21**	**197**	**68,78**	**216**	**84,32**	**69**	**29,60**	**1085**	**3.458,80**
GDP (Million EURO) (Source : TUİK)			**421.327,7**		**474.175,0**		**501.159,4**		**443.605,6**					
Energy R&D funds % of GDP			**0,0106%**		**0,0125%**		**0,0137%**		**0,019%**					

As shown in

Figure 4.13 total energy R&D funds (including solar) are increasing. TUBITAK funds were highest in 2007, meanwhile DPT funds doubled itself after 2007.This has caused a serious increase in total funding.

Figure 4.13: Total energy funds according to the years



	2006	2007	2008	2009
Private Firms	0	20.000	90.000	191.000
NGO (UFTP)	0	0	30.763	57.866
Universities	13.948.455	2.325.490	2.038.819	2.159.201
İnternational Funds	0	1.538.066	7.272.261	5.664.740
Governmental organizations	5.370.992	9.938.402	11.509.284	13.752.803
The Ministry of Industry	0	103.098	1.926.154	728.574
KOSGEB	67.646	103.569	178.678	820.308
DPT	13.225.000	19.054.100	36.342.441	46.100.442
TTGV	810.957	1.200.349	961.594	2.949.598
TUBİTAK	11.141.556	24.925.720	8.437.289	11.895.832

Until 2005,the funds for total energy R&D projects (in total 325 projects) were 3.172,32 Euro as shown

Table 4-21**.** Between 2006-2009,the total project count rised to 691 and the funding to 256,87 Million Euro as totally. The fact that the project count is rising means the knowledge and interest about energy topics has increased.

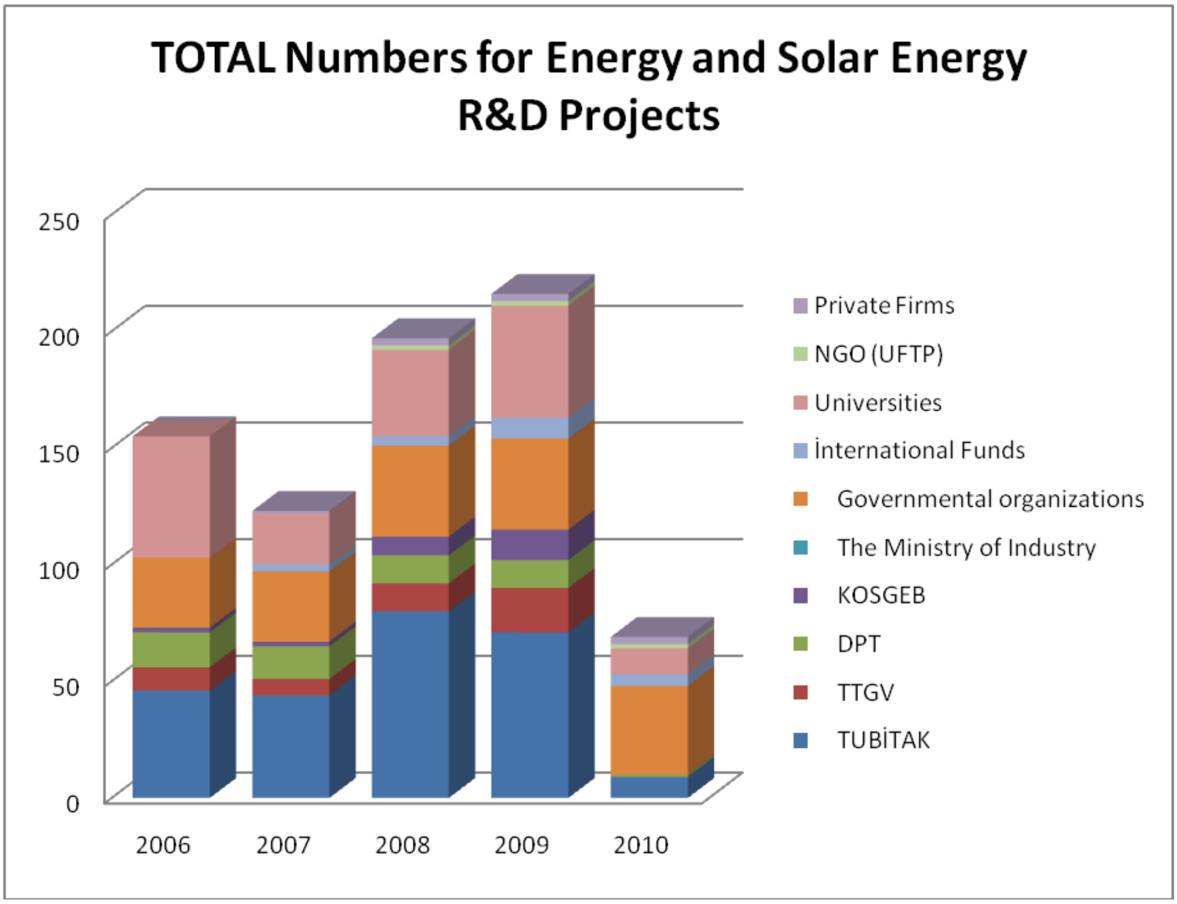
Table 4-21 : Project Numbers and Budgets for Energy and Solar Energy R&D Projects

	Up to 2005	**2006**	**2007**	**2008**	**2009**	**2006-2009 TOTAL**
Project number (unit)	**325**	**155**	**123**	**197**	**216**	**691**
Solar	69	37	35	54	51	177
Other energy	256	118	88	143	165	514
Total budget (Million EURO)	**3.172,32**	**44,56**	**59,21**	**68,78**	**84,32**	**256,87**
Solar	124,99	3,56	9,28	3,96	7,32	24,12

Other Energy	3.047,32	41,01	49,92	64,83	76,99	232,75
GDP (Million EURO)		421.328	474.175	501.159	443.605	
% of GDP		**0,0105%**	**0,0125%**	**0,0137%**	**0,019%**	

Increasing of project numbers according to the years can be shown in **Figure 4.14.** The project number of 2010 is just only for 3 months of 2010. Projects funded by TUBİTAK and universities are the primary reason of incresing.

Figure 4.14: Project numbers according to the years



A different ranking occurs when energy-related public R&D funds are reported in relation to GDP. The "R&D budget/GDP" ratio has increased for the last four years from 0,0106% to 0,019% for Turkey between 2006-2009 years. According to the EU SET-PLAN documents, in 2005 especially France and the Nordic Member States Finland and Denmark as well as the Netherlands have spending 0.03% - 0.055 % of GDP. This corresponds to

0.086% and 0.024% of GDP for Japan and USA in 2005, respectively. Comparing these rates with the survey results the following observations are made.

- R & D resources for total energy are very low according to the EU, japan and USA figures. Comparison of this rate of solar energy is not possible due to lack of any related data.
- The resources allocated to energy R&D in the year 2008-2009 has increased that 44,56 Million EURO by 2006, 59,20 Million EURO by 2007, 68,78 Million EURO by 2008 and 84,32 Million EURO by 2009. The reason for this increase is EU funds and DPT sources.
- EU reports show that private sector's share in energy is 45% in EU. According to the TUBITAK reports, even though private sector's share in Turkey in all R&D budgets (as total not only energy) is 44.2%. The results of this survey show that the private sector’s share in energy R&D turned out to be as low as 0,0709% of total energy funds. This is because only 3 companies have submitted data to the survey study although the survey was sent to 233 private companies. Also private sector is waiting for the new legislation and the private sector invests to high potential areas for commercialization in the areas of R & D.

The Ministry of Energy has announced in the strategic plan that per year R&D budget is 35-50 Billion TL (approx. 16,2-23,2 Billion EURO) in the 2010-2014 that is approx 4,6 times of survey finding, but targets or topics related to solar energy is not a included._EU has budgeted 16 Billion Euros for PV and CSP R&D projects at the period 2010-2020. These figures show that, target of Turkey is very good for energy subject. Turkey is able to reach like EU countries and USA in this technological field that has neccesity of objectives and strategic plan with a defined budget.

4.5 Economics and Employement Impacts of Solar Energy in Turkey

The positive impacts of an increasing share of solar energy on the mitigation of climate change and on decreasing the dependence of energy imports are indisputable. However, the *full economic* impacts of supporting solar energy technologies are controversial and have been frequently disputed. In addition, goods and services are required from other industries thereby indirectly providing employment via subcontractors and suppliers. Secondly, foreign trade plays a role. Foreign trade undoubtedly introduces a challenge to the employment effect analyses. This issue of foreign trade is expected to become increasingly prevalent in the future as the number of large solar energy companies expanding to international status increases. Gross employment therefore results from the sum of direct and indirect employment derived from the national and international turnover of domestic companies. While this figure is always positive, there are counterbalancing effects and the total - net - employment effect can be positive or negative.

The net employment effect additionally takes the effects of the expanding use of solar energy on other economic sectors into account. The so-called budget effect derives from the additional costs of solar energy technologies. Therefore, parts of the private and / or public budgets will be spent on energy from solar sources and cannot be spent on other goods. The reduced expenditures on other goods lead to reduced turnover and therefore to a reduction in employment. Currently it has a negative influence on employment in other sectors. In the future, should solar energy become cheaper than conventional energy, this effect might be reversed in the favor of renewable energy. Economics effects of solar energy as summary like following items; .[165]

+ Investment + Operating and maintance costs + Parts production and services from sub-contractors + Export- İmport- Subsidary impacts +/- Budget impacts = Net Employment impacts

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[165] Federal Ministry for The Environment, Nature Conservation and Nuclear safety, ZWs and DLR, International Workshop "Renewable Energy: Employment Effects" Models, Discussions and Results, 2007

Solar energy will be direct economic impacts on economy of Turkey. These may include:

- sustainable global market partnership for companies in the lead market,
- a substantial increase in exports,

- a high degree of competition and low prices for consumers,
- creation of high skilled jobs due to technology marketing and research and development functions in the lead market,
- Market attractiveness as an investment location for multinational firms which seek to become insiders in the lead market,
- Property and Sales Tax Effects
- Regional Income Effects
- Employment Effects

Other secondary impacts would include lower emissions, reduced dependency on energy imports and lower health bills due to the neglected health impacts of climate change.

In the longer run additional effects such as **growing export capabilities** may be important. An industry that is able to produce investment goods for the renewable energy industry (photovoltaic cells etc.) can increase value by exporting these goods. There may be positive effects on the economy as far as the exported goods contain parts crafted domestically. This is of course, related to a lot of macroeconomic factors determining the comparative advantage of one country against other countries in the same industry. This comparative advantage may be higher in industries with a high technological specificness than in other areas. After publishing of renewable energy law in 2005 and energy efficiency law in 2007, local investors rapidly began to invest in energy projects. On the newspapers (Dünya Gazetesi, dated 28 December 2009) reports about big investment projects of big investors have been published approximimetly totally as 32 Billion USD as following;

- SABANCI Holding 6 Billion USD
- ZORLU Holding 5 Billion USD
- SANKO Holding 2 Billion USD

- BORUSAN Holding 1,5 Billion USD
- GAMA Holding 3 Billion USD
- ÇALIK Holding 8 Billion USD
- OKAN Holding 1,5 Billion USD
- GE Turkey 4 Billion USD
- SARAN Holding 1 Billion USD

In 2008, automotive and iron-steel parts export amount of Turkey was 32 Billion USD. An amount that is equal to the new investment for energy figures will create a multiplier effect in the economy. As before mentioned detailed on **Chapter 3.4,** local investors (Analtech, Saran Holding, AYT, Tera Solar) with joined venture agreement have started big investment projects on the PV production and solar energy plants in Turkey. Despite all the uncertainties of the legislation period in Turkey for solar energy, the preparation of solar roadmap that has been mentioned on **Chapter 4.3** has helped the figures of employment effects for solar energy as

Table 4-22**.**

Table 4-22: Solar Roadmap Target Figures

Subjects	PV			CSP		
	2010	2020	2030	2010	2020	2030
Domestic production of PV and CSP parts		30%	60%		70%	100%
Domestic production of grid connection		60%	80%		-	-
System Installation cost (EURO/Wp)	3	1,7	1	2.8	2	1
Total power installed capacity (MWp)		4.800	7.000		200	1.000
Power generation cost (EURO cent/kWh)		12	6		6	4

As mentioned in detail on **Chapter 2.5,** investment, operation and maintenance, and the provision of fuel create direct employment in the solar energy industry. As you can see in **Table 0-6** , a wide range of methods have been used for estimation of economic effects of solar energy that make a direct comparison of the numbers difficult. For some of the studies, authors have been used interview models with important players and projects in the industry. Some studies that focus on calculating the employment impacts of the renewables industry have used input-output models (I-O). In Turkey, because solar energy installation has not been built, any employment and economic data from local industry could not be achieved in the depth interview with local investors. Because of the start-up period of solar energy in Turkey and because there is no data about the complete value chain and the interdependence of the different economic sectors including labor and tax inputs, complex method like as input-output models could not be used for this study. Paying attention to the types of jobs created and economic impacts are based on governmental supporting policy.

The employment impacts of a power generation project can be divided into the construction and operation periods. During the construction phase of the project, there is a direct economic impact from the portion of goods and services purchased for the project from local vendors. For example, local labor is used for construction and concrete is purchased from a local concrete plant. At the end of all this study, the following figures were based on estimates for calculating of direct employment of solar energy in Turkey.

PV jobs created:

- 34.6 jobs/MWp for installation 2.7 jobs/MWp operation and maintanace [166]
- 10 jobs per MWp of capacity, 36 additional jobs per MWp installed capacity in the wholesale, retail, installation and maintenance services sector [167]

CSP Jobs created:

- 20 direct jobs / year during construction, 20 direct jobs / year during construction [168]
- Every 100 MWp installed will provide 400 full-time equivalent manufacturing jobs, 600 contracting and installation jobs, and 30 annual jobs in O&M [169]

Table 4-23 shows employment impacts of solar energy in Turkey with target value from solar roadmap shown as **Table 4-22** . **As as result, totally direct employment are**

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[166] Federal Ministry for The Environment, Nature Conservation and Nuclear safety, ZWs and DLR, International Workshop "Renewable Energy: Employment Effects" Models, Discussions and Results, 2007
[167] JRC, PV Status Report, 2008
[168] MED-CSP, German Aerospace Center (DLR), Concentrating Solar Power for the Mediterranean Region Final Report, Institute of Technical Thermodynamics Section Systems Analysis and Technology Assessment, 2005
[169] EREC, Renewable Energy Technology Roadmap 20% by 2020, 2009

approximetly 200.000 persons of solar energy power plant in Turkey. Validity of these figures depends on the government's support and employment policies.

Table 4-23 : Employement Effects of Solar Energy in Turkey in 2020

Subjects	PV	CSP	TOTAL
Construction Budget (EURO/Wp)	3 - 1,7	2,8 - 2	
Installed Power (MWp)	4800	200	
Investment (Million EURO)	14.400 – 8.160	560 - 400	**14.960 – 8.560**
Employement/MWp	37-46	10-40	
Total employement (person)	**177.000-220.800**	**2.000-8.000**	**179.600-228.800**

Direct employment impacts are the jobs directly installed by the project in the region on installation, operating and maintenance and service facilities. Indirect employment impacts are also referred to as the "multiplier" impacts of each dollar spent in the region. These impacts are created when a dollar is spent on goods or services produced by suppliers in the region. For example, if a dollar is spent on equipment manufactured in the region, the manufacturer spends a portion of this dollar to hire additional employees, expand production and purchase goods and services. The degree to which a dollar spent on a particular industry is re-spent in the region is the "multiplier" for that industry. There are also multiplier impacts created by other expenditures. Two types of multipliers are often used by economists, aggregate and sectoral.

Aggregate multipliers measure the interrelatedness of the entire economy. These multipliers are usually estimated for regional economics, using an economic base technique. This technique divides the economy's income or employment into basic (export serving) and nonbasic (local serving). Dividing total income or employment by basic income or employment yields multipliers which estimate the change in total employment or income generated by a one-unit change in export income or employment.

Because some industries (sectors) tend to purchase more locally per export dollar than others, different sectors of an economy have different multipliers. Therefore, economists also estimate sectoral multipliers, which indicate the change in total economic activity (employment, income, or output), generated by a one unit change in exports of a given sector. A sector is a group of firms engaged in the same general type of business. In some sectors multiplier effect is high, in some of them it is very low. USA Central Bank (Fed) has done an analysis which gives an idea about it. According to the research; the industry with the highest multiplier effects is 2.87 in automobiles and vehicle manufacturing sector. Others multipliers effects are; [170]

- Food and tobacco production 2,61
- Agriculture 2,33
- Construction 2,27
- Public investment 2,22
- Defence 1,91
- Service sectors 1,49-1,39

if multiplier effect of solar energy in Turkey is theoretically accepted as 2, total employment effects of solar energy would be 350.000-450.000 person. According to the TUİK report dated 15.4.2010, the overall unemployment rate is 13,5% in total and the rate is 15,6% is urban areas, 40,1% of the unemployed are university graduated (highly educated and skilled). The unemployed in 2010 are in total of 3.361.000 people. 3.026.000 people of these unemployed people have work experience. Solar energy will create high skilled jobs due to technology marketing and research and development functions in Turkey.

The following factors also have significant economics impacts altough they can not be calculated exactly.

- Market attractiveness as an investment location for multinational firms
- Sales revenue of solar industry and multiplier effects of these revenues into economy
- Value-Added Taxes(VAT)
- Social insurance institution (SGK) effects
- Income tax effects for employment and instutions

[170] Ateş, M.R, Hürriyet Journal, 'çarpan etkisi yüksek sektörlerle krizden çıkmak kolay olabilir', 2009

The paper of employment effects has been presented in Solar Future 2010 Conferance at 11-12 February 2010 in İstanbul.

5. Conclusion

Turkey has the potential to be an example of success in the solar energy economy, but additional efforts are needed. As an initial step, the government of Turkey should prepare a strategic roadmap for growing a sustainable solar energy market and specific targets must be set. Solar energy systems should immediately be placed in Turkey’s energy production policy to meet the increased demand for energy. It is necessary to plan the use of solar energy by cost effective methods. Local production of solar energy technology can reduce the investment costs significantly. The government, the universities and the companies should be encouraged by financial support to research and develop the uses of solar energy all around the country. Research and development studies on the efficiency of solar cells should be financially supported, and the utilization of these cells in the residential sector should also be supported by the government. The aforementioned legislative recommendations must be addressed if Turkey is to become an influential participant in the global solar energy market.

The role of the government in formulating and implementing favorable policies for renewable energy development is vital. But the private sector, which has the capacity to mobilize funds, needs to be involved in renewable energy development. In order to facilitate rapid replication of solar technologies, policies should be put in place to encourage the private sector to consider the technologies and to invest in developing and implementing solar projects. Extensive research and technological development are essential for the Turkey Solar industry to remain competitive and to open up new markets. Improved co-operation between the research sector and industry will help the research sector to better understand the needs of the solar industry and its customers, and the development of more suitable technologies.

Following subjects are more important for solar energy booming in Turkey.

- **Legislation and Supporting mechanism**

- Timely legislation – The upcoming legislation should be completed no later than the second quarter of 2010.
    - More incentives through **feed in tariffs** should be available.

    - **Energy efficiency -** PV installations in buildings should be encouraged to improve energy performance according to the EU standards.
    - **Investor support** – The necessary transmission and generator facilities could be included in investments by solar plant developers.
    - **Domestic production support -** Encouragement of domestic / inland production of solar energy systems through incentives and subsidies.
    - **Tax reduction** should be accepted for buildings with necessary insulation and with architecture suitable for renewable energies.
    - **Support for large and small projects** – The new legislation should detail the support for projects including off-grid and residential solar systems. PV installations for electiricty should be supported and encouraged without the network connection area at underdeveloped regions of Anatolia.
    - Other **additional incentives** for equipment investment and export for solar energy
- **Procedures and other facilities**
    - **Improved licensing processes -** The process of acquiring licenses should be streamlined and accelerated.
    - **Clarify procedures** – The audit and control of the processes should be clearly identified.
    - **Siting assistance** – ETKB should prepare a database for the determination of appropriate land and sites for plants.
    - **Transmission expansion** – The building of transmission lines and related infrastructure should be opened to assist the licensing process for plant investors.
    - **Monitoring and evaluation** – Information monitoring systems should be installed and information should be tracked on at least an hourly production basis.
- **Set standards**
    - Facility layout and construction standards as well as control mechanisms should be determined by the government.

    - Using EN standards in solar energy systems should be compulsory. Production and marketing of solar systems only above a certain predefined yield and standards.

    - Increase the number of certified and accredited laboratories where measurements of solar systems can be done reliably.
- **Pilot investment**
    - At least 2-3 pilot CSP plants must be installed in Turkey by government in order to set standards before detailed procedures are prepared.
- **Joint venture with industrialized countires**
    - Joint venture should be made for component production and not only plant installation. Turkish industry has a capacity of technology production.
- **Research and development funds**
    - **Solar roadmap –**the government must prepare the solar technology roadmap by taking **PV Roadmap of** UFTP and Solar roadmap of ICAT in consideration.
    - **The share of GDP should be increased to match at least EU countries 0.03% or most likely to 0.086% of Japan.**
    - **R&D center -** Turkey should aim to be the base of R & D. Turkey has the most overqualified youngest employment in comparison to the EU countires.
    - **The Middle East and North Africa (MENA) and The Commonwealth of Independent States (CIS)** (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan) **region** - Turkey is the geographical center of MENA and CIS region. Technology and solar energy products exports are a crucial.
    - Actively encourage the formation of private-public partnerships and, as appropriate, provide incentives for energy companies to increase R&D expenditures.
    - **National R & D support should be increased** to become commercially oriented with TUBİTAK, DPT, TTGV, KOSGEB and The Ministry of Industry and The Ministry of Energy and Resources.

    - **Test facilities –** Pilot CSP plant that capacities are min 10-20 Mwp and PV plant should be established together with the government and universities in order to develop the local technology and to test the efficiency and productivity for 2-3 years.
- **A free carbon market** should be established.
    - Legislation of the carbon market establishment should be prepared.
    - The promotion of low carbon programs and long-term Green House Gas (GHG) emission savings should be supported by a green technology fund.
- **Awareness -** Projects and applications by governments and communities to increase public awareness over ecological aspects of solar energy should be realized

The private sector and investors are ready for producing electricity through solar energy. Solar energy plants can be easily installed by domestic producers if R & D support to the solar energy project is increased.

It is hoped that this study tries to contribute to the vision of the other researchers to handle deeper analyses in Turkish solar energy and to the politicians for setting strategic visions and targets for solar energy and for organizing supportive policies and research and development funds.

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7. Appendix :

SURVEY LETTER EXAMPLE

Sayın ………………

TUBİTAK Başkan Yrd.

Dünya'nın enerji geleceği ile ilgili raporlara bakıldığında 2100 yılında güneş enerjisinin birincil enerji kaynağı olacağı görülmektedir Türkiye; ekonomik güneş enerjisi potansiyeli bakımından; Orta Doğu ve Kuzey Afrika ülkeleri hariç, AB ülkeleri içerisinde öne çıkmaktadır. Bu alanda öncü ülkeler Amerika Birleşik Devletleri, Almanya, İspanya, Çin ve Japonya değerlendirme raporları incelendiğinde güneş enerjisinin ekonomiye katkısının araştırma ve geliştirme çalışmaları ile parallelik gösterdiği görülmüştür. AB araştırma ve geliştirme stratejik planı SET-PLAN dokümanlarında 2005 yılı rakamları ile birçok **AB üyesi ülkede GYMH nın %0.01- 0.03 oranında enerji alanına ayrıldığı, Macaristan, Fransa ve Finlandinya'da bu oranın %0.04-0.05'e ulaştığı, Japonya da %0.086 ve ABD de %0.024 olduğu görülmektedir.**

Bu noktadan hareketle, Yeditepe Üniversitesi, Sosyal Bilimler Enstitüsü, İşletme Yüksek Lisansı'nda **'Türkiye'de Güneş Enerjisi Pazarı ve Potansiyel Ekonomik Faydalarının Değerlendirilmesi'** konusunda danışmanlığını yaptığım tez öğrencim Müjgan ÇETİN'in çalışmalarında kullanılmak üzere, ülkemizin bu konuda araştırma ve geliştirme bütçelerine ihtiyacımız bulunmaktadır. Tez kapsamında, enerji alanında ve özelde GÜNEŞ Enerjisi alanında kurumunuzun desteklediği ve/veya kuruluşunuzun öz kaynakları ile geliştirdiği projeler için yıllar bazında ar-ge harcamalarını ve bütçelerini değerlendirmek amaçlanmaktadır.

Şüphesiz, bu çalışma; politika üretenlere yol gösterir nitelikte sonuçlar ortaya koyacaktır. Ne var ki çalışmanın olumlu sonuçlar üretebilmesi, için bu konuda politika belirleyici kurumlarımızın ve ar-ge yatırımı yaparak bu konuda kaynak ayırmış kuruluşların mevcut verilerine ulaşmak büyük önem taşımaktadır. Hem sektörel fayda, hem de bilimsel sonuçlar üretmeyi hedeflediğimiz bu çalışmada; desteğinizi almak büyük önem taşımaktadır. Çalışma sonuçlarının kurumunuzla paylaşılacağını belirtir, konu ile ilgili olumlu yanıtlarınızı bekleriz.

Aşağıdaki tabloya uygun bilgileri hazırlarken, SORMAK ISTEDIGINIZ KONULARDA egrican@yeditepe.edu.tr ve mujgan@sistemyon.com.tr adresimize elektronik posta göndermekte ya da aşağıdaki iletişim bilgilerinden ulaşmakta çekinmeyiniz. Mümkün ise iki hafta içerisinde ekli tabloya uygun şekilde tamamladığınız destek programları bazındaki bilgileri yine aynı elektronik posta adresine ulaştırabilirsiniz. Yardımınızı esirgemeyeceğinizi umar, işbirliğiniz için çok teşekkür ederiz.
Saygılarımızla,

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EK -1 : TUBİTAK Akademik ve Kamu Ar-ge Destekleri

TUBİTAK Akademik ve Kamu Ar-ge Enerji ve Güneş Enerjisi Destekleri

a) Enerji Alanıda Desteklenen Proje Sayısı ve Destek Bütçesi

Programlar	2005 ve öncesi		2006		2007		2008		2009		2010 ve sonrası		TOPLAM	
	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)
1001 Araştırma projeleri														
1002 Hızlı Destek														
1008 Patent														
1010 EVRENA														
1509 Uluslar arası ar-ge														
1011 Uluslar arası projeler														
1301 İŞBAP														
3501 Kariyer programları														
ERA-NET														
1007 Kamu Ar-ge														
TOPLAM														
TOPLAM TÜBİTAK DESTEKLERİ														

b) Güneş Enerjisi Alanında Desteklenen Proje Sayısı ve Destek Bütçesi

Programlar	2005 ve öncesi		2006		2007		2008		2009		2010 ve sonrası		TOPLAM	
	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)	Proje sayısı (Adet)	Bütçe (Euro)
1001 Araştırma projeleri														
1002 Hızlı Destek														
1008 Patent														
1010 EVRENA														
1509 Uluslar arası ar-ge														
1011 Uluslar arası projeler														
1301 İŞBAP														
3501 Kariyer programları														
ERA-NET														
1007 Kamu Ar-ge														

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6. **Email:** mujgan@sistemyon.com.tr
7. **Nationality :** T.C.
8. **Civil status :** Single
9. **Education :** University

Institution (Dates)	**Degree(s) or Diploma(s) obtained**
Middle East Technical University Engineering Faculty, Ankara/Turkey, 1983	Industrial Engineering B.Sc,
Yeditepe University – Istanbul 2008-	Management Business Administarion – continue (Presentation of Thesis that subject is ‘Turkey’s Solar Energy market Study and Potential Economics benefits’)

10. Language skills : (1 –execllent to 5-basic)

	Reading	Speaking	Writing
Turkish	Mother Tongue		
English	1	2	2

11. Membership of Professional bodies :

Membership of Management Consultancy Association YDD (Yonetim Danışmanları Derneği) in Turkey. Membership of TKB (Türk Kadınlar Birliği – Turkish Women Association) Membership of Red Crescent of Turkey (KIZILAY) Membership of Kalite Derneği (Quality Association) Member of the TOSYOV (SME association)

12. Other Skills :

- Significant project management skills and knowledge: planning and coordination
- Strategic management experience in both profit based and non profit organizations
- Excellent skills in communication and collaboration as project manager as a multi-disciplinary person
- Quality management system, Health and safety management system, ITIL Foundation certificate, İnformation security management system auditor and quality system project manager
- Initiator of projects funded by international (UNDP and EU) and national organizations
- Good listener and problem solver as manager and team person
- Experience of negotiating and liasing with Government officials in particular in relation with NGO
- Customer focus, key account management knowledge in SMEs (Small and Medium Enterprises)
- Ability to work under pressure with complex institutional and organizational settings
- Trainer for the Courses: Quality Management, İnformation Management, Productivity management, OHSAS 18001 Ocupational Healty and Safety Assurance System, Business Process Re-enginnering , Costumer Satisfaction, Human Resources Management, Just in Time Production , Project Management,

13. Present Position : Lead Consultant in SISTEM Management Consultancy

14. Years witin the firm : **14 years**

15. Key qualifications :

• Cofund **Evaluator of EU 7 Frame** –Marie Curie Action • Project Evaluator of **Çukurova – Orta Karadeniz Kalkınma Ajansı** • **Technology auditor of R&D Projects for TUBİTAK and TTGV (Technology Development)** • Management experience for Information and communication technology • **ITIL Foundation certificate** and **Lead auditor in ISO-27001 İnformation Safety Management system and ISO-9000:2000 Quality Management System, OHSAS 18001 Occupational Health and safety system** • **Educator of KalDer (Quality Association)** • **Educator of KOSGEB and Certified consultant of KOSGEB** • **Certified consultant of TURQUALİTY program** • **Enterpronuer Development trainee and project manager** • Management experience for management consultancy, inovation and research and development projects and Information-communication technology and quality-environmental-health and safety management • Experience in planning, project/programme formulation and capacity building

16. Specific experience in the region :

Country	Date from - Date to	Description
Turkey	1993-2010	• Inovation and R&D Projects proposal preparation and evaluation • Planning, management and implementation of businnes development consultancy and education service for TRABZON –KOSGEB entrepreneurs. • Planned, designed and implemented re-engineering, total quality management, human resources management, sales and marketing, environmental and healthy and safety management system projects • Analyzing and implementing development projects in NGO • Founded of national academic backbone of internet and national information and document retrival center of TUBİTAK-ULAKBIM with searching international (UNDP funds and World Bank) and national fund negotiating and liasing with Government officials • Internet privitaztion projcets • MIS projects for TUBİTAK for all facilites • Human resources projects for R&D facilities • Planned, designed, deployed and implemented information systems projects such as BI (Business Intellegence), ERP (Enterprise resource planing), SCM (Supply chain management), CRM (Custumer Relationship Management), e-learning, e-business, Knowledge Management, Asset management, Execuitve Information system, Unified messaging system, GIS, Mobile system (WAP, GPRS and SMS)

17. Professional experience :

Date from - Date to	Location	Company	Position	Description
2008-2010	istanbul	Yeditepe University	Ar-ge project coordinator	Project development and coordination with university and industry and sectoral organiztions
1996-2010	İstanbul	SİSTEM Management Consultancy	General Manager and Lead Consultant	Inovation and Research and development projects TURQUALTY Brand development projects Quality, occupational health and safety, environmental management system projects and entreprenuer development projects, Productivity improvement projects, NGO development projects, Responsible for all B2B, ERP, CRM, SCM and mobile information system design and implementation, Strategic plan preparation projects, Training
1993-1996	Ankara	TUBITAK	Director of IT Department Consultant of CEO	Responsible for all strategic projects (privitazion of internet service provider and computer clup activities and foundation of ULAKBIM that is national academic backbone of internet and national information and document retrival center of TUBİTAK) at national basis negotiating and liasing with Government officials. Responsible for MIS project and total quality project and human resources projects
1993-1996	Ankara	TURK TRAKTOR	Project Consultant	ERP and subcontractor development projects
1991- 1993	İstanbul	FATOS A.Ş	Factory Manager	All production activities and quality project
1987-1991	İstanbul	ARCELİK A.Ş.	Industrial Engineering Chief	Responsible for all investment and productivity development projects
1985-1987	Ankara	BILTEK A.Ş.	System Expert	Responsible for system design and implementation
1983-1985	Ankara	SEMEK A.Ş	Production Planning Chief	Responsible for production planning activities of high voltage cutter

18. Other relevant information (eg, Publications)

- **Proje YAPABİLSEM**, Project Management **Book** for youngers, Optimist, 2007
- IFC, **Market Study Report of Solar Energy in Turkey**, 2010
- Solar Future 2010 Congress, **'Economics benefits and Employment Impacts of Solar Energy in Turkey'**, 2010
- Weekly articiles in Milliyet internet journal
- TÜBİTAK İnformation System, Kara Harp Okulu Sistem Mühendisliği Sempozyumu, 1995
- Total Quality managment in research and development organization, 1995, 4.Ulusal Kalite Kongresi
- Effects of Information to The Organization, I. Uluslararası İnsan Kaynakları Sempozyumu, 1995

- Many articles in different periodical magazines