

Task 1 Strategic PV Analysis and Outreach

National Survey Report of PV Power Applications in Turkey 2018

Prepared by:
Prof. Dr. Bulent Yesilata

PVPS

PHOTOVOLTAIC POWER SYSTEMS
TECHNOLOGY COLLABORATION PROGRAMME



WHAT IS IEA PVPS TCP

The International Energy Agency (IEA), founded in 1974, is an autonomous body within the framework of the Organization for Economic Cooperation and Development (OECD). The IEA carries out a comprehensive programme of energy cooperation among its 30 member countries and with the participation of the European Commission. The IEA Photovoltaic Power Systems Programme (IEA PVPS) is one of the collaborative research and development agreements (technology collaboration programmes) within the IEA and was established in 1993. The mission of the programme is to *“enhance the international collaborative efforts which facilitate the role of photovoltaic solar energy as a cornerstone in the transition to sustainable energy systems.”*

In order to achieve this, the Programme’s participants have undertaken a variety of joint research projects in PV power systems applications. The overall programme is headed by an Executive Committee, comprised of one delegate from each country or organisation member, which designates distinct ‘Tasks,’ that may be research projects or activity areas. This report has been prepared under Task 1, which deals with market and industry analysis, strategic research and facilitates the exchange and dissemination of information arising from the overall IEA PVPS Programme.

The IEA PVPS participating countries are Australia, Austria, Belgium, Canada, Chile, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Malaysia, Mexico, Morocco, the Netherlands, Norway, Portugal, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, and the United States of America. The European Commission, Solar Power Europe, the Smart Electric Power Alliance (SEPA), the Solar Energy Industries Association and the Copper Alliance are also members.

Visit us at: www.iea-pvps.org

WHAT IS IEA PVPS task 1

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. An important deliverable of Task 1 is the annual “Trends in photovoltaic applications” report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the country National Survey Report for the year 2018. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

Authors:

Writing: Prof. Dr. Bülent Yeşilata, GUNDER & AYBU Energy Systems Engineering Department

Data: Publicly available data from various national and international resources

Analysis: Esen Erkan (General Secretary, GUNDER)

DISCLAIMER:

The IEA PVPS TCP is organised under the auspices of the International Energy Agency (IEA) but is functionally and legally autonomous. Views, findings and publications of the IEA PVPS TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries



TABLE OF CONTENTS

1	INSTALLATION DATA	3
1.1	Applications for Photovoltaics	3
1.2	Total photovoltaic power installed	3
2	COMPETITIVENESS OF PV ELECTRICITY	6
2.1	Module prices.....	6
2.2	System prices	6
2.3	Cost breakdown of PV installations.....	7
2.4	Financial Parameters and specific financing programs	8
2.5	Additional Country information	8
3	POLICY FRAMEWORK	9
3.1	National targets for PV	9
3.2	Direct support policies for PV installations	9
3.3	Self-consumption measures	11
3.4	Tenders, auctions & similar schemes	11
3.5	Other utility-scale measures including floating and agricultural PV	12
4	INDUSTRY	14
4.1	Production of feedstocks, ingots and wafers (crystalline silicon industry)	14
4.2	Production of photovoltaic cells and modules (including TF and CPV)	14
4.3	Manufacturers and suppliers of other components	15
5	PV IN THE ECONOMY	17
5.1	Labour places	17
5.2	Business value	17
6	INTEREST FROM ELECTRICITY STAKEHOLDERS.....	18
6.1	Structure of the electricity system	18
6.2	Interest from electricity utility businesses	18
7	HIGHLIGHTS AND PROSPECTS	20
8	REFERENCES	20



1 INSTALLATION DATA

The PV power systems market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries. Other applications such as small mobile devices are not considered in this report. For the purposes of this report, PV installations are included in the 2018 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2018, although commissioning may have taken place at a later date.

1.1 Applications for Photovoltaics

By the end of 2018, there are 5 868 PV power plants (5 062,9 MW in total) in operation, of only nine (81,7 MW in total) are in the licensed segment [1]. The legislation defined the unlicensed electricity power limit as max. 1 MW until second half of 2019 when the limit extended up to 5 MW [2]. Until the beginning of 2016, some investors had preferred to install MW scaled PV power plants in total by covering a few unlicensed plants, but it is now prohibited by the changed amendments made to the Unlicensed Electricity Generation Regulation on 23 March 2016 [3]. In Turkey, 5 862 small-scale, unlicensed, PV power plants (up to 1 MW) are already in operation with an installed capacity of 4 981,2 MW in 2018. In 2018, six PV power plant in the licensed segment were connected to the national grid [1].

1.2 Total photovoltaic power installed

Table 1: Annual PV power installed during calendar year 2018.

		Installed PV capacity in 2018 [MW]	AC or DC
PV capacity	Off-grid	*	-
	Decentralized	*	-
	Centralized	2102	AC
	Total	2102	AC

* no available trustable data specifically belonging to 2018-year was obtained.

Table 2: Data collection process.

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	1,1-1,05
Is the collection process done by an official body or a private company/Association?	1.Solar Energy Association of Turkey 2. Data published by Public Bodies (i.e. EMRA)
Link to official statistics	1. https://www.gunder.org.tr/ 2. https://www.epdk.org.tr/Detay/Icerik/1-1271/electricityreports
	Relevant data was collected from available internet sources and estimated in some cases where data is not available, by using scientific approaches at the author's ability.

Table 3: The cumulative installed PV power in 4 sub-markets.

Year	Off-grid [MW] (including large hybrids)	Grid-connected distributed [MW] (BAPV, BIPV)	Grid-connected centralized [MW] (Ground, floating, agricultural...)	Total [MW]
2005	0,1*	-	-	0,1
2006	0,2*	-	-	0,2
2007	0,5*	-	-	0,5
2008	0,9*	0,1*	-	1
2009	4,8*	0,2*	-	5
2010	5,7*	0,3*	-	6
2011	6,0*	0,5*	0,5	7
2012	6,5*	0,5*	12	19
2013	6,5*	0,5*	18	25
2014	7,3*	0,7*	40	48
2015	8,1*	0,9*	249	258
2016	8,1*	0,9*	833	842
2017	9,0*	1,0*	2997***	3007
2018	9,0**	1,0**	5099	5109

* Consolidated data from various internet sources, university reports, publicly available news, unofficial reports by NGO's (i.e. National Photovoltaic Platform of Turkey, Solar Energy Associations of Turkey), off-grid and BPAV installations known by the author. Please also note that Photovoltaics began developing in Turkey in 2000 with small-scale off-grid plants producing less than 20 kWp. By 2010, the overwhelming number of installations were off-grid systems. However, due to an increase in the feed-in tariff, massive growth has been recorded in the number of on-grid systems installed since 2012.

** no available trustable data specifically belonging to 2018-year was obtained.

*** <https://www.epdk.org.tr/Detay/Icerik/1-1271/electricityreports> (corrected data based on the latest Electricity Market Development Report 2018 published in 2019)

Table 4: Other PV market information.

	2018 Numbers
Number of PV systems in operation in your country	5 868
Capacity of decommissioned PV systems during the year [MW]	0
Capacity of repowered PV systems during the year [MW]	0
Total capacity connected to the low voltage distribution grid [MW]	*
Total capacity connected to the medium voltage distribution grid [MW]	*
Total capacity connected to the high voltage transmission grid [MW]	5868

* no reliable data is available



Table 5: PV power and the broader national energy market.

	2017 numbers	2018 numbers
Total power generation capacities [GW]	84,68	88,50
Total renewable power generation capacities (including hydropower) [GW]	36,63	39,56
Total electricity demand [TWh]	292,00	302,77
Total energy demand [TWh]	1479,99	1534,58
New power generation capacities installed in 2018 [GW]	-	3,82
New renewable power generation capacities installed in 2018 (including hydropower) [GW]	-	2,92
Estimated total PV electricity production (including self-consumed PV electricity) in [TWh]	2,86	7,92
Total PV electricity production as a % of total electricity consumption	0,9	2,62

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Table 6: Typical module prices for a number of years.

Year	Lowest price of a standard module crystalline silicon	Highest price of a standard module crystalline silicon	Typical price of a standard module crystalline silicon
2017	-	-	-
2018*	0,35	0,55	0,45

* the price has stabilized since 2018, hence no data given for previous years

2.2 System prices

Table 7: Turnkey PV system prices of different typical PV systems.

Category/Size	Typical applications and brief details	Current prices [USD/W]
Off-grid 1-5 kW	A stand-alone PV system is a system that is installed to generate electricity to a device or a household that is not connected to the public grid. (write the typical off-grid application and since in your country)	-
Residential BAPV 5-10 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected households. Typically roof-mounted systems on villas and single-family homes.	0,95-1,25
Residential BIPV 5-10 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected households. Typically, on villas and single-family homes.	-
Small commercial BAPV 10-100 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	0,90-1,00
Small commercial BIPV 10-100 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	-
Large commercial BAPV 100-250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected large commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	0,85-1,00
Large commercial BIPV 100-250 kW	Grid-connected, building integrated, distributed PV systems installed to produce electricity to grid-connected commercial buildings, such as public buildings, multi-family houses, agriculture barns, grocery stores etc.	-
Industrial BAPV >250 kW	Grid-connected, roof-mounted, distributed PV systems installed to produce electricity to grid-connected industrial buildings, warehouses, etc.	0,8-0,95
Small centralized PV 1-20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	0,75-0,9
Large centralized PV >20 MW	Grid-connected, ground-mounted, centralized PV systems that work as central power station. The electricity generated in this type of facility is not tied to a specific customer and the purpose is to produce electricity for sale.	<0,75*

*Not common size yet for Turkey, price is given as expected decrease comparing with smaller plant size of 20 MW.

Table 8: National trends in system prices for different applications

Year	Residential BAPV Grid-connected, roof-mounted, distributed PV system 5-10 kW [USD/W]	Small commercial BAPV Grid-connected, roof-mounted, distributed PV systems 10-100 kW [USD/W]	Large commercial BAPV Grid-connected, roof-mounted, distributed PV systems 100-250 kW [USD/W]	Small centralized PV Grid-connected, ground-mounted, centralized PV systems 10-20 MW [USD/W]
2017	-	-	-	-
2018*	0,95-1,15	0,90-1,00	0,85-1,00	0,75-0,9

*the price has stabilized since 2018, hence no data given for previous years

2.3 Cost breakdown of PV installations

Table 9: Cost breakdown for a grid-connected roof-mounted, distributed residential PV system of 5-10 kW.

Cost category	Average [USD/W]	Low [USD/W]	High [USD/W]
Hardware			
Module	0,5	0,42	0,58
Inverter	0,2	0,16	0,24
Mounting material	0,10	0,08	0,12
Other electronics (cables, etc.)	0,15	0,12	0,18
Subtotal Hardware	0,95		
Soft costs			
Planning	0,05		
Installation work	0,05		
Shipping and travel expenses to customer			
Permits and commissioning (i.e. cost for electrician, etc.)	0,1		
Project margin			
Subtotal Soft costs	0,2		
Total (excluding VAT)	-		
Average VAT	-		
Total (including VAT)	1,15		

Table 10: Cost breakdown for a grid-connected, ground-mounted, centralized PV systems of >10 MW.

Cost category	Average [USD/W]	Low [USD/W]	High [USD/W]
Hardware			
Module	0,48	0,42	0,54
Inverter	0,18	0,14	0,22
Mounting material	0,07	0,06	0,08
Other electronics (cables, etc.)	0,05	0,04	0,06
Subtotal Hardware	0,78		
Soft costs*			

* No reliable data was obtained regarding with soft costs



2.4 Financial Parameters and specific financing programs

Currently, the only available finance option to homeowners is a personal loan with a short tenor (of up to 48 months). The Ekokredi has a personal loan with a slightly longer tenor (of up to 60 months for house owners). Interest rates for these loans are generally high (at roughly 1.79% per month for 'Term Loan'-based loans).

In the commercial sector, loan availability is better. Commercial firms can obtain more favourable loan terms to finance a RSPV investment. These loans generally have longer tenors (up to 120 months) and lower interest rates (i.e. EUR libor + 3.75%).

For the public sector, there are currently loans available through the Ilbank.

2.5 Additional Country information

This paragraph provides additional information regarding the country's population and additional parameters linked to its electricity system.

Table 11: Country information.

Retail electricity prices for a household [\$cent/kWh]	8,01
Retail electricity prices for a commercial company [\$cent/kWh]	9,56
Retail electricity prices for an industrial company [\$cent/kWh]	8,32
Population at the end of 2018	82,319,724
Country size [km ²]	783,562
Average PV yield in [kWh/kW]	1500 kWh/kW



3 POLICY FRAMEWORK

3.1 National targets for PV

Turkey's ambitious vision for 2023, the centennial anniversary of foundation of the Republic, builds upon this foundation with targets for renewable energy resources that include:

- Raising Total Installed Power Capacity to 120 GW
- Increasing Share of Renewables to 30 Percent
- Maximizing Use of Hydropower and Reaching 34 GW
- Increasing Wind Installed Capacity to 20 GW
- Increasing Solar Installed Capacity to 10 GW
- Installing 1 GW Geothermal
- Extending Use of Smart Grids

3.2 Direct support policies for PV installations

In Turkey, two main laws, the Laws 6446 (New Electricity Market Law) and 6094 (Law Amending the Law on the Utilization of Renewable Energy Resources in Electricity Generation), are directly related to the utilization of solar energy. The Law 6446 introduces some important changes in the current electricity market system, including amendments to license types, framing its provisions around each type of market activity, specific provisions for certain license types (generation, transmission, distribution, wholesale, retail, auto-producer and auto-producer group), the introduction of a preliminary licensing mechanism and investment incentives, such as extended deadlines and grace periods for environmental compliance. The Law 6094 law introduces significant amendments to improve the incentive mechanism under the Renewable Energy Law (Law No: 5346) and encourage renewable energy investment opportunities [4]. According to the Law 6094, a purchase guarantee of 13,3 USDcents/kWh is given for solar electric energy production for ten years. The incentives are available for the PV power plants for 5-years which are or will be in operation before December 31, 2020. Some supplementary subsidies for local equipment products for the first five years of operation are as follows:

- PV module installation and mechanical construction (+0,8 USDcents/kWh),
- PV modules (+1,3 USDcents/kWh),
- PV cells (+3,5 USDcents/kWh),
- Inverter (+0,6 USDcents/kWh),
- Material focusing solar energy on PV modules (+0,5 USDcents/kWh).

Turkey aims to increase the share of renewable energy in its production mix. In line with this goal, Energy and Natural Resources Ministry is continuing with its Renewable Energy Designated Area (YEKA) projects. YEKAs are defined under a separate regulation issued in the Law 5346. YEKA in privately owned or state-owned lands identify the feasible areas for large-scale renewable energy projects. The ETKB provided the details as follows: (i) determination of potential YEKAs, (ii) feasibility and infrastructure studies, (iii) publication of final YEKAs in the Official Gazette, (iv) prerequisites and procedures for the applicants, (v) auction procedures, (vi) implementation of manufacturing facility, (vii) construction of renewable energy power plants. The Regulation on YEKAs has come into force following its promulgation in the Official Gazette dated October 9, 2016. Although the concept of YEKAs was introduced in Turkish legislation in 2005, it remained mostly inactive until this date. The objectives of the Regulation can be regarded as forming large-scale YEKAs in order to make effective and efficient use of renewable energy sources, and rapidly completing investment projects by assigning these areas to investors, and enabling high-tech equipment used in the



generation facilities to be domestically manufactured or supplied and contribute to technology transfer. YEKAs will be determined and developed following either (i) the necessary studies undertaken by the General Directorate of Renewable Energy, or (ii) following a tender to be held for the allocation of connection capacity [5].

While projects conducted within the framework of YEKA benefit fifth-area investment incentives, companies with the highest rate of domestic transfer of technology and production will be given priority [6]. The first bidding was held in Karapınar, Konya with an allocated capacity of 1 GW on March 20, 2017. A consortium consisting of Hanwha Q CELLS and Kalyon Enerji Yatirimlari A.S. was awarded by submitting the lowest bid, 6,99 USDcent/kWh, to construct the largest PV power plant with an installed capacity of 1 GW (AC) in Turkey. The purchase guarantee price will be valid for 15 years. As part of the award criteria, the consortium has to build a fully integrated solar cell and module factory with a capacity of 500 MW within the next 21 months. The new facility will consist of integrate ingot, wafer, cell and module processes. In addition to the manufacturing facility, the consortium will establish on-site research and development (R&D) centre with 100 permanent employees. The Karapınar YEKA-1 Solar Power Plant tender was the first practice in the energy sector to be based on the condition of localization and YEKA-based price determination [6-9].

The second bidding within the framework of YEKA was intended to realize by the end of 2018 with a total capacity of 1000 MW for three sites/locations divided into three tenders. 500 MW to be allocated would be assigned to the Sanliurfa-Viransehir site in the southeast of the country, 200 MW to the Hatay-Erzin site, in the same region, and 300 MW to the Nigde-Bor site, in central Anatolia, for which a 30 MW/ 90 MWh (AC) Li-ion battery storage project would also be tendered. The sites were identified by the Turkish government in April 2018. The Turkish government had stipulated selected projects must incorporate a minimum 60% of PV panels manufactured in Turkey. In addition, a minimum cell efficiency of 21% and module efficiency of 18% had been set as minimum standards. Selected projects would have to start commercial operation by January 2024. However, the bidding for three sites was cancelled due to economic situation of the country. Now, the government is reconstructing the details of the tender and is expected to re-announce it within 2019 [10].

Turkey very recently adopted new regulation (published in Official Gazette numbered 30772 on 12 May 2019) on unlicensed electricity production in the electricity market [11]. The procedures and principles applicable to real and legal persons, who may produce unlicensed electricity are updated. The primary purpose of the updates introduced with the new Regulation on Unlicensed Electricity Production in Electricity Market (the "Regulation") and the Presidential Decree Number 1044 dated 10 May 2019 (the "Decree"), is to bring in small-sized plants into the economy by allowing them to generate energy for mainly self-consumption purposes, without the need to obtain a license or establish a company. The essential changes introduced by the Regulation and the Decree are as follows:

- The upper capacity limit of 1 MW to be eligible to benefit from unlicensed generation has been increased to 5 MW, for facilities which become eligible to receive a calling letter after the date of 10 May 2019.
- Solar energy production facilities having a capacity below 5 MW may now only be established as a roof or façade application.
- It is mandatory to establish the generation facilities and consumption facilities for unlicensed generation in the same distribution region. Accordingly, so long as the generation and consumption facilities are in the same distribution region, they do not need to be established in the same location.

- The installed capacity of the generation facilities cannot exceed the power limit of the relevant consumption facility set out under the connection agreement. If there is no electricity consumption in the consumption facility linked with the generation facility, no payment within the scope of the Renewable Energy Resources Support Mechanism (YEKDEM) will be made for the relevant month.
- The hourly electricity production amount read from the meter data will be calculated as per the accounting period and then notified to the related supply company. The related supply company will calculate the payment to be made for the surplus electricity purchased and inform the market operator thereof. The companies will pay producers the calculated amount regarding the surplus from the payment made by market operators. If the producers consumed excessive electricity, then this amount will be paid to suppliers.

3.3 Self-consumption measures

New regulations were offered by the Energy Market Regulatory Authority in January 2018 to make it easier for the development of household scale (10 kW or less) rooftop solar in Turkey, including a net-metering style provision that would allow such facilities to sell back excess electricity to the grid at 13,3 USDcent/kWh. This was shortly followed by an amendment to tax statutes, also exempting the excess electricity sales of these small-scale solar facilities from income taxes. These are welcome sources of support for a rooftop solar sector [12].

Table 12: Summary of self-consumption regulations for small private PV systems in 2018.

PV self-consumption	1	Right to self-consume	X
	2	Revenues from self-consumed PV	
	3	Charges to finance Transmission, Distribution grids & Renewable Levies	
Excess PV electricity	4	Revenues from excess PV electricity injected into the grid	X
	5	Maximum timeframe for compensation of fluxes	
	6	Geographical compensation (virtual self-consumption or metering)	
Other characteristics	7	Regulatory scheme duration	X
	8	Third party ownership accepted	
	9	Grid codes and/or additional taxes/fees impacting the revenues of the prosumer	
	10	Regulations on enablers of self-consumption (storage, DSM...)	
	11	PV system size limitations	X
	12	Electricity system limitations	
	13	Additional features	

3.4 Tenders, auctions & similar schemes

The Ministry of Energy and Natural Resources issued a Regulation on Renewable Energy Resource Zones on October 9, 2016 in the Official Gazette. The Regulation introduced a new investment model to support renewable energy investments and incentivize local manufacturing of renewable generation assets. The main purposes of the Regulation are to use renewable energy resources much more efficiently and effectively by identifying renewable energy zones on the public, treasury, or private-owned territories; to realize the renewable energy investments much more rapidly; to manufacture renewable energy equipment in Turkey; to use locally-manufactured equipment/components; and to contribute to research and development activities through technology transfer. A renewable energy resource zone (RE-



Zone) and its electrical connection capacity utilization rights can be offered to an eligible entity under the “Allocation on the Condition of Local Manufacturing” or “Allocation on the Condition of Using Locally-Manufactured Equipment” mechanisms.

In the first mechanism, the legal entity being offered the RE-Zone and its connection capacity utilization rights must establish an equipment manufacturing factory in Turkey according to the standards and the terms of references (ToR). A Research and Development (R&D) Center must be established by the legal entity as well. In the R&D Center, activities must be implemented for a certain period of time and in line with the pre-determined obligatory conditions like budget, number of employees, and staff qualifications. In this mechanism, locally-manufactured equipment and other local components that are defined in the ToR must be used in the RE-Zone.

In the second mechanism, the RE-Zone and its electrical connection capacity utilization rights are given to a legal entity who wins the competition and commits to procure locally manufactured equipment and other related local components (balance of the plant) for the power plant from available Turkish factories. The equipment and components must have certain levels of local content ratios as defined in the ToR’s and be compatible with the national or international standards [13].

Unlike the licensed projects that are subject to reverse-auction from the RES Support tariffs and are eligible for further local content support as required by the Law 5346, the bidding process for RE-Zone projects calls for a reduction from a specific ceiling price that covers both the FIT and local content support. This means that the winning legal entities will not be entitled to extra local content support. However, the PPA term in RE-Zone model goes far beyond the FIT period (currently ten years) required in the Law, and this period has been determined as 15 years for the 1 GW solar power plant tender for Karapınar RE-Zone-1 and in the 1 GW Wind RE-Zone Tender.

As mentioned above, In 2017, Turkey finalized the largest-ever solar and wind power reverse-auctions based on the first mechanism. On March 20, 2017 a consortium of Turkey’s Kalyon Enerji and South Korea’s Hanwha Q CELLS won the tender for the construction of a 1-GW solar power plant in the Karapınar district of the Central Anatolian province of Konya. The winning bid was a price of USD 6.99 cent/kWh. The tender – held in a reverse auction where the ceiling price per kWh was USD 8 cent/kWh – will see 1 GW of installed capacity along with a manufacturing factory for photovoltaic (PV) equipment coming online over the next two years. Under the terms of the tender, the power purchase contract will be valid for 15 years, and the solar equipment used must be domestically sourced. The total investment in this solar energy mega project is estimated at USD 1.3 billion. The solar power plant will be operational for 30 years and meet the energy needs of more than 600,000 households. The project company will also be conducting R&D activities in Turkey for at least 10 years with the employment of at least 80% local staff.

3.5 Other utility-scale measures including floating and agricultural PV

Turkey is a recipient under the IPARD II program for the period between 2014 and 2020. IPARD II does not only support investors in agricultural and stock farming activities but also in renewable energy investments. Incentives are granted by the Agricultural and Rural Development Support Institution (the "ARDSI"). Granted measures for renewable energy investments can be separated to two types [14].



The first type covers renewable energy investments which are implemented for the self-consumption of the facilities operating in the agriculture sector. The second type covers renewable energy investments which are supported under the Farm Diversification and Business Development Measure with the Code number 302-7 (the "302-7 Measure") pursuant to which recipients can sell power to electricity distribution companies without making their facility connected to agricultural production. The 302-7 Measure is granted for renewable energy investments (up to 1 MW of installed power) which are photovoltaic solar energy systems, concentrated solar energy systems, wind energy systems, geothermal, biomass, micro-cogeneration (for power and/or heat generation). Hydroelectric investments are not covered under the 302- Measure. Amounts granted for renewable energy projects within the scope of the 302-7 Measure can only be used for certain type of expenses which are also listed in the applications documents of the 302-7 Measure. In general, these are as follows: construction, modernization and extension of renewable energy facilities; acquisition of stationary engines and equipment for renewable energy facilities; and Acquisition of software and IT equipment for the commissioning of renewable energy facilities.

Investments that are implemented in 42 provinces are eligible to apply under the 302-7 and grant rates vary depending on the province, varying between 65% and 50% of total investment cost.

4 INDUSTRY

4.1 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Regarding to PV manufacturing activities, currently there is not any manufacturer on feedstock, ingots and wafers in Turkey.

4.2 Production of photovoltaic cells and modules (including TF and CPV)

Currently, there are 29 PV module manufacturers in Turkey with a production capacity of more than 3 500 MW annually [15].

	FIRMS	CAP		FIRMS	CAP
1	3A SOLAR	60 MW	16	SOLARTÜRK A.Ş.	210 MW
2	ALFA SOLAR	100 MW	17	SOLİMPEKS A.Ş.	36 MW
3	ATD ENERJİ	36 MW	18	ZAHİT ENERJİ A.Ş.	65 MW
4	BEREKET ENERJİ	150 MW	19	ELİN A.Ş.	240 MW
5	CW ENERJİ LTD.	350 MW	20	DESİBA ENERJİ A.Ş.	200 MW
6	ENDÜSTRİ ELEKTİRK	250 MW	21	ADMEN ENERJİ A.Ş.	65 MW
7	SMART A.Ş.	400 MW	22	SOLENTAD	80 MW
8	GAZİOĞLU SOLAR	120 MW	23	SOLONN A.Ş.	120 MW
9	GEST	150 MW	24	ANKARA SOLAR	60 MW
10	GTC	135 MW	25	ANTAK ENERJİ LTD	40 MW
11	MAR SOLAR A.Ş.	300 MW	26	TERA LTD	24 MW
12	ÖDÜL SOLAR A.Ş.	180 MW	27	TETRA TELEKOM LTD	15 MW
13	SCHMID PEKİNTAŞ A.Ş.	90 MW	28	MİR SOLAR	130 MW
14	PLURAWATT	40 MW	29	SP ENERJİ	60 MW
15	SEHA ENERJİ	80 MW			

Turkey has nearly 50 EPC companies for PV sector. List of most EPC companies is given below [15]:

	EPC FIRMS		EPC FIRMS		EPC FIRMS
1	EKİNLER ENDÜSTRİ A.Ş.	18	ENSO ELEKTRİK LTD. ŞTİ.	35	SOLARTÜRK ENERJİ A.Ş.

2	ELSE ENERJİ LTD. ŞTİ.	19	GC ENERJİ LTD. ŞTİ.	36	SUNVİTAL ENERJİ LTD. ŞTİ.
3	EUROPOWER SOLAR ENERJİ	20	GENERAL SOLAR ENERJİ LTD. ŞTİ.	37	TEGNATİA ENERJİ A.Ş.
4	GAZİOĞLUSOLAR ENERJİ SAN. ve TİC. A.Ş.	21	GÖZE ENERJİ A.Ş.	38	TEKNO RAY SOLAR ENERJİ A.Ş.
5	ŞARA ENERJİ İNŞAAT TİC. VE SAN. A.Ş.	22	HALK ENERJİ A.Ş.	39	TREND ERK ENERJİ TEKNOJİLERİ A.Ş.
6	ZORLU ENERJİ ELEKTRİK ÜRETİM A.Ş.	23	ISUN ENERJİ A.Ş.	40	VAM MÜHENDİSLİK TAAHHÜT TİC. LTD. ŞTİ.
7	VERGO ENERJİ SİSTEMLERİ SAN. VE TİC. AŞ.	24	İBC SOLAR LTD ŞTİ.	41	YP ENERJİ A.Ş.
8	AKKAŞOĞLU Grup ENERJİ SANAYİ VE TİC. LTD. ŞTİ.	25	LUVİ ENERJİ AŞ.	42	ZEN ENERJİ A.Ş.
9	AKSARAY ENERJİ. LTD. ŞTİ.	26	NATUREL 1 ENERJİ TİC. A.Ş	43	DAL YENİLENEBİLİR ENERJİ A.Ş.
10	ASEMA TEKNİK İNŞ. ENERJİ LTD. ŞTİ.	27	NORM ENERJİ LTD. ŞTİ.	44	KONAR ENERJİ TAR. TUR. SAN. TİC. A.Ş.
11	ASUNİM YEN. ENERJİ TEKNOJİLERİ İNŞ. MÜH.	28	PEMENERJİ SAN. TİC. LTD. ŞTİ.	45	GALTEK MÜHENDİSLİK. LTD. ŞTİ.
12	AVG ENERJİ LTD. ŞTİ.	29	PRIME ENERJİ A.Ş.		
13	BFİ ALTERNATİF ENERJİ	30	RALEN ENERJİ LTD ŞTİ		
14	CAUTHA TURKEY YEN ENERJİ İNŞAAT A.Ş.	31	SATURN POWER ENERJİ SAN. VE TİC. A.Ş.		
15	CB GRUP ENERJİ A.Ş.	32	SENERJİ MÜHENDİSLİK LTD. ŞTİ.		
16	CNENERJİ ÜRETİM SİS. VE YÖNETİMİ A.Ş.	33	SMS ENERJİ. LTD. ŞTİ.		
17	Eko Yenilenebilir Enerjiler A.Ş. (EKORE)	34	SOLARS ENERJİ SİSTEMLERİ A.Ş.		

4.3 Manufacturers and suppliers of other components

A list of Turkish wholesalers and distributors of solar panels, components, taken from <https://www.ensolar.com>, is given below:

3S Seven Solar
AC/DC Electronic Systems



ACS Energy Systems
Aku Energy
AY-Solar
Bahar Enerji
BAS
Cikcik Enerji
Cimo
CWE
Depar Solar
Derin Marin
Else Energy
EMASolar
Endepo
Esis Enerji
EZG Solar
Foton Enerji
Güvenli Enerji
HS Sevik Enerji
İnform Elektronik
Koctas Teknoloji Dis Ticaret
Krannich Solar
Laterna
Linetech Eletronik Sistemler
Mitsui & Co.
Neoenerji Clean Energy
Netta Elektronik
Norm Energy Systems
PA Engineering
Pem
Polat Solar
PV-Systems
Royalstar Energy Systems
Sader
Senerji Solutions
Solar Cell
Solar Dukkan
Solar Ofis
Solvo Solar
SP Enerji
Sunensys
Teknik Solar Enerji
Teksan
TransmerGreen
Tursolar Enerji Sistemleri
URL Solar
Zorlu Enerji



5 PV IN THE ECONOMY

This chapter aims to provide information on the benefits of PV for the economy.

5.1 Labour places

Estimated number for PV-related full time employment includes all jobs in public research and development, Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D; and all other, including within electricity companies, installation companies etc.

Table13: Estimated PV-related full-time labour places in 2018

Market category	Number of full-time labour places
Total	31 000*

* estimated based on the numbers given in [16] and the rate for PV given in [17].

5.2 Business value

Table 14: Rough estimation of the value of the PV business in 2018 (VAT is excluded).

Sub-market	Capacity installed in 2017 [MW]	Average price [\$/W]	Value	Sub-market
Off-grid	0,9	1,0	0,9 M\$	0,9 M\$
Grid-connected distributed	1,0	1,0	1,0 M\$	1,0 M\$
Grid-connected centralized	2164	0,7	1471,3 M\$	1471,3 M\$
Value of PV business in 2018				2 946,6 M\$

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

Until the 1980s, the Turkish electricity sector was concentrated in the Turkish Electricity Authority (TEK) – the integrated monopoly for generation, transmission and distribution. Since then, the government has unbundled and partially privatized the industry. In 1984, the state allowed private sector participation in generation by introducing different investment models: build-operate-transfer (BOT), build-operate-own (BOO), transfer of operating rights (TOOR), independent power production (IPP) and auto-production. Under a BOT concession, a private company could build and operate a plant for an agreed period and then transfer it to the state at no cost. A BOO concession is similar to BOT but allows investors to retain ownership of the assets at the end of the contract. Under a TOOR model, an existing state facility would be operated by a private entity under a lease agreement. The BOT, BOO, and TOOR contract were signed between the private investors and the state-owned generation and transmission company and included a “take-or-pay” clause, under which the government would purchase the output at fixed prices.

In 1997, with the technical and financial support of the World Bank, Turkey’s Ministry of Energy and Natural Resources (MENR) began preparing the legal framework for a competitive electricity market. Following the enactment of the 2001 Electricity Market Law, Turkey unbundled the sector into different business activities as is shown in the figure below.

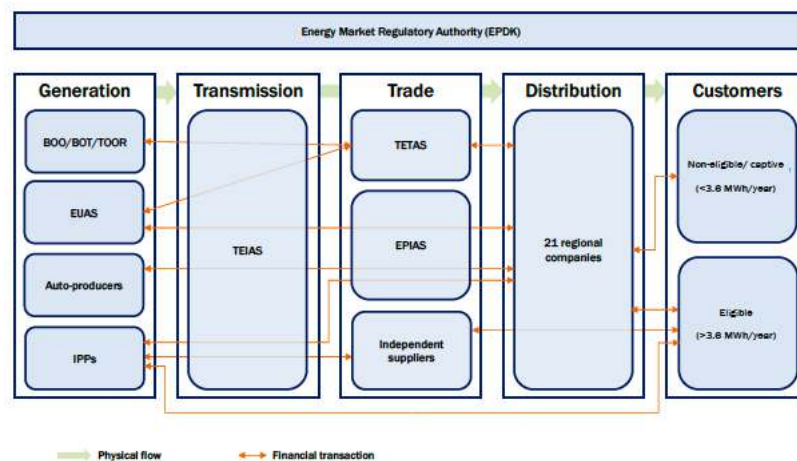


Figure 1: Overview of the electric power sector in Turkey after privatization [18].

The state-owned generation and transmission company (former TEAS) was split into three new entities responsible for generation (EUAS), transmission (TEIAS), and wholesale (TETAS). At the beginning of the liberalization process, TETAS acted as a single buyer for private generation and then was transformed into a market participant exposed to competition. It is the only remaining state-owned supply undertaking after privatization. The number of wholesale licenses has been increasing rapidly since 2003 [18].

Currently, there are more than 150 private companies holding wholesale licenses. TETAS took over the BOT, BOO, and TOOR contracts and it is also responsible for electricity import and export. TEDAS, the state-run distribution and retail entity, was restructured into 21 regional distribution companies, all of which are privately owned. Distribution and retail activities were unbundled following the electricity Market Law of 2013. Since January 2013, distribution companies are allowed to carry out generation and wholesale activities but only under separate legal accounts.



The electricity law of 2011 also mandated an independent regulatory authority – the Energy Market Regulatory Authority (EMRA), to issue licenses; determine and approve tariffs; set the eligibility limits for market opening; draft secondary legislation; and solve disputes and apply penalties in electricity, natural-gas, petroleum and LPG markets. In 2015, EMRA announced the establishment Turkish Energy Stock Market (EPIAS). It was established as a private company (with 40% of its shares held by private companies, the rest held equally by TEIAS and the Istanbul Stock Exchange) and authorized to manage and control electricity merchandise throughout the country. EPIAS operates electricity transactions both in day ahead market and intra-day.

In 2015, about 30% of the total electricity was sold on the market, while some 70% of wholesale traded capacity is done through bilateral negotiated contracts. On the demand side, eligible consumers (purchasing more than 3.6 MWh per year) are free to procure electricity from a supplier of their choice. Non-eligible consumers can purchase electricity only from retail companies holding retail license in their region [18].



7 HIGHLIGHTS AND PROSPECTS

1. Turkey has great potential in terms of both heat generation and electricity production from renewable energy sources such as solar, wind, hydroelectric, geothermal, biomass and wave, although it will be necessary to update the legislation in order for this potential to pass through in full. There is significant demand-management potential in the industry to reduce peak demand in electricity, but also a need to improve legislation and the market structure. Even if legislation and incentives exist in the field of efficiency, the target effect has not been fully achieved yet. In this respect, legislative development is foreseen by the Government.

The Ministry has developed a strategic plan for 2015–2019 for the energy market. This plan is founded on the themes of the current needs of the energy sector, expectations for the future and the policy development required in the field of natural resources. The Ministry's 2015–2019 Updated Strategic Plan consists in total of eight themes, 16 objects and 61 purposes. In the field of energy and natural resources: good governance and stakeholder interaction; regional and international activity; technology, R&D and innovation; and improving the investment climate, are discussed. Additionally, in the energy sector: security of supply; and energy efficiency and saving; and in the natural resources sector: efficient use of raw materials; and security of raw materials supply, are constituted in the framework of the plan. The establishment of energy-storage systems, and the establishment of the legislative infrastructure for the integration of energy-storage systems into the network, are in the scope of the Ministry's plan.

2. In terms of research and development, Turkey's capacity has been increasing in the recent years. In addition to several General Directorates under the Ministry of Energy and Natural Resources, the Marmara Research Center of the Technological and Scientific Research Center of Turkey also carries on solar energy related research projects along with a number of universities. Ege University, Muğla University, Middle East Technical University, İstanbul Technical University, Kocaeli University, Harran University and Firat University can be counted among the chief academic institutions in the country that are involved with solar energy research. Solar photovoltaic science and engineering is also gaining ground in the curriculum of related undergraduate and graduate programs in such institutions. Surely the proliferation of such programs and research will help in meeting the countries need for expertise in the area [19].

3. The PV market of Turkey is being accelerated and development is seen in all dimensions from production to installation with the support of raising awareness in all levels of society. The Turkish Solar Energy Associations continued their endeavors to facilitate information flow for a healthy market development. One of the events organized by GÜNDER and UFTP entitled "SOLARTR 2018 Conference and Exhibition" was concluded in Istanbul on November 29-30, 2018, in addition to several meetings and workshops organized for capacity building and removing the barriers along the whole year. The conference has been organized with the participation of the leading organizations in the solar energy industry and from researchers to industry representatives, from public to contractors all stakeholders came together to evaluate solar energy and the development of the industry (see Cover Picture).

4. Turkey has extended the periods set forth for the connection agreements in unlicensed electricity investments, renewable energy source areas, and the Renewable Energy Resources Support Mechanism ("YEKDEM") with the Law Number 7186 Amending Income Tax Law and Certain Other Laws (the "Omnibus Bill"). According to the Omnibus Bill, The period for connection agreements of the power plants with the installed power below 1 Megawatt has been extended for 120 days [20].



The periods concerning the rights and obligations under the agreements below have been extended for 36 months as of 19 July 2019 Agreements concerning renewable energy sources areas which are contracted as of 19 July 2019 according to the procedure specified under the Electricity Market Law ("Law"), Transfer agreements and electricity sales agreements concluded prior to 19 July 2019, with the purpose of building an electric power plant based on renewable energy sources or local coal and which are privatized, in line with the procedure specified under the Law. Within this period, not only the related agreements but also shares of the project company can be transferred. The agreements to be transferred in this respect will be exempted from stamp tax. Periods under the YEKDEM for the power plants generating energy based on the resources defined as biomass will not commence as of becoming operational but as of entering into YEKDEM.

5. Turkey's Energy Market Regulatory Authority (the "EMRA") has updated the Procedures and Principles Regarding Applications for Pre-License and License Proceedings with its decision published in the Official Gazette dated 6 July 2019 and numbered 30823 (the "Decision") entered into force as of the date of publication. In line with the Decision, the electronic application procedure has been introduced for pre-license and license applications. The documents required for pre-license and license applications have also been updated [21]. According to the new procedures, the following applications shall be made electronically via the EMRA Application System by electronic application authorized persons:

- Pre-license applications, amendments, merger or spin-offs and termination requests,
- Production license applications, amendments, merger or spin-offs and termination requests,
- Supply license applications, amendments, merger or spin-offs and termination requests,
- Facility/ project transfer applications,
- Renewable Energy Resources Support Mechanism (YEKDEM) applications.

On the other hand, applications for licenses concerning (i) transmission, (ii) distribution, (iii) Organized Industrial Zone (OSB) distribution, (iv) OSB production, (v) market operation and (vi) nuclear energy-based pre-license and licenses, as well as applications regarding their amendment and termination shall continue to be made in writing. In order to make the applications in an electronic environment, the legal entity which will apply must notify EMRA of the authorized person to make electronic applications, in writing with a petition and certificate of authorization attached to the Decision. The authorized person who will apply on behalf of the legal entity will be granted access to the EMRA Application.

System within five working days following the submission of the authorization document. Third parties who are not authorized to represent and bind the legal entity may also be authorized for an electronic application. In such a case, a specific power of attorney will be granted to such third person. The powers which must be included in the power of attorney to be submitted to EMRA are also specified in the Decision. EMRA Application System will be accessed through an e-government password, an electronic signature or a mobile signature. EMRA has also foreseen a transition period for electronic applications. Accordingly, applications required to be made in the electronic environment can continue to be made in writing until 30 November 2019. In addition to the electronic application procedure, the documents which need to be submitted to EMRA for applications regarding pre-license and licenses have also been updated under the Decision.



8 REFERENCES

- [1] Electricity Market Development Report 2018, <https://www.epdk.org.tr/Detay/Icerik/1-1271/electricityreports> (2019)
- [2] <http://www.mondaq.com/turkey/x/818764/Oil+Gas+Electricity/Turkey+Adopts+New+Regulation+On+Unlicensed+Electricity+Production+In+The+Electricity+Market>
- [3] <http://www.mondaq.com/turkey/x/533324/Oil+Gas+Electricity/Summary+of+2016+Amendments+on+Turkish+Legal+Framework+of>
- [4] “National Renewable Energy Action Plan for Turkey”, Republic of Turkey Energy and Natural Resources Ministry, December 2014.
- [5] “\$1.5 billion solar power investment set for Konya”, <https://www.dailysabah.com/energy/2016/10/04/15-billion-solar-power-investment-set-for-konya>
- [6] Turkey started construction of its first solar module plant, <https://www.esiasce.eu/turkey-started-construction-first-solar-module-plant/>, December 27, 2017
- [7] Turkey's biggest solar plant to be built by Kalyon-Hanwha Co., <https://www.dailysabah.com/energy/2017/03/20/turkeys-biggest-solar-plant-to-be-built-by-kalyon-hanwha-co>, March 20, 2017.
- [8] Hanwha-Kalyon JV to build 500MW PV manufacturing facility in Turkey, <https://www.power-technology.com/news/hanwha-kalyon-jv-build-500mw-pv-manufacturing-facility-turkey/>
- [9] Hanwha Q CELLS News, https://hanwha-qcells.com/qcells-office/press/press-releases-en/2017_Q4/171226, December 22, 2017.
- [10] <http://www.hurriyetdailynews.com/turkeys-electricity-consumption-rises-0-75-pct-in-2018-140386>
- [11] <https://www.morogluarseven.com/news-and-publications/turkey-adopts-new-regulation-on-unlicensed-electricity-production-in-the-electricity-market/>
- [12] <http://www.mondaq.com/turkey/x/688298/Renewables/New+Rules+For+Rooftop+Solar>
- [13] <http://turkishpolicy.com/article/933/renewable-energy-investment-in-turkey-between-aspiration-and-endurance>
- [14] <http://www.mondaq.com/turkey/x/703208/Renewables/IPARD+Incentives+On+The+Renewable+Energy+Investments>
- [15] Solar PV Market Research and Analysis by GUNDER, unpublished work (2019)
- [16] Renewable Energy and Jobs – Annual Review 2019, IRENA, www.irena.org.
- [17] Steward Redqueen, How Power Investments Contribute to Jobs and Economic Growth in Turkey, IFC: International Finance Corporation (2017)
- [18] Market Report Turkey – Photovoltaics (2014), dena Market Information System, <https://www.german-energy-solutions.de/GES/Navigation/DE/Home/home.html>
- [19] Bavbek, G., Solar Photovoltaic Market in Turkey: Prospects and Challenges, Centre for Economics and Foreign Policy Studies (EDAM) Climate Action Paper Series 2015/1, 2015.
- [20] <http://www.mondaq.com/turkey/x/841604/Renewables/Turkey+Extends+Certain+Periods+Specified+Under+Renewable+Energy+Legislation>
- [21] <http://www.mondaq.com/turkey/x/839456/Renewables/Electronic+Application+Requirement+For+Energy+Markets+PreLicense+And+Licenses+Has+Been+Introduced?type=related>

