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Sunny Days for Renewable Energy

Developments and expectations in solar energy sector in the light of current regulations

January 2013

Introduction

According to the decision made during the meeting by EMRA on May 24th 2012, in the scope of fifth paragraph in 6/c clause of RER Law with Nu. 5346 it is decided that generation application licenses for generation facilities based on RER licensed solar energy capacity rated at 600 MW will be taken between June 10 and June14, 2013.

This decision made on this date is crucial for the path of the SPPs. According to legislation, 12-months of solar measurements are required for the license application. This announcement made on May 2012 allows for sufficient amount of time to investors for measurement data that are required. Declarations of EMRA which are not official yet are in the direction of that establishment of SPPs in agricultural lands is not allowed and land usage per MW is limited by 20,000 m^2.

Applications will be accepted on June 2013, and the maximum limit is set to be 600 MW, however it is expected that by 2023 the limit will be raised to 3,000 MW.

According to the unofficial declaration made by EMRA, €1.5 billion investment is expected for 600 MW SPPs at the first stage.

The first part of this report includes information on potential of solar energy in Turkey, currently available technologies and it also focuses on costs and legislations related to evaluated SPPs. The second part of the report consists of what can SPPs expect in Turkey.

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High potential, decreasing costs and incentives

Turkey has high solar radiation along with high sunshine duration due its geographical location. According to research conducted by the General Directorate of Renewable Energy, Turkey's annual sunshine duration is 2,640 hours and average annual solar irradiance is recorded as 1,311 kWh/m2. South East Anatolia region receives the highest solar energy resource followed by the Mediterranean Region. The table below demonstrates the average solar energy intensity and average sunshine duration for seven main regions of Turkey.

Table 1: Average solar energy intensity and average sunshine duration based on seven main regions.

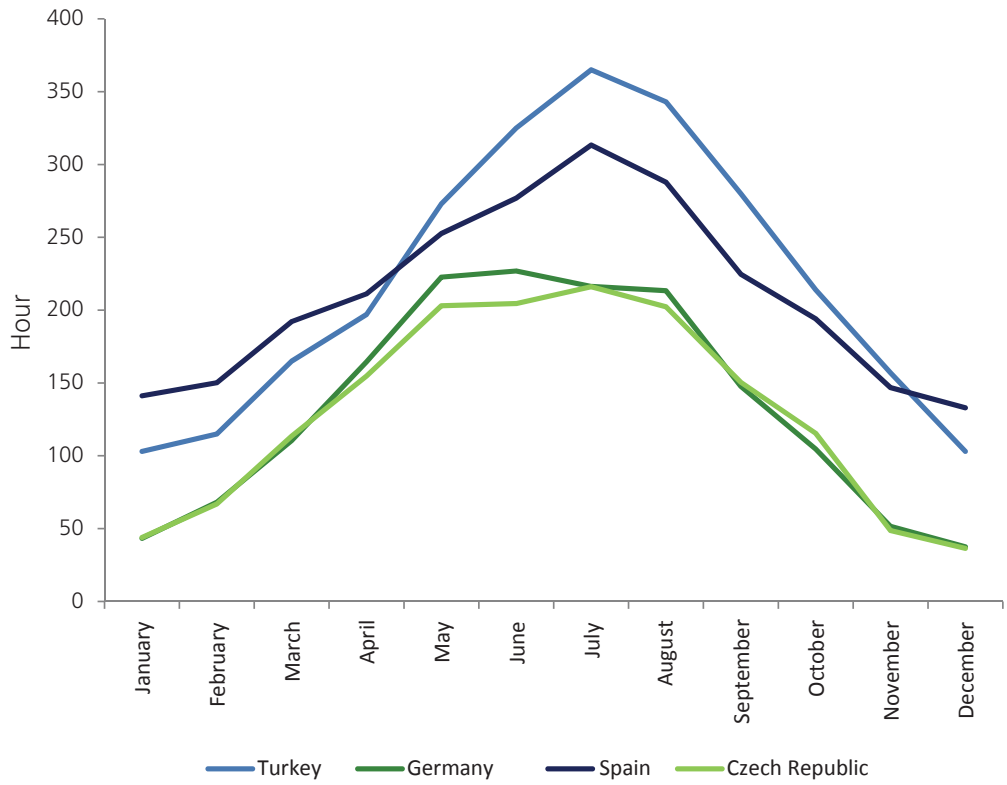
Region	Total average solar energy (kWh/m2)	Average sunshine duration (hour/year)
Southeastern Anatolia	1.460	2.993
Mediterranean	1.390	2.956
Eastern Anatolia	1.365	2.664
Central Anatolia	1.314	2.628
Aegean	1.304	2.738
Marmara	1.168	2.409
Black Sea	1.120	1.971

Source: General Directorate of Renewable Energy

Turkey has higher potential for solar energy compared to Germany, Spain and Czech Republic of Continental Europe –leading investors for solar power. However, Turkey lags behind these countries since the regulations were recently published.

Approximately 2% of Germany's electricity is provided by photovoltaics (PV) due to the country's high feed-in-tariff levels. The graph below shows Turkey's sunshine period along with European Union's leading countries investing in solar energy.

Figure 1: Hourly sunshine period comparison



Source: GDRE, National Oceanic and Atmospheric Administration

Solar Technologies

Solar energy technologies have higher initial investments compared to other low carbon technologies and are 20% less efficient in generation.

Solar technologies employed for electricity generation can be listed as follows;

- Photovoltaic (PV)
- Concentrated Solar Power (CSP)
- Concentrated Photovoltaic (CPV)

PV cells convert solar radiation to electricity using semiconductors. PV modules consist of various solar cells that are electrically connected to each other. Materials which are used for photovoltaic cells can be either Monocrystalline or Polycrystalline crystals.

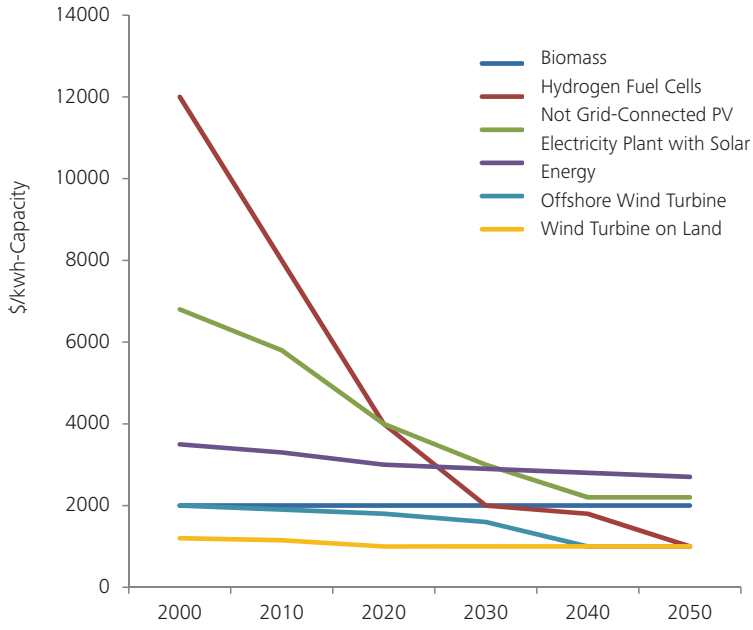
CSP systems use mirrors or lenses to concentrate sunlight onto a small area with a receiver and then solar energy captured by sunlight is converted into heat.

The PV modules utilize sunlight directly in order to generate electricity and their capacity factor is defined as approximately 14-24%. CSP technologies demonstrate their prominence in capacity factor, applied technology, and making use of the received sunlight. CSP power plants that have Thermal Energy Storage can achieve a capacity factor between 40-50% and stay in operation an extra 6.5 to 7 hours compared to power stations lacking Thermal Energy Storage. The capacity factor falls between 20% to 28% percent for CSP technologies without Thermal Energy Storage.

CPV technologies are similar to CSP systems in terms of concentrating sunlight into a small area of photovoltaic cells via lenses or curved mirrors. However, unlike CSP systems which convert sunlight to heat and then to electricity, CPV technology converts sunlight direct into electricity via PV cells. Currently 85% of the solar cells in the market are made from Wafer based silicon (c-Si). Efficiency of commercially used polycrystalline or monocrystalline PV modules changes between 12% to 20%.

PV module prices differ greatly according to technology, efficiency and generation cost. In order to have low cost for PV technologies, the raw material prices need to be low as well. Many initiatives that have been introduced by many countries reduced the costs of PVs and allowed the technology to develop further.

Figure 2: Change of renewable energy technology's cost by years



There are two crucial photovoltaic technologies that are used to produce solar panels; they are PV cells (c-Si) and thin film. Solar panels using thin film have lower cost per kW compared to c-Si but their efficiency to convert sunlight to electricity is lower as well. High-efficiency PV modules have higher profit margin in the market compared to PV modules that have low efficiency. The main reason behind this is because, high-efficiency PV modules will utilize a smaller area compared to low-efficiency PV modules to generate the same amount of electricity.

A PV array rated at 1kW usually requires about 10m2 of space. The size of the space differs depending on the technology.
$0.10 increase reflects 1% increase in efficiency. For example, a PV module which has an efficiency of 20% is priced at $1 more per Watt compared to a PV module that has 10% efficiency.

Figure 2 demonstrates the cost of renewable energy technologies that have changed throughout the years.

PV modules are expected to work at higher efficiencies in the future due to the developments in monochyrstillaine and polycrystalline technologies. The costs of PV modules are also expected to decrease over the course of 30 years.

PV Support Levels in European Countries

According to the strategy report published by Ministry of Energy and Natural Resources (MENR) in May 2009, Turkey aims to generate 30% of its energy from the renewable energy resources by 2023. Regulatory framework includes feed-in-tariff for photovoltaics and concentrated solar energy which is determined as 0.133 $/kWh (0,10 €/kWh) and upper limit for local equipment bonus is determined as 0.067$/kWh (0.052 €/kWh)

Recently, incentives and feed-in tariffs have been reduced in countries that are excelling in solar energy –Germany, United Kingdom, Spain and Czech Republic- due to economic crises in Europe, in some cases incentive mechanism are completely removed.

Germany

Feed-in tariffs for Germany which have been prepared on 1st of January 2011 is shown in the table below. However, it has been stated that these prices will be changed after June 2012.

Table 2: Feed-in-Tariff Levels in Germany

Type	System Size	Feed-in Tariff (€/kWh)
Grid-Connected PV	<30 kWh	0.287
	Between 30 and 100 kWh	0.273
	Between 100 kWh and 1 MWh	0.259
	>1MWh	0.216
Not Grid-Connected PV	<30 kWh	0.124*/0.167**
	Between 30 and 100 kWh	0.110/0.153
	Between 100 and 500 kWh	0.095/0.139

*:Meeting consumption until 30%
**:Meeting consumption more than 30%

In addition to the table mentioned previously, fixed prices for ground-mounted PVs are determined to be 0.211€/kWh. The cost of installed PV capacity (6GW) in Germany for years 2000 to 2008 was 35 billion Euros. The installed PV capacity increased by 7.5 GW in years 2009 to 2010 and the cost for this increase was 18 billion Euros. Germany has decided in March 2012 to reduce the feed-in tariffs for small size enterprises from 19.5 € cent/kWh to 16.5 € cent/kWh. Feed-in tariff level for industries generating above 10 MW was reduced to 13.5 €/kWh and the feed-in tariffs will be completely removed after June 2012.

Czech Republic

Czech Republic implements different kinds of incentive mechanisms. These mechanisms include; feed-in tariff, green bonus and tax exemption. Green bonus allows the suppliers to benefit from the European Structural Fund and National Energy Conservation Fund. Profit from electricity sold is exempt from tax. Installations over 100 kW benefited from incentive priced at 0.6873 €/kWh, whereas installations between 30 to 100 kW benefited from incentive priced at 0.6623 €/kWh until end of 2010. As a result of the implemented incentives, installed solar capacity of 1 MW in the end of year 2006 increased to 6 GW by end of 2010.

Czech Republic reached the aimed installed capacity for SPPs in a fast pace. However, the cheapening technologies resulted in excessive load of incentive values. In order to balance these excessive load of incentive values, Czech Republic imposed obligation to installations of 30 kW or higher (in 2009 and 2010) to pay retroactive tax and it lowered feed-in tariff level by 50%.

The following incentive mechanisms were determined by the Czech Republic Energy Market Regulatory Authority and implemented on January 2011.

- 0.311 €/kWh for installations up to 30 kW.
- 0.245 €/kWh for installations between 30 and 100 kW.
- 0.228 €/kWh for installations greater than 100 kW.

Spain

Renewable energy resources regulation declared by Spain in 2007 determined the feed-in tariff for solar panels as 0.44 €/kWh. In this scope, according to regulation number RD 661/2007 the following feed-in tariff levels are offered;

- 0.4659 €/kWh for installations less than 100 kW for first the 25 years and after that priced at 0.3727 €/kWh.
- 0.4417 €/kWh for installations between 100 kW and 10 MW for the first 25 years and after that priced at 0.3534 €/kWh.
- 0.2431 €/kWh for installations between 10 MW to 50 MW for the first 25 years and after that priced at 0.1945 €/kWh.

Even though Spain predicted development of 400 MWs with respect to given prices above, the installed SPP capacity reached to 3,000 MW in the first 18 months of the applied tariff. This caused serious burden on the public finance. Duration of feed-in tariff faced some limitations after the declaration of 1565/10 and RD-L number 14/10 directives. Tariffs were also decreased by 45% depending on installation size and type. Tariffs for new PV installations;

- 0.289 €/kWh for roof installations with building integration rated up to 29 kWp.
- 0.204 €/kWh for roof installations with building integration rated greater than 20 kWp.

UK

According to revised incentive mechanism in April 2011, the feed-in tariff levels are determined as follows;

- 0.445 €/kWh for installations between up to 10 kW.
- 0.361 €/kWh for installations between 0.1 to 5 MW.

However, after incentive evaluation on 9th of July 2011, the following tariff system was applied on August 2011;

- 0.135 €/kWh for ground-mounted PV installations rated at up to 10 MW.
- 0.224 €/kWh for installations between 50 kW to 150 kW.
- 0.176 €/kWh for installations between 150 kW to 250 kW.
- 0.100 €/kWh for installations between 250 kW to 5 MW.

These regulations were adjusted due to the cheapening technology especially the fast rise of the roof type solar panels during 2008 to 2009 added more burden to public finance in time of the global crises.

Analysis: Effect of incentive levels

Incentive levels in Turkey are lower than the ones in Europe, therefore the effect of incentives is a controversial issue. Nevertheless, investors are highly interested in SPP projects. In the absence of any bonus originating from local equipment use, Turkey has lower incentive levels compared to Germany, Spain, and Czech Republic. The main reasons behind this relative low level of incentives is that there is a need to promote locally produced equipments and controlling the finance requirements to be met by by public budget due to cheapening technology.

Existing tariff structure supports investors to give preference to domestic equipment. However, currently there is limited capacity for manufacturing domestic equipment. However, the capacity has been increasing regarding manufacturing domestic equipment and solar PV cells have the highest domestic contribution. It is expected that more time is needed in order have locally produced equipment available.

Table 3: Comparison of Tariff Levels

	Feed-in Tariff Level (EURcent/kWh)
Germany*	13.5
Spain	13.5
Czech Republic	28.8
England	10
Turkey**	10

*Being zero by July 2012
** Including domestic contribution addition, the values stated on the table may change as 6.7 USDcent/kWh for PV technology and 9.2 USDcent/kWh for intensive one and in EUR cent/kWh term 5 and 6.9 respectively.

Regulatory framework

Figure 3 below demonstrates the regulatory framework for the solar energy power plant investments. General policies for the solar power plants are determined by the Renewable Energy Law, whereas secondary legislation defines the methods. It is crucial to follow Ministry of Energy and Natural Resources' announcements which present important information such as; EMRA Board decisions, documentation submission date, and necessary documents for licenses. According to official newspaper published by MENR on 4th of February, 2012 announcement regarding standards for SPPs have been changed and that the total solar radiation received by the horizontal surface of the panels need to be equal to 160 kW/m2 or higher than this value.

Figure -3 Regulatory Framework Legislations

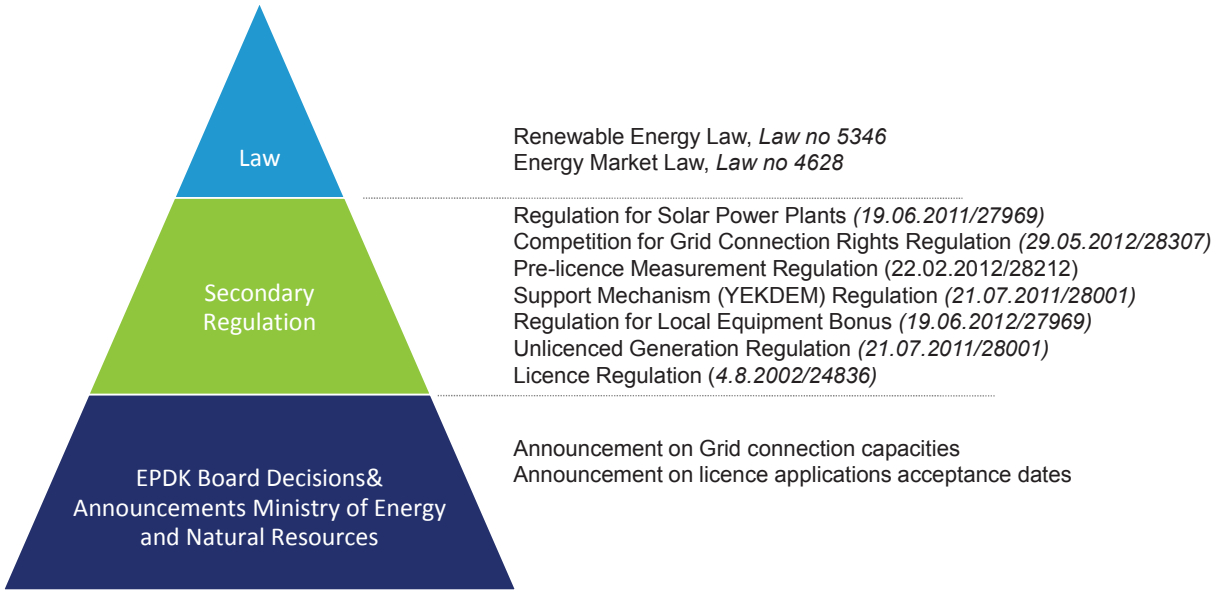


Table 4: Critical Issues in the Relevant Legislations

Regulation	Critical issues
Renewable Energy Law	• Solar generation is entitled for a 13.3 USDcent/kWh for the next 10 years following its commissioning. This covers the SPPs that are commissioned before 31.12.2015, however extension would be possible with a decree of Council of Ministers. SPPs cover both condensed solar and solar PV. • SPPs which use local equipments are entitled for a local equipment bonus for duration of 5 years. Below additions are granted to locally produced equipment:

Locally Produced Component	Bonus (USDcent/kWh)
Solar PV	
PV Panel Integration and production of structural solar mechanics	0,8
PV Modules	1,3
PV Module Cells	3,5
Invertor	0,6
Material that focuses radiation on the PV Module	0,5
Concentrated Solar	
Radiation collector tube	2,4
Reflective surface	0,6
Sun tracking system	0,6
Mechanical components of heat energy storage system	1,3
Mechanical components of the steam generation system	2,4
Stirling engine	1,3
Panel Integration and production of structural solar mechanics	0,6

- Incentives other than the Feed in Tariff are briefly stated below:

• The Ministry of the Environment and Forestry or The Ministry of Finance can, upon payment of a fee, allow, rent or give the right to use any kinds of immovable properties accepted as forest lands, owned by the Treasury or controlled by the government for facilities, transportation roads and network connection points in order to enable the generation of electricity from renewable resources.

• SPPs commissioned before 31.12.2015 an 85% discount will be applied to any permit, rent, servitude or right of use fees for energy transmission lines, including the ones that will be transferred to TEIAS and distribution companies, between transportation roads and system connection points as defined in their licenses for the first ten years of their investment and operating period. Moreover, Forest Village Relations (ORKÖY) and forestation payments will not be required from these facilities for forest areas.

• Any natural or legal entities that generate electricity using renewable energy resources having an installed power of less than 500 kW has the opportunity to benefit from the above mentioned fixed price for ten years for all electricity energy generated that is excess to their needs that is added to the distribution system. For all facilities that are not obliged to establish a company or to take a license as specified under the Electricity Market Law, it is obligatory that all electricity energy

Table 4: Critical Issues in the Relevant Legislations

Regulation	Critical issues
Regulation For Solar Power Plants	• This regulation sets the standards that SPPs need to comply. Accordingly, for performance of the panels • TS EN 61215, • TS EN 61646, • TS EN 62108 and for safety tests • TS EN 61730 standards are applicable. • Generation of SPPs will be monitored by YEGM, and YEGM will be responsible to take precautions for fraud (e.g. in case of hybrid plants) accordingly, all SPPs have to install meteorological equipment to measure wind speed and direction, heat and other relevant inputs. Further, penalties will be introduced for fraud on the solar generation.
Regulation for Competition for Grid Connection Rights	This regulation sets the framework for how the grid connection rights that will be granted to SPP license applicants. • At the moment, transformers to which SPPs can be connected are announced. Accordingly, SPP project developers who targeted the same transformator (either in case their site is intersecting or totally overlapping) have to compete for grid connection rights through a tendering process. • Tendering process will be carried out by TEİAŞ and SPP project developers are expected to submit bids on the amount of reduction from the FIT level of 13,3 USDcent/kWh. • Whether a particular SPP will be entitled for connection right without a competition or not will be determined only after EPDK collects all the license applications and determines which SPP projects are intersecting/overlapping. EPDK then makes a list of applicants who need to enter in the competition tender. • The tender will be publicly open. • In order to participate in tender, bank guarantee letter is required and its value is calculated by multiplying the value obtained by rounding up two decimal digits of the installed capacity in terms of MW by TL10,000. Guarantee letter of the company who wins the competition is kept by TEİAŞ until related project is commissioned. • Company which is granted connection right cannot demand withdrawal from RER support mechanism during the 10- year period as stated in the Law

Table 4: Critical Issues in the Relevant Legislations

Regulation	Critical issues
	• Competition process is designed as follows:

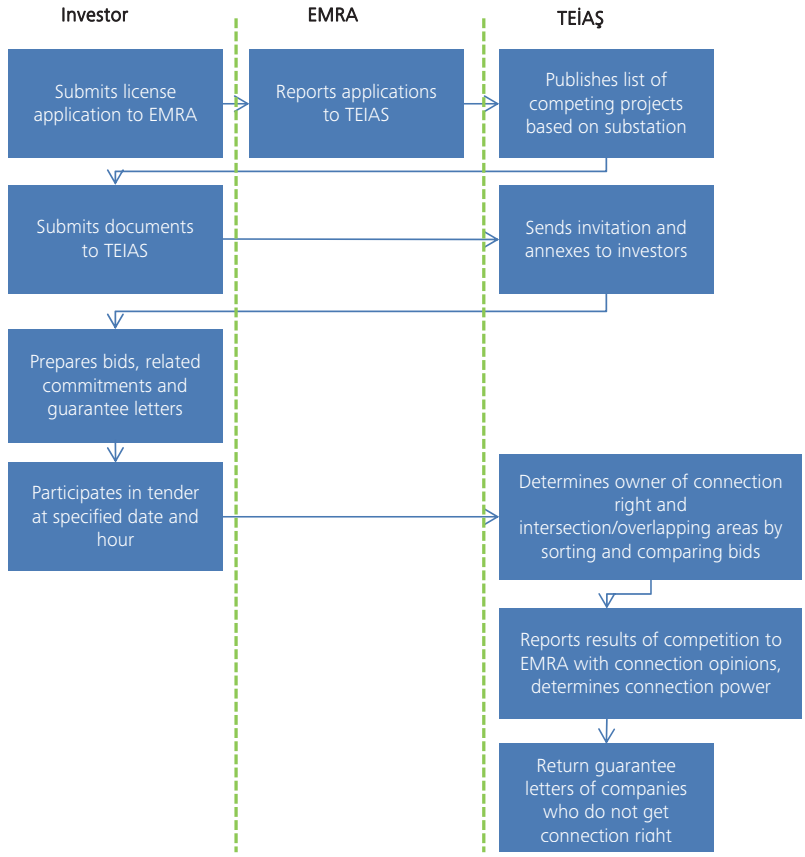


Table 4: Critical Issues in the Relevant Legislations

Regulation	Critical issues
	• Evaluations to determine the correction right owner was designed as follows:

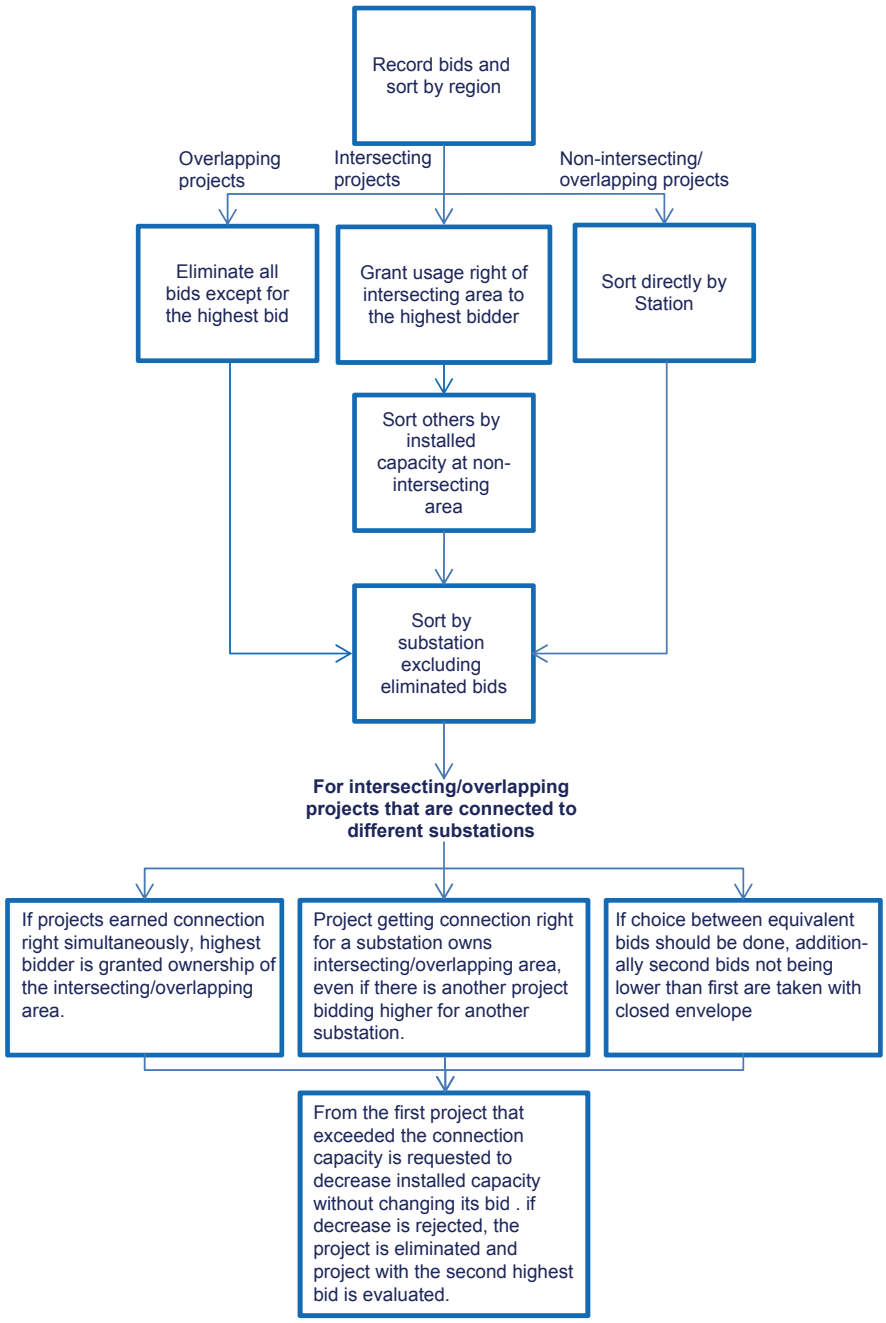


Table 4: Critical Issues in the Relevant Legislations

Regulation	Critical issues
Regulation for pre-license measurements	This regulation is about the measurement standards for the radiation and duration of solar energy. Accordingly, • SPP license application should include a data set of one year on solar radiation and sunny times. The data set should consist of 6-months on-site measurement data and interpolations of the on-site data to have complete one-year data. No more than 20% of the on-site data loss is acceptable. Data losses up to 20% have to be compensated with the available data from General Directorate of Meteorology (MGM, in Turkish) and by using statistical data completion techniques (interpolation etc). • Results must be submitted during the license application in standard format (Annex 4 of the Regulation). • Installation of measurement equipments is critical, too, and should be reported in the standard format (Annex 3 of the Regulation). It should be noted that the installation of the measurement equipment is subject to the approval of MGM. • SPP investor is responsible from obtaining the required permits to install the meteorological equipment. • Measurement equipment covers pyronometer (with a 1-minute or 10-minute granularity), sensors to measure sunny time (with a 1-minute granularity and hourly recording), heat, relative humidity, wind speed and direction and a data logger. • Sensors have to be compliant with the TS ISO 9060 or ISO 9060 standards and relevant compliance documents should be included in the application package. • Original data have to be reported periodically to MGM digitally. The SPP investor is responsible from assuring the reliability of the data. • For those SPP investors who have started measurements beforehand, their data set is regarded acceptable only in case the documentation related to the installation of measurement equipment is approved by MGM.
Regulation for pre-license wind and solar measurement applications	How measurement applications are done is detailed with thisregulation. According to this: • Separate application is done for each measurement station. • Application fee is 3.000 TL for each station in 2012. • Control of measurement station in terms of compatibility to establishment specifications is done by personnel of MGM within the 15 days after establishment and establishment report is prepared.

Table 4: Critical Issues in the Relevant Legislations

Regulation	Critical issues
	It is predicted that measurement data from a system with a fixed IP address to a server allocated by MGM is sent automatically at a particular hour of each day. However, another method approved by MGM with which data are sent securely can be accepted. • During the measurement period, more than 20% data loss because of operation and/or maintenance or miscellaneous reasons cannot be accepted. 20% data loss is accepted as 20% of total record number of 10 minutes data required to be recorded during the measurement period. Data loss until this limit is obtained by benefiting from data of the nearest meteorology station which can represent current data and activity area and by using statistical data completion methods. In addition, statistical methods used for this aim like linear interpolation, moving average, correlation, arithmetic average and median usage are stated in detail. • Reference meteorology station used for completion of lack data can be chosen within the automatic meteorology stations published in MGM web page which are around the same latitude. Moreover, if there is more than one station established by the same firm in measurement area, data of these stations can be used for completing the data loss of each other.
Regulation for Support Mechanism (YEKDEM)	YEKDEM is the acronym for support mechanism of renewables. Accordingly each supplier is indirectly obliged to purchase electricity that is generated from renewable resources. The mechanism works basically as below: • SPP Investor, who has Renewable Energy Resource Certificate (YEK Belgesi, in Turkish) and is a YEKDEM participant, submits its estimated generation which is in hourly resolution in the day ahead, to the National Load Dispatch Center (MYTM, in Turkish) • The Market Operator (PMUM, in Turkish) on a monthly basis, calculates the amount of payment that is payable to the YEKDEM participant and reports this information. • YEKDEM participant prepares and sends an invoice to PMUM, and receives its payment on a monthly basis.

Table 4: Critical Issues in the Relevant Legislations

Regulation	Critical issues
Regulation for unlicensed generation	• Unlicensed generation refers to the generation of renewable power plants and cogeneration plants smaller than 500 kW capacity. These power plants are not obliged to be owned by a company; real persons might own these plants without establishing a company. Accordingly, power plants of less than 500 kWh capacity are entitled to direct their excess (unused) energy to the grid and to be considered as YEKDEM participants, to be paid for this excess energy. This allows for the development of roof top solar PV panels. • There are issues to be clarified about the metering of rooftop panels, and as of June 2012, there are no rooftop (unlicensed) solar panels that receive payment within the YEKDEM scheme.
Regulation for domestic manufacturing of equipment used in plants	This regulation states the principals about how domestic contribution addition in the law is applied. According to this, component produced within the countryside is defined and it is predicted that these components should be certificated. SPP investors used equipment produced in Turkey should affirm the certificates of related components to MENR and/or the institution charged by MENR. On the other hand, this regulation also includes some uncertainties with its current situation and it is not applied.

Investment Process

This section of the report focuses on installations which are considered to be licensed generation, and the important process for the SPP investments. Legislations and expectations for unlicensed generation differ greatly from licensed generation

Procedures for the licensed SPP investments are listed below;

- Determining investment principles for SPPs (Location, installed capacity, financing method etc.), start of the measurement process, conducting pre-feasibility study
- Pre-license application
- Completion of the environmental impact assessment and other related permissions
- Conducting technical and financial feasibility study depending on measured data, completion of project development
- License application
- Obtaining the license after completing necessary documentation if connection right is acquired
- Finding financial support, supply of equipment and start construction

SPPs need to be planned and implemented appropriately since they are very costly and therefore have high risks with respect to investments. The investment process consists of four major phases and they are measurement & feasibility, project development, construction and development. The investor should take into account of all these phases and proceed with thorough planning based on data, and risk analysis. Important points that should be considered by the investors are listed below;

Measurement & Feasibility

- Analytical approach to location selection
- Conducting measurements in compliance with the legislations
- Emphasis on data quality
- Technical feasibility based on measured results
- Financial feasibility based on long term (after expiration of FIT) price forecast.

Project Development

- Calculating long term generation values
- Preparation of detailed business plan.
- Analytical approach to equipment selection
- 3rd party involvement in quality and compatibility of equipment with design principles
- Design of grid connection.
- Social impact assessment
- Risk analysis including technical, financial and environmental risks

Construction

- Independent 3rd party monitoring
- Employing program management approach
- Risk management applications

Operation

- Optimization and continuous performance monitoring
- Daily forecasts and monitoring of meteorological data
- Seeking outsourcing opportunities to decrease operational costs

Measurement and feasibility

As mentioned in relevant legislations, year-round measurements are the most critical input for the technical feasibility. Quality of the measured data plays a crucial role for a realistic feasibility study. A realistic modeling of the operational expenditures and a forecast for the electricity prices after the 10 year period FIT expiration is required for financial feasibility. Agricultural lands and areas that pose potential conflict should be avoided during the selection of the location for the SPPs.

Project development

Financial, technical and all legal aspects need to be considered during the process of project development. Guarantee of equipment quality and equipment selection plays a crucial role in this process. It is important to note that number of equipment is manufactured up on the request of the manufacturer. Therefore, in order to make sure of equipment quality, a third party audit is recommended. Equipment quality is critical for the amount of electricity generated and maintenance costs of the power plant, hence this is important for creditors. The design of equipment and grid connection should be completed after obtaining the license, whereas other steps of design and development should be completed before acquiring the license.

Due to their costly nature, a proper risk assessment is crucial before investing in SPPs. Environmental, political, technical, financial and tax related risks should be considered in a holistic way, and thorough risk management plans should be prepared, addressing what can be done for risks that can be eliminated and what can be done for mitigating risks that cannot be eliminated.

Construction

It would be advantageous to employ a program management approach throughout the construction process to better manage the risks mentioned above. Especially creditor institutions may require involvement of an independent and technical third party to monitor the construction process.

Operation

Monitoring operation process hourly or even with higher frequencies is critical in terms of controlling whether the equipment is generating electricity in the expected level or not. Monitoring the instances that generation drops below the expected level and searching reasons of this drop is important for securing the design generation level, as it enables to detect equipment breakdowns and other problems that reduce generation, and allow for timely intervention. There are several software packages that help SPP investors monitor the generation.

Last but not least: TEİAŞ Tenders for Connection and Feasibility

SPP investors will be bidding for the grid connection rights, within the framework of the preannounced methodology that we explained in the previous section. It is essential that SPP investors carefully determine their bid price analytically and taking feasibility into consideration. A reliable and realistic feasibility study should be done and the feasible levels of bids should be calculated. It should be noted that there are "lessons learned" from the connection right tenders of wind power plants: In these tenders for the WPPs, some investors bid aggressively, just to earn the connection right regardless of the level of bid, without paying attention to the feasibility of their WPP projects and ended up with an overpriced connection right (in other words, contribution price payable to TEİAŞ) which does not allow them to realize the investment. Investors who earned the connection right with a high level of contribution fee, are now having hard time in finding finance for their projects and completing their investment. Solar investors thus should be aware of the consequences of their bid prices, and should rely on analytical approaches and feasibility studies.

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