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RESEARCH ARTICLE

Market Formation in Turkish Solar Electricity Generation: Technology Innovation System Approach[1]

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Abstract

The Technological Innovation System (TIS) is a theoretical approach to the analysis of a new technology's diffusion dynamics. The development and establishment of market-related structures are essential for maturing a TIS and its long-term success, especially at the beginning of sectoral development. In this paper, we focus on market formation in the Turkish solar electricity generation TIS to understand how the market forms. We made an empirical study and benefitted from structural analysis, functional analysis, and process analysis to point out how green transition efforts have started with the market formation process in the Turkish solar energy sector during the first phase of sectoral development. We conducted fifty-seven interviews with key experts in the energy sector in the 2013-2015 period when the sector just started to develop. The structural analysis showed that the most active actors are companies, consultancy organizations, public organizations, and real persons; networks are associations and cooperative organizations, and institutions are general legislation and political developments. The process analysis showed that the constitutive processes are institutionalizing and associating for the formation of market segments, and competing and communicating for the formation of market transactions. The functional analysis pointed out that at the beginning of the TIS development, the market formation was in the nursing phase, but developing very fast.

Keywords: *Market Formation, Solar Energy, Türkiye, Technology Diffusion, Sustainable Transition, Technological Innovation System.*

Jel Codes: *O32, O33, Q01, Q54, Q55*

Türkiye'de Güneş Enerjisinden Elektrik Üretiminde Piyasa Oluşumu: Teknoloji Yenilik Sistemi Yaklaşımı

Özet

Teknolojik Yenilik Sistemi (TYS), yeni bir teknolojinin yayılma dinamiklerinin analizi için geliştirilmiş teorik bir yaklaşımdır. Bir TYS'nin gelişimi ve onun uzun vadeli başarısı için, özellikle sektörel gelişimin başlangıcında, pazarla ilgili yapıların gelişmesi ve yerleşmesi esastır. Bu çalışmada, piyasanın nasıl oluştuğunu anlamak için Türkiye'de güneşten elektrik üretimi teknoloji yenilik sisteminde piyasa oluşumuna odaklanılmıştır. Türkiye güneş enerjisi sektöründe yeşil geçiş çalışmalarının, piyasa oluşum süreciyle birlikte başladığını vurgulamak için tam da sektör henüz gelişmeye ve piyasa oluşmaya başladığı dönemde ampirik bir çalışma yapılmıştır ve yapısal analiz, fonksiyonel analiz ve süreç analizinden yararlanılmıştır. Bu kapsamda alan araştırmasında enerji sektöründeki kilit uzmanlarla 2013-2015 döneminde elli yedi adet görüşme gerçekleştirilmiştir. Yapısal analiz sonuçları, en aktif aktörlerin şirketler, danışmanlık kuruluşları, kamu kuruluşları ve gerçek kişiler olduğunu; ağların dernekler ve kooperatif kuruluşları, kurumların ise genel mevzuat ve siyasi gelişmeler olduğunu işaret etmiştir. Süreç analizi kurucu süreçlerin, her bir pazar segmenti için 'kurumsallaşma' ve 'ilişki kurma' olduğunu; piyasa işlemlerinin oluşumu için ise 'rekabet etme' ve 'iletişim kurma' olduğunu göstermiştir. İşlevsel analiz, TYS gelişiminin başlangıç fazında, pazar oluşumunun ilk aşamalarda olduğunu ancak çok hızlı geliştiğini göstermiştir.

Anahtar kelimeler: *Piyasa oluşumu, güneş enerjisi, türkiye, teknoloji yayılımı, sürdürülebilir geçiş, teknoloji yenilik sistemi*
Jel Kodu: *O32, O33, Q01, Q54, Q55*

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1. INTRODUCTION

With the dissemination of globalization in the world economic system that can be seen easily in the economic activities of the production, consumption, and, any type of energy generation; the immediate supply of energy demand needed for these activities is emerging as a major problem. With this problem, the debate on sustainable and clean energy supply comes to the fore (UNFCCC, 2015). Notably, the dominance of fossil fuels in primary energy consumption and electricity generation increases concerns about the environment and climate change (UNFCCC, 2015), as in Türkiye, where these fuels are also dominant. Moreover, it makes import dependency for fossil fuels a crucial problem for Türkiye (Özcan, 2019) since Türkiye is not self-sufficient in fossil fuels.

The main energy problem emerges to meet increasing energy demand and promote energy transition, and one promising solution is to increase the rate of environmentally clean alternative energy resources in the energy bundle (Erden-Topal, 2016; Keleş and Bilgen, 2012). For this purpose, it is proposed to balance the bundle of electricity generation sources by increasing the role of clean energy sources in electricity generation (World Economic Forum, 2016). Besides other alternatives, renewables are primary, domestic, clean, environmentally friendly, and never-ending energy resources (Demirbas, 2006). Especially in countries where the dominant energy sources are imported fossil fuels, like Türkiye, energy production from domestic and clean renewable sources becomes a promising solution (Asif and Muneer, 2007; Toklu, 2013; Yüksel and Kaygusuz, 2011).

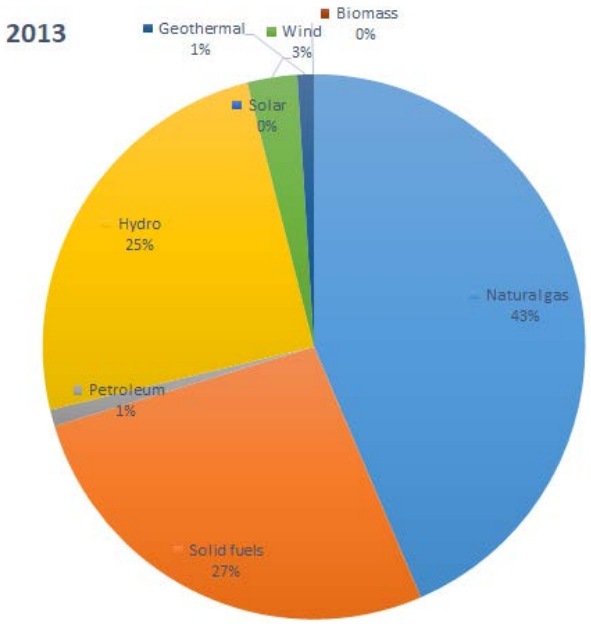
For Türkiye, increasing the use of renewable energy sources is beneficial for meeting the energy demand and promoting sustainable energy transition. Especially for the years 2010-2015, the beginning of solar electricity generation (by Photovoltaics-PV technology), the rate of renewable sources in total electricity generation was 29% (in 2013- Figure 1). Apart from hydroelectrical power (25%), the individual rates of clean and domestic sources such as wind power (3%) and solar power (0%) were very small in electricity generation (ETKB, 2013). For the most updated official data, according to the Ministry of Energy and Natural Resources (ETKB) Turkish General Energy Equilibrium Table 2020, in electricity generation, the shares of natural gas, solid fuels, and petroleum are 29%, 17%, and 0.1% (Figure 2). Hence in 2020, 47% of electricity is generated from mostly imported fossil fuels (ETKB, 2020). In 2013 this rate is 71%, and there was no installed solar power capacity[1]. Therefore, there is still an import dependency in Türkiye, and so renewable electricity generation and diffusion of these generation technologies are seen as an option for solving this problem in the energy sector to promote sustainable transition.

Renewable energy sources are used in heating, electricity production, and lighting. In Türkiye, electricity generation from renewable sources is an alternative solution to the energy problem, and it is motivated by the Turkish Energy Policy (Şalvarlı and Şalvarlı, 2017). Therefore, renewable electricity generation is seen as an option for solving energy problems in Türkiye, and by this motivation, solar electricity generation, mainly by PV technologies (only installed solar power technology in Türkiye) is examined as an empirical case in Türkiye.

Markets are the social spaces that include multiple actors as the economic agents, and long-term processes that co-evolve with society as a whole. To understand the market dynamics, we need to take into account all structural elements of the markets. Markets are not just separate sub-systems of the socio-technical system; rather, they are one of the organs of the societal body. To analyse the dynamics of new technology diffusion (like solar electricity generation in Türkiye), the market is one of the critical components of the theoretical standpoint of TIS.

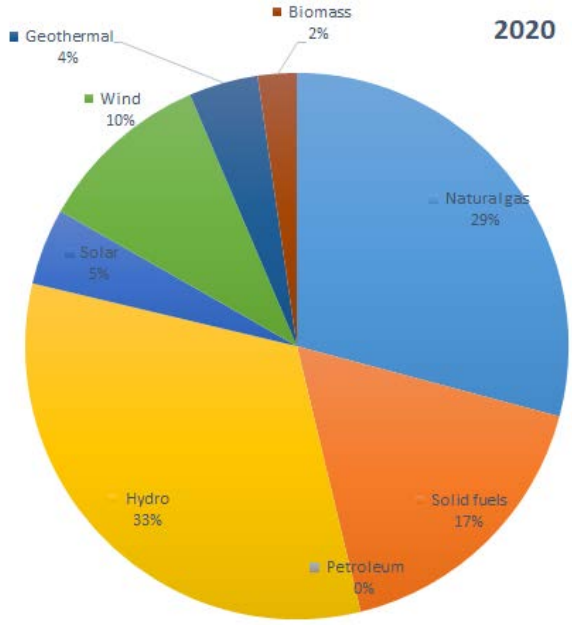
[1] As shown in Figure 2 in 2020, the shares of renewable energy (solar: 4.5%, wind: 10.3%, geothermal: 4.1%, biomass: 2.3%, and hydropower: 32.3%) is 53.5 %. If we omit hydropower, the share (of emerging renewable energy sources) is 21.2% (ETKB, 2020).

Figure 1: Distribution of Sources in Electricity Generation (2013)



Source: ETKB (2013)

Figure 2: Distribution of Sources in Electricity Generation (2020)



Source: ETKB (2020)

In Türkiye, the Technological Innovation System (TIS) in solar electricity generation has been developing and improving very rapidly, especially since 2010. However, the market is still in the emerging phase. The market formation is one of many crucial dynamics of diffusion, such as knowledge creation, legitimation, entrepreneurial activities, the guidance of research, and allocation of sources essential for the long-term success of a technology. In Möllering market constitution analysis (Möllering, 2009), which started the market formation analysis in emerging renewable energy technologies, it is claimed that markets are constituted when market exchanges are regularly performed while constitutive elements are in the marketplace (Möllering, 2009). For a market to form, these elements undergo transformative processes to constitute markets (Möllering, 2009).

Moreover, market formation is recognized as a critical systemic process (Hekkert, Suurs, Negro, Kuhlmann and Smits, 2007; Schot and Geels, 2008), and market segments and transactions play essential roles in the diffusion of emerging technology (Dewald and Truffer, 2012), however less attention has been paid to legitimized perception of market boundaries, the role of actors, the interplay between markets and the process of market formation (Boon, Edler and Robinson, 2020:346). Here, we aim to make an empirical analysis of the solar electricity market formation, and we used market formation analysis in TIS to understand “the interactions and relations between actors, networks, and institutions that facilitate the diffusion of emerging technology" like different examples of emerging technology cases elaborated in Boon et al. (2020), Dewald and Truffer (2012), Kjellberg and Helgesson (2007) and Köhler et al., (2019).

The paper is organized as follows. In the second section, market formation in the TIS and the conceptual framework used here are elaborated. The third section explains the data collection. In the fourth section, market formation in solar electricity generation in Türkiye is described based on empirical analysis. The discussion section gives a summary of the solar electricity generation market formation in Türkiye, and the conclusion and further research conclude with the summary of market formation dynamics.

2. RELATED WORKS: MARKET FORMATION IN TECHNOLOGY INNOVATION SYSTEMS

The main concern of this paper is to understand 'market formation' and to position it at the core of emerging renewable energy technologies' diffusion targeting sustainable transitions in socio-technical systems. Here the starting point is the 'market'. There are four main theoretical frameworks to understand sustainable transitions, namely the multi-level perspective (MLP), the technological innovation system (TIS) approach, strategic niche management (SNM), and transition management (TM) (Köhler et al., 2019; Markard, Hekkert and Jacobsson, 2015; Van Den Bergh, Truffer and Kallis, 2011). According to these frameworks, markets are regarded as (i)the application domains of the new technology, one of seven dimensions of the macro-level socio-technical regime (Geels, 2002) and one of the institutions aligned with other institutions (Smith, Voß, and Grin, 2010) in the MLP, (ii) the protected spaces appropriate for specific applications of new technology (Bergek, Jacobsson, Carlsson, Lindmark and Rickne, 2008; Hekkert et al., 2007), the accelerator of building and developing the TIS, the support of system innovation development (Hekkert and Negro, 2009), and one of the micro-level processes explaining TIS formation (Markard et al., 2015) in the TIS, (iii) the niches of innovations in the protected spaces where these new technologies are born, enhanced by various types of support, and enter the mainstream market (Geels and Raven, 2006), the place of final destination for new technology can expose after passing through the valley of death linking R&D and market introduction, and replace the existing technology (Schot and Geels, 2008) in the SNM, and (iv) the public places where governments guarantee fair market structure (rather than monopoly o oligopoly) (Rotmans, Kemp and van Asselt, 2001) in the TM.

2.1. What is market formation in a TIS?

The TIS defines market formation as a fundamental function. Among these theoretical frameworks, the TIS examines diffusion performance in functional terms (Bergek et al., 2008). The functions are the intermediate level between components (structural building elements of actors, networks, and institutions) of the TIS and its performance as a whole. These functions are 'Experimentation', 'Market formation', 'Legitimation', 'Resource Mobilization', 'Knowledge Development', 'Development of externalities', and 'Influence on the Direction of Research' (Bergek and Jacobbson, 2003; Bergek et al., 2008; Hekkert et al., 2007; Jacobsson, Sandén and Bångens, 2004; Jacobsson and Bergek, 2004). By functional analysis, it is possible to grasp what is actually 'achieved' in the system (Bergek et al., 2008) to reach the ultimate goal of sustainable transition.

In the TIS framework, market formation is described as passing through the nursing market to the bridging market and then to the mass market. Dewald and Truffer (2012: 405-406) claims that the nursing phase is characterized by uncertainty, openness to variety creation in technological design, and pioneering prime movers. With the shift toward the bridging market, market transactions become clear where the new user segments and product variants appear. In maturing into a mass market, the overall market becomes homogeneous, and the market transactions are formed concretely. Moreover, the TIS is appropriate for technology-specific cases, such as emerging solar technologies (Huang and Wu, 2009; Jacobsson and Bergek, 2004; Jacobsson and Johnson, 2000), energy transitions (Geels, 2004; Hekkert et al., 2007), and the diffusion of new technology (Bergek, 2002; Bergek et al., 2008; Carlsson et al., 2002; Carlsson and Stankiewicz, 1991; Galli and Teubal, 1997; Huang and Wu, 2009; Markard and Truffer, 2008).

2.2 The analytical framework of market formation analysis

2.2.1 Why do we focus on market formation here?

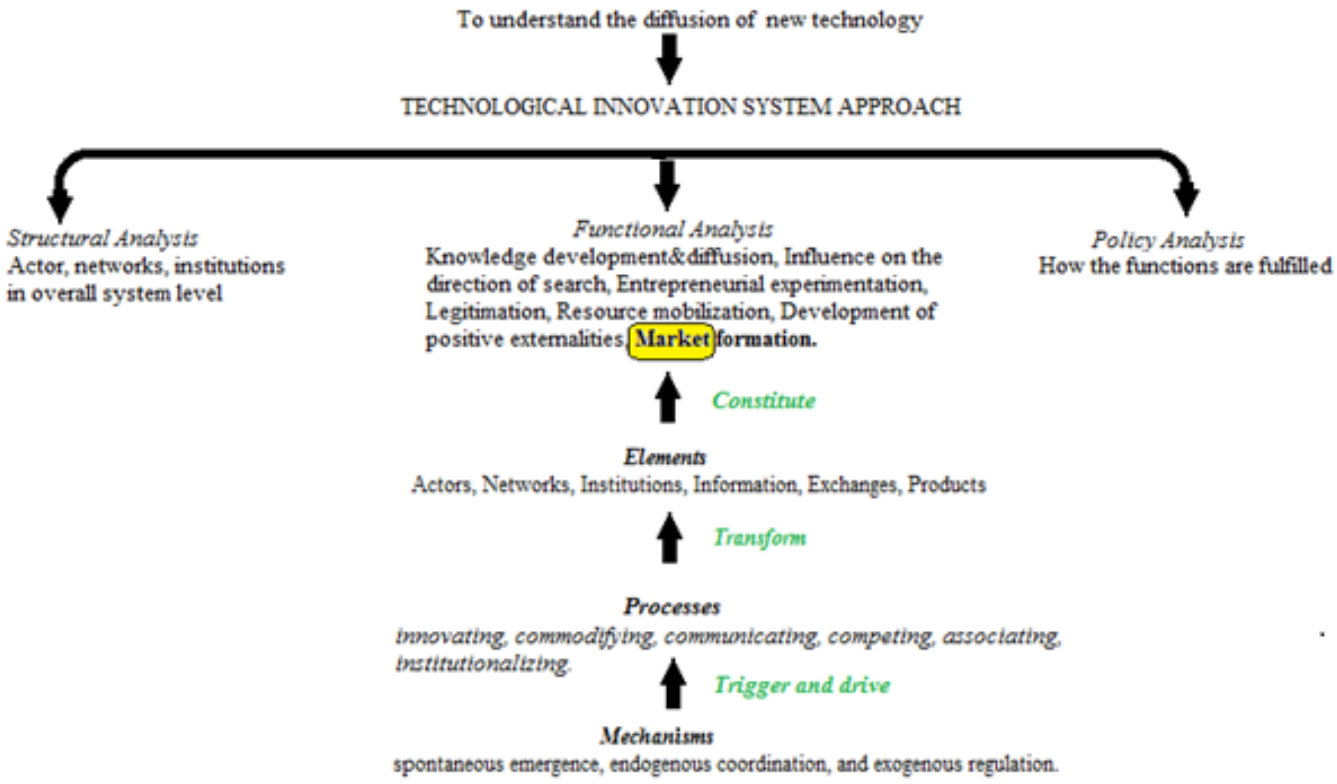
We focus on market formation since we highlight the emergence and development of market-related structures for maturing TIS and its long-term success for sustainable energy transitions (Dewald and Truffer, 2011; Jacobsson and Bergek, 2004). Moreover, our preliminary research (of in-depth

interviews with key experts in 2012), which was performed to determine the main problem in the renewable energy sector, highlighted market formation as the new research direction. Therefore, 'market formation' is chosen as the focus of analysis; since the main weaknesses that hinder the diffusion of emerging renewable energy technologies (such as cost, high initial investment, and the role of government as the only user) are grouped under market formation dynamics.

2.2.2 What is the conceptual framework of market formation?

Within the TIS framework, the driving forces of the market are "exogenously given and typically lead to linear growth patterns" (Dewald and Truffer, 2012). However, the market formation process has endogenous dynamics and for elaborating it potential interactions and co-dynamics between technological, institutional, political and user-related aspects of new technology should be considered (Dewald and Truffer, 2011). Instead of a linear and exogenous conceptualization, the concept of 'market segments' is introduced (Dewald and Truffer, 2011). As a result, as shown in Figure 3, a more explicit analysis of market formation is proposed by (i) identifying actors, networks, and institutions at the level of self-contained market segments (structural analysis of TIS), (ii) assessing the different market segments' stage of development and their mutual interdependence (process analysis of TIS) and (iii) analysing the contribution of specific market segments to the overall TIS performance (functional analysis) (Dewald and Truffer, 2011, 2012). Here we made an empirical analysis to describe how market segments are formed in the Turkish Solar Electricity Generation Sector. We applied these three-fold market formation analysis to describe constituting practices and collective efforts to form market segments (and hence the market) in the Turkish solar electricity generation case where the sustainable transition efforts have started with the market formation dynamics.

Figure 3: Basic Framework for Market Constitution Analysis



Source: Adapted from (Bergek et al., 2008; Möllering, 2009)

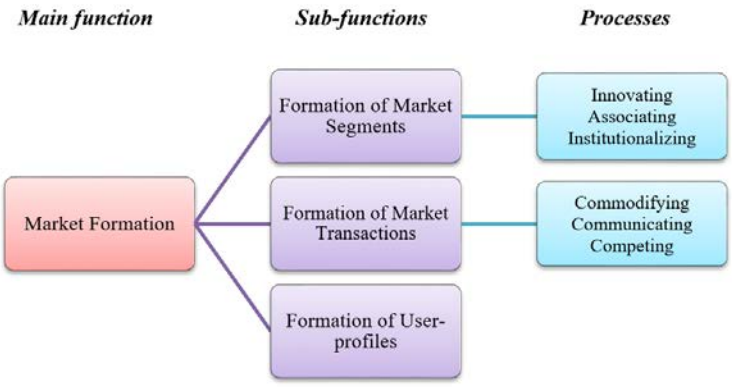
2.3 Structural Analysis

The Structural Analysis involves determining the components of the market. The first stage is to identify the actors in the market (constitution of actors). Actors are mainly the individuals, the firms, financial organizations, research organizations and knowledge institutes, public organizations, civil society, and interest organizations (Bergek et al., 2008, Carlsson et al., 2002; Edquist, 2011; Wieczorek and Hekkert, 2012). Each actor's contribution is crucial to understanding market formation in detail and we used the economic activities (electricity generation, consultancy, regulation, and supply) to define these contributions. In the second stage, we identified the building of networks (constitution of networks). Networks are the interactions and cooperative relationships between actors (Wieczorek and Hekkert, 2012) that make the system more adaptable to different circumstances (Carlsson, Jacobsson, Holmén and Rickne, 2002). In the third stage, we analysed the constitution of institutions which are identified as culture, norms, laws, regulations, and routines that "need to be adjusted to new technology if it to diffuse (Bergek, Jacobsson, Carlsson, Lindmark and Rickne, 2008)". Moreover, "properties of the components and relationships between them which characterize the system (Carlsson et al., 2002)" and everyday habits, routines, and established practices were analyzed (Edquist, 2011).

2.4. Process Analysis

The process analysis is performed to assess market segment's development and their mutual interdependence. Market formation sub-functions arise to elaborate on the market formation dynamics in a TIS (Möllering, 2009). These sub-functions are associated with the processes of 'innovating', 'commodifying', 'communicating', 'competing', 'associating', and 'institutionalizing' (Dewald and Truffer, 2012) that form two sets of sub-functions called the 'formation of market segments' and 'formation of market transactions' (Möllering, 2009). For solar electricity generation in Türkiye, we described these two sub-functions. The formation of market segments focuses on the specific actor, network, and institutional structures established for selling a specific product to end-user groups (Möllering, 2009). This sub-function is shaped by the processes of 'innovating', 'associating', and 'institutionalizing' (Dewald and Truffer, 2012). The formation of the market transaction is related to "the exchange relationship between supply and demand for the end-products" (Dewald and Truffer, 2012). 'Commodifying', 'communicating' and 'competing' are the fundamental processes that shape this sub-function. The formation of user-profiles takes place if consumers develop preferences when exposed to new technology products (Möllering, 2009) (Figure 4).

Figure 4: Detailed analysis of market formation function associated with processes



Source: By the authors benefitting from Dewald and Truffer (2012) and Möllering (2009)

2.5. Functional Analysis

The functional analysis is performed to evaluate the contribution of specific market segments to the overall TIS performance. Here we examined three market phases' (of nursing, bridging, and mass) main features described by Dewald and Truffer (2012). When the market formation is in the nursing phase, the formation of the market segment is predominant, the market transactions are formed initially, learning and coordination depend on close interaction between actors, and communication between the actors is critical for the success of new technology. Pioneering movers and intermediary actors play crucial roles to make new technology more accessible and utilizable. When the markets shift toward bridging markets, transactions become clear, the processes of commodifying and competing become regular, the market volume expands, and product configurations diversify. In maturing into a mass market, the diffusion of new technology becomes apparent, and the overall market becomes homogeneous, market transactions form concretely, and broader consumer segments and price-based competition are prevalent.

3. METHOD and MATERIALS

In field research, we asked key actors their views on how the market forms and then we described the market formation process based on these views. We used semi-structured in-depth interviews. The interviewees (respondents) were key solar electricity generation actors in Türkiye since the primary data sources were their perspectives, experiences, approaches, beliefs, and functions regarding market formation. The sampling strategy was purposeful sampling to pick the information-rich cases in the population (Flyvbjerg, 2006; Patton, 2002). The primary determinant of the interviewee is the economic activity of the actor in the renewable energy market since it is accepted that economic activity defines the contribution to the market formation process. All interviewees were engaged in one of the following economic activities in the solar electricity generation market: electricity generation (G), regulation of the market (R), consultancy (C) to the actors, or equipment supply (S).

The interviews were conducted between December 2013 and February 2015. We specifically generated the data from this period since the market emerged very recently and started to develop after 2013, the year when the unlicensed regulation was issued, the license capacity of 600 MW of solar electricity generation was announced and the upper limit for unlicensed electricity generation increased to 1 MW from 500 KW, and the total installed solar electricity generation capacity is zero (ETKB, 2013). Specifically, in 2016, the official installed solar electricity generation capacity reached to 833 MW (ETKB, 2013) and impactful developments took place, for example, the applications for 600 MW solar electricity generation licensed power plants were collected, and the first tenders were organized and realized, and unlicensed electricity generation capacities for power distribution units started to be announced monthly by Turkish Central Distribution Company (TEİAŞ). Therefore, the period 2013-2015 (including the preliminary research) was chosen as the data generation period as the development and establishment of solar electricity generation for analysing the market formation process in Türkiye.

During this period, we conducted fifty-seven face-to-face interviews. In the market, there are the actor groups of (i) real/potential license holders in solar electricity generation, (ii) the actors involved in unlicensed solar electricity generation, (iii) bureaucrats, public servants, and researchers involved in solar electricity generation. For this field research, the authors visited different cities in Türkiye (such as Ankara, Istanbul, İzmir, Antalya, Denizli, Balıkesir, Kayseri, and Gaziantep).For meeting the research aim, we specifically used twenty-two interviews that give the most relevant data about solar electricity generation. We reported the quotions from each interviewee by using the ancyrom "Int." with his/her economic activity. For ex. first interviewee with economic activity of electricity generation is referred as Int.G1

The interview guide was prepared by using a 'general interview guide approach' to ask questions about the same topics with minor modifications (Patton, 2002). The interview guide has five main sections, and in this paper, we referred to the answers to the questions in the section 'Market Formation'.

To analyse the raw data, the analytical framework approach was used to organize the responses question by question (Patton, 2002). For practical purposes, the software called 'Qualitative Data Analysis (QDA) Miner' was used by uploading verbatim transcripts of the interviews. In the analysis, by 'open coding' to delineate the raw data (Corbin and Strauss, 2008), we derived 440 codes and 13 sub-categories from the 5 main sections of the interview guide. The codes were clustered in sub-categories. The sub-categories used in our study are 'Market Constituents' and 'Market Development'.

4. FINDINGS OF THE EMPIRICAL ANALYSIS: MARKET FORMATION IN TURKISH SOLAR ELECTRICITY GENERATION

4.1. First Stage: Structural Analysis of Market Formation

In Türkiye, renewable electricity generation methods shape the general structure of the solar electricity generation market. These methods are described by the legal framework documents in Table 2. Based on this legal framework, these methods are licensed, and unlicensed solar electricity generation, and hence the market segments are the "Licensed solar electricity generation market segment" and "Unlicensed solar electricity generation market segment"[1], which diverges by the installed power threshold of 1 MW[2].

In the structural analysis, the mechanisms that shape these constitutive elements, and then the operation of these mechanisms in each market segment are elaborated in Table 1 (Möllering, 2009). Field research shows that the mechanism *of exogenous regulation* shaped the structural elements in the *licensed market*. In the *unlicensed market,* there are two phases of market formation, *exogenous regulation* shaped the first phase, and *spontaneous emergence* shaped the second phase[3].

Table 1: Mechanisms of structural elements' constitution

		In Constitutive Mechanisms of		
		Exogenous regulation through:	**Endogenous coordination through:**	**Spontaneous emergence through:**
Structural Elements:	*Actors*	Policies on entrepreneurship and antitrust	Strategic management	Entrepreneurial opportunism
	Networks	Policies on cartels, consortia, associations	Relationship management	Recurrent interaction with known partners

[1]Up to 1 MW, the investors are exempted from licensing and establishing legal entities (Gözen, 2015). For more than 1 MW, investors must obtain a license from the Energy Market Regulatory Authority (EPDK). Unlicensed electricity generators can use all generated electricity for self-consumption or can export the surplus to the electricity distribution system. This surplus must be purchased by the relevant distribution company for ten years. In licensed electricity generation, the licenses are issued for up to a term of forty-nine years at once. The minimum term is ten years. For this period, the license owners are bound to the Renewable Energy Support Mechanism, which pays 13.3 USX/kWh for solar electricity until the end of 2020. After 2021, with the new renewable energy support mechanism announced on Jan. 30, 2021, in the Official Gazette, new support (YEKDEM) will be applied to the power plants that will be built between Jan. 01, 2021, and Dec. 31, 2025, and the feed-in tariff prices will be in TL, and the upper limit will be 5.1 USX/kWh for solar electricity (Gökmen, 2021). If the license holders use the mechanical equipment manufactured domestically by the local factors of production. In that case, this price is increased by a maximum of 8 TL kuruş/KWh1 for solar energy, depending on the contribution of domestic production. This additional support is for five years from the commissioning of the solar electricity generation power plant.

[2] This upper limit was increased to 5 MW by amendment in the Unlicensed Electricity Generation Decree in May 2019.

[3] By using this framework, we perform separate structural analyses for Licensed & Unlicensed Market Segments, and they are summarized in detail in Table 3 and Table 4, respectively.

	Institutions	General legislation and cultural/political development	Contracting, institutional entrepreneurship	Normalization, repetition, and objectivation

Source: Möllering (2009)

4.1.1 Constitution of Actors

In the licensed market, the actors become a part of the exchange by being subject to *policies on antitrust and entrepreneurship* through the *mechanism of exogenous regulation* as determined by Dewald and Truffer (2012). The licensed solar electricity generation market constitution was attributed to the policies. One of these policies was "promoting entrepreneurship for solar energy in energy specialized industrial zones". Int. G8, one of the large-scale electricity generators and a distribution license owner in addition to being an investor in solar energy technology, pointed out the Konya-Karapınar Region[1]. This is an example of a specialization zone. He indicated that his company decided to enter this sector with a large investment in the licensed solar market to benefit from this opportunity.

According to Int. C18, another entrepreneurship policy is "to facilitate the emergence of resilient investors". According to him, license applicants were entrepreneurs who had reliable financial resources and wanted to be the first movers. Int. C18 defended the government policies and actions in the sector that led such an entrepreneur profile to emerge in the licensed market.

On the other hand, Int. G5 criticized one of the government policies (measurement prerequisite in license applications), which was said to be implemented to create resilient entrepreneurs in renewable energy systems. Despite it was not necessary and different methods could guarantee entrepreneurs' resilience, this policy also shaped the actors in the market.

The unlicensed market is formed in two phases. This market segment is organized and formulated to support self-consumption. In the first phase, the actors become a part of market exchange by being subject to policies as asserted by exogenous regulation. This phase ended with a political intervention increasing the limit of unlicensed generation from 500 kW to 1 MW (since 2019, 5 MW). This intervention created an entrepreneurial opportunity for unlicensed generators to build 1 MW (especially solar energy) power plants side by side and to sell the electricity generated instead of consuming it themselves. Through this intervention, the second phase was started and the mechanism of spontaneous emergence shaped market formation in this new phase. After this change, comparatively large-scale power plants have been constructed for commercial purposes. Int. C25 claimed that "the change in limit made unlicensed investments more feasible."

According to Int. G16, after this intervention to increase the upper limit, a new model of electricity generation arose, and a new actor group emerged to export the surplus electricity to the distribution system and earn money. According to Int. G16, due to the lags in licensing in solar electricity generation and the new limit for license exemption, unlicensed EG developed as a substitute for licensed EG.

Moreover, Int. S6 underlined that approximately 80% of new unlicensed electricity generation power plants were on-field power plants constructed for commercial purposes, like licensed power plants. One of the consultant firm representatives, Int. C18 expressed that his firm, which entered the renewable energy market in 2011, grew fourfold recently due to the dynamism in the unlicensed electricity market segment, especially after 2013. He mentioned that this high speed of growth was based on unlicensed electricity generation, which replaced the licensed one[2].

[1] Konya-Karapınar is a district in central Türkiye where 3000 MW solar power plants will be built gradually with a PV Panel Production Facility and R&D Center.

[2] Since this field research was conducted in 2014-2015, and these years are when the unlicensed renewable power plants were created as a learning ground for solar electricity generation, we proposed that the unlicensed market is formed in two phases with spontaneous emergence and exogenous regulation, consecutively. After 2017 as the first solar energy licenses were granted and the power plants

4.1.2 Constitution of Networks

In Turkish solar electricity generation, from field research and desk research, it is explicitly seen that networks in solar electricity generation are facilitated and built by the constitution of the associations and civil society initiatives. All actors are coming together for networking activities to achieve benefits for the sector under the umbrella of associations. The leading associations, GUNDER (International Solar Energy Society - Türkiye Section, founded in 1992), GENSED (Turkish Solar Energy Industry Association, founded in 2009), and GUYAD[1] (Solar Energy Investors Association, founded in 2016) in solar energy were founded by the decision of the Board of Ministers during the rise in interest in renewable energy in Türkiye. Due to this reason, this can be regarded as evidence of the emergence of networks as a result of policies on cartels, consortia, and associations. Moreover, these associations are in a close relationship with the policymakers, and they declare on their websites that they are working in coordination with public organizations. Specifically, GUNDER has public servants on its management board. As an association representative, Int. C9 asserted that it represents the International Solar Energy Society via direct delegation by the ETKB.

In addition to associations, another networking activity was initialized and led by a social media platform (now in 2021, calling itself a social company[2]), the SolarBaba Platform, which has been active since 1996. This platform is the most active social media network and it is a civil society initiative. The number of institutional members and supporters reached 120k in 2021. Via this platform, the members can communicate about any current agenda of solar energy and come together for formally organized events (such as conferences, workshops, and seminars) and informal organizations (such as dinners). The founder and the director of this platform is one of the interviewees, and he has more than 20 years of experience in the renewable energy sector. Due to this experience, he can establish recurrent interactions with known partners in the solar energy sector for networking.

Therefore, in the Turkish solar electricity generation market, networks are built via associations that are directly established by government policies concerning networking activity as claimed by the market constitution mechanism of exogenous regulation (Licensed Market Segment and in the first phase of the Unlicensed Market Segment).

4.1.3 Constitution of Institutions

In both licensed and unlicensed market segments, institutions are constituted by exogenous regulation as a result of general legislation and cultural/political development (Table 2).

Table 2: Legal Framework for Institutional Alignment in solar electricity in Türkiye

Laws	✓ Law on Utilization of Renewable Energy Sources to Generate Electrical Energy (No: 5346), ✓ Electricity Market Law (6446)

started to operate, the unlicensed market segment started to develop with its dynamics of small-scale systems mainly built for self-consumption.

[1] GUYAD was established in 2016 after the field research and analysis for this paper were completed. This is an update about the sector made specifically for this paper.

[2] For the information about the SolarBaba platform, see: https://www.solarbaba.com/hakkimizda/ (last access: August 08.2021)

Regulations	✓ Electricity Market License Regulation, ✓ Certification and Support of Renewable Energy Sources Regulation, ✓ Regulation on Unlicensed Electricity Generation in the Electricity Market, ✓ Regulation for Technical Assessment of Solar Energy License Applications, ✓ The regulation of Solar Energy Based Power Plants, ✓ Regulation for Domestic Production of Equipment Used in Solar Energy Based Power Plants.
Communications	✓ Communication of Pre-License Applications for the Construction of Solar Energy Based Power Plants, ✓ Communication about Enforcement of Unlicensed Electricity Generation, Communication of Solar Potential Measurement, ✓ Communication of Environmental Impact Assessment, ✓ Communication For Measurement in S-E License Applications

According to the interviewees, institutions in solar electricity generation are in the process of forming during market development. As the general legislation sets the framework conditions, the rules and regulations are adjusted according to mainly cultural motives and political events. The most prominent cultural motive is "to make something up as you go along". This idiom was frequently used to emphasize the changing rules and regulations regarding market development in Türkiye. Int. G15 claimed that the Energy Market Regulatory Authority (EPDK) constructed and updated the details of solar power plant pre-licensing procedures simultaneously with his company's pre-license application. Int. C7 also underlined the same cultural motive. According to him, "the regulations (Electricity Market License Regulation) have been changed three times since 2010 (in 2015 - the date of the interview), and the last version is the third version.[1] The government is improving the regulations as the problems are solved." These frequent changes and updates are normal and expected for a market in the initial phase of development and in the process of forming.

On the other hand, Int. C5 mentioned the role of political developments in the establishment of institutions. During her career of 16 years, even the names and the functions of governmental organizations have changed many times. She claimed that the authority to apply for renewable energy licenses has changed four times (up to 2015), and its authorization and responsibilities have changed as well.[2].

Detailed summaries of each market segment's structural analyses are presented in Table 3 and Table 4.

[1] The amendments and updates about the laws and regulations in the renewable energy electricity generation market can be seen on the Ministry of Energy and Natural Resources web page (https://www.epdk.gov.tr/Detay/Icerik/23-2-3/mevzuat, Last access: August 08.2021). The regulation mentioned in the interview is the "Electricity Market License Regulation", first issued in 2013 and updated twenty times, in 2014 (2 times), 2015 (2 times), 2016 (1 time), 2017 (3 times), 2018 (3 times), 2019 (4 times), 2020 (4 times), and 2021 (1 time). Another important legal framework document, the "Law on Utilization of Renewable Energy Sources to generate Electrical Energy (No: 5346)", was first released in May 2005. Up to November 2020 (the current version), there were five amendments, in 2012, 2016, 2019, and 2020 (two times). Moreover, the regulation named "Certification and Support of Renewable Energy Sources Regulation", first released in October 2013, has been updated thirteen times, in 2016 (2 times), 2017 (2 times), 2018 (2 times), 2019 (2 times), and 2020 (5 times).

[2] In 2018, the General Directorate of Renewable Energy was closed and all the duties and responsibilities concerning the renewable energy sector were transferred to the General Directorate of Energy Affairs.

Table 3: Summary of Structural Analysis for Licensed Electricity Generation

Group of Organizations:	Actors (Economic Activity):	Contribution of Economic Activity to Market Formation:	Constitutive Mechanisms:
Companies	Electricity generators (G)	apply for licensed electricity generation based on renewable sources and generate electricity in this market segment	Exogenous regulation via the policies on entrepreneurship and antitrust that have roots in the legal framework: ***Policies on entrepreneurship:*** - Entrepreneurship in solar energy specialization zones (referred to ETKB decision in 08.09. 2015 Official Gazette about Konya-Karapınar Renewable Energy Source Region) - To facilitate entrepreneurial actor profile in the renewable energy sector (Tender regulation in Law on Utilization of Renewable Energy Sources to Generate Electrical Energy) - Additional connection capacities to motivate more entrepreneurs (To realize 5 GW of PV was announced in the National Renewable Energy Action Plan released in December 2014 (ETKB, 2014)) - Measurement prerequisite (in Law on Utilization of Renewable Energy Sources to Generate Electrical Energy)- not needed, it is criticized!
	Equipment suppliers (S)	supply needed equipment to the electricity generators	
	Electricity distributors (R)	issue official opinion concerning the connection to the grid	
Consultancy Organizations	Intermediary consultants (C)	assist the license applicant and construction of the power plants	
	Consultants in government organizations (C)	make the laws and regulations more explicit and more applicable in the license application and granting	
	Consultants in academic organizations (C)	engaged in research and development activities that may increase the efficiency of the technology in power plant	
Public Organizations	TEIAŞ (R)	- announces the available transmission capacity to connect solar power plants to the national grid, - evaluates the license applications' compatibility to the announced capacity, - allocates transmission capacity to licensed power plants, - signs connection and/or use of system agreements with license holding legal entities	Exogenous regulation via the policies on entrepreneurship and antitrust that have roots in the legal framework ***Policies on antitrust*** - To abolish the monopolistic power of imported fossil fuels in electricity generation (stated in Energy Supply Security Document (ETKB, 2009)) - Announcement of small capacities to hinder monopolistic structures (For solar energy 600 MW was announced in 2013, 1000 MW in 2016, 1000 MW in 2019, and 1000 MW in 2021 by ETKB)
	EPDK (R)	- accepts and evaluates solar energy pre-license applications - signs the pre-license agreements with the winning participant of the license tender.	
	YEGM (now EIGM) (R)	evaluates the pre-license applications before tender	
	ETKB (R)	- responsible for the acceptance of the licensed power plants - issues renewable energy resource certificate	
	CSB (R)	Responsible for Environmental Impact Assessment	
	OSIB (R)	Management of energy potential measurement procedures	
	GTHB (R)	Evaluation of the power plant construction field, whether being a cultivation area or not.	

Table 4: Summary of Structural Analysis for Unlicensed Electricity Generation

Group of Organizations:	Actors:	Contribution of Economic Activity to Market Formation:	Constitutive Mechanisms:
Companies	Electricity Generators (electricity subscriber legal entities) (G)	apply for unlicensed electricity generation based on renewable energy sources	**First Phase: Exogenous regulation** **Policies on entrepreneurship and antitrust** - Self-consumption motivation: to support each actor to generate his electricity consumption (not only the home-based consumption but also commercial organizations (such as factories) consumption - The beginning and learning phase of renewable electricity generation **Second phase: Spontaneous Emergence & Entrepreneurial opportunism** - Entrepreneurial opportunity: increasing exemption limit from 500 kW to 1 MW - To benefit from the increased limit on unlicensed electricity generation - a new actor group emerged to export the surplus electricity generation to the distribution system - large-scale power plants started to be constructed for commercial purposes rather than to generate electricity for self-consumption - Unlicensed power plants (a kind of new medium of investments in renewable electricity) for commercial purposes replacing licensed electricity generation
	Equipment suppliers (S)	supply needed equipment to the electricity generators	
	Electricity distributors (R)	collect the unlicensed electricity generation applications and evaluate them	
Consultancy Organizations	Intermediary consultants (C)	assist the unlicensed electricity generation applicants in mediating the application and construction of the power plants	
	Consultant bureaucrats in government organizations (C)	make the laws and regulations more explicit and more applicable in the unlicensed electricity generation applications	
	Consultant academics in academic organizations (C)	engaged in research and development activities that may contribute indirectly to the investor by increasing the efficiency of the technology in power plants	
Public Organizations	TEİAŞ (R)	takes the power plant projects from unlicensed electricity generation investors who have a Connections Invitation Letter and evaluates these projects.	
	EIGM (formerly YEGM) (R)	makes technical evaluation of unlicensed electricity generation applications submitted by a relevant network operator	
	CSB (R)	The Directorate of Environment and Urbanizations in each city issues the document "Exemption from Environmental Impact Assessment for unlicensed electricity power plant"	
	GTHB (R)	The Directorate of Forestry and Water Affairs in each city assesses the appropriability of the power plant construction field, whether being a cultivation area or not.	
Real Persons	Electricity subscribers (R)	apply for unlicensed electricity generation based on renewable sources	

4.2. Second Stage: Process Analysis of Market Formation

Process Analysis can be briefly summarized as describing the formation of market segments and formation of market transactions with the transformative processes to acquire market formation potential (Möllering, 2009).

4.2.1 Formation of Market Segments

In the Turkish solar electricity generation market, dominant processes that shaped the formation of market segments were institutionalizing and associating. *Institutionalizing* is the process that which certain rules of exchange and the sanctions attached to them are applied across many exchanges and become taken for granted, and, *associating* is the process that which relationships are established between actors that constitute networks, convey status, and work against the anonymity of markets (Möllering, 2009).
One dimension of institutionalizing is learning by doing. Int. G3 defined the formation of market segments as a learning process in which the repeated practices of rules and regulation and recurrent interactions and exchanges between the actors shape the general framework of the market segment. Int. G12 also defined the period since 2007 (the year in which the first renewable energy license applications were collected for wind energy) as a learning process. According to Int. G12, the government chose to take deliberate steps in solar electricity generation to avoid the same mistakes made in wind energy. These deliberate (and sometimes slow) steps were to institutionalize the solar electricity generation market.
Moreover, institutionalizing is also crucial for domestic technology development activities. Int. G1 and Int. G12, domestic technology producers, and Int. G2, a technology producer with foreign partners, underlined the institutionalizing process for the robustness of the market. According to Int. G1, as the rules and regulations became certain and applied to all investments, his company could be more aggressive about technology development.
Associating is the other process that shapes the formation of market segments. Especially in the ULM, actors established more intense relationships for market transactions in an uncertain environment. Unlicensed generation moved into the second phase due to malfunctions in licensing and as a result of an amendment in the law about upper limits. Int. G13 claimed that during the emergence of the second phase relationships between actors played a crucial role. Consultants and NGOs started to negotiate with policymakers for this change. The close relationships between actors yielded strong synergy that led to a desirable outcome.

4.2.2 Formation of Market Transactions

The field research confirmed that in the Turkish solar electricity generation market segment transactions take place via *competing* and *communicating* processes. Competing is "the structural condition of competition and the spirit in which market exchanges are initiated and performed" and communicating is "making facts relevant and available to market actors, who then interpret and act on them" (Möllering, 2009).
Market transactions in licensed electricity generation occur through the *competing* process. Especially after privatization started in 2001, licensing has been used as a new marketing model for increasing the participation of the private sector in the energy market (Öztürk, Bezir and Özek, 2008) and hence increasing the efficiency through competition. For granting solar electricity generation licenses, tenders are issued if there is more than one application. In tenders, license applicants bid for the contribution fee, and these offers were very high, especially for the tenders in 2015. According to Int. C4,

during the collection of the license applications for solar in 2013, there was excess demand. This demand led to a competitive environment in license tenders. Specifically, in solar energy, high contribution fee offers underpinned the competition in the market. According to Int. G1, these participation fees determined the real values of the solar electricity generation projects and investors deliberately chose to make these high offers. In the ULM, the process of *communicating* creates exchanges. In this segment, the market is formed in two phases, and this is a direct result of the communication process. The meetings and organizations in the solar electricity generation market took the ULM from the first to the second phase. During this change, close interaction and communication between the actors shaped market formation. According to Int. G7, this communication started with the steps taken by the government, such as increasing the unlicensed electricity generation limit and retarding the licensing process. Therefore, the actors in the sector took the messages and repositioned themselves to make new investments. Int. R1 asserted that the energy regulation authority was steering the energy sector by using incentives. She stated that re-arrangements in the legal framework were made after feedback from the market was assessed, and this was enabled by close communication with the actors in the sector.

4.3. Third Stage: Functional Analysis of Market Formation

In the third stage of functional analysis, it is clearly seen that the time period of 2013-2015 in Türkiye was the first phase, so to say the nursing phase, of solar electricity generation sectoral development, and hence the solar electricity generation market formation has just started to emerge. The main reason behind this observation is the fact that the Turkish solar electricity generation market in this period has the essential characteristics of the nursing phase.

From the field research, it is seen that market segments are still forming and this formation process has not yet been completed. The process of solar licensing of 600 MW was completed in May 2015, and new solar license capacities of the app. 3000 MW has been announced gradually since then. The unlicensed electricity generation regulation was updated in May 2019 (With this new regulation, the capacity limit is increased from 1 MW to 5 MW. In the five years between 2015 and 2020, the installed solar capacity increased rapidly. According to a report by the Turkish Central Distribution Company (TEİAŞ), in May 2022 installed solar energy reached 8,479.1 MW (licensed: 17%, unlicensed: 86%) out of a total 101,518.3 MW (TEİAŞ, 2022). Therefore, we see that the solar energy market segments are still under construction but growing very fast (especially since 2015), and institutionalization of the sector and investments are still ongoing.

Moreover, in Turkish solar electricity generation, learning and coordination depend on close interactions between actors as in the nursing phase. Due to this reason, the formation of the unlicensed market segment has been shaped by the process of *associating*. In unlicensed electricity generation, actors establish more intense relationships to realize the market transactions in an uncertain environment. In the formation of the unlicensed market, particularly during the transition from the first stage to the second, learning and coordination played a crucial role, and the leapfrog emerged from the interaction between the policymakers and the electricity generators who demand large-scale unlicensed electricity generation. As a result, after amendments in the Renewable Energy Law and Electricity Market Law large-scale unlicensed electricity generation became possible.

Another prominent feature of the Turkish solar electricity generation market is the existence of uncertainty. This uncertainty was created by the practical implications of the regulations and the activities to increase renewable electricity generation. Int. G7 pointed out the uncertainty in the unlicensed market. He said that his company could not plan to enter the sector, because the managers could not be sure whether the obligation of self-consumption[14] would be imposed on unlicensed power plants or not. "Therefore, we cannot dare participate in unlicensed renewable electricity generation," he stated.
Moreover, in the nursing phase intermediary actors are important since communication is critical for success (Dewald & Truffer, 2012). This is also valid for the Turkish case, because these intermediary actors, engineering, procurement, and construction firms, bring together the equipment suppliers and investors, the bureaucrats, NGOs, and civil society representatives. The role of the government as the primary (and still the only) renewable electricity user was the last evidence showing that market formation is in the nursing phase.

5. DISCUSSION

This paper reviewed the market formation in Turkish solar electricity generation using qualitative field research. The framework includes structural, process, and functional analyses. We benefitted from mechanisms, related processes, and the details of these processes to understand market formation.
Dewald and Truffer (2012) made the market formation analysis using the framework mentioned above for German PV Markets to understand the local sources of market formation. This study attempts to analyze market formation in Germany for different market segments shaped by user profiles and for different phases of market formation (nursing, bridging, and mass). On the other hand, in the present study, we specifically focus on the processes and dynamics in each step of structural, process, and functional analyses, then define the constitutive elements and mechanisms in the Turkish solar electricity generation market segments. The empirical contribution of the present study is to analyze the Turkish solar electricity generation market formation in the first phase of sectoral development when the market just started to emerge. The conceptual contribution is to make this analysis in detail of the structural, process, and functional analyses.

6. CONCLUDING REMARKS AND FUTURE RESEARCH

In this paper, we reviewed the market formation in Turkish solar electricity generation by using qualitative field research in the first phase of sectoral development. The focus of the analysis is the market formation in the Turkish solar electricity generation TIS. We made an empirical study to understand how green transition efforts have started with the market formation process in the Turkish solar energy sector with a qualitative data set of fifty-seven interviews with key experts in the energy sector in the 2013-2015 period when the sector just started to develop. The market formation framework includes structural analysis, process analysis, and functional analysis. In the first stage of structural analysis, we identified actors, networks, and institutions at the level of self-contained market segments. In the second stage, we made a process analysis to assess each solar electricity market segment's stage of development and their mutual

[1] If it is mandated by law, renewable energy power plant owners will have to consume some part of the electricity generated in the plants.

interdependence. In the third stage, we made a functional analysis to understand the progress of the solar electricity market. Different than other studies, here, the market formation has been analyzed from the (electricity) producers 'perspective.

The structural analysis showed that in solar electricity market segments, actors are companies, consultancy organizations, public organizations, and real persons (electricity subscriber individuals). In both market segments, networks are associations and cooperative organizations; institutions are general legislation and the political developments in the Turkish Solar Energy Sector. These structural elements are constituted through the mechanism of exogenous regulation in the licensed market. On the other hand, the unlicensed market is formed in two levels, and the structural components are constituted through the mechanism of exogenous regulation in the first level and spontaneous emergence in the second level.

In the second stage of market formation, we made a process analysis. At this stage, processes that constitute market formation sub-functions are the focus. For the formation of market segments, institutionalizing is the primary constitutive process in the licensed generation, and associating is the primary constitutive process in the unlicensed generation. The institutionalizing process comprises learning by doing, holistic sectoral analysis, and domestic technology development support by decreasing uncertainty. On the other hand, the associating process encompasses the interaction between the actors (especially the investors) and feedback taken from the sector.

For the formation of market transactions, competing is the primary constitutive process in the licensed generation and communicating in the unlicensed generation. Competing mainly refers to the tender regulations in the licensed market. Primarily communicating refers to the formation dynamics of the unlicensed market. For the formation of user profiles, it is seen that in Turkish renewable electricity generation, the user profiles do not mature yet and are not diversified much. The only user is the government.

In the third stage, by the functional analysis, it is seen that the market formation of solar electricity generation in Türkiye is in the nursing phase. Hence, the diffusion of emerging solar electricity generation technologies is at the beginning and shaped by the sub-function of market segment formation. In this phase, the Turkish market is dominated by uncertainty, learning, and coordination which depends on close interaction between actors, the government as the prime mover is dominant, and the product variation is not much (but the environment is open for variety creation in technological design), and commercialization has not been succeeded in the established market structure.

For the future research, a follow-up study can be done to revisit the market formation in solar energy electricity generation in Türkiye. Here, at first sight, the level of sectoral development in solar electricity generation can be diagnosed, and then the current situation of the market's structure, and the factors that affected the current structure can be analyzed. Moreover, this study was made as an example of technology diffusion of emerging technologies. The same framework can be applied to other strategic emerging technologies to understand main dynamics behind of this technology, and the market formation. The lessons learnt derived from this study can be determined and tested in different contexts, specifically in Türkiye, for different emerging renewable energy technologies.

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REFERENCES

Asif, M., and Muneer, T. (2007). Energy supply, its demand and security issues for developed and emerging economies. Renewable and Sustainable Energy Reviews, 11(7), 1388–1413. https://doi.org/10.1016/j.rser.2005.12.004

Bergek, A. and Jacobbson, S. (2003). The emergence of a growth industry: a comparative analysis of the German, Dutch and Swedish wind turbine industries. U. Metcalfe, Stanley J. and Cantner (Ed.), Change, Transformation and Development (pp. 197–227). New York; London: Springer.

Bergek, A. (2002). Shaping and Exploiting Technological Opportunities : The Case of Renewable Energy Technology in Sweden Department of Industrial Dynamics (Issue May). Chalmers University of Technology.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., and Rickne, A. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. Research Policy, 37(3), 407–429. https://doi.org/10.1016/j.respol.2007.12.003

Boon, W. P. C., Edler, J., and Robinson, D. K. R. (2020). Market formation in the context of transitions: A comment on the transitions agenda. Environmental Innovation and Societal Transitions, 34, 346–347. https://doi.org/10.1016/j.eist.2019.11.006

Carlsson, B., Jacobsson, S., Holmén, M., and Rickne, A. (2002). Innovation systems: analytical and methodological issues. Research Policy, 31, 233–245. https://doi.org/10.1016/S0048-7333(01)00138-X

Carlsson, B., and Stankiewicz, R. (1991). On the nature, function and composition of technological systems. Journal of Evolutionary Economics, 1(2), 93–118. https://doi.org/10.1007/BF01224915

Corbin, J. and Strauss, A. (2008). Basics of qualitative research: Techniques and Procedures for Developing Grounded Theory (3rd Edition). London, New Delhi: Thousand Oaks : Sage Publications

Demirbas, A. (2006). Electrical power production facilities from green energy sources. Energy Sources, Part B: Economics, Planning and Policy, 1(3), 291–301. https://doi.org/10.1080/15567240500400648

Dewald, U., and Truffer, B. (2011). Market formation in technological innovation systems-Diffusion of photovoltaic applications in Germany. Industry and Innovation, 18(3), 285–300. https://doi.org/10.1080/13662716.2011.561028

Dewald, U., and Truffer, B. (2012). The Local Sources of Market Formation: Explaining Regional Growth Differentials in German Photovoltaic Markets. European Planning Studies, 20(3), 397–420. https://doi.org/10.1080/09654313.2012.651803

Edquist, C. (2011). Design of innovation policy through diagnostic analysis: Identification of systemic problems (or failures). Industrial and Corporate Change, 20(6), 1725–1753. https://doi.org/10.1093/icc/dtr060

Erden-Topal, Y. (2016). A Policy Design Model for Market Formation of Solar and Wind Electricity Generation in Türkiye (Unpublished PhD. Dissertation). Middle East Technical University Graduate School of Social Sciences, Ankara

ETKB (Ministry of Energy and Natural Resources). (2013). 2013 Yılı Genel Enerji Tablosu. Access address: https://enerji.gov.tr/eigm-raporlari

ETKB (Ministry of Energy and Natural Resources). (2016). 2016 Yılı Genel Enerji Tablosu. Access address: https://enerji.gov.tr/eigm-raporlari

ETKB (Ministry of Energy and Natural Resources). (2020). 2020 Yılı Genel Enerji Tablosu. Access address: https://enerji.gov.tr/eigm-raporlari

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. Qualitative Inquiry, 12(2), 219–245. https://doi.org/10.1177/1077800405284363

Galli, R. and Teubal, M. (1997). Paradigmatic shifts in national innovation systems. In C. Edquist (Ed.), Systems of Innovation. Pinter Publisher.

Geels, F., and Raven, R. (2006). Non-linearity and expectations in niche-development trajectories: Ups and downs in Dutch biogas development (1973-2003). Technology Analysis and Strategic Management, 18(3–4), 375–392. https://doi.org/10.1080/09537320600777143

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case study. Research Policy, 31(8–9), 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. Research Policy, 33(6–7), 897–920. https://doi.org/10.1016/j.respol.2004.01.015

Gökmen, N. (2021), Türkiye: New Renewable Energy Support Mechanism Announced, Address: https://www.mondaq.com/Türkiye/renewables/1031996/new-renewable-energy-support-mechanism-announced

Gözen, M. (2015). Unlicensed Renewable Energy Generation: A Review of Regulation and Applications in the Context of Türkiye. International Journal of Energy Economics and Policy, 5(1), 1–13.

Hekkert, M. P., and Negro, S. O. (2009). Functions of innovation systems as a framework to understand sustainable technological change: Empirical evidence for earlier claims. Technological Forecasting and Social Change, 76(4), 584–594. https://doi.org/10.1016/j.techfore.2008.04.013

Hekkert, M. P. P., Suurs, R. A. A., Negro, S.O., Kuhlmann, S. and Smits, R. E. H. M. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological Forecasting and Social Change, 74(4), 413–432. https://doi.org/10.1016/j.techfore.2006.03.002

Huang, Y. H., and Wu, J. H. (2009). A transition toward a market expansion phase: Policies for promoting wind power in Taiwan. Energy, 34(4), 437–447. https://doi.org/10.1016/j.energy.2008.12.003

Jacobsson, S., and Bergek, A. (2004). Transforming the energy sector: The evolution of technological systems in renewable energy technology. Industrial and Corporate Change, 13(5), 815–849. https://doi.org/10.1093/icc/dth032

Jacobsson, S., and Johnson, A. (2000). The diffusion of renewable energy technology: An analytical framework and key issues for research. Energy Policy, 28(9), 625–640. https://doi.org/10.1016/S0301-4215(00)00041-0

Jacobsson, S., Sandén, B., and Bångens, L. (2004). Transforming the Energy System — the Evolution of the German Technological System for Solar Cells, Technology Analysis and Strategic Management, 16(1), 3–30. https://doi.org/10.1080/0953732032000199061

Keleş, S., and Bilgen, S. (2012). Renewable energy sources in Türkiye for climate change mitigation and energy sustainability. Renewable and Sustainable Energy Reviews, 16(7), 5199–5206. https://doi.org/10.1016/j.rser.2012.05.026

Kjellberg, H., and Helgesson, C. F. (2007). On the nature of markets and their practices. Marketing Theory, 7(2), 137–162. https://doi.org/10.1177/1470593107076862

Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., Mcmeekin, A., Mühlemeier, M.S., Nykvist, B. ,Pel, B. , Raven, R., Rohracher, H. , Sandén, B., Schot, J., Sovacool, B., Turnheim, B. Welch, D. and Wells, P. (2019). An agenda for sustainability transitions research : State of the art and future directions. Environmental Innovation and Societal Transitions, 31(January), 1–32.

https://doi.org/10.1016/j.eist.2019.01.004
Markard, J., Hekkert, M. and Jacobsson, S. (2015). The technological innovation systems framework: Response to six criticisms. Environmental Innovation and Societal Transitions, 16, 76–86. https://doi.org/10.1016/j.eist.2015.07.006
Markard, J., Raven, R. and Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. Research Policy, 41(6), 955–967. https://doi.org/10.1016/j.respol.2012.02.013
Markard, J., and Truffer, B. (2008). Technological innovation systems and the multi-level perspective: Towards an integrated framework. Research Policy, 37(4), 596–615. https://doi.org/10.1016/j.respol.2008.01.004
Möllering, G. (2009). Market Constitution Analysis A New Framework Applied to Solar Power Technology Markets (09/7; MPIfG Working Paper). https://doi.org/10.2139/ssrn.1456833
Özcan, M. (2019). Factors influencing the electricity generation preferences of Turkish citizens: Citizens' attitudes and policy recommendations in the context of climate change and environmental impact. Renewable Energy, 132, 381–393. https://doi.org/10.1016/j.renene.2018.08.006
Öztürk, M., Bezir, N. C., and Özek, N. (2008). Energy market structure of Türkiye. Energy Sources, Part B: Economics, Planning and Policy, 3(4), 384–395. https://doi.org/10.1080/15567240701418548
Patton, M. Q. (2002). Qualitative Research and Evaluation Methods (3rd Edition). London, New Delhi: Thousand Oaks : Sage Publications.
Rotmans, J., Kemp, R. and van Asselt, M. (2001). More evolution than revolution. Foresight, 3(1), 1–17.
Şalvarlı, H., and Şalvarlı, M. S. (2017). Trends on energy policy and sustainable development in Türkiye. Energy Sources, Part B: Economics, Planning and Policy, 12(6), 512–518. https://doi.org/10.1080/15567249.2016.1217284
Schot, J., and Geels, F. W. (2008). Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. Technology Analysis and Strategic Management, 20(5), 537–554. https://doi.org/10.1080/09537320802292651
Smith, A., Voß, J. P. and Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. Research Policy, 39(4), 435–448. https://doi.org/10.1016/j.respol.2010.01.023
TEİAŞ (Turkish Electricity Transmission Corporation) (2022), Santral Kurulu Guc Raporları (Haziran 2022), Address: https://www.teias.gov.tr/kurulu-guc-raporlari
Toklu, E. (2013). Overview of potential and utilization of renewable energy sources in Türkiye. Renewable Energy, 50, 456–463. https://doi.org/10.1016/j.renene.2012.06.035
UNFCCC. (2015). Paris Climate Change Conference-November 2015, COP 21. Adoption of the Paris Agreement. Proposal by the President., 21932 (December), 32. https://doi.org/FCCC/CP/2015/L.9/Rev.1
Van Den Bergh, J. C. J. M., Truffer, B. and Kallis, G. (2011). Environmental innovation and societal transitions: Introduction and overview. Environmental Innovation and Societal Transitions, 1(1), 1–23. https://doi.org/10.1016/j.eist.2011.04.010
Wieczorek, A. J. and Hekkert, M. P. (2012). Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. Science and Public Policy, 39(1), 74–87. https://doi.org/10.1093/scipol/scr008
World Economic Forum. (2016). Renewable energy is not enough: it needs to be sustainable. Access address: https://www.weforum.org/agenda/2015/09/renewable-energy-is-not-enough-it-needs-to-be-sustainable

Yüksel, I. and Kaygusuz, K. (2011). Renewable energy sources for clean and sustainable energy policies in Türkiye. Renewable and Sustainable Energy Reviews, 15(8), 4132–4144. https://doi.org/10.1016/j.rser.2011.07.007