Multi-method approach for the comparative analysis of solar and wind energy industry structures in Germany and Iran

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Abstract: The objective of this paper is comparing solar and wind energy industry structures in Germany and Iran through applying four industry analysis techniques known as strategy tools in technological issues including five forces model, diamond model, triple helix model, and sectoral innovation system in a comprehensive model. Regarding the purpose of the study, four research questions are specified which emphasises on understanding and analysing the current competition conditions, competitive advantage in the global market, main institutional players, and conditions of functions of innovation system. In order to answer the questions, a field interview using a questionnaire was conducted which includes indicators derived from literature review. Respondents are 30 experts who are aware of the solar and wind energy industry in Iran and Germany and are selected by purposive sampling. In order to further justify the answers provided by the participants, various world statistical data is used and presented.

Keywords: comparative analysis; renewable energy; industry structure; Germany; Iran.

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1 Introduction

Industry analysis and corporate strategy development are two interrelated basic concepts leading to superior performance. Industry analyses sometimes make use of techniques referred to as strategy tools in technological issues; these tools include five forces model, diamond model, 'triple helix' model, and sectoral innovation system (SIS) (Porter, 1990). The complexities of the structure of an industry are the result of various factors that are in immediate relation to the company and affect how capable the company is in operating in the markets and serving its customers (Van der Geer, 2007). Anticipating and influencing competition and profitability, in addition to effective strategic positioning, require a proper understanding of industry structure (Porter, 2008).

Porter's five forces are based on a theory in which assumes the attractiveness of an industry is influenced by the market structure since this structure affects the behaviour of market participants (Dälken, 2014). In addition, Porter (1990) classified national attributes into six broad factors that foster competitive advantage in particular industries. This classification has become a key tool for the analysis of competitiveness. A key point here is that competitions occur among firms and industries not among nations and that a nation's competitiveness is the result of competitive advantage at the firm and industry level.

With regard to triple helix, Etzkowitz (2002) and Sunitiyoso et al. (2012) argued that it is a spiral model of innovation based on multiple interrelationships that intersect at different points in the process of knowledge capitalisation. The Triple Helix model of university-industry-government (UIG) relations attempts to incorporate the dynamics of both communication and organisation through presenting the concept of an overlay of exchange relations that feeds back on the institutional arrangements.

The concept of 'functions in a technological innovation system' indicates contributions of one or more system components, whether positive or negative, in an attempt to develop, diffuse, and apply innovations to a certain field of technology (Bergek et al., 2008). 'Functional pattern' can be used in examining an innovation system for a specific technology or product, i.e., a sectoral system of innovation or a technological system that can be analysed in terms of how these functions are served (Johnson and Jacobsson, 2000). According to Bergek (2002), some scholars take the country as the unit of analysis, arguing that choice of technology and learning is affected by what he terms as 'national systems of innovation'; while others focus on 'regional systems of innovation' which is closely related to cultural variables; still others study 'industrial networks' that represent long-term interrelations among companies; Finally, some focus on 'technological systems' or 'sectorial innovation system', which are specific to a particular technology or product.

This paper presents a comprehensive model to compare solar and wind energy industry structures in Germany and Iran by drawing on the four methods mentioned above. In accordance with this aim, this study are determining and comparing the current competition conditions, competitive advantage in the global market, main institutional players, and current conditions of functions of innovation system of solar and wind energy industry in both countries. Five forces model was used to understand the competitive forces, and their underlying causes with regard to the condition of the industry concerning competition and profitability. Diamond model was employed to study and compare competitive advantage of the industry of Germany and Iran in the global market. For defining the major players in the industry, triple helix model was applied in addition to SIS which is helpful in describing the functions of each actor. Thus, the differences of solar and wind energy industry in the countries can be better clarified by making use of the four methods. For this purpose, a field interview was conducted through using a questionnaire which includes indicators determined by literature review. Respondents are 30 experts who are aware of the solar and wind energy industry in Iran and Germany and are selected by purposive sampling. Various world statistical data is used to further justify the answers provided by the participants.

2 Literature review

2.1 Five forces of competitive model

Porter's model is based on the idea that competitive intensity and attractiveness of a market are determined by five forces: bargaining power of suppliers, bargaining power of customers, threat of substitutes, threat of new entrants, and rivalry among existing firms (Porter, 2008; Progress et al., 2013). Each force in the model consists of a number of components that shape the strength of each force and its influence on the degree of competition (He, 2005).

In Porter's models, suppliers pose a threat as sometimes they can impose higher prices on inputs they provide for a company or lower the quality of the inputs they supply, thereby depressing the company's profitability (Amrollahi and Akhgar, 2013). Lee et al. (2012) described sub-forces related to bargaining power of suppliers including dependence on suppliers, supplier switching cost, supplier uniqueness due to its differentiated products, importance of suppliers as a result of their products, threat of forward integration done by suppliers, and large number of suppliers. In this case, Ucmak and Arslan (2012) stated some sub-forces such as the current number of suppliers, the power of current suppliers, forward integration, and the availability of suppliers. To illustrate some sub-factors of bargaining power of suppliers, Wu et al. (2012) mentioned supplier switching cost because of its unique products, threat of forward integration, importance of supplier, the number of suppliers, and the degree of company's importance.

Buyers can also sometimes be viewed as competitive threats as they can ask for lower prices or higher quality services (which can increase operating costs) (Amrollahi and Akhgar, 2013). Lee et al. (2012) cited sub-forces related to bargaining power of buyers such as large number of buyers, dependence on buyers, buyers' switching cost, unique and differentiated products, importance of products to buyers, and threat of backward integration. In this regard, Ucmak and Arslan (2012) described some sub-forces including the number of buyers, significance of products, and backward integration. Wu et al. (2012) stated large number of purchases, having significant fraction of the buyer's cost, differentiated products, switching costs, having low profits, threat of backward integration, and having full information.

The next factor in Porter's model is the threats of substitute product. Substitute products are those of industries that the consumers can purchase instead of the products of the industry being analysed and be served in a similar way (Amrollahi and Akhgar, 2013). Lee et al. (2012) expressed the threats of substitute products by sub-forces including number of substitutes, their closeness, and other ways to provide the same value. Ucmak and Arslan (2012) described also some sub-forces such as the amount of substitute products, their price, and their quality. In this case, Wu et al. (2012) cited the amount of price-performance trade off, and producing of substitute products by industries earning high profits.

In addition, barriers to entry to an industry are sometimes erected to reduce the threats posed by new entrants to the marketplace. Lee et al. (2012) stated advantages of economies of scale, prohibition made by government regulation, cost advantage due to learning curve, the amount of initial capital requirement, and customer switching costs. Regarding barriers to entry, Ucmak and Arslan (2012) cited the opportunity to access distribution channels, government regulation, cost advantage, and the amount of capital requirement. Wu et al. (2012) mentioned economic of scale, product differentiation, initial capital requirement, switching cost, the availability of distribution channels, and government policy.

The last competitive force in Porter's model is the extent of rivalry among established companies within an industry. Lee et al. (2012) described the number of companies, difference between capacity and demand, differentiation in products, and exit barriers. Ucmak and Arslan (2012) stated distribution of power among current rivals, growth rate of industry, possibility to exit the market, and the possibility to grow. Wu et al. (2012) mentioned the number of competitors, industry growth, differentiation, switching costs, and exit barriers.

2.2 Porter's diamond model

Diamond model is used here to analyse the international competition of both nations. In this model, Porter (1990) determined four major elements: factor conditions, demand conditions, related and supporting industries, and firm strategy, structure, and rivalry. Furthermore, 'government' and 'chance' were included as factors that may affect the functioning of these four (Öz, 2002).

a Factor conditions: these conditions are associated with such indices as the existing potential of renewable energy resources (human, physical, knowledge, and capital), quality of math and science education, renewable energy infrastructure, and patent applications filed under the patent cooperation treaty (PCT) for renewable technologies (Dögel et al., 2012). Fathi and Ahmadian (2016) described factor conditions by sub-factors including the availability of raw material, access to infrastructures, cultural and social values, wages and expectations of labour forces, and their knowledge and proficiency. In this case, Herciu (2013) mentioned hiring and firing costs, availability of financial services, and quality of overall infrastructure.

b Demand conditions in the home market: this can be explained in terms of the existing capacity (MW), market growth (p.a. %), and education index (Dögel et al., 2012). Regarding demand condition, Fathi and Ahmadian (2016) stated sub-factors such as the purchasing power of customers, market size, demand growth rate, and terms and condition of distribution, delivery, and after sale services. Herciu (2013) cited the size of market, trade tariffs, and procedures to start a business.

c Related and supporting industries: This can be measured by incorporating such indicators as share of medium and high-tech value added in total manufacturing as well as gross domestic expenditure on R&D (Dögel et al., 2012). In this case, Fathi and Ahmadian (2016) referred to the quality of communication between various firms, and technology maturity of the country as indicators to analyse the condition of related industries. Herciu (2013) emphasised on the quality and quantity provided by suppliers. An organisation is more competitive if there are strong suppliers and related industries that can contribute to provision of an infrastructure.

d Firm strategy, structure, and rivalry: This factor often consists of competition intensity, corporate mergers and acquisitions by the target country in addition to innovation capacity (Dögel et al., 2012). Regarding this factor, Fathi and Ahmadian (2016) mentioned plans and also organisational charts. Additionally, Herciu (2013) focused on firm-level technological ability.

e Government and culture: this can be explained in terms of financial support systems and environmental regulations as well as two dimensions of Hofstede's theory about national culture: values for masculinity and avoiding uncertainty (Dögel et al., 2012). By making use of industrialisation based on rural renewable energy, the government can lead the economy toward a path that encourages policy, fostering market, and having standard and science-based management (Lixia and Yanling, 2009). To measure the condition of government, Fathi and Ahmadian (2016) used general plans, financial policies, and government's rules. Herciu (2013) applied government debt, favouritism in decisions, corruption, and policymaking as indicators to analyse this factor.

f Chance: this includes factors that largely occur outside the sector, are not forecast, and sometimes affected by such factors as new inventions, political decisions by foreign governments, wars, rapid changes in financial markets or exchange rates, surges of world or regional demand, discontinuities in input costs, and other radical technical changes (biotechnology and microelectronic) (Bakan and Doğan, 2012). In this regard, Fathi and Ahmadian (2016) cited some sub-factors including international sanctions, foreign investment, the significance of the strategic situation of the country in the area, and currency fluctuation.

2.3 Triple helix model

The triple helix model leads to a view on the institutional actors in the network. Interactions based on bi-lateral and tri-lateral relations will become more sophisticated if three selection environments are involved as described by this model: wealth generation (industry), novelty production (academia), and public control (government) (Leydesdorff and Meyer, 2006). There are fluctuating boundaries between public and private, science and technology, university and industry. Tasks previously carried out by other sectors are being undertaken by universities and firms. Science and technology policies at various levels are expected to shape these relationships.

Moeliodihardjo et al. (2012) and Etzkowitz et al. (2007) argue that in a statist regime (Triple Helix I), government leads academia and industry. In a laissez-faire regime (Triple Helix II), industry is the driving force, with the other two spheres as ancillary support structures. In a knowledge-based society, university and other knowledge-producing institutions have the key function, acting in partnership with industry and government and even taking the leadership in joint initiatives, in a balanced model

(Triple Helix III). In a university-led developmental model, the university plays the leading role. The university is the gravitational centre that commences the partnership.

2.4 Functions of innovation system

Recently a number of studies have applied the system functions approach, which has led to a number of system functions lists in the literature. Hekkert et al. (2007) noted the differences between hard and soft functions. Hard functions are adopted by hard organisations that carry out R&D and supply scientific and technical services to third parties; on the other hand, soft functions require soft institutions i.e., regulatory entities; this often consists of catalytic and interface roles including diffusion of information, knowledge, and technology; policy making; design and implementation of institutions concerning patents, laws, standards, etc.; diffusion of scientific culture, and professional coordination (Hekkert et al., 2007). In this regard, Edquist (2001) pointed out five functions: to create new knowledge, guide the direction of the search process, supply resources, i.e., capital, competence and other resources, facilitate the creation of positive external economies (in the form of an exchange of information, knowledge and visions), and facilitate the formation of markets.

Bergek et al. (2008) pointed to some functions used when mapping the key processes in innovation system (IS) dynamics: knowledge development and diffusion, influence on the direction of search, entrepreneurial experimentation, market formation, resource mobilisation, legitimation, and development of positive externalities or ‘free utilities’. Kamp et al. (2009) noted seven functions that include entrepreneurial activities, knowledge development, knowledge diffusion through networks, guidance of the search, market formation, resource mobilisation, and support from advocacy coalitions. In the present study, the following functions have been included based on the existing viewpoints:

- *Function 1* – Entrepreneurial activities: entrepreneurs are very important in innovation system because of evolvements of innovation system under significant uncertainty in respect of technologies, applications and markets. This function is closely related to the knowledge development function, but the role of the entrepreneur is generating and taking advantage of business opportunities by turning the potential of new knowledge development, networks and markets into concrete action. To analyse this function, Rooy (2012) used indicators such as type of entrepreneur, change in the number of entrepreneurs, and recent and future activities.
- *Function 2* – Knowledge development: as noted by Lundvall (1992), the most fundamental resource in the modern economy is knowledge and, accordingly, the most important process is learning; therefore, R&D and knowledge development are prerequisites within the innovation system. This function encompasses three types of learning processes distinguished by Kamp et al. (2004): ‘learning by searching’, ‘learning by doing’, and ‘learning by using’. Rooy (2012) applied indicators including type of organisation performing research, type of research activities, start of national research project, international recognition, start of production, production cost changes, and feedback from market to analyse this function.

- *Function 3* – Knowledge diffusion through networks: learning by interacting as defined by Kamp et al. (2004) is commonly known as the transfer of knowledge between different linked actors. This is important in a strict R&D setting, but especially in a heterogeneous context where R&D meets government, competitors and market. In this case, collaboration between organisations on R&D, and formalised exchange methods are used by Rooy (2012) as indicators for the analysis of the knowledge diffusion.
- *Function 4* – Guidance of the search: it can be initiated by government through goal setting, motivating actors by a technological breakthrough and new proven technologies. In order to analyse this function, Rooy (2012) applied indicators such as targets set by government or industry, support for goals, technological expectations, and expected continuation of development.
- *Function 5* – Market formation: for new technologies markets may not exist, or be greatly under developed; potential customers may not have articulated their demand (or even have the competence to do so) and price/performance of the new technology may be poor. In this case, 'nursing markets' may be formed to help actors acquire information and develop the new technology and expectations. Such markets may later get replaced by 'bridging markets' that provide for increased volume and growth in technological IS (Jacobsson and Bergek, 2003). In addition, this function can be analysed by market size, and financial market incentives (Rooy, 2012).
- *Function 6* – Resource mobilisation: resources, both financial, human and physical, are necessary as a basic input to all the activities within the IS. Additionally, availability of venture capital, research employees, raw materials, and specialised education programs can be used to analyse this function (Rooy, 2012).
- *Function 7* – Support from advocacy coalitions: advocacy coalitions can function as a catalyst to create legitimacy for the new technology and to prevent resistance to change. To analyse this function, Rooy (2012) mentioned indicators including existence of advocacy coalitions, and activities of coalitions.

3 Research methodology

In this study, the main purpose is to identify the current condition of solar and wind energy industry of Germany and Iran by using multi-method approach including Porter's five force model, diamond model, triple helix model, and functions of innovation system. As it is clear from Figure 1, there are four research questions in line with the main objective. To answer them, a field interview using questionnaire was conducted which includes indicators defined in the research model. Items are measured using the Likert third scale, low, medium, and high. Respondents are 30 experts who are aware of the solar and wind energy industry in Iran and Germany and are selected by purposive sampling. In order to further justify the answers provided by the participants, various world statistical data is used. The research method is quantitative and purpose of research is analytical due to using measurable data to recognise facts and numerical analysis of collected data.

Figure 1 Research model

Multi-method approach for the comparative analysis of solar and wind energy industry structures

Five forces of competitive model

What are the current competition conditions of solar and wind energy industry in Germany and Iran?

Threat of new entrants	Government regulation (support)	Lee et al. (2012); Wu et al. (2012)
	The amount of capital requirement	Lee et al. (2012); Wu et al. (2012); Ucmak and Arslan (2012)
	Political stability	By researcher
	New industry	By researcher
Bargaining power of suppliers	Number of suppliers	Lee et al. (2012); Wu et al. (2012); Ucmak and Arslan (2012)
	Political stability	By researcher
Bargaining power of buyers	Number of buyers	Lee et al. (2012); Wu et al. (2012); Ucmak and Arslan (2012)
	Unique and differentiated products	Lee et al. (2012); Wu et al. (2012); Ucmak and Arslan (2012)
Threat of substitute	Number of substitutes	Lee et al. (2012); Wu et al. (2012); Ucmak and Arslan (2012)
	Demand of products	By researcher
Rivalry among existing competitors	Number of companies	Lee et al. (2012); Wu et al. (2012)

Porter's Diamond

What are the competitive advantage of solar and wind energy industry of Germany and Iran in the global market?

Firms strategy, structure, and rivalry	Plans	Fathi and Ahmadian (2016)
	Abilities	Herciu (2013)
Demand condition	Market size	Fathi and Ahmadian (2016); Herciu (2013)
	The growth rate of demand	Fathi and Ahmadian (2016)
Related and supporting industries	Supplier quality	Herciu (2013)
	Technology maturity of the country	Fathi and Ahmadian (2016); Herciu (2013)
Factor condition	Quality of overall infrastructure	Fathi and Ahmadian (2016); Herciu (2013)
	Availability of financial support	Herciu (2013)
Chance	Political stability	Fathi and Ahmadian (2016)
	Financial stability	Fathi and Ahmadian (2016)
	Amount of foreign investment	Fathi and Ahmadian (2016)
Government	Plans	Fathi and Ahmadian (2016)
	Policies	Fathi and Ahmadian (2016)
	Rules	Fathi and Ahmadian (2016)

Multi-method approach for the comparative analysis of solar and wind energy industry structures

Triple helix model

What are the main institutional players in solar and wind energy industry of Germany and Iran?

Function of innovation system (FIS)

What are the current conditions of FIS of solar and wind energy industry in Germany and Iran?

Entrepreneurial activities	Trends of entrepreneurial	Rooy (2012)
Knowledge management	Trends of research activities	Rooy (2012)
Knowledge diffusion through networks	Collaboration between organisations on R&D	Rooy (2012)
Guidance of the research	Targets set by government or industry	Rooy (2012)
Market formation	Financial market incentives	Rooy (2012)
Resource mobilisation	Availability of resources	Rooy (2012)
Creation of legitimacy	Existence of advocacy coalitions	Rooy (2012)

4 Results

4.1 Analysis of solar and wind energy industry in Germany and Iran based on five forces model

This model is helpful in examining the balance of power in solar and wind energy industry in both countries among different types of organisations, and analysing the attractiveness and potential profitability of the industry. It is a strategic tool designed to help review the strengths of a market position, based on the five key forces.

4.1.1 Analysis of solar and wind energy industry in Germany

The analysis of the five major forces in solar and wind energy industry in Germany led to the findings shown in Table 1.

Table 1 Analysis of five forces in solar and wind energy industry in Germany

No.	*Forces*	*Sub-forces*	*Solar*		*Wind*	
			Average	*Standard deviation*	*Wind*	*Standard deviation*
1	Threat of new entrants	Government regulation	2.60	0.67	2.60	0.67
		The amount of capital requirement (–)	1.10	0.87	2.95	0.85
		Political stability	2.90	0.54	2.90	0.54
		New industry	2.40	0.78	2.40	0.78
2	Bargaining power of suppliers	Number of suppliers (–)	2.57	0.72	1.00	0.89
		Political stability (–)	2.90	0.54	2.90	0.54
3	Bargaining power of buyers	Number of buyers (–)	2.50	0.93	1.66	0.87
		Unique and differentiated products (–)	1.00	0.84	1.60	0.96
4	Threat of substitute	Number of substitutes	2.60	0.64	2.60	0.64
		Demand of products (–)	2.40	0.65	2.53	0.74
5	Rivalry	Number of companies	2.83	0.86	2.60	0.63

According to Boeckle et al. (2010), financial and regulatory measures have been adopted by German government to adapt to changing market conditions and to be able to response to the demands of the private sector. In addition, various factors such as focusing on innovation and high rate of investments, macro-economic factors like political stability, Germany's openness to trade and foreign investment, strong anti-trust policies, and the lack of corruption have played a pivotal role in the intensity of threat of new entrants and thereby local rivalry in both solar and wind energy industry.

In general, the industry of wind technologies manufacturers like turbine producers rarely faces threats of the potential entry of new competitors. More than anything, a manufacturer in wind energy industry needs experience and know how, enormous investments, reduction in logistic costs, and increased delivery speed (Sieck, 2014).

In case of bargaining power for suppliers, even though solar technologies are highly technological and require many resources to manufacture, no one has a monopoly over the market as customers have access to a large number of manufacturers and new-entrants (Erkamo, 2013). As far as wind technologies are concerned, it is of great significance to be able to supply high quality technologies with a fast delivery in order to achieve a reputation that impacts the overall profitability. A company may establish broader control against suppliers through owning suppliers, vertical integration in a long term, and sub-contracting in long-term agreements (Sieck, 2014).

The buyers do not have too much bargaining power in the market either, even though there are two kinds of products that can utilise sunlight: solar cells and solar thermal collectors, which function in different ways. Therefore, depending on the desirable function, the buyer has only one option for the product. The buyer does not have a broad scope to manoeuvre, although there are still differences in terms of the materials and technology used for this purpose (Erkamo, 2013).

Buyers in the wind energy industry are usually owners of wind park and project developer. In case of wind farm, potential buyers are utility companies, local governments, pension funds, or other investors. Furthermore, given the unique characteristics of geographic areas, project developer, as the part of the supply chain that connects the manufacturer to the park owner, has limited options. This reduces the bargaining power on the part of the buyer (Sieck, 2014).

Threat of substitute products or services is of course ever present, because energy can be produced and obtained in many ways such as fossil fuels and nuclear power. In addition, renewable energy comes in different forms including wind, tides, geothermal and solar energies (Erkamo, 2013; Sieck, 2014). Moreover, many investors are mainly interested in investment only; this should be noted, however, that other forms of investments, e.g., stocks, bonds, and funds, can be used instead (Sieck, 2014).

Unlike threat of substitutes, Germany has numerous customers for solar and wind technologies, whether in its domestic market or in the common European market. For example, CO_2 reduction targets are legally binding and strict environmental impact assessments are enforced at the European and national level. The regulatory and technical standards in Germany are very high. The role of the government on the demand side is also important. In addition, Germany has planned to give up nuclear energy in 2022. Therefore, there is a growing demand for solar and wind production and subsequently for their technologies.

The high level of diversification of the economy in domestic German market and the common European market creates a highly competitive business environment in which German companies will compete. Economic success in German market is largely determined by high efficiency of large companies and small or medium-sized enterprises (SMEs) based on the international standards (Boeckle et al., 2010). There are about 15,000 companies, among them 350 manufacturers, operating in the solar energy industry in Germany. This obviously means competition. Although these are usually SMEs, big businesses also compete here (Erkamo, 2013). The competition is not limited to domestic companies, as Chinese companies, with their low manufacturing prices, hold 80& of the solar-panel market in the European Union (EU) (Erkamo, 2013).

Germany's local context has encouraged appropriate forms of investment and sustained upgrading amongst companies engaged in the wind technologies manufacturing. Although the sector is largely dominated by the German large businesses, competition has resulted in the emergence of some (smaller) locally based rivals and robust related and supporting industries. In addition, players from China, India, and other countries have emerged and entered this competition by providing products at lower prices (Boeckle et al., 2010).

4.1.2 Analysis of solar and wind industry in Iran

The results for the analysis of solar and wind energy industries in Iran are shown in Table 2:

Table 2 Analysis of five forces in solar and wind energy industry in Iran

No.	*Forces*	*Sub-factor*	*Solar*		*Wind*	
			Average	*Standard deviation*	*Wind*	*Standard deviation*
1	Threat of new entrants	Government regulation	2.47	0.65	2.47	0.76
		The amount of capital requirement (–)	2.15	0.78	2.85	0.89
		Political stability	1.25	0.95	1.25	0.95
		New industry	2.83	0.67	2.76	0.72
2	Bargaining power of suppliers	Number of suppliers (–)	1.45	0.95	1.10	0.99
		Political stability (–)	1.25	0.95	1.25	0.95
3	Bargaining power of buyers	Number of buyers (–)	1.30	0.98	1.10	0.86
		Unique and differentiated products (–)	1.20	0.75	1.25	0.87
4	Threat of substitute	Number of substitutes	2.90	0.98	2.90	0.98
		Demand of products (–)	1.30	0.89	1.10	0.92
5	Rivalry	Number of companies	1.40	0.75	1.10	0.78

Since the industry is new, and new incentive programs have been adopted under governmental regulations, threat of new entrants is clearly a possible threat in the solar and wind energy industry. One of the important barriers for new entrants is limited capitals or lack of investors particularly for SMEs. Moreover, international sanction has its own negative effect on new entrants in new energy industry; for instance, threat of new entrants will be increased by absorbing foreign investments and expertise needed to expand the capacity.

Suppliers usually threaten to raise prices or reduce the quality of goods and services. Solar and wind technologies are supplied by domestic or foreign companies, especially by China whose products are cheaper than those produced domestically. International sanctions have profoundly affected Iran's energy sector. Sanctions have prompted to affect international trade, including supply and delivery of solar and wind technologies. Hence, foreign suppliers have a large bargaining power. In contrast, local manufacturers have less bargaining power than their foreign competitors due to the price difference mentioned above.

The price is very important for buyers in both solar and wind energy industries. It can also motivate companies competing against each other to reduce their profitability. Since buyers are usually public institutions, especially in the wind energy industry, this gives the government a large bargaining power which accompanies large volume of its orders. Furthermore, there is lack of differentiation and diversity in technologies.

Substitute products or services severely threaten new energy sector. Given the existing crude oil and natural gas reserves, and despite the fact that Iran's oil and natural gas production growth has declined over the past few years because of international sanctions, oil and gas are still great substitutes for renewable energies.

In addition, Iran is one of the most energy intensive countries globally with per capital energy consumption 15 times that of Japan and 10 times that of EU. In addition, enormous energy subsidies in Iran have made it one of the most energy inefficient countries of the world, with the energy intensity three times higher than global average and 2.5 times the Middle Eastern average (Meidani and Zabihi, 2014; Farahani et al., 2012). Consequently, despite possessing natural resources and the problem of high energy subsidies, Iran has planned to motivate companies in the field of new energy particularly solar and wind energies.

In Iran, there are around 100 companies in the solar energy industry while about 50 companies are operating in the wind energy section. This largely consists of importers, dealers, and service providers. A small number of companies are manufactures. The rivalry is not limited to domestic companies. Nevertheless, a significant number of products and services in solar and wind technologies are provided and controlled by the government. Government can be regarded as a huge competitor against private sector.

4.1.3 Analysis of solar and wind energy industry in Germany and Iran using diamond model

Corporate strategies have to increasingly emerge in a global context. Diamond model determines factors of national advantage. It suggests that the national home base of an organisation plays an important role in shaping the extent to which it is likely to achieve advantage on a global scale. This home base provides basic factors, which support or hinder organisations from building advantages in global competition. The results for the analysis of solar and wind energy industries in Germany and Iran are shown in Table 3:

Table 3 The analysis of diamond model in the solar and wind energy industries of Germany and Iran

No.	*Factors*	*Indicators*	*Germany*		*Iran*	
			Average	*Standard deviation*	*Average*	*Standard deviation*
1	Firms strategy, structure, and rivalry	Plans	2.67	1.10	1.45	0.96
		Abilities	2.54	1.08	1.43	0.87
2	Demand condition	Market size	2.70	0.89	1.20	1.09
		The growth rate of demand	2.45	0.94	1.67	1.10
3	Related and supporting industries	Supplier quality	2.78	0.86	1.34	0.84
		Technology maturity of the country	2.67	1.12	1.45	0.75
4	Factor condition	Quality of overall infrastructure	2.54	0.86	1.87	1.15
		Availability of financial support	2.90	0.74	1.67	1.03
5	Chance	Political stability	2.90	0.54	1.25	1.08
		Financial stability	2.80	0.87	1.25	0.98
		Amount of foreign investment	2.54	0.45	1.45	0.65
6	Government	Plans	2.90	0.56	2.67	1.03
		Policies	2.90	0.53	2.67	1.05
		Rules	2.90	0.46	2.54	1.12

Regarding firm strategy, structure, and rivalry, German SMEs in solar and wind energy industry have more ability and the specific plans. In case of demand condition, wind installed capacity in Germany in 2014 was 35,678 GW while solar capacity was 38,124 GW (Burger, 2015). By 2009, Iran had a wind power capacity of 130 MW (Wikipedia, *Wind Power in Iran*). However, the capacity of wind energy in Iran is 33,000 MW (IRNA). Energy generated by solar power reached 53 MW in 2005 and 67 MW in 2011 (Wikipedia, *Energy in Iran*).

Table 4 Installed wind power capacity (MW)

	End 2012	*New 2013*	*Total (end of 2013)*
Germany	31,270	3,238	34,250
Iran	91	–	91

Source: Global Wind Energy Council (2013)

To illustrate related and supporting industries, gross domestic expenditure on R&D can be used as an indicator to estimate the measures of this factor. Research and development (R&D) expenditure (% of GDP) in Iran was reported at 0.79 in 2008, according to the World Bank. In addition, R&D expenditure (% of GDP) in Germany was last measured at 2.84 in 2011 and about 2.7 in 2008.

Regarding factor conditions, Germany in 2012 invested €19.5 bil. in renewable energy while its total revenue only from wind energy installations in 2012 was €1,430 m. along with €1,220 m. from photovoltaics energy installations. In addition, gross employment in wind energy was 63,900 in 2004 and 101,100 in 2011, respectively. The figures for solar energy were 25,100 and 124,400 in 2004 and 2011, respectively (Volkmann, 2013). Iran in 2014 devoted IRR 250 bil. in the field of new energies which indicates a 25% increase compared to 2013. In 2013, Almost 4,000 job opportunities were created in the field of renewable energy in Iran.

According to the report of U.S. Energy Information Administration (2014), international sanctions have profoundly affected Iran's energy sector. Sanctions have prompted to affect foreign investment in Iran's energy sector, limiting the technology and expertise needed to expand the capacity at energy fields. In case of government, general plans, policies and rules such as credit guarantee and financial institutions to support, and encourage investment and development in both countries are almost high.

4.2 Analysis of solar and wind energy industry in Germany and Iran using triple helix model

4.2.1 Analysis of solar and wind energy industry in Germany

Germany's wind technology industry is composed of a highly effective network of different players (UIG) as described below:

a Government institutions: these institutions are in charge of directing the activities associated with the development of the industry at macro level.

b Research institutions: these include universities, applied science schools, and R&D centres directed to develop wind technologies in particular wind turbines and also develop professional human resources. It is noteworthy that many of the research centres are located at large companies in wind energy industry especially in the field of wind turbines and in fact, they operate as an R&D department.

Players referred to below constitute the wind industry.

c Wind turbine manufacturers: these companies aim to design, test, manufacture, and support the operation and maintenance of wind turbines. Germany is one of the world leading manufacturers of the wind turbines. These companies can be classified into three categories:

- Turbine manufacturers: manufacture and supply of wind turbines is performed by these companies. These companies may manufacture just some parts of the wind turbine and perform the combination of the design, construction and installation of the wind turbine.
- Component manufacturers: these companies offer products and services to manufacturers of wind turbines. Some of these products include towers, blades, gearboxes, converters/generators, controls, and other specialised components.
- Sub-component manufacturers: these companies provide some parts known as standard components and raw materials (especially steel and glass reinforced plastics) for component manufacturers. Thus, they do not communicate directly with turbine manufacturers.

d Wind park operators

- Wind park developers (wind project developers): these companies focus on building wind farms, construction and operation of the farm including purchase or lease of land, turbine supply, construction, installation of some tools used to estimate wind resource, providing secure transferring and sale of generated wind power.
- Grid connection vendors (wind farm operators): these companies operate the wind farms that are connected to the power grid and produce and sell electricity to the customer. These companies also perform some activities related to the development of wind projects and services such as maintenance.

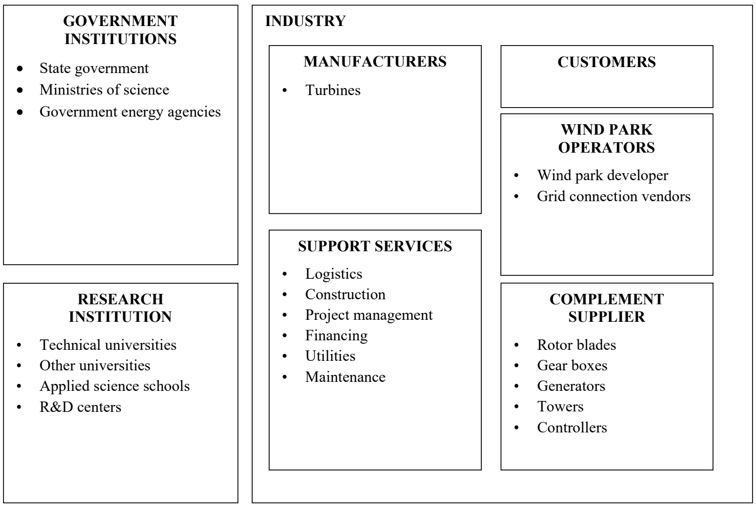
e Support services

- Investment companies: they make investments for profit purposes. Interest rates and payback period should be worthy enough to appeal the investors.
- Financiers: they are generally large experienced banks in the field of financing industrial projects. They are responsible for providing cash and other financial resources necessary for the development of wind projects. In many cases, investors play financing role. In addition, banks and public financial institutions aligned with government policy support the funding through loans and grants.
- Service providers: they mainly include reference laboratories, companies responsible for maintenance, consultants, and auditors. Reference laboratories which are supervised by the government are responsible for standardisation and certification and also monitoring to ensure the quality and quantity of electricity producers and other investors. Maintenance companies are responsible for the maintenance and repair of the wind turbines. Given the technical issues related to the maintenance, they have skilled and experienced human resources. Consultants provide specialised consulting for other companies in the field of wind energy. Auditors are responsible for auditing the components, sub-components, and turbine as well as testing the components, when required.

f Customers: They are private or public companies that purchase generated electricity and deliver it to end consumers by providing the necessary infrastructure and receiving the payments.

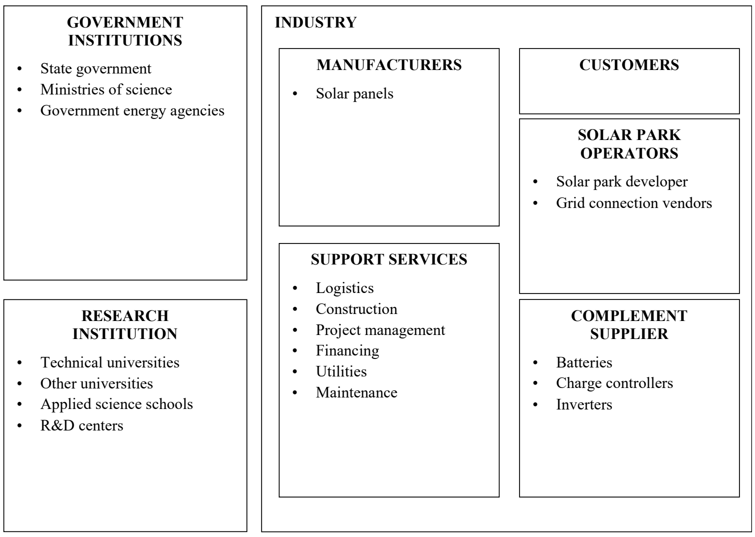
Players in the wind energy industry in Germany are shown in Figure 2.

Figure 2 Players in the wind energy industry in Germany



According to wind industry players, solar energy industry in Germany can be defined as follows. Note that in the solar energy industry, solar energy parks are not necessarily sources of energy. In other words, customers can be private or public companies that have installed solar technologies on the roof of their houses and can purchase generated electricity and deliver it to end consumers.

Figure 3 Players in the solar energy industry in Germany



4.2.2 Analysis of solar and wind energy industry in Iran

Iran's wind energy industry is composed of a network of different players as described below:

Government institutions are divided into four categories, depending on their roles in the industry:

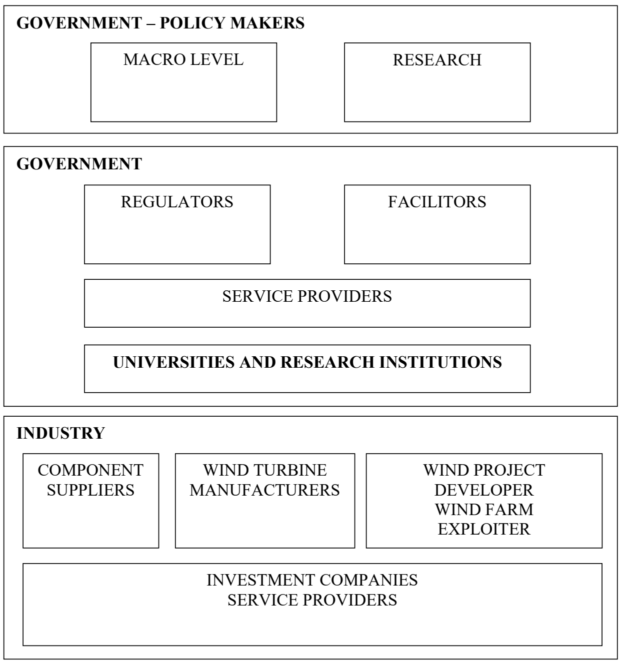
a Policy makers, e.g., the Parliament: they determine macro-level policies and directions that should be followed by governments and businesses, and used to prioritise services and the roles of actors in the industry.

b Regulators, e.g., Ministry of Energy: they regulate requirements and responsibilities of each company and institution.

c Facilitators, e.g., the Central Bank: they develop and improve the service market and provide support for a better political environment.

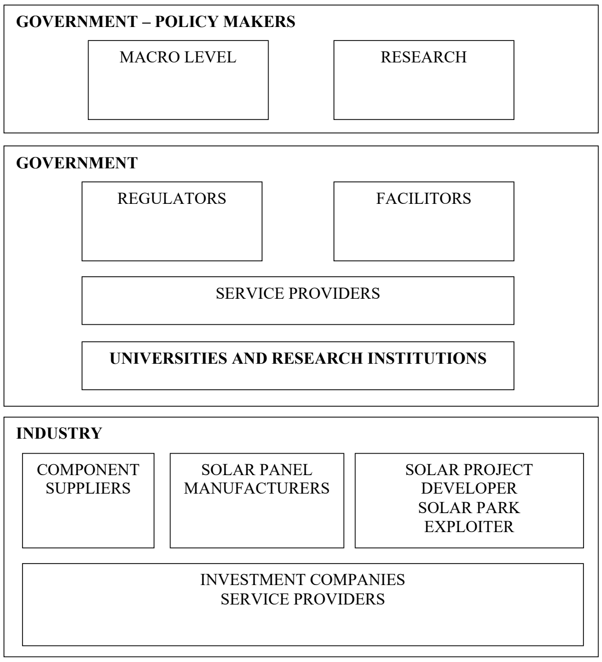
d Service providers, e.g., Power Development Organisation: they are organisations and institutions that provide services directly to the industry.

Figure 4 Players in the wind energy industry in Iran



According to wind energy industry players, solar energy industry in Iran can be defined as follows. Note that in the solar energy industry, solar energy parks are not necessarily regarded as sources of energy. In other words, customers can be usually public companies that have installed solar technologies on the roof of their houses and can use generated electricity.

Figure 5 Players in the solar energy industry in Iran



4.3 Analysis of solar and wind energy industry in Germany and Iran using functions of innovation system (IS)

Results obtained through functions of IS are shown in Table 5.

Table 5 Analysis of solar and wind energy industry in Germany and Iran using FIS

No.	*Indicators*	*Germany*		*Iran*	
		Average	*Standard deviation*	*Average*	*Standard deviation*
1	Trends of entrepreneurial	2.76	1.09	2.45	1.12
2	Trends of research activities	2.60	0.89	1.34	0.98
3	Collaboration between organisations on R&D	2.85	0.74	1.10	0.76
4	Targets set by government or industry	2.90	0.87	2.67	1.10
5	Financial market incentives	2.70	1.09	2.45	1.09
6	Availability of resources	2.60	1.10	2.20	1.13
7	Existence of advocacy coalitions	2.80	0.65	1.45	1.08

A GEM survey about entrepreneurial attitudes and perceptions (shown in the Table 6) measured the general public's attitudes towards and perceptions of entrepreneurship (Amoros and Bosma, 2013). A positive public attitude creates beneficial externalities such as cultural supports, financial resources, and networking opportunities for current and future entrepreneurs. The questionnaire involved a number of categories that appear as the headings of the columns in Table 6.

Table 6 Entrepreneurial attitudes and perceptions

	Perceived opportunities	*Perceived capabilities*	*Fear of failure*	*Entrepreneurship intentions*
Germany	31.3	37.7	38.6	6.8
Iran	37.0	56.5	36.4	30.6

	Entrepreneurship as a good career choice	*High status to successful entrepreneurs*	*Media attention to successful entrepreneurs*
Germany	49.4	75.2	49.9
Iran	64.1	82.4	59.9

Source: Amoros and Bosma (2013)

The numbers in the table represent percentages of the respondents who expressed certain attitudes. For example, 37.0% of the respondents in Iran perceived good opportunities for entrepreneurship. The percent of the respondents who perceived good opportunities in Germany is 31.3%. Next, 56.5% of the Iranian respondents perceived confidence in their own entrepreneurial capabilities. The figure drops to 37.7% in Germany. The third question of the survey involved assessment of fear of failure. A relatively large percentage of Iranian respondents (36.4%) expressed their fear of failure compared to the 38.6% of German respondents.

The category showing the intention of the respondent for starting a business represents a very high percentage (30.6%) in Iran compared to Germany (6.8%). A larger percentage of Iranian respondents (64.1%) considered entrepreneurship a good career choice compared to the almost 49.4% of the German respondents who believed entrepreneurship is a suitable career option. Almost 82.4% of the Iranian respondents perceived successful entrepreneurs to enjoy high status in the society compared to 75.2% of the German respondents who believed the same. The proportion of the respondents in the Iranian and German samples regarding the question of whether entrepreneurs received high media attention is roughly equal to 59.9% for Iran and 49.9% for Germany.

Table 7 shows some additional survey results about phases of entrepreneurial activity in Iran and Germany.

Table 7 The participation of individuals in entrepreneurship activity

	Nascent entrepreneurship rate	*New business ownership rate*	*Total early-stage entrepreneurship activity (TEA)*	*Established business ownership rate*
Germany	3.1	2	5	5.1
Iran	6.4	6.1	12.3	10.6

	Discontinuation of businesses	*Necessity-driven (% of TEA)*	*Improvement-driven opportunity (% of TEA)*
Germany	1.5	18.7	55.7
Iran	5.7	38	35.8

Source: Amoros and Bosma (2013)

An economy's total early-stage entrepreneurial activity (TEA) rate is defined as the prevalence rate of individuals in the working age population who are actively involved in business start-ups, either in the phase in advance to the birth of a firm (nascent entrepreneurs), or the phase spanning 42 months after the birth of a firm (owner managers of new firms). It is shown that a higher percentage of the respondents in Iran (12.3%) were involved in TEA compared to 5% of the respondents in Germany. The established business ownership rate (owner-managers in businesses that exist 3 1/2 years or more) in Iran (10.6 %) is higher than that in Germany (5.1%), while the rate of discontinuation of business in Iran (5.7%) is considerably higher than that in Germany (1.5%). The necessity driven businesses (entrepreneurs that are pushed into starting a business because they have no other options for work) out of the total TEA is 38% and 18.7% in Iran and Germany, respectively. However, the improvement driven entrepreneurship (entrepreneurs who sought to either earn more money or be more independent, as opposed to maintain income) in Germany (55.7%) outweighs the same for Iran (35.8%).

For knowledge development; one of the measures to assess the volume of knowledge creation and development is the number of scientific and technical journal articles. According to world development report (The World Bank, 2012), the numbers of scientific and technical journal articles in 2009 in Iran and Germany were 6,313 and 45,003, respectively. Another measure is the number of patents and industrial design applications compared in Germany and Iran as shown in Tables 8 and 9.

Table 8 Patent applications by patent office and origin, 2012

	Applications by office			*Equivalent applications by origin*	*PCT international applications*		*PCT national phase entry*	
	Total	*Resident*	*Non-resident*	*Total (1)*	*Receiving office*	*Origin*	*Office*	*Origin*
Germany	61,340	46,620	14,720	178,896	1,424	18,764	4,490	72,951
Iran	–	–	–	68	n.a.	2	–	5

Note: (1) Equivalent applications by origin data are incomplete, as some offices do not report detailed statistics containing the origin of applications.

Source: WIPI (2013)

Table 9 Industrial design applications by office and origin, 2012

	Application design count by office			*Application design count by origin*	*Equivalent application design count by origin*	*Hague international applications*	
	Total	*Resident*	*Non-resident*	*Total (1)*	*Total (1)*	*Origin*	*Designated Hague member*
Germany	55,599	42,962	12,637	76,369	655,499	663	191
Iran	–	–	–	1	1	0	n.a.

Note: (1) Design count by origin are incomplete, as some offices do not report the origin of applications.

Source: WIPI (2013)

International research and technological collaboration is known as one of the indicators to measure knowledge diffusion which is much higher in Germany. International sanctions have clearly limited the amount of international research and collaborations in Iran compared to Germany. As an indicator of guidance of the search, policy development and priority setting have been performed in both countries but not properly implemented in Iran. Market formation like the guidance of the search, although there are incentives and inducement mechanisms for market growth, such incentives were not effectively implemented in Iran. Domestic credit to private sector (% of GDP), which in 2010 amounted to 107.8 in Germany compared to 36.7 in Iran (The World Bank, 2012), shows supports to private sectors.

Resource mobilisation refers to availability of resources like research employees which is compared in Table 10.

Table 10 R&D full-time equivalent per million people

	Researchers 2005–2009	*Technicians 2005–2009*
Germany	3,780	1,329
Iran	751	–

Source: The World Bank (2012)

Support from advocacy coalitions in Germany plays greater role. Functions of IS in the solar and wind energy industry in Germany and Iran are shown in Figures 6 and 7.

Figure 6 Functions of (IS) in the solar and wind energy industry in Germany

Entrepreneurial activities:

- Federal Ministry for Education and Research (Bundesministerium für Bildung und Forschung, BMBF)
- Federal Ministry of Economics and Technology (BMWi)
- Scientific societies such as Helmholz
- Industry Associations
- Universities
- Research institutes
- SMEs

Knowledge development:

- Scientific societies such as Helmholz
- Industry Associations
- Universities
- Research institutes
- SMEs

Knowledge diffusion through networks:

- BMBF
- Scientific societies such as Helmholz
- Industry Associations
- Universities
- Research institutes
- SMEs

Guidance of the search:

- BMBF
- BMWi

Market formation:

- Industry players

Resource mobilisation:

- Ministry of Finance
- Programme Funding such as BMBF, German Research Foundation (Deutsche Forschungsgemeinschaft, DFG), and "Länder" program.
- Institutional Funding such as Universities, Max Planck Society for the Advancement of Science (MPG), Helmholtz Association, Scientific Association Gottfried Wilhelm Leibnis (Wissenschaftsgemeinschaft Gottfried Wilhelm Leibnis e.V., WGL), and Fraunhofer Society (Fraunhofer Gesellschaft, FHG)
- Target-group specific funding such research by SMEs

Support from advocacy coalitions;

- Ministry of Justice
- Federal Parliament
- "Länder" Parliaments
- Committee Education, Research and Technology Assessment

Figure 7 Functions of (IS) in the solar and wind energy in Iran

Entrepreneurial activities:

- Supreme Council of Science and Research
- Universities
- Science and technology parks

Knowledge development:

- Research institutes
- Universities
- Organisations specially knowledge-based organisations and SMEs

Knowledge diffusion through networks:

- Technology Cooperation Office of the President's Office
- Iranian Research organisation for science and technology (IROST)
- Universities
- Research institutes

Guidance of the search:

- Renewable energy innovation committee
- Supreme Council of Science and Research
- Supreme Council of the Cultural Revolution
- Ministry of Science, Research, and Technology (MSRT)

Market formation:

- Ministry of Energy
- Iran Power Development Company (IPDC)
- Tavanir Organisation
- Renewable Energy Organisation of Iran
- Ministry of Commerce
- Ministry of Economic Affairs and Finance
- Industry players

Resource mobilisation:

- Tavanir Organisation
- Renewable Energy Organisation of Iran
- Organisation of Natural Resources
- Central Bank
- Universities
- Research Institutes
- Organisations specially knowledge based organisations and SMEs

Support from advocacy coalitions

- The Expediency Discernment Council
- Parliament
- Ministry of Energy
- Oil Ministry
- Ministry of Industry
- Environmental Protection Agency

5 Discussion

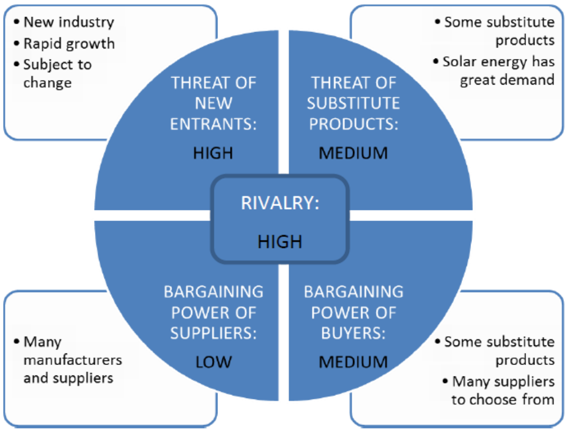
Rivalry among existing competitors in Germany is obviously fierce and not limited to domestic companies. Given the newness of the industry, openness to trade, and strong anti-trust policies, threat of new entrants is high in the solar energy; however because of the requirements for experience in wind energy, threat of new entrants is at medium level in this section. No one has a monopoly over the solar market, but since supplying high quality technologies in wind market is a main factor, supplier in wind industry have medium bargaining power. Moreover, buyers in both industries have medium bargaining power of in because of limited options they can choose from. In spite of the fact that there are threats of substitutes in solar and wind technologies, Germany has numerous customers in both markets, thus lowering the threat to a moderate level.

The levels of the five forces in the solar and wind energy industry of Germany are described in Table 11 and Figures 8 and 9.

Table 11 Value of five forces in the solar and wind energy industry in Germany

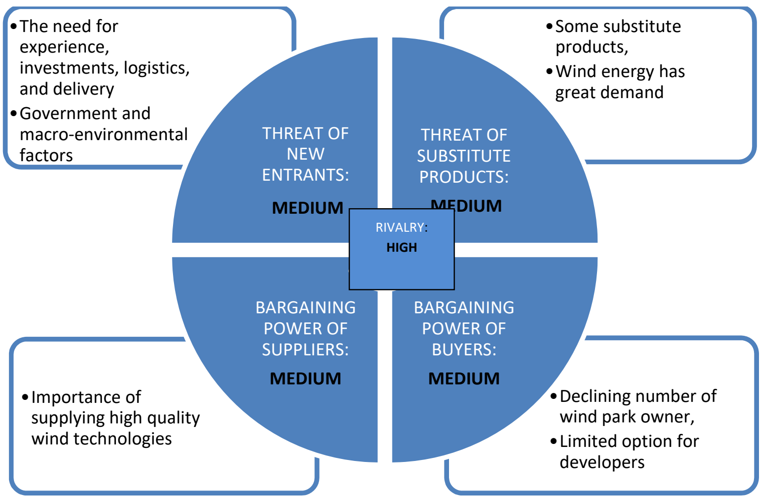
Forces	*Solar (average)*	*Value*	*Wind (average)*	*Value*
Threat of new entrants	2.45	High (> 2)	1.98	Medium (> 1 and < 2)
Bargaining power of suppliers	0.27	Low (< 1)	1.05	Medium (> 1 and < 2)
Bargaining power of buyers	1.25	Medium (> 1 and < 2)	1.37	Medium (> 1 and < 2)
Threat of substitute	1.60	Medium (> 1 and < 2)	1.53	Medium (> 1 and < 2)
Rivalry	2.83	High (> 2)	2.60	High (> 2)

Figure 8 The levels of the five forces in the solar energy industry in Germany (see online version for colours)



Source: Erkamo (2013)

Figure 9 The levels of the five forces in the solar energy industry in Germany (see online version for colours)



Source: Boeckle et al. (2010) and Sieck (2014)

Contrary to Germany, rivalry among existing competitors in Iran is medium due to the significant role of government. Despite the fact that government legislated and regulated new rules and incentive programs, threat of new entrants is medium because of the international sanctions and the need for investment. Additionally, especially as a result of international sanction, the bargaining power of suppliers is medium. Due to lack of uniqueness and also low number of buyers, the bargaining power of buyers is medium. Threat of substitute is high because of high number of substitutes and low demand of renewable energies.

Figure 10 and Table 12 illustrate the levels of the five forces in the solar and wind energy industry in Iran.

Figure 10 The levels of the five forces in the solar and wind energy industry in Iran (see online version for colours)

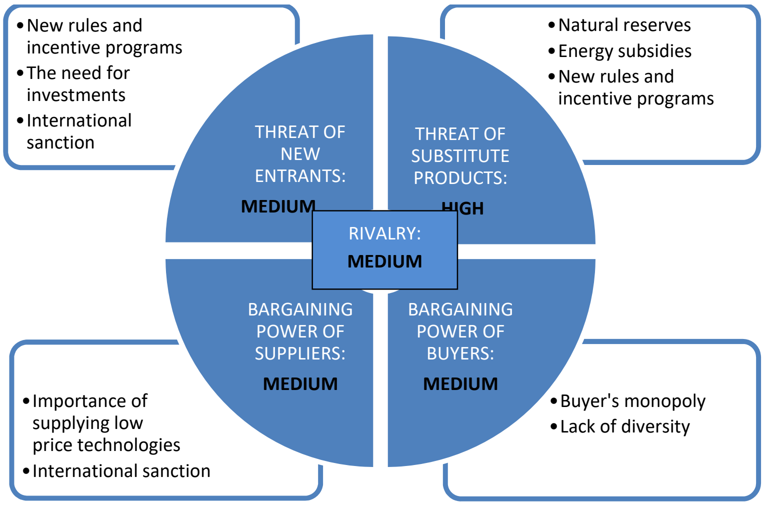


Table 12 Value of five forces in the solar and wind energy industry in Iran

Forces	*Solar (average)*	*Wind (average)*	*Value*
Threat of new entrants	1.83	1.66	Medium (> 1 and < 2)
Bargaining power of suppliers	1.65	1.83	Medium (> 1 and < 2)
Bargaining power of buyers	1.75	1.83	Medium (> 1 and < 2)
Threat of substitute	2.30	2.40	High (> 2)
Rivalry	1.40	1.10	Medium (> 1 and < 2)

Based on the theory of triple helix, in Germany industry plays an important role in comparison with the government. In contrast, in Iran the government plays a very extensive role. In Germany, in order to achieve the target in 2010, the main research and innovation policy objectives include improving the development of new technologies, commercialisation of research results, technology transfer and links between industry and science, engagement of SMEs in R&D and innovation, stimulation of new technology-based start-ups, development of research and technology-based regional clusters, financing R&D and innovation activities (e.g., supply of venture capital, financial support for R&D and innovation in SMEs), removing bureaucratic obstacles for research and innovation activities, using higher education sector to secure quality and availability of trained and skilled young researchers, engineers, and the promotion of innovation in the five new states of the Federation (Länder) in the course of their economic restructuring (Proneos GmbH, 2006). In other words, although government plays a key role in policy making, supports and funds R&D and innovation, and intensifies the cooperation among industry and research players, but research institutes and societies and SMEs strongly influence the economic strength and innovation performance.

According to UNCTAD (2005), the major actors in Iran's national system of innovation and consequently in new energy industry are government ministries, research institutes/universities and large enterprise. By virtue of ownership of almost all the research institutes/universities and a vast majority of the enterprises, the government has become the most significant player in Iran's NSI. With the exception of a small number of high-tech start-up enterprises, the contribution of the private sector to innovation and technology development is limited. Government-owned research institutes and universities perform most of the innovation/technology development activities.

According to the results of entrepreneurial activities, entrepreneurial activities in Iran are robust. However, to a certain extent, these activities in the emerging economy of Iran are necessity driven, rather than improvement driven. As it is clear from other functions, much of entrepreneurship in Iran does not involve innovation. Accordingly, inadequate innovation in Iran is primarily due to a weakness in the innovation system of the country. This means that the technological systems of the country have not adequately matured so that they can encourage and nurture innovations.

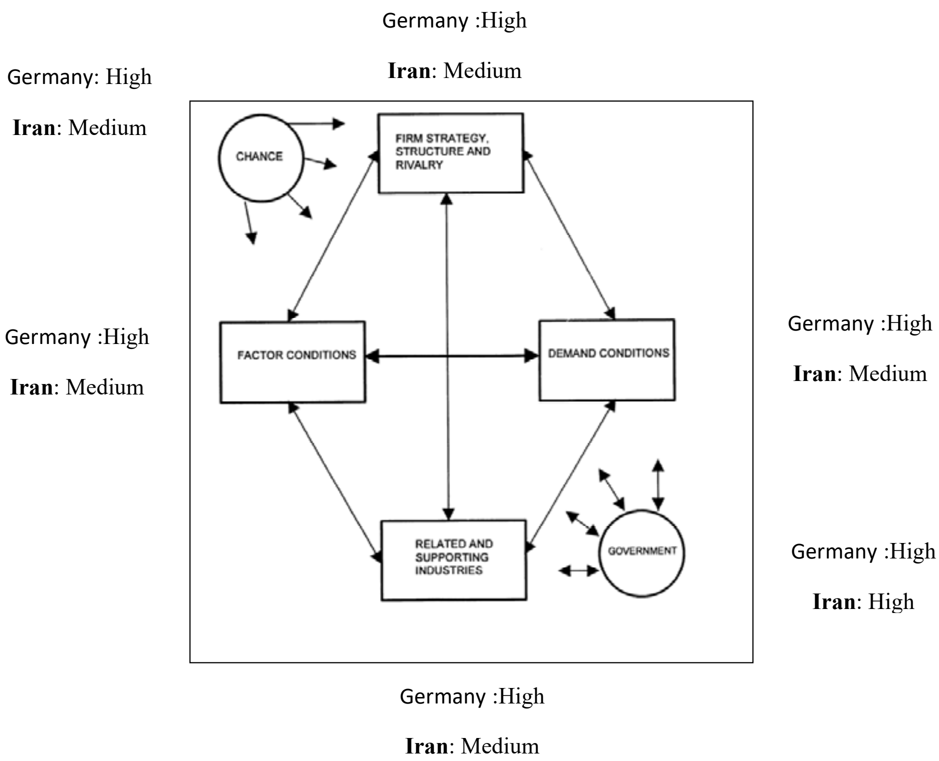
Besides, the Iranian IS is a supply-push system. It is based on the implicit philosophy that 'supply creates its own demand'. That is, the implicit assumption of government science and technology decision making is that industry will learn to use a technology that has been supplied. Clearly, this system is totally different from a demand-pull system of innovation in Germany, where to meet the market demand and rigor of competition, enterprises are forced to invest considerable resources in R&D for innovation.

As it is clear from Table 13 and Figure 11, factor conditions regarding resources and infrastructure, the state of home demand, supporting industries such as R&D, and domestic competition in Germany are considerably stronger than Iran. Governments in both countries sustain the renewable energy by providing regulations and financial support. In addition, due to openness of international collaboration in Germany, there are more opportunities in this country for developing renewable energy.

Table 13 Value of diamond factors in the solar and wind energy industry in Germany and Iran

Forces	*Germany*		*Iran*	
	Average	*Value*	*Average*	*Value*
Firms strategy, structure, and rivalry	2.60	High (> 2)	1.44	Medium (> 1 and < 2)
Demand condition	2.57	High (> 2)	1.44	Medium (> 1 and < 2)
Related and supporting industries	2.73	High (> 2)	1.39	Medium (> 1 and < 2)
Factor condition	2.72	High (> 2)	1.77	Medium (> 1 and < 2)
Chance	2.75	High (> 2)	1.32	Medium (> 1 and < 2)
Government	2.90	High (> 2)	2.63	High (> 2)

Figure 11 Diamond model in the solar and wind energy industry in Germany and Iran



6 Conclusions

This study examined the solar and wind energy industry of Germany and Iran according to five forces model and clearly indicated that this industry is more competitive in Germany than it is in Iran. An obvious finding of this analysis is that a major obstacle and the cause of the low competitiveness of the industry in Iran is the international sanction. The negative effects of these sanctions are already visible on the macro and micro environmental factors of the country. For instance, Iran generally had no access to international markets for buying and selling. In addition, since Iran has usually been an importer of technologies, performing research, development and commercialisation of technology is expensive and time-consuming, limiting the industry's capabilities in competing with the cheaper imported technologies. Although, improving innovation requires national and also international collaboration, sanctions have made international collaboration very difficult. Another obstacle is the dependency on oil and gas as resources of energy. About 90% of foreign exchange revenues are gained through exports of oil and gas (Farzanegan, 2011). However, Iran planned to support renewable energy projects through various policies and regulations such as 'Renewable Portfolio Standards (5,000 MW RE Power in 2020)' (IEA, 2014). Another important reason for low competitiveness of Iran's solar and wind industry is the number of customers or buyers' monopoly. It arises as a result of subsidies for energy and lack of public awareness about solar and wind technologies.

Furthermore, this study defined major actors in the solar and wind energy industry in Germany and Iran. In Germany there is a systematic integration among universities, industry, and government contrary to Iran whose government plays a key role in this area, limiting the role played by the industry. In this regard, Iran's government sets out to support industry and private sectors. For example, 'Renewable Portfolio Standards (5,000 MW RE Power in 2020)' for wind and solar energy industry has enabled the government to support private and cooperative sectors by using managed funds and loan interest subsidies to pave the way for the installation of 5,000 MW wind and solar energy in order to help establish infrastructures required to manufacture solar and wind power plant equipment, deploy clean energy, and increase the renewable share in the country energy mix (IEA, 2014).

This study also presented and examined the functions of IS in solar and wind energy industry in both countries. In Germany, SMEs are important actors in the majority of functions and regarded as main pillars of its economy. Although in Iran SMEs generally play role in the market formation and entrepreneurial activities, recently due to the emphasis and support for renewable energies and knowledge-based organisations, they will be more involved in knowledge development and diffusion.

Furthermore, this study investigated the competitive advantage of the solar and wind energy industry of both countries in the global market. In addition to the competitive, innovation, and government conditions discussed explicitly in the five forces model, innovation system, and triple helix, this study also examined the resources, current installed capacity, and opportunities. According to the statistics presented by Amoros and Bosma (2013), for entrepreneurial activities which are closely related to knowledge development, Iran has an appropriate status concerning human resources which should be systematically organised and integrated. Existing plan for achieving 5,000 MW RE power in 2020 by solar and wind technologies should be followed and monitored. With regard to opportunities, the worst obstacle, as described earlier, is international sanctions which threatens all industries in Iran.

In short, this paper studied the status of solar and wind energy industry in Germany and Iran based on a comprehensive model made by four methods by using a questionnaire which includes indicators defined in the research model, and drawing on the available world statistical data. Each method checks out the industry with a limited perspective; however, a more comprehensive view was provided by applying all these methods together.

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