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International Energy Security Indicators and Turkey's Energy Security Risk Score

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ABSTRACT: Energy security has been a priority for many countries. What makes energy security that important is; its bilateral relationship with economic, political, social, environmental sustainability and military issues. As an inevitable consequence of globalization cooperation in the field has been a must and it is required international energy security indicators to make energy security risk evaluations in order to establish adequate policies. The aim of the study is to review energy security within the concept of international energy security indicators, international energy security risk index, international energy security rankings and to reveal Turkey's energy security risk summary emphasizing the components of energy security issue.

Keywords: Energy security indicators; energy security risk.
JEL Classifications: F50; Q40.

1. Introduction

Energy is vital for sustainable development and sustainability is not only at the heart of development, but also of economic, environmental, social and military policies. To ensure the sustainability of the policies "security" appears as a mandatory objective to achieve. Furthermore, recent crises prooved that energy security must be considered in national and international energy policies and related strategies.

Energy security is briefly defined as the uninterrupted availability of energy sources at an affordable price taking account environmental concerns and sustainable development. To form national and international energy policies considering energy security requires international indicators. International index of energy security risk allows to make comparisons between countries. Because energy security risk is a multifaceted issue; international energy security risk scores and international energy security rankings reflect countries' factors of energy security including diversification of source, relationship among nations, environmental acceptability, sufficiency relative to demand, accessible/available/affordable/competitive/reliable/uninterruptible supply. Risks are classified as physical, economic, political, regulatory, social, environmental reminding the threats like human intervention, equipment failure and extreme weather. The energy security indicators; international energy security risk scores and international energy security rankings are influenced by mentioned risks and threat. Following that international energy security risk scores and international energy security rankings affect economic, political, social and environmental indicators reciprocatively.

The rest of paper is organized as follows. In section 2 several energy security definitions are presented. International energy security indicators are presented in section 3. Section 4 examines international energy security risk index. Section 5 considers international energy security rankings and Turkey's energy security risk. The final section concludes.

2. The Components of Energy Security

Energy security is a complex issue with its multiple dimensions. Currently energy security is not only at the heart of the national and international energy policies, but also at the heart of the national and international security policies. To better understand why, it is needed to clarify the components of the energy security.

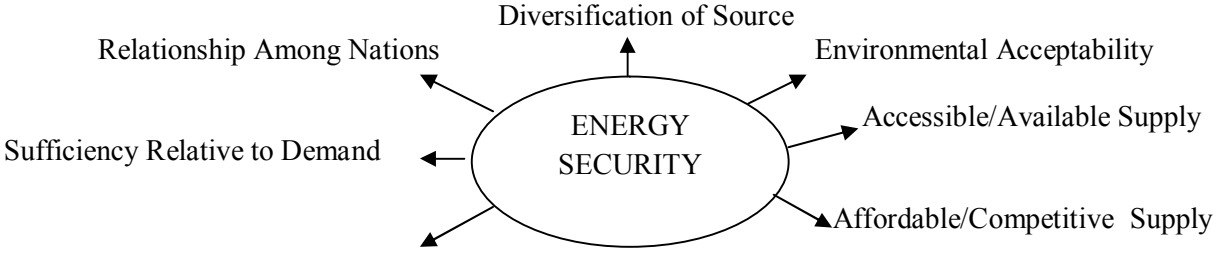
The IEA defines energy security as the uninterrupted availability of energy sources at an affordable price and examines it in the short and long terms (IEA, 2014a):

•in the long term, energy security concerns with timely investments to supply energy in accordance with economic development and sustainable environmental needs,

• in the short term, energy security focuses on the ability to react promptly to sudden changes in the supply-demand balance. World Coal Association considers resource availability for the long term and relates short-term security to supply disruptions of the primary fuel or of the generated electricity (WCA, 2014). World Economic Forum (WEF) Global Agenda Council on Energy Security and Yueh (Yueh, 2010:216) defined energy security as the reliable, stable and sustainable supply of energy at affordable prices and at an acceptable social cost. The European Commission's (2000) defined energy security as the "the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers (private and industrial), while respecting environmental concerns and looking towards sustainable development, as enshrined in Articles 2 and 6 of the Treaty on European Union". Yergin (2006) defined energy security as the availability of sufficient supplies at affordable prices. Winzer claimed that "secure energy means that the risks of interruption to energy supply are low" (Winzer, 2011:4). Shih suggests that energy security is assured when a nation can reliably, economically, environmentally and safely deliver energy in sufficient quantities to support growing economy and defense needs (Shih, 2014).). Bohi and Toman (1996) drew attention to the lack of energy security and defined energy insecurity as "the loss of economic welfare that may occur as a result of a change in the price or availability of energy."

In point of fact the meaning of energy security differentiates from countrys' dependence to their energy imports. Accordingly; countries which are highly dependent on imported oil and gas adheres energy security to supply whereas, countries which export oil and gas adheres energy security to demand (Tippee, 2014). This variability of the definition of energy security is also stressed by M uller-Kraenner (2008), Kruyt et al. (2009) and Chester (2010). However, all of the definitions of energy security includes availability, sufficiency, affordability, welfare, energy products (or supplies) and interruptions as common points. Figure 1 shows the components of energy security.

Figure 1. Factors of Energy Security



Source: IEA (2014a), Tippee (2014).

3. International Energy Security Indicators

Measuring energy security requires indicators. To determine indicators it is needed to determine threats to energy security. The indicators of energy security are summarized below which are determined considering these threats like human intervention, equipment failure and extreme weather (POST, 2012):

•Energy Resources

1-Supply and prices can be disrupted by political action.

2-Energy Security is threatened by the depletion of conventional oil reserves.

3-Restricted rezerves of oil and gas threatens energy security.

4-Import dependence is an indicator of reduced energy security.

5-A more diverse energy system contributes energy security.

•Infrastructure

Electricity networks can be damaged by bad weather.

•**Demand**

Gas demand can be difficult to meet in a cold winter's day.

1-Overall energy demand

2-Energy demand per home or unit of economic activity

3-Energy costs as a proportion of total expenditure

4-Capacity for demand side response

It is also required energy security metrics for international index. Energy security metrics used in international index are classified as global fuels, fuel ımports, energy expenditure, price&market volatility, energy use ıntensity, electric power sector, transportation sector and enviromental (U.S. Chamber of Commerce, 2013:68):

"Global Fuels: Measure the reliability and diversity of global reserves and supplies of oil, natural gas and coal. Higher reliability and diversity mean a lower risk to energy security.

Fuel Imports: Measure the exposure of the national economies to unreliable and concentrated supplies of oil, natural gas and coal. Higher supply reliability and diversity and lower import levels mean a lower risk to energy security.

Energy Expenditure: Measure the magnitude of energy costs to national economies and the exposure of consumers to price shocks. Lower costs and exposure mean a lower risk to energy security.

Price & Market Volatility: Measure the susceptibility of national economies to large swings in energy prices. Lower volatility means a lower risk to energy security.

Energy Use Intensity: Measure energy use in relation to population and economic output. Lower use of energy by industry to produce goods and services means a lower risk to energy security.

Electric Power Sector: Measure indirectly the reliability of electricity generating capacity. Higher diversity means a lower risk to energy security.

Transportation Sector: Measure efficiency of energy use in the transport sector per unit of GDP and population. Greater efficiency means a lower risk to energy security.

Enviromental: Measure the exposure of national economies to national and international greenhouse gas emission reduction mandates. Lower emissions of carbon dioxide from energy mean a lower risk to energy security."

It is important for the indicators to reflect all of the components adequately. Energy intensity, energy dependency for different energy sources (oil, gas,…), reserves-to-production ratios (oil, gas,…), energy price (oil price), share of biofuels in road transport are the most popular indicators of energy security (Badea 2010):

Energy Intensity *= TPES / GDP*

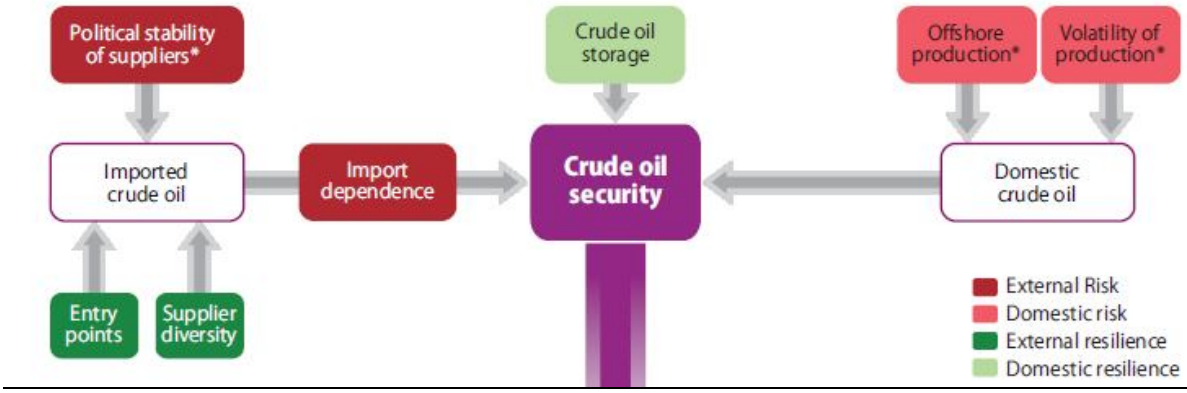
Energy Dependency for Different Energy Sources (Oil, Gas,…) *= Import / Gross Inland Energy (%)*

Reserves-to-Production Ratios (Oil, Gas,…) *= Proven Reserves / Primary Production (Y)*

Share of Biofuels in Road Transport*=Biofuel Consumption /Petrol & Diesel Consumption (%)*

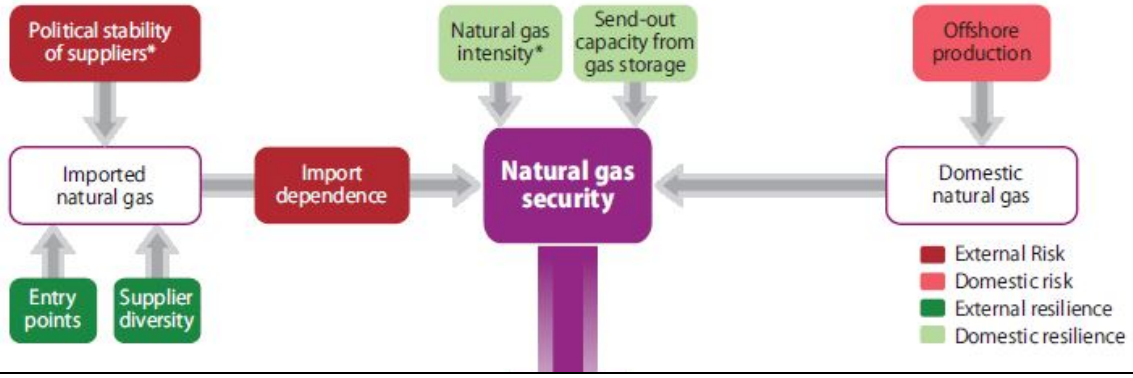
Following figures 2 and 3 illustrate the schematic diagrams for crude oil and natural gas security with indicators respectively.

Figure 2. Schematic Diagram for Crude Oil Security with Indicators



Source: IEA (2014b).

Figure 3. Schematic Diagram for Natural Gas Security with Indicators



Source: IEA (2014b).

Energy security indicators are also the strategies for enhancing energy security (Badea 2010):

- increasing the number of fuels and technologies,
- increasing the number of suppliers for each fuel (especially if imported),
- developing storage capacity for different fuels,
- using endogenous energy resources,
- increasing energy efficiency and conservation.

4. International Energy Security Risk Index

As an inevitable consequence of globalization, the energy systems of the countries has been interconnected tightly. This means that energy policies cannot be considered seperately anymore. When this is the case each step will affect another and international analysis becomes a must in the field. "**The International Index of Energy Security Risk**" allows us to compare energy security risks between countries, country groups and shows the change in energy security risks over time using two indicators; energy security risk scores and international energy security rankings in absolute terms and relative to a baseline average of the OECD countries (U.S. Chamber of Commerce, 2013:65).

Likewise, the European Union gives priority to the security of energy. The Commission's green paper classifies risk as physical, economic, political, regulatory, social, environmental in the energy arena and explains the sources of risk as below (Labandeira and Manzano, 2014):

Physical risks: distinguishing between permanent disruption (due to stoppages in energy production or to exhaustion of energy resources) and temporary disruptions (due to geopolitical crisis or natural disasters).

Economic risks: caused by volatility in energy prices after imbalances between demand and supply.

Political risks: brought about by energy exporting countries that intend to employ energy deliveries as a political weapon.

Regulatory risks**:** due to poor regulations in domestic markets and regulatory variability in exporting countries (both in terms of security of energy investments and of security of supply contracts).

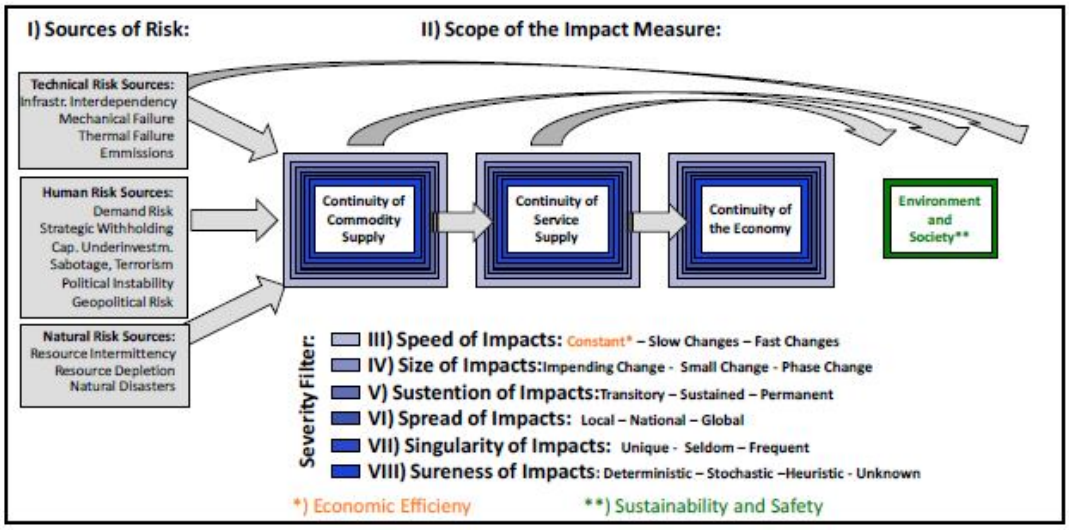
Social risks: due to social conflicts linked to continuous increases in energy prices.

Environmental risks: related to the energy sector (oil spills, nuclear accidents, etc.) and may cause serious environmental damages.

In figure 4, the extents of energy security referring to the sources of risk are showed. The IEA has developed the Model of Short-Term Energy Security (MOSES), a tool to inform energy-security policies through quantifying vulnerabilities of energy systems and based on a set of quantitative indicators that measures risks and resilience of security of energy supply in IEA countries (IEA, 2014b).

Table 1 shows crude oil, oil products, natural gas, coal, hydropower and nuclear power under the categorization of dimension and indication using IEA, OECD, Worldbank and various national sources. According to the table, energy sources' risk and resilience are analyzed both domestically and externally. And then external-domestic risk-resilience are explained as indicators.

Figure 4. Extents of Energy Security Referring to the Sources of Risk



Source: Winzer (2011:10).

Table 1. Risk and Resilience Indicators Used in MOSES

Energy source	Dimension		Indicator	Source(s)
Crude oil	External	Risk	Net-import dependence	IEA
			Weighted average of political stability of suppliers	IEA, OECD
		Res.	Entry points (ports and pipelines)	IEA
			Diversity of suppliers	IEA
	Domestic	Risk	Proportion of offshore production	IEA
			Volatility of domestic production	IEA
		Res.	Stock level	IEA
Oil products	External	Risk	Net-import dependence	IEA
		Res.	Diversity of suppliers	IEA
			Entry points (ports and pipelines)	IEA
	Domestic	Res.	Number of refineries	IEA
			Flexibility of refining infrastructure	IEA
			Stock level	IEA
Natural gas	External	Risk	Net-import dependence	IEA
			Weighted average of political stability of suppliers	IEA, OECD
		Res.	Entry points (LNG ports and pipelines)	IEA
			Diversity of suppliers	IEA
	Domestic	Risk	Proportion of offshore production	IEA
		Res.	Daily send-out capacity from underground and LNG storage	IEA
			Natural gas intensity	IEA, World Bank
Coal	External	Risk	Net-import dependence	IEA
		Res.	Entry points (ports and pipelines)	IEA
			Diversity of suppliers	IEA
	Domestic	Risk	Proportion of mining that is underground	various national sources
Hydropower	Domestic	Risk/ Res.	Annual volatility of production	IEA
Nuclear power	Domestic	Risk	Unplanned outage rate	IAEA
			Average age of nuclear power plants	IAEA
		Res.	Diversity of reactor models	IAEA
			Number of nuclear power plants	IAEA

Source: IEA (2014b).

5. International Energy Security Rankings and Turkey's Energy Security Risk Summary

International energy security risk scores and international energy security rankings of the countries, allow to make an evaluation about their energy security risk potentials. Table 2 shows energy security risk scores and rankings for 25 large energy-consuming countries. The table enables us to compare countries' energy security risk scores against each other and the OECD average in 2012. The highest (best) rank has the lowest numerical risk score and the lowest (worst) rank has the highest numerical risk score. As it is; Norway is the most energy secure country since 2001. With a risk score 1,194; Turkey exceeds OECD average which is 1,051.

Table 2. Energy Security Risk Scores and Rankings for 25 Large Energy Using Countries (2012)

Country	Risk Score	Large Energy User Group Rank
Norway	909	1
Mexico	928	2
New Zealand	955	3
United Kingdom	973	4
Canada	987	5
United States	999	6
Australia	1,000	7
Denmark	1,024	8
Germany	1,047	9
OECD	1,051	
France	1,088	10
Poland	1,101	11
Indonesia	1,127	12
Spain	1,173	13
Russia	1,176	14
Turkey	1,194	15
South Africa	1,207	16
Italy	1,208	17
Japan	1,219	18
China	1,228	19
Brazil	1,231	20
India	1,237	21
Netherlands	1,312	22
South Korea	1,514	23
Thailand	1,559	24
Ukraine	2,250	25

Source: U.S. Chamber of Commerce (2013:9).

Table 3 provides evidence that countries' energy security rankings exhibit steady tendency. The country having a good energy security rank seems to maintain it and vice-versa. U. S. Chamber of Commerce states that the fall in energy security risks of the countries' are related to lower energy prices and expenditure volatility in the corresponding years. The table shows that Ukraine was the least energy secure country in the large energy user group with a score of 2,250, which is 114% above the OECD average.

Meeting 26 % of the total energy demand by domestic resources Turkey aims to (MFA, 2014)

"•diversify its energy supply routes and source countries,

•increase the share of renewables and include the nuclear in its energy mix,

•take significant steps to increase energy efficiency,

•contribute to Europe's energy security".

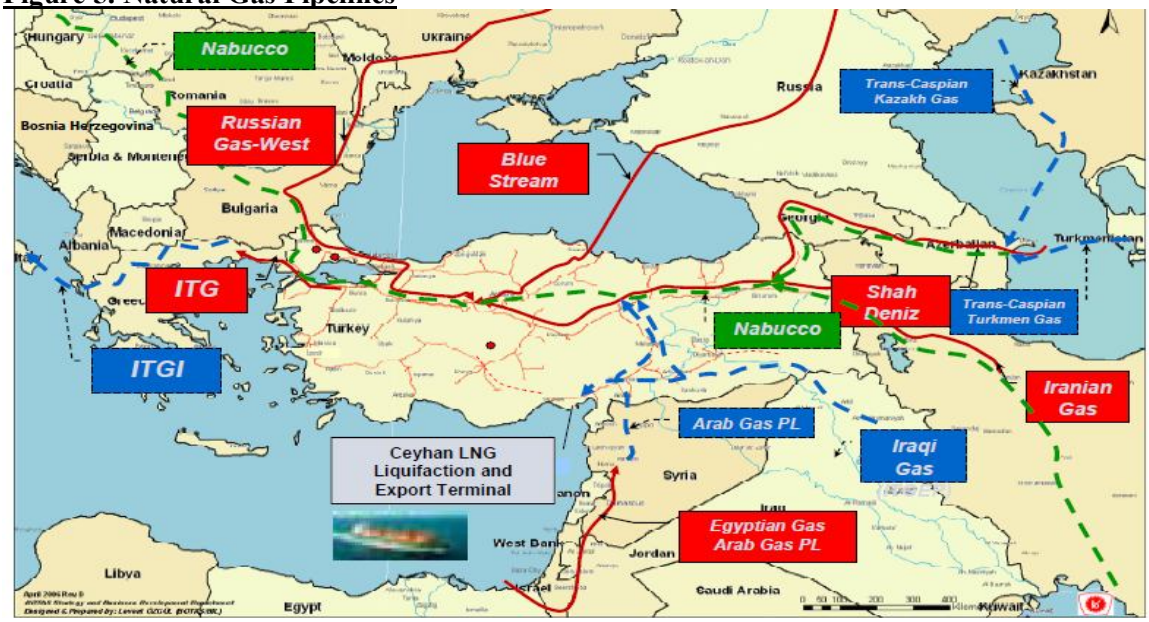
Table 3. Energy Security Rankings for Large Energy User Group 1980-2012

	1980	1985	1990	1995	2000	2005	2010	2011	2012
Australia	2	5	3	4	4	6	5	5	7
Brazil	12	8	11	13	16	14	14	18	20
Canada	8	7	5	5	6	5	6	6	5
China	23	23	23	20	17	18	21	20	19
Denmark	18	14	12	16	8	8	8	8	8
France	17	16	15	12	11	11	10	10	10
Germany	14	15	16	10	7	7	9	9	9
India	13	20	19	21	21	20	19	21	21
Indonesia	7	9	7	6	12	12	13	12	12
Italy	15	18	21	17	19	19	18	17	17
Japan	20	21	18	19	20	16	15	14	18
Mexico	1	1	1	1	1	2	2	2	2
Netherlands	21	19	20	18	18	22	22	22	22
New Zealand	3	2	4	3	3	4	3	3	3
Norway	6	6	6	8	5	1	1	1	1
Poland	11	12	13	14	10	10	12	11	11
Russia	24	24	24	23	22	21	20	19	14
South Africa	16	13	14	15	14	13	16	16	16
South Korea	22	22	22	24	24	23	23	23	23
Spain	10	11	9	11	13	17	11	13	13
Thailand	19	17	17	22	23	24	24	24	24
Turkey	5	4	10	9	15	15	17	15	15
Ukraine	25	25	25	25	25	25	25	25	25
United Kingdom	4	3	2	2	2	3	4	4	4
United States	9	10	8	7	9	9	7	7	6

Source: U.S. Chamber of Commerce (2013:12).

Turkey is a natural energy corridor between the Middle East and the Caspian basin and Europe in consequence of its geographical location. Turkey plays a critical role for Europe aiming to diversify its energy suppliers for natural gas. Turkey has already the potential to become an important hub for oil and gas transported through pipelines Blue Stream for Russian gas, BTC for Caspian oil and gas, The interconnector to Greece and Links to Iran and Iraq (Barysch, 2014). For this reason Turkey has a key position for Europe's energy security. Figure 5 presents natural gas pipelines considering Turkey's location.

Figure 5. Natural Gas Pipelines



Source: European Commission (2014).

The last table group (table 4) shows Turkey's energy security risk summary, Turkey's and OECD's risk index scores and Turkey's energy security risk variance from OECD respectively. The table shows that Turkey's energy security risk score was 1,194 in 2012 whereas energy security risk score was 1,268 in the previous year. However large energy user group ranks remain stable; 15 both in 2011 and 2012. Turkey's energy security risk score was 875 in 1980 and the same value in 2012 is 319 points more than that score. Besides Turkey had the best energy security risk score in 1985 which is 777, and the worst energy security risk score 1,268 in 2011. The table provides evidence that Turkey's overall energy security risk scores have risen fast implementing the lowest (worst) energy security large energy user group rank.

Table 4. Turkey's Energy Security Risk Summary

Energy Security Risk Summary: Turkey	
Risk Scores:	
2012 Energy Security Risk Score	1,194
2012 Large Energy User Group Rank	15
Score in Previous Year	1,268
Rank in Previous Year	15
Score in 1980	875
Average Score: 1980-2012	913
Best Energy Security Risk Score	777 (1985)
Worst Energy Security Risk Score	1,268 (2011)
Risk Scores Relative to OECD Average:	
Average Annual Difference 1980-2012	5%
Best Relative Score	-15% (1981)
Worst Relative Score	19% (2009)

Source: U.S. Chamber of Commerce (2013:56).

6. Conclusion

Being one of the main targets of national and international energy policies; energy security is of interest to all nations. The reason of the close interest is the reflection of energy security in political actions. Allowing to compare energy security risks between countries, country groups and showing the change in energy security risks over time; "the international index of energy security risk" uses two indicators energy security risk scores and international energy security rankings. International energy security risk scores and international energy security rankings are determinants for the future routes of the policy makers. They give an idea about countries' economic, political, social, environmental structure. Thus score and ranking values have multidimensional effects on trade, investment, energy agreements and contracts. On the other hand, international energy security risk scores and international energy security rankings serve to enhance energy security.

Turkey's best energy security risk score was in 1985; 777. On the other hand in 2011 Turkey had the worst energy security risk score which was 1,268. In 2012; the energy security risk score of Turkey was 1,194 which is less than the previous year's, but is still high. Because energy security risk score is an indicator of economic, political, social and environmental risk as well; it denotes the problems in the related fields. Since therefore economic, political, social and environmental improvements will be reflected in the energy security risk score and vice-versa.

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