Measuring Turkey's Energy Security in the Natural Gas Sector: *Potential Outcomes of the Nabucco and South Stream Projects*

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Advisors:
Prof. Dr. Ulrich Wurzel
Dipl.-Vw. Dipl.-Geogr. Lech Suwala

By
Volkan Emre

Abtract

This paper presents a quantitative assessment of the impact of two gas pipeline projects, Nabucco and South Stream, on Turkey's energy security. The incidence of the impact is based on three dimensions of energy security: supply-demand balance, production source diversity, and transit route diversity. This paper relies on the Herfindahl Hirschman Index (HHI) and the adjusted Shannon Weiner Index (SWI) to evaluate and compare the impact of the various project implementation scenarios. The main findings are that both projects enhance Turkey's energy security and provide valuable and timely energy supply in the medium-term but their contribution is inadequate and marginal in the long-run. More specifically, the implementation of Nabucco significantly reduces the market concentration of producers whereas the South Stream project improves transit diversity by including Bulgaria as a major transit player. Surprisingly, implementation of Nabucco reduces transit diversity security because it includes politically volatile regions like Iraq and Georgia.

Acknowledgements

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List of Abbreviations

Bcm/y	Billion Cubic Meters per Year
BOTAS	Turkish State Pipeline Corporation
BTE	Baku-Tbilisi-Erzurum Pipeline
CEEC	Central and Eastern European Countries
EMRA	Republic of Turkey Energy Market Regulation Authority
EIU	Economic Intelligence Unit
EUAS	Republic of Turkey Electricity Generation Company
EU	European Union
GIE	Gas Infrastructure Europe
HHI	The Herfindahl Hirschman Index
MENR	Republic of Turkey Ministry of Energy and Natural Resources
MFA	Republic of Turkey Ministry of Foreign Affairs
OECD	Organization of Economic Cooperation and Development
OPEC	Organization of Petroleum Exporting Countries
PIGM	Republic of Turkey General Directorate of Petroleum Affairs
SOCAR	State Oil Company of Azerbaijan Republic
SWI	The Shannon-Weiner Index
TANAP	Trans Anatolian Gas Pipeline
Toe	Tonne of oil equivalent
USDA	United States Department of Agriculture

Chapter 1

Introduction

The Turkish economy was the fastest growing economy in Europe last year, with a growth rate around 9 percent (IMF, 2012, p. 194). Turkey's average annual real GDP growth from 2002 to 2011 has also been the highest in Europe, averaging 5.2 percent (See Figure 1.1).

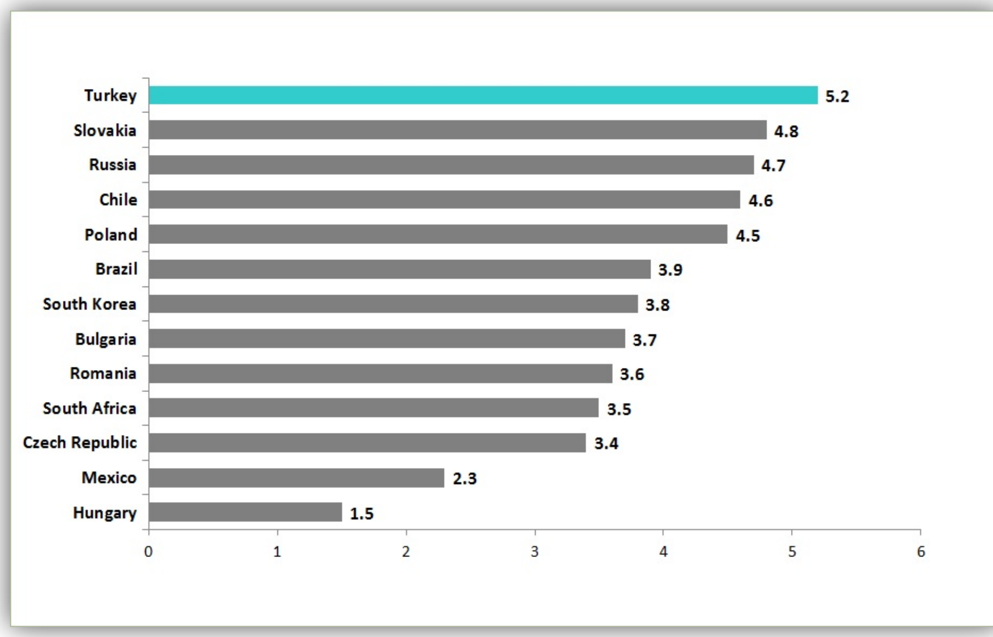


Figure 1.1: Turkey's Average Annual Real GDP growth from 2002–2011. Source: `www.invest.gov.tr`

At a time when the world economy has been falling prey to a global recession, Turkey has emerged as a regional economic giant. Its GDP has more than tripled in the last decade, from $231 billion in 2002 to $772 billion in 2011 (TurkStat Online Database, 2012). Over the same period, the GDP per capita has risen from $3,500 to $10,444, a remarkable accomplishment to say the least (TurkStat Online Database, 2012). At the rate, Turkey's economy is expected to sustain a growth rate of 6.7 percent through 2017, the highest in OECD countries (OECD, 2009, p. 73).

Turkey's economic performance and its forecasted growth potential cannot be realized without an affordable and consistent supply of energy. For this reason, this paper assesses the relevance of energy security in addressing Turkey's future energy needs.

1.1 Motivation

Natural gas plays an increasingly important role in Turkey's economic miracle. Turkey relies on natural gas for almost 45 percent of its electricity generation, and accounts for over 30 percent in Turkey's consumption energy mix, and has a domestic production of less than 2 percent of its consumption (EUAS, 2012, p. 22; EMRA, 2012, p. 21; PIGM Online database., 2012). As a result, Turkey's incredibly high reliance on natural gas imports, its growing energy needs, and a projected demand-supply deficit, makes this topic both intriguing and challenging for an academic examination.

Turkey's geostrategic location allows it to become a natural bridge between Central Asia, Middle East, the Caspian, and Europe. Turkey is thus surrounded by the world's largest producers of gas like Russia, Iran, Turkmenistan, and Azerbaijan; and can further supply this gas to the European region. Therefore, Turkey can make use of its location not just as a major natural gas consumer but also as a major transit hub, connecting the world's largest gas producers to the world's largest natural gas market.

This paper focuses on two natural gas pipeline projects, Nabucco and South Stream, and assesses their contribution to Turkey's energy supply security. This study adds to the literature by focusing on Turkey's energy needs and providing a quantifiable assessment of the impact of these projects in terms of demand-supply assessment, producer diversity and transit route diversity.

1.2 Objectives

The research objectives of this study involve a detailed analysis of Turkey's energy needs, especially in reference to the demand-supply gap that is projected to be visible in the next few years. In addition, this study seeks to contextualize the issue of energy security of supply of natural gas with a special focus on Turkey, its energy needs, its energy mix, and its import capacity. In this pursuit, this study builds on a theoretical framework first introduced by a KPMG study[1], which can be utilized to measure Turkey's long-term energy security of natural gas. Moreover, this study intends to contribute positively in terms of its findings, its policy recommendations, and in initiating a much-needed discourse on the issue of energy security in Turkey.

[1] Nabucco vs. South Stream: The Effects and Feasibility in the Central and Eastern European Union, 2009

1.3 Structure of the Paper

This paper is structured in 5 chapters. Chapter 2 presents an introduction to the theoretical background of energy security and outlines the various concepts and distinctions relevant to the topic that are used throughout this paper. Strictly speaking, this study does not have a conventional literature review or a methodological framework refined to each chapter. Since this paper is an academic assessment of two practical gas pipeline projects, the literature and methodology are amalgamated and spread throughout the paper, but presented in a coherent manner such that each chapter follows from the previous one. Chapter 3 discusses the role of natural gas in Turkey's economy, delving in detail into its demand and supply components and projecting long-term estimates of the demand-supply gap. Further, this chapter introduces the idea of both the Nabucco and South Stream projects.

Next, chapter 4 presents the methodological framework that is used to evaluate the various sub-scenarios involving the implementation of both projects. Finally, chapter 5 presents the conclusion and recommendations for Turkey.

1.4 Project Qualification

This research endeavor is a fruition of months of laborious investigation and analysis. Unlike a purely academic study which is primarily static in its dimensions, this area of research involves real projects that are not yet implemented, and so prone to several dynamic changes in their parameters. As this study drew closer to conclusion, several unforeseen parameter changes took place that have jeopardized the planned Nabucco project and transformed it into Nabucco West[2]. Another gas pipeline project, TANAP is being considered instead of Nabucco and it could serve Turkey's energy needs. If these changes are finalized and the Nabucco project is shelved, the findings in this study specifically focusing on Nabucco will be less useful. However, the generally constructed methodological framework and the abstract approach can still be applied to the TANAP project. In fact, a similar evaluation of the TANAP project has been completed using the publicly available data from Turkish Ministry of Energy (MENR) and State Oil Company of Azerbaijan (SOCAR). The results are presented in the appendix.

[2]These changes were made public on 28th June 2012, by which time this project had almost been finalized.

Chapter 2

Concepts of Energy Security and Turkey

The concept of energy security is not new, but more recently, the idea has received newfound relevance in a stream of subject areas like international relations, national security, and economic and energy policy. As mentioned in the introduction, this paper offers an evaluation of the extent to which two gas pipeline projects, Nabucco and South Stream, will contribute to Turkey's energy security vis-á-vis supply of natural gas. An academic approach to such an evaluation would require a sound theoretical framework that lays out the premises, presents well-defined and precise definitions, establish relationships and inferences, and separates out the impact on energy security from these two pipeline projects from the larger natural gas and total energy supply. The rest of the chapter is structured as follows. First, this chapter presents a number of relevant definitions and explains a few related concepts related to energy security, energy demand and supply, followed by an exposition of security of natural gas supply and the security of distribution networks. Second, this chapter contextualizes the concept of energy security with respect to Turkey's energy security strategy with a special focus on the role of natural gas in Turkey's energy security.

2.1 Energy Security

2.1.1 Definitions

The concept of energy security is broadly defined and malleable to the extent that there is no universally acceptable definition. However, an examination of a number of frequently used definitions makes the concept of energy security sufficiently palpable for the purpose of this paper.

> "*Energy security can be defined as a state where the risks related to high dependence on energy imports, political instability in producing and/or transit countries, as well as of other adverse contingencies, are mastered at reasonable economic costs.*" – (von Hirschhausen, 2005, p. 2).

In essence, the definition underscores the importance of uninterrupted supply of energy at a fair price. The extent of 'security' thus depends on the stability and consistency of supply. Understandably, the key to uninterrupted energy supply is diversification. The supply of energy depends on a host of factors like the type of fuel, i.e. coal, oil, natural gas, etc., the supplier, and the distribution network. Naturally, then, the diversification of energy supply means a diversification of all these factors.

A country that can utilize a variety of energy sources has a better energy security than a country that relies predominantly on fewer sources of energy. Similarly, a country that has access to a greater number of suppliers of energy has better energy security than a country that has a few concentrated suppliers. Moreover, a country that relies on multiple distribution networks has a better energy security than a country with a concentrated distribution and supply network. In addition, a greater number of transit destinations also add more uncertainty in energy supply. In reference to energy diversification, Frederic Jenny, Chair OECD Competition Committee, has made a succinct and meaningful observation (Jenny, 2007, p. 14):

> "*Reducing dependence on oil and gas through diversification of fuels and their geographic sources and more efficient use of energy must be central to long term policies aimed at enhancing energy security. It is not the proportionate dependence on any one fuel type which counts, but the extent of alternative sources of that fuel and the practicability of switching fuels in a crisis. In that respect, the prospects for consumers are worsening.*" – (IEA, 2005, pp 267–268).

The definition offered by the International Energy Agency (IEA) has a similar resonance. According to IEA:

> "*The uninterrupted physical availability at a price which is affordable, while respecting environment concerns". The need to increase "energy security" was the main objective underpinning the establishment of the IEA. With particular emphasis on oil security, the Agency was created in order to establish effective mechanisms for the implementation of policies on a broad spectrum of energy issues: mechanisms that were workable and reliable, and could be implemented on a co-operative basis.*" – (IEA Official Web Site, 2012).

Without delving into too much detail it must be noted that energy security has several peripheral dimensions in the context of environmental concerns, international bi-lateral and multilateral relations among nations, reserve stocks, energy efficiency, and crisis response management. The emergence of energy security as an essential feature of economy policy, national security, and often of foreign policy, is as a consequence of such high reliance on energy by almost all modern economies. The next section presents future energy projections in order to provide an overview of the importance of energy security.

2.1.2 Future Energy Projections

According to BP Energy Outlook 2030 (2012), the world's primary energy consumption is forecasted to grow steadily at 1.6 percent per annum from 2010 to 2030, leading to an almost 39 percent increase in the global energy consumption by 2030 (BP, 2012a, p. 11). Almost all of this growth, around 96 percent, is in non-OECD countries. By 2030, non-OECD countries will account for 65 percent of the world consumption, almost 70 percent higher than the 2010 level of 54 percent

(BP, 2012a, p. 11). Amongst the non-OECD countries, half of this growth in energy consumption is attributed to developing economies like India and China. Between 2008 and 2035, increase in energy consumption is forecasted at 53 percent with fossil fuel accounting for almost 80 percent of energy supply (EIA, 2011, p. 2).

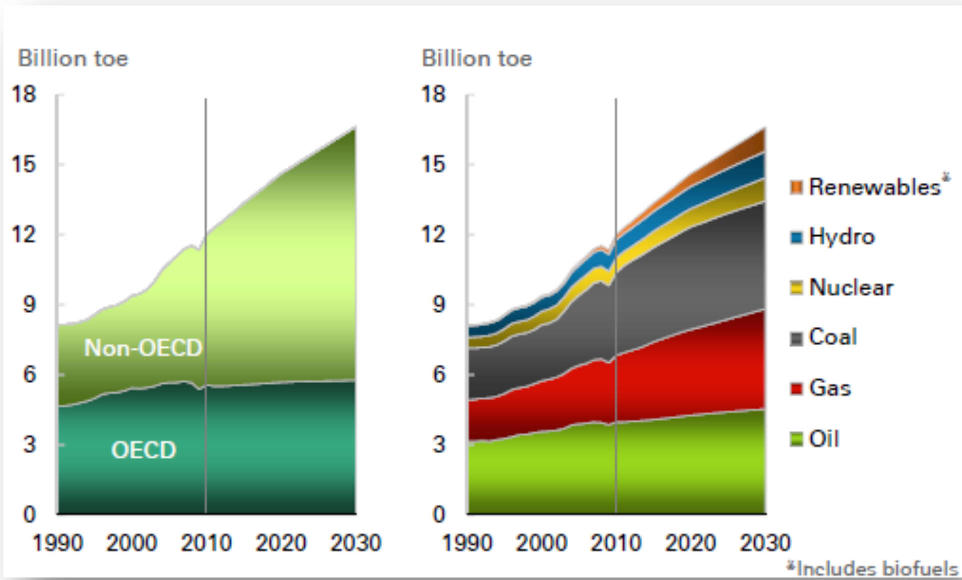


Figure 2.1: Energy Consumption Growth. Source: (BP, 2012a, p. 10).

Albeit OECD average energy growth till 2030 is an insignificant 0.2% per annum, Turkey has had the fastest energy growth rate in OECD countries over the last 10 years (MENR, 2011, p. 4). From 2011 to 2012 Turkey has the second largest growing electricity and natural gas markets after China and this growth is expected to sustain over medium-term (EMRA, 2012, p. 5). This is why Turkey cannot be classified as a typical OECD country with a stagnant energy security concern; instead, Turkey's growing energy need highlights a growing concern about its energy security[1].

[1]Differences in the energy efficiency between OECD countries must be taken into account for a relative comparison in the growing energy needs. Out of 29 countries, Turkey ranks in the 21th place in the energy efficiency statistics (Flippini and Hunt, 2009, p. 23). Turkey's higher growing energy needs partly come from the inefficient use of energy. The lack of energy efficiency and its negative empirical consequences for Turkey are out of the scope of this study.

2.2 Energy Demand and Supply

2.2.1 Security of Energy Demand and Supply

It should be noted that energy demand requires security of supply while energy supply needs security of demand. This makes economic sense. A country that needs energy as an input for production and consumption wants stable and affordable energy supply, thus it needs security of supply. On the other hand, a country that extracts oil or gas, or mines coal, needs an effective demand to fulfill, thus it needs a security of energy demand. Oil and gas exporting countries like Saudi Arabia, Iran, Kuwait, Iraq, Oman, and Russia have economies that generate most of their revenue through exporting these fossil fuels. Disequilibrium, or a shock, in energy prices creates instability. Excess demand not only increases the price of energy, but also makes it difficult for energy suppliers to increase extraction and production on a short notice. Excess supply, on the other hand, leads to a fall in prices, and also increased storage costs and the associated storage risk. For this reason, a deviation in prices from their expected trends hurts both producers and consumers, whereas stability and expected movements in prices is advantageous for both consumers and suppliers.

The fact that both the exporter and the importer of energy benefit from predictable and stable energy prices does not mean that they do not have competing interests. As pointed out earlier, the security of energy supply depends on diversification of types of energy usage, diversification of suppliers, and a supply from multiple distribution networks. Conversely, energy security of demand depends on the lack of alternatives of the particular type of energy, the lack of competitors who supply energy to target market, and control over distribution network.

The scope of this study is restricted to a very specific analysis. To reiterate, this thesis evaluates the impact of Nabucco and South Stream pipe-line projects on Turkey's long-term energy security supply of natural gas. There are two key facets that refine the scope of this study. First, this study is about the security of energy supply of natural gas as Turkey is a net importer of natural gas, and so it is concerned with security of energy supply. Second, this study is about long-term supply. The second dimension warrants further explanation. Therefore, the next sub-section discusses the difference between short-term and long-term energy supply and justifies why this study focuses on long-term energy supply of natural gas.

2.2.2 Short-term and long-term Security of Supply

The difference between short-term and long-term energy supply mirrors a typical economics text-book case of differences between short-term and long-term supply. Economic theory suggests that short-term supply is inelastic but in long-term the supply is elastic. The reason is that in the short-term increasing or adjusting production and distribution capacity is difficult and unlikely. Moreover, finding substitutes and switching to alternative sources is also a long-term undertaking.

In context of energy supply, IEA points out that short-term energy security is the ability of an energy system to be able to respond quickly to shocks or sudden changes in supply and demand (IEA Official Web Site, 2012). Most efficient systems use a reserve energy supply back-up to stabilize any short-term fluctuations. In contrast, the long-term energy security depends on investment in infrastructure, pipelines, distribution networks, new exploration and mining, contracts and negotiations with suppliers, etc.

2.3 Role of Natural Gas in Security of Energy Supply

The term energy security perhaps has a predecessor in the literature more commonly known as the "oil crisis". Historically, global energy supply has been so heavily dependent on oil that energy security and energy crises was a synonym for oil security and oil crisis. Victor et al. (2006, pp. 3–27) point out that energy security was primarily associated with oil disruptions, oil shocks, and middle-eastern oil conflicts, but over the last 50 years energy security has also come to include natural gas as an important component.

Natural gas is the world's fastest growing fossil-fuel, with a growth in consumption around 1.6 percent per annum from 2008 to 2035, and contributing to 31 percent of projected global growth in energy consumption (EIA, 2011, p. 2; BP, 2012a, p. 11). More recently, natural gas has become relatively feasible for a number of countries because of its low-carbon intensity in comparison to coal and oil and because of its lower capital costs and fuel efficiency (EIA, 2011, p. 3). As a result, natural gas has become a popular source of energy in electric power generation and industrial manufacturing. However, unlike oil, natural gas infrastructure is more capital intensive because gas is difficult to store and its transportation through pipe-lines requires an actual physical link between exporter and consumers (Victor et al., 2006, pp. 3–27).

The added complexity from transit of natural gas pipelines makes it even more likely for natural gas to be used as political leverage, much like how oil has been used in the past. In fact, the Russia-Ukraine gas war in 2009 is a case in point. The political dimension of energy security and the exploitation of supply for political gains or bargaining are discussed in detail in later chapters.

2.4 The Role of Pipelines in Ensuring Security of Energy Supply

As pointed out earlier, energy security of supply of natural gas depends not just on the provider but also on transit countries through which the gas pipeline crosses. The risks associated with the involvement of transit routes aggregate exponentially. Although a detailed analysis of such risk assessment is not relevant for the purpose of this thesis, a cursory discussion of how transit risk could accumulate will be purposeful. With each addition of a transit country, there is an added layer of security risk which has a potential for conflict between the source country, transit countries and the consumer destination (Stern, 2006, pp. 32–36). A transit country can cut-off gas supplies if it has a dispute with the supplier, the buyer, or another transit country. It is thus straight-forward to see how every additional transit destination can be affected by several bi-lateral relationships between the transit country and other affected countries. According to some estimates (Scotti and Vedres, 2012, p. 1) pipeline development till 2030 will weigh the security concerns of energy supply more heavily in transit countries rather than the source country.

European Union, which is the largest market for natural gas, imported more than 75 percent of its consumption in 2008 (Scotti and Vedres, 2012, p. 2) . Most of EU's gas is imported from three countries, Russia, Algeria, and Norway (EuroStat Online Database, 2012).

2.5 Turkey's Energy Security

2.5.1 Turkey's Geostrategic Location

Turkey has an ideal geostrategic location in terms of its access to world's natural gas and oil reserves. Fossil-fuel reserves in Middle-East and Caspian that account for almost 72 percent of world's proven gas reserves and 73 percent of world's oil reserves are in accessible proximity to Turkey (MFA, 2009, p. 2). Turkey's geostrategic location is not just advantageous from a consumption standpoint, but it is also ideally located for a secure transit passage and a bridge between energy suppliers and energy consumers. Turkey's role as transit country has also been enhanced by the East-West Energy Corridor that connects the European market to the Caspian oil and gas reserves. Table 2.1 below presents the global natural gas supply and illustrates that Turkey's geographic location affords it access to various suppliers of natural gas.

Turkey should benefit greatly from its strategic location, especially because of its growing energy needs and its heavy reliance on natural gas.

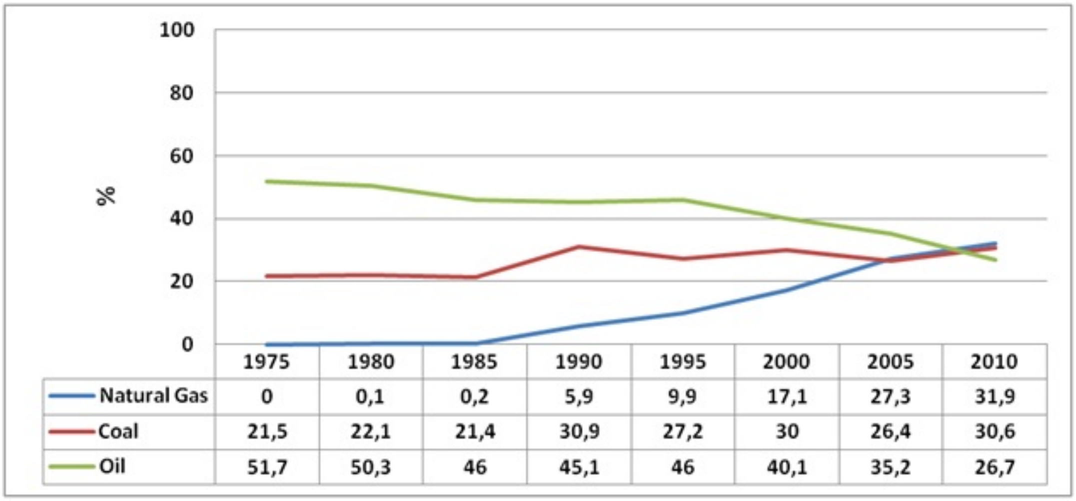
Region-Country	Volume (Trillion Cubic Metres)	Share of total in the World(%)
Total World	208,4	100,0
Total Middle East	80,0	38,4
Total Europe & Eurasia	78.7	37,8
Russian Federation	44,6	21,4
Iran	33,1	15,9
Turkmenistan	24,3	11,7
Iraq	3,6	1,7
Egypt	2,2	1,1
Azerbaijan	1,3	0,6
Syria	0,3	0,1

Table 2.1: Proved Natural Gas Reserves 2011. Source: (BP, 2012b), own extractions.

2.5.2 Natural Gas in Turkey's Energy Security

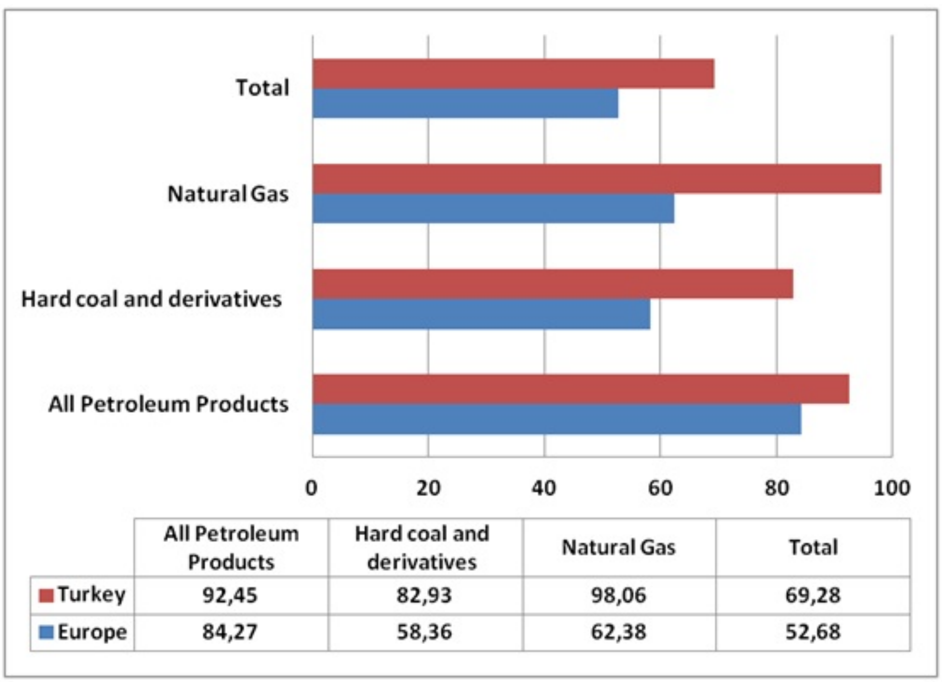
Natural gas is not only the largest source of energy consumption in Turkey, but it is also the largest resource in electricity production. This means that natural gas forms the bedrock of Turkey's industrial and manufacturing basis as it is the largest source of energy. Figure 2.2 and Figure 2.3 below illustrate the contribution of natural gas in Turkey's energy consumption and Turkey's dependence on natural gas to meet its domestic energy needs. Figure 2.4 shows that Turkey's energy dependency, in percentage terms, is greater than Europe's energy dependency on natural gas. This finding underscores the significance of natural gas in Turkey's economy. As a natural corollary, this also highlights the role of natural gas in Turkey's energy security supply.

Thus far the discussion in this section has presented an overview of Turkey's advantageous geographic location for its access to natural gas, followed by a preliminary discussion of the importance of natural gas and its role in Turkey's economy. To put simply, this means that Turkey has a heavy dependence on natural gas and it also has plenty of viable options to secure gas supplies. The next logical question is that what Turkey has done so far to secure natural gas supplies? The following sub-section presents a brief overview of Turkey's energy security strategy vis-á-vis natural gas supply.



	1975	1980	1985	1990	1995	2000	2005	2010
Natural Gas	0	0,1	0,2	5,9	9,9	17,1	27,3	31,9
Coal	21,5	22,1	21,4	30,9	27,2	30	26,4	30,6
Oil	51,7	50,3	46	45,1	46	40,1	35,2	26,7

Figure 2.2: Energy Source Contribution in Turkey's Total Energy Consumption Between 1975 and 2010. Source: (EMRA, 2012, p. 21), own extractions



	All Petroleum Products	Hard coal and derivatives	Natural Gas	Total
Turkey	92,45	82,93	98,06	69,28
Europe	84,27	58,36	62,38	52,68

Figure 2.3: Energy Dependence as % of Net Imports in Gross Inland Consumption in 2010. Source: (EuroStat Online Database, 2012),own extractions

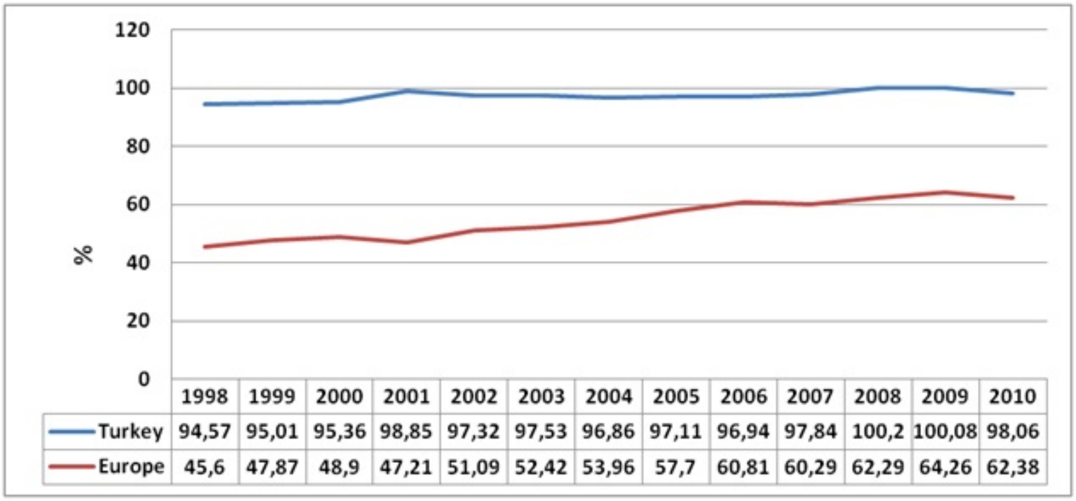


Figure 2.4: Energy Dependence % of Net Imports in Gross Inland Consumption in Natural Gas Between 1998 and 2010. Source: (EMRA, 2012, p. 21), own extractions

2.5.3 Turkey's Energy Security Strategy

Turkey has direct pipeline access to the world's biggest natural gas supplier, Russia, and also to Iran and Azerbaijan. Also, another pipeline project called 'Iraqi Feeder' is planned under the Nabucco project that will be discussed in detail in the next chapter. Turkey also has an import agreement with Turkmenistan but it has not been operational because of Russia's dispute in the Trans-Caspian Sea transit permission. Unless the dispute is resolved, it is less likely that the Turkmen gas can be imported. To add even higher uncertainty, Iran is also disinclined to allow a transit passage for the gas from Turkmenistan. Both Iran and Russia's issues with Turkmenistan's gas seem to grow out of their competition for the supply of natural gas. By disallowing the transit, they are in effect ensuring security of demand for their natural gas supply.

In 2006, the Arab gas pipeline that was to transport Egyptian gas to Turkey via Syria, Jordan, Lebanon and Romania was initiated. In 2011, the project fell apart due to terrorist attacks and the Arab Spring. Both the Arab gas pipeline and the Turkmenistan gas agreement project offer a common lesson that such transnational projects are laden with risks and uncertainties that go beyond the technical and financial feasibility of projects into political and geostrategic risks. This important lesson brings to acknowledgement a rather discomforting fact that despite Turkey's proximity to world's 72 percent gas reserves, the region is often an epicenter of turbulence and unrest. Such untoward situations not only vastly diminish Turkey's ability to benefit from the gas reserves but also make the existing and planned supply lines vulnerable and unpredictable.

It is in this context that this paper seeks to shed light on two of the most important gas pipeline projects under consideration. The next chapter discusses in detail Turkey's project demand, supply, capacity, and shortage, and how Nabucco and South Stream gas pipeline projects can help address the future energy challenges.

Chapter 3

Turkish Natural Gas Sector and Proposed Pipeline Projects

3.1 Natural Gas in Turkey

Natural gas provides the largest contribution to Turkey's energy consumption. In 2010, natural gas accounted for a sizable 32 percent, with other sources like coal and oil lagging behind with 30.7 percent and 26.7 percent respectively (EMRA, 2012, p. 21). Electricity production is perhaps the foremost use of energy. Turkey's mix of energy for electricity production is also most highly dependent on natural gas availability as almost 45 percent of all electricity production is from natural gas (EUAS, 2012, p. 21). The next closest electricity production source in Turkey's energy mix is hydroelectricity production, contributing nearly 31 percent, almost two-thirds of the contribution from natural gas.

In the last decade, Turkey has had the highest energy consumption growth rate in OECD countries, and this trend is forecasted to persist in the short-to-medium term. In 2010, Turkey's total primary energy consumption was 109.27 million tonne of oil equivalent (toe). By 2015, this figure is expected to reach 170 million toe, and by 2022, almost doubling to 222 toe (MENR, 2011, p. 3). Predictably, such high growth figures cannot be sustained without adequate and secure energy supplies. Given these projections, Turkey's high energy dependency on natural gas is a matter of serious concern and calls for a thorough investigation. This chapter presents an analysis of Turkey's natural gas demand and supply, the two proposed natural gas pipeline projects, Nabucco and South Stream, and their potential impact on Turkey's energy security.

3.1.1 Natural Gas Demand

During the last decade, natural gas consumption in Turkey has seen an increase of approximately 230 percent, with an annual compound growth rate of 9.3 percent from 2004 to 2010, and an 18 percent growth from 2010 to 2011 (EMRA, 2012, p. 20). Given Turkey's energy consumption growth forecast, natural gas consumption for electricity generation and Turkey's dependence on natural gas is likely to maintain this steep rise (Özen, 2012, p. 18). An increase in the demand for electricity will lead to an increase in the natural gas prices because natural gas fired power stations rely on it for its increased efficiency over coal, while hydroelectric production alternative has its limitations.

The increase in natural gas consumption is not solely attributed to an increase in electricity production, but also from industrial and household use of natural gas. In 2010, there was 36 percent rise in industrial use of natural gas (Özen, 2012, p. 15). Moreover, Turkey's developing transport infrastructure is still expanding with a vast potential to create an infrastructure network across all provinces. Such a transport network will indeed further increase Turkey's dependency on natural gas and contribute to an upward push in the natural gas prices.

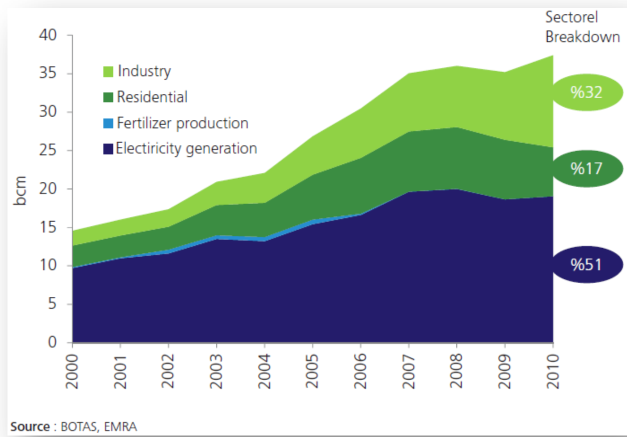


Figure 3.1: The Use of Natural Gas Demand in Turkey. Source: (Özen, 2012, p. 15).

3.1.2 Natural Gas Supply

Turkey's natural gas demand exceeds its domestic gas supply so the supply deficit is met by natural gas imports. For this reasons, Turkey's natural gas supply has two sources, the domestic production and supply, and natural gas import.

Domestic Production

For a country that uses natural gas as the primary energy source for electricity consumption, Turkey's domestic gas production is at an alarmingly small scale. Domestic production accounts for a negligible 2 percent of total consumption. Consequently, Turkey depends on natural gas imports for 98 percent of its supply (Özen, 2012, p. 16). In an attempt to reduce Turkey's dependency on gas imports, Turkey has signed agreements with Shell to start exploration and extraction in the Mediterranean Sea and Southeastern Anatolia.

According to the present domestic gas reserves, extraction, and production figures, domestic reserves will last only another 7 years. This time-frame is computed using the remaining domestic natural gas reserves and the average annual gas production between 2007 and 2011. Figure 3.2 below presents this information graphically.

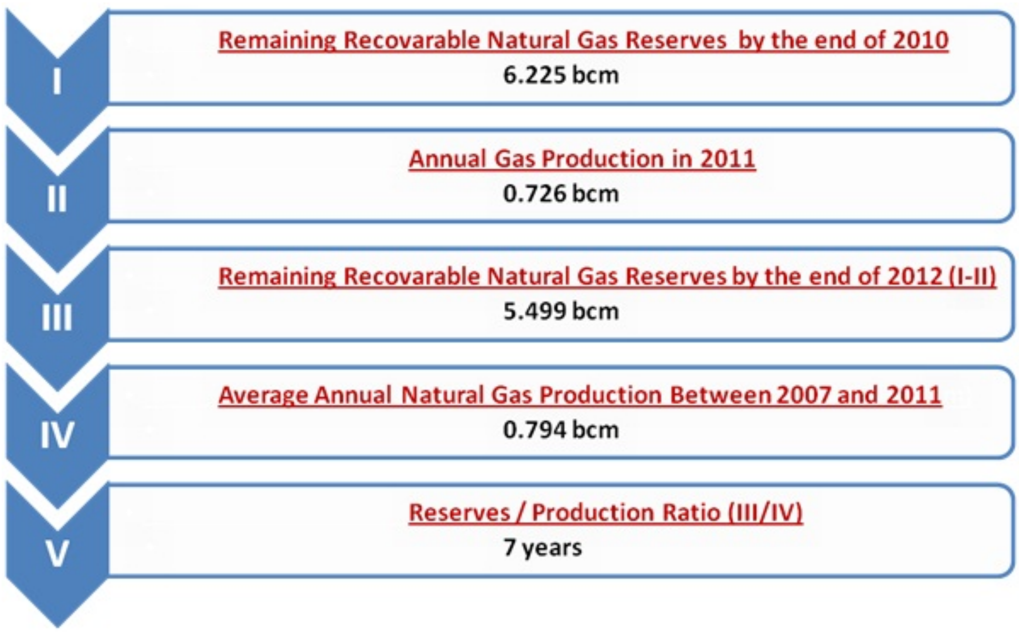


Figure 3.2: Overview to Turkey's Natural Gas Reserves and Production. Source: (PIGM Online database., 2012; EMRA, 2012), own extractions and calculations

Import

Turkey relies most heavily on natural gas imports which accounts for 98 percent of natural gas consumption. Purchasing gas in the international market is somewhat different than buying other internationally traded commodities. Unlike oil, natural gas needs gas pipelines to be delivered to the consumer. Moreover, purchase of natural gas requires forward contracts and agreements, with contractual obligations to buy a predetermined quantity. Turkey had signed such contracts back in the 1990s, based on forecasted demand growth for the next 25 years (Özen, 2012, p. 16).

At present, there are four different gas pipeline networks transporting gas to Turkey, listed in Table 3.1 below. The Nabucco project that is under consideration, if implemented, will introduce an additional import and transit pipeline to and from Turkey.

Name of the pipeline	Production source	Transit route	Existing capacity	Potential capacity
Trans-Balkan Import Line	Russia	South Russia-Ukraine- Moldovia-Romania-Bulgaria	16 bcm/year	16 bcm/year
Blue Stream Import Line	Russia	Directly from Russia crossing Black Sea	16 bcm/year	16 bcm/year
BTE Import Line	Azerbaijan	Baku - Tiblisi - Erzurum	8 bcm/year	22 bcm/year
East Anatolian Import Line	Iran	Directly from Iran	10 bcm/year	20 bcm/year
TGI Export Line	Azerbaijan	Azerbeijan-Turkey-Greece-Italy	12 bcm/year	12 bcm/year

Table 3.1: Existing Import/Export Pipeline Infrastructure for Natural Gas in Turkey. Source: (BOTAS Online Database, 2012; EMRA, 2012; PIGM Online database., 2012), own extractions.

However, in the next 10 to 15 years, most of the agreements under which Turkey is importing natural gas, are about to expire. As the expiry date of such contracts draws nearer, Turkey's natural gas security of supply concerns point to a heightened challenge in energy security of supply. Table 3.2 below shows the critical dates at which some of these agreements expire.

Country	Type of transportation	bcm per year	Signature date	Effective date	Duration (years)	Remaining years
Russia	Pipeline	6	14.02.1986	1987	25	-
Russia	Pipeline	8	18.02.1998	1998	23	9
Russia	Pipeline	16	15.12.1997	2003	25	16
Azerbeijan	Pipeline	6,6	12.03.2001	2007	15	10
Turkmenistan	Pipeline	16	21.05.1999	-	30	-
Iran	Pipeline	10	08.08.1996	2001	25	14
Nigeria	LNG	1,2	09.11.1995	1999	22	9
Algeria	LNG	4	14.04.1988	1994	20	2

Table 3.2: Natural Gas Purchase Contracts of Turkey. Source: (BOTAS Online Database, 2012), own extractions.

The contract with Russia for 6 bcm per year is due to expire in 2012 and has not been renewed as yet. Therefore, a loss in import capacity of 6 bcm per year is likely. In 2014, the LNG contract of 4 bcm per year with Algeria is going to expire, if not renewed. Similarly, in 2021, contracts with Russia and Nigeria are due to expire, which will cause a total loss in import capacity of 9.2 bcm per year. A 10 bcm per year contract with Iran is set to expire in 2022 while the last contract with Russia of 16 bcm per year will expire in 2028.

Another factor in Turkey's energy supply security is the lack of diversification in natural gas supply. Russia, Iran, Azerbaijan and Algeria constitute the four largest suppliers, with Russia being the single largest supplier. Table 3.3 below lists the seven years of supply data from all natural gas suppliers.

Years	Russia	Iran	Azerbaijan	Algeria	Nigeria	Spot LNG	Total
2005	17,52	4,25	0,00	3,79	1,01	0,00	26,57
2006	19,32	5,59	0,00	4,13	1,10	0,08	30,22
2007	22,76	6,05	1,26	4,21	1,40	0,17	35,84
2008	23,16	4,11	4,58	4,15	1,02	0,33	37,35
2009	19,47	5,25	4,96	4,49	0,90	0,78	35,86
2010	17,58	7,77	4,52	3,91	1,19	3,08	38,04
2011	25,41	8,19	3,81	4,16	1,25	1,07	43,88

Table 3.3: Natural Gas Imports of Turkey in bcm between 2005 and 2011. Source:(EMRA, 2012), own extractions.

Russia is the world's biggest natural gas producer, with almost 26 percent of world's natural gas reserves. It is also the world's largest exporter of natural gas, and Turkey's largest supplier of gas, accounting for almost 58 percent of all gas imports (BP, 2012a, pp. 28–30). Russia is not just a supplier of natural gas, but its state backed gas giant, Gazprom, also has a near monopoly over pipeline networks and distribution nodes. Turkey has a direct pipeline connection with Russia via the undersea Blue Stream Pipeline, through the Black Sea. To diversify its natural gas suppliers, Turkey has signed agreements with Azerbaijan through which Turkey will receive an additional 6 bcm per year from Azerbaijan's Shah Sea Phase 2.

Pipeline Imports	Billion Cubic Meters (bcm)	% Share in Pipeline Imports	% Share in Total Imports
Russia	25.41	67.9%	57.9%
Azerbaijan	3.81	10.2%	8.7%
Iran	8.19	21.9%	18.7%
Total Pipeline Imports	**37.40**	**100.0%**	**85.2%**
Liquefied natural gas (LNG) Imports	**Billion Cubic Meters (bcm)**	**% Share in LNG Imports**	**% Share in Total Imports**
Algeria	4.16	64.2%	9.5%
Nigeria	1.25	19.3%	2.8%
Spot Market	1.07	16.5%	2.4%
Total LNG Imports	**6.47**	**100.0%**	**14.8%**
Total Imports (Pipeline + LNG)	**43.88**		
Pipeline Exports	**Billion Cubic Meters (bcm)**	**% Share in Pipeline Exports**	**% Share in Total Exports**
Greece	0.71	100.0%	100.0%
Total Exports	**0.71**		

Table 3.4: Natural Gas Trade Movements of Turkey in 2011. Source:(BP, 2012b, pp. 28–30), own extractions.

For commodities like natural gas, supply of the resource is not just determined by the availability and transportation but also the capacity to provide a consumption smoothing through storage capability.

3.1.3 Storage

Storage capacity has a useful contribution in ensuring short-term supply security. Natural gas can be stored through a reserve system connected to the pipeline network, or through LNG. Turkey has an underground storage capacity that is expected to reach 4.16 bcm by 2015 (EMRA, 2012, p. 36).

3.1.4 Transit and Export

Turkey has a central geostrategic location in relation to the energy corridor that could connect Central Asian gas supply to Europe. Turkey's geostrategic location for gas transit is doubly useful for Europe. First, Turkey will carry gas from Azerbaijan, Iran and other Central Asian countries which can add to Europe's energy diversification in terms of suppliers and reduce Europe's increasingly high dependence on Russia. Second, Turkey offers a diversification not just of suppliers but also of the supply route and distribution networks. Unlike Ukraine, Georgia, and other Central and East European Countries (CEECs) Turkey is a more reliable partner than Ukraine, which cut-off transit gas supply to 18 European nations in early 2009. Also, Turkey's gas pipelines and distribution network will not be an instrument of Gazprom, as is the case in many transit supply systems that are currently operational in Europe.

Turkish leadership has aimed to exploit Turkey's suitable geostrategic location so as to steer the country into a gas transit hub. To this end, Turkey has signed a bilateral Turkey-Greece Interconnector in 2003, and a tri-lateral Turkey-Italy-Greece Interconnector in 2007 to add 5 bcm per year in transit. By 2020, Turkey aims to increase the transit volume to Europe to 100 bcm per year (Umucu, 2008, p. 61).

As Figure 3.3 shows, Turkey's location allows it to be a natural bridge between the Caspian, Middle East, and Europe. Since July 2007, the East-West Energy Corridor, namely the Baku-Tbilisi-Erzurum (BTE) Natural Gas Pipeline, has been operation and carrying 6.6 bcm a year from Azerbaijan, and the pipeline will extend to Turkmenistan and Kazakhstan to tap into world's fourth largest gas reserves (MFA, 2009, p. 4). Turkey's energy diversification not only ensures Turkey's energy security but will also provide Europe with another major artery for gas supply, thus in effect, increasing Europe's energy diversity and security.

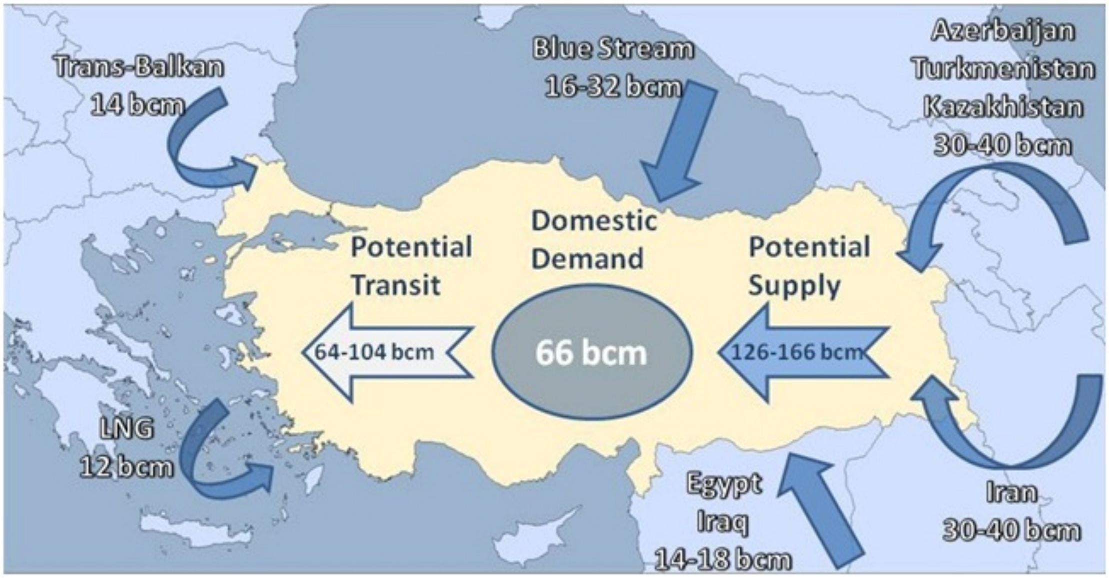


Figure 3.3: Export and Transit Scenario for Turkey. Source: (Umucu, 2008, p. 62), own visual design

3.2 Proposed Natural Gas Pipeline Projects

3.2.1 Nabucco

The Nabucco Gas Pipeline project can play a pivotal role in Europe's energy diversification by providing an energy artery that will give Western Europe access to 60,000 bcm Caspian and Middle Eastern gas reserves (Nabucco Official Web Site, 2012). In the long-term, Nabucco will ensure energy diversification and energy security not just for transit countries like Turkey, Hungary, Bulgaria, Romania, Austria, but also for greater Europe.

Central Asia, the Caspian, and the Middle East have one of the largest reserves of natural gas. Europe, on the other hand, is the largest and most lucrative market for natural gas. Trade between the two makes economic sense. However, the gas pipeline and energy transit route business is seldom driven by a purely economic rationale. In practical terms, as Dmitri Trenin, Deputy Director at the Carnegie Center at Moscow quipped, the energy business is a political business. A gas pipeline network thus involves economic and logistic feasibility, financial backing, political support, surety of long-term and reliable diplomatic relationships with transition and supplier countries, binding contractual agreements from buyers and suppliers, and several other contingencies. The Nabucco project meets most of these conditions and appears on the whole promising and impactful in its entirety. Figure 3.5 shows the project timeline.

Figure 3.4: Nabucco Pipeline Route. Source: (Nabucco Official Web Site, 2012).

Figure 3.5: Construction Timeline of the Nabucco Project. Source: (Nabucco Official Web Site, 2012).

The Nabucco project has presented itself both as a challenge and as an opportunity to leaders through Central Asia, Turkey, and across Europe. The Nabucco pipeline will not only ensure diversification but it will also lead to price competition. For instance, in January 2009, when Russia cut off supplies to Ukraine, Russia's renegotiated ask price for 1 thousand cubic meters of gas was $250, while European countries like Germany and France were paying twice this rate. Greater supplier diversity will push gas prices towards the international price equilibrium and eliminate such price discrimination.

Another added advantage that Turkey will receive from Nabucco is that in the time of crisis, the pipeline could operate in the opposite direction to meet Turkey's domestic energy needs. This means that Turkey has ensured a mechanism through which it will first ensure that its domestic demand is not being neglected while it facilitates transit gas, but instead, it first provides adequately to the domestic needs (Yinanc, 2009).

In sum, Nabucco's geo strategic significance, energy security contribution, economic and logistic feasibility has long been established. Still, the eventual realization of the Nabucco project remains to be seen. The next sub-section presents the second project, South Stream.

3.2.2 South Stream

The South Stream pipeline is primarily intended to serve the European need for diversification. The pipeline will not directly affect Turkey because it is not directly involved in the pipeline as a transit country. The area under the Black Sea that the pipeline will pass through, however, falls under Turkey's marine zone and will thus require Turkey's assent to be used as a transit route. Turkey is expected to get additional natural gas supply via existing Trans-Balkan import line which is assumed to be connected to the South Stream in the Bulgarian Territory. For Europeans, South Stream only adds another transit route for Russian gas supplies, and does not increase supply diversity. During the 2009 Russia-Ukraine gas war, Gazprom lost as much as $2 billion in revenue as Ukraine cut-off transit gas to 18 European countries. And almost 70 percent of Russian gas relies only on one gas pipeline to reach Europe. Given this scenario, South Stream, which has a full capacity of 63 bcm per year, can have a significant impact on European energy security. Figure 3.6 below shows South Stream's pipeline network and Gazprom's partnership with major European gas companies.

In a sense, the South Stream project is a rival project to Nabucco which is backed by Turkey and the EU, while the South Stream is predominantly a Russian venture. The Table 3.5 below summarizes a comparison between the two projects.

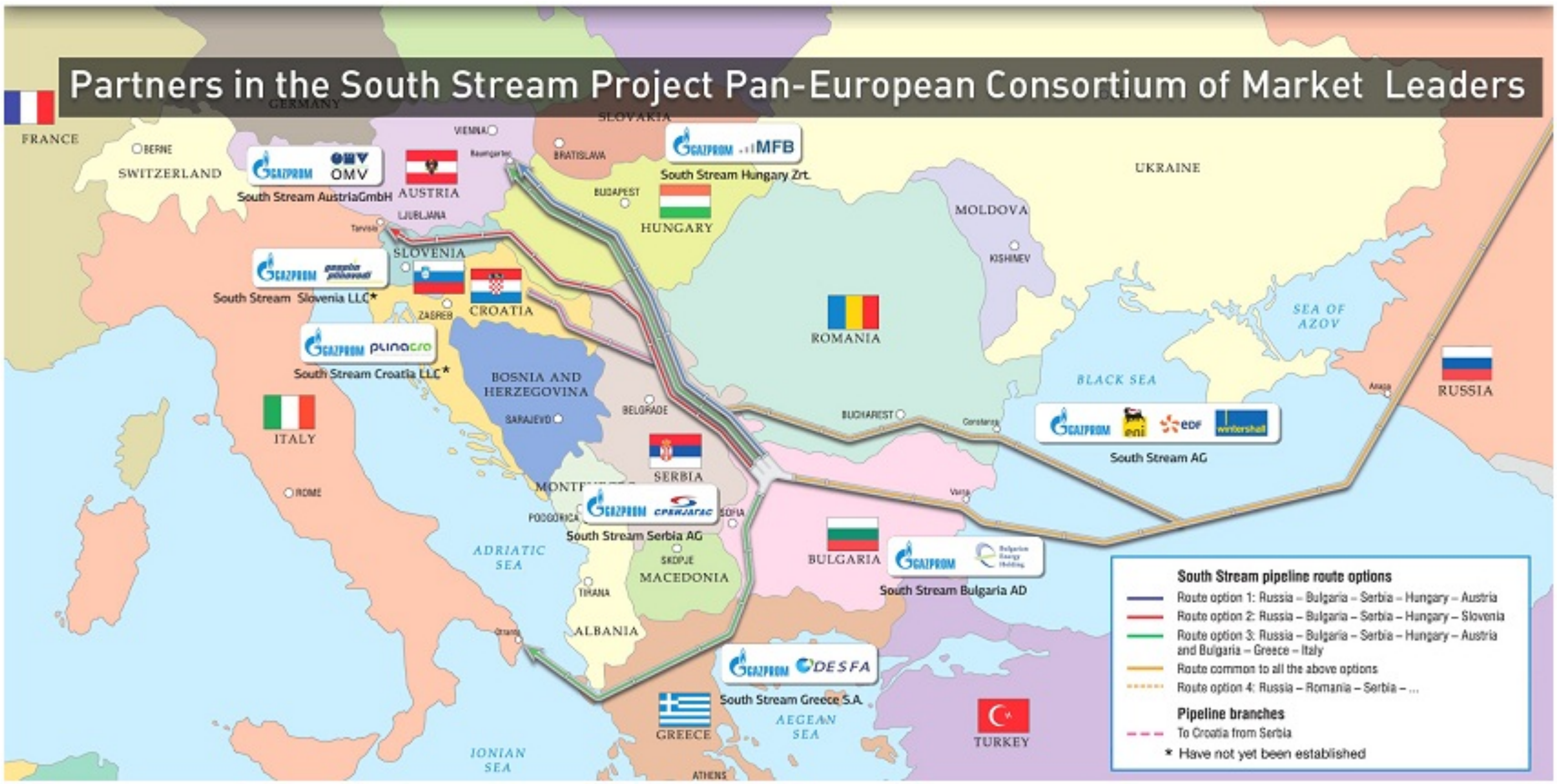


Figure 3.6: Overview to the South Stream Project. Source: (Gazprom, 2012).

	Nabucco	South Stream
Launch Date	*End of 2017*	*End of 2015*
Legal Status	*Intergovernmental Agreements were signed on July 2009 / Construction will start in the end of 2013*	*Intergovernmental Agreements were signed Turkey granted permit in 2011/Construction will start in late 2012*
Length	*3300 km*	*2523 - 3463 km* 923 km off shore, 1600-2540 km on shore
Capacity	*31 bcm/year* 8-10 bcm at the first stage for 3- 4 years	*63 bcm/year* 15.75 bcm at the first stage until 2018
Potential Sources	*Azerbaijan, Turkmenistan, Kazakhstan, Egypt, Iran*	*Russia, Central Asia, Azerbaijan*
Estimated Cost	*EUR 7.9 Billion*	*EUR 15.5 Billion*
Sponsors	*EU, Turkey , USA*	*Russia*
Transit Countries	*Turkey, Bulgaria, Romania, Hungary, Austria*	*Russia, Bulgaria, Serbia, Hungary, Austria, Slovenia, Greece, Italy*
Companies	***Nabucco International GMBH:** All Domestic Companies have equal shares* OMV(AUS), MOL(HUN), Transgaz(ROM), Bulgargaz(BUL), BOTAS(TUR),RWE(GER)	***Southstream AG:** Equally owned by Gazprom and ENI (ITA) Talks between South Stream and local corporatians are in progress*
Pros	*Promises Production Source Diversity for the Importers*	*Promises Transit Improved Transit Security for the Importers*
Cons	*No Suppliers contracted yet Lack of commitment of the parties*	*High Construction Costs No Diversification in Production Sources for the Importers*

Table 3.5: Summary of the Nabucco and South Stream Projects. Source: (Nabucco Official Web Site, 2012; Gazprom, 2012).

3.3 Previous Literature on Nabucco and South Stream

There is a plethora of literature on both the Nabucco and South Stream pipeline projects. However, most such studies present the political feasibility, often placing one project as a rival to the other. This paper takes a different perspective and focuses particularly on the long-term economic feasibility of both projects. For instance, Huppmann et al. (2009) discuss different scenarios with respect to political ambiance such as 'full halt of Russian exports to Western Europe,' and regional demand growth such as 'increased demand from India and China.' Scotti and Vedres (2012) presents a discussion on politics of pipelines and weighs in on the increased relevance of transit routes in future energy security. Such transit routes, he further notes, are based in politically unstable countries and so are going to be increasingly unable to improve energy security on the whole.

Dieckhöner (2010) tests a baseline model based on simulations and finds that both Nabucco and South Stream projects will increase Europe's energy security and even marginally reduce the cost of gas in a number of Eastern European countries. However, Dieckhoener's analysis focuses primarily on Europe while this paper views the issue from Turkey's perspective. Similarly, a KMPG working paper (KPMG, 2009) studies the impact of Nabucco and South Stream specifically on Eastern Europe. The study confirms that compared to the current situation, these projects will serve their objectives of providing supplier diversification, route diversification, and meeting demand supply balance. Furthermore, the study also emphasizes that Nabucco would reduce Europe's dependency on Russian gas.

The next chapter presents the methodological framework for this study along with a detailed analysis of the findings.

Chapter 4

Measuring Security of Supply Effects of the Nabucco and South Stream Projects for Turkey

4.1 Methodology

The purpose of this chapter is to devise a methodological framework needed to asses and evaluate the impact of Nabucco and South Stream in ensuring Turkey's long-term energy supply security in natural gas. Amongst the several factors that determine energy security of supply, this thesis focuses on the energy security contribution by these two particular pipeline projects.

4.1.1 Methodological Approach

The methodological approach is inspired by KPMG's research paper[1] on the effects and feasibility of Nabucco and South Stream projects in the Central and East European Countries. This thesis has adapted the KPMG framework to tailor it to analyze the impact of Nabucco and South Stream on Turkey's long-term energy security supply.

This research builds up on KPMG's research approach. The original research offered a single scenario with four sub-scenarios. This research goes a step further by considering three main scenarios and consequently 12 sub-scenarios. In addition, this paper uses the Adjusted Shannon-Weiner index, a quantitative measure of diversity, to estimate the reliability of the production sources and transit routes, while KPMG has used a different approach.

This paper uses the same precursor as in the original KPMG study by structuring the analysis using three pillars to measure long-term security of energy supply effects, namely:

1. Demand-Supply Balance Assessment

2. Production Source Diversity

3. Transit Route Diversity

[1] Nabucco vs. South Stream: The effects and feasibility in the Central and Eastern European Region, 2009

The scenario analysis for the above mentioned three pillars is restricted to a time-frame between 2008 and 2027 that includes projections of 15 years from 2012 to 2027. Figure 4.1 below illustrates the three main scenarios with four sub-scenarios each.

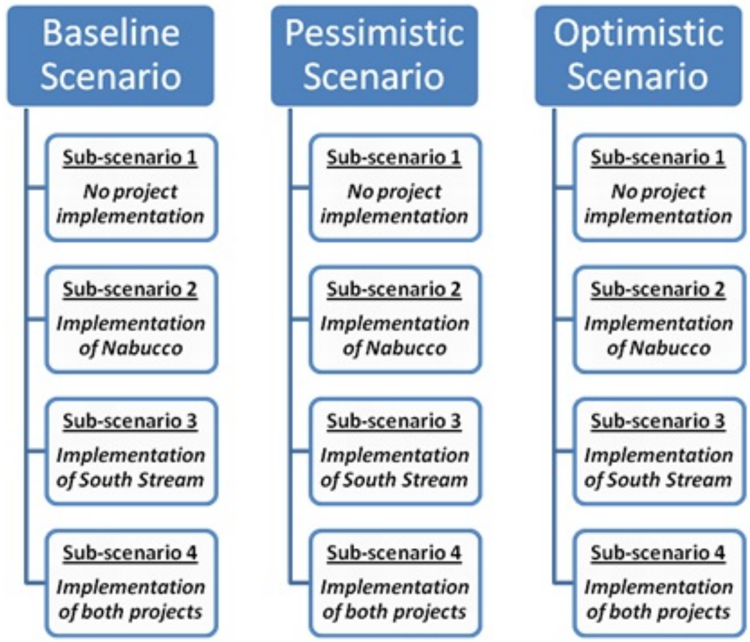


Figure 4.1: Scenarios Analyses.

For the sake of brevity, only the baseline scenario along with its sub-scenarios is discussed in the body of this chapter while the remaining scenarios and their accompanying sub-scenarios are presented in the Appendix . It must also be noted that the three main scenarios, the baseline scenario, the optimistic scenario and the pessimistic scenario arise because of the differences in calculation of the estimations in the expected consumption curve for natural gas. The chart on the next page presents a graphical overview of the methodological approach.

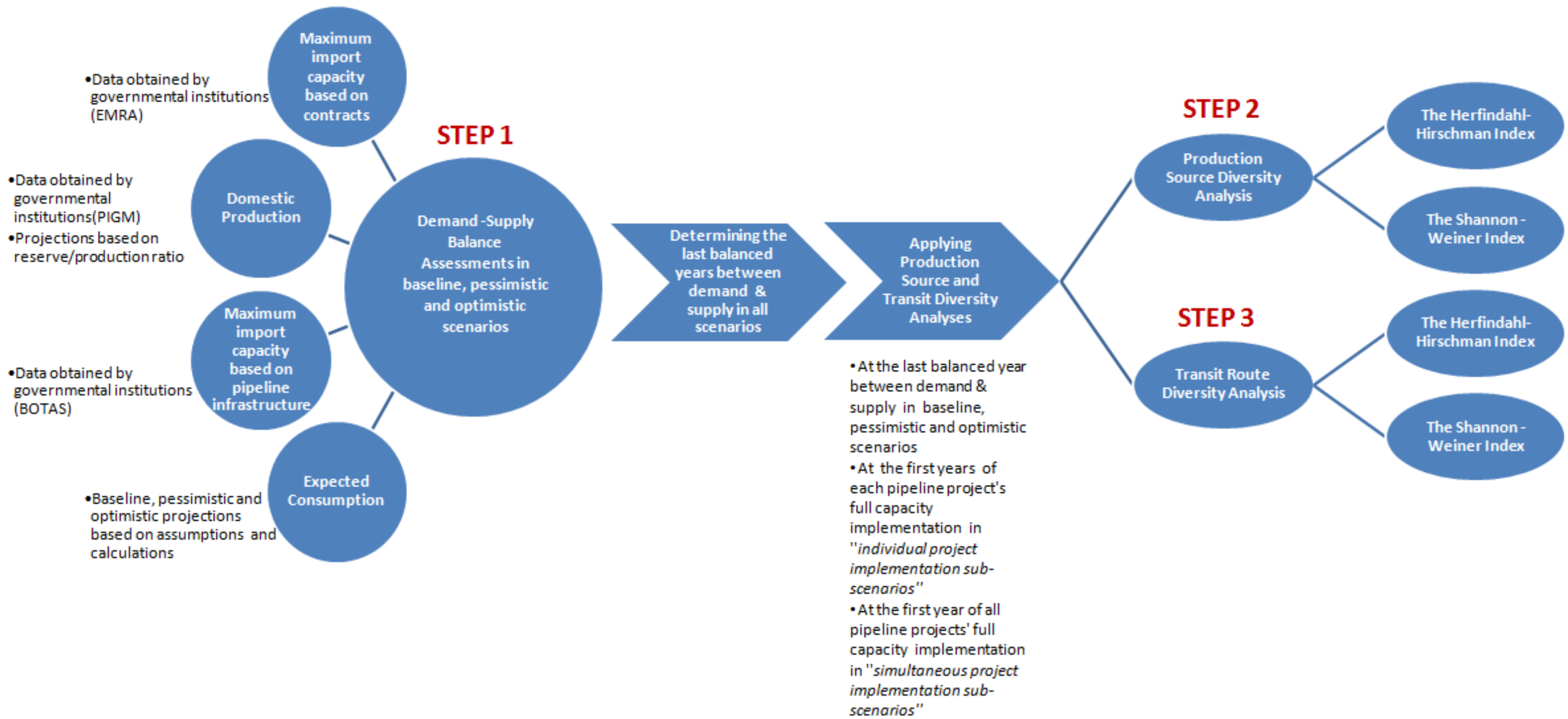


Figure 4.2: Methodological Framework.

4.1.2 Implementation, Assumptions and Data

Step 1: Demand – Supply Balance Assessment

The demand – supply balance assessment uses the fact that domestic demand grows at a calculated rate while the supply is based on an aggregation of future contracts, taking into account the future expiries and renewals. Thus, using aggregate numbers of supply capacities from all sources combined, a supply capacity range can be computed. There are four major determinants that could impact the demand – supply dynamics, and consequently their equilibrium.

1. Total forecasted domestic natural gas consumption
2. Domestic natural gas production
3. Maximum import capacity based on contracts, and
4. Maximum import capacity based on existing pipeline infrastructure

In order to get precise estimates of demand and supply, estimates and figures from these four determinants are compiled and aggregated. The total projected domestic demand for natural gas can be forecasted using the expected consumption function. On the supply side, domestic natural gas production, natural gas contracts (including the LNG contracts) and the existing pipeline capacity are taken into account[2].

1. **Expected Consumption**. The past consumption and future expected consumption are strongly correlated with the real GDP. For this reason, a real GDP data set which is obtained from the USDA is used to compute a natural gas consumption function. The basic premise underlying this approach is that the future natural gas consumption in Turkey will grow with real GDP at a magnitude consistently maintain over time. Since the natural gas consumption function mirrors the growth in real GDP, the various scenarios discussed above are in fact rooted in the different scenarios of GDP growth. Figure 4.3 below exhibits the various steps and processes employed to forecast an expected consumption function.

   The data is used to establish a static relationship, a ratio between natural gas consumption and GDP from 2005 to 2011, and this ratio is then assumed to remain constant through 2027. The natural gas consumption function is then extrapolated based on GDP growth estimates and this constant value ratio, for the baseline scenario. For the optimistic scenario, two standard deviations are added to the average consumption to real GDP ratio for 2005

[2] There are two notable assumptions for the following analyses. First, Turkey's natural gas import contract with Turkmenistan is not incorporated in this analysis because it has not been feasible in terms of pipelines so far. Second, gas exports from Turkey to Greece amount to a nominal 0.75 bcm per year are excluded from the following analyses as such trivial volume has only a symbolic value for both countries.

to 2011, while two standard deviations are subtracted from this average for the pessimistic scenario. The three different ratios for the three scenarios are then used with the real GDP projections to construct three different expected consumption functions.

Figure 4.3: Expected Consumption Function Construction.

2. **Domestic Production**. Turkey's domestic natural gas production stands at a very nominal 2 percent of its total consumption. This paper assumes that there will not be any significant new gas reserve discoveries or exploration and the current domestic production will continue on its present path.

3. **Maximum Import Capacity Based on Contracts**. Maximum import capacity is calculated by accounting for current contracts with the various suppliers of natural gas and LNG, already presented in detail in chapter 3. This analysis assumes that there will be no contract renewals or new contracts initiated in the foreseeable future.

4. **Maximum Import Capacity Based on Existing Pipeline Infrastructure**. The pipeline infrastructure capacity is computed using BOTAS' daily maximum deployable capacity data for the import pipelines. This analysis assumes that there will be no major breakdown in the existing infrastructure, and no impediment in its working on full capacity. Moreover, depreciation of the pipeline network is ignored for the purpose of this analysis. The contribu-

tion from Nabucco and South Stream is considered to be *added* on to the existing maximum supply capacity. The underlying assumption is that the current infrastructure will be utilized to its maximum before contribution from Nabucco or South Stream could be counted towards energy security.

Step 2: Production Source Diversity Analysis

Production Source Diversity Analysis is based on the idea that energy security is enhanced by well-diversified and reliable energy sources. This paper uses two different analytical approaches for quantifying diversity with respect to energy suppliers:

1. **The Herfindahl Hirschman Index (HHI)**. The HHI is a commonly used and widely accepted index for quantifying the market concentration of a defined industry (Vizcarrondo, 2004, p. 20). It is most often used in competition economics to measure market dominance by a few firms and to assess their monopoly power. The more concentrated an industry, the greater monopoly power its firms enjoy, often calling for antitrust cases to increase competition through diversification of suppliers. Mathematically, the HHI measures the sum of the squares of the individual market share of each firm in the industry. If one firm has 100 percent share then the HHI is $100^2 = 10,000$ and if 100 firms have a 1 percent market share each, then the HHI will equal 100.

$$\text{HHI} = \sum_{i=1}^{n} (\text{MS}_i)^2$$

   According to the Horizontal Merge Guidelines of U.S Department of Justice and Federal Trade Commission, an HHI below 1500 indicates an unconcentrated market, an HHI between 1500 and 2500 represents a moderately concentrated market, while an HHI above 2500 implies a highly concentrated market (U.S Department of Justice and the Federal Trade Commission, 2012, p. 18). This paper extends the HHI analysis to Turkey's suppliers of natural gas and measures the impact of Nabucco and South Stream in these terms.

2. **The Adjusted Shannon Weiner Index (SWI).** The second approach that this paper uses is the Shannon Weiner Index (SWI), a commonly used diversity index[3]. The SWI is ideally used for measuring diversity by taking into account the richness and relative abundance of species (Spellerberg and Fedor, 2003, pp. 177–179). The basic idea can be extended to an array of situations. Mathematically, the SWI is the sum of the proportion of an element in

[3] In some cases this index is spelled 'the Shannon Wiener Index' by different sources.

the total number, multiplied by the natural log of this proportion[4].

$$\text{SWI} = -\sum_{i=1}^{s} (p_i)(\ln p_i)$$

This paper uses an aggregated version of the simple SWI, the Adjusted SWI.

$$\text{SW} = \left(-\sum_{i} x_i \ln x_i b_i\right)(1 + g_i)$$

The adjusted SWI takes into account additional factors apart from diversity and relative concentration. Here, x is the market share of the supplying country, i. The coefficient g represents the share of indigenous energy production. The coefficient b represents an index of political stability of the supplier country. This dimension can be particularly useful in proxying for transit route risk. Several rating agency indices are available to be used as a measure of political stability. This paper uses the Political Instability Index of the Economist Intelligence Unit (EIU, 2012) for the parameter b. Table 4.1 below presents the Political Instability Index of the concerned countries for the purpose of this analysis. Given the proportion is the market share of a supplying country i , the more supplying firms, and the better diversified the market share concentration, the greater the SWI index will be (von Hirschhausen, 2005, p. 3). However, the coefficient b can slightly change the result despite the increase in the supplying firms. The index value ranges from 0, no diversification at all, to approximately 2, fully diversified.

Country	EIU Political Instability Index Rating (0-1 Scale)
Turkey	0,68
Russia	0,65
Azerbeijan	0,52
Iran	0,62
Iraq	0,79
Georgia	0,63
Bulgaria	0,6
Romania	0,64
Ukraine	0,76
Moldova	0,75

Table 4.1: EIU Political Instability Index of 2009. Source: (EIU, 2012).

[4]The negative sign appears to make the negative natural log value a positive number.

Step 3: Transit Route Diversity Analysis

As in the case of Production Source Diversity, Transit Route Diversity also relies on diversity and reliability of transit countries. The methodological approach for assessing Transit Route Diversity will thus employ a similar technique and rely on the HHI and the adjusted SWI indices.

Critical Cut-off Dates for the Step 3 Analyses

1. Last balanced year between demand and supply: production source and transit route diversity analyses will be implemented at the last year in which there is adequate supply to meet the demand.

2. First years of each pipeline project's full capacity implementation: production source and transit route diversity analyses will be assessed at the first years of each pipeline's project's full capacity implementation in the sub-scenarios, each of which have individual project implementation assumptions.

3. At the first year of both pipeline projects' full capacity implementation: production source and transit route diversity analyses will be assessed at the first year of both project pipelines' full capacity implementation in the sub-scenarios which have simultaneous project implementation assumptions.

4.2 Demand – Supply Balance Assessment

4.2.1 Sub–Scenario 1 : No Project Implementation

According to current estimates, the natural gas demand in Turkey is forecasted to grow steadily at an annual rate of 3.45 percent between 2011 and 2027 from 43.88 bcm per year to 75 bcm per year. As previously pointed out, domestic production remains limited at 0.73 bcm per year and so most of the domestic demand is met by gas imports. In the absence of new agreements or renewed contracts, Turkey's maximum import capacity will fall to 16 bcm per year in 2027. 2013 is the last year in which supply addresses demand, and starting from 2014 an increasing demand – supply deficit will be evident.

Turkey's existing pipeline infrastructure network will allow a maximum import capacity of 53.1 bcm per year (BOTAS Online Database, 2012). As shown in Figure 4.4, till 2018 there is excess capacity in the existing pipeline infrastructure. Beyond 2018, even if Turkey renews or signs new gas import agreements, the pipeline infrastructure will be insufficient to carry the imported volume necessary to meet domestic gas demand.

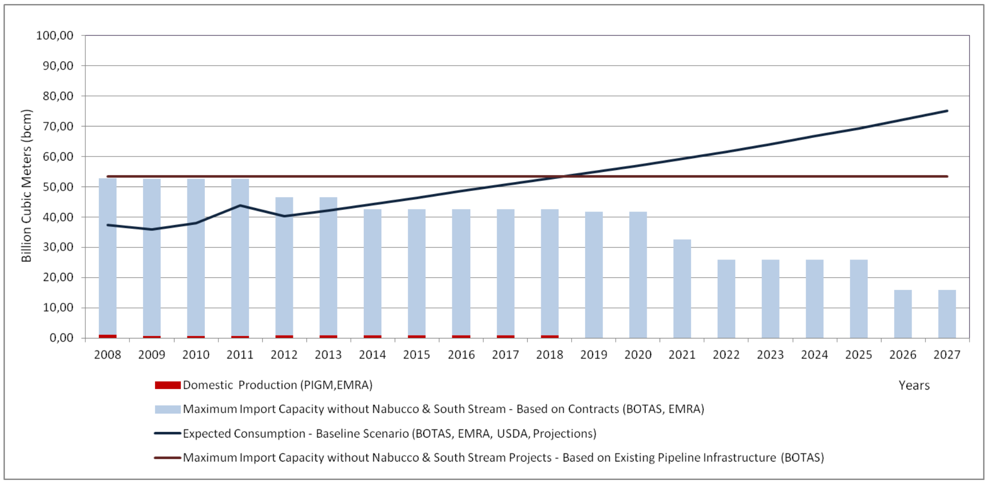


Figure 4.4: Demand–Supply Balance Assessment in Sub-Scenario 1 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; USDA Online Database, 2012), own extractions and projections.

As Figure 4.4 shows, Turkey's natural gas demand first exceeds the contractual import supply in 2014, and then also exceeds existing maximum pipeline network capacity in 2018.

4.2.2 Sub–Scenario 2 : Individual Implementation of Nabucco

Sub–scenario 2 intends to demonstrate the individual contribution of the Nabucco pipeline project in enhancing Turkey's import capacity. The assumptions and baseline forecasts are the same as in the previous sub–scenario, and Nabucco's capacity contribution is extracted using publicly available data from Nabucco's website. According to the terms laid out on the project information, half of Nabucco's capacity is for third party access while the rest is equally shared amongst shareholders including Botas, the Turkish state owned enterprise. Under competitive conditions, if both Botas and private companies are treated as one entity then Turkey's share of the Nabucco project reaches approximately 16.7 percent of the full Nabucco capacity.

Initially, the Nabucco capacity is planned to be 9 bcm per year, rising to its full planned capacity of 31 bcm per year in 4 years (Nabucco Official Web Site, 2012). Based on these assumptions, a fair estimate of 1.5 bcm per year from 2017 to 2020, and 5.17 bcm per year from then on, is expected to be added to Turkey's natural gas imports from the Nabucco pipeline project. Figure 4.5 illustrates this graphically, and exhibits the increasing gas supply deficit despite Nabucco's contribution.

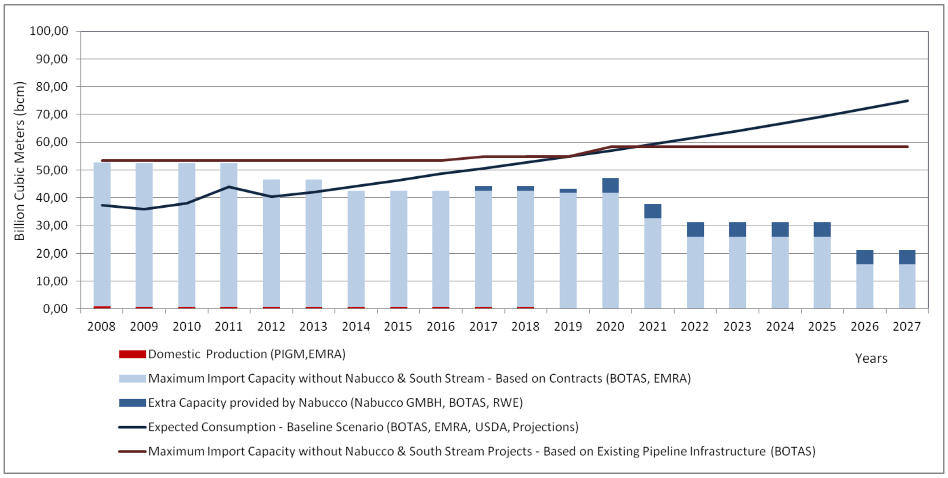


Figure 4.5: Demand –Supply Balance Assessment in Sub-Scenario 2 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; USDA Online Database, 2012), own extractions and projections.

4.2.3 Sub–Scenario 3 : Individual Implementation of South Stream

In this sub–scenario, the baseline case of "*No Project Implementation*" is built upon by adding South Stream's contribution. The assumptions, forecasts, and the basic scenario is the same. The distribution of 63 bcm per year capacity of South Stream is unclear so far. Gazprom has not disclosed distribution quotas for export to Turkey and the transit gas to European countries. However, based on publicly available information a conjectural calculation can be produced. Assuming that Turkey's share of Russian natural gas imports remains unchanged at 11.4 percent, and also assuming that Germany imports gas from Russia directly through Nord Stream, and not through South Stream, Turkey's share of imports from Russia will increase to 13.3 percent, yielding 4.19 bcm per year to Turkey from the South Stream at full capacity (BP, 2012a, pp. 28–30).

According to the informational available on South Stream pipeline project, the transition to full capacity is going to be gradual from 2015 to 2018. During the transition phase, Turkey's natural gas import from South Stream is going to be a nominal 1.04 bcm per year.

The South Stream project will not make any improvements in Turkey's gas pipeline infrastructure, for this reason, the last balanced year in terms of demand and maximum import capacity remains unchanged from the baseline scenario of "*No Project Implementation*".

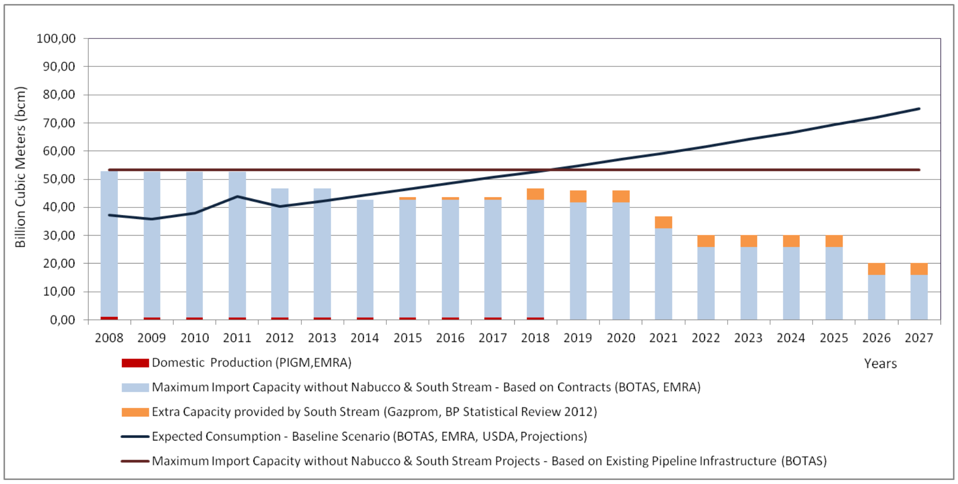


Figure 4.6: Demand–Supply Balance Assessment in Sub-Scenario 3 under the Baseline Scenario Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; USDA Online Database, 2012), own extractions and projections.

4.2.4 Sub–Scenario 4 : Simultaneous Implementation of Both Projects

This sub–scenario aggregates the contribution of both the Nabucco and South Stream pipeline projects. Naturally, the assumptions and forecasts associated with each individual project have carried forward to this sub–scenario.

Admittedly, implementing both projects simultaneously still will not meet Turkey's growing demand adequately, but it will certainly mitigate the growing deficit, as shown in Figure 4.7. Also, the last year in which the maximum pipeline capacity can meet the forecasted demand growth is 2020, beyond which expected forecasted demand exceeds the existing pipeline capacity even after Nabucco's contributions.

4.3 Production Source Diversity Assessment

As pointed out previously, diversification is the most effective way of achieving security of energy supply. In addition, the reliability of suppliers and supply lines is also a key element in ensuring energy security. This paper relies on three approaches for assessing the production source diversity assessment:

1. Distribution of suppliers in the selected years

2. Market concentration based on the Herfindahl Hirschman Index (HHI)

3. Quantification of diversification with the adjusted Shannon Weiner Index (SWI) that also

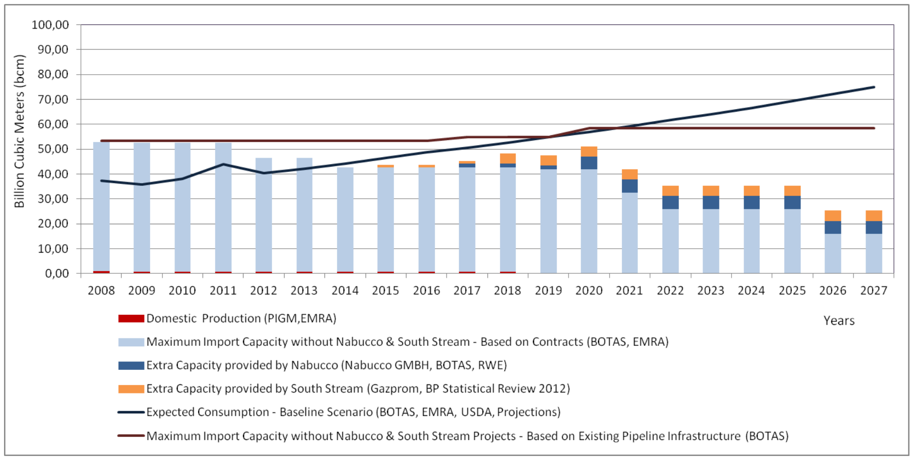


Figure 4.7: Demand–Supply Balance Assessment in Sub-Scenario 4 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; USDA Online Database, 2012), own extractions and projections.

takes into account political stability and reliability of sources

Both the production source and transit route diversity assessments are conducted at critical time junctions in the supply – demand balance assessment. The methodological framework and the projected estimates are deduced using the approach shown in the flow chart below. A detailed explanation illustrating the steps in calculation is presented in the appendix.

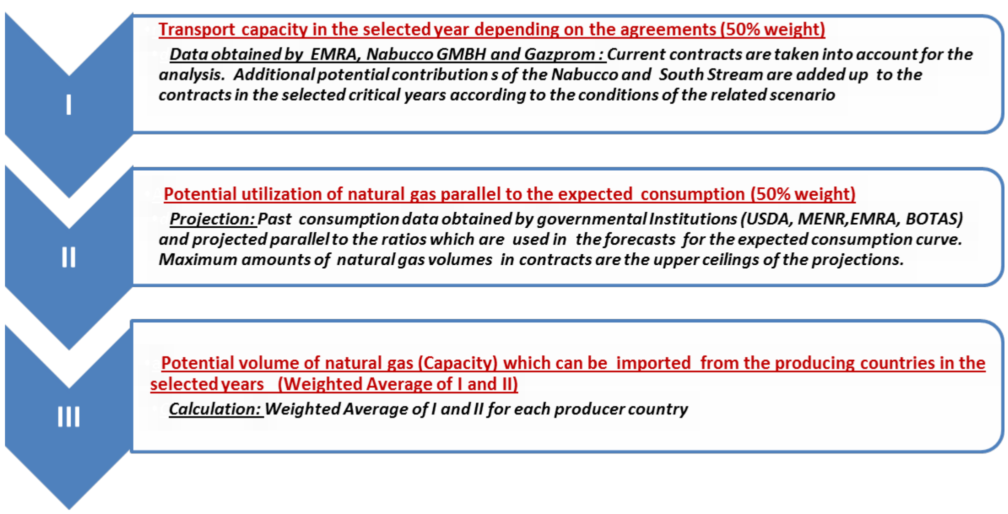


Figure 4.8: Methodological Framework, Data Attainment and Processing.

The following analyses assume that there will be no alternative pipeline projects, import agreements, or contract renewals during this time.

4.3.1 Sub–Scenario 1 : No Project Implementation

Figure 4.9 below shows the natural gas suppliers of Turkey without any future investment in a pipeline project. Unsurprisingly, Russia is the major supplier of natural gas to Turkey, with its market dominance for gas supply around 62 percent.

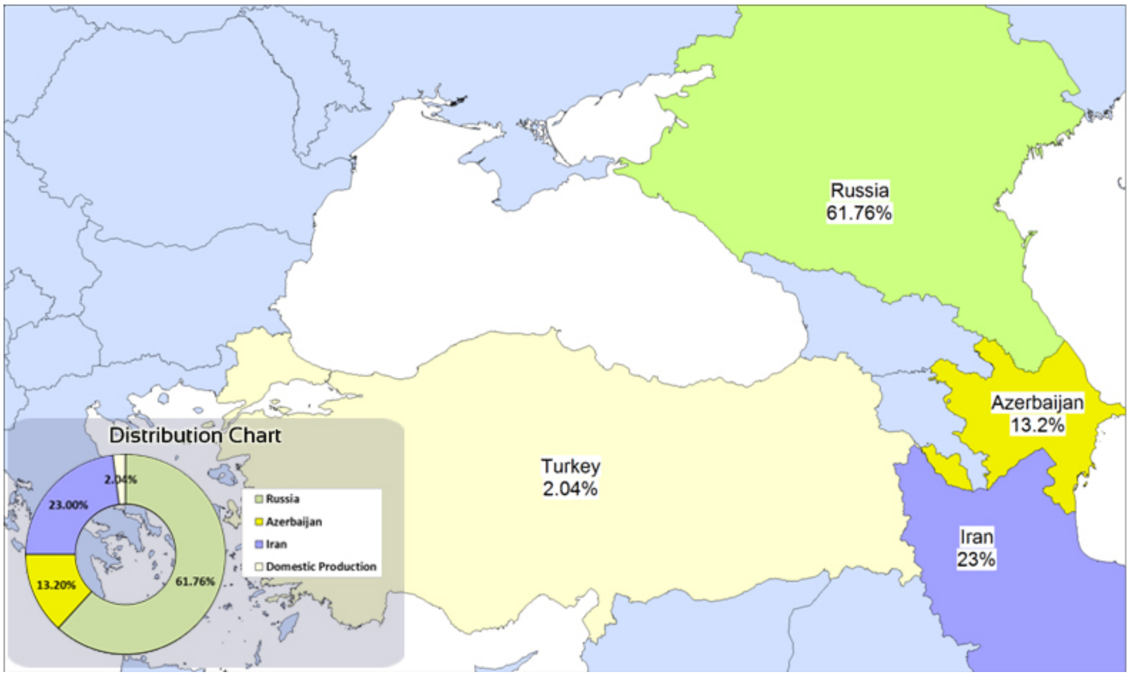


Figure 4.9: Distribution of Suppliers in Sub-Scenario 1 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

The market concentration as measured by the HHI is 4522 which indicates that the market for natural gas suppliers is highly concentrated. The adjusted SWI is 0.553 which indicates a serious lack of diversity and relative abundance of supply sources.

The Herfindahl Hirschman Index: 4522

The Adjusted Shannon Weiner Index: 0.553

4.3.2 Sub–Scenario 2 : Individual Implementation of Nabucco

By 2020, domestic production of natural gas erodes to zero and consequently the percentage share of remaining suppliers appears trivially inflated. After the Nabucco project is implemented and reaches its full capacity in 2020, Russia's dominance decreases slightly whereas that of Azerbaijan and Iraq increases. Figure 4.10 below shows a drastically lower dominance for Russia which is a result of full capacity Nabucco implementation but also because of a significant increase in utilization rates from other importing countries.

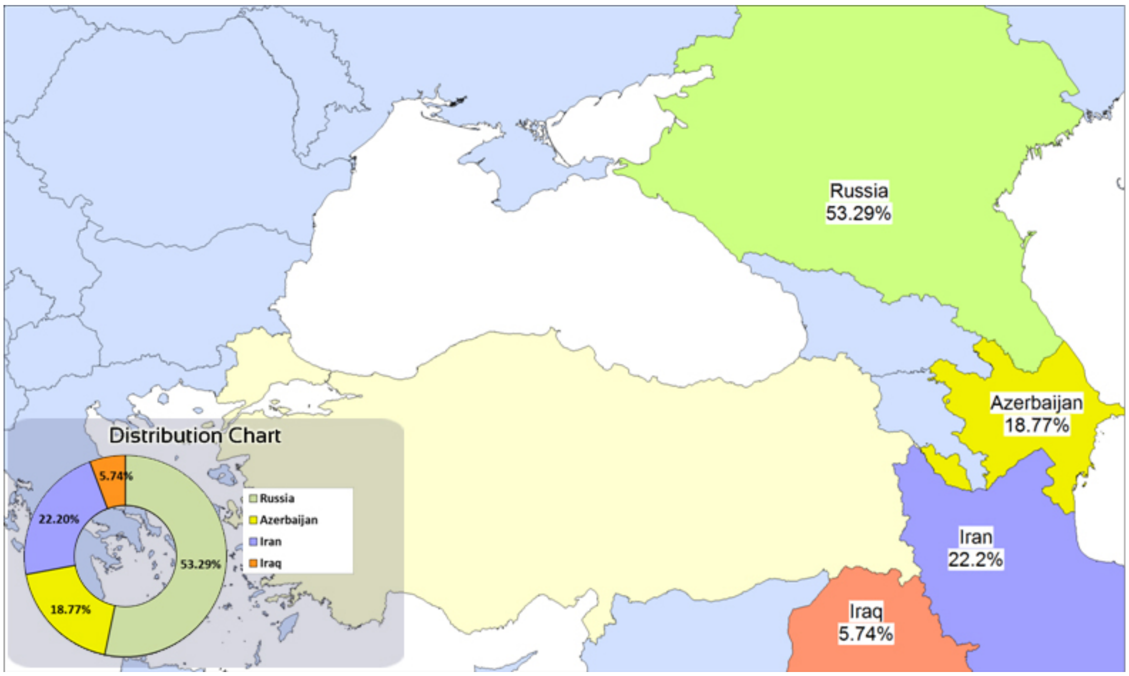


Figure 4.10: Distribution of suppliers in Sub-Scenario 2 under the Baseline Scenario Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

As a result, both HHI and the adjusted SWI show a significant improvement. The HHI decreases from 4522 to 3718, which is a significant decline, but still sufficiently high for the industry to qualify as a highly concentrated industry. Similarly, the adjusted SWI has also shown a significant improvement from 0.533 to 0.718 but still does not indicate a comfortable level of diversity.

The Herfindahl Hirschman Index: 3718

The Adjusted Shannon Weiner Index: 0.718

4.3.3 Sub–Scenario 3 : Individual Implementation of South Stream

The South Stream pipeline project offers an interesting trade-off. On the one hand, it provides energy security by promising the much needed additional gas to feed Turkey's domestic demand. On the other hand, it increases Turkey's energy dependence on Russia, and decreases supplier and route diversity. Below captures this scenario.

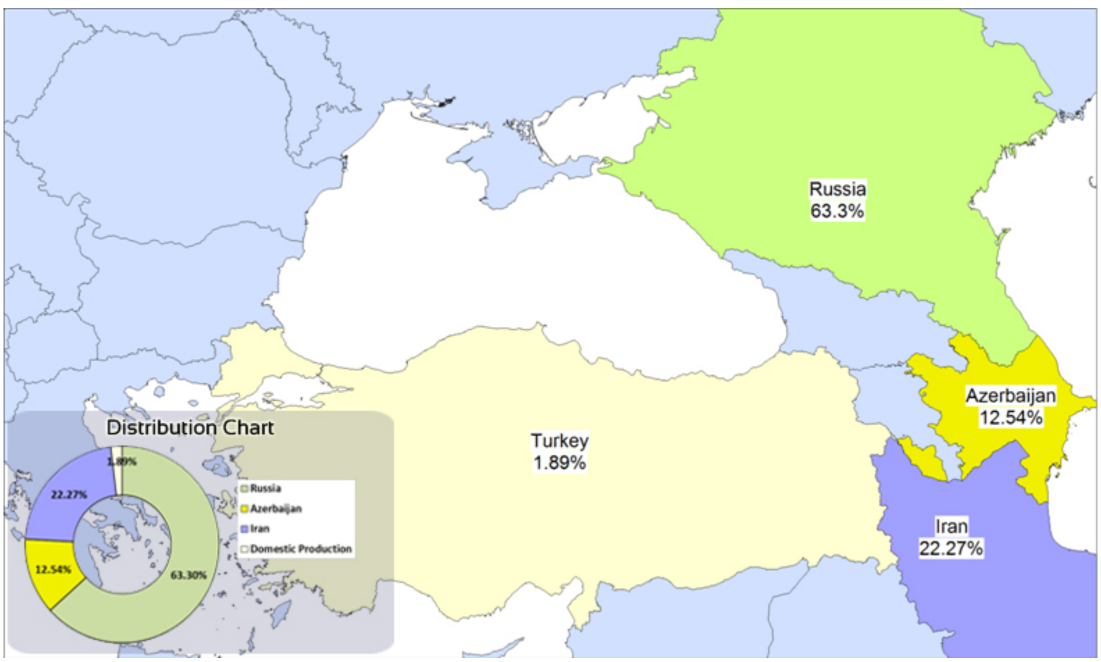


Figure 4.11: Distribution of Suppliers in Sub-Scenario 3 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

As expected, the implementation of South Stream increases Russia's dominance and thus leads to an even more concentrated market. This is confirmed by the HHI value of 4664 which is the highest in all sub–scenarios, implying an increasingly concentrated market. The adjusted SWI follows a similar trajectory and decreases to 0.540, the lowest of all sub–scenarios.

The Herfindahl Hirschman Index: 4664

The Adjusted Shannon Weiner Index: 0.540

4.3.4 Sub–Scenario 4 : Simultaneous Implementation of Both Projects

The implementation of both projects simultaneously has an offsetting effect in terms of diversity. Where Nabucco reduces Turkey's energy dependence on Russia, South Stream increases it. Thus, Nabucco increases diversity by providing an alternative supply line and South Stream reduces it increasing dependence on an already dominant supplier of energy.

In mathematical terms, the Nabucco project yields the lowest HHI and the highest SWI values; while the South Stream project yields the highest HHI and the lowest SWI values. A simultaneous implementation of both will naturally yield HHI and SWI values that are in the mid-range of the two extreme values presented in sub–scenarios 2 and 3.

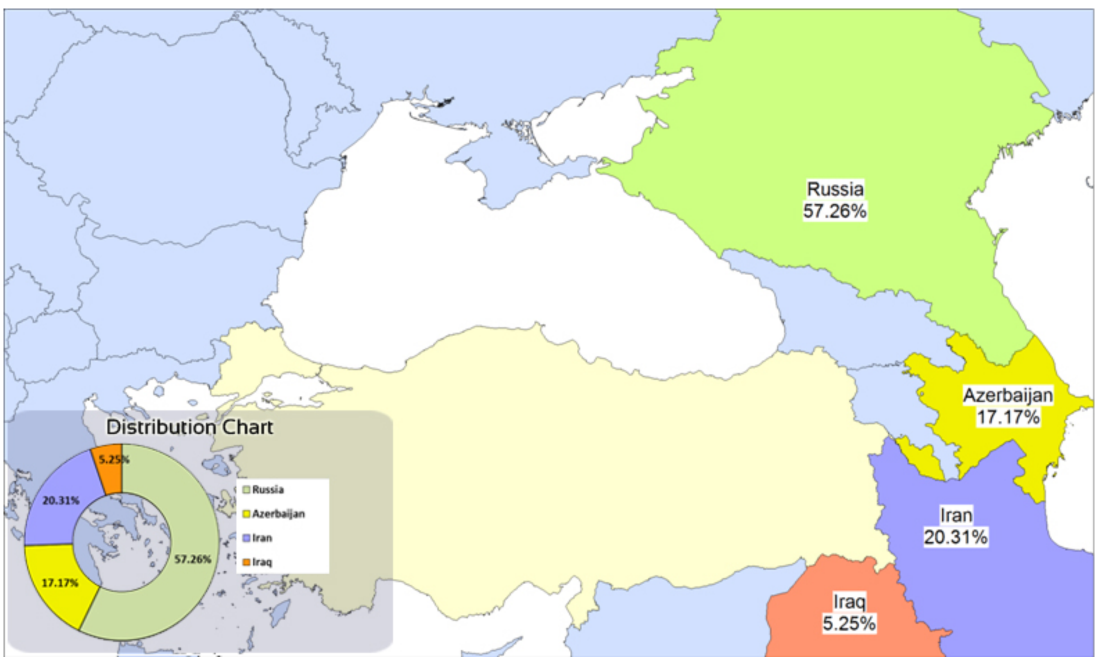


Figure 4.12: Distribution of Suppliers in Sub-Scenario 4 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

The HHI value after implementing both projects is 4014 which is still reflective of a highly concentrated market according to the guidelines presented in section 4.1. The SWI value is 0.688

which is a slight improvement from implementing South Stream alone, but still less diversified than implementing Nabucco alone. All in all, the option to implement both projects simultaneously brings a middle ground in terms of diversity and market concentration but both projects do increase Turkey's energy security in terms of meeting gas demand.

The Herfindahl Hirschman Index: 4014
The Adjusted Shannon Weiner Index: 0.688

4.4 Transit Route Diversity Assessment

The transit route diversity assessment takes a similar approach to that of the production source diversity assessment. As in the previous case, the key to transit route diversity is diversification and increased reliability of the various sources. Again, the three main approaches to assessing the transit route diversity are:

1. Distribution of suppliers in the selected years
2. Distribution of suppliers in the selected years
3. Quantification of diversification with the adjusted Shannon Weiner Index (SWI) that also takes into account political stability and reliability of sources.

An important element in inspecting transit route diversity is taking into account the transit route risk. This risk can further be classified into several categories. The most common is the political risk, where a case in point is the Ukraine Russia gas war of 2009 during which Russia cut-off gas supplies to Ukraine because of price disagreement and in retaliation Ukraine cut-off transit gas to 18 European countries. Another risk factor is the technical risk of pipeline operations and distribution networks. This study however, restricts the analysis to political risk and ignores technical risks of pipelines. To this end, this approach relies on the Political Instability Index published by the Economist Intelligence Unit for capturing transit risk for each country.

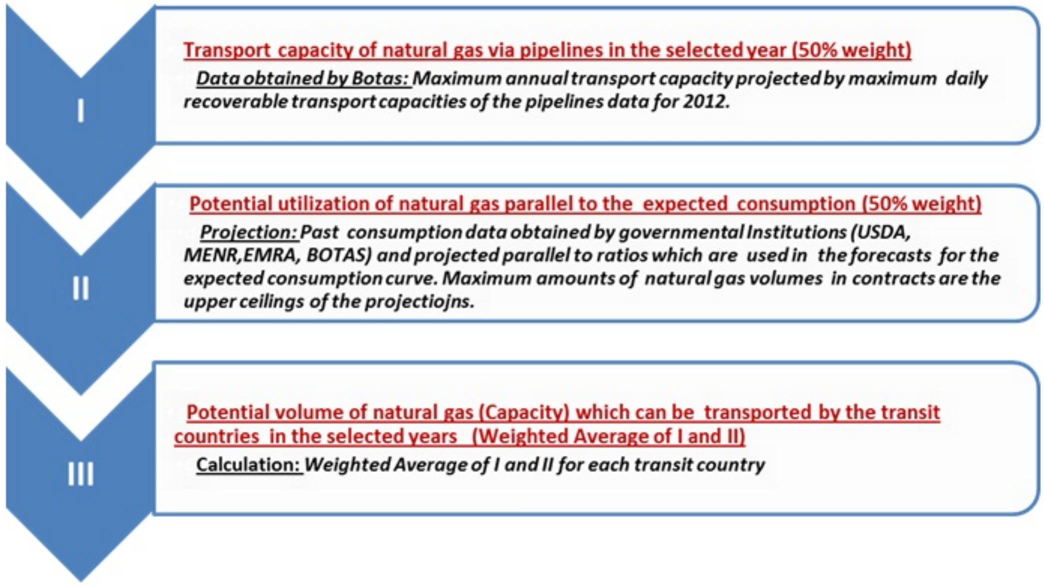


Figure 4.13: Methodological Framework and Data Processing Flow Chart for Transit Route Risk Assessment.

As with the previous scenarios, this scenario also assumes that there will be no major investments in pipeline infrastructure other than Nabucco and South Stream.

4.4.1 Sub–Scenario 1 : No Project Implementation

Turkey's geostrategic location plays a pivotal role in ensuring its relatively abundant and diverse supply routes. Turkey has a direct access to Russian gas with a sub-sea level pipeline, Blue Stream. Russia maintains its dominance not just as the biggest supplier but also as a transit route. Iran is the next most important transit country and gas supplier which is directly connected to Turkey. Equally important are the countries along the Trans-Balkan import line that deliver Russian gas to Turkey. The third largest share in distribution is that of Georgia which delivers the Azerbaijani gas to Turkey. Figure 4.14 below illustrates the distribution shares of all major transit route countries.

In terms of diversification of transit routes, the HHI and SWI values show a marked improvement from the production source diversity values. Evidently, having a greater number of transit routes has decreased the market concentration and also increased diversity and reliability. This is shown by the much lower value of HHI of 2107 which implies a 'moderately concentrated market,' a clear improvement from 'highly concentrated market' in production source diversity. Similarly, the adjusted SWI value is also much higher, around 1.3, which indicates a much more diversified transit supply route.

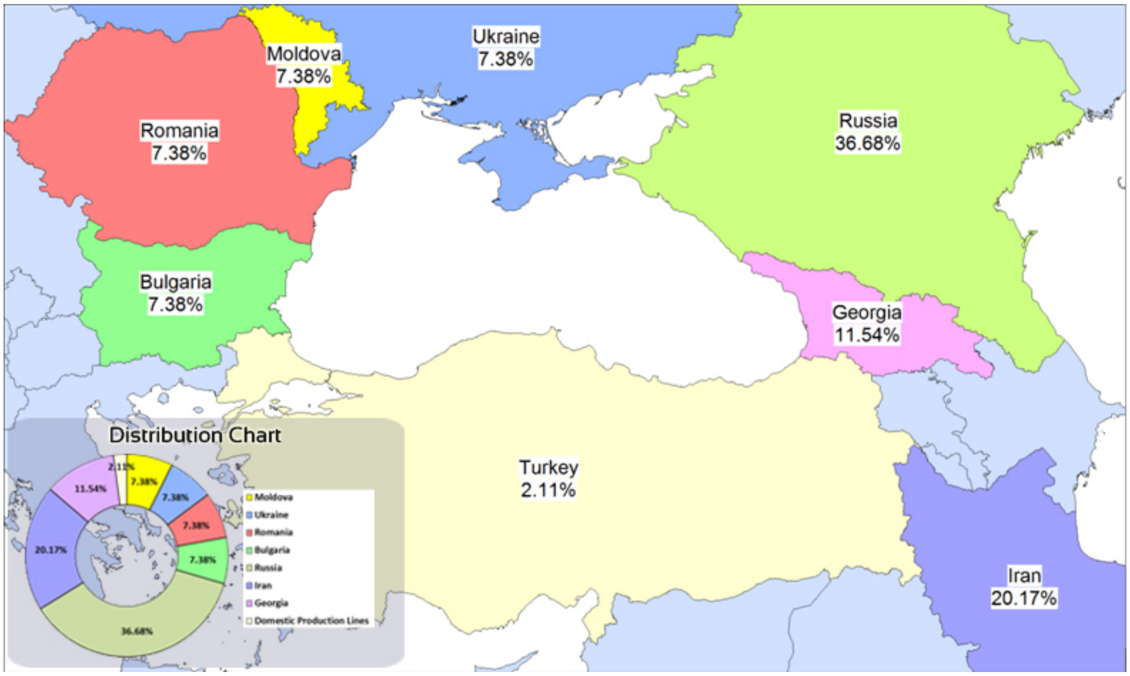


Figure 4.14: Distribution of Transit Countries in Sub-Scenario 1 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

The Herfindahl Hirschman Index: 2107

The Adjusted Shannon Weiner Index: 1.295

4.4.2 Sub–Scenario 2 : Individual Implementation of Nabucco

The individual implementation of Nabucco reduces the energy transit route dominance by Russia and Trans-Balkan states, increases the transit share of Georgia and also adds Iraq as another supplier and a transit destination. Below shows the transit route distribution shares in 2020, once the Nabucco project has been completed and is fully operational.

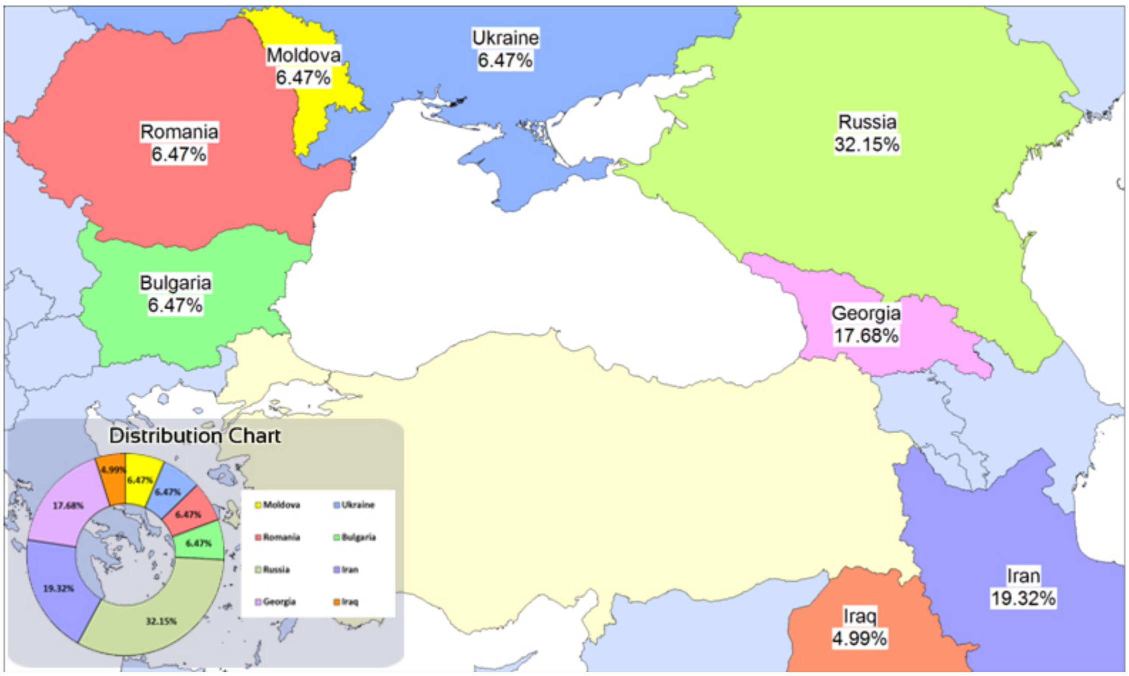


Figure 4.15: Distribution of Transit Countries in Sub-Scenario 2 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

The HHI value falls drastically to 1785 which qualifies the transit route industry for a 'moderately concentrated market.' Individual implementation of Nabucco reduces market concentration in the transit route industry. On the other hand, the SWI value surprisingly falls to 1.232. One major factor contributing to a decrease in SWI value could be the political instability in Iraq.

The Herfindahl Hirschman Index: 1785

The Adjusted Shannon Weiner Index: 1.232

4.4.3 Sub–Scenario 3 : Individual Implementation of South Stream

The implementation of South Stream alone increases Bulgaria's relevance as a major transit player. A seemingly contradictory fact is that Russia's dominance as an energy supplier increases while its dominance as a transit route decreases. Figure 4.16 below illustrates the distribution of transit countries in 2016, at the completion of the South Stream project.

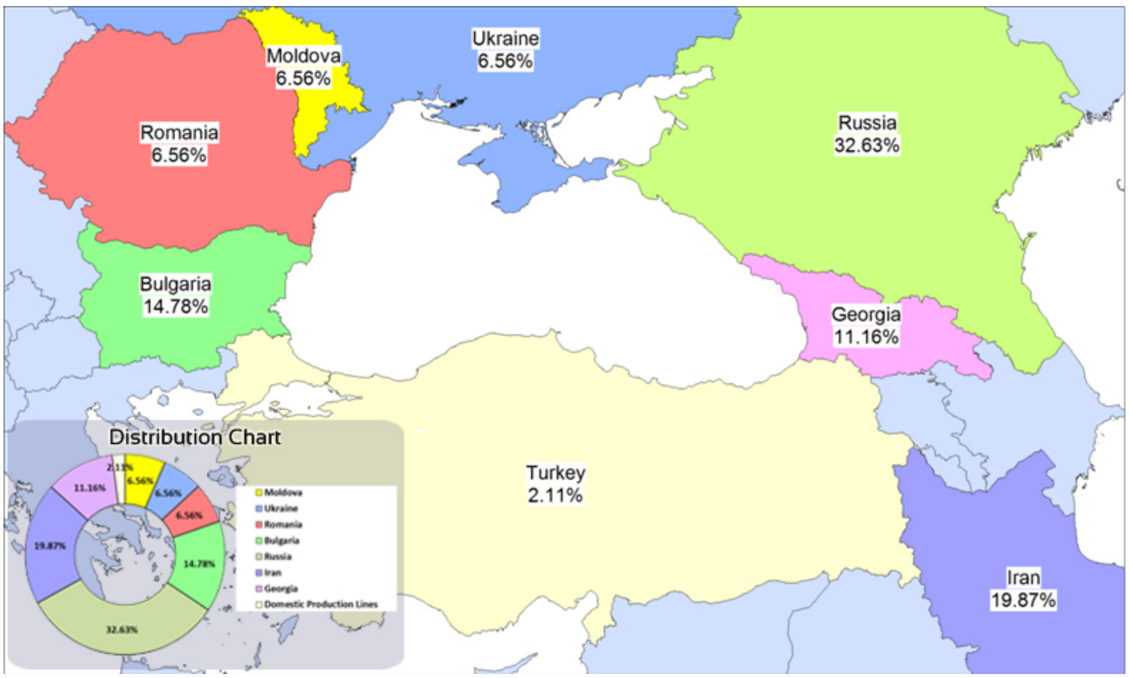


Figure 4.16: Distribution of Transit Countries in Sub-Scenario 3 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

The HHI value rises slightly above the previous scenario of the Nabucco only implementation from 1785 to 1828. Still, the increase is marginal and the industry as a whole is classified as 'moderately concentrated market.' The SWI value is the highest among all scenarios which means that individual implementation of South Stream provides the highest diversification and reliability of transit routes. The SWI value is 1.319.

The Herfindahl Hirschman Index: 1828

The Adjusted Shannon Weiner Index: 1.319

4.4.4 Sub–Scenario 4 : Simultaneous Implementation of Both Projects

The transit distribution assessment for both projects implementation is conducted in 2020 when both Nabucco and South Stream are fully operational. This scenario provides the lowest value for HHI which means that market concentration declines further when both projects are implemented simultaneously. The HHI for this scenario is 1595. In contrast, the SWI value is 1.248 which is the third best option for Turkey after sub–scenarios 3 and 1. This means that implementing both projects leads to a decline in relative diversity of transit routes.

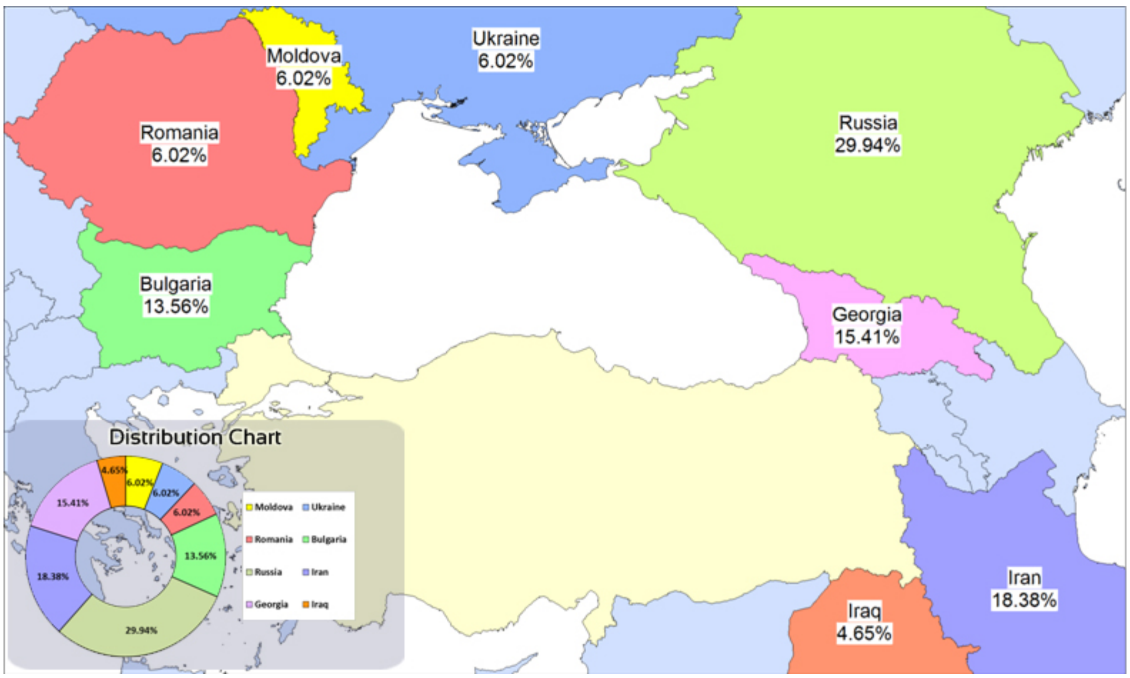


Figure 4.17: Distribution of Transit Countries in Sub-Scenario 4 under the Baseline Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012; Gazprom, 2012). Own extractions and projections.

The Herfindahl Hirschman Index: 1595

The Adjusted Shannon Weiner Index: 1.248

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

This paper presents a multidimensional approach to quantify and analyze Turkey's energy security of supply with reference to the implementation of the Nabucco and South Stream projects. The three main dimensions of assessment include demand – supply balance assessment, producer source diversity, and transit route diversity. The demand – supply balance assessment, based on contractual supply agreements finds that Turkey's natural gas surplus will become a deficit starting from 2014. The same assessment based on pipeline capacity finds that barring any additional investment in pipeline infrastructure, Turkey's gas demand will rise beyond the maximum pipeline capacity by 2020. Although Nabucco implementation will enhance Turkey's pipeline capacity, in the long-term, this enhancement is marginal when compared to the growing disconnect between Turkey's natural gas demand and its maximum supply-line capacity. The bottom line is that even though both Nabucco and South Stream would provide a valuable and timely contribution to meeting Turkey's rising gas needs, in the long-run they are simply inadequate in ensuring a sustainable and secure energy supply.

The project level sub-scenario analysis vis-á-vis producer diversity and transit route diversity reveals useful findings about gas supply and transit industry, and about Turkey's broader energy security. The Nabucco project contributes to a significant improvement in the HHI value, indicating a reduction in market concentration, implying a higher level of competition among suppliers and transit route destinations. Surprisingly, the SWI value of Nabucco only shows a moderate improvement from baseline, as compared to South Stream. The underlying reason is that Nabucco includes politically instable areas like Georgia and Iraq for transit routes, and so the adjusted SWI which takes into account political instability in addition to diversity and relative abundance, has a lesser value for Nabucco as compared to South Stream.

On the other hand, South Stream also offers an interesting trade-off. Implementation of South Stream increases Russia's dominance both as an energy supplier and as a transit route, as validated by the relatively higher HHI values. Still the increased dominance of Russia, higher market concentration and diminished competition are compensated for, in part, by greater energy supply. The

SWI value shows yet another facet of this project. The implementation of South Stream increases Bulgaria's role as a major transit player, and because this route has more diversity and a relatively stable political and economic environment, the SWI value for South Stream is the highest.

To reiterate, energy security of supply is a function of a host of factors in which continuous supply, diversity of suppliers, diversity and risk of transit routes, all play a major role. In the South Stream scenario, energy security is enhanced because of increased supply but off-set because of diminished diversity and an increased dependence on Russia. It is practically impossible to quantify the two off-setting trends. This paper argues that increased energy supply with diminished diversity is still a better option than facing an energy shortage of that magnitude. Therefore, the implementation of both projects together would be beneficial for Turkey's energy security and their contributions to meeting Turkey's rising gas demand would be marginal but valuable and timely.

5.2 Recommendations

One way to address Turkey's perpetually rising energy need is to reduce consumption. Turkey is one of the least energy efficient countries in the OECD and this must change if Turkey wants to improve its energy security in the long-run. In addition, Turkey must renew its energy supply contracts and sign new supply agreements that ensure delivering on energy needs based on future energy projections. To ensure safe and affordable gas transportation, Turkey must also invest to upgrade its pipeline capacity so it can meet its projected demand beyond 2020.

This paper advocates the implementation of both Nabucco and South Stream. Predictably, the Turkish government also realizes the importance and scope of these projects. However, since the energy business operates primarily in the wider geopolitical realm, the Turkish government must actively support these projects at both the diplomatic and political levels if it wants to gain a greater role as a major transit player in the region. Beyond these two projects, Turkey should continue its exploration activities along the Mediterranean.

This paper has mostly focused on diversity within the realm of natural gas supply, source, and transit routes. On a broader scope, Turkey must also diversify away from its heavy reliance on natural gas itself. Turkey's energy mix should move towards renewable energy like hydro, thermal, solar and wind power generation. Even in non-renewable sources, nuclear energy seems like a viable alternative.

Finally, this paper reiterates that both Nabucco and South Stream will provide valuable and timely gas supply, but in the long-run, their contribution is inadequate and marginal to meet Turkey's growing energy needs. To fully address the energy challenge, Turkey must act decisively and aggressively with a multi-pronged approach that includes, but is not limited to, renewing gas supply contracts, improving energy efficiency, increasing energy exploration, and diversification towards renewable, clean, and sustainable energy.

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Appendix A

Demand–Supply Balance Assessments in Pessimistic and Optimistic Scenarios

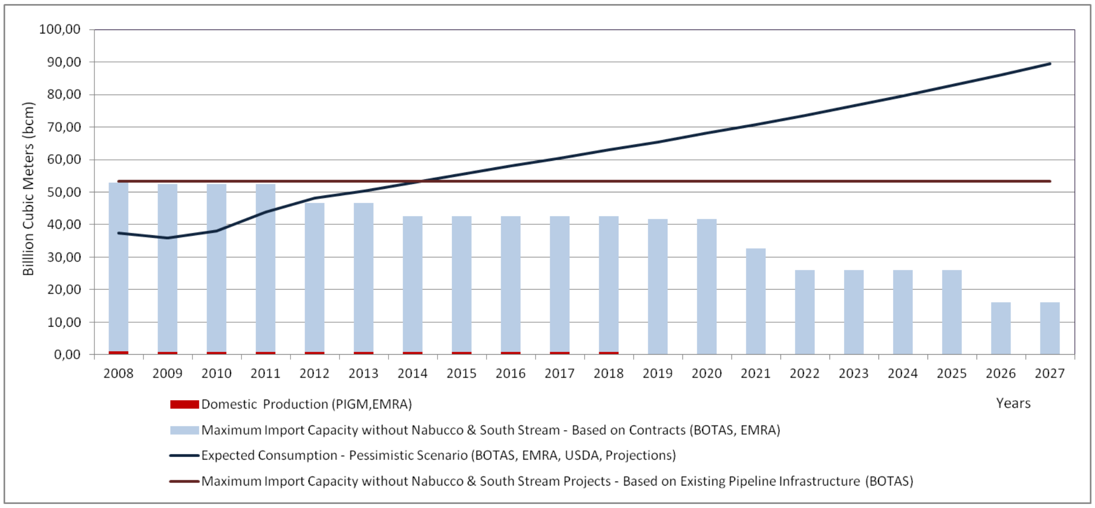

Figure A.1: Demand-Supply Balance Assessment in Sub-Scenario 1 in Pessimistic Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012), own extractions and projections.

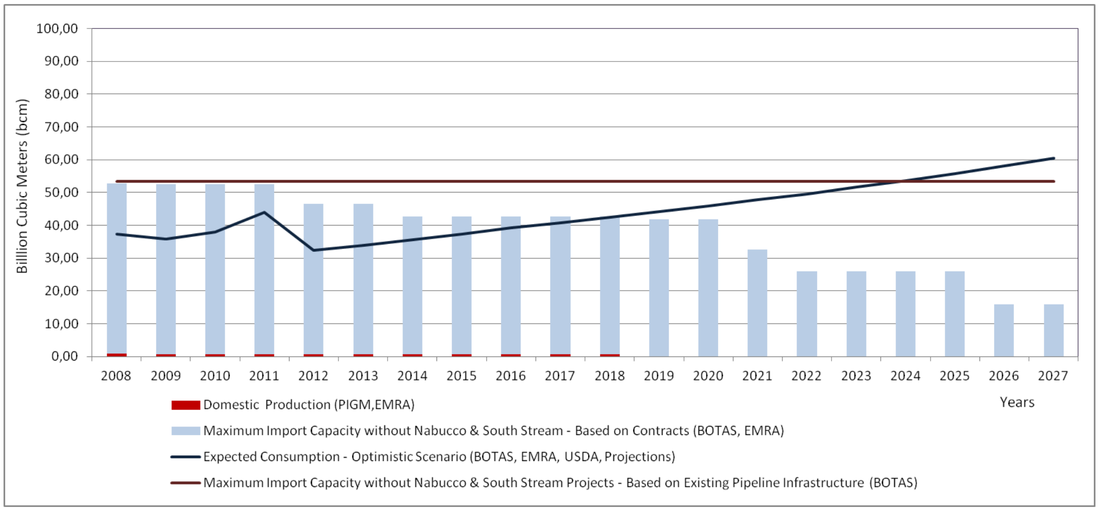

Figure A.2: Demand-Supply Balance Assessment in Sub Scenario 1 under the Optimistic Scenario. Source: (PIGM Online database., 2012; EMRA, 2012; BOTAS Online Database, 2012; GIE Online natural gas network database, 2012; Nabucco Official Web Site, 2012). Own extractions and projections.

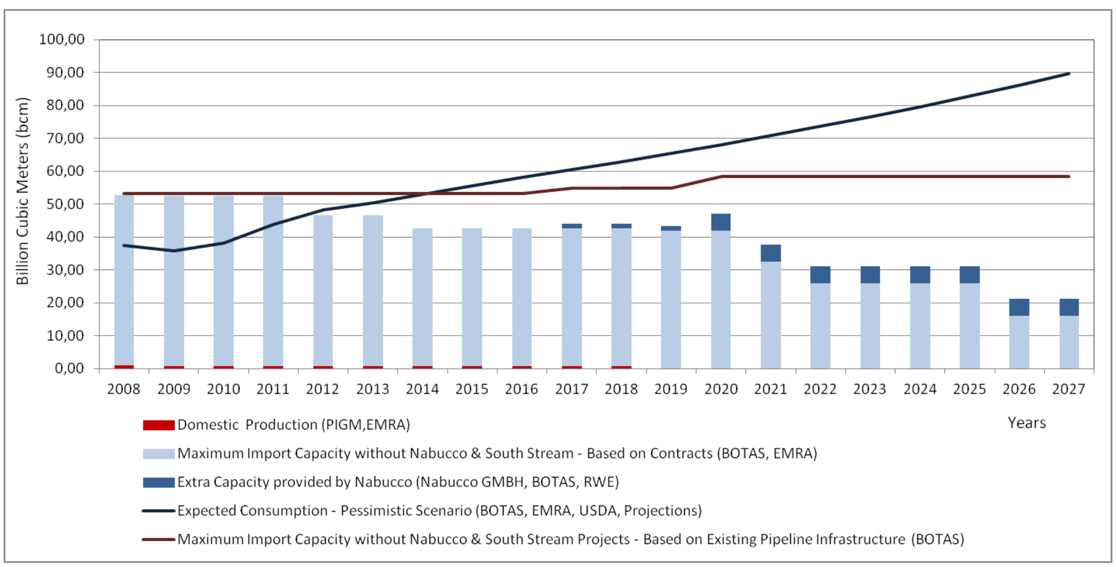

Figure A.3: Demand-Supply Balance Assessment in Sub Scenario 2 under the Pessimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections.

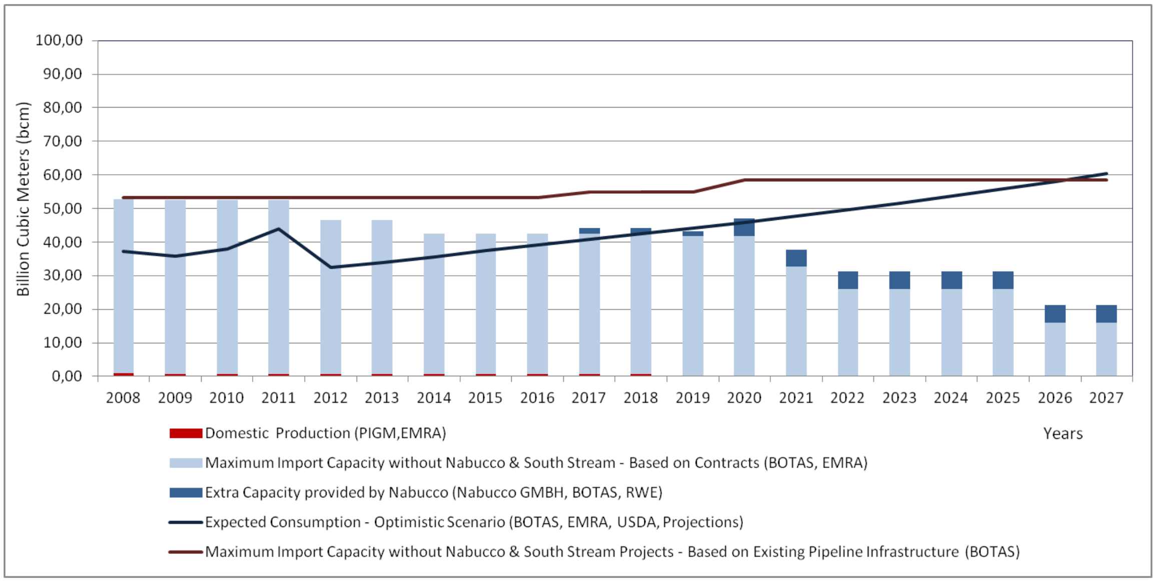

Figure A.4: Demand-Supply Balance Assessment in Sub-Scenario 2 under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections

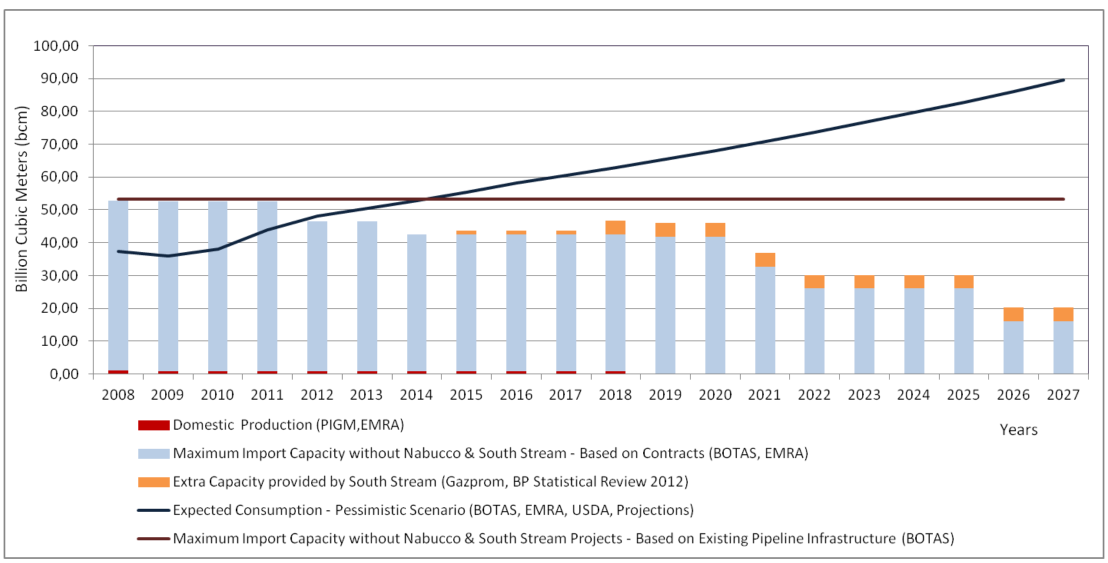

Figure A.5: Demand-Supply Balance Assessment in Sub-Scenario 3 under the Pessimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections.

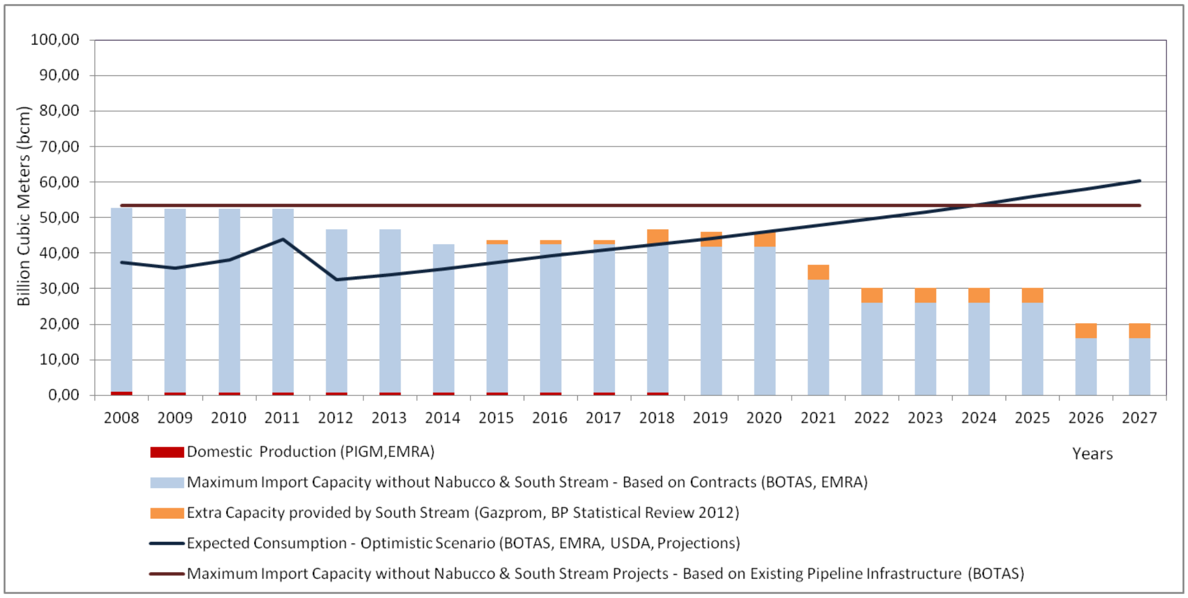

Figure A.6: Demand-Supply Balance Assessment in Sub-Scenario 3 under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections.

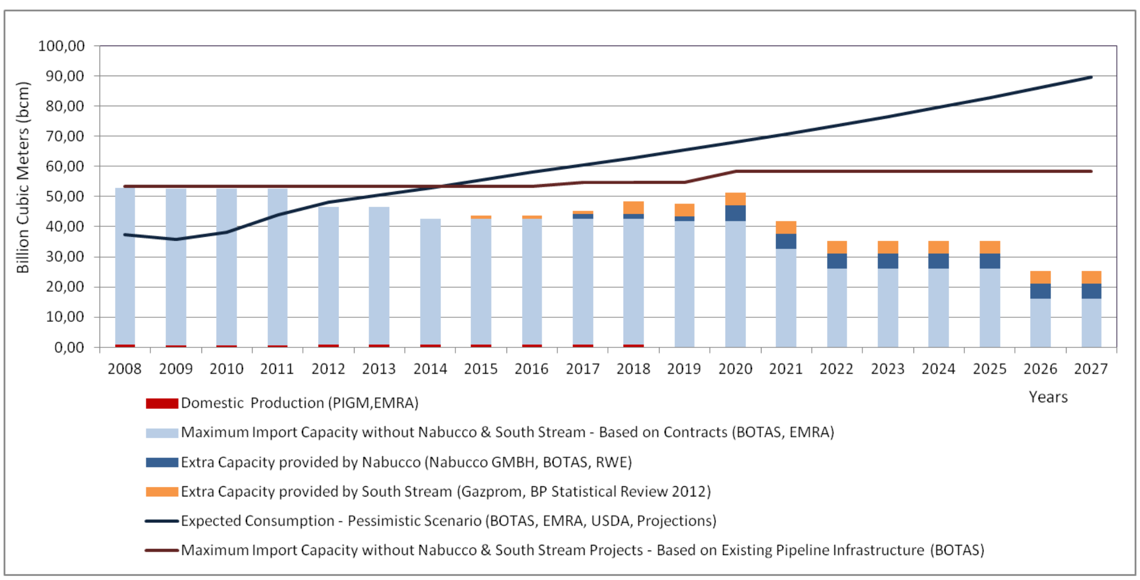

Figure A.7: Demand-Supply Balance Assessment in Sub-Scenario 4 under the Pessimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections

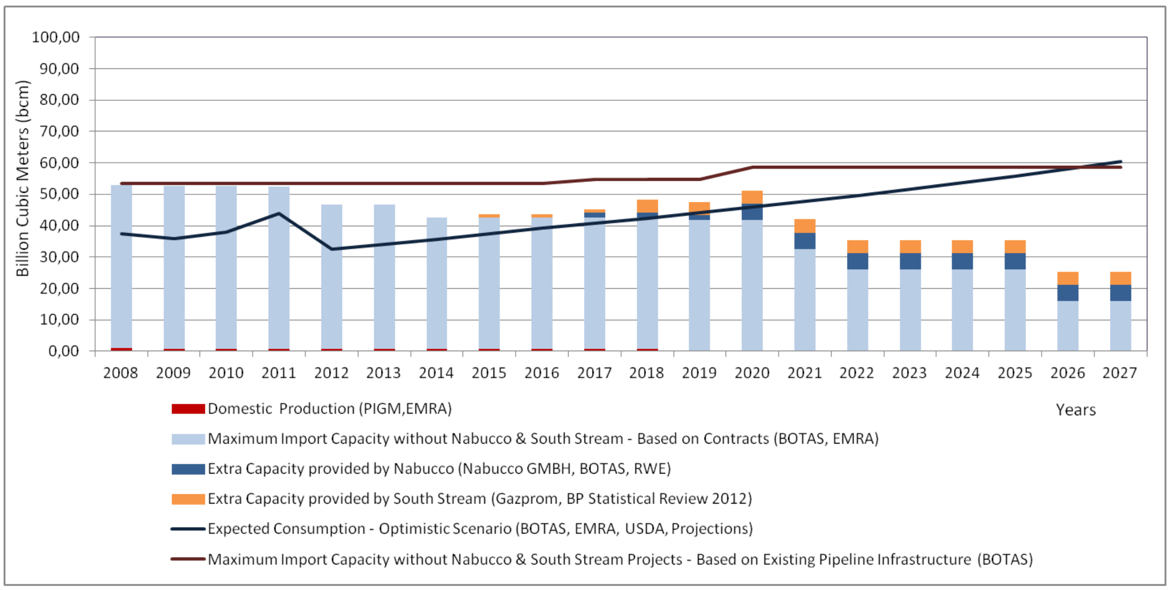

Figure A.8: Demand-Supply Balance Assessment in Sub-Scenario 4 under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections

Appendix B

Demand–Supply Balance Assessments and Production Source and Transit Route Diversity Analyses and Data Used in Individual Implementation of TANAP Scenarios

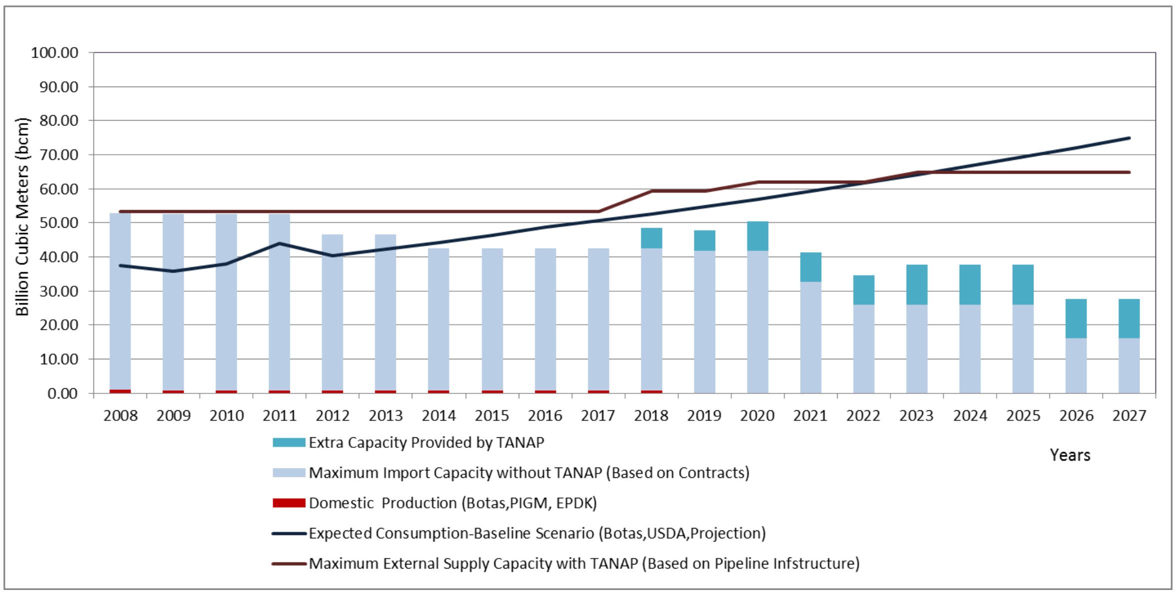

Figure B.1: Demand-Supply Balance Assessment in "Individual Implementation of TANAP" Sub-Scenario under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, SOCAR Official Website 2012, MENR Official Website 2012, Own extractions and projections

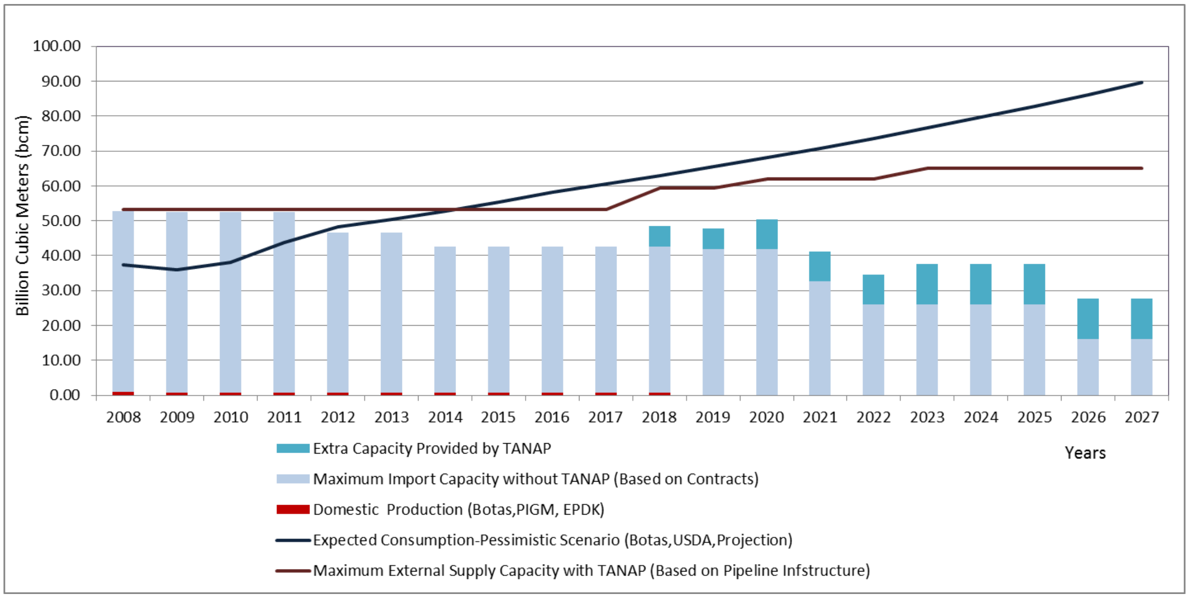

Figure B.2: Demand-Supply Balance Assessment in "Individual Implementation of TANAP" Sub-Scenario under the Pessimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, SOCAR Official Website 2012, MENR Official Website 2012, Own extractions and projections.

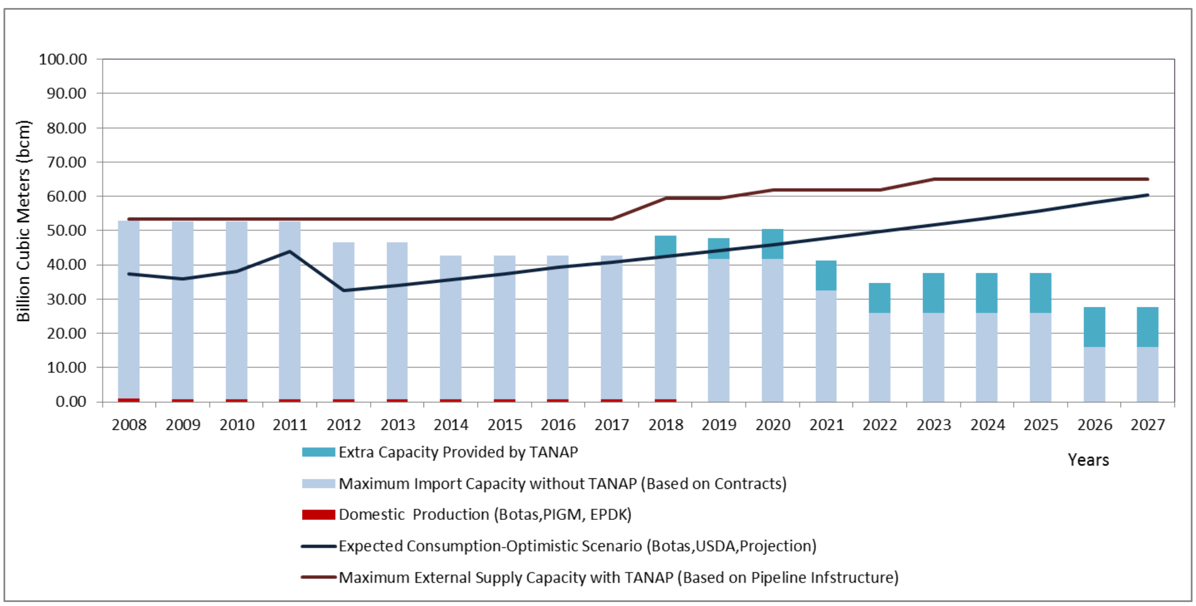

Figure B.3: Demand-Supply Balance Assessment in "Individual Implementation of TANAP" Sub-Scenario under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, SOCAR Official Website 2012, MENR Official Website 2012, Own extractions and projections

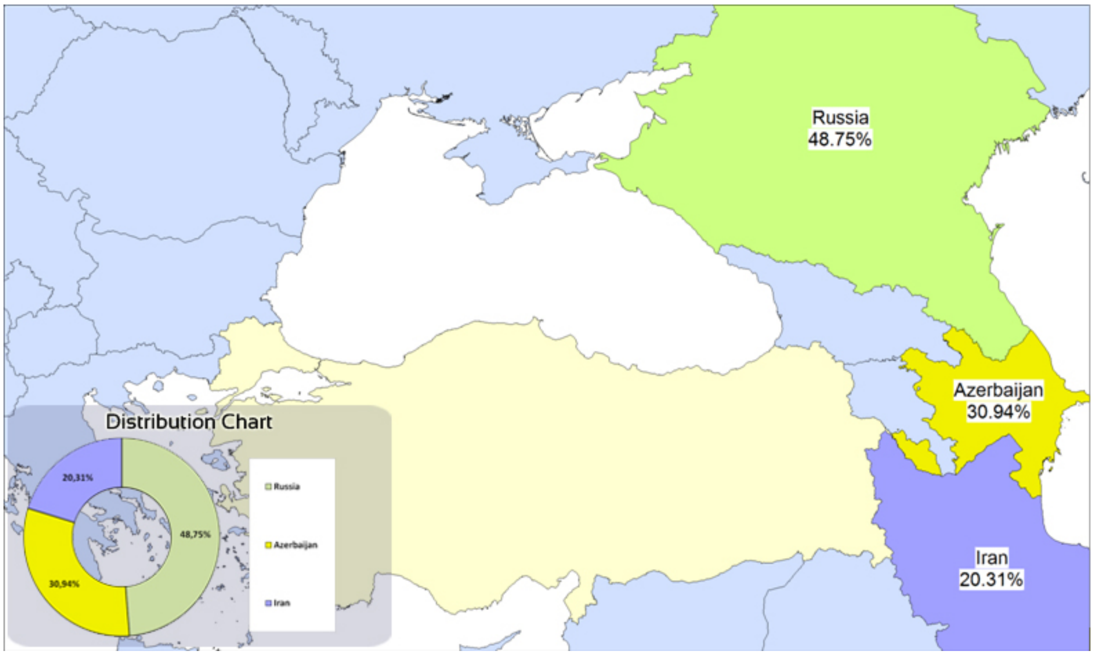

Figure B.4: Distribution of Producer Countries in Production Source Diversity Analysis under the 'Individual Implementation of TANAP' scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, SOCAR Official Website 2012, MENR Official Website 2012, Own extractions and projections

The Herfindahl Hirschman Index: 3746

The Adjusted Shannon Weiner Index: 0.617

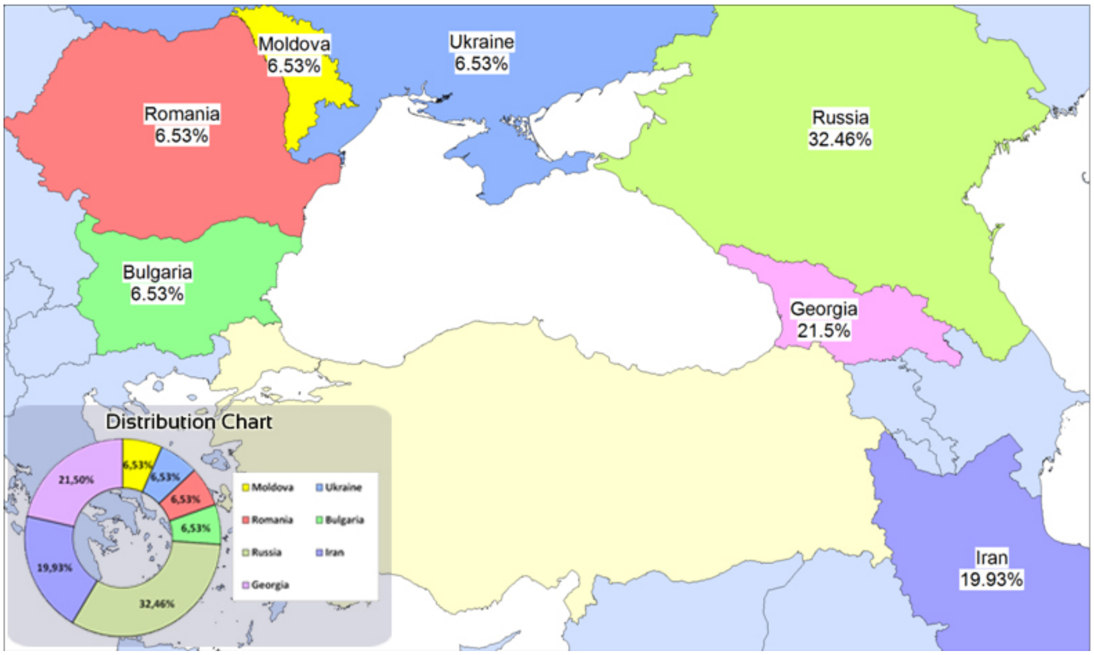

Figure B.5: Distribution of Transit Countries in Transit Route Diversity Analysis under the 'Individual Implementation of TANAP' scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, SOCAR Official Website 2012, MENR Official Website 2012, Own extractions and projections

The Herfindahl Hirschman Index: 2083

The Adjusted Shannon Weiner Index: 1.134

	I) Agreements in 2020 in bcm - (50% weight)	II) Utilization Volume in 2020 Parallel to Ex.Consumption With Contract Restriction -in bcm - (50% weight)	III) Expected Imports from Production Sources-bcm-(Weighted Average of I and II) in bcm-(Weighted Average of I and II)	IV)Expected Utilization Rate % of total	V) LN Value of IV
Russia	24,00	24,00	24,00	48,75%	-0,718
Azerbaijan	15,23	15,23	15,23	30,94%	-1,173
Iran	10,00	10,00	10,00	20,31%	-1,594
Domestic Production	0,00	0,00	0,00	0,00%	
Total	**49,23**	**49,23**	**49,23**	**100,00%**	

Table B.1: Parameters used in the Production Source Diversity Assessment indices in the 'Individual Implementation of TANAP Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, SOCAR Official Website 2012, MENR Official Website 2012, Own extractions and projections

	I-Transport Capacity in 2020 in bcm- (50% weight)	II-Potenial Utilization of Natural Gas Parallel to Expected Consumption in 2020 in bcm (50% weight)	III-Potenial Capacity in 2020-bcm-(Weighted Average of I and II) in bcm (Weighted Average of I and II)	IV- Potenial Capacity in 2020 (% of total)	V) LN Value of IV
Trans -Balkan Import line	**18,77**	**8,00**	**13,39**	**26,11%**	**-134,28%**
Moldova	4,69	2,00	3,35	6,53%	-272,91%
Ukraine	4,69	2,00	3,35	6,53%	-272,91%
Romania	4,69	2,00	3,35	6,53%	-272,91%
Bulgaria	4,69	2,00	3,35	6,53%	-272,91%
Blue Stream Import Line	**17,28**	**16,00**	**16,64**	**32,46%**	**-112,52%**
Russia	17,28	16,00	16,64	32,46%	-112,52%
East Anatolia Main Transit Import Line	**10,44**	**10,00**	**10,22**	**19,93%**	**-161,29%**
Iran	10,44	10,00	10,22	19,93%	-161,29%
BTE Import Line	**6,82**	**15,23**	**11,02**	**21,50%**	**-153,71%**
Georgia	6,82	15,23	11,02	21,50%	
Domestic Production Lines to the Delivery System	**0,00**	**0,00**	**0,00**	**0,00%**	
Domestic Production Lines	0,00	0,00	0,00	0,00%	
Total Import Capacity	**53,31**	**49,23**	**51,27**	**100,00%**	

Table B.2: Parameters used in the Transit Route Diversity Assessment indices in the ‘Individual Implementation of TANAP Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, SOCAR Official Website 2012, MENR Official Website 2012, Own extractions and projections

Appendix C

Production Source Diversity and Transit Route Diversity Analyses in Pessimistic and Optimistic Scenarios

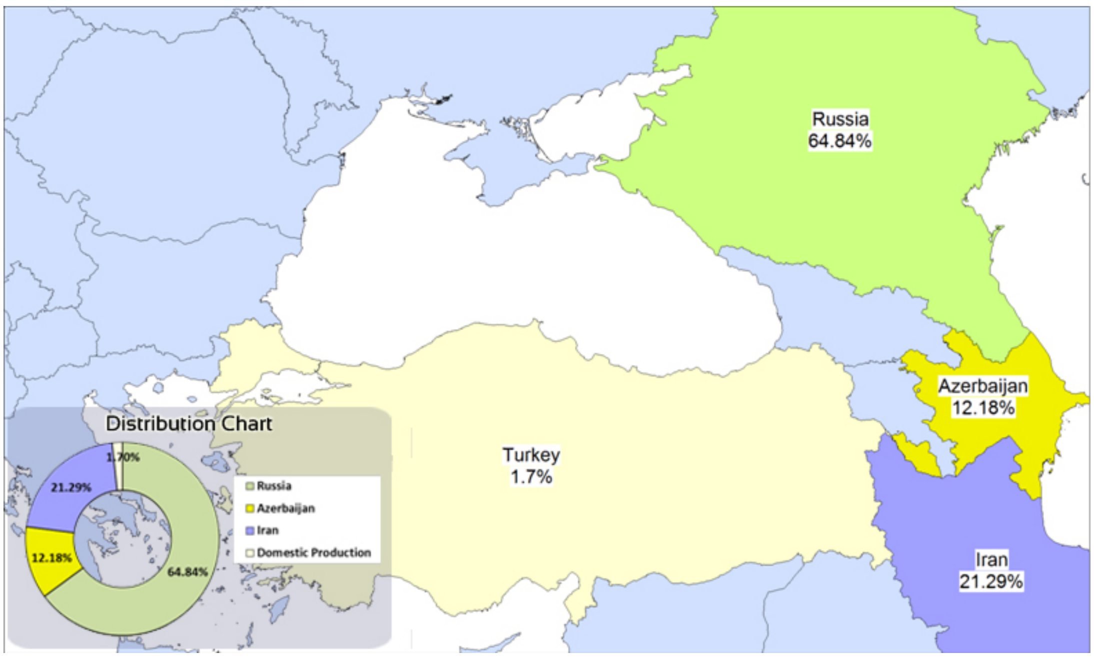

Figure C.1: Distribution of Producer Countries in Production Source Diversity Analysis in Sub-Scenario 1 under the Pessimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Websit 2012, South Stream Official Website 2012, Own extractions and projections

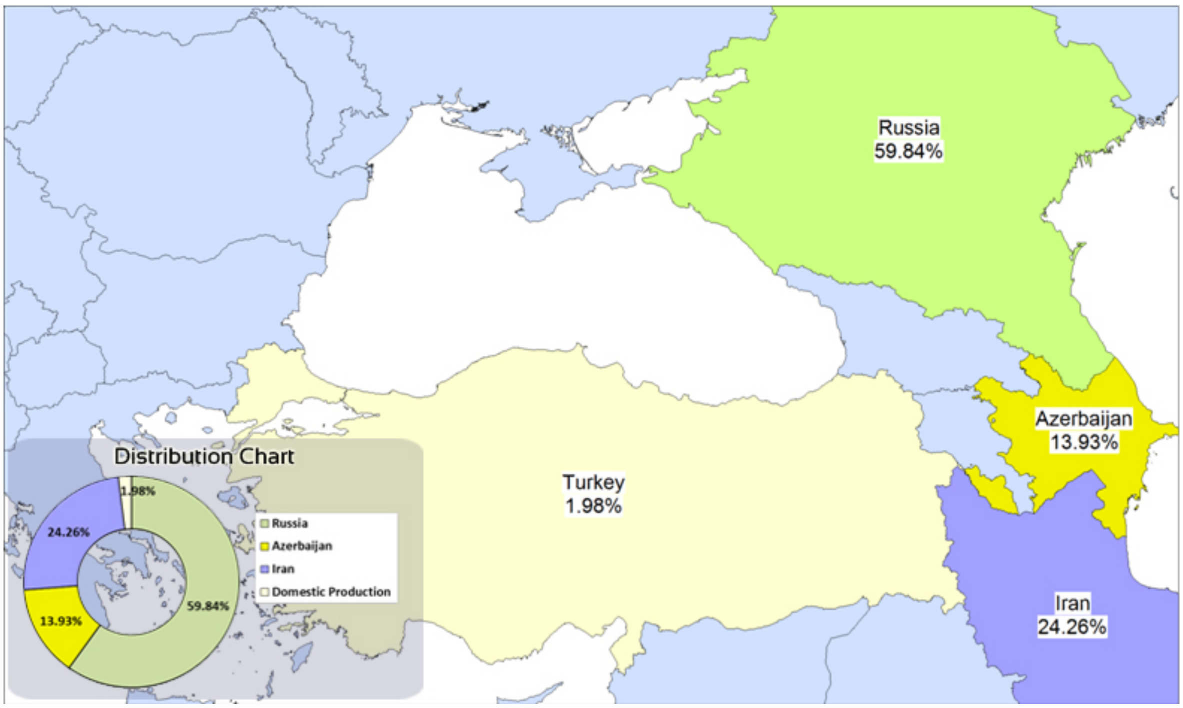

Figure C.2: Distribution of Producer Countries in Production Source Diversity Analysis in Sub-Scenario 1 under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

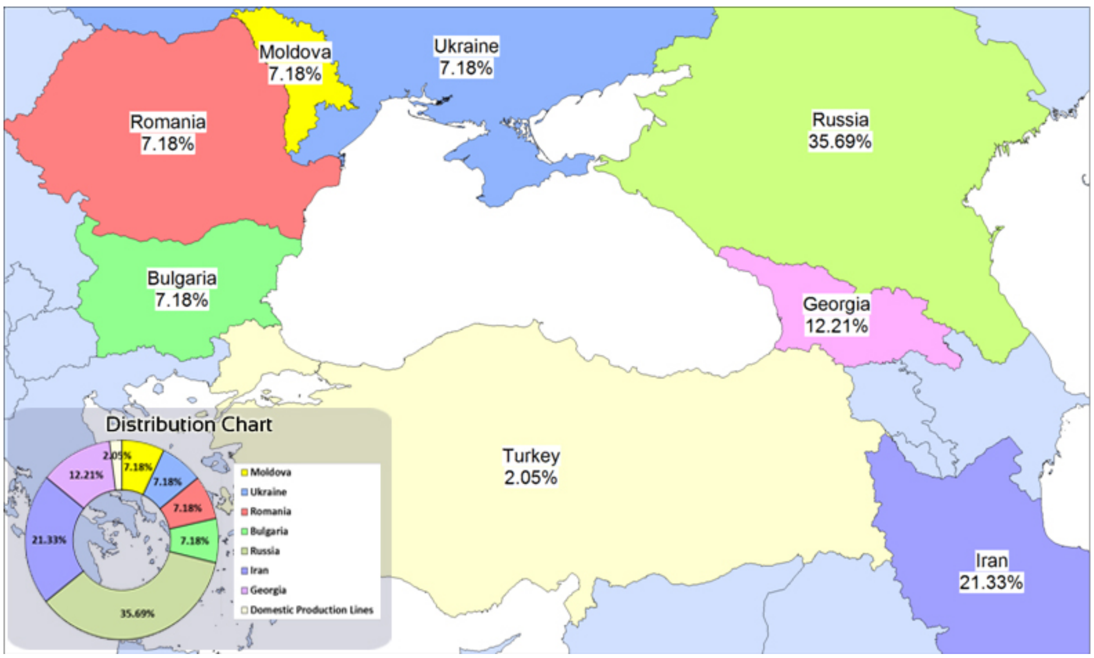

Figure C.3: Distribution of Transit Countries in Transit Route Diversity Analysis in Sub-Scenario 1 under the Pessimistic Scenario Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

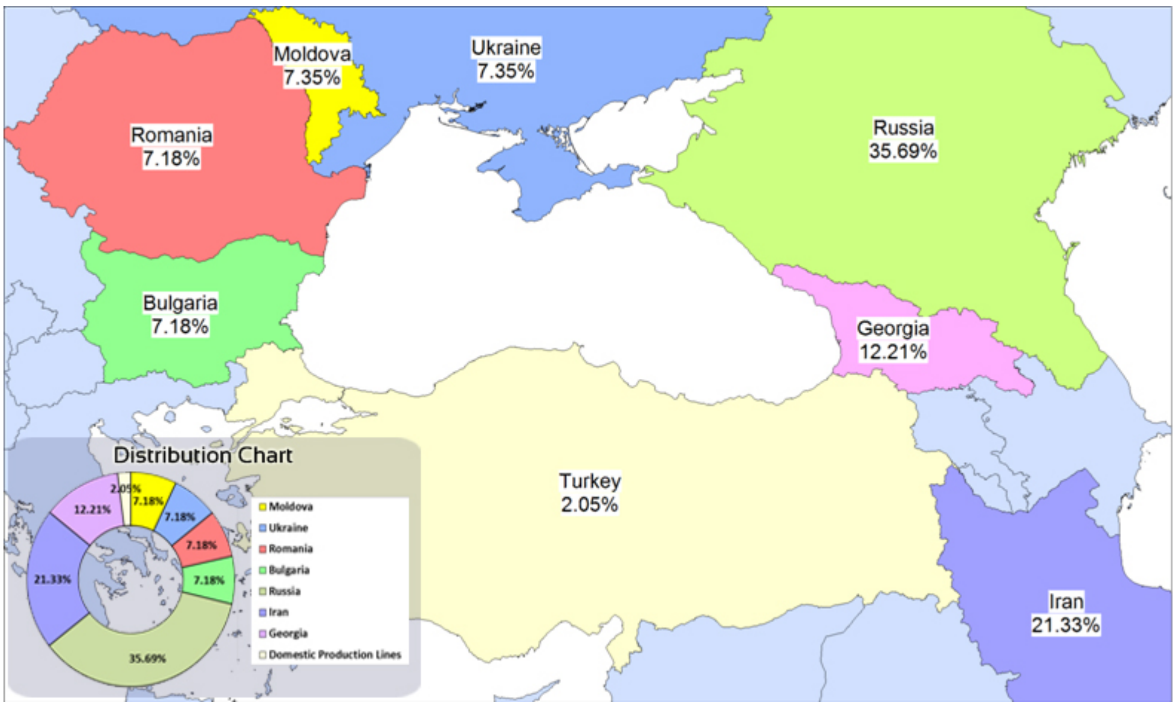

Figure C.4: Distribution of Transit Countries in Transit Route Diversity Analysis in Sub-Scenario 1 under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

Appendix D

Summary of the Results in Baseline, Pessimistic and Optimistic Scenario Analyses

	Baseline Scenarios			
	Scenario 1 No Project Implementation	Scenario 2 Implementation of Nabucco	Scenario 3 Implementation of South Stream	Scenario 4 Implementation of both projects
Supply - Demand Balance Assesment	Critical Dates	Critical Dates	Critical Dates	Critical Dates
Las Balanced Year Between Demand and Supply - Based on Contracts&Domestic Production	2013	2013	2013	2013
Las Balanced Year Between Demand and Supply - Based on Existing Pipelines	2018	2020	2018	2020
Production Sourse Diversity	Index Values for 2013	Index Values for 2020	Index Values for 2018	Index Values for 2020
Herfindahl - Hirschman Index	4522	3726	4664	4024
Shannon-Weiner Index	0,553	0,717	0,541	0,687
Transit Route Diversity	Index Values for 2013	Index Values for 2020	Index Values for 2018	Index Values for 2020
Herfindahl - Hirschman Index (HHI)	2107	1787	1828	1597
Adjusted Shannon-Weiner Index (SWI)	1,295	1,232	1,319	1,248

Table D.1: Summary of The Results in Baseline Scenario Analysis. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections

	Pessimistic Scenarios			
	Scenario 1 No Project Implementation	Scenario 2 Implementation of Nabucco	Scenario 3 Implementation of South Stream	Scenario 4 Implementation of both projects
Supply - Demand Balance Assesment	Critical Dates	Critical Dates	Critical Dates	Critical Dates
Las Balanced Year Between Demand and Supply - Based on Contracts	2011	2011	2011	2011
Las Balanced Year Between Demand and Supply - Based on Contracts	2014	2014	2014	2014
Production Sourse Diversity				
Herfindahl - Hirschman Index	4808	3718	4664	4014
Shannon-Weiner Index	0.529	0.718	0.541	0.688
Transit Route Diversity				
Herfindahl - Hirschman Index (HHI)	2121	1785	1828	1595
Adjusted Shannon-Weiner Index (SWI)	1.289	1.232	1.319	1.248

Table D.2: Summary of The Results in Pessimistic Scenario Analysis. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website 2012, South Stream Official Website 2012, Own extractions and projections. Note: Results of the production source and transit route diversity analyses under scenario 2, scenario 3 and scenario 4 are the same as the ones in the baseline scenario since the assumptions and critical dates do not differ from each other.

	Optimistic Scenarios			
	Scenario 1 No Project Implementation	Scenario 2 Implementation of Nabucco	Scenario 3 Implementation of South Stream	Scenario 4 Implementation of both projects
Supply - Demand Balance Assesment	Index Values	Index Values	Index Values	Index Values
Las Balanced Year Between Demand and Supply - Based on Contracts	2017	2018	2020	2020
Las Balanced Year Between Demand and Supply - Based on Contracts	2024	2026	2024	2026
Production Sourse Diversity	Index Values	Index Values	Index Values	Index Values
Herfindahl - Hirschman Index	4367	3718	4664	4014
Shannon-Weiner Index	0.567	0.718	0.541	0.688
Transit Route Diversity	Index Values	Index Values	Index Values	Index Values
Herfindahl - Hirschman Index (HHI)	2089	1785	1828	1595
Adjusted Shannon-Weiner Index (SWI)	1.290	1.232	1.319	1.248

Table D.3: Summary of The Results in Optimistic Scenario Analysis. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections. Note: Results of the production source and transit route diversity analyses under scenario 2, scenario 3 and scenario 4 are the same as the ones in the baseline scenario since the assumptions and critical dates do not differ from each other.

Appendix E

Demand–Supply Balance Assessment Data and Calculations

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm	bcm
Domestic Production (PIGM,EMRA)	1,01	0,73	0,73	0,73	0,79	0,79	0,79	0,79	0,79	0,79	0,79	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Expected Consumption - Baseline Scenario (BOTAS, EMRA, USDA, Projections)	37,35	35,86	38,04	43,88	40,34	42,17	44,26	46,42	48,64	50,67	52,69	54,80	56,99	59,27	61,64	64,11	66,67	69,34	72,11	75,00
Expected Consumption - Pessimistic Scenario (BOTAS, EMRA, USDA, Projections)	37,35	35,86	38,04	43,88	48,18	50,37	52,87	55,45	58,10	60,52	62,94	65,46	68,08	70,80	73,63	76,58	79,64	82,82	86,14	89,58
Expected Consumption - Optimistic Scenario (BOTAS, EMRA, USDA, Projections)	37,35	35,86	38,04	43,88	32,50	33,97	35,66	37,40	39,18	40,81	42,45	44,15	45,91	47,75	49,66	51,64	53,71	55,86	58,09	60,42
Maximum Import Capacity without any Project Implementation - Based on Contracts (BOTAS, EMRA)	51,80	51,80	51,80	51,80	45,80	45,80	41,80	41,80	41,80	41,80	41,80	41,80	41,80	32,60	26,00	26,00	26,00	26,00	16,00	16,00
Maximum Import Capacity without any Project Implementation-Based on Pipeline Infstructure (BOTAS)	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31	53,31
Extra Capacity provided by Nabucco (Nabucco GMBH)										1,50	1,50	1,50	5,17	5,17	5,17	5,17	5,17	5,17	5,17	5,17
Extra Capacity provided by South Stream (Gazprom, BP Statistical Review 2012)								1,04	1,04	1,04	4,19	4,19	4,19	4,19	4,19	4,19	4,19	4,19	4,19	4,19
Extra Capacity provided by TANAP (MENR, SOCAR)											6,00	6,00	8,63	8,63	8,63	11,63	11,63	11,63	11,63	11,63

Table E.1: Parameters used in the Demand-Supply Balance Assessment indices for all scenarios. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
I - Natural Gas Consumption of Turkey (bcm/y)	14.6	16.0	17.4	20.9	22.1	26.6	30.2	35.8	37.4	35.9	**38.0**	**43.9**
II - Real 2005 GDP ($billions)	386.6	364.6	387.0	407.4	445.6	483.0	516.3	540.4	544.0	517.7	564.0	601.2
III - Ratio (I/II)	**3.77**	**4.40**	**4.49**	**5.14**	**4.96**	**5.50**	**5.85**	**6.63**	**6.87**	**6.93**	**6.74**	**7.30**

Table E.2: Parameters used in the calculation of the expected consumption. Source: Databases of USDA, BOTAS, EMRA, Own extractions and projections.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
IV- Projected Real 2005 GDP ($billions) of Turkey between 2011 and 2030	601.2	616.3	644.2	676.2	709.2	743.0	774.0	805.0	837.2	870.7	905.5	941.7	979.4	1018.6	1059.3	1101.7	1145.7
V - Projected Real Natural Gas Consumption - Baseline Scenario	43.9	40.3	42.2	44.3	46.4	48.6	50.7	52.7	54.8	57.0	59.3	61.6	64.1	66.7	69.3	72.1	75.0
VI - Projected Real Natural Gas Consumption - Pessimistic Scenario	43.9	48.2	50.4	52.9	55.5	58.1	60.5	62.9	65.5	68.1	70.8	73.6	76.6	79.6	82.8	86.1	89.6
VII - Projected Real Natural Gas Consumption - Optimistic Scenario	43.9	32.5	34.0	35.7	37.4	39.2	40.8	42.4	44.1	45.9	47.7	49.7	51.6	53.7	55.9	58.1	60.4

Table E.3: Parameters used in the calculation of the expected consumption. Source: Databases of USDA, BOTAS, EMRA, Own extractions and projections.

Appendix F

Production Source and Transit Route Diversity Analyses Data

	I) Agreements in 2013 in bcm - (50% weight)	II) Utilization Volume in 2013 Parallel to Ex.Consumption With Contract Restriction -in bcm - (50% weight)	III) Expected Imports from Production Sources-bcm-(Weighted Average of I and II) in bcm-(Weighted Average of I and II)	IV)Expected Utilization Rate % of total	V) LN Value of IV
Russia	24,00	24,00	24,00	61,76%	-0,482
Azerbaijan	6,60	3,66	5,13	13,20%	-2,025
Iran	10,00	7,87	8,94	23,00%	-1,470
Domestic Production	0,79	0,79	0,79	2,04%	-3,890
Total	**40,60**	**35,53**	**38,86**	**100,00%**	

Table F.1: Parameters used in the Production Source Diversity Assessment indices in the Sub-Scenario 1 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I) Agreements in 2020 in bcm - (50% weight)	II) Utilization Volume in 2020 Parallel to Ex.Consumption With Contract Restriction -in bcm - (50% weight)	III) Expected Imports from Production Sources-bcm-(Weighted Average of I and II) in bcm-(Weighted Average of I and II)	IV)Expected Utilization Rate % of total	V) LN Value of IV
Russia	24,00	24,00	24,00	53,41%	-0,627
Azerbaijan	9,18	7,53	8,36	18,59%	-1,682
Iran	10,00	10,00	10,00	22,25%	-1,503
Iraq	2,58	2,58	2,58	5,75%	-2,856
Total	**45,77**	**44,11**	**44,94**	**100,00%**	

Table F.2: Parameters used in the Production Source Diversity Assessment indices in the Sub-Scenario 2 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I) Agreements in 2016 in bcm - (50% weight)	II) Utilization Volume in 2016 Parallel to Ex.Consumption With Contract Restriction -in bcm - (50% weight)	III) Expected Imports from Production Sources-bcm-(Weighted Average of I and II) in bcm-(Weighted Average of I and II)	IV)Expected Utilization Rate % of total	V) LN Value of IV
Russia	28,19	28,19	28,19	63,30%	-0,457
Azerbaijan	6,60	4,57	5,59	12,54%	-2,076
Iran	10,00	9,84	9,92	22,27%	-1,502
Iraq	0,79	0,79	0,84	1,89%	-3,971
Total	**44,79**	**43,39**	**44,53**	**100,00%**	

Table F.3: Parameters used in the Production Source Diversity Assessment indices in the Sub-Scenario 3 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I) Agreements in 2020 in bcm - (50% weight)	II) Utilization Volume in 2020 Parallel to Ex.Consumption With Contract Restriction -in bcm - (50% weight)	III) Expected Imports from Production Sources-bcm-(Weighted Average of I and II) in bcm-(Weighted Average of I and II)	IV)Expected Utilization Rate % of total	V) LN Value of IV
Russia	28,19	28,19	28,19	57,38%	-0,555
Azerbaijan	9,18	7,53	8,36	17,01%	-1,772
Iran	10,00	10,00	10,00	20,35%	-1,592
Iraq	2,58	2,58	2,58	5,26%	-2,945
Total	**49,96**	**48,30**	**49,13**	**100,00%**	

Table F.4: Parameters used in the Production Source Diversity Assessment indices in the Sub-Scenario 4 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I) Agreements in 2011 in bcm - (50% weight)	II) Utilization Volume in 2011 Parallel to Ex.Consumption With Contract Restriction -in bcm - (50% weight)	III) Expected Imports from Production Sources-bcm-(Weighted Average of I and II) in bcm-(Weighted Average of I and II)	IV)Expected Utilization Rate % of total	V) LN Value of IV
Russia	30,00	25,41	27,70	64,84%	-0,433
Azerbaijan	6,60	3,81	5,20	12,18%	-2,106
Iran	10,00	8,19	9,10	21,29%	-1,547
Domestic Production	0,73	0,73	0,73	1,70%	-4,075
Total	**46,60**	**37,40**	**42,73**	**100,00%**	

Table F.5: Parameters used in the Production Source Diversity Assessment indices in the Sub-Scenario 1 under the Pessimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I) Agreements in 2017 in bcm - (50% weight)	II) Utilization Volume in 2017 Parallel to Ex.Consumption With Contract Restriction -in bcm - (50% weight)	III) Expected Imports from Production Sources-bcm-(Weighted Average of I and II) in bcm-(Weighted Average of I and II)	IV)Expected Utilization Rate % of total	V) LN Value of IV
Russia	24,00	24,00	24,00	59,84%	-0,514
Azerbaijan	6,60	4,57	5,59	13,93%	-1,971
Iran	10,00	9,46	9,73	24,26%	-1,416
Domestic Production	0,79	0,79	0,79	1,98%	-3,922
Total	**40,60**	**38,03**	**40,11**	**100,00%**	

Table F.6: Parameters used in the Production Source Diversity Assessment indices in the Sub-Scenario1 under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I-Transport Capacity in 2013 in bcm- (50% weight)	II-Potenial Utilization of Natural Gas Parallel to Expected Consumption in 2013 in bcm (50% weight)	III-Potenial Capacity in 2013-bcm-(Weighted Average of I and II) in bcm (Weighted Average of I and II)	IV- Potenial Capacity in 2013 (% of total)	V) LN Value of IV
Trans -Balkan Import line	**18,77**	**8,00**	**13,39**	**29,50%**	**-1,221**
Moldova	4,69	2,00	3,35	7,38%	-2,607
Ukraine	4,69	2,00	3,35	7,38%	-2,607
Romania	4,69	2,00	3,35	7,38%	-2,607
Bulgaria	4,69	2,00	3,35	7,38%	-2,607
Blue Stream Import Line	**17,28**	**16,00**	**16,64**	**36,68%**	**-1,003**
Russia	17,28	16,00	16,64	36,68%	-1,003
East Anatolia Main Transit Import Line	**10,44**	**7,87**	**9,15**	**20,17%**	**-1,601**
Iran	10,44	7,87	9,15	20,17%	-1,601
BTE Import Line	**6,82**	**3,66**	**5,24**	**11,54%**	**-2,159**
Georgia	6,82	3,66	5,24	11,54%	-2,159
Domestic Production Lines to the Delivery System	**1,12**	**0,79**	**0,96**	**2,11%**	**-3,860**
Domestic Production Lines	1,12	0,79	0,96	2,11%	-3,860
Total Import Capacity	**54,43**	**36,32**	**45,38**	**100,00%**	

Table F.7: Parameters used in the Transit Route Diversity Assessment indices in the Sub-Scenario 1 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I-Transport Capacity in 2020 in bcm- (50% weight)	II-Potenial Utilization of Natural Gas Parallel to Expected Consumption in 2020 in bcm (50% weight)	III-Potenial Capacity in 2020-bcm-(Weighted Average of I and II) in bcm (Weighted Average of I and II)	IV- Potenial Capacity in 2020 (% of total)	V) LN Value of IV
Trans -Balkan Import line	**18,77**	**8,00**	**13,39**	**25,91%**	**-1,351**
Moldova	4,69	2,00	3,35	6,48%	-2,737
Ukraine	4,69	2,00	3,35	6,48%	-2,737
Romania	4,69	2,00	3,35	6,48%	-2,737
Bulgaria	4,69	2,00	3,35	6,48%	-2,737
Blue Stream Import Line	**17,28**	**16,00**	**16,64**	**32,21%**	**-1,133**
Russia	17,28	16,00	16,64	32,21%	-1,133
East Anatolia Main Transit Import Line	**10,00**	**10,00**	**10,00**	**19,35%**	**-1,642**
Iran	10,00	10,00	10,00	19,35%	-1,642
BTE Import Line	**8,00**	**4,94**	**6,47**	**12,53%**	**-2,077**
Georgia	8,00	4,94	6,47	12,53%	-2,077
Nabucco Import Lines	**5,17**	**5,17**	**5,17**	**10,00%**	**-2,303**
Georgia	2,58	2,58	2,58	5,00%	-2,996
Iraq	2,58	2,58	2,58	5,00%	-2,996
Total Import Capacity	**59,23**	**44,11**	**51,67**	**100,00%**	

Table F.8: Parameters used in the Transit Route Diversity Assessment indices in the Sub-Scenario 2 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I-Transport Capacity in 2016 in bcm- (50% weight)	II-Potenial Utilization of Natural Gas Parallel to Expected Consumption in 2016 in bcm (50% weight)	III-Potenial Capacity in 2016-bcm-(Weighted Average of I and II) in bcm (Weighted Average of I and II)	IV- Potenial Capacity in 2016 (% of total)	V) LN Value of IV
Trans -Balkan Import line	**18,77**	**8,00**	**13,39**	**26,25%**	**-1,338**
Moldova	4,69	2,00	3,35	6,56%	-2,724
Ukraine	4,69	2,00	3,35	6,56%	-2,724
Romania	4,69	2,00	3,35	6,56%	-2,724
Bulgaria	4,69	2,00	3,35	6,56%	-2,724
Blue Stream Import Line	**17,28**	**16,00**	**16,64**	**32,63%**	**-1,120**
Russia	17,28	16,00	16,64	32,63%	-1,120
East Anatolia Main Transit Import Line	**10,44**	**9,84**	**10,14**	**19,87%**	**-1,616**
Iran	10,44	9,84	10,14	19,87%	-1,616
BTE Import Line	**6,82**	**4,57**	**5,69**	**11,16%**	**-2,192**
Georgia	6,82	4,57	5,69	11,16%	-2,192
Contribution of S.Stream to the Trans-Balkan Import Line	**4,19**	**4,19**	**4,19**	**8,21%**	**-2,499**
Bulgaria	4,19	4,19	4,19	8,21%	-2,499
Domestic Production Lines to the Delivery System	**1,12**	**0,79**	**0,96**	**2,11%**	-3,860
Domestic Production Lines	1,12	0,79	0,96	2,11%	
Total Import Capacity	**58,62**	**43,39**	**51,01**	**100,00%**	

Table F.9: Parameters used in the Transit Route Diversity Assessment indices in the Sub-Scenario 3 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I-Transport Capacity in 2020 in bcm- (50% weight)	II-Potenial Utilization of Natural Gas Parallel to Expected Consumption in 2020 in bcm (50% weight)	III-Potenial Capacity in 2020-bcm-(Weighted Average of I and II) in bcm (Weighted Average of I and II)	IV- Potenial Capacity in 2020 (% of total)	V) LN Value of IV
Trans -Balkan Import line	**18,77**	**8,00**	**13,39**	**24,13%**	**-1,422**
Moldova	4,69	2,00	3,35	6,03%	-2,808
Ukraine	4,69	2,00	3,35	6,03%	-2,808
Romania	4,69	2,00	3,35	6,03%	-2,808
Bulgaria	4,69	2,00	3,35	6,03%	-2,808
Blue Stream Import Line	**17,28**	**16,00**	**16,64**	**29,99%**	**-1,204**
Russia	17,28	16,00	16,64	29,99%	-1,204
East Anatolia Main Transit Import Line	**10,44**	**10,00**	**10,22**	**18,42%**	**-1,692**
Iran	10,44	10,00	10,22	18,42%	-1,692
BTE Import Line	**6,82**	**4,94**	**5,88**	**10,60%**	**-2,244**
Georgia	6,82	4,94	5,88	10,60%	-2,244
Nabucco Import Lines	**5,17**	**5,17**	**5,17**	**9,31%**	**-2,374**
Georgia	2,58	2,58	2,58	4,66%	-3,067
Iraq	**2,58**	**2,58**	**2,58**	**4,66%**	-3,067
Contribution of S.Stream to the Trans-Balkan Import Line	4,19	4,19	4,19	7,55%	
Bulgaria	**4,19**	**4,19**	**4,19**	**7,55%**	
Total Import Capacity	**62,67**	**48,30**	**55,49**	**100,00%**	

Table F.10: Parameters used in the Transit Route Diversity Assessment indices in the Sub-Scenario 4 under the Baseline Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I-Transport Capacity in 2011 in bcm- (50% weight)	II-Potenial Utilization of Natural Gas Parallel to Expected Consumption in 2011 in bcm (50% weight)	III-Potenial Capacity in 2011-bcm-(Weighted Average of I and II) in bcm (Weighted Average of I and II)	IV- Potenial Capacity in 2011 (% of total)	V) LN Value of IV
Trans -Balkan Import line	**18,77**	**8,47**	**13,62**	**29,41%**	**-1,224**
Moldova	4,69	2,12	3,41	7,35%	-2,610
Ukraine	4,69	2,12	3,41	7,35%	-2,610
Romania	4,69	2,12	3,41	7,35%	-2,610
Bulgaria	4,69	2,12	3,41	7,35%	-2,610
Blue Stream Import Line	**17,28**	**16,94**	**17,11**	**36,95%**	**-0,996**
Russia	17,28	16,94	17,11	36,95%	-0,996
East Anatolia Main Transit Import Line	**10,44**	**8,19**	**9,31**	**20,11%**	**-1,604**
Iran	10,44	8,19	9,31	20,11%	-1,604
BTE Import Line	**6,82**	**3,81**	**5,31**	**11,47%**	**-2,166**
Georgia	6,82	3,81	5,31	11,47%	-2,166
Domestic Production Lines to the Delivery System	**1,12**	**0,79**	**0,96**	**2,06%**	**-3,881**
Domestic Production Lines	1,12	0,79	0,96	2,06%	-3,881
Total Import Capacity	**54,43**	**38,20**	**46,31**	**100,00%**	

Table F.11: Figure 1: Parameters used in the Transit Route Diversity Assessment indices in the Sub-Scenario 1 under the Pessimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections

	I-Transport Capacity in 2017 in bcm- (50% weight)	II-Potenial Utilization of Natural Gas Parallel to Expected Consumption in 2017 in bcm (50% weight)	III-Potenial Capacity in 2017-bcm-(Weighted Average of I and II) in bcm (Weighted Average of I and II)	IV- Potenial Capacity in 2017 (% of total)	V) LN Value of IV
Trans -Balkan Import line	**18,77**	**8,00**	**13,39**	**28,71%**	**-1,248**
Moldova	4,69	2,00	3,35	7,18%	-2,634
Ukraine	4,69	2,00	3,35	7,18%	-2,634
Romania	4,69	2,00	3,35	7,18%	-2,634
Bulgaria	4,69	2,00	3,35	7,18%	-2,634
Blue Stream Import Line	**17,28**	**16,00**	**16,64**	**35,69%**	**-1,030**
Russia	17,28	16,00	16,64	35,69%	-1,030
East Anatolia Main Transit Import Line	**10,44**	**9,46**	**9,95**	**21,33%**	**-1,545**
Iran	10,44	9,46	9,95	21,33%	-1,545
BTE Import Line	**6,82**	**4,57**	**5,69**	**12,21%**	**-2,103**
Georgia	6,82	4,57	5,69	12,21%	-2,103
Domestic Production Lines to the Delivery System	**1,12**	**0,79**	**0,96**	**2,05%**	**-3,888**
Domestic Production Lines	1,12	0,79	0,96	2,05%	-3,888
Total Import Capacity	**54,43**	**38,82**	**46,63**	**100,00%**	

Table F.12: Parameters used in the Transit Route Diversity Assessment indices in the Sub-Scenario 1 under the Optimistic Scenario. Source: Databases of PIGM, EMRA, BOTAS, GIE, Nabucco Official Website April 2012, South Stream Official Website April 2012, Own extractions and projections.