Turkey's shale gas potential and comparison of its success factors with the US and European developments

Article *in* International Journal of Energy Technology and Policy · January 2017

DOI: 10.1504/IJETP.2017.10006281

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Sırrı Uyanık
KTO Karatay University
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Turkey's shale gas potential and comparison of its success factors with the US and European developments

Sirri Uyanik

Energy Management Department,
Faculty of Economics and Administrative Sciences,
KTO Karatay University,
Konya, Turkey
Email: sirri.uyanik@isken.com.tr

Abstract: Recent shale gas developments has been transforming the USA with repercussions on world economy in general; as well as having a great impact on the formation of short and mid-term global energy future. It is even dubbed as the unexpected energy revolution of the 21st century. The fact that the USA has so far had an outstanding success in shale gas development deserves close attention and therefore, the study of how the same fact could be applicable and replicable in other shale resourceful countries and to what extent the factors leading to this success are utilisable in other countries is very relevant. In this respect, Europe and Turkey are also known to have some considerable shale resources. Due to high dependence on gas imports, the issue gains even more significance for Turkey. In light of the above considerations, such a comparison between the USA and Europe-Turkey, with regards to shale gas developments, might be interesting and necessary. In this paper, it is aimed to analyse the US shale revolution and more importantly to make a comparison between the US and European implementations so far and especially Turkish potential and prospects in that regard.

Keywords: shale gas; shale gas reservoirs Turkey; renewable energy; economics and policy; shale gas revolution.

Reference to this paper should be made as follows: Uyanik, S. (2017) 'Turkey's shale gas potential and comparison of its success factors with the US and European developments', *Int. J. Energy Technology and Policy*, Vol. 13, No. 4, pp.293–304.

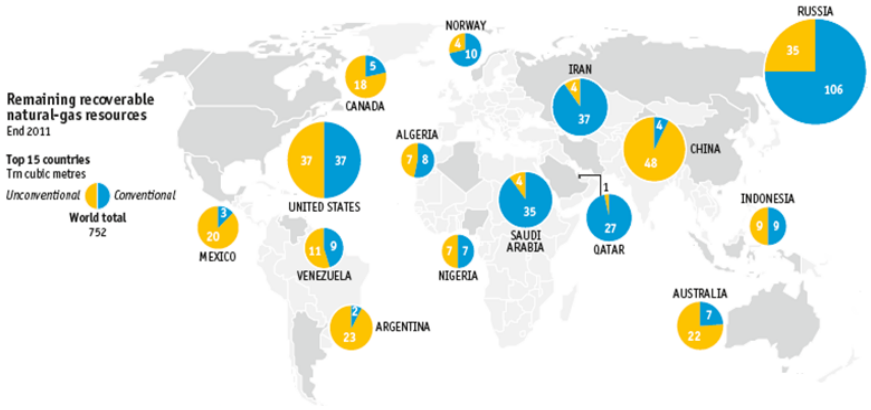
Biographical notes: Sirri Uyanik is an Assistant Professor of Energy Management at Karatay University, Konya, Turkey. He is also an energy sector professional with extensive experience in site-selection, planning, operation and contract management of power plants and energy projects. Turkish energy market is his special area of expertise.

1 Introduction

Global natural gas reserves have been increasing in a steady way for around 30 years. Consequently world production grown significantly as well while at the beginning of the first decade of the 21st century it looked as though global gas reserves might last only

around 50 years. New findings (especially shale gas) is said to have increased that period up to 200 years (The Economist, 2012). Global gas resource base is now estimated to be around 800 cubic metres (tcm) a measure of the total gas in the ground rather than what might be economically recoverable. Not only the USA but parts of Europe, China, Argentina, Brazil and some other countries (Figure 1) are assumed to have considerable quantities of shale gas. That prospect obviously has a potential to transform global energy outlook.

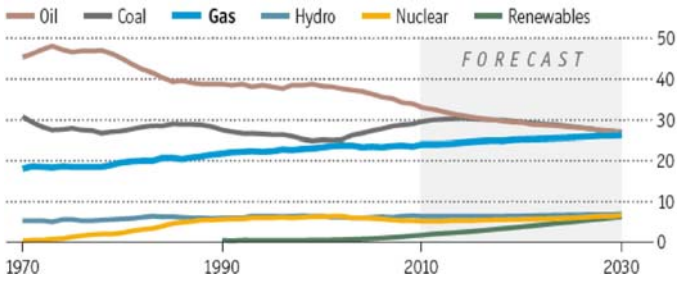
Figure 1 Remaining recoverable natural-gas resources (see online version for colours)



Source: IEA (2011)

In 2011, the IEA published a report entitled *Are We Entering a Golden Age of Gas* (IEA, 2011). In the most promising scenario, if shale development goes full steam ahead, the share of gas in the global energy mix may rise from 21% today to 25% in 2035 (Figure 2).

Figure 2 Share of world primary energy % (see online version for colours)



Source: IEA (2011)

However, there are valid questions and concerns that America's shale gas boom which has transformed the country's energy outlook can at all be replicated elsewhere let alone with the same degree of success.

2 The US shale gas revolution

2.1 Shale gas as a resource

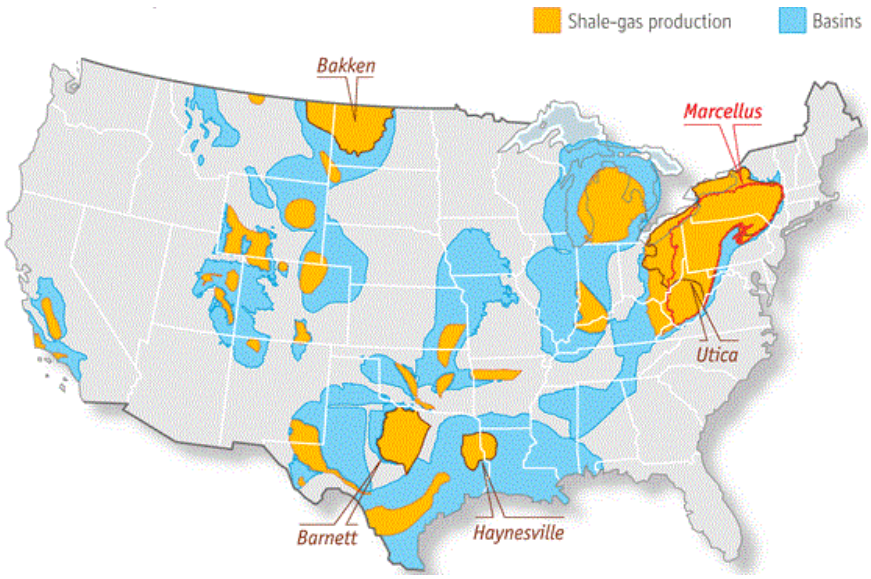
Natural gas is found in a variety of geological settings. Natural gas resource areas or 'plays' are classified by the geological characteristics of the reservoir. Conventional gas is produced from, well-defined reservoirs with permeability greater than a specified lower limit. The other three types, (unconventional), involve reservoirs where permeability is low and they include 'tight' sandstones, coal beds and most importantly shales.

The shale formations include a wide range of sedimentary rock types which generally are only 100–200 feet thick but deposited over large areas. Shales serve as source rock for the gas found in conventional reservoirs, and gas that has not escaped from the shale is held in the strata in one of three ways adsorbed on the rock surface, as free gas in fissures, or as free gas in the rock pores. Horizontal drilling creates more reservoir contact than is possible with a vertical well; hydraulic fracturing increases well permeability, enabling the gas trapped in the rock to be produced at economic flow rates (Jacoby, 2011).

2.2 The main factors contributing to American shale success story

US shale deposits are extensive, including the Barnett, Haynesville, Bakkenshales in Texas, Louisiana, North Dakota, along with the Marcellus shale that underlies portions of the states of Pennsylvania, West Virginia and New York (Figure 3).

Figure 3 America's hotspots (see online version for colours)



Source: IEA (2011)

A variety of factors can briefly name and listed below to have supported America's shale boon:

- Experienced oil service industry-technological advances and entrepreneurial spirit: although it has been known for long that shale gas deposits exist in different areas in the USA, it was however evaluated to have been economically unrecoverable. Recently, it has become commercially viable in because of innovative applications of technology (horizontal drilling), a technique known as 'fracking'. The history of the US hydrocarbon extraction and experienced oil services industry has been a very good breeding ground for shale gas revolution. Especially to be mentioned here, is the effort of one man: George Mitchell, the boss of an oil-service company, who saw the potential for improving fracking to get at the gas (Yergin, 2011). Consequently, increasing efficiencies overtime has resulted in a boom in shale gas investment and caused expectations of a natural gas revolution (Deutch, 2011).

The property rights and regulations related to land development are also favourably and flexibly used. The fact that individual own the mineral rights under their property which actually encourages the entrepreneurial spirit and makes the owners more enthusiastic about new ventures of drilling and extracting. On the other hand, the usage flexibility of pipelines are also favourable in the sense that pipeline owners are legally under obligation to allow anyone to pay to use them to transfer gas from the well to the customer (Deutsch, 2015).

The fact that licensing and permitting regulations and processes have been relatively easier and quicker for shale gas industry has also contributed. The stance of the states in the shale developing areas has so far been favourable and generally not the local governments but states have the jurisdiction and authority for permitting (Jopson, 2014).

Easy and ready access to capital, especially a deep and liquid gas market, has been very conducive.

2.3 Impact of shale revolution on US economy and policy

Main benefits of 'shale gas revolution' to US economy can be summarised as

- sharp decrease in gas price, that is three to four times lower than European prices: (it should be noted that US Henry Hub spot price decreased to $2.75 per mBTU, which was $8.69 in 2005 (Melikoğlu, 2014)
- creation of nearly a million jobs by 2011
- reducing LNG imports
- restoring competitiveness of the US industry generally (especially chemicals, petrochemicals)
- last but not least, contribution of $18.6 billion, in 2010, to US GDP (IHS Global Insight, 2011).

On the other hand, in terms of environmental policy, America has recorded a decline in greenhouse-gas emissions of 450 million tons, over the last five years. This has mainly been achieved through the partial switch from coal to gas in power generation. The share

of gas has risen to 25%. In 2011 coal-generated power was down to 42%, its lowest level for nearly 70 years. The biggest effect, especially in future, might be in transport sector. Transport is responsible for around a third of all US carbon emissions and gas produces around 25% less carbon dioxide and much cheaper currently than petrol. Using gas in transportation vehicles as compressed natural gas (CNG) or LNG, or indirectly by converting gas into liquid fuel or power for electric vehicles can help further reduce emissions.

2.4 Issues, concerns about 'negative consequences' of shale

Beyond above mentioned clear positive results in many aspects, however, there are both economic and environmental concern about shale gas; most economic concerns are related to revelations about deliberate overestimations of yield and deposits, unprofitability and declining well capacities (Papatulica, 2014). The key environmental concerns, on the other hand, are; groundwater contamination and wastewater generation, causing greenhouse gas emissions during operations and increased seismic activity, habitat fragmentation and land use (Krupnick et al., 2014). Out of these environmental issues, especially water contamination and methane release is given more attention below.

The most 'hot button' environmental issue in the USA is the possibility of shale gas development operations compromising drinking water aquifer quality through leakage of methane or through migration of drilling, fracking, and formation fluids. The other major concern is released methane, which is much more powerful an agent of global warming than CO_2. Any unburned methane or methane leaking from wells, equipment, or pipelines, whether on purpose (vented) or otherwise (fugitive), contributes powerfully to global warming and these concerns lead to questions about whether natural gas is really a low-carbon fuel compared with coal or diesel (Krupnick et al., 2014).

3 Shale gas exploitation in Europe

The perceived economic miracle of shale gas has naturally urged many other countries looking to the development of their own resources of shale gas. Although none of the European countries ranks in the table of 'top estimated technically recoverable (unproved) shale gas resources countries' list (Table 1), the total of European resources could go up to 18 trillion cubic metres (tcm) (EIA, 2013) with large chunks being in Poland, Ukraine, France, UK, Germany, Spain and Romania. A map of shale gas potential of Europe is given in Figure 4.

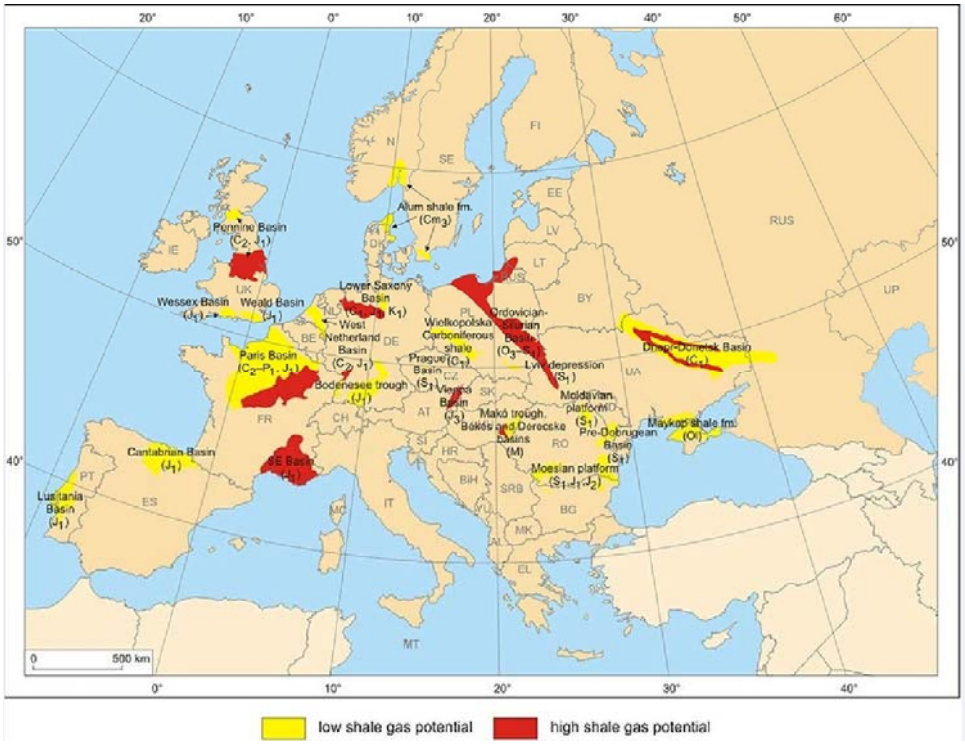
Although shale gas drilling has started in some European countries already, the progress is very slow. It should be noted that Poland and Ukraine are more enthusiastic about it, understandable due to problems of energy security and Russian dependence. However it is reported that due to disappointing drilling results, ExxonMobil and ConocoPhillips has already walked away from Poland (The Economist, 2012). Another non-encouraging result came from Denmark where Total announced hesitation over 'worthy resource' (Karbuz, 2015).

Table 1 Top ten list

Country	*Shale gas resource (trillion cubic metre)*
China	31.6
Argentina	22.7
Algeria	20.0
USA	18.8
Canada	16.2
Mexico	15.4
Australia	12.4
South Africa	11.0
Russia	8.1
Brazil	6.9
Other countries	43.5
World total	206.7

Source: EIA (2013)

Figure 4 Map of shale gas potential Europe (see online version for colours)



Source: Polish Geological Institute (2012)

Considering developments across the EU countries the below five main reasons are identified as to the question of why the fracking bonanza is not actually hitting Europe:

1 *The political and regulatory factor (regulatory uncertainty)*

No one country across the bloc has the same legislation. European Commission's recommendations to manage potential environmental risks associated with fracking are not binding and open to various interpretations. Bulgaria and France outright banned fracking in 2012 and 2013 (Stefanini and Oroschakoff, 2015). Thus, licensing and regulation on fracking has been proving more difficult in Europe. Additionally the EU gas market is currently far less liberal than that of the USA. There are limitations as far as access to transport capacity is concerned. It seems that the physical infrastructure place, but it is not accessible to all players. Such market imperfections discourage investments (Kavalov and Pelletier, 2012).

2 *Local concern and acceptance*

Local opposition and negative public opinion concerns about fracking are on the rise. It is the local communities that will have to deal with the local consequences and politically, the central governments can not move without the support of the local authorities (Stefanini and Oroschakoff, 2015). High population density is also a major issue at local level in Europe. Considering the intensive drilling over a large surface area, may present a high density major barrier to shale gas extraction due to the increased possibility of conflict with other land users (Kavalov and Pelletier, 2012). As an example to overcome this kind of difficulty, the UK Government announced plans that will ensure local people have a say over the development of shale exploration in their area, but at the same time allow the industry benefit from a swift process for developing safe and suitable new sites (World Oil, 2015).

3 *Unfavourable geology and infrastructure*

The extent of geological knowledge at EU level is less advanced than in the USA. There is no comparable, consistent and comprehensive EU geological repository. European shale plays tend to be deeper, more clay-rich and muddier than the US ones, making it harder and more expensive to drill (Kavalov and Pelletier, 2012).

On the other hand, both technical and commercial know-how and infrastructure are scarce in Europe. A major hurdle is the insufficient availability of equipment and trained staff, which is mainly due to the far smaller number of service companies than in the USA.

4 *Unappealing costs (the question of economies of scale)*

As in the USA, drilling costs are $3 to 10 million per well, the estimates for Europe is much higher. For Example in Poland, the government has put the cost of the 70 wells drilled so far at roughly $15 million each, but it could go as high as $50 million. This means producers need an even higher gas price to justify their investment in Europe. Thus, while energy prices are low, it can be said that there would not be much pressure for companies to look into exploring shale gas in Europe (Stefanini and Oroschakoff, 2015).

5 *Lacking rewards*

The US shale gas revolution has given rise to 'shale-ionaires,' or landowners who greatly benefited from shale royalties. But in Europe, everything below ground belongs to state or crown, giving landowners less reason to allow a drilling on their lands (Stefanini and Oroschakoff, 2015). Therefore, while there are more than 1200 drilling rigs in the USA, the number is very scarce in Europe, even in Poland, in the farthest progressed country, they number only half a dozen (Karbuz, 2015).

Based on above observations and explanations we can therefore conclude that:

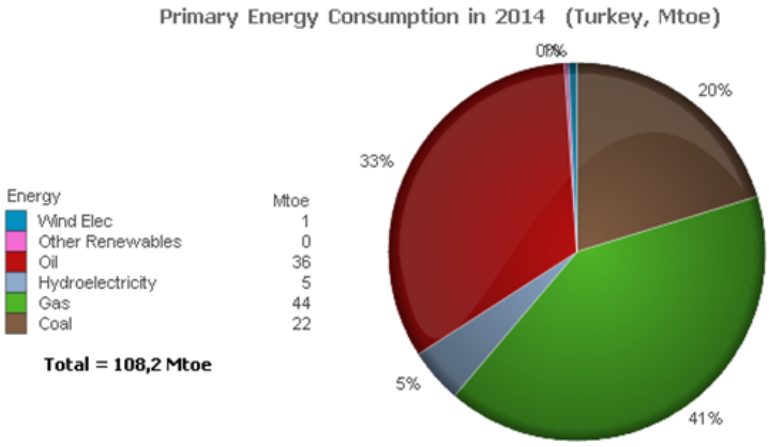
- the future of European shale gas industry is presently unclear
- early and tentative results show that, even developed to some extent, shale gas neither alleviate dependance and security concerns nor lead to a significant drop in gas price (Riepin and Müsgens, 2015)
- European investors seem actually to watch the USA to see if it becomes a gas exporter, implying both reducing the reliance on imports from Russia and as a substitute to own European domestic shale gas development, due to difficulties and high cost expectations (KPMG Global Energy Institute, 2011).

Despite all the above points, concerns of energy security and the need of resource diversification in energy is putting pressure on the EU to urge the exploitation of shale gas, but under strict environmental conditions and by recognising the right of each country to choose the type of resources to develop.

4 Shale gas potential and its prospects in Turkey

Before discussing the potential and prospects of shale in Turkey, it might be useful to give a brief summary about the existing energy usage and resources in the country (Figure 5).

Figure 5 Chart of primary energy consumption in 2014 Turkey (see online version for colours)

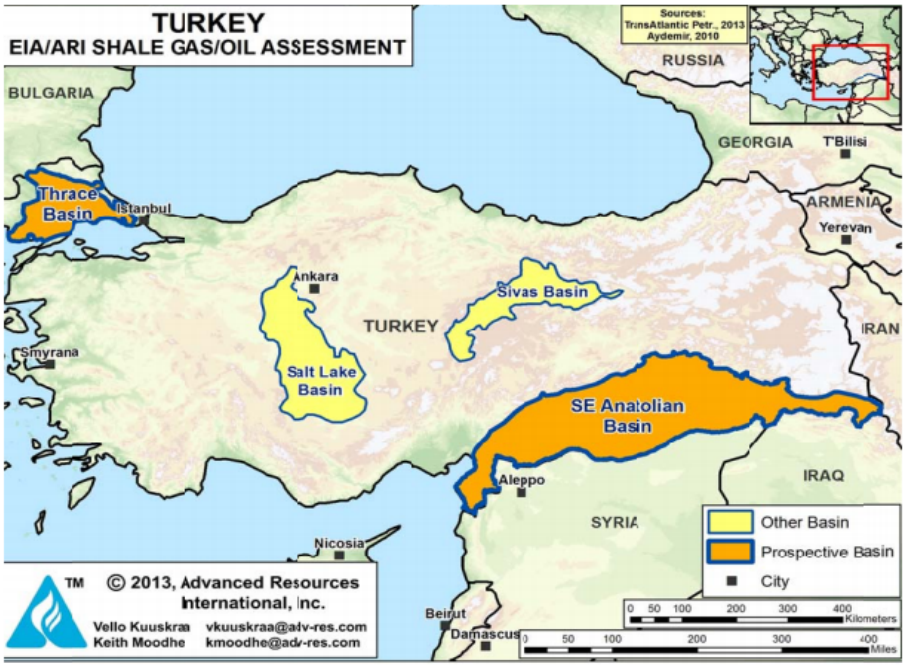


Source: US EIA Historical Statistics (2014)

As seen from the Figure 5, gas contributes considerably to energy mix and 98% of the total used gas amount is actually imported (nearly 50 bcm). As in Europe, most of it comes from Russia (~65%), raising concerns of 'high energy dependence'. The fact that gas-fired electricity amounts to ~40% of total makes this picture even bleaker. This observation actually critically increases the significance attributed to success of shale potential in Turkey. In other words, the Country is in desperate need of own resources of gas for economic and ultimately energy security reasons. There are actually conflicting opinions and insufficient data on the scale of resources in Turkey. What is clear may be that, the answer to the question, 'is there shale gas in Turkey' is affirmative. We have estimates that, Turkey holds some 1.8 trillion cubic metre (tcm) of technically recoverable shale gas (EIA, 2013). An industry expert, however, put the 'proven reserve' amount as little as just six to seven billion cubic metres (bcm) (Coşkun and Ergin, 2013).

It is known that Turkey has at least five basins estimated to have considerable fossil fuels: Southeastern Anatolia, Thrace, Eastern Anatolia, the Black Sea Basin (high-sea) and the Central Anatolian Basin. According to the research conducted by Advanced Resources International consultancy company under the initiative of the US Energy Information Agency in 41 countries, the overall extractable shale gas reserves in Dadas and Hamitabat basins is around 650 billion cubic metres (IEA, 2012). There are ongoing studies in these two regions. Shell Upstream Turkey conducts the drilling activities at Dadas Formation as a result of a contract signed in 2011 with Turkish Petroleum Corporation (TPAO). Three wells around Diyarbakir are being drilled to reach the necessary parameters to determine the gas potential and its availability in Dadas Formation. The results have yet to be announced.

Figure 6 Map of shale gas and oil assessment of Turkey (see online version for colours)



Source: ARI (2013)

Considering the extent of resources, the main arguments in favour of exploration and exploitation of shale gas in Turkey can be mentioned:

- being one of the largest gas markets in Europe (consumption of 50 bcm in 2014, with steady annual increase to reach ~ 70 bcm by 2025); the country is in urgent need of gas
- import of 98% of above mentioned amount; i.e., foreign energy dependence at a very high level that creates concerns of energy security. High dependence of power generation on imported gas (more than 40%)
- the prospect of gaining access to domestic gas with hopefully lower prices compared to current import price
- to reduce energy import bill and consequently current account deficit and increase the competitiveness of the industry

On the other hand however, the below main points can be identified as the main challenges in the way of a possible 'shale gas reality' for Turkey:

- Timely verification of presence of gas and see if its production in commercial quantities can be developed. As the only source is the EIA estimation, there remains urgent need for more systematic research (Arslanalp, 2015; Okumuş, 2013).
- Lack of experience, know-how and technology, which could partially be compensated by attracting international companies for operation and investment.
- Even in the case of proven reserves (as EIA study only shows recoverable resources regardless of economics), demonstrating that shale gas extraction is profitable and also cheaper than import prices.
- Designing, adopting and adjusting licensing and other regulations to support exploitation.
- As in Europe, overcoming unfavourable land and mining rights regime, which do not lure and encourage landowner.
- Securing public acceptance after negative publicity in Europe and some unfavourable experiences in the USA.

5 Conclusions for Turkey

Under the circumstances above, one might ask what chances of success for shale gas exploitation exist in Turkey? Will it be successful enough to especially reduce the enormous gas import bill for the country? Or will it have a limited effect considering the huge consumption (50 bcm)? Will it have a tangible contribution to so-called energy independence or supply security or at least diversification of resources? When we compare the conditions prevailing today's Turkey, Europe and the USA, it can safely be said that the situation of Turkey, in terms of the possibility of the development of shale gas resources has more similarity to European experience than actually the US one, in respect to geological structures and socio-economic dynamics, market conditions, industrial experience and expertise, legal systems and bureaucratic difficulties, etc.

Therefore, it will not be difficult to assume from the foregoing discussion that there will be many questions and problems waiting (considering basically lack of success conditions of the US case) in the way of the development of shale gas resources in Turkey. Despite all the uncertainty however, one can also optimistically suppose that if the exploratory drills are successful, and all other hurdles are overcome, and environmental safeguards are in place, Turkey can also be successful in shale gas development. Even under that assumption however, it should be kept in mind that; shale gas can only be one of the means for Turkey to reduce energy import dependence (it has now reduced to 70%).

- Main aim of Turkey's energy security and independence should only be achieved through a mix of policies such as diversification of energy supply (including import fuels, sources and countries), energy efficiency and being an energy hub.
- In desperate need of energy, from as diverse sources as possible, due to energy supply security problem, Turkey should continue to develop its own indigenous renewable as well as other fossil resources, namely vast lignites.
- It is expected that at least another decade to pass for the challenges to be overcome, necessary preparations and technical build-up to come to fruit, even in the case of success. The positive impact thus, could not be anticipated before 2030. One may also conclude that considering the comparable conditions with the USA, the cost of shale gas in Turkey will most likely be similar to Europe. That is, one should not be too optimistic about cheap gas in Turkey.

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