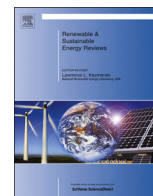




ELSEVIER

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Shale gas: Analysis of its role in the global energy market



Mehmet Melikoglu*

Department of Chemical Engineering, Gebze Institute of Technology, 41400 Gebze, Kocaeli, Turkey

ARTICLE INFO

Article history:

Received 2 January 2014

Received in revised form

14 April 2014

Accepted 1 May 2014

Keywords:

Environmental impacts

Natural gas

Production projections

Resource potential

Shale gas

ABSTRACT

Shale gas revolution that took place in the United States at the beginning of the 21st century has still been shaping our global fossil fuel market. In 2012, the U.S. has surpassed Russia in natural gas production for the first time since 1982. At the same year, annual average U.S. Henry hub natural gas spot price decreased to \$2.75 per million BTU, which was \$8.69 per million BTU in 2005. In 2013, proved shale gas reserves of the world is estimated at nearly 2.7 trillion cubic metres (tcm) and unproved resources at staggering 203.9 tcm. As a result, there is a global rush to develop most of this resource as possible. However, shale gas is no miracle fuel. It has been suggested that its effects on the environment could be worse than conventional natural gas. Fugitive methane emissions, groundwater pollution, and increased seismicity are amongst the most important potential environmental side effects. There is also concern about the accuracy of resource potential estimations due to lack of data and specifically designed shale gas reservoir models. Nonetheless, the analysis in this study clearly showed that without developing global shale gas resources we have to consume 66% of our proved natural gas reserves to supply the demand till 2040. This would make most of the world natural gas importers, and rules of economy dictate that limited supply and increasing demand would skyrocket natural gas prices. Therefore, shale gas resource development is not an option but a must for the continuance of our global energy market and economy.

© 2014 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	461
2. Shale gas formation and recovery	462
2.1. Formation	462
2.2. Recovery	462
3. Environmental problems associated with shale gas production and fracking	462
3.1. Groundwater contamination and wastewater generation	462
3.2. Greenhouse gas and fugitive methane emissions	463
3.3. Increased seismic activity	463
4. Global shale gas potential and production projections	463
5. The top 10 countries with technically recoverable shale gas resources in the world	464
5.1. The United States	464
5.2. China	465
5.3. Argentina	465
5.4. Algeria	465
5.5. Canada	465
5.6. Mexico	465
5.7. Australia	466
5.8. South Africa	466
5.9. Russia	466
5.10. Brazil	466
5.11. The European Union	466
5.12. A comparative assessment across the top 10 countries with technically recoverable shale gas resources in the world	466

* Tel.: +90 262 605 21 21; fax: +90 262 605 21 05.

E-mail address: mmelikoglu@gyte.edu.tr

6. Conclusion 466
 Acknowledgements 467
 References 467

1. Introduction

In 2011, the three types of fossil fuels: natural gas, oil, and coal provided 21.3%, 31.5%, and 28.8% of the global total primary energy supply (TPES), respectively; whereas, renewable energy sources provided merely 13.3% of the global TPES [1]. Thus, the share of fossil fuels in the global TPES was 81.6% or nearly 4.4 times the share of renewable energy sources. To be clear, the remaining 5.1% of the global TPES was supplied from nuclear power. Although, futurists in 1970s predicted that most of our energy need in 2000s would be supplied from renewable energy sources, we are living in world that is predominantly powered by fossil fuels [2].

Today, the TPES gap between renewables and fossil fuels is too wide to close, and there is no readily deployable energy generation technology that can provide the necessary replacement base load to stabilise the intermittency of renewable energy generation [3]. Also, the high monetary cost of renewable energy investments is a major problem [4,5]. As a result, it is evident that we will keep on using fossil fuels at these TPES ratios in the next couple of decades [6].

Out of the three types of fossil fuels, natural gas is becoming extremely important in the global energy market. Natural gas is a versatile fuel for electricity generation, heating, and transportation. Also, it has been identified as one of the principal options to reduce greenhouse gas emissions when shifting from other fossil fuels [7,8] over the entire life cycle. Life cycle assessment (LCA) is a well established method to understand the environmental impacts of energy conversion systems considering both renewable and non-renewable energy consumption during the whole life cycle [9,10]. From the LCA perspective, natural gas can be used to supply

base load electricity with high technical flexibility if it can be supplied at lower costs [11]. As a result, there has been a continuous, steady growth of its consumption in domestic households, industry, and power plants around the globe over the last 40 years [12]. Timeline of global natural gas consumption is shown in Fig. 1 [13]. On the negative side, production of natural gas is geographically limited, as shown in Table 1 [13], and increased consumption in countries, which do not have indigenous reserves, worsen their trade deficit and cost billions of dollars each year. But, this might change soon as a result of the “shale gas revolution”, which took place in the United States in the early 21st century [14,15].

Today the U.S. natural gas price is around \$4 per million British thermal units (BTUs), which is well below its ten year average of about \$5.70 and prices of nearly \$14 in Britain and \$17 in Asia [16]. Detailed information about the U.S. Henry hub natural gas spot price is reported in Table 2 [17]. In addition, the U.S. surpassed Russia in natural gas production last year, pulling ahead for the first time since 1982 [18]. As a result of this dramatic change in the U.S. natural gas supply, other countries who import natural gas but also proved to have large shale gas deposits, like China, the United Kingdom, and Turkey are now keen to develop their resources [19–21]. It is anticipated that this trend will spread to other countries and shale gas investments will increase at an exponential rate in the second half of this decade.

However, shale gas development also has its cons. The opponents are highly concerned about its potential environmental impacts on our climate and energy security. Linguist and author, Noam Chomsky is highly concerned about the environmental impacts of shale gas development. Quoting his opinion about this subject: “When you turn to energy production, in market exchanges each participant is asking what can I gain from it? You don’t ask what are the costs to others. In this case the cost to others is the destruction of the environment. So the externalities are not trivial” [22]. Also, Claude Turmes who is a member of the European Parliament for Luxembourg’s Green Party and green energy spokesperson considers that shale gas as a dangerous Trojan horse for Europe’s energy policy [23].

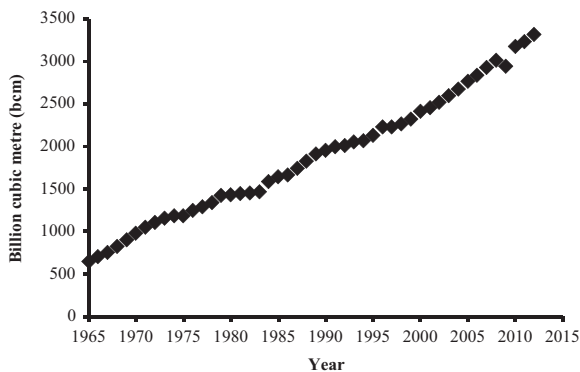


Fig. 1. Global natural gas consumption, in billion cubic metres (bcm) [13].

Table 1
 Global natural gas production in 2012 by region, in billion cubic metres (bcm) [13].

Region	Production (bcm)	Share of total (%)
Total Europe & Eurasia	1035.4	30.7
Total North America	896.4	26.8
Total Middle East	548.4	16.3
Total Asia Pacific	490.2	14.5
Total Africa	216.2	6.4
Total South & Central America	177.3	5.3
World total	3363.9	100.0

Table 2
 The U.S. Henry Hub Natural Gas Spot Price (dollars per million Btu) [17].

Year	Price (dollars per million Btu)
1997	2.49
1998	2.09
1999	2.27
2000	4.31
2001	3.96
2002	3.38
2003	5.47
2004	5.89
2005	8.69
2006	6.73
2007	6.97
2008	8.86
2009	3.94
2010	4.37
2011	4.00
2012	2.75

Download English Version:

<https://daneshyari.com/en/article/8119636>

Download Persian Version:

<https://daneshyari.com/article/8119636>

[Daneshyari.com](https://daneshyari.com)