Energy Policy 37 (2009) 3520–3534

Contents lists available at ScienceDirect

Energy Policy

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

Assessment of demand for natural gas from the electricity sector in India

P.R. Shukla [a], Subash Dhar [b,*], David G. Victor [c], Mike Jackson [d]

[a] Public Systems Group, Indian Institute of Management Ahmedabad, India
[b] UNEP Risø Centre, Risø DTU, Frederiksborgvej 399, Building 142, DK-4000, Roskilde, Denmark
[c] Law at Stanford Law School and Director of Program on Sustainable Development, Stanford University, USA
[d] Program on Sustainable Development, Stanford University, USA

ARTICLE INFO

Article history:
Received 21 April 2008
Accepted 29 March 2009
Available online 21 June 2009

Keywords:
Gas market
Electricity
Energy modeling

ABSTRACT

Electricity sector is among the key users of natural gas. The sustained electricity deficit and environment policies have added to an already rising demand for gas. This paper tries to understand gas demand in future from electricity sector. This paper models the future demand for gas in India from the electricity sector under alternative scenarios for the period 2005–2025, using bottom-up ANSWER MARKAL model. The scenarios are differentiated by alternate economic growth projections and policies related to coal reforms, infrastructure choices and local environment. The results across scenarios show that gas competes with coal as a base-load option if price difference is below US $ 4 per MBtu. At higher price difference gas penetrates only the peak power market. Gas demand is lower in the high economic growth scenario, since electricity sector is more flexible in substitution of primary energy. Gas demand reduces also in cases when coal supply curve shifts rightwards such as under coal reforms and coal-by-wire scenarios. Local environmental (SO_2 emissions) control promotes end of pipe solutions flue gas desulfurisation (FGD) initially, though in the longer term mitigation happens by fuel substitution (coal by gas) and introduction of clean coal technologies integrated gasification combined cycle (IGCC).

1. Introduction

Electricity sector accounted for 35% of natural gas consumption in 2005. High share of electricity sector is on account of government policies which gave it priority in gas allocation. A spurt in gas supplies is in the offing as there have been major gas finds off the east coast[1] and there are proposals for creating a nationwide gas transmission grid to link these supplies to the existing and new markets (Fig. 1).

There is, however, a different environment in which future growth of gas market is going to take place. The new supplies will be more expensive as majority of the gas would come from deep sea basin. The production sharing contracts for new supplies allow for market determined pricing. Spreads of gas infrastructures will make gas accessible to new consumer segments like transport, residential and small industrial consumers with different price sensitivities. At the same time, lack of reforms in coal and electricity markets could significantly affect fuel choices made by power producers. In fact, electricity sector has shown faster growth in gas demand during the post-1991 reforms period and the same has been attributed to failure of electricity and coal markets (Shukla et al., 2005). In this paper, we would therefore like to understand demand of gas for power generation under alternative growth and reform scenarios in coal and power sector and what will be the implications for climate and electricity prices.

The future fuel choices for power sector in India have been modelled using energy system models in the past with focus on climate change issues (Shukla, 2006, 1997; Garg et al., 2003). In the immediate past, there are two government reports, which have looked at future energy scenarios, (GoI, 2006; TERI, 2006) and both provide projections for gas in electricity sector for different GDP growth rates. The issue of reforms in power sector and the impacts on fuel choices has been studied (Shukla et al., 2004) but the same has not been projected for future. Therefore, a study which has looked at reforms in coal and electricity sector in India and its impact on fuel choices in power sector with consequent implications for power prices and externalities has not been studied and this paper is trying to address this gap.

Reforms in energy markets have been fairly difficult in the past and even in future creation of a competitive market would be difficult in coal and electricity markets (GoI, 2006). In this paper, we focus largely on reforms on the generation side and coal markets. Finally, we explore the impact on fuel choice under local environmental constraints (SOx) as more aggressive measures to

* Corresponding author. Tel.: +45 4677 5135; fax: +45 4632 1999.
E-mail addresses: shukla@iimahd.ernet.in (P.R. Shukla), sudh@risoe.dtu.dk, sdhar26@yahoo.co.in (S. Dhar), dgvictor@law.stanford.edu (D.G. Victor), mjacks3@gmail.com (M. Jackson).

[1] Gas reserves have increased from 648 bcm in 1998 to 1075 bcm in 2005 (CMIE) due to recent gas finds.

0301-4215/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2009.03.067

Fig. 1. Gas infrastructures: existing and proposed.

reduce local air pollution are expected in future (Garg et al., 2006). The expectations about future growth of the Indian economy show a wide range—the Planning Commission of India currently talks of 8% and 9% GDP growth rates through 2032 (GoI, 2006) whereas the International Energy Agency (IEA) has talked of a 6.1% GDP growth for period till 2030 (IEA, 2007). Therefore, five GDP growth rate scenarios were used in this study to explore the impact of this uncertainty on fuel requirements and demand.

The paper is organized as follows. The first section talks about evolution of electricity generation markets in India to give a background to a reader uninitiated to Indian energy sector. A section follows this on future growth scenarios where we analyze gas demand for electricity sector under alternative expectations of growth rates and another section on policy reforms in coal and electricity sector. In the end, we conclude with a discussion of the results.

2. Evolution of gas in Indian electricity market

Electricity generation in India till 1991 was done mainly by government-owned entities—State Electricity Boards (SEBs) owned by respective state governments and Central government-owned entities (Shukla et al., 2004). In line with the definition of a utility provided in the Electricity Act, 2003 all these above-mentioned entities are referred to as utilities. In 1991, as a part of overall economic liberalization of the Indian economy, power generation was opened for investment by private sector (Shukla et al., 2004). It was believed that reforms in generation are the best way to begin and distribution reforms could follow later (Godbole, 2002). The reforms were able to attract only few private players into generation (Shukla et al., 2004) and as a result the electricity shortages also persisted (Fig. 2).

The Indian electricity sector follows inverted tariffs—industrial customers cross subsidize the low or uncollected tariffs from residential and agricultural users. Persistent shortages, high tariffs and spill over benefits like waste heat made it attractive for industrial units to go for their own generation, which is referred as captive generation. The Electricity Act, 2003 has also introduced a provision of allowing captive plants to supply directly to consumers. The evolution of captive is discussed after discussion of utilities.

2.1. Fuel choices within utilities

Gas competes with coal for base load and hydro for peak load. Coal has been the mainstay fuel choice of the utilities and