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International Fuel Market: Behaviour and Impact

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Table of Contents

Abstract

It becomes imperative to understand the nexus between different fuel sources in a world where countries are increasingly interdependent on each other to satisfy their energy needs. The Global Governance 2022 (Cheng, et al., 2013) report predicts the possibilities of two worlds in 2022: the fragmented world, and the internationally integrated market. The fragmented world focuses on supplier economies controlling fuel assets resorting to regional alliances (energy arrangements) to resolve resource conflicts; the integrated market provides an outlook wherein the market experiences growth in player participation (produces equal consumers) leading to global integration through bilateral investment treaties and enhanced collaboration and competition. The region where the two worlds intersect would provide a platform for new suppliers and new consumers of energy sources thus calling for immediate shift in the geopolitics of energy. For such a change to take place, it becomes necessary to understand the present market dynamics that govern fuel sources, especially coal. This is because coal continues to be the most dominant fuel in the world energy mix despite its propensity to lead to greater carbon emissions.

Coal pricing so far was primarily determined by demand and supply. But with concerns emanating on the climate change front, countries began shifting towards greener fuels and the availability of unconventional fossil fuel like shale gas at such an optimal time led to a boost in its demand. Thus a third factor was added that determined coal prices. This report seeks to lay out this inter-dependence of prices between coal and natural gas. It does so by looking at energy demand trends across the world and the production-consumption pattern for both coal and natural gas. The recent shift in the US's energy pattern towards shale gas led to an over-supply of coal in the market which caused coal prices to fall sharply. European countries like Germany, Italy, and the UK took advantage of this fall to diversify their energy mix leading to higher overall coal consumption.

To all this, we add a third dimension of the Indian scenario. India dependence on coal for power generation continues unabated. Despite India being the fourth largest coal producer in the world, supply has not kept up with demand, thus leading to higher imports. This problem is compounded with factors such as inadequate gas infrastructure to support its burgeoning energy needs and rupee depreciation. Therefore, we are extremely sensitive to any price fluctuations in global markets. This report throws light on the Indian energy market, understands the coal-gas nexus in the Indian context and also looks at the gas infrastructure in the country.

Understanding the nexus that governs international fuel behaviour will pave the way for strategic policy options towards making energy more affordable, accessible and sustainable. Policies in this regard would include scaling-up energy transport infrastructure for energy access, inducing investments in the sector to make energy affordable and setting cross-border regulations and climate action and technology cooperation to ensure sustainability (Han Cheng, 2013).

Introduction

Coal continues to be a dominant fuel in most countries' energy supply despite alternate fuels gaining importance in the fuel mix. Nearly 90 per cent of coal produced is consumed by four heavy industries around the world: power generation, steel, construction materials and chemicals. At the same time, the increased significance of shale gas in the recent past indicates a larger role for natural gas in world energy production in the future. Hydraulic fracking has resulted in successful shale gas production in the US and Canada with potential exploration in Europe, China and Australia (Fawzi, 2013). For this reason, the geopolitics surrounding the coal and gas production and consumption strategies have become essential to explore. The increasing trade in oil and gas markets on the global level has allowed countries to narrow the growing gap between domestic energy demand and production. The development of shale gas and shale oil technologies has proved to be a 'game changer' for the American Economy (TERI, 2014). This has had trickle down impact with many countries like Canada, Poland, and China among others coming forward to adopt this practice, while at the same time it has led to abundance of other resources such as coal in the international market. The diminishing economic difference between nations has seen an equal growth in their energy requirement (demand).

The availability of cheap domestic gas, due to the revolutionary extraction techniques of shale gas, has resulted in the US, one of the major consumers of coal in the world, to reduce its coal consumption. For two decades from 1990 to 2010, nearly half of the power generation in US was sourced from coal thermal power plants. This share declined to 32 per cent as of April 2012, equalling the natural gas share in power generation (US EIA, 2012).

The US continues to be a major gas consumer followed by Russia, Iran and China with consumption of 722.1 billion cubic meters (bcm) in 2012 (BP Stats, 2013) (Figure 1). The mechanisms governing the production and consumption of coal and gas have varied based on market conditions, availability of new sources of fuel, as well as the environmental risk and the sustainability factor surrounding exhaustion of fossil fuels. In this regard, China, now the largest emitter of greenhouse gases, is undertaking several measures to cut pollution levels. Considerable increases in its clean energy capacity through solar, nuclear, wind and hydro have been a step in this direction. Nevertheless, the reliance on fossil fuels will continue, if not increase, despite such concerns. Coal will hold a major share in the country's energy mix as power generation capacities continue to be set up. At the same time, selected European nations, particularly Germany, UK and Poland, are looking at coal as a major fuel in its energy mix, in the light of low coal market prices.

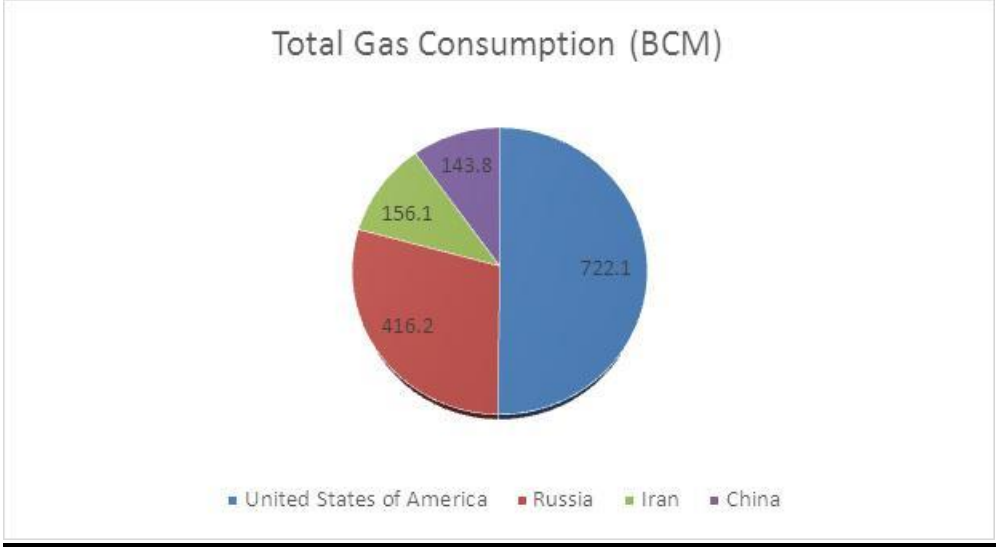

Figure 1 Total Gas Consumption for 2012
Source: BP Stats, 2013

The paper first looks into the linkages between the coal and gas market on the international platform, examining how each of these sources has impacted the demand, supply as well as the pricing of the other. It begins by examining the Global Gas Market in terms of its production (and export) and consumption (and import) among major players, followed by a similar examination of the Global Coal Market. Further, the paper discusses the interplay between the coal and gas market in turn testing the substitution effect between sectors. The paper concludes by providing the medium term implication on the Indian energy market.

Global Gas Market

The development of regional gas markets has so far been limited to North America and Europe. It is only recently that the Asian markets are witnessing more integration in gas trade. While gas in the North America and Europe regions was being supplied through pipelines, the Asian market was supplied gas through liquefied natural gas (LNG) imports. The growing need to meet power generation targets, industrial-residential use as well as transportation requirements have built a suitable market between the cheaper and traditionally abundant coal and the relatively environmentally friendly and growing natural gas resource.

The revolution of shale gas in the US market, enhanced the role of natural gas in the primary energy mix, thereby facilitating a gradual transition towards greener sources of energy. First produced in Fredonia, New York in 1821, shale gas is not a new phenomenon. However, in the context of the current global energy scenario where energy security and environmental uncertainty are determining the future of global energy markets, its recognition has grown multi-folds, with extensive exploration and extraction activities being carried out in different parts of the world.

Demand and Supply

Natural gas accounted for 23.94 per cent of world primary energy consumption in 2012 (BP, 2013) and 21.4 per cent of total primary energy supply in 2010 (IEA, 2012a). The world production of natural gas has increased over the last four decades at a compounded annual growth rate of 4.2 per cent (Figure 2). Gas production in 2012 was pegged at 3,363.9 bcm registering a 2.2 per cent growth over 2011. However, this growth is slower than the average of 2.7 per cent per year achieved during the last decade on account of a less favourable economic environment.

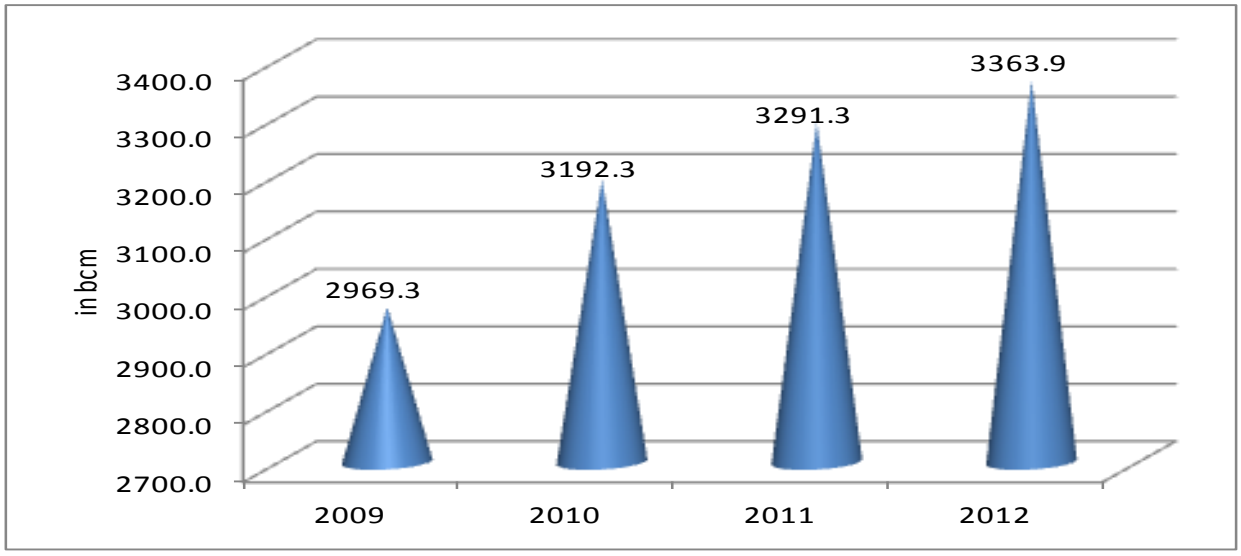

Figure 2 World Natural Gas Production
Source: Statistical Review of World Energy 2013, BP Global

The largest share in global natural gas production is of the US, Russian Federation and Iran, who also are the leading consumers of the fuel in the world. The top ten producer and consumers of natural gas in the world have been listed in Table 1.

Table 1 World Top 10 Natural Gas Producers and Consumers in 2012

Rank	Producer Countries	Production (BCM)	Consumer Countries	Consumption (BCM)
1	US	681.39	US	722.1
2	Russian Federation	592.27	Russian Federation	416.2
3	Iran	160.5	Iran	156.1
4	Qatar	157.05	China	143.8
5	Canada	156.55	Japan	116.7
6	Norway	114.92	Saudi Arabia	102.8
7	China	107.22	Canada	100.7
8	Saudi Arabia	102.8	Mexico	83.7
9	Algeria	81.5	United Kingdom	78.3
10	Indonesia	71.07	Germany	75.2

Source: Standing Committee on Petroleum and Natural Gas, 19th Lok Sabha Report

After reaching its initial peak of 3,054 bcm in 2008, the total natural gas production declined globally in 2009, owing to the 2008 economic recession and the fall in gas price (owing to reduced industrial and manufacturing activity, and lower electricity use) as examined by the US Energy Information Agency. The production then picked up pace at a CAGR of over 4 per cent, 2010 onwards.

The pricing of natural gas has been an extended debate in the national as well as the international space. So far, the prices in North America were set via spot contracts with gas-to-gas competition while in Europe they were being set through long-term contracts tied to the price of oil. As of 2012, the price of natural gas in the US has remained at low level of around $3 per million British thermal units (mBtu); the European spot prices, albeit three to four times higher than those in US, are still at a discount of European long-term contracts, while prices in Japan peaked at a level considerably higher than those in Europe (Warner ten Kate, 2013). At the same time, the global demand of natural gas can be anticipated to grow given the increasing environmental concerns surrounding fossil fuel usage (coal and oil). In 2012, the sector registered demand growth of 2 per cent. The Fukushima Daiichi nuclear accident, that took place in March 2011, has also boosted the regional demand for gas that is likely to replace nuclear in Japanese power generation mix.

With production of gas from shale, the total gas production in the US increased from a little over 550 bcm in 2001 to more than 680 bcm in 2012, recording an annual growth of nearly 2 per cent in the eleven year period. This increase in production has also led to a decline in the gap between gas consumption and production from domestic sources (TERI, 2014). Gas is gradually gaining equal share in the electricity generation with coal.

The overall gas trade volumes (LNG and Pipeline gas) have only marginally increased from 1,029.83 bcm in 2011 to 1,033.39 bcm in 2012. The gas exports in 2012 were concentrated among the Russian Federation (200.73 bcm), Qatar (124.67 bcm) and Norway (111.35 bcm)1. While exports from Russia and Norway are chiefly through pipelines, Qatar leads in LNG exports. Other dominant export players include Canada with 83.82 bcm of only pipeline exports and Asia Pacific countries (except China, Japan and Indonesia) with 89.99 bcm of pipeline and LNG exports. On the import side, Japan imports 118.79 bcm of LNG, accounting for 11.5 per cent of total imports followed by European nation (excluding Germany, Italy and Norway) with total imports of 105.83 bcm and a 10 per cent share (majority of pipeline exports).

The US imports of LNG have undergone drastic decline to low quantities of 4.9 bcm in 2012, falling 50 per cent over 2011 imports (BP Stats, 2013). Moreover, authorizations are now increasingly being sought by project developers to build a new LNG terminal (green field) or expand a terminal (brown field) primarily for export purposes. This is because most of the existing LNG terminals were initially

[1] International Pipeline Trade: Exports sourced from Russia (27 per cent), Norway (15 per cent) and Canada (12 per cent); International LNG Trade: Exports sources from Qatar (33 per cent), Malaysia (10 per cent) and Australia (9 per cent)

designed to receive natural gas imports, so they lack the essential feature for exporting LNG—namely the liquefaction facility that make the fuel easier to store or transport.

LNG represents 31 per cent of the world gas trade. A combination of infrastructure setbacks, operational delays and lower than expected production levels among major producer countries has restricted LNG gas supplies leading to some extent of market tightness (CEDIGAZ, 2013). Nevertheless, large exports from North America (US and Canada) would alter international gas prices. The global natural gas markets is spread over three major regions — the North American, the European, and the Asia/Oceania region (Japan, China, Korea and Taiwan). Over the period January-August 2013, the North American gas demand (LNG + Pipeline) stood at 597 bcm, Europe at 339 bcm and Asia/ Oceanic region at 244 bcm (Tetsuo Morikawa, 2014). With falling international gas demand from the US, the supplies for exports are being diverted to the European and Asian markets. For Europe, this has particular significance as it reduces their (the countries') dependence on Russia, and helps diversify import sources. At the same time, countries in Asia/Oceania will also benefit, both from the increasing availability of short-term and long-term contracts as well as the possibility of reducing their risk basket through greater diversification of import sources (Soni & Joshi, forthcoming). Meanwhile, the significant slowdown that was seen in the European gas market2, specifically, United Kingdom, France and Spain has been compensated for by an increase in LNG gas demand from the emerging Asian markets (specifically Asia Pacific, Japan and China). Also, the Fukushima nuclear accident in Japan augmented the energy appetite for LNG in order to offset the deficit in nuclear-generated power.
In spite of the shale gas revolution in the US, the pricing and supply-demand scenario in the three major hubs remains distinctly different. Therefore, a change in the circumstances or any possible market integration is unlikely to be seen in the medium term.

Global coal market

The reduced dependence of coal by the US markets, as a result of the gas abundance has led to an increase in coal availability in the international market. As per the estimates by BP Global, world coal consumption grew by 2.5 per cent in 2012 (January-December), though below the 10-year average of 4.4 per cent over the past decade. It nevertheless continues to be the fastest-growing fossil fuel in the energy mix.

International hard coal (includes steam and coking coal) trade increased from 385 million tonnes (mt) in 1982 to an estimated 1,276 mt in 2012. Yet, only 17 per cent of the total coal production is traded internationally, while the trade share stands at 60 per cent for oil and 33 per cent for natural gas. This is also because much of the coal production is domestically consumed by the countries (Cornot-Gandolphe, 2013). While China consumes all of its coal production, the Asian markets comprise

[2] With a shift towards coal based generation

nearly 25 per cent of the US coal exports. The US coal is also being taken up by the European countries including Germany, UK and Italy.

The prolonged oversupply situation in global coal markets led to Newcastle benchmark prices of coal crashing by 13.1 per cent to $81.45 a tonne in 2013. In addition to a slow down in import demand from China, relative reduction in imports by Indian power developers due to weakening of the rupee exerted pressure on coal.

Production

Concentrated among four countries, coal production is dominated by China with a production of 3,650 mt in 2012, registering a 3.8 per cent increase over 2011 (Figure 3). This is distantly followed by US, India and Australia with 922 mt, 606 mt and 431 mt respectively. Therefore, any trends in the coal market can be significantly influenced by changes in market dynamics in China. In terms of coal reserves, the US holds the largest coal reserves of 2.37 billion tonnes (bt) followed by the Russia with 1.57 bt and China with 1.14 bt as of 2012. The net increase in coal production has majorly been accounted for by the Asia-Pacific region intensifying production activities, offsetting the annual decline of over 7 per cent over 2011-2012 in US coal production. This increase in production has nevertheless helped improve the reserve-to-production ratios in these countries.

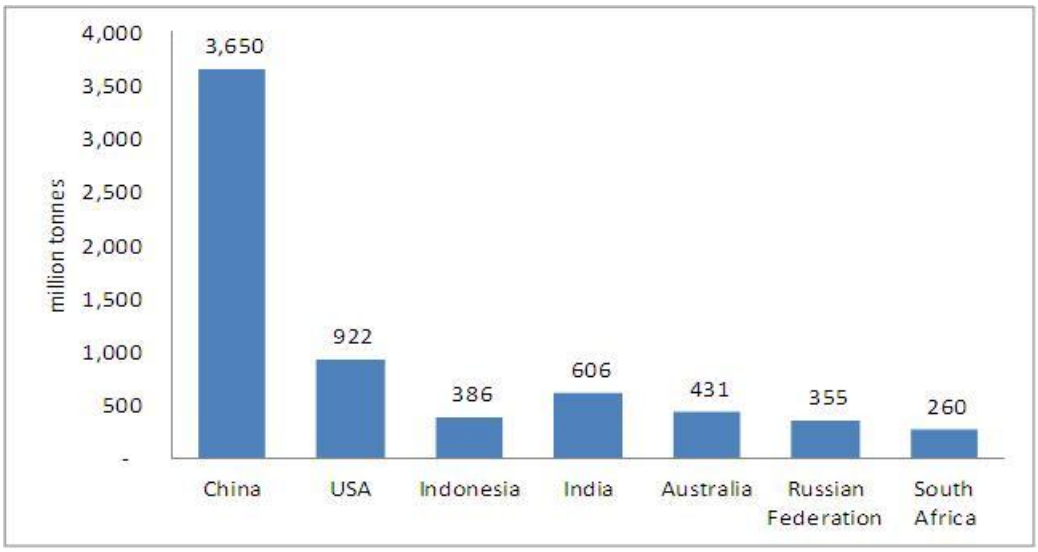

Figure 3 Major Coal Producers (2012)
Source: Statistical Review of World Energy 2013, BP Global

The coal export space is concentrated between countries including Australia, Indonesia, US, Russia, South Africa, and Colombia which has recently emerged as a strong exporter. These countries together account for about 84 per cent of the total (Cornot-Gandolphe, 2013). Asia sources its imports from Australia, South Africa and Indonesia. Over the past year, Colombia has surfaced as an important supplier to the European and now Asian markets. Though the country has a modest coal production of 89.2 mt, over 90 per cent of its production is exported bringing significant foreign

capital to the developing country. Coal production is being carried out by private players that are looking at increasing the production capacity by two fold in the coming years.

With coal exports driving its economy, Indonesia surpassed Australia as the leading coal exporter in 2011 with exports of 310 mt. Major markets for the Indonesian coal include India, China, Japan, South Korea and the European nations. Production of coal in Indonesia quadrupled in the period 2001-2011, despite relatively low domestic consumption. The export growth has been driven by the close proximity of key export markets (India and China), low capital and operating costs and speedy mine-approval mechanism.

Almost 70 per cent of the total energy supply in South Africa comes from coal. Of the total production, it exports nearly 30 per cent, mainly through the Richards Bay Coal Terminal, making South Africa the fourth-largest coal exporting country in the world.

Consumption

The sufficient coal stock in the medium term, easy integration of coal-fired power into existing power systems and the gradual flattening of the global energy platform between major nations has contributed significantly to the rapidly increasing coal demand across the globe. As estimated by the IEA, the world coal demand is expected to increase at an average rate of 2.3 per cent each year to 2018. (International Energy Agency, 2012).

The expansion in coal demand over the past 8-10 years was driven by the rise in Chinese and other Asian economies. In addition to being the second largest global economy, China also accounts for nearly 47 per cent of the global coal production and consumption (US EIA, 2013). During the period from 2006 to 2010, the Chinese coal consumption captured 46 per cent of the basket. At the same time, emerging and growing Asian markets (Korea, Taiwan, India among others), in the process of upgrading their industrial capacities, increased their demands to meet their growth potentials. India, the third largest coal importer, is one such market that has witnessed a significant jump of nearly 180 per cent in coal imports over the past five years from 49.79 mt in 2007-08 to 137.56 mt in 2012-13. The high dependence on imports has surfaced on account of the chronic power shortages, domestic coal supplies deficits and the logistical constraints in getting existing coal stocks transported to plant locations. Amidst severe regulatory gaps surrounding mine operations, many Indian coal players, such as JSW Energy Limited, Reliance Power Limited and Tata Power Company Limited, have resorted to increased overseas mine acquisitions to achieve fuel security on account of non-operationalization of allocated coal blocks to power developers.

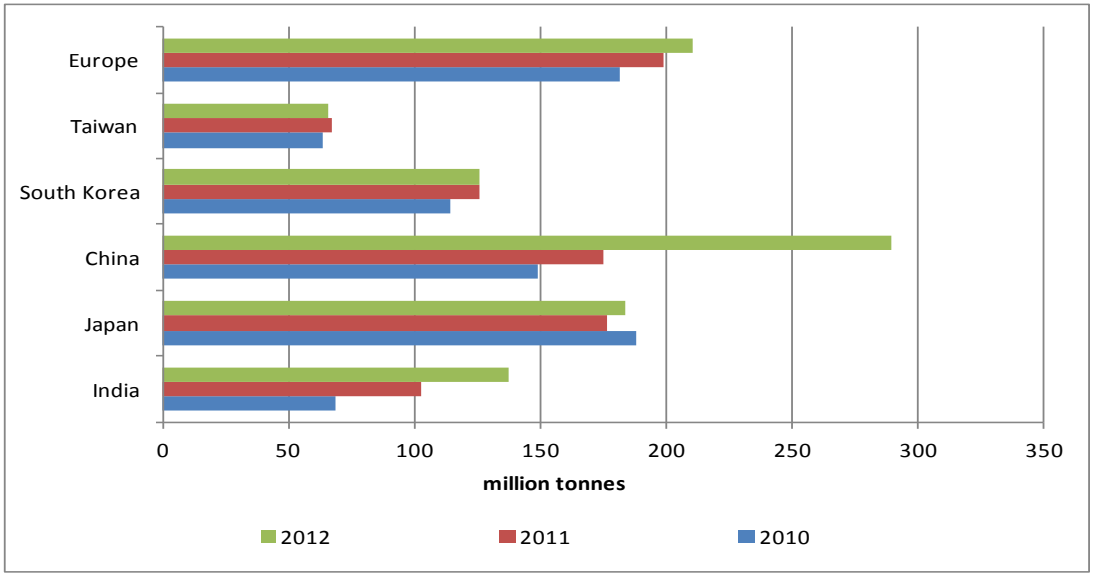

Figure 4 Major Coal Importers
Source: US EIA and other sources

In 2011, China overtook Japan as the largest importer with 175 mt of coal imports. China's transformation into a net importer of coal has made it one of Australia's main export markets in less than five years (Ben Caldecott, 2013), constituting 18 per cent of its thermal coal exports in 2012. Japan imported 184 mt in 2012 while South Korea imported 126 mt, sourcing their coal from Australian and Indonesian coal markets. However the ongoing slowdown of the Chinese economy (since 2012) has emerged as a big concern for coal producers, implying less power demand and thus falling coal consumption. Furthermore, the growing concern over environmental deterioration is likely to shift China's coal demand for low rank imports away from currently expected levels (Ben Caldecott, 2013). The fall in Japanese coal imports was a consequence of the Fukushima accident that damaged five coal-based power plants aggregating 7 GW. Lower import demand by steel producers further contributed to this decrease.

Coal and Gas Interplay

The world natural gas reserves at the end of 2012 stood at 187.3 trillion cubic meters while the coal reserve as per the 2013 Survey of Energy Resources, World Energy Council stood at 860.94 billion tonnes (BP 2013). As per proved reserves in 2012, coal reserves are sufficient to meet 109 years of global production and natural gas has been estimated to meet nearly 58 years of global production. A gradual shift towards natural gas adoption for power generation, industrial practices and transportation is being witnessed.

A major and probably the most important driver of demand for fuels in the global energy market are the market determined prices surrounding them. The following charts provide a 15-year price trend for natural gas and coal.

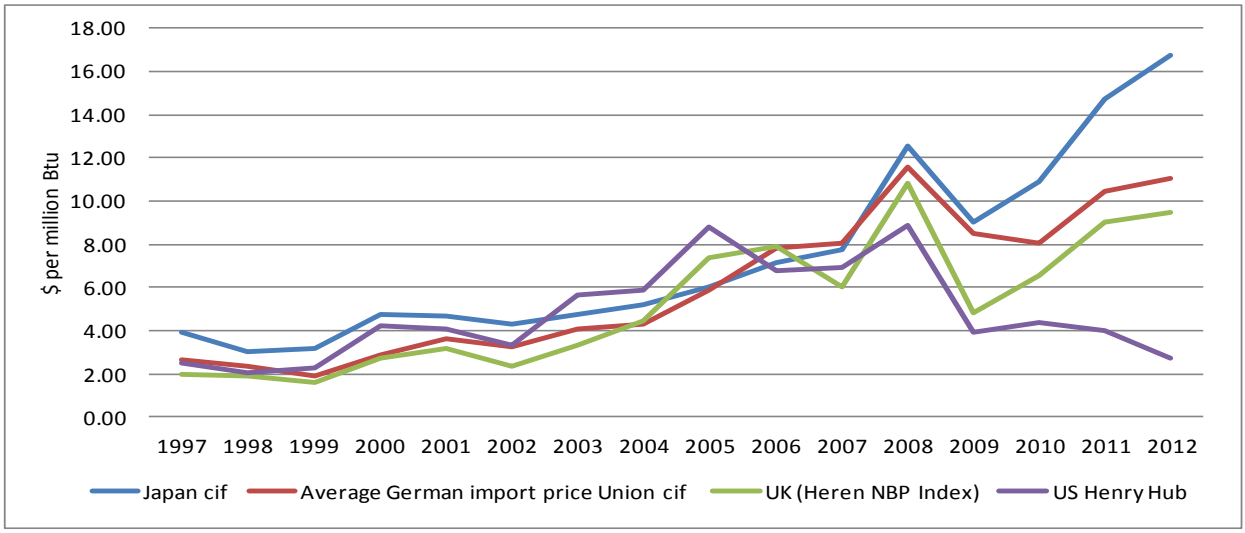

Figure 5 International Natural Gas Prices (15-year period)
Source: Statistical Review of World Energy 2013, BP Global

The increased popularity of shale gas has been reshaping the global oil and gas markets. The imports of coal and natural gas have considerably fallen in the US, while the use of domestic natural gas for power generation in the country has risen. Today, natural gas and coal nearly match in share (32 per cent and 34 per cent respectively) in the US primary energy mix. A relative substitution of gas for coal can thus be seen in the US market with consumption of coal falling from 495.5 mtoe in 2011 to 437.8 mtoe in 2012 and gas consumption rising from 626.5 mtoe to 654 mtoe over the same year (BP Stats, 2013). The drop in coal-based electricity and a corresponding rise in power generation from natural gas has resulted in falling levels of greenhouse gas emissions.

The abundance of gas has reduced its prices at the US Henry Hub, giving it an advantage for trade over other suppliers. The Henry Hub plunged more than 30 per cent over 2012, as producers pursued production of shale gas and maintained ample supply. However, the same was not seen at other terminals. As examined by CEDIGAZ, in 2012, gas price differentials between the three main regional markets (United States, Europe, and Japan) widened further. The surge in the Japanese LNG price, owing to rising demand after the Fukushima crisis, is reflected in the rise of the oil price. In Europe, the average gas price of long-term contracts (which include a share of spot indexation) was also pushed up by both the rise in the Brent price and the NBP spot price. However, the existing price differentials between the North American and Asia-Pacific gas markets—current gas prices are about $3 per million British thermal unit (mmBtu) in North America, and $13–$16/mmBtu in the Asia Pacific—make the prospect for exports to Asia attractive to some producers. Having said that, coal availability increased mainly because of the U.S, but the pricing in the Asian market, unlike the European market remained light.

In 2013, the trend of diverging regional gas prices, observed since 2009, has remained a common feature, and outside North America, natural gas and LNG prices are expected to remain at high levels. On the other hand, pressure of the fall in international coal price is likely to make distressed producers in coal exporting majors -Indonesia and Australia- cut back production activities to address the issue of over-supply, with the aim of bringing back coal prices to previous high levels.

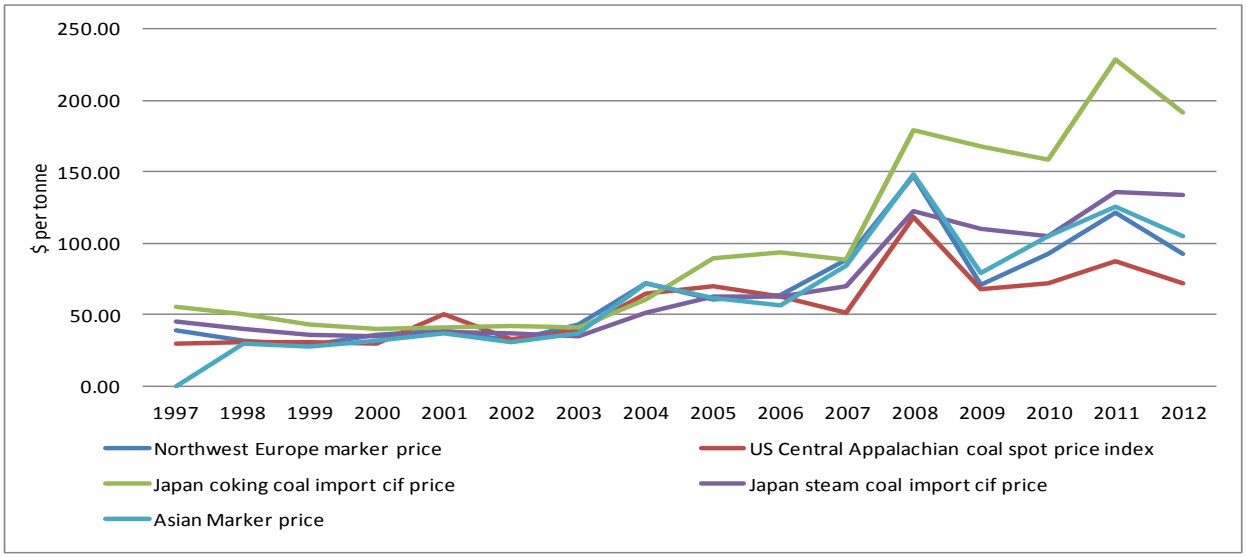

Figure 6 International Coal Prices (15-year period)
Source: Statistical Review of World Energy 2013, BP Global

The international coal prices on all trading platforms plummeted in 2012 by 16-24 per cent (BP Stats, 2013). This comes after the sector witnessed a price rise in 2011. A likely reason for this decline is the over-supply situation in the global market as a result of US exporting majority of its coal production into the global market and replacing domestic fuel consumption with gas. This advantage of the favourably low prices was taken up more significantly by European countries that were heading towards a switch from gas to coal. The upsurge of coal use in Europe boosted by its competitiveness against natural gas in the power sector increased coal imports by nearly 6 per cent from 199 mt in 2011 to 210.9 mt by end of 2012. Not only were domestic coal prices in Europe on a higher scale, the prices of coal imports were lower even compared to the high gas prices (that were linked to oil prices). Despite European gas contracts negotiated previously with Russian gas giant, Gazprom, the European gas prices continued to stay high. A major part of the increase in coal came from Germany that has been replacing its nuclear energy space and switching to coal-based power generation that now contributes 52 per cent of its electricity demand as compared to 43.5% in 2011 (Franke, 2013). Coal consumption for Germany rose by 4.2 per cent over 2012. The high gas prices have also led to European consumers pressurizing natural gas producers to change the pricing structure. Another contributor to high coal consumption is the low cost of carbon allowance (Euro 4 per mt as compared to Euro 20 per mt in 2011) that has made gas-to-coal switch profitable. While renewables such as solar and wind have grabbed increasing shares in fuel mix in Germany, they have displaced gas but not coal. New coal capacities are also being built to adhere to the new EU

environment standards expected to come in 2016. Other import markets also experienced an upward trend in coal imports, such as the Indian imports which rose from 102.85 mt in 2011-12 to 145.79 mt in 2012-13, while for Japan, the imports increased by 4 per to 182 mt in 2012 (BP Stats, 2013).

Indian Energy Market

In 2012, the energy consumption from all fuels stood at 563.5 million tonne oil equivalent (mtoe). The primary energy mix is dominated by coal, holding 53 per cent followed by oil (30 per cent) and natural gas (9 per cent). India stands as the fourth largest coal importer in the world with heavy dependence on imports to meet its annual coal requirements, despite huge geological coal reserves to the tune of 298.91 billion tones (CMPDI, 2013). The coal imports increased from 102.85 mt in 2011 to 145.79 mt in 2012 (Bureau, 2012). This is expected to further rise, with power demand on the upward slope as well as with supercritical coal-fired thermal capacities being planned. As per the Annual Plan 2012-13, the sectoral coal demand by the power sector alone was estimated at 512 mt that is expected to reach 683.08 mt by 2016-17. Meanwhile, the total domestic coal production target stands at 615 mt (by CIL) at the end of the Twelfth Plan Period. This demand-supply gap provides a broad window for imports to come in.

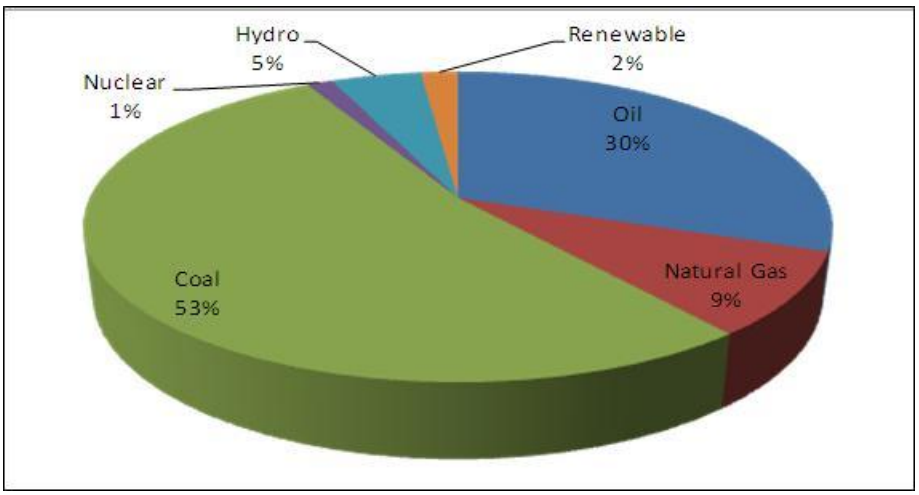

Figure 7 Energy Mix in India (2012)
Source Standing Committee on Petroleum and Natural Gas, 19th Lok Sabha Report

Presently, India is mainly dependent on Indonesia and South Africa for thermal coal imports, while it turns to Australia for its coking coal requirements. Imports from Indonesia recorded an increase of 50 per cent, to around 82 mt in 2012-13, a 10 per cent increase from Australia to 30.5 mt for the period, with the biggest growth seen from South Africa, which increased by about 66 per cent to 20.3 mt (Lok Sabha , 2014). Any change in the coal policy regulations in the respective markets will have huge short and medium term implication on the Indian coal industry. For instance, Indonesian thermal coal, the most economic coal source for India, contributes nearly 60 per cent of total imports, as the coal is of lower calorific value and, hence, priced cheaper. In 2011, Indonesia adopted a new

pricing method that aligned coal rates with international markets under the benchmark prices called the HBA Index, taking the price of coal above US$100 a tonne. This sudden increase of about 30 per cent in the price of coal raised production costs for the import dependent Indian coal producers (Salva Report, 2013). The imposition of carbon tax on coal production by the Australian government also led to the increase in coal prices of imports in India. In the medium run this has impacted the coal quantity imported from Indonesia and Australia negatively, with power developers cutting down coal imports. At the domestic level, this cost increase has caused stalling of installed capacities, affecting company revenues and power supply levels.

Regulatory circumstances in these countries are reflective on the increased coal prices to India. While deals and mine acquisitions are being made with Australian and South African coal producers, the risk of high costs as a consequence of changes in coal export taxing policies remains high. Towards securing sustainable supply, developers have begun efforts in identifying new avenues for supply, like Mozambique and Columbia. However, challenges in these countries exist ranging from lack of infrastructure to export coal out of country, concerns over stability of political and fiscal regime, unavailability of skilled manpower, etc.

Despite the current coal price windfall in the international market, the eventual expenditure by Indian consumers has gone up substantially, due to rupee depreciation and firming up of shipping rates. In addition, the higher landed cost of fuel, coupled with pressure on final product prices, has made coal users extremely price-sensitive, leading to narrowing of cost margins at the trading end. As the consumers avoid long-term contracts with traders to take advantage of weak prices in the spot market, the traders end up missing the opportunity to hedge risks of price volatility.

Amidst high valued-coal imports, alternative fuel options of natural gas and renewables substituting energy requirement in the country fall short of expectations. While the renewable energy portfolio is yet to come a long way in displacing conventional energy sources, the case with natural gas is laden with distressed cost characteristics. India is the fifth largest LNG importer after Japan, South Korea, the U.K. and Spain, importing approximately 13 million tonnes per annum (mpta) in 2012. The power and fertilizer sector account for more than 50 per cent of the gas consumption, which is set to rise in the coming years. The expected increase in domestic production was significantly lower than earlier projections due to a steady reduction in gas output from the Reliance Infrastructure's Krishna-Godavari D6 field. At the same time, natural gas availability through non-conventional sources like Coal Bed Methane (CBM), Shale gas and gas hydrates remain unexplored, due to unfavourable regulatory policies and lack of domestic infrastructure. Majority of domestic natural gas today is priced at $ 4.2 per mBtu almost one-third the price at which LNG is imported by Petronet LNG Limited and other firms. In the current situation, meeting the soaring LNG demand is plagued with pricing, infrastructure and competition challenges. The average price of power from coal, around $0.7 per kWh, is much lower than the price of power produced from LNG-at $1.5-2 per kWh. With a current low sale price of electricity, coal stands as a more economic fuel, thus putting added pressure

on coal imports. In addition, stiff competition from existing far-east (Japan, South Korea and Taiwan) and Chinese import markets makes securing LNG at economical prices challenging.

In order to sustain the domestic LNG market and keeping green targets in mind, the overall operationalization and development of LNG terminals needs to be carried out; producer-consumer price expectation must be firmed up; decisions on upstream participation in integrated liquefaction projects must be taken and a tax efficient structure needs to come around.

BOX 1: Impact on Climate Change

Several studies carried out across the world have indicated that a worldwide partial shift from coal to natural gas could lower the increase in global temperatures. However, knowing the possible emissions by the two fuels and the extent of their impact is essential to determining the potential climate benefits/ losses of coal and natural gas use. Climate Central has found the extent of reduction in global warming with a switch from coal to gas to depend on the rate at which coal electricity is replaced by gas electricity, the time elapsed after switching from coal to gas and the methane leak rate from the natural gas system (*Larson, E: Natural Gas and Climate Change, Climate Central, May 2013*).

Coal has the highest carbon content of all fossil fuels thus contributing the most to the global carbon dioxide (CO_2) emissions. As estimated by the IEA report, coal consumption has accounted for 60 per cent of the rise in heat-trapped CO_2 emissions globally since 2000. As countries build up coal-fired capacities to meet their domestic power requirements, the need to keep a check on carbon emissions and pollution levels becomes crucial. China, one of the major producers and consumers of coal, has been actively pursuing strategies to formulate advanced coal technologies in order to avoid capturing and mitigating CO_2 emissions at high costs. The carbon emission targets set by the U.S. Environmental Protection Agency has restricted the use of coal in the country over the past few years.

The rate of methane leaks from natural gas combustion process greatly impacts possible climate benefits. In the US, the methane leak rate has been estimated to range between less than 1 per cent of the methane production to 8 per cent.

Over the past 10 years, the growth in the global CO2 emission levels has averaged at around 2.7 per cent. After a decrease of 1.3 per cent in global CO2 emission in 2009, as a result of the 2008 global financial and economic crisis, the global carbon emission in 2013 is expected to reach 36 billion tonnes, according to the Global Carbon Project, registering a 2.3 per cent year-on-year increase. A majority of these emissions are expected to be sourced from major coal and gas trading economies such as US, China, Europe and India among others.

Global Carbon Emission from Coal and Gas

Country	Coal Emission volume ($MtCO_2$)	Country	Gas Emission Volume ($MtCO_2$)
China	6,985	USA	1,363
USA	1,625	Russian Federation	880
India	1,519	Iran	317
Japan	438	China	265
South Africa	380	Japan	243
South Korea	301	Canada	191
Australia	190	Saudi Arabia	179
Indonesia	159	United Kingdom	153
Taiwan	157	Germany	152

Source: Global Carbon Atlas

BOX 2: Shale Gas Revolution

The United States has led the revolution in unconventional gas production in the past decade. However, shale gas is not a new "discovery". Small amounts of shale gas were first produced in Fredonia, New York in 1821. Small amounts of shale gas were produced from the Appalachian and Illinois basins between the 1860s and 1920s for use in nearby cities (Green, 2011). It was the commercially feasible combination of two existing technologies, namely hydraulic fracturing and horizontal drilling, which was the major driver of the unprecedented boom in shale gas production after 2005.

The shale gas "revolution" in the United States explains why the US Henry Hub prices broke away from the general trend after 2009. As a result of the excess supply fo natural gas in the country, the US Henry Hub price declined from around USD 9 per million British thermal units (mBtu) in 2008 to around USD 3 per mBtu in 2012. However, the increasing supply of natural gas globally has had no discernible effect on Japanese LNG (an indicator of Asian LNG prices). Japanese LNG price has consistently increased since 2008, marking a stark deviation from the trend of US Henry Hub prices. This is due to the linkage of Japanese LNG with crude oil prices, specifically the Japanese Customs-cleared Crude Cocktail (JCC) price. The linkage between Japanese crude import price and price of LNG is very strong, with a linear correlation of 92.64 per cent.

Alongside the revolutionary price and production impacts, it should be kept in mind that the process of shale gas extraction has heavy environmental risks associated with it. Fracking fluids contain harmful chemicals which can potentially cause groundwater contamination and/or soil contamination. Moreover, the process is much more water intensive than conventional hydrocarbon extraction. Thirdly, the exploration stage necessitates drilling of multiple exploratory wells to judge resource potential in a particular area.
With the shale gas boom in the United States impacting the international natural gas trends, much remains to be seen on part of energy intensive economies to adopt steps to explore shale gas reserves.

(*excerpt from paper 'Natural gas: International trends and their relevance for India', Chaterjee & Joshi, 2014*)

Annexure Table 2 Global Coal Production (2002-2012) (mt)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
China	1,550.40	1,834.90	2,122.61	2,349.52	2,528.55	2,691.64	2,802.00	2,973.00	3,235.00	3,516.00	3,650.00
USA	992.72	972.28	1,008.88	1,026.48	1,054.83	1,040.21	1,063.05	975.15	983.72	993.94	922.06
Indonesia	103.33	114.28	132.35	152.72	193.76	216.95	240.25	256.18	275.16	353.27	386.00
India	358.10	375.35	407.67	428.43	449.19	478.41	515.88	555.99	573.83	570.12	605.84
Australia	340.80	349.57	361.60	375.33	383.03	392.55	404.65	418.52	423.98	415.49	431.17
Russian Federation	255.75	276.66	281.73	298.30	309.90	313.50	328.60	301.30	321.60	335.10	354.80
South Africa	220.20	237.88	243.37	244.36	244.78	247.67	252.58	250.58	257.21	251.61	260.03
World	4,960.99	5,314.66	5,724.56	6,049.88	6,358.35	6,589.43	6,822.25	6,901.27	7,251.78	7,691.62	7,864.55

Source: Statistical Review of World Energy 2013, BP Global

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