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Energy Security in Times of Uncertainty

Editors

Jayant Prasad

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Foreword

Energy security has been defined as "the uninterrupted availability of energy sources at an affordable price" by the International Energy Agency (IEA). Until the 1980s, the steady and unfettered supply of inexpensive oil, without the uncertainty of embargoes and cost manipulation, were the key concerns. Today's challenges, however, go beyond stable oil supplies. They include an array of issues, such as securing maritime space and mitigating climate change. Energy security is conditioned by geological availability, geopolitical accessibility, economic affordability, and environmental sustainability.

Energy security is critical for national security. Security studies in the 1980s had already expanded beyond the politico-military domain to include several non-traditional aspects of security, including energy. The importance of energy security for growth – from a national, regional and indeed, a global perspective – is self-evident.

Martin Wolf points out, in a recent *Financial Times* piece, that among the risks that threaten global growth, disruption of energy supplies is among the most important. In our remarkable contemporary times, he writes, the global economy has grown uninterruptedly every year since the early 1950s – at an average of over 3 per cent, measured in purchasing power parity. Only four times, Wolf notes, global output growth dipped under 2 per cent – in 1975, 1981, 1982, and 2009. Except for the last instance, when the dip was caused by the 2008 financial crisis, the others were the consequence of oil price shocks, triggered by conflicts in West Asia.

Energy occupies a central role in the survival and prosperity of individual States, and shapes both geo-economics and geopolitics within the international system. While nations with rich energy resources enjoy economic and political leverage, lack of resources creates an existential threat for others, since sustainable economic development is preconditioned on stable energy supplies. This imperative contextualises the importance of energy security for the fastest growing major consumers of energy, such as China, Japan, South Korea, India, and other key countries of the Association of Southeast Asian States (ASEAN), which must sustain their growth in the face of formidable economic headwinds. These States should learn how to harmonise growth with environmental protection.

Energy security assumes significance, given the challenges in the energy market, such as inadequate supply, high demand and energy dependency, escalating prices, and political flux in energy-producing regions. Moreover, the problems related to the energy issue go beyond scientific or technological aspects and extend to predictable regulatory mechanisms, financing, and energy infrastructure management. Today, climate change, environmental degradation, and a relative scarcity of natural resources, aided by disruptive technologies, including information technology, have all combined to present new threats – either individually, or even as subsets of hybrid warfare. Equally, new opportunities have also emerged to deal with these challenges in a more sustainable manner. The study of these subjects has therefore become imperative for analysts and practitioners of national security.

The goal of national authorities is to gain access to sustainable energy supplies, effect improvements in energy efficiency, and develop new sustainable energy sources, which in turn will require technological innovation, capital funding, and knowledge in handling issues arising across the energy demand-supply chain. These are challenges for both policymakers and market managers for application in issues like market forecasting, risk management, pricing, and policy development.

For Asian countries, the challenges are arguably more critical. The traditional energy market, which was dominated by developed countries, is now giving way to emerging economies, most of which are in Asia. According to the IEA, around 95 per cent of the projected growth in energy demand is in developing countries, particularly in Asia, with energy consumption growing at 2.3 per cent annually between 2012 and 2035. Energy consumption in developed nations, by contrast, is growing at just 0.2 per cent per annum over this period and is projected to fall from 2030 onwards. As a result, rapid and sustained economic development has placed the Asian countries at the centre of growth in global energy demand, thereby altering the geopolitics of global energy and, in turn, throwing up critical new energy policy and security challenges for their governments. Conversely, the choices and policies that are, and will be, adopted by Asian countries will have far-reaching implications that extend way beyond their borders.

Yet another contemporary challenge is that of dealing with global warming, climate change and pollution, which are a result of more than a century of dependence on fossil fuels. In their attempt to respond to the threat of climate change by stemming the rise in carbon emissions and limiting a global temperature rise in this century to well below 2 degrees Celsius above pre-industrial levels through the Paris Agreement, the global community has taken up the challenge of increasing the share of cleaner and more sustainable energy resources in their national energy mix. In fact, the IEA has gone as far as to predict that renewable energy resources will become the largest source of electricity supply before 2030, accounting for 27 per cent of the primary energy mix in 2040, up from 8 per cent in 2016. Whether this will be so for Asian developing countries like India and China needs to be carefully watched.

While this may address the issue of arresting, and even reversing the rise in global temperatures, it may give rise to competition to control the primary resources required for renewable energy appliances. Moreover, the changes that will be required to shift to more sustainable forms of energy will entail an overhaul of current energy sectors, which in turn will necessitate access to huge investments, be it for large-scale energy infrastructure or energy technology. For example, power grids that encompass, and eventually transcend national and geographical boundaries, face the twin challenges of economic viability and practicality.

Given that Asian nations, more than others, are particularly vulnerable to the vicissitudes of the energy markets as well as to the effects of climate change, the 2017 edition of the *Asian Strategic Review* has taken up the issue of energy security with the aim of outlining and understanding the challenges that lie ahead for some of these nations. It outlines the current and future dilemmas of the regional governments as they grapple with multiple challenges in delivering sustainable and affordable energy resources to their peoples, essential for their economic and social well-being.

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Hydrocarbon Markets in Asia: Adapting to Changing Narratives

Lydia Powell

Introduction

During the last six decades, the expectation within and outside the global hydrocarbon (oil and natural gas) industry was that scarcity would remain the key factor driving policy, plans and prices of hydrocarbons for the foreseeable future. This expectation was not significantly modified even when international efforts to reduce greenhouse gas (GHG) emissions from the production and use of hydrocarbons gathered momentum about two decades ago. In fact, scarcity of hydrocarbons was among the primary rationales embedded in narratives that argued for a global transition away from hydrocarbons to reduce GHG emissions. The idea of the impending scarcity of hydrocarbons sharpened after the global financial crisis in 2008. However, the post-crisis years challenged conjectures of scarcity, partly on account of the stagnation in global economic growth, and partly on account of the unexpected availability of hydrocarbons from unconventional sources. The outlook for the foreseeable future is one of hydrocarbon abundance and relatively low prices. This has so far been beneficial for the Asian economies that import hydrocarbons but less so for economies that are dependent on revenues from the production and export of hydrocarbons.

The fact that the much anticipated scarcity of hydrocarbons has failed to materialise is interpreted both as a sign of impending economic stagnation but also as an opportunity for alternative energy sources to underwrite new economic growth models in developing Asia. This chapter briefly explores the dominant narratives of the hydrocarbon sector that shaped the responses from large oil importing Asian economies such as India and China, and concludes with the argument that the large hydrocarbon-importing Asian economies should shape narratives rather than remain passive consumers of narratives from industrialised economies. The focus of the chapter is primarily on oil as it is the subject of global narratives.

Narratives of Scarcity

1970-1980: OPEC Scripts Narratives of Scarcity

The idea of scarcity of hydrocarbons arises from the essential physical characteristic of fossil fuels – that their supply is finite and depletion is inherent in their use. It was the depletion of easily accessible oil and gas resources in the absence of a price mechanism in the United States that precipitated the energy crisis of the early 1970s. In 1947 the trade position of the United States had shifted from that of the largest net exporter of oil to that of the largest net importer, despite the fact that the country continued to produce more than one-half of the world's crude oil.[1] When the oil embargoes imposed by oil-producing countries in the Persian Gulf temporarily tripled oil prices in 1973-74 and doubled oil prices in 1979-80, the United States was the only industrialised country that controlled oil price and consequently had little or no capacity to increase prices in the domestic market to suppress demand.[2]

The dramatic increase in the price of oil in this period redefined the energy policies of industrialised nations from one that managed abundance to one that managed scarcity. Countries in Western Europe, barring France, and the United States reached an agreement to create the International Energy Agency (IEA) in 1974 to counter the actions of OPEC (Oil Producing and Exporting Countries).[3] Though Henry Kissinger, who coordinated the international response to the oil crisis, had ambitious plans for the IEA, it eventually became a modest mechanism for managing scarcity through an oil sharing arrangement between member countries and through the maintenance of strategic stocks to mitigate supply risk.[4] The developing nations in general, and Asian oil-importing countries in particular, embraced the narratives of scarcity and chose to pursue policies that strengthened relationships with oil producing and exporting countries in the Persian Gulf. For India, dependence on international oil companies and their reluctance to address domestic concerns during the oil crises highlighted the need for self-sufficiency.[5] India and China promoted policies for the development of domestic oil resources and for the ownership of hydrocarbon resources outside their borders to attain self-sufficiency in ownership of hydrocarbon resources.[6] To a limited extent reforms in the pricing policies for hydrocarbons were introduced to promote conservation of hydrocarbons.

This was a period of high oil price volatility as cooperative arrangements between producing and consuming countries, hitherto mediated by major international oil companies, had broken down. OPEC was in its early stage of development and was yet to replace international oil companies in mediating global supply and price of hydrocarbons. While the industrial economies sought refuge in the mechanics of the market to address the challenge, developing countries in Asia, dependent on oil imports, reinforced the role of the State to take on the uncertainty in the oil market. This not only put oil-importing Asian economies, particularly China and India, at a disadvantage when the global oil sector shifted decidedly in favour of the market after the OPEC embargoes, but also earned a downgrade in international rankings as both India and China were seen as countries that were ready to pursue national strategic interests at the expense of far-reaching social and economic reforms. China and India were also said to be free-riding on the energy security safety nets of the industrialised countries.[7] Some predictions said that a resource war would materialise between these two countries, primarily in the context of oil.[8] These views did not take into account the fact that India, and to a lesser extent China, were in the early stages of industrialisation and were, therefore, pursuing policies that were not significantly different from those that the developed countries had pursued when they were at the same stage of development.

1980-1990: Market Scripts Narrative of Scarcity

The role of the market in mediating supply and demand increased after 1980, but this did not mean greater stability in the hydrocarbon sector. The revival of peak oil and related theories and strategic stocking by industrialised economies that removed oil from the market were seen to be contributing to the increase in price volatility. Furthermore, speculation from financialisation was said to be increasing the fluidity and amplitude of price volatility. One of the notable developments in the early 1980s was the short interlude to the narrative of scarcity, when the price of crude oil traded internationally declined by 50 per cent between 1981 and 1986.[9] An increase in oil production from key oil producing countries as well as production from non-OPEC countries contributed to the decline in oil prices. Other factors that contributed to the decline in prices included a warm winter in North America, lower than expected global economic growth and greater than expected decline in oil consumption by developing countries.[10]

The decline in oil prices did not significantly alter the prevailing view of the impending scarcity of oil and to a lesser extent, the scarcity of natural gas. The invasion of Kuwait by Iraq in 1990 and the subsequent increase in the price of oil quickly revived the narrative of scarcity. Oil importing Asian economies such as India, Pakistan, Thailand and the Philippines indulged in panic buying of oil in the spot market because of the sudden abrogation of contracts and the realisation that domestic economic flexibility and the potential for fuel switching was limited.[11] The economies of South Korea and Thailand, which boasted high rates of oil demand growth, implemented policies that reflected the importance of price in mediating demand, and also implemented measures that acknowledged the significance of strategic oil stocks in mitigating volume risk.[12]

The latter part of the 1990s saw a revival of 'peak oil' theories with some well-known petroleum geologists predicting that global oil production would peak before 2010.[13] The IEA expected global demand for oil to grow to 112 million barrels per day (mbpd) and non-Middle East oil production to peak by 2010. The reduction in non-Middle East production was expected to increase the share of Middle East oil in meeting global oil demand to 62 per cent by 2020. As even this level of production from the Middle East was considered inadequate to meet global demand, 'unidentified' unconventional oil, whose production was expected to rise from zero in 2010 to 19 mbpd in 2020, was expected to fill the gap.[14] Geologists who predicted peak oil production by 2010 interpreted the IEA's expectation that 'unidentified' unconventional oil would meet a share of the anticipated demand as an euphemism for oil shortage.

However, these predictions did not evoke panic responses from oil-importing developed countries as they had in the past. The key among many reasons for this was that the oil dependence of industrialised economies had fallen dramatically since the oil embargoes of the 1970s on account of policies that increased efficiency in using oil and policies that promoted substitutes for oil. By 1991, countries in the Organisation for Economic Cooperation and Development (OECD) required 40 per cent less oil to produce a unit of output than in 1973, representing an average efficiency gain of 2.9 per cent a year.[15]

Furthermore, the prospect of unconventional oil to replace conventional oil appeared to be much brighter on account of technological advances. Though narratives on impending oil scarcity that largely emerged from industrialised countries persisted through the 1990s and 2000s, they appeared to target growth in hydrocarbon consumption in large industrialising economies, particularly China and India. OECD oil demand growth was on the path of structural decline since 2005. On the other hand, non-OECD countries such as China and India that had an expanding population, strong income growth, and more energy-intensive economic activity, were simulating demand. In oil-producing regions such as the Soviet Union and the Middle East, the increase in crude oil prices simulated economic activity and, in turn, encouraged oil consumption. The message embedded in the narratives that emerged in this period was that the growth in oil consumption in industrialising nations was undesirable as carbon-di-oxide (CO_2) emissions from the use of oil (and other fossil fuels) was contributing to changes in the climate. The emphasis on constraining oil consumption by developing countries was a shift from earlier narratives that strongly argued for increasing investments in the production of hydrocarbons so as to increase their supply and lower prices to ease consumption in developed countries.

For Asia and the rest of the oil importing industrialising world, the growth in demand at a time when more expensive unconventional oil supply was expected to replace conventional oil supplies, was not necessarily a positive development. Conventional oil supply was expected to hit its peak-plateau around the mid-2000s. As old oil, with production costs under $20 a barrel in places like Saudi Arabia, is depleted and is replaced by new oil from tar sands or shale formations with production costs over $50 a barrel, the price of hydrocarbons would have to increase to accommodate the higher cost of production. Most of the cost increases would be passed on to poorer consumers in Asia and other non-OECD countries.

The demand shift from West to East also posed another problem as data and information flow on which oil supply and prices depended on was fastest and most detailed in parts of the world where demand was weakening, while data was slower and less comprehensive in parts of the world with runaway demand growth. The push for higher quality and timely data from the industrialising economies was reflected in activities of the IEA that implemented programmes and missions for enhancing institutional capacity in partner countries (primarily China and India) on energy data, analyses, and policy formulation.[16] The industrialised countries represented by the IEA also pushed for China and India to build and maintain strategic stocks of oil to address short-term volume and price risk.[17] Though strategic stockpiling of oil was promoted by policymakers as the best way of insuring against supply shocks, questions remained as to whether the high cost of maintaining these stocks justified the benefits, especially for the developing economies.[18]

2000-2015: Demand Scripts Narratives of Scarcity

In the late 1990s, the emergence of China and India as relatively large consumers of energy added momentum to the narratives of scarcity. In 1990, oil consumption in China and India accounted for less than 3.5 mbpd, or about 5 per cent of global oil use.[19] In 2003, oil consumption in China and India doubled to 7 mbpd, or 10 per cent of global consumption. Oil consumption was expected to double in China and India in the following decade. The growth in oil demand of China and India was interpreted as a driver of scarcity, and this was expected to unsettle the global petroleum order dominated by the United States and its preference for market instruments to mediate scarcity.[20] The preference of non-market interventions by both China and India to secure their oil and gas needs was cited as the key reason for the concern. Commentators in the industrialised world saw a new 'energy silk-road' materialising between oil and gas producers in the Middle East and large consumers in Asia, and interpreted it as an 'unwelcome nexus'.[21] The relentless quest of Chinese and Indian national oil companies for equity investments in oil and gas assets around the world and their pursuit of bilateral relationships with oil-producing countries in the Middle East was portrayed as a zero-sum competition for energy resources that would, among other things, lock up energy supplies and consequently undermine energy security for the rest of the world.[22]

In 2008, when average annual crude prices remained above $100 per barrel (bbl)[23] and the price of internationally-traded natural gas in Asian markets hovered around $10 per million British thermal units (mBtu),[24] even reputed development agencies stated that the world was entering the long anticipated age of hydrocarbon scarcity on account of unprecedented growth in demand. The International Monetary Fund's (IMF) World Economic Outlook for 2011 explicitly stated that the persistent increase in oil prices in the preceding decade indicated that the global oil markets had entered a period of increased scarcity and that the expected rapid growth in oil demand in emerging market economies, along with a downshift in the trend growth of oil supply, meant that a return to abundance was unlikely in the near term.[25] Though the IEA's World Energy

Outlook 2011 did not use the word 'scarcity', it observed that the investment in production was insufficient to meet demand and that oil prices would increase significantly in a scenario of deferred investment.[26]

Political rhetoric on the increase in the price of hydrocarbons was openly assigning blame on growth in consumption to developing countries. In early 2012, US President Barack Obama blamed growth in oil consumption in India, China, and Brazil for the increase in oil prices.[27] Citing rising auto sales in these countries, he said that 'as people in India and China got wealthier they bought more cars and filled them up like Americans do, driving up oil prices'. He pointed out that the number of cars in China had more than tripled and that nearly 10 million cars were added in China alone in 2010.

The IEA's World Economic Outlook for 2012 stated that China alone would account for about 50 per cent of the net increase in oil demand in the following two decades and that this would offset the steady decline in efficiency gains, inter-fuel substitution and saturation effects in OECD countries.[28] It added that for every barrel of oil eliminated from OECD oil demand, two additional barrels of oil would be consumed in the developing countries in the same period.

In 2011, the outlook for natural gas was more optimistic compared to that of oil in terms of demand growth but less so in terms of supply growth. The World Energy Outlook of the IEA observed that natural gas may be entering a 'golden age' pulled by the increase in the supply of unconventional gas resources and pushed by the decline in nuclear power generating capacity in OECD countries and favourable policies in OECD and large consuming countries such as India and China.[29] Natural gas was expected to replace coal as the second largest primary fuel, and the United States was expected to emerge as a large importer of natural gas.[30] The price of natural gas was expected to decline initially but increase after 2015. The underlying argument was that gas prices would follow oil prices and that higher prices would stimulate investment in the sector.[31]

In this period, there was intense pressure on developing countries in international forums such as the G20 and G8 to reduce the subsidies on oil and natural gas consumption to curb demand.[32] India and China committed to reducing subsidies and initiated pricing reforms, but they could not make much progress as the price of oil remained high, and any attempt to pass through price increases to the final consumer was expected to increase inflation (mainly India) and reduce the competitiveness of manufacturing industries (mainly China).[33] Though large developing countries were targeted for action, their consumption at a per person level remained far below that of developed countries. In 2000, the United States consumed 19.7 mbpd or roughly 25.5 barrels of oil per person per year. By 2010 the population of the United States had increased by 10 per cent but the country's oil consumption had fallen to 19.1 mbpd or 22.6 barrels per person per year. In 2000, oil consumption in China was 4.8 mbpd, or 1.4 barrels per person per year. In 2010, consumption had grown to 9.1 mbpd, or 2.5 barrels per person per year. Hypothetically, if China's per capita oil consumption were the same as that of the United States, the world would have run out of oil as China alone would have needed all the oil that is produced in 2010. If the roughly 90 million barrels that the world consumed each day were divided equally between 7 billion people, each would be entitled to about 4.7 barrels per annum which was 79 per cent lower than the average consumption in the United States and 54 per cent lower than the average consumption in the EU. The rhetoric of scarcity targeting consumption of oil in large developing countries did not anticipate the secular trend of energy price declines that began after touching a peak in 2013 that initiated new perspectives of abundance.

Conclusions: Responding to the Narrative of Abundance

The narrative of abundance in the hydrocarbon sector that began to gather momentum when the price of commodities in general and fossil fuels in particular showed signs of stubborn stagnation and decline after 2013. Expectations of quick mobilisation of supply in the future (such as US shale production) are also seen to be contributing to narratives of abundance that have lowered concerns over oil price spikes and oil supply interruptions.[34] Under an optimistic policy scenario, the United States is expected to become a net exporter of natural gas by 2020 and become self-sufficient in energy in net terms by 2035.[35] North America as a whole is expected to emerge as a net oil exporter accelerating the shift in the direction of international oil trade with almost 95 per cent of Middle East oil flowing to Asia. Links between regional gas markets are expected to evolve with LNG trade becoming more flexible and accommodating in contract terms. What is driving this narrative is the assessment that North America may have at least half of unconventional oil resources, amounting to an estimated 3200 billion barrels, which is equal to more than half of all remaining resources.[36]

In the era of abundance, some forecasts argue that crude oil prices would fall to $20/barrel (bbl) over the short term and that OPEC's hold over oil prices could become history.[37] These projections are based on the emergence of a new oil world order dependent on a 'call on shale' rather than a 'call on OPEC' as it was in the past. With shale oil technologies, oil production is seen to have become more like manufacturing as it gets cheaper with better technology. Unlike traditional resource extraction, which was characterised by high upfront costs, long gestation periods and extended periods of production that amounted to inelasticity of supply, shale oil production has low capital costs, very low gestation periods and small production cycles that underpin elasticity of supply. It is presumed that when oil prices rise above $60/bbl, more fracking wells would come on-line and when oil prices fall below $60/bbl, fracking wells would go offline.

Another more significant reason for low prices is thought to be more specific to the oil market than to the general state of the global economy.[38] During the financial crisis, the aggregate demand for all commodities fell, which meant that the price of oil was reflecting the global business cycle. An analysis of the current decline in oil prices concludes that it is the result of changes in the 'precautionary demand' for oil associated with shifts in expectations about future oil supply relative to future demand which are specific to the oil sector.[39] The key argument is that as expectations of an economic slowdown in the future have intensified, the need to hold inventories of oil has reduced, which has in turn kept prices low. The key inferences from this analysis are that, firstly, oil demand shocks, rather than oil supply shocks, have made a larger contribution to oil shocks and, secondly, that demand shocks are likely to influence the oil sector much more than supply shocks in the future.

In the context of oil demand, the narrative of India leading demand growth and in the process underpinning price stability have gathered momentum since 2016. India was labelled the 'star performer' in petroleum consumption by the IEA, and it observed that India would 'take over from China as the main growth market for oil'.[40] Oil demand in the first quarter of 2016 was 400,000 bpd higher year on year representing nearly 30 per cent of global increase. India is projected to be the largest single source of oil demand growth until 2040, but even by 2030, its per person oil consumption is expected to increase to only 1.7 barrels per year from the current 1.1 barrels per year, partly on account of the greater dependence on public transport.[41] According to BP's outlook for 2035, India's energy demand will grow at 4.2 per cent per year, faster than all major economies in the world. Energy in transport, where petroleum fuels dominate, is expected to grow by 5.1 per cent a year from 2014 to 2035, with oil taking 93 per cent of market share by 2035. Not surprisingly, this growth in demand is expected to be dominated by road transport with petroleum demand in India touching 5.6 mbpd by 2040.

The growth in consumption of oil for transportation in India has also raised concerns over the consequent increase in CO_2 emissions. Ethanol blended with liquid petroleum transportation fuels and the use of electric vehicles are the most popular solutions. However, these are not likely to make a significant difference as ethanol as a fuel is expected to account for only about 0.2 mbpd by 2040 in India, which is less than 3 per cent of the total oil consumption in the transport segment expected in 2040.[42] The target for electric vehicle penetration in India is modest – at 200,000-400,000 vehicles by 2020.[43] The narratives of optimism (over India's oil demand growth boosting prices) and narratives of pessimism (over CO_2 emission from the growth in consumption of hydrocarbons in India) attract disproportionate attention on India's oil consumption and lead to perceptions of over-consumption. The reality is a significant under-consumption.

Energy use in transport in India at 1.5 mbpd in 2013 accounted for only 14 per cent of final energy consumption, which is much lower than the share of energy use in transportation in many other countries.[44] The use of energy per person for transportation at less than half a barrel a year is one-sixth of the world average. Avoided import bills from energy efficiency in oil use (primarily transport) is less than $10 per person in India, compared to over $250 per person in USA and $60 per person in China, on account of the high levels of vehicle ownership in USA.[45] The return in terms of avoided petroleum consumption per person for a given unit of effort is likely to be much greater in the United States than it is in India.

Dependence on borrowed narratives has meant that policies in place in oil-importing Asian economies continue to be based on the assumption that energy in general and oil in particular will remain scarce, expensive and unreliable. The policy responses are primarily offensive in nature as they seek to maximise benefits in relation to other actors (nations). These responses are not necessarily the direct consequence of these threats but the political interpretations of the threat[46] and are essentially non-linear responses to the perceived threats derived from a range of academic approaches that were used and abandoned by industrialised economies.

Building relationships with hydrocarbon-producing countries or making equity investments in hydrocarbon resources of other countries are derived from realist approaches of international relations theory. These responses will have less relevance in a world of abundance. No matter how much oil a country produces or how much equity oil it invests in or how much oil it imports, the price the country would pay for oil will remain the same as the price of oil is its opportunity cost. In a globally integrated market, the opportunity cost of oil is the same, irrespective of whether it is produced within or outside the country.

Equity oil investments are projected as hedges against high oil prices, but that is not fully applicable for large, growing and oil-importing countries. Assuming that equity investments are made at a time when prices were fair, the country may benefit, at least in theory, if it can profit from the investment when its economy is slow or stagnant.[47] If the country accounts for the significant share of marginal demand for oil, oil prices and therefore profits from equity oil investments are likely to be high only when the economy is growing strongly and consuming plenty of oil. The result is that equity investments will add to a country's income when the economy is growing strongly and subtract from it when it is stagnant. This is the opposite of what a hedge is supposed to do.

If a country's equity oil investments are in countries that are not considered to be democratic or transparent, property rights in foreign oil assets will diminish as oil price increases. The country that hosts equity oil can appropriate rents from an increase in oil prices through windfall taxes; the country can also nationalise its hydrocarbon assets.

Rational choice theories argue that investing in institutions such as regulatory bodies produce norms and regular practices that build the basis for stability and security in economic relations. While this response may apply to both an environment of scarcity and as well as an environment of abundance, the pre-conditions for building impartial institutions appear to be inadequate in many developing countries. Liberalising the hydrocarbon sector and allowing the market to set the price of hydrocarbons is derived from liberal economic theories, which see the market as the best means of mediating imbalances in supply and demand of scarce resources such as energy. While the market has proved its ability to balance supply and demand in industrialised countries, it is known that norms of the market cannot be imposed on a population living in poverty with little or no means to participate in the market.

Econometric models that are used for energy planning are also based on the premise that hydrocarbons will remain scarce, expensive and unreliable. They forecast hydrocarbon demand as a function of the growth rate of gross domestic product (GDP) and then proceed to recommend ways and means to secure the scarce, expensive and unreliable energy resources in the light of exponential growth in demand for energy. The cornucopian assumption of uninterrupted growth and progress is embedded in these strategies.

The unfolding collapse in commodity prices in general and energy prices in particular, make assumptions of scarcity and high prices inaccurate. The assumption that oil supply from the Persian Gulf will remain uncertain and undependable is also questionable in the light of the fact that peak demand for oil rather than peak supply is anticipated with increasing probability in the next two decades.[48] Energy forecasts assume that underlying structural relationships in the economy will vary gradually. In reality, discontinuities and disruptive events have changed underlying economic and behavioural relationships. Assumptions about human behaviour may also prove to be inaccurate.

The current trends that contradict past expectations of scarcity may reverse or change course, but they present an opportunity for oil-importing countries such as India to revisit the underlying assumptions that are embedded in its dominant responses. While the extent of uncertainty in the energy sector precludes the identification of a definitive solution for hydrocarbon-importing developing countries, three key policy pathways that are independent of how the future unfolds may be considered. First, oil-importing emerging economies in Asia should focus on developing original narratives of hydrocarbon supply and demand that are based on their respective priorities and needs, rather than remain passive consumers of external narratives that project priorities of developed nations. Second, investing in a flexible energy system that can adapt to shifts in the energy market can also prove to be valuable in the emerging uncertain environment. Though this requires accommodating redundancies in the system that can be expensive, it will open up options for fuel-switching that can respond to price and other signals. Third, strategies for reducing the oil dependency of the economy (oil required for the production of a unit of GDP) could mitigate the impact of both supply and demand shocks, and in addition contribute to the reduction of CO_2 emissions.

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Continuity through Change: China's Energy Security in a New Era

*Cui Shoujun**

ABSTRACT

China is the world's largest energy consumer; therefore, energy security is vital for its global rise. The domestic energy shortage has become China's Achilles' heel, which justifies the strategy of diversifying energy supply and internationalising energy cooperation. As China's foreign oil dependence ratio soars, oil remains its main worry. Accessing reliable supply resource at a reasonable price and securing maritime transit routes are the key objectives for achieving sustainable oil security. China's oil security is somehow still vulnerable as it is over-dependent on the chaotic Middle East, but is less sensitive to the oil price due to the current price slump. While expanding the diversification of oil supply will be a continuity policy for China's future energy security, the "Belt and Road Initiative" enables China to promote economic and energy integration with countries along the "New Silk Roads", bringing about a change in China's international energy dynamics.

Introduction

China is the largest primary energy consumer in the world, and energy security is the strategic pivot for its global rise. Due to rapid industrialisation

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and urbanisation, China's total energy consumption has increased steadily, while the domestic energy production is relatively inadequate, thus raising concerns about its national energy security sustainability. From a political perspective, for a top energy consumer and importer such as China, sustainable energy security requires a reliable import source, a secure transit route, and an affordable import price.

Today, China is the world's second-largest oil consumer and has surpassed the US as the world's largest net oil importer. China's foreign oil dependence ratio almost reached 60 per cent in 2014, so oil is China's main worry and safeguarding oil security lies at the heart of China's overall energy security. It is worth noting that half of China's imported oil comes from the Middle East – a "shattered zone" that frequently experiences geopolitical upheavals. Arguably, China's energy security is still vulnerable considering the overdependence on the Middle East and the insecure maritime transit routes, while it is less sensitive to the oil price due to the substantial drop in oil price since the end of 2014. In the coming decades, China will steadily implement the international energy cooperation strategy to mitigate the security concerns. The ambitious "Belt and Road Initiative" will provide China with a window of opportunity for promoting regional integration and energy cooperation in Eurasia and Africa.

This chapter is divided into three parts. The first part introduces the background and connotation of China's energy policy, arguing that China's energy policy can be prioritised with domestication, diversification, globalisation and de-carbonisation as the four pillars of China's long-term energy optimisation strategy. Following that, the second part explores the concept and challenges of China's energy security and explains that energy security can only be achieved through international cooperation, so "Going Global" is the inevitable choice. Lastly, it expounds the motivation, content and implication of the "Belt and Road Initiative", highlighting the energy perspective.

The Context and Connotation of China's Energy Policy

Energy supply is vital to sustain China's economy; therefore, energy security is the cornerstone of China's economic security. Since 1978, when the "Reform and Opening up" policy was adopted, China's economy has grown rapidly. So far, China has become the world's second-largest economy, transforming itself from an agriculture-based economy into an industry-based economy. The fast pace of industrialisation, urbanisation and modernisation has greatly improved the standard of living in China, but at the same time led to a dramatic increase in the energy demand, thereby significantly increasing the dependence on imported oil. Although China's economic growth has been slowing down since 2014, due to the sluggish external climate and internal economic restructuring, in 2015 China still recorded the world's largest increment in primary energy consumption for the 15th year.[1]

Looking back on its energy trajectory, China became a net oil importer in 1993, a net natural gas importer in 2007 and then a net coal importer in 2009.[2] The shortage in China's domestic energy supply, oil in particular, has become a bottleneck restricting the sustainable growth of Chinese economy, in turn becoming the Achilles' heel of China's global ascendance.

Coal, oil and natural gas, the three traditional fossil fuels, constitute China's energy consumption. From the perspective of energy reserves, China has "rich coal, scarce oil and insufficient gas" resources. Oil is the key to China's energy security. According to the data released by BP (formerly, British Petroleum), at the end of 2015, China's total proved reserves of coal were 114.5 billion tons, accounting for 12.8 per cent of the world's total reserves, with a reserve-production ratio standing at 31;[3] China's total proved reserves of oil were 18.5 billion barrels, accounting for 1.1 per cent of the world's total proven reserves, with a reserve-production ratio of 11.7;[4] China's total proved reserves of natural gas were 3.8 trillion cubic metres, accounting for 2.1 per cent of the world's total proven reserves, with a reserve-production ratio of 27.8.[5] Therefore, China's coal resources are relatively abundant, but the production life of the remaining oil and natural gas is relatively short.

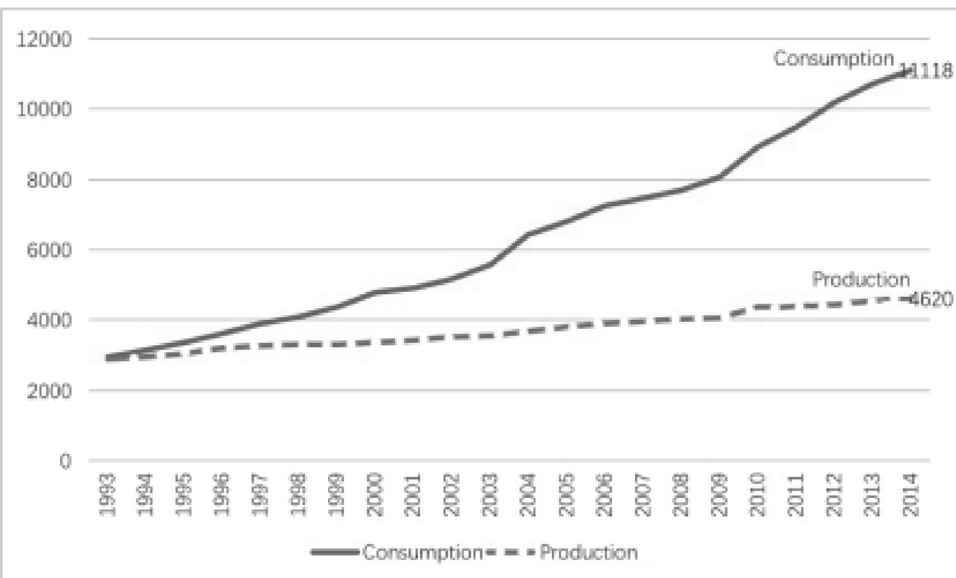
From the perspective of energy consumption, the coal-dominated energy consumption structure is difficult to change in the near future, because of the reality of China's resources endowment. Coal will continue to be a major source of energy supply for China's economic development. According to the National Bureau of Statistics of China, in 2014, China's primary energy consumption structure was as follows: coal accounted for 66 per cent, crude oil for 17.1 per cent, natural gas for 5.7 per cent and hydropower, nuclear power, wind power and other renewable energy resources just accounted for 1.12 per cent.[6] China is the largest producer and consumer of coal in the world, and inefficient utilisation of coal resources has generated considerable emission of pollutants including sulphur and nitrogen, which has caused serious environmental pollution. For the purpose of reducing both carbon dioxide emission and smoggy air, China has to reduce the consumption of coal and increase the utilisation of cleaner energy resources such as natural gas.

The role of oil and natural gas in China's economic development and energy security is increasingly important. However, the gap between supply and demand is huge, and China's external dependence on oil and natural gas is high, especially oil. Since the 1990s, China's oil demand has been rising annually. In 2015, China's crude oil consumption was 560 million tons, up 6.3 per cent over 2014, accounting for 12.9 per cent of global oil consumption. However, in comparison, China's crude oil production in 2015 was only 215 million tons, up only 1.5 per cent over 2014, accounting for 4.9 per cent of global production.[7] The substantial increase in China's crude oil consumption and the stagnation in its production strike a sharp contrast, which means China has to rely on overseas oil supply to fill the gap (see Figure 1).

The US Energy Information Administration (EIA) announced that China had surpassed the US at the end of 2013 as the world's largest net oil importer, because of China's rising consumption and limited domestic production. China's oil consumption growth accounted for about 43 per cent of the world's oil consumption growth in 2014, and China accounted for more than one-fourth of the global oil consumption growth in 2015.[8]

China's dependence ratio on imported oil has repeatedly hit record highs, from 6.69 per cent in 1993 to 31 per cent in 2000. By 2014, its

Figure 1: China's Oil Production and Consumption, 1993-2014



Source: US EIA

dependence on imported oil had almost reached 60 per cent.[9] It is estimated that by 2020, China's dependence on imported oil will be as high as 66 per cent.[10] China's main crude oil suppliers are Saudi Arabia, Iran, Iraq, Kuwait and other Gulf countries of the Middle East, a region known as the heartland of global oil reserves and production. However, the Middle East has become an unstable geopolitical "shattered zone" due to continual internal ethnic and religious conflicts and external intervention of the great global powers. Since 2011, the unrest, referred to as "the Arab Spring" by Western media and scholars, in Tunisia, Egypt, Libya, Yemen, Bahrain, Syria and other countries has led to overall chaos in the Middle East Islamic world. The geopolitical unrest in the Middle East has far-reaching implications on the global energy market, while the Syrian War and Iran crisis, in particular, has been of concern to China's energy supply security.

As energy consumption in Asian countries continues to increase, the gravity of global energy consumption has gradually shifted to Asia. In the decade from 2002 to 2012, the share of global fossil fuel trade going to China and India more than doubled in value terms, up from 4.4 per cent to 10.8 per cent, and more than tripled in weight terms, up from 4.5 per cent to 14.3 per cent.[11] In the next 20 years, this trend will continue to strengthen. China and India will be more dependent on the Persian Gulf and African oil, Russian natural gas and Australian coal. What can be predicted is that regional and structural energy shortages, caused by the unbalanced distribution of global energy, will be further exacerbated. Environmental issues, in particular climate change, partially caused by the excessive and inefficient use of fossil fuels, will require serious attention. As a rising power, China is already facing greater challenges in ensuring energy security both physically and environmentally.

Faced with such a gloomy picture of energy security, it is an important strategic task for Chinese policymakers to maintain long-term, stable and sustainable supply of energy resources. Based on "China's Energy Policy 2012", the so-called energy white paper issued in 2012, and "China's Energy Development Action Plan (2014-2020)" released in 2014, the four pillars of China's energy policies can be outlined as follows:

The first pillar is energy domestication. This means that China is set to rely more on domestic resources extraction, and in the meanwhile, reduce external dependence. China endeavours to raise the proportion of clean, low-carbon fossil energy and non-fossil energy in the energy mix, promote efficient and clean utilisation of coal, develop substitute energy resources in a scientific way and speed up the optimisation of energy production and the consumption mix. China's State Council is planning to install more efficient, self-sufficient, green and innovative energy production and consumption mix by 2020. The primary target of the plan is to raise the share of natural gas to above 10 per cent and to reduce the share of coal to below 62 per cent by 2020, as indicated in "China's Energy Development Strategy Action Plan (2014-2020).[12] For example, the Chinese Government has put emphasis on hydropower development with a special focus on ecological protection. The mountainous region in Southwest China is rich in water resources as several major rivers originate from here. The well-known Three Gorges Hydropower Dam is built in the Yangtze River watershed, and is operated in a way so as to both generate electric power and preserve regional ecological balance.

The second pillar is energy diversification. China is expanding its foreign energy imports robustly and is trying to build a diversified structure of import supply. To fulfil energy security, China's oil import diversification strategy comprises the following three components: Firstly, reducing the proportion of Middle Eastern oil imports to less than one-third of the total imports, meanwhile maintaining the share of African oil imports. Secondly, expanding the proportion of oil imports from Russia, Central Asia and Latin America. Energy supply from the above regions can substitute the volume reduction from the Middle East. To achieve that goal, China needs to strengthen its cooperation with oil-rich developing countries in an innovative way, such as China's current "Loan-for-Oil" cooperation approach with Venezuela, which means China provides financial loan to Venezuela to pump up Venezuelan oil production and in return Venezuela can reward China with additional oil supply. By way of extracting additional oil resources that a host country was previously unable to develop, China offers an attractive approach to those developing countries that are short of capital and lack the technological know-how. Thirdly, China should access and explore the North American energy market. The abundant shale oil and gas resources in the US and oil sand deposits in Canada have substantially reshaped the world energy market, and Chinese energy enterprises have already set their feet on North America through mergers and acquisitions. It is self-evident that a diversified energy supply pattern is conducive to enhance energy import safety by reducing the disruption risk in times of geopolitical crises.

The third pillar is energy globalisation. Undoubtedly, the fast pace of economic globalisation brings about resource globalisation. In the context of globalisation, energy importing countries such as China cannot underestimate the importance of international cooperation in safeguarding domestic energy security. Since the late 1990s, the "Going Out" strategy was formally adopted on the basis of "Reform and Opening-up" policy, and it was written into "the Outline of the Tenth Five-Year Plan for National Economic and Social Development" as a top national strategy in the beginning of the 21st century. In October 2003, the Third Plenary Session of the 16th Chinese Communist Party (CCP) Central Committee adopted "the Decision of Some Issues Concerning the Improvement of the Socialist Market Economy" and accelerated the implementation of the "Going Out" strategy; since then numerous Chinese companies have spread their operations overseas as per the government's policy. Due to limited domestic energy reserves, the Chinese Government has been steadily encouraging Chinese enterprises to go global for exploring the overseas energy market and strengthening transnational cooperation with energy-rich countries. In the meantime, the Chinese Government is actively seeking to cooperate with international energy organisations, such as the International Energy Agency (IEA) and the Organisation of Petroleum Exporting Countries (OPEC), in an effort to nurture a better international energy order. The most recent and ambitious "One Belt and One Road Initiative" is an upgraded version of the "Going Out" strategy with the aim of fostering an even closer international energy cooperation mechanism.

The last pillar is energy de-carbonisation. Due to the fast pace of industrialisation and urbanisation, the conflict between economic growth and environmental protection has intensified. From a domestic perspective, to develop its economy in a sustainable way, China should immediately embark on a low-carbon economy road. From an international perspective, China as a responsible power needs to work with other countries to reduce greenhouse gas emissions, protect the environment and deal with climate change. It is in the common interest of all countries to strengthen cooperation on the climate change issue. In November 2014, China and the US reached a consensus on climate change for the first time. According to this consensus, the ceiling of China's industrialisation and urbanisation growth will be measured and quantified by the greenhouse gas emission reduction agreement. China's carbon emission is expected to peak around 2030, and the proportion of non-fossil energy in primary energy consumption will be increased to 20 per cent by 2030.[13] China-US Joint Presidential Statement on Climate Change was released in September 2015, which laid a solid foundation for the Paris Agreement. By the end of 2015, at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21), the Paris Agreement was finally adopted. From commitment to action, the Chinese Government has been making unremitting efforts.

Therefore, the intractably intertwined, inseparable and mutually reinforcing four main pillars of China's energy policy – localisation, diversification, globalisation and de-carbonisation – are consistently implemented in practice to safeguard China's energy security. China's "13th Five-Year Plan for the National Economic and Social Development" released at the end of 2015 also echoes the aforementioned energy policy by specifying the following six points: deepening energy revolution; promoting reforms in energy production and utilisation; optimising energy supply structure; improving efficiency of energy use; building a low-carbon, safe and efficient modern energy system; and maintaining national energy security. It can be argued that in the coming decades the four pillars will be the essential components for coping with China's energy bottleneck and achieving a sustainable energy supply future.

The Challenges to China's Energy Security

The concept of "energy security" was first defined by the Western countries after the first oil crisis in the early 1970s. Daniel Yergin, chairman of Cambridge Energy Research Associates, argued that "consuming countries declare that they want 'security of supply' – that is, reliability and availability of energy at reasonable price".[14] In the narrow term of political security, excluding the ecological or environmental factor, the "supply security" of an oil importing country can be divided into three aspects: reliability of import sources, security of oil transportation routes and affordability of the oil price. Simply put, for China, a country that is increasingly dependent on imported oil, energy security means securing reliable oil supply to sustain the country's economic growth and social development.[15]

From a geopolitical point of view, energy security can be divided into "Absolute Security" and "Relative Security". Absolute security is a kind of hegemonic security, which means that the hegemonic energy consuming country takes advantage of its strong economic, political and military power to control the world's major oil and gas sources and supply lines, secure the world's strategic transit routes and chokepoints, dominate international energy organisations and ensure the reliability of energy supply and affordability of energy price. The US is the only country that has the capability of achieving absolute energy security in the contemporary era. Since the end of the Cold War, the US has basically controlled the global oil and gas resources and transit chokepoints through military cooperation with its allies.

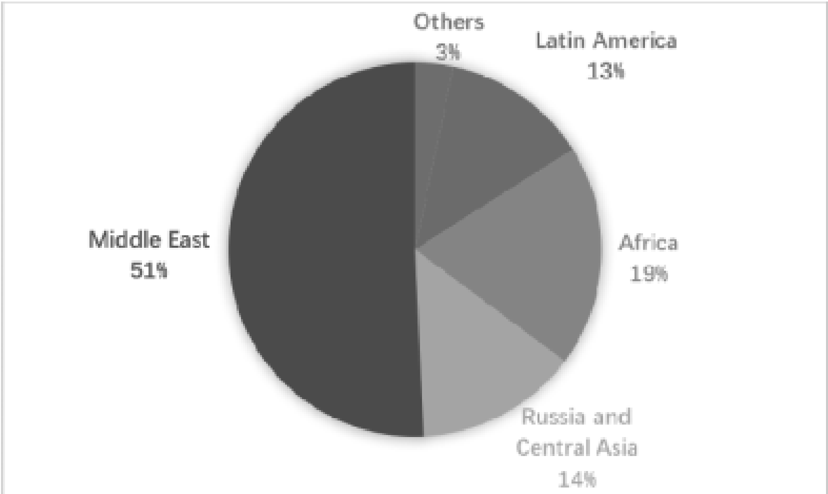
Relative security means cooperative security. On the one hand, it refers to the energy consuming and producing countries achieving energy security through international cooperation, through bilateral oil and gas exploration and exploitation, trade, investments, pipeline constructions, and overseas asset mergers and acquisitions. On the other hand, it also includes multilateral collaborations among energy consuming countries for the purpose of ensuring collective energy security, through the establishment of international energy organisations, energy contingency mechanisms, energy intelligence sharing mechanisms, strategic oil reserve mechanisms, oil price stabilisation mechanisms and transportation security management mechanisms.

As a top energy consumer and emerging power which is pursuing peaceful development on the global stage, China has neither the intention nor the capability of choosing "absolute security", therefore, cooperative security is the best way for China to ensure its "relative security".

After three decades of rapid economic growth, China is currently the largest energy consumer in the world. For China, oil is now an economic and a security concern.[16] As mentioned earlier, the reliability of oil import sources and affordability of oil price are essential for China's energy security, while a diversification of the oil supply structure is critical to safeguard China's import security and reduce supply disruption risks. Although China has been working on import diversification persistently and has relatively achieved more productive effect since the beginning of the 21st century, it is worth noting that around half of China's imported oil still comes from the Middle East. From the reliability perspective, it is argued that China's oil security is somehow still vulnerable as it overdependent on the Middle East. From the affordability perspective, the global oil price slump since the end of 2014 has had a favourable impact on China, as China can now import oil at a lower price. In this sense, China is less sensitive to the oil price but still vulnerable to oil supply.

The first challenge to China's energy security is, as mentioned earlier, its over-reliance on the Middle East oil. According to the statistics on oil import sources released by the General Administration of Customs of the People's Republic of China, Middle Eastern countries supplied 51 per cent of China's total import volume in 2015 (see Figure 2). The same source reveals that Saudi Arabia ranks first among the top 10 oil exporting countries to China (see Figure 3). In fact, Saudi Arabia has been China's largest oil supplier for more than a decade. Other leading Middle East oil suppliers include Iraq, Oman, Iran, Kuwait and the United Arab Emirates.

Figure 2: Composition of China's Oil Imports in 2015

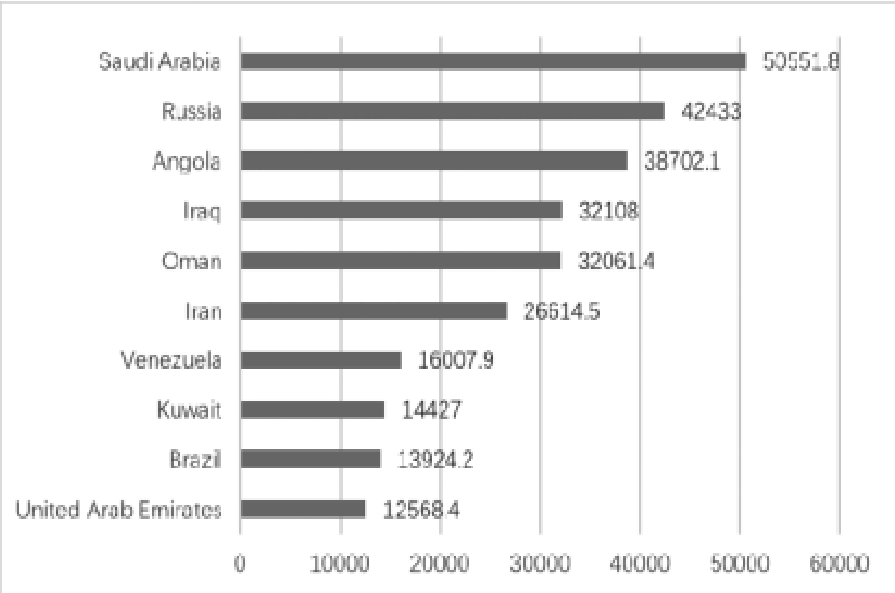


Source: General Administration of Customs of the People's Republic of China

Since the outset of the Arab Spring, the Middle Eastern region has continuously suffered from unrest which is partially an embodiment of the religious and sectarian conflicts between the Sunnis and Shiites, the Yemen war driven by the power struggle between Saudi Arabia and Iran, the rise of the "Islamic State" as a new destructive force in this region, etc. At the same time, the Middle East is also regarded as a geopolitical chessboard for the world's great powers in pursuit of their own interests. If the situation in the Middle East deteriorates any more, the oil outbound flow in the region might be disrupted; thus, China's oil supply security will unavoidably be threatened, and huge economic losses will be inevitable.

China's oil import dependence ratio is now higher than the US. Moreover, the US crude oil supply mainly comes from its neighbouring countries, such as the Gulf of Mexico, Canada and other relatively stable areas. In the meantime, the American oil import dependence ratio is dwindling because of the booming domestic shale oil production and the breakthroughs in horizontal drilling and hydraulic fracturing technology, while Chinese import reliance is growing as the domestic oil production is shrinking year by year. Therefore, China's energy security is facing an enormous challenge that is hard to mitigate in the short term.

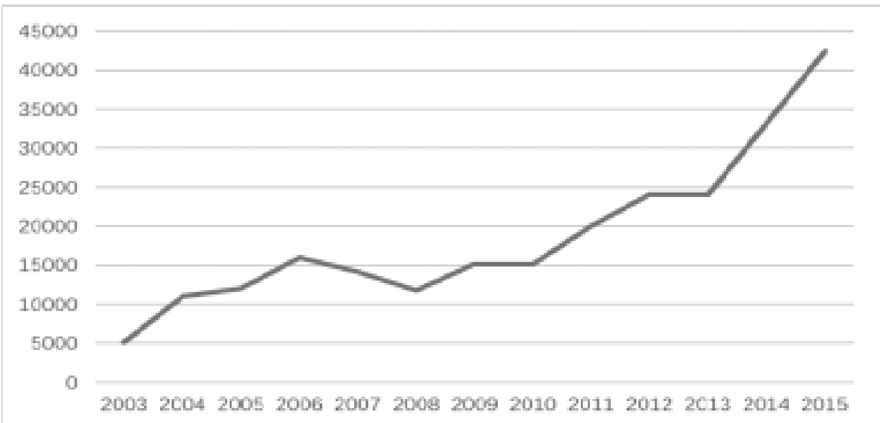
Figure 3. Top 10 Sources of China's Oil Imports, 2015 (Unit: Kiloton)



Source: General Administration of Customs of the People's Republic of China

In addition to the Middle East, Russia has gradually become another major supplier of crude oil to China (see Figure 3). According to the data from the General Administration of Customs of the People's Republic of China, Russian crude oil export to China totalled 42.43 million tons in 2015, an increase of 28 per cent, compared to the previous year (see Figure 4), second only to Saudi Arabia which exported 50.55 million tons of crude oil to China in the same year.[17] Despite the current good momentum of Sino-Russian bilateral relations, the Sino-Russian energy cooperation is not without its weaknesses. Since 2003, Russia has annually supplied more than 10 million tons of crude oil to China through the railways. In April 2009, according to the agreement signed by the two countries, China provided US$25 billion as advance payment to Russia to build an energy infrastructure project such as the East Siberia-Pacific oil pipeline which can guarantee 15 million tons of oil to China every year for 20 consecutive years. In 2014, Russia's annual oil supply to China had reached 33.1 million tons, accounting for more than 10 per cent of China's total crude oil import.[18] Due to low oil prices and financial sanctions imposed by the US and its European allies, Russian oil and gas enterprises have to adjust Russia's export policy, with the Asian countries as their future export destinations so as to reduce Russia's market reliance on Europe. In East Asia, China, Japan and South Korea are all contending for the Russian oil and gas, constituting its main importing market, and as an energy exporter, Russia understandably hopes to sell its oil and gas at a higher price. Japanese Prime Minister Shinzo Abe has been courting the Russian President Vladimir Putin for a gas deal in recent years, which has caused concerns in China, particularly as the political relations between China and Japan are not stable. In the future, the ties between China, Japan and Russia will complicate the energy dynamics further in East Asia.

Figure 4: China's Oil Import Volume from Russia, 2003-2015 (Unit: Kiloton)



Source: General Administration of Customs of the People's Republic of China

Second, China's oil transportation is vulnerable due to its maritime transportation routes. With regards to the transit of China's imported oil, except around 10 per cent of the oil that is pumped to China via land-based pipelines mostly from Central Asia and Russia, the vast majority of imported oil relies on maritime shipping.[19] The US EIA has listed the top six "world oil transit chokepoints", responsible for a combined 57 per cent of all seaborne oil trade.[20] Based on data from the US EIA, the narrow and strategic Strait of Hormuz and the Strait of Malacca, which connect the Persian Gulf to the Arabian Sea and the Indian Ocean to the Pacific Ocean, respectively, are the two busiest and most critical transit straits in the world. They are also the two important strategic transit chokepoints for Chinese oil and gas importation. For China, the Strait of Hormuz is the only exit for its oil supply from the Gulf.[21] In the worst-case scenario when a regional conflict or war breaks out, the blockade of the Straits will lead to a sharp drop in oil export volume, which will produce a disastrous impact on

China's oil supply security. The same is true for the Strait of Malacca, through which more than 80 per cent of China's oil imports transit.[22] A majority of Chinese reports argue that the import of oil from politically unstable countries and through potentially insecure routes, like the Malacca Strait, is the most pressing challenge to the security of China's energy supplies.[23]

In recent years, non-traditional security threats, such as piracy attacks, have increased significantly, which further exacerbates the vulnerability of China's oil supply security. The deployment of maritime anti-piracy escort operations of the Chinese People's Liberation Army Navy (PLAN) in the Gulf of Aden since 2008 has contributed to fulfil the objective of safeguarding maritime shipping security while providing common goods to the international society.[24] Recently, on April 8, 2016, China's Ministry of Defence reported that the construction of China's first overseas military base in Djibouti – officially a logistics support base – had begun. Djibouti is a small but highly strategically located country on the Horn of Africa, particularly for securing China's energy importation security.[25] The deal ensures China's military presence in the country up to 2026, with a contingent of up to 10,000 soldiers.

Furthermore, China has been seeking to build more pipelines to reduce the reliance on maritime transportation. From a geopolitical point of view, the construction of cross-border oil and gas pipelines has the function of "locking up" resource supplier and importer, which will produce the spillover effect of energy cooperation and promote mutual trust between the linked countries. On the other hand, compared to maritime shipping, pipelines are less elastic and certainly more reliable, but once the pipeline is built, it will be difficult to re-route the oil and gas trade. Therefore, the construction of the Sino-Kazakhstan oil pipeline, the Sino-Turkmenistan gas pipeline, the Sino-Myanmar oil pipeline and the Sino-Russian oil pipeline has eased the "Malacca Straits Dilemma". Thus, despite limitations, China is making efforts to improve the vulnerability of its maritime oil transportation.

Third, China's sensitivity to oil price has declined. In the past, when the oil price was high, China had bought a large amount of high-priced oil for storage in fear that the oil price would continue to rise. Since September 2014, the fall in the oil price has lessened China's fear of soaring oil expenditure due to its huge importation volume. The current plunge in the price of oil is partly due to the sluggish world economy, which is consuming less oil than the markets had anticipated, and partly due to OPEC itself, which has produced more than the market had expected. In addition, due to the shale oil revolution, the US has completed around 20,000 new wells since 2010 – more than 10 times the number drilled by Saudi Arabia – boosting its oil production by a third to nearly 9 million barrels per day, only 1 million short of the Saudi output.[26] The Saudi-American oil contest has tipped the world from a shortage of oil to a surplus, which benefits major oil consumers, primarily China.

Furthermore, a fall in the oil price is often seen as similar in its effects to a tax cut for consumers who then have more to spend on other goods and services. It also reduces costs for businesses that use oil products, that is, those wherein goods need to be transported, along with the petrochemical industry which makes plastics, fertilisers, synthetic fabrics, etc. using raw material made from refined oil. It is particularly of importance, as China's economy is now slowing down a little bit. It shouldn't surprise anyone that, in the period of low oil price, China is buying more oil than ever, and, reportedly, also building up its strategic oil reserves to fulfil its goal of increasing the strategic oil reserve storage capacity from its current 37 days to 100 days by 2020.

As China faces the challenges to its energy security, it is essential for the country to expand and diversify its overseas energy supply sources by reducing its overdependence on the Middle East oil. Meanwhile, China also needs to actively participate in international maritime safety cooperation by providing more public services to combat non-traditional security threats such as piracy. Regarding price sensitivity, China should speed up the pace to build China's oil futures market in order to increase its weight in deciding oil prices in the long run.

The "Belt and Road Initiative" and Energy Cooperation

The "Belt and Road Initiative" is China's most ambitious project aimed at stimulating economic development in a vast region covering sub-regions in Asia, Europe and Africa, which accounts for 64 per cent of the world's population and 30 per cent of the world's total gross domestic product (GDP).[27] China has launched efforts to build two transcontinental "New Silk Roads" which would connect Asia, Africa, and Europe through infrastructure projects, trade, investment and human exchange.[28] The "Belt and Road Initiative" was first introduced by China's President Xi Jinping in the fall of 2013 during his visits to Kazakhstan and Indonesia as the "Silk Road Economic Belt" and "21st Century Maritime Silk Road", respectively, which are its two prongs. In spring 2015, China's top economic planning agency, the National Development and Reform Commission (NDRC), released a general plan for action, outlining some key points of

"Belt and Road" and highlighting the need to build land and maritime "economic corridors". These corridors are expected to be prioritised in China's 13th Five-Year Plan, which will run from 2016 to 2020 and guide national investment strategy throughout that period.

New challenges have arisen because the internal and external conditions have changed significantly. From the perspective of the domestic environment, China's economy faces an over-capacity pressure. The government needs to reformulate the economic structure and upgrade industrial composition, instead of simply absorbing inward foreign direct investment (FDI).[29] From the perspective of the international environment, many Asian and African countries are experiencing a new round of turbulent transition, and China's diplomatic priority should be on fostering amicable neighbourhood relations to facilitate the ascent of the Chinese clout. So, it is imperative for the Chinese Government to revise the connotations of traditional strategic partnerships, with an eye for developing a new Asia-Africa partnership network in the new era.

Arguably, the "Belt and Road Initiative" has become China's paramount policy to engage with Eurasia and Africa for long-term economic growth, development and integration. It signifies an aspiring new stage of China's "Going Out" approach. The first and foremost step is increasing regional connectivity by financing mega-infrastructure projects in Asian and African countries, which has been illustrated by the launching of the US$40 billion Silk Road Fund and the US$100 billion Asian Infrastructure Investment Bank (AIIB).[30]

The establishment of the AIIB will not only fill in the capital requirements of the construction of the "Belt and Road Initiative", but also provide high-quality financial services, improving the efficiency of capital utilisation in Asia and attracting global capital to Asia. The AIIB is committed to promoting infrastructure construction and connectivity in Asia, including energy infrastructure projects in the "Belt and Road" member countries, which will undoubtedly improve the existing pattern of China's energy security, expand its ability to respond to the energy crisis and further strengthen the energy security in the transportation process.

From a geopolitical perspective, it can be argued that this ambitious initiative is closely related to China's energy security. The region covered by the "Belt and Road Initiative" includes the main reserved area of conventional oil and gas resources and concentrated area of energy consumption. According to the data from the Institute of China's Oil Economic Technology, the region has an estimated proved oil reserves of 133.8 billion tons, accounting for 57 per cent of the world's total reserves.

And its proved natural gas reserves are 155 trillion cubic metres, accounting for 78 per cent of the world's total reserves.[31] Among the 65 "Belt and Road" countries, there are more than 20 oil-producing countries, some of which are major oil suppliers to China (see Table 1).

Table 1: 65 Oil Producing "Belt and Road" Countries and Their Production Percentage in the World Market

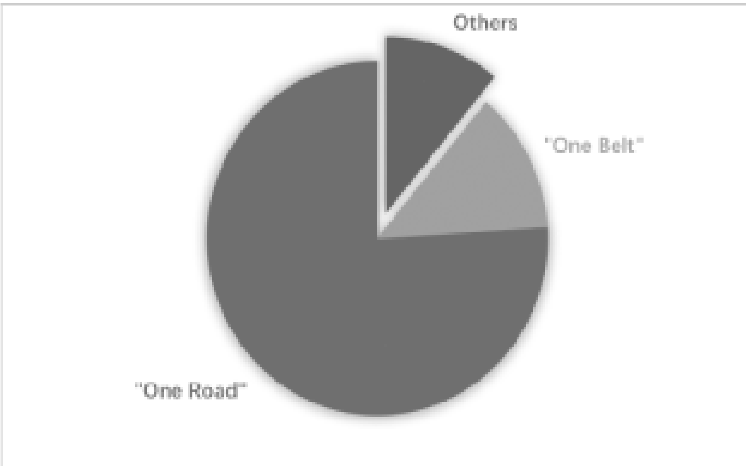
Region	*Countries*
East Asia	Mongolia
Association of Southeast Asian Nations (ASEAN)	Singapore, Malaysia (0.7%), Indonesia (0.9%), Myanmar, Thailand (0.4%), Laos, Cambodia, Vietnam, Brunei (0.1%), and Philippine
West Asia	Iran (4.2%), Iraq (4.5%), Turkey, Syria (less than 0.05%), Jordan, Lebanon, Israel, Palestine, Saudi Arabia (13%), Yemen (less than 0.05%), Oman (1.1%), United Arab Emirates (4.0%), Qatar (1.8%), Kuwait (3.4%), Bahrain, Greece, Cyprus and Egypt (0.8%)
South Asia	India (0.9%) (though not a part of the "Belt and Road" project), Pakistan, Bangladesh, Afghanistan, Sri Lanka, Maldives, Nepal and Bhutan
Central Asia	Kazakhstan (1.8%), Uzbekistan (0.1%), Turkmenistan (0.3%) Tajikistan and Kyrgyzstan
Commonwealth of Independence States (CIS)	Russia (12.4%), Ukraine, Belarus, Georgia, Azerbaijan, Armenia and Moldova (1.0%)
Central and Eastern Europe	Poland, Lithuania, Latvia, Estonia, Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Albania, Romania (0.1%), Bulgaria and Macedonia

Source: BP Statistical Review of World Energy, 2016.

According to China's strategic oil plan, in order to ensure its energy security, the Chinese Government has planned "four major energy import routes", including one seaborne lane and three land-based corridors. The seaborne shipping lane is the waterway from Malacca Strait to the South China Sea, transporting crude oil and liquefied natural gas (LNG) to China. The three land-based corridors refer to the northeast route (China-Russia), northwest route (China-Central Asia) and southwest route (China-Myanmar). The northwest route includes the China-Central Asia gas pipeline (annual capacity of 30 billion cubic metres) and the China-Kazakhstan crude oil pipeline (annual capacity of 20 million tons). The southwest route refers to the China-Myanmar oil and gas pipelines. Currently, the Chinese side of the Sino-Russian gas pipeline is still under construction and will be put into operation by 2018.

From an energy perspective, the Maritime Silk Road is somehow overlapping with China's maritime oil transit route, while the land-based Silk Road is coinciding with the three land importation corridors. To some extent, the Middle Eastern oil producers, Russia, Central Asian countries, Southeast Asian countries and others are covered by the "Belt and Road Initiative". In this sense, the "Belt and Road Initiative" closely connects Asia, Europe and Africa, which overlaps with China's major energy import sources and import routes.

Figure 5: Composition of China's Oil Imports in 2015



Source: China Customs Statistics

China aims to build close energy ties, and take advantage of its financial capacity manifested in its huge foreign reserves to promote infrastructure projects in Asia. China is planning to use the new AIIB platform to promote regional connectivity by financing infrastructure projects.[32] According to the Asian Development Bank, there is a huge "gap" in financing infrastructure construction in Asia where US$800 billion investment is needed annually during 2010-2020.[33] Given that infrastructure is at the core of the "Belt and Road Initiative", there is a responsibility on China as the founder to play a constructive role in shaping regional economic and financial architecture and promoting regional energy cooperation.

Against the backdrop of the "Belt and Road Initiative", in June 2014, at the sixth Ministerial Conference of the China-Arab States Cooperation Forum (CASCF), Chinese President Xi Jinping proposed the establishment of a "1+2+3" pattern of cooperation: energy cooperation at the core; then infrastructure construction plus trade and investment facilitation as two wings; and three new areas of high-tech cooperation – nuclear energy, space satellites and other new energy initiatives. President Xi underscored that in the next 10 years efforts should be made to increase the bilateral trade volume from the US$240 billion in 2013 to US$600 billion.[34] In September 2016, Saudi Arabia and the United Arab Emirates agreed to begin using Chinese Renminbi as the oil trading settlement currency, in a bid to move away from the US dollar in order to avoid exchange rate volatility. This move will further strengthen the internationalisation of Chinese currency and expand China's economic and financial presence in the Gulf region.

Initiated in 2010, the China-Gulf Cooperation Council (GCC) Strategic Dialogue targeted at building a strategic partnership. While both sides agreed to accelerate the pace of establishing a Free Trade Area (FTA), China asserted its desire to play a more active role in regional affairs, such as maintaining Gulf stability and combating the Islamic State.

Significantly, Sino-Gulf relations have moved far beyond the hydrocarbon sector, although that clearly remains important. For example, there is substantial rise in Gulf-China capital investment and joint ventures over the past decade.[35] A mutual upstream and downstream interdependence has formed, as the GCC invests its sovereign wealth funds in Chinese oil refining and petrochemical industries and China increases its investment in the GCC's financial, construction and energy sectors.

In November 2016, the Gwadar Port, which China has built in the province of Baluchistan, was officially launched. The Gwadar Port is viewed as a major oil-shipping lane that can serve as an energy corridor from western China through Pakistan to the Persian Gulf.[36] In fact, in 2014, the Chinese Government committed to spending US$45.6 billion over the next six years to build the China-Pakistan Economic Corridor, which will include the construction of highways, railways, and natural gas and oil pipelines connecting China to the Middle East. China's stake in Gwadar will also allow it to expand its influence in the Indian Ocean, a vital route for oil transportation between the Atlantic and the Pacific Oceans. In addition, it can also enable China to bypass the Strait of Malacca to improve China's maritime transit security.[37] Thus, China is committed to deepening its energy cooperation with the "Belt and Road" countries.

As already mentioned, China is expanding its footprint in Eurasia and Africa by advocating the "Belt and Road Initiative": the new financial architecture aims to not only promote economic connectivity through infrastructure, trade, and investment in the region but also help strengthen political trust and cooperation. The development of infrastructure and stability of the political environment of the "Belt and Road" countries, in turn, will promote the stability of China's energy security in the long term.

Conclusion

As the world's largest energy consumer, energy security is the cornerstone of China's rise, while oil security is the key to China's energy security. The reliability of oil supply sources, the safety of oil transit routes and affordability of the oil price are the three main concerns for Chinese policymakers. Although China has been seeking oil supply diversification for decades, China's oil imports are still overdependent on Middle Eastern countries, which means China's oil security remains vulnerable in terms of supply. In the coming decades, China will steadily continue the diversification strategy by reducing the proportion of Middle Eastern oil imports and expanding supply from Russia, Africa, Central Asia and Latin America. On the other hand, the fall in the oil price since 2014 has decreased the sensitivity of China's oil economy and produced a favourable impact on Chinese economic development.

The inauguration of the ambitious "Belt and Road Initiative" has provided new opportunities to transform China's international energy policy. It is promoting regional connectivity and integration by financing infrastructure construction, trade and investment, thereby strengthening energy cooperation with energy supplying "Belt and Road" countries. From a long-term perspective, the "Belt and Road Initiative" will not only be beneficial to the economic growth and political stability of the "Belt and Road" countries, especially in the Middle East which supplies half of China's imported oil, but also effectively reduce the vulnerability of China's energy security. Nevertheless, the ambitious project is facing enormous challenges, considering the stark distinctions among these countries such as cultural differences, diverse political systems and multi-levels of economic development. To fulfil China's aspirations, policy coherence should be coupled with country-to-country particularity. The road ahead is far from an even one, but the barriers are not insurmountable.

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3

A Relook on Energy Security After Fukushima

Masakazu Toyoda

Introduction

Japan has one of the lowest energy self-sufficiency rates in the world, making it one of the poorest in terms of energy endowment. This is why Japan has leaned on nuclear energy, which is positioned as a semi-domestic energy source. But several years have gone by since the accident at the Fukushima I Nuclear Power Plant made the government halt operations of all its commissioned 54 nuclear plants; yet only three of them were restarted as of December 2016. In the meantime, the global energy environment has shifted dramatically, and Japan remains beset by all sorts of energy issues. This chapter presents Japan's efforts towards energy security in its post-Fukushima phase and the implications thereof for the Asian countries.

The Fukushima Accident and Energy Security

The Many Issues Raised by the Fukushima Accident

The Great East Japan Earthquake Disaster on March 11, 2011, had a significant impact on the Japanese economy and society in general, bringing about a sea change in Japan's energy policy. The disaster was the consequence of a quake-triggered giant tsunami that cut off the Fukushima I power supply, resulting in a grave accident and a core meltdown. Although no one died from the accident itself, 80,000 people were forced to evacuate to avoid exposure to radiation. Decontamination in Fukushima has been proceeding steadily.

In the energy mix developed to meet the challenge of climate change by the Japanese Government almost exactly a year before the accident, the share in the total electricity of nuclear energy as a zero greenhouse gas (GHG) emission energy source was expected to rise from just below 30 per cent to 50 per cent by 2030. Together with 20 per cent from renewable energy sources, it would have brought the share of zero emission energy to 70 per cent. Post-disaster, this had to be revised from the bottom up.

Japan is one of the most energy-poor countries in the world, with hydropower and other renewables (the only other domestic energy source besides nuclear energy-which counts as a semi-domestic energy source) at only 6 per cent of the primary energy. A new and independent regulatory regime was established after the accident (as has been explained later), but until the new regime started to function, operations were suspended at all 54 units, resulting in the self-sufficiency rate, which had hovered near 20 per cent before the accident, including the semi-domestic nuclear energy sector, tumbling to 6 per cent. It goes without saying that this created a sense of crisis among policymakers and others concerned.

By contrast, China and India had self-sufficiency rates of 86 per cent and 67 per cent, respectively, while Italy at 23 per cent had the lowest rate of self-sufficiency among the G7 countries, and the US and Canada at 86 per cent and 172 per cent, respectively.[1] Furthermore, as the nuclear power plants shut down one after the other, the Middle East's share of Japan's oil supply, which had declined to around 70 per cent by the beginning of the 1990s, rose again to 84 per cent by 2014, surpassing the 78 per cent reached in 1973 at the time of the First Oil Crisis.

Energy security was not the only issue created by the shutdown of the nuclear power plants; climate change being another. CO_2 emissions jumped as thermal power plants fuelled by oil, coal and natural gas replaced the nuclear power plants. Japan's reduction target for the first commitment period (2008-2012) under the Kyoto Protocol agreed to in 1997, had seen a 6 per cent reduction from the 1990 level. The actual results averaged to a 1.4 per cent increase over the 1990 level due to the massive generation of CO_2 emissions in the wake of the accident. At the same time, Japan purchased emission credits under the Kyoto Protocol from other member countries (counting as a 5.9 per cent reduction), which, together with absorption by forests (counting as a 3.9 per cent reduction), made it possible to achieve an 8.4 per cent reduction. The credits, meanwhile, are estimated to have cost nearly ¥590 billion (US$5.9 billion).

Rising energy costs are yet another problem. The cost of power generation at a thermal power plant is higher than at a nuclear power plant in Japan. The electricity rates for households and industries went up approximately 20 per cent and 30 per cent, respectively.

In the autumn of 2011, the Ministry of Economy, Trade and Industry (METI) and the Agency of Natural Resources and Energy, which are responsible for energy policy in Japan, called on the Strategic Policy Committee of the Committee for Natural Resources and Energy, the policy advisory council of the METI on energy, to begin deliberations on a new course for energy policy. However, it took two-and-a-half years just to establish the basic framework, and more than another year to develop the new energy mix. In other words, it took almost four years to put forth the new direction for energy policy. In the meantime, the government had changed hands from the Democratic Party of Japan (DPJ)-led coalition to one led by the Liberal Democratic Party (LDP).

The reason why it took so long was because in addition to the apprehension over the safety of nuclear energy generated by the nuclear power plant accident during the Great East Japan Earthquake Disaster, at least three major changes in the energy environment had occurred.

The Three, Near-Simultaneous Changes

The three changes were: First, the "Arab Spring" and the destabilisation of the Middle East; second, the collapse of the price of oil that started around the middle of 2014, and third, the deepening of the negotiations on climate change with the milestone Paris Agreement. Add to these the growing concern over the safety of nuclear energy, and it means that four major, once-in-a-few decades changes took place almost simultaneously over a four to five-year period. The impact of each of these changes is discussed as follows:

The "Arab Spring" and the Destabilisation of the Middle East

At the end of 2010, a young Tunisian vegetable vendor burned himself to death after having his merchandise confiscated when he refused to pay a bribe to the police, touching off criticism of the establishment that developed into a democratisation movement. The fire of democratisation that was ignited in Tunisia spread like wildfire to Egypt, Libya and the Middle East in general. Although the revolutions resulted in regime changes, political and social stability has yet to return to many countries. In Syria, where a similar popular revolution appeared to be taking place, the battle between the regime and the rebels continues, while the Islamic State of Iraq and

Syria (ISIS), or Daesh, has seized the opportunity to escalate its atrocious terrorist activities. The confrontation between Iran and Saudi Arabia has worsened after the easing of the sanctions on Iran over its nuclear programme, while the Israeli-Palestinian conflict since the end of the Second World War continues unchanged. The plummeting price of oil has further deepened the distress of the Middle East countries whose public coffers rely on oil and gas export revenues. If this results in a rewriting of the borders of the Middle East, it could turn out to be the kind of situation that arises only once in half a century.

Further casting a shadow on the instability of the Middle East is the confrontation between the West and Russia caused by the annexation of Ukraine by the latter and the confrontation between China and its neighbours over the South China Sea. If this geopolitical destabilisation process is attributed to the policy change in the US to relinquish its "role as the world's policeman", the creation of a new world order will be required to restore stability. Japan's reliance on the Middle East for energy supplies surpassed 80 per cent as all its nuclear power plants ceased operation after the accident. The destabilisation of the Middle East made ensuring energy security an urgent issue.

The Collapse of the Price of Oil, a "Rerun" of the Situation Three Decades Ago

From 2013 to the summer of 2014, the price of oil stayed up in the vicinity of US$120 per barrel but plummeted close to US$20 by January 2016. The November 2016 agreement between the Organisation of the Petroleum Exporting Countries (OPEC) and Russia on reducing production has helped bring it back in the neighbourhood of US$50 per barrel, but some suggest that it might keep rising in the near future. The shale revolution is the reason for this. Unlike conventional oil, tight (shale) oil is forcibly squeezed out of oil and gas deposits in underground shale formations by effectively using horizontal drilling and hydraulic fracturing. It had been difficult to bring shale oil to the market because of the high cost involved until the price of oil soared, taking gas prices along with it. Once shale oil established itself in the market, subsequent productivity gains have made it difficult to drive it out of the market even when the price of oil declined somewhat. Although the number of oil rigs did drop significantly in line with the falling price of oil, production has not shown much of a decline, and is poised to return to the market as the price of oil goes up. Even with the agreement between OPEC and non-OPEC countries to reduce production, there is no room for the price of oil to rise steadily unless this excessive supply is resolved.

Indeed, a similar situation arose exactly three decades ago in the mid-1980s. On that occasion, two oil crises in the 1970s had sent the price of oil soaring, with the result that high-cost non-OPEC producers emerged. For this reason, I call the recent collapse in oil price a "re-run". What does this "re-run" tell us? When the price of oil rises above what market conditions warrant, new, high-cost oil emerges, creating a surplus, and sending the price of oil plummeting.

These fluctuations in the price of oil are clearly unwelcome to oil-producing countries, but it is not necessarily a boon for consumer countries either. Upstream investment in oil and gas has fallen for two consecutive years in the face of the downturn in energy prices to only half of what it was just a few years ago. There is the danger that this will invite supply shortfalls and spiking prices in the future. Unsustainable reductions in the price of oil are by no means desirable from a mid- to a long-term perspective on energy security.

The Deepening of the Negotiations on Climate Change with the Milestone Paris Agreement

The response to the issue of climate change is the international action to stabilise the concentration of GHGs and protect the climate, based on the international framework concerning the issue of global warming that was adopted at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992. Representatives from 172 countries participated in the 1992 Rio Conference. Later, there was an agreement on reduction targets at the Kyoto Conference, but only 37 countries participated in this agreement, and the US stayed out, having failed to ratify.

By comparison, the fact that over 180 countries brought their reduction targets together for the agreement is a major success. Interest in climate change has declined in Japan; one of the reasons being that many climate change activists switched to opposing nuclear energy after the accident at the nuclear power plant. The Japanese Government itself faces a serious dilemma, torn between the need to fulfil its responsibilities as the country with the third-largest gross domestic product (GDP) in the world and the ongoing increase in CO_2 emissions due to the shutdown of the nuclear power plants. Japan must pursue energy security that is compatible with measures to combat climate change.

From "3E" to "3E plus S"

In April 2014, approximately three years after the Fukushima accident, the aforementioned Strategic Policy Committee conducted, after a one-year delay, what was supposed to be a triennial review of the Strategic Energy Plan and compiled a new Energy Plan in light of the changes in the international energy environment, in addition to the accident.

One key point of the new Energy Plan was the addition of "S" as in "safety" to the "3ES" (energy security, environment, and economic efficiency) of the basic perspective for energy policy, making it "3E+S". Safety was already a basic presumption, but its importance was made explicit.

Another key point was that it positioned nuclear energy and coal as the "important base-load power source[s]" for primary energy.[2] Renewable energy was regarded as "a promising, multi-characteristic and important energy source ... [that] can be domestically produced free of greenhouse gas emissions",[3] while oil and gas each remained only an "important energy source". In the advisory council, there were experts who disagreed with positioning nuclear energy as an "important base-load power source". However, it is impossible to secure "3E" without nuclear energy as a semi-domestic energy given the unstable, post-accident international energy environment, and a consensus was ultimately reached on this point. Incidentally, the reason why nuclear energy is positioned as a semi-domestic energy is because of the long-term stockpile of plutonium being kept in light of the five years necessary between the purchase of uranium and its use for power generation.

However, it is insufficient for the government to merely classify energy sources qualitatively. The development of an energy mix that could serve as a clear target for energy composition of the future was required. This was a task that took more than another year for the advisory council to fulfil.

Five Necessary Responses

Promoting Energy Conservation

Maximising energy conservation by reducing energy consumption is an important precondition for developing the energy mix. The greatest challenge here for Japan is that it became the world's most energy-efficient economy after the two oil crises, and hence there were varied views on the extent to which it was possible. Some experts were of the view that no further economic growth was necessary, while others thought that energy conservation that impeded growth was meaningless. Ultimately, it was decided to set a target for energy conservation that was equivalent to the results of the 20 years immediately after the second oil crisis. This meant a 35 per cent improvement in the energy intensity over the next 20 years. The idea was to be able to do something that had already been done before.

However, the price of oil had jumped by more than a factor of 20 as the result of the previous two oil crises, and the whole world had faced the same problem. This time around, it was a purely Japanese issue. Moreover, energy conservation efforts have languished over the last 20 years, with a less than 10 per cent improvement. The conclusion was to aim at a 35 per cent improvement, the equivalent of the outcome of the oil crises. As a result, it was decided that assuming an annual growth rate of 1.7 per cent over the next 20 years, a 13 per cent reduction in primary energy consumption by 2030 from the business-as-usual case would be aimed at, as well as energy conservation of approximately 7 per cent from the current level (in 2013).

It was stated that there are at least three major perspectives on specific measures. The first is the renewal of equipment and facilities in the industrial sector. The Japanese economy has stalled for more than a decade, and the renewal of plants and equipment has been slow. The idea here is to promote further energy conservation through the introduction of new facilities by providing policy support for the renewal of plants and equipment, since there are limits to further energy conservation with existing plants and equipment.

Second is energy conservation in buildings. Japan leads the world in energy conservation with transport equipment and electric machinery, such as automobiles, air conditioners, and TV sets, but the advisory council felt that there was still plenty of room for energy conservation in buildings. Japanese summers are hot and humid. It was felt that there was insufficient use of insulating material in homes and office buildings compared to North European countries with their cold winters. Now Japan is moving into the last frontier. Typical examples are zero energy houses (ZEHs) and zero energy buildings (ZEBs). In ZEHs and ZEBs, energy consumption is reduced by thoroughgoing energy conservation, and energy is generated by photovoltaics, which is stored in batteries, if there is an excess, to be used as required. The targets have been set to achieve ZEHs and ZEBs as the average for new housing and new office buildings, respectively, by 2030. The important thing here is to keep costs within reasonable limits.

Third is the use of information technology (IT). IT can be used in all sectors, homes, offices, industry, and transportation – home energy management system (HEMS), building energy management system (BEMS), factory energy management system (FEMS), and transportation energy management system (TEMS) or Information Transportation System (ITS) for controlling traffic flow. When this is executed at the community level, smart communities emerge. However, the view appears to be gaining acceptance that it is more effective to use those individual technologies on a national or transnational level instead of developing dispersed, independent smart communities if the centralised grid is robust.

Energy Mix Plan

The most important policy in Japan for realising “3E+S” is the energy mix plan. As a measure against climate change, Europe has set 20-20-20 (the goal of the European Union [EU] to achieve a 20 per cent increase in energy efficiency, a 20 per cent reduction in CO_2 emissions, and make use of 20 per cent renewables by 2020) partial energy targets, but they do not seem to have a comprehensive energy mix. The US is blessed with an abundance of energy, and with the current shale revolution, it has not only become completely self-sufficient in terms of energy, but it is on the verge of becoming an exporter. Although the US has in place regulatory measures against climate change, the energy used is basically left to the market to choose. However, an extremely energy-poor country such as Japan cannot afford to leave such choices to market mechanisms. Joint activities are carried out by the public and private sectors to address demand and supply energy according to the compiled energy mix target based on “3E (which has now become 3E+S)”.

The energy mix determined in 2010, focusing intensely on measures to counter climate change, aimed to achieve an extremely ambitious target of zero GHG emissions for 70 per cent of power sources by 2030. However, 50 per cent of this 70 per cent target was to rely on nuclear power. But the Japanese people have begun questioning the reliability of nuclear power since the accident, forcing a review of this target. This led to a split within the advisory committee regarding the pros and cons of nuclear power, and discussions faltered. But an agreement was finally reached in July 2015, more than four years after the accident, as mentioned above. The decisive factor was the reaching of an agreement in the three targeted values for “3E”, with the ensuring of safety for nuclear power stations being a precondition. The first target, with a focus on ensuring genuine energy security, aims to achieve greater self-sufficiency in energy (around 25 per cent) than Japan had before the earthquake. The second target, with a focus on ensuring economic feasibility through the supplying of energy at practical costs, aims to lower the cost of electricity from the current level. The third target, based on the idea that the supply of energy must contribute to measures to counter climate change, aims to cut GHG emissions to levels that are comparable to the targets set by the US and Europe. These are the goals of the so-called "3Es", but for an extremely energy-poor country such as Japan, the "3E" itself is, in a broad sense, like an energy security indicator, because it would not win the support of people if it were to make energy very expensive or damage the environment, even if it were capable of ensuring the supply of energy.

In terms of "S", or safety, a goal was set to reduce the reliance on nuclear power as much as possible. As a result, the energy mix plan was laid down first, to which energy needed for power generation and for transportation and industries, etc. was added to determine the primary energy mix. The energy mix consists of renewable energy (22-24 per cent), nuclear power (20-22 per cent), liquefied natural gas (LNG, 27 per cent), coal (26 per cent) and oil (3 per cent) in 2030. The primary energy mix consists of renewable energy (13-14 per cent), nuclear power (10-11 per cent), LNG (18 per cent), coal (25 per cent), liquefied petroleum gas (LPG, 3 per cent) and oil (30 per cent) again in 2030. Compared to the previous mix, the proportion of zero GHG emission power sources has decreased from 70 per cent to 44 per cent.

The proportion of fossil fuels has increased accordingly. The reason for these ratios is that this is the only way the three numerical targets can be achieved. The first priority is achieving self-sufficiency, which under the new energy mix is 24 per cent, placing it just within the permissible range. The second priority is the cost of power which, according to calculations based on a draft plan of the cost of different sources of energy put together by a working group formed by experts in sync with the work of the advisory committee, is set to decrease by 2-5 per cent from the 2013 costs. The third priority is the goal to reduce GHG emissions, and under the new energy mix, the rate of reduction is 26 per cent compared to 2013 levels, placing it on par with the EU target of 40 per cent (compared to 1990 levels, to be achieved by 2030) and the US target of 26-28 per cent (compared to 2005 levels, to be achieved by 2025). It is difficult to make direct comparisons because the years on which the reduction targets are based and the years in which the targets will be achieved are all different. But the carbon emission intensities in the target years for Japan, the US and EU are 0.16, 0.2-0.28 and 0.17, respectively, placing Japan on a par with the EU, while more effort is needed on behalf of the US.

The energy mix is a kind of simultaneous equation. Changing the mix or the parameters, will change the outcome, which is the goal. For example, increasing the proportion of solar or wind power to replace nuclear power increases the use of gas thermal power generation as a backup system, increasing CO_2 emissions and raising the price of electricity. It would be ideal if nuclear power could be replaced with geothermal power or hydroelectric power, which are stable and require no backup system, but there are fears that they will damage the environment or have an adverse effect on hot springs. This makes it difficult to obtain the approval of local residents, limiting their numbers. Meanwhile, increasing the number of solar or wind power generators to replace thermal power generation increases the cost of electricity. There is no such thing as the perfect source of energy from the perspective of "3E+S". Incidentally, the proportion of nuclear power has decreased dramatically compared to the 30 per cent or so before the accident. In a broad sense, this energy mix is a rare combination that satisfies the requirements for energy security.

Reducing the Cost of Renewable Energy

Is this energy mix achievable? The use of renewable sources of energy is achievable if the feed-in tariff (FIT) programme is made use of and the high cost of levies is ignored. In fact, the problem in Japan is that the costs of solar and wind power are relatively high compared to those of other countries. Moving forward, it was decided that an auction system would be adopted to try and lower the cost of levies on solar power, which can be implemented quickly.

Another problem is the preference for mega solar power. Wind power and geothermal power require time to carry out environmental assessments, and they need the approval of local residents, which is not easy to acquire. Therefore, to ensure the balanced adoption of renewable power sources, the government has decided to announce purchasing prices over the next few years for power sources that require long lead times.

Ensuring the Safety of Nuclear Power

If anything, the restarting of nuclear power plants is the most difficult part of achieving the energy mix. Realising the targeted ratio of nuclear power (20–22 per cent) in the power generation mix will require the restarting of at least 30 or so units and improving the rate of operation from around 60 per cent (the rate before the accident) to more than 80 per cent. However, only five nuclear reactors have so far been deemed safe for restarting upon completion of inspections by the Nuclear Regulatory Commission (NRC) but by the end of December 2016, only three had actually been restarted. As for the other two reactors, the Otsu District Court has ordered the halting of operations due to a ruling that "safety standards are insufficient". Kansai Electric Power, the operator, has appealed to the Osaka High Court, and a ruling is due within the next few months.

What has led to this delay in restarting the reactors? The delay has been in the recovery of trust for nuclear power. A public opinion poll has revealed that almost 50 per cent of people are still cautious about the reintroduction of nuclear power, and only around 30 per cent agree with the restarting of the reactors. How can trust be reinstated quickly? Technology, a regulatory regime and culture are believed to be the key factors in securing safety for nuclear power. The nuclear reactor was able to withstand the earthquake during the Fukushima accident, so there are no serious problems with the safety of the technology. The problem was the 16 m high tsunami, which struck after the earthquake, leading to the loss of all power sources, and resulting in the failure of the cooling system. This was, in fact, a problem of the regulatory agency, which failed to account for the total loss of power in their safety standards. Since the September 11, 2001, attacks on the World Trade Centre in the US, wherein many lives were lost, countries in Europe and the US have adopted standards that take into account the total loss of power. Before the accident, Japan's regulatory agency was a part of the government office promoting nuclear power, and it has been pointed out that a major part of the problem was that the regulatory agency was not given sufficient autonomy. However, an independent Nuclear Regulation Authority was established later, in the fall of 2013, and one of the world's strictest safety standards were set, on which inspections have since been based. In fact, overseas experts have pointed out the need for greater efficiency in inspections. It can be said that the regulatory regime in Japan has now become the international standard. What has yet to catch up with this standard is the culture of safety. This requires the understanding of operators, as well as the general public. Operators must not stop at meeting the safety standards of the regulatory agency, but they must also cooperate with one another in pursuit of even greater safety. The Institute of Nuclear Power Operations (INPO) in the US is a typical example of this. This institute evaluates the safety performance of all nuclear reactors in the US, and those that are deemed safe enjoy the advantages of being able to undergo US NRC inspections smoothly and lower insurance rates. In Japan, too, the Japan Nuclear Safety Institute (JANSI) was established in 2012, and efforts are being made to ensure the safe use of nuclear power based on a similar philosophy. The culture of safety among the general public remains the major issue. Before the accident, the myth that nuclear energy was completely safe was widely believed in Japan. Because of this, many people in Japan were shocked by the accident and now tend to regard nuclear power as being absolutely unsafe. However, the reality is that there is no such thing as absolute safety or absolute danger. Everything is based on probability, and it is entirely relative. The important thing is whether the risk of an accident has been lowered to a "tolerable level" or not. The Japanese people tend to demand zero risk, but the unfortunate fact is that there is no such thing as zero risk energy. Nuclear accidents cannot occur in the absence of nuclear power, but climate change is becoming a serious problem, and there is the possibility of it causing major disasters. In that sense, the lack of nuclear power also comes with major risks. Moreover, in the absence of nuclear power, the cost of electricity in Japan will rise, prompting companies to move their factories overseas, and this carries the major risk of loss of jobs. Unless people are able to change this zero risk attitude, their distrust of nuclear power will not go away. In the decision by the Otsu District Court to prohibit operation of the Takahama Nuclear Power Plants, the court ruled that the safety standards of the regulation authority are inadequate, but this is believed to be because the judge is expecting a zero risk realisation. The deepening of discussions on the culture of safety among Japanese people is an important and urgent matter. On the other hand, emergency and evacuation drills will become indispensable because the risk has not been completely eliminated.

Emergency Measures

The government must be ready for any emergency situation because the accident probability will not drop to zero even with extensive efforts to ensure nuclear power safety, and this preparation extends to oil and natural gas. The most important preparation is stockpiling. In Japan, private sector companies have reserve obligations of 70 days for oil and 50 days for oil gas. Japan also has national reserves and joint reserves with oil producers. Oil reserves as of September 2016 totalled 183 days with private sector reserves at 78 days, national (public) reserves at 105 days and joint reserves with oil-producing countries at five days, leading to national total reserves at 183 days.[4]

With LNG, meanwhile, it is difficult technologically and economically to have reserves in excess of the ordinary inventories of 20-30 days. The government is reviewing the possibility of an expansion.

In its *Energy Outlook 2016*, the Institute of Energy Economics, Japan (IEEJ) conducted an analysis of supply disruption scenarios. The analysis indicates that a supply disruption of 10 million barrels of oil per day due to some unpredictable incidents in the Middle East might potentially cause roughly a 10 per cent contraction of the global economy on average. Going by region and country, the Middle East countries obviously would incur the heaviest impact with an estimated economic setback of about 20 per cent. The net hardest hit in order are Japan and South Korea and then the EU and India. The analysis projects a GDP decline of over 10 per cent in all these countries. While stockpiling can alleviate some impact, it is most important to promote cooperation among related countries to prevent supply disruptions from occurring.

Participation by Japanese companies in upstream investments and thereby obtaining autonomous developed crude oil is also an effective tool in energy security. While development investments decline globally when oil prices weaken because of risks, Japan has revised the Japan Oil, Gas and Metals National Corporation (JOGMEC) Act so that it can provide more financial support to the activities of private sector companies, including acquisitions and investments in overseas state-run companies.

Implications for Emerging Countries in Asia

Against the backdrop of the Fukushima accident and major changes in world energy conditions that occurred around the same time, Japan is strengthening not only quantitative security but also broadly defined energy security measures, such as securing rational prices and dealing with climate change. What implications might these activities have for Asian countries?

Oil self-supply ratios in countries of the Association of Southeast Asian Nations (ASEAN), China and India are likely to drop sharply accompanying growth in their economies. It is estimated that the ratio will decline during 2014-2040 from 53 per cent to 20 per cent, 42 per cent to 22 per cent and 23 per cent to 5 per cent, respectively.

The first thing that needs to be done in light of this trend is the promotion of energy savings. While energy consumption per capita is small, consumption per unit of GDP is not low in terms of the energy intensity. There is still significant room for energy savings. Promotion of energy savings also contributes to maximising curtailment of the rise in energy consumption that comes with economic growth.

The second step is the preparation of an energy mix. It is worth doing this with an approach of setting targets from a 3E+S perspective and then solving for simultaneous equations. The process should involve targets for raising energy self-supply, reduction of GHG emissions and lowering electricity fees, with an aim to create energy structure goals that meet the desired image.

The third step is the introduction of renewable energy resources at the lowest possible cost. While FIT regimes are effective, they can result in high costs. It is important to flexibly reduce the purchase price in accordance with the rollout volume and ultimately let the price be decided in an auction.

The fourth step concerns the role of nuclear power as an important energy for countries with large populations from the 3E perspective of strengthening energy security and lowering GHG emissions. The concern is ensuring safety. This takes more than technology and requires a suitable regulatory scheme and establishment of a safety culture.

The final step is strengthening hydrocarbon reserves. National governments can reinforce reserves if it is difficult to set obligatory levels for private sector firms.

Japan's experience in debating and implementing broadly defined energy security in the aftermath of the nuclear plant accident accompanying the Great East Japan Earthquake and massive tsunami provides a useful reference for many Asian countries.

NOTES

1. Organisation for Economic Cooperation and Development (OECD)/International Energy Agency (IEA), 2014.
2. Agency for Natural Resources and Energy (April 2014), *Strategic Energy Plan* (Trans.), p 21. Available online at http://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf
3. Ibid.
4. Closing Oil Stock Levels in Days of Net Imports, Japan, International Energy Agency, September 2016, http://www.iea.org/netimports/?y=2016&m=09

4

Ensuring South Korea's Energy Security? Priorities, Problems and Prospects

Se Hyun Ahn

ABSTRACT

In recent years, South Korea has encountered a number of energy security problems. The nation's energy diplomacy has virtually stopped functioning, mostly due to domestic political reasons. Furthermore, the nation's energy security has been endangered because its policy has been poorly executed with no concrete goals and no rational choice of an energy mix plan. This chapter seeks to examine South Korea's most urgent energy security agenda at the moment and recommends how the country should cope with these specific issues. This chapter also contends that the current problems of South Korea's energy security and the deadlock of its energy diplomacy stems from the ignorance of the exact definition of energy security at the national level, which includes policymakers, academia and various political groups, including the top leadership. As a result, South Korea's energy security is highly likely to face significant disarray in the coming decades since the nation's energy security clock has been set back five years. Nonetheless, it is crucially important for South Korea to keep an energy balance of power between continental and maritime groups for the coming century.

Introduction

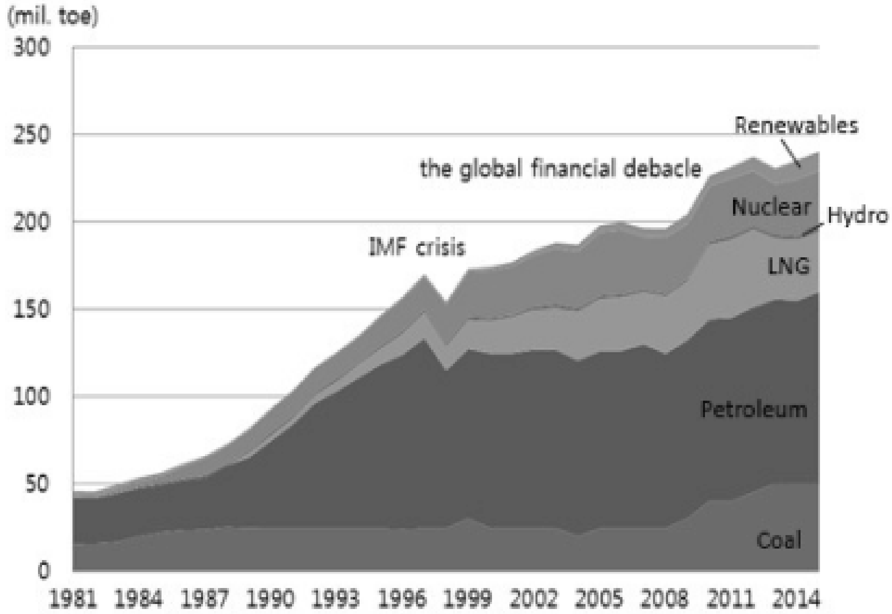
In recent years, South Korea has encountered a number of energy security and diplomacy problems. During President Park's administration, in particular, most of Korea's energy diplomatic activities substantially ceased to function, mostly due to domestic political reasons. Moreover, the country's energy security has been endangered because South Korea's energy mix policy has been poorly implemented in the past few years in the domestic context. The policy clearly lacked concrete energy security goals and thus failed to adopt the right energy mix. This eventually led to the failure of energy diplomacy. This chapter intends to analyse South Korea's most urgent energy security agenda at the present juncture and seeks to outline how the country should respond to these specific issues. Moreover, it outlines South Korea's energy mix policy according to various energy resources.

The current problems of South Korea's energy security and the deadlock of South Korea's energy diplomacy stemmed from the ignorance of the exact definition of energy security at the national level, including policymakers, academia, interest groups, different political parties as well as the President's office. In the next few decades, Korea's energy security is highly likely to face a significant challenge since the nation's current energy security clock has been set back five years, that is, before and during the Park Administration, and there is grave concern that South Korea's energy diplomacy will become stagnant. Nonetheless, South Korea must prepare for two levels of the energy alliance game in the region simultaneously: The first is forming continental energy alliances through pipelines and grid mechanisms, and second, through energy maritime alliances through the sea route and offshore resource development in the region. In particular, it is urgent and imperative that South Korea develops its Sector Seven oilfield with relevant regional partners in the near future since Sector Seven's clock is ticking.

South Korea Energy Trend

South Korea is desperately in need of vast amounts of natural resources to maintain its fast economic growth. Nonetheless, South Korea possesses very limited domestic sources of energy and relies almost completely on energy imports. As an energy-poor country with insufficient natural resources, South Korea's energy import dependency ratio is 96 per cent while ranking 10th in the world in energy consumption. It ranks ninth, 16th and 13th in the world in terms of consumption of oil, gas and coal, respectively, and fifth, sixth and third, respectively, in terms of oil, gas, and coal imports. For instance, energy imports as a percentage of total demand rose from 73.5 per cent in 1980 to 96.8 per cent in 2005. Moreover, South Korea imports all its oil and natural gas requirements. While South Korea remains one of the world's largest oil consumers (and at present it is the main fuel used in the country as shown in Figure 1), demand for oil as a percentage of total energy demand is projected to fall from 53 per cent in 2003 to 39 per cent by 2030.[1]

Figure 1: Trends in Final Energy Consumption



Source: Korea Energy Economics Institute (KEEI), 2016

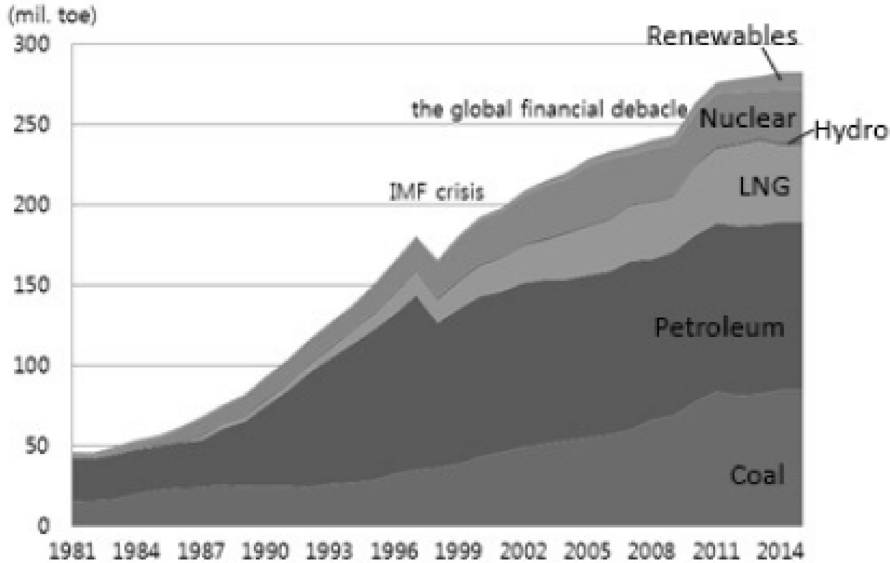
South Korea's Energy Security Priorities

What are South Korea's current energy security objectives? South Korea has several important energy security goals, which is reflected in the geopolitics and global energy market trends. These goals are related to both traditional security and non-traditional security in Northeast Asia. More importantly, these goals are closely interwoven with each other. From South Korea's perspective, the primary objectives of energy security are as follows:

1) The South Korean government should employ a smart power mix plan. It has promoted the use of nuclear power and renewable energy intensively in the past few years as compared to other energy resources despite the danger of a Fukushima-like incident (see Figure 2).

Nonetheless, this has led to major policy failure and potential problems for the country. It is essential for the South Korean government to turn to natural gas, considering the recent dramatic increase of micro dust in the

Figure 2: Trends in Total Primary Energy Supply



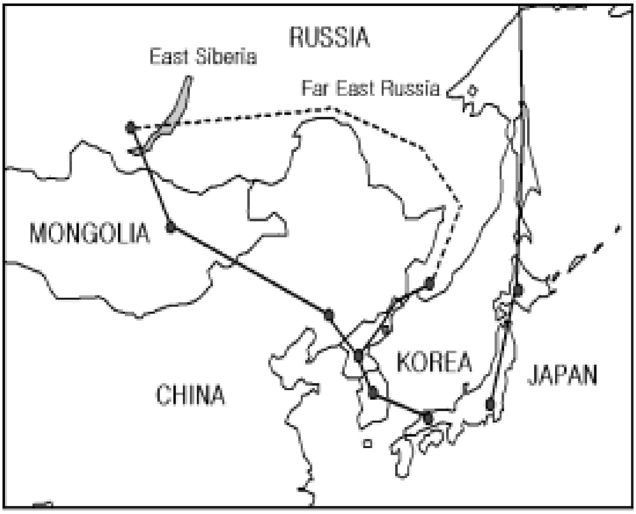
Source: KEEI, 2015

nation over the past few years. Also, the country must reconsider its most recent energy policy of building additional nuclear power plants, and should cut down the use of coal. (South Korea's energy mix policy is discussed in detail later in the chapter.)

2) One of the South Korean government's most important energy security objectives is to frame North Korea's energy security and thereby draw out the roadmap of the energy security framework for a possible reunified Korea. North Korea's energy security has completely collapsed for decades, and it is desperately in need of foreign assistance. Accordingly, natural gas seems to be a perfect solution for Pyongyang due to its diverse supply options, either from Russia or from North America. Moreover, the energy Supergrid project through the North Korean border has been mentioned as the most realistic, if grand, energy project in the region (see Figure 3). In this sense, North Korea is regarded as an important energy transit country in Northeast Asia. It is important to understand that the issue of North Korea's energy security should not only be accounted for from a commercial perspective, but from a larger geo-political framework in the longer term.[2]

3) Accessing Russia's oil and gas resources from the eastern Siberian region is another key component of South Korea's future energy security priority. In fact, South Korea is located between the energy continental power group

Figure 3: Northeast Supergrid Project

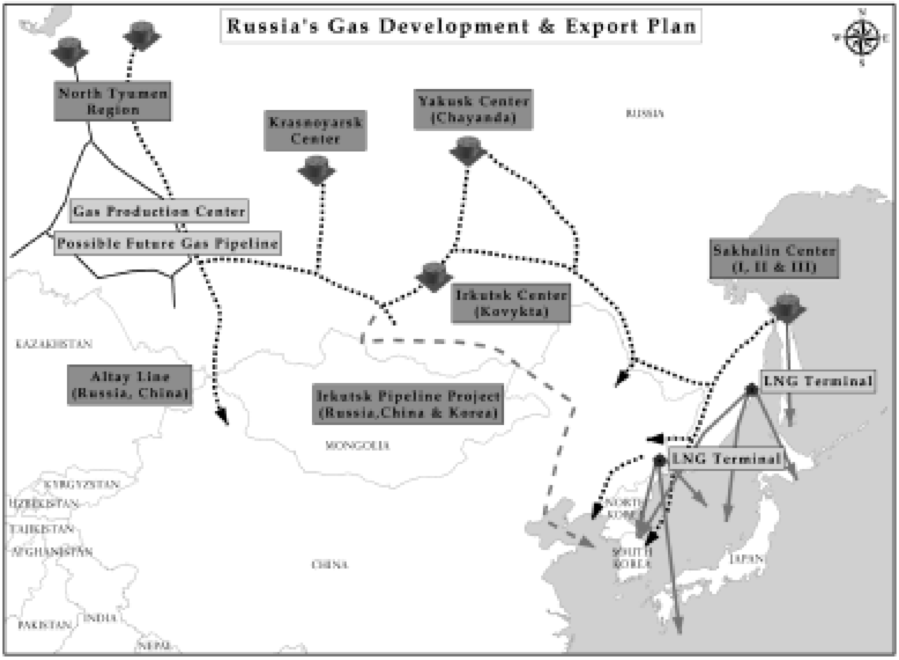


and maritime power. Recently, following the shale gas revolution, South Korea was actively courted by both Russia and the US to join their respective alliances. In particular, Eastern Siberia can turn out to be a very promising region given the short distance between the region and the Korean Peninsula, similar to the Russian-German energy rapprochement, as demonstrated in the past few decades. Recently, a natural gas pipeline project linking the two Koreas and Russia has been brought to the diplomatic table in the region, and is the focal point of Northeast Asian energy security cooperation. At the same time, Sino-Russian energy relations should also be carefully examined and analysed in detail to understand the current Northeast Asian energy flow.

It is crucially important to point out that South Korea is considered the perfect energy partner for Russia compared to other nations, including China, Japan and India, for various reasons. In terms of geopolitics, regional rivalry and historical constraints, Russia is keen that both South and North Korea engage in the 'energy great game' initiated by it. No doubt, energy cooperation between Russia and South Korea is extremely important; however, neither side is moving as fast as they should due to a wide range of obstacles, both domestic and international. Natural gas from Russia's Eastern Siberian field has the potential to not only drastically reduce Northeast Asia's energy shortage but also help diversify the region's dependence for energy imports from the Middle East and Southeast Asia.

Nevertheless, the potential for Russian natural gas reaching any of the

Figure 4: Russia's Natural Gas Export Policy



Source: KEEI, 2016

Northeast Asian countries, including South Korea, has remained only a wish for almost two decades due to several reasons.

First, Russia and China have been haggling over the price of gas. Although the oil trade between the two countries is relatively smooth, natural gas continues to remain problematic in Northeast Asia. However, gas flow is more important to South Korea, China, Japan and Russia, compared to oil since gas is largely a regional energy phenomenon, although a global gas market is emerging. Although China and Russia had arrived at an agreement on their gas price negotiations in 2014, the two countries still remain wary of each other, and the gas deal is not perceived as a game changer. Although China's market is important for Russia's PNG (piped natural gas) success, it is not a necessary condition. Moreover, despite plans for further gas market development, China's reliance on Turkmenistan, Kazakhstan, Myanmar and Australia has led to a soft market for relatively high-priced gas. And yet, China-Russia gas cooperation is a major factor for Russian gas transfer to Asia. In other words, it is highly unlikely that Russian gas will flow to Asia without the Chinese market.[3]

Second, the geo-politics of route determination has been a very sensitive and primary issue for Russian gas transfer to Northeast Asia. Although routing the pipeline via North Korea and Mongolia would make more economic sense, government and private sector sensitivities have led to proposed routes that circumvent the two countries, thus driving up costs of any such pipeline. Hence, transit country discussions still remain the focal point of the pipeline gas mechanism in the region.

Third, in Northeast Asia, the level of trust between the states is very low. Moreover, gas investments are one of the most complicated transactions compared to other energy business negotiations. In other words, natural gas is more difficult to trade than oil and requires much more confidence, guarantees and money from investors and governments. In this respect, the lack of confidence among states in the region, especially towards Russia, diminishes the possibility of a natural gas collaboration.

Fourth, in the same context, the Northeast Asian states tend to be quite wary about Moscow's resource diplomacy. Rising oil prices have traditionally given Russia the impetus to use energy as a political weapon. In Eastern Europe, the Near Abroad and elsewhere, and barring Western Europe, Russia has tended to pull some political strings in the course of gas diplomacy. As a result, East Asia still perceives Russia as a risk in terms of gas supplies from Russia.

4) How to build further strong energy alliance with the US is another important objective. South Korea and the US could elevate the existing strong alliance to the level of a special energy alliance through a Free Trade Agreement (FTA) between the two sides. In particular, the two sides could strengthen their energy alliance with the transfer of the US natural gas and crude oil. For example, the US could use South Korea's natural gas terminal to expand its Asian export market in the longer term. This type of alliance could be a more realistic scenario, given that the level of trust between the two states is very high, possibly even higher than the US-Japan alliance, for two reasons – both countries now have an FTA, as well as a 'blood alliance' since they fought together during the Korean War, whereas Japan does not yet have an FTA with the US and the two countries were enemy states during the Second World War.

5) Establishing a global oil and gas hub in the Korean peninsula also remains one of South Korea's energy security goals, despite several obstacles. South Korea is where in the future massive amount of Russian gas and North American gas will be imported, and therefore the country offers a perfect location to build a natural gas import and export station of a global scale, especially in its east coast. Nevertheless, South Korea would

also have to compete with Shanghai, Singapore and Japan for setting up a regional gas hub.

6) Maintaining sustainable development and clean energy is considered to be one of the most urgent energy security goals and concerns. Over the last several years. South Korea has experienced severe environmental problems with astronomically increasing micro dust coming from China, especially following 2010. The level of air quality (except in the summer) in South Korea has dramatically gone down after the 2008 Beijing Olympics. This is due to the fact that the consumption of coal in China also increased significantly, and most coal-generated factories have been shifted to the east coast of China, which is close to the Korean Peninsula. The severe smog and micro dust from China will cause significant regional security problems in the future. Therefore, the South Korean government should take appropriate steps or actions, while collaborating with the Chinese government in a more concrete way.

Designing the nation's energy diplomacy and security policy effectively is South Korea's daunting yet necessary task. In this respect, a proper energy security programme should be introduced at the national level, which should include the president, congress, ministries, media and the armed forces. Unfortunately, the leaders in the Korean Peninsula lack an understanding of the exact concept of energy security, and this often leads to national energy policy flaws.

Offshore resource development within the US-Japan-South Korea trilateral energy alliance is an interesting possibility. In comparison with the Sino-Russian energy alliance or potential Sino-Russian-South Korean energy alliance, the US-Japan-South Korea energy alliance could create a more reliable and predictable energy market system based upon decades of strong political and military alliances. Specific elements of energy alliance cooperation may include natural gas (shale gas) transfer and collaboration with gas-related industries, such as the gas automobile industry, as well as joint offshore resource development in the Pacific Ocean.

Japan and South Korea have been interested in developing offshore energy resources since the 1960s. More importantly, the three countries can cooperate on oil exploration and production in the South Korea-Japan Joint Development Zone (JDZ). The JDZ is located between the southern part of Jeju Island and west of Kyushu, close to the East China Sea area (see Figures 5 and 6). In Korea, the JDZ is often called the Sector 7 oil field. It is estimated that this field contains 7.2 billion tons of oil and gas, which is equivalent to the reserves in the Black Sea and is considered to hold more gas reserves than Saudi Arabia. Notably, China does not recognise the JDZ because it is too close to the East China Sea, and connected to the Chunxiao gas field, one of the biggest offshore gas fields in the East China Sea.

Figure 5: Sector 7 Offshore Development

Source: Insight, http://www.insight.co.kr/news/30526

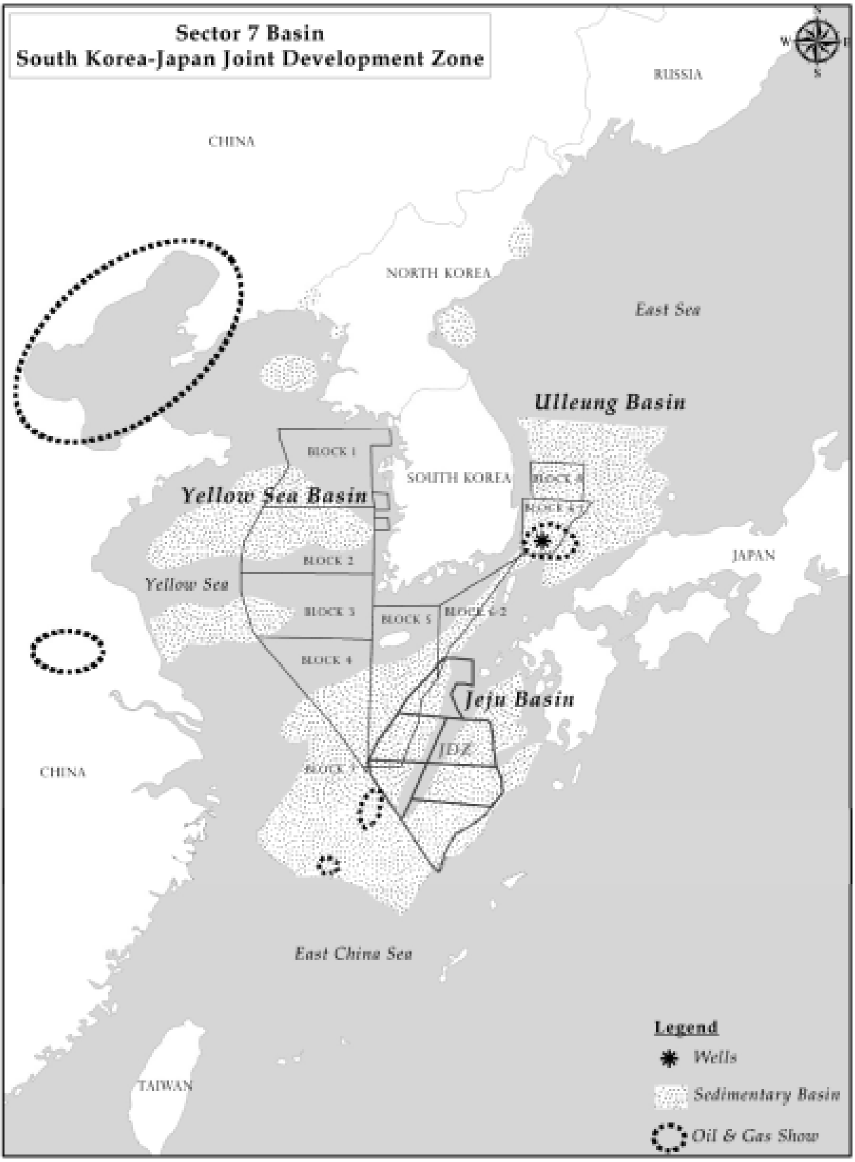
Alternatively, the three nations could work on framing the energy security policy in North Korea, including oil exploration in the North Korean offshore area in the future instead. Furthermore, a three-nation alliance could also work on energy transport-related sea route safety regulation activities or sea-lane communication issues as well as nuclear safety regulation in the future.

Finally, it is essential to examine the current development and obstacles of Sino-Russian energy relations as well as the possible energy transfer among China, Russia and the Korean Peninsula. This could lead the US, Japan and South Korea to implement the right energy strategy to form a new energy alliance among the three nations.

Energy Diplomacy

South Korea's energy diplomacy faces several challenges. Under Park Keun Hye's administration, most of the energy diplomacy activities virtually ceased to function. There are two explanations for this. First, the concept of energy security was simply missing amongst the top leadership, including at the legislative and judicial levels, as well as the presidential

Figure 6: Sector 7 (South Korea-Japan Joint Development Zone) Basin



Source: Korea National Oil Corporation (KNOC), http://www.knoc.co.kr/ENG/sub03/sub03_1_1_4.jsp office. In this respect, an energy security education programme must be introduced as early as possible. Politicians are seriously in need of learning the true concept of energy security. Moreover, energy security should not be a part of party politics or the election agenda, even though it offers quite a tempting and lucrative political agenda, as it is the most important element of national security. Yet, the Korean leadership does not seem to be aware of the importance of energy security.

Second, energy has been highly politicised within South Korean politics. The Lee Myung Bak Administration was hit by a series of energy-related scandals and corruption charges. Therefore, since the beginning of her presidential term, his successor, the former President Park, wanted to distance herself from the Lee Administration in terms of energy policy. Accordingly, the energy companies are still heavily regulated by the government, with the state energy companies being the primary target for annual government inspections. From the energy security perspective, excessive government intervention in energy diplomacy or related activities is not desirable because it is likely to shrink or malfunction the energy market or energy diplomacy.

Nonetheless, South Korea's primary energy diplomacy objective in the past several decades has been the diversification of the energy import market through four different channels: (1) The Middle East, (2) Southeast Asia, (3) Russia and the former Soviet Union; and (4) the new North American gas market. Furthermore, it is essential to point out that the Korean government desperately needs to keep up with the five megatrends of the global energy market in the future: the North American Shale revolution, Eastern Siberian natural gas, Turkmenistan natural gas, Mozambique natural gas and Brazilian offshore oil fields.

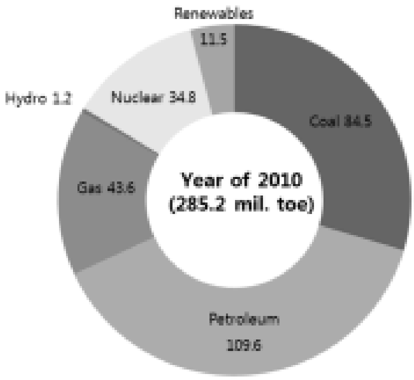
Recently, the Korean government has also set up a few specific energy policy goals for the Northeast Asian energy cooperation:

1) Framing or ensuring energy security in North Korea;
2) Establishing Northeast-Asian oil and natural gas hub facilities in the Korean Peninsula; and
3) Setting up multilateral frameworks to ensure the safety of nuclear power generation facilities such as Top Regulators' Meeting (TRM) and TRM plus. The TRM guides nuclear power safety cooperation among China, Japan and South Korea.

Energy Power Mix

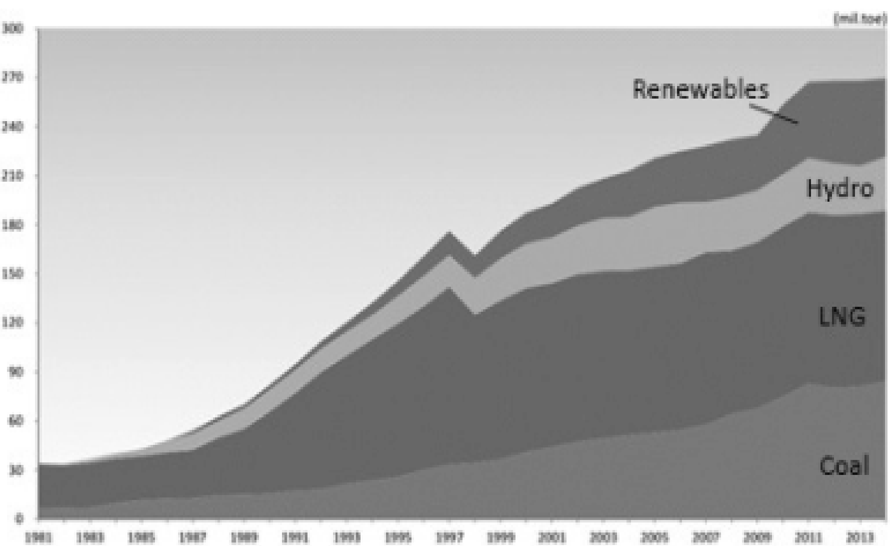
The Energy Power Mix policy is a very important element of current energy security. The quality of a country's energy mix policy reflects the status of its energy security and diplomacy. And in the given context, South Korea's most recent energy power mix plan has not been well implemented as it is skewed towards nuclear power generation and renewable energy. In other words, it does not reflect global energy trends, is short-sighted and is likely to create a wide range of energy security problems.

Figure 7: Trends in Total Primary Energy Supply



South Korea, like Japan, depends on foreign energy resources to meet its domestic requirements: the current rate of energy independence is only 3 per cent, which includes hydropower, anthracite (coal) and a small segment of renewable energy. Other than that, Seoul imports most of its energy requirements, including oil, coal and natural gas.

Figure 8: Energy Imports



Nonetheless, conventionally speaking, South Korea's current energy mix is perceived to be stable vis-à-vis global standards because energy resources for power generation have been diversified, compared with the early 1980s when oil used to be the primary source for power generation. Now, coal, nuclear power and natural gas have replaced oil for power generation. In short, external factors, primarily, the global energy market situation and the energy prices, have been the two most dominating variables determining South Korea's energy power mix plan.

In recent times, however, the energy power mix in South Korea has faced the following four domestic constraints:

1) Korea is over-dependent on nuclear power generation.
2) The Korean Government did not keep up with the current megatrend of the global energy market – the natural gas boom. It underestimated the role of natural gas in the global market, thus failing to incorporate it into the national energy power mix.
3) The Korean government overvalued the capacity of renewable energy. Renewable energy is neither base load energy like nuclear power or coal, nor peak load energy like liquefied natural gas (LNG).
4) Korea needs urgent energy reform, specifically regarding energy price and energy taxation. In other words, the Korean energy industry needs to be restructured and is desperately in need of significant reform.[4]

Notably, several environmental groups support nuclear power generation since nuclear power plants produce low CO_2 emission. This is a very interesting phenomenon throughout the world. Despite the 2011 Fukushima disaster, the threat of climate change has made nuclear power generation rather fashionable, especially in East Asia, including South Korea, and the US. However, in South Korea, land is limited, and the national energy power mix plan has not taken into account the total security cost of nuclear power plants.

Moreover, in Korea, the government-directed energy planning is divided into multiple units, including basic energy planning, basic power supply and demand planning, long-term natural gas supply and demand planning, renewable energy planning, basic energy utilisation planning and global energy diplomacy strategic planning – and thus faces a lack of integration because energy planning is not well-connected. Therefore, the South Korean government needs to urgently bring all these individual planning units together and also seek to rearrange them in terms of order. It is interesting to note that in Korea's most recent sixth and seventh basic national energy power mix plans, natural gas was not taken into consideration at all.[5]

Conclusion

This chapter reviewed South Korea's current energy security priorities and problems, as well as energy mix policy settings. The chapter revealed that under former President Park's Administration, South Korea faced a wide range of energy security problems at the national level. The nation's energy diplomacy lost almost all its momentum mostly because of domestic political reasons. Furthermore, the nation's energy security has been endangered because Korea's energy security policy, for example, its energy master plan, was poorly executed without any concrete goals or rational choice of an energy mix plan.

Nonetheless, this chapter analyses South Korea's most urgent current energy security task and the country's possible responses to the specific issues arising therefrom. It argued that the current problems of the country's energy security and the deadlock of its energy diplomacy stem from an ignorance of the exact definition of energy security at the national level among policymakers, members of academia, political leadership and media. Due to South Korea's domestic political turmoil, the country is fiercely divided on most issues, and consequently, the energy security issue has become the most sensitive and tempting political agenda.

As a result, not a single national energy company dares to expand its business abroad. Nor do the respective policymakers want to discuss any energy security policy. This is even more depressing when we see that the Japanese and Chinese leaders are most aggressively pushing forward their energy diplomacy concerns, especially given the current low global oil price. South Korea's top officials are simply concerned with CO_2 emission and renewable energy, while not realising the importance of natural gas and the true meaning of energy security. Korean energy policymakers' main problem is that they always tend to follow Washington's energy and environmental policymaking philosophy. Unless there is a revolutionary change in the understanding of the new energy security concept, South Korea's energy security is highly likely to face significant disarray in the coming decades.

It is essential to point out that national political leaders and energy policymakers should keep up with the global energy megatrends and set the upcoming energy security agenda. And most importantly, energy security policy and energy diplomacy should be depoliticised in South

Korea. National leaders in the Blue House, national congress, prosecutor's office and political parties must not look at the energy security issue as a political decoy or an issue to incite the public. Finally, it is vital to understand that energy diplomacy is the continuation of the domestic energy security issue and is an important component of the current national energy security policy. It is equally important for political leaders to understand that energy security no longer means only diversification or access. It also includes basic knowledge, vision and capacity of the leaders to understand the nexus between energy and national security per se, as it is vitally important for South Korea to maintain an energy balance of power between continental and maritime groups for the coming century.

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5

Russia's Asian Energy Pivot: A Prodigious Realignment

Rajeev Lala

ABSTRACT

This chapter examines the evolution of Russia's strategic realignment towards Asia – the Asian Energy Pivot – and how this realignment has gained strength in 2016. The chapter explores various interconnected topics critical to the evolution of Russia's realignment to the east.

Introduction

Russia's realignment comprises of a host of factors including, but not restricted to, the price rises after the OPEC meetings in Algiers and Vienna; a healthy M&A (mergers and acquisitions) market involving Russian and Asian upstream and downstream companies; the successful sale of the stake held by the Russian government in Rosneft; an unexpected deal between Russia and OPEC involving production cuts post-Vienna meeting in late 2016; and the fight to gain market share in Asia. While a lot of attention and analysis is focused on Asian countries and their efforts to enhance their supply security, there is an equal and important factor at play, i.e., Russia's efforts to ensure demand security.

This chapter argues that the Russian energy pivot to Asia is a strategic effort to:

1) expand its oil and gas revenue footprint
2) strengthen the prospects of the Russian energy sector and secure investments in a 'lower for longer' price environment

3) secure market share in one of the last major growth markets for crude oil and gas

Policy Implications

While Asian countries work on diversifying their sources of oil and gas, it is China and India (and potentially Japan and Indonesia) that are crucial to Russia's Asian energy pivot. Hence, relationships with these countries are critical to Russia succeeding in its energy realignment.

Historically, oil and gas investments have involved foreign capital moving into Russian upstream assets. Although this remains true even today, there has been a material outflow of capital from Russian oil and gas companies into the global, and especially Asian, energy assets. This two-way flow of significant investments strengthens the pivot in unprecedented ways.

Russian energy companies have successfully navigated the depths of the oil price crash and seem reasonably well prepared to ride a stronger oil price environment. This has geopolitical implications for the state as well as its relationships with existing large and growing Asian energy consumers.

Russia's Asian Energy Pivot: A Prodigious Realignment

When the city of Vladivostok was established in the 1860s, the city was named to literally mean 'the ruler of the east'. The city of St. Petersburg was built as Russia's 'Window to the West', and despite having invested a large amount of time, energy and effort to stay focused on the West, Russia has always had an eye on Asia. When President Vladimir Putin revived the old imperial symbol of the two-headed eagle, with one head looking west at Europe and the other looking east at the vast Russian territory in Asia, one could argue that he was looking to diversify Russian oil and gas exports that are the largest source of revenue for the government and for the Russian economy that depends on resource extraction and their export.

Emergence of the 'Asia Pivot'

Russia hosted the APEC (Asia Pacific Economic Cooperation) summit in Vladivostok in September 2012, where it revealed its 'Asia Pivot'[1] as a signal to the West that it was ready to embrace the growth of the Asian continent and strengthen its economic relations with large Asian economies. At the summit, President Putin discussed the strengths of the Asian economies and reiterated Russia's status as an "integral part of the Asia-Pacific region".[2] Putin also stressed on the fact that "Russia is a leading...and reliable energy supplier".[3] It was clear that energy exports, and within that spectrum, exports of oil and gas, were to form the bedrock of Russia's Asian Pivot.

The realignment was seen by many in Europe as a sign of things to come, with many analysts and politicians wondering what strengths and degree of commitment existed in Moscow towards the Pivot. Two years later, in his address to the Valdai International Discussion Club in October 2014, President Putin defended Russia's focus on Asia by stating:

> *"Our active policy in the Asian-Pacific region began not just yesterday and not in response to sanctions, but is a policy that we have been following for a good many years now. Like many other countries, including Western countries, we saw that Asia is playing an ever greater role in the world, in the economy and in politics, and there is simply no way we can afford to overlook these developments."*[4]

The rise of Asia has always been looked at by Moscow with interest, intrigue and many a times, with fear. Historically, Russia's engagement with its Asian neighbours was mostly on military-strategic terms.[5] However, Asia's rising economic might and dependency on energy imports is allowing Putin to work on partnering with the region as a reliable energy supplier. For Russian policymakers, the status of the geostrategic vulnerabilities of the country's Far East region is now counterbalanced by the growing narrative of the region being an energy bridge to oil and gas importers in Asia.

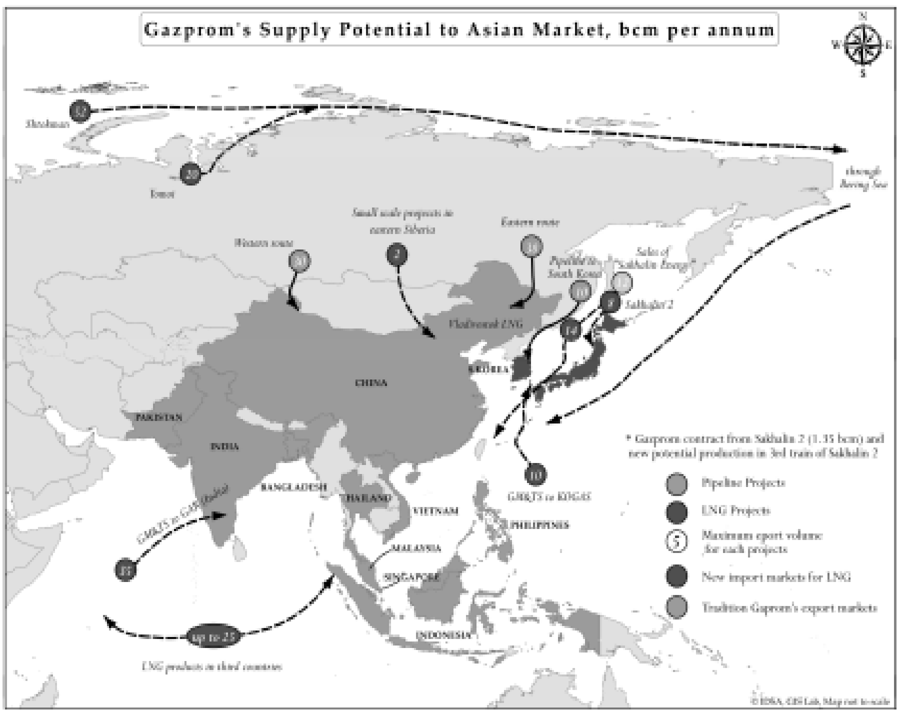
Energy and Trade – The Bridge to Asia

The Asian growth story has been in the making for decades and while various economies have emerged as attractive at different points (Asian tigers, the rise of China, the emergence of India), it was only in the 2010s that Russia pivoted east and looked at Asia not just as a consumer of its weapons, but also as a primary source of demand for its most lucrative resources – oil and gas.

Russia continues to sell weapons to anyone in Asia who is willing to buy.[6] Some analysts have called this strategy – a 'study in paradox'[7]. This has led to a delicate balancing act, especially in the South China Sea, where Russia is the main weapons supplier to both China and Vietnam. It is also the top weapons supplier to India, and despite the inroads made by American companies in the Indian defence market, Russia retains its lead in weapon sales to India[8].

Weapons sales are the legacy that has sustained Russian relationships with many Asian countries, but Russian trade with Asian countries is miniscule compared to the trade relations Asian countries have with each other and with the United States. In a sign of its intent to push for greater trade links with Asia, Russia and China agreed to push for a free-trade area in the Asia-Pacific region after a meeting between President Putin and Chinese President Xi Jinping during the APEC summit in Lima, Peru, in November 2016[9]. The Russia-led Eurasian Economic Union (EEU) also signed a free-trade agreement with Vietnam covering 90 per cent of all goods traded.[10] The Union, which comprises Russia, Armenia, Belarus, Kazakhstan and Kyrgyzstan, is a key platform for Russia and is considered by analysts to be a counter-balance to the European Union.

Gazprom's Supply Potential to Asian Market



Source: Gazprom Export[11]

While any strengthening of trade relations with Asia will require strengthening of the Russian economy, a short-to-medium-term boost to trade will primarily involve the export of natural resources, an area of historic strength for Russia and which resource-hungry Asian countries remain keen consumers of.

Oil and Gas Exports – The Centrepiece of the Realignment

Within the mix of vast reserves of mineral resources that Russia holds, oil and gas form the most lucrative component. The first 16 years of the 21st century have seen Russia rally Japan and China at various times to partner with its oil and gas projects in the far east – by inviting capital and technology from these countries, and as end-consumers for the same vast resources in its Far East region. However, the country remains undecided on how exactly it wants to shape its energy relationship with Japan or China.

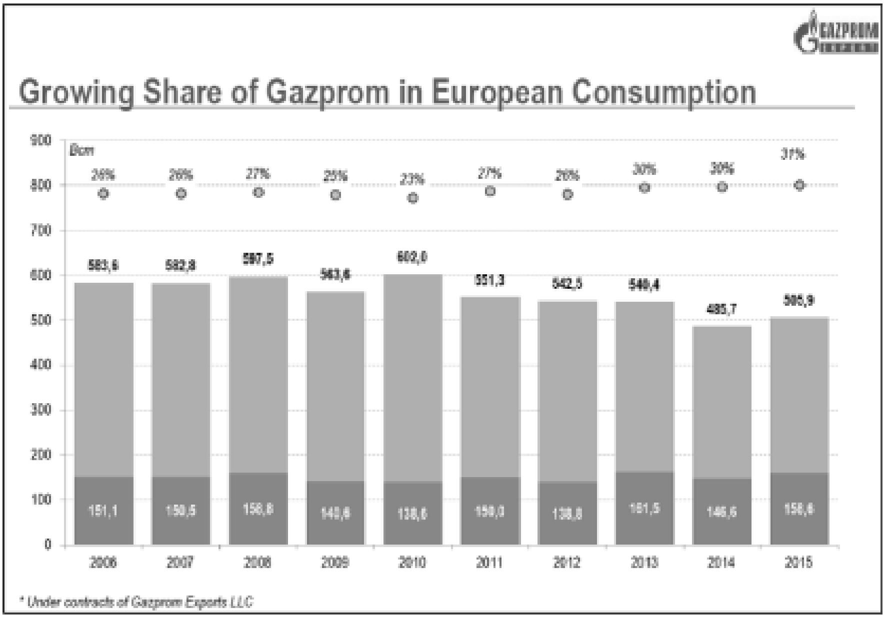
Gazprom created a gas strategy for Asia in 2003, dubbed the 'Eastern Gas Program', with the Russian government adopting the strategy in September 2006.[12] The aim of the strategy was to secure long-term gas supplies for consumers in Eastern Siberia and the Far East and help establish a new major route to export Russian gas to Asia-Pacific.

Most of Russia's focus in the period was tilted towards securing and growing its market share in the European energy basket – oil, gas, and coal. After the break-up of the Soviet Union, Gazprom was the primary entity that emerged from the Soviet era Ministry of Natural Gas and was the focal point of Russia's energy relationship with Europe. The company enjoyed multiple advantages, including the high geological quality of its major operating fields that allowed lower costs, as well as the fact that major export infrastructure had been put into operation, i.e., the 'sunk costs' were already invested. The resultant large profits were used to prop up the Russian economy as well as expand gas exports.

Europe – Gazprom's Core Market

Russian gas exports to Europe have formed the bedrock of its energy industry and, as the largest contributor to government coffers, was the basis for economic regeneration after the collapse following the breakup of the Soviet Union. At one level, the strategy of Gazprom to raise its market share in Europe has seen some success, with the company's share in European gas consumption rising – from 26 per cent in 2006 to 31 per cent in 2015. However, the growth in volumes in this period have been tepid, with volume growing from 151 bcm in 2006 to about 159 bcm in 2015. This low volume growth is because European gas consumption has fallen from 584 bcm in 2006 to 506 bcm in 2015.

Growing Share of Gazprom in European Consumption



Source: Gazprom Export[13]

Difficulties in the Core

However, as European consumption has fallen[14] and as the continent's markets have undergone changes in reaction to the development of an increasingly robust spot LNG market and strengthening of intra-EU pipeline linkages, many of the consumers have periodically clashed with the prevailing Russian business model of long-term oil-linked contracts containing take-or-pay and destination clauses. Gazprom's insistence on an integrated ownership structure in which both the transportation infrastructure and gas within it are owned by the same entity has been particularly targeted by the EU.

The EU has accused Gazprom of unfair practices stating that "*some of its business practices in Central and Eastern European gas markets constitute an abuse of its dominant market position in breach of EU antitrust rules*".[15] While Gazprom has said that it is working on resolving the charges,[16] Brussels is in a delicate situation where were it to not take measures that are deemed punitive against Gazprom, or if there is a perception that Gazprom escaped without any heavy punishment, the EU member states in Central and East Europe would vehemently oppose any deal. This complicates matters for

Gazprom, which is the monopoly gas exporter of Russia and depends on lucrative export contracts with European consumers for its revenue.

In addition, Western sanctions on Russia have slowed down development of new difficult-to-develop reserves, although recent reports suggest that domestic companies like Rosneft and Gazprom Neft (oil arm of Gazprom) are raising production.[17] The sanctions have come at a difficult time when the oil price has slumped, and have effectively banned the financial and technological participation of western oil and gas companies in Russian projects.

'Lower for Longer' – Trouble for Gazprom?

The global gas market has seen phenomenal growth and changes in the past decade. There is in fact a lively ongoing debate about whether the assertion by the International Energy Agency (IEA) in 2011 of a 'Golden age of Gas'[18] was *premature*[19] or *a false dawn*[20]. While the debate continues, it is clear that the natural gas market has evolved tremendously in the past decade. On the demand side, large new consumers like China and India emerged, the Fukushima nuclear disaster led to a surge in Japanese demand, and new markets like Pakistan and Jordan were on the lookout for LNG deals. On the supply side, mega projects in Australia and especially the rise of the tight gas industry in the United States created a situation of oversupply (also caused by a slowdown in Chinese demand) that may persist for some time. This oversupply is leading to more flexibility in gas deals with a majority of new deals allowing destination flexibility and resulting in lower trading margins across the board.[21]

The evolution of the global, and particularly European, gas market has presented Gazprom (and the Russia state) with multiple challenges as well as opportunities. One of the ways the state and its energy giants have reacted is to 'Look East' while keeping an eye on the west – just like the two-headed eagle. An example of this is Gazprom stating that while Europe will remain its '*top export market*',[22] Asia will be the '*driver of new business opportunities*'.[23]

The evolution of the gas market in the past few years has coincided with a revolutionary change in the well-established, albeit very volatile, oil market. Growing US tight oil and gas production forced the hand of OPEC, which in November 2014 opened its spigots and moved away from production controls. In the words of Ali Al-Naimi, the former Saudi oil minister and architect of the 2014 OPEC policy allowing pumping of oil without any quotas,

> *"The oil market is much bigger than just OPEC. We tried hard to bring everyone together, OPEC and non-OPEC, to seek consensus. But there was no appetite for sharing the burden...So we left it to the market as the most efficient way to re-balance supply and demand. It was — it is — a simple case of letting the market work."*[24]

While OPEC reviewed its decision two years later in December 2016, the world has adjusted to a 'lower for longer' environment, and the supply surge has forced a rethink from all oil and gas market participants.[25]

Within this new dynamic of the oil and gas markets, two points stand out as having significant long-term effects on energy markets, and these points have contributed to Russia's Asian energy pivot. They are the US shale boom and the expansion of the Panama Canal.

US Tight Oil and Gas – from *Peak Oil* to *Peak Oil Demand*

One of the most significant events in the 21st century has been the rise of the US shale oil and gas industry.

For a perspective on the volume growth of the shale industry:

1) The United States has gone from producing about 350,000 b/d of tight oil in 2000, to an average of 4.3 mmb/d in 2016.
2) In shale gas, US production has jumped from 2.1 bcf/d (59465377.84 cubic metres) in 2000 to 43 bcf/d (1217624403.46 cubic metres) in 2016.

These phenomenal growth numbers have resulted in a reversal of strategies (and many a fortunes) in the global oil and gas industry. In September 2005 when Gazprom exported its first tanker of LNG to Cove Point regasification terminal in Maryland, United States,[26] the prevailing wisdom was that the United States would become a major LNG importer and it was only a matter of time that Russian exports would be a major source of those imports. The company had signed a number of Memorandum of Understandings (MoUs) with American oil and gas companies like Chevron, ConocoPhillips, ExxonMobil, and Sempra Energy. Gazprom's goal was to participate in North American LNG regasification projects, market gas supplies in the US, and carry out gas exchange transactions through North American pipeline infrastructure. The rise of the US tight oil and gas industry has significantly dented those plans, and it is highly unlikely in the foreseeable future that the industry will reverse course.

The surge in US tight gas production led to dozens of applications to the US Federal Energy Regulatory Commission (FERC) for approvals for LNG export terminals. As of 14 December 2016 the FERC had approved

10 export terminals of which 7 are under construction.[27] Additionally, 16 new proposals are pending before the FERC.[28] Only three out of the 26 terminals proposed are on the US East Coast: the Eagle LNG Partners' Jacksonville Florida project; Cove Point LNG plant in Maryland; and a project proposed by Southern LNG Company in Georgia. The remaining 23 projects proposed are for the coastal Gulf of Mexico.

To say that the phenomenal growth in US tight oil and gas production has global repercussions would be an understatement. The improvements in fracking technology have moved the world from 'peak oil'[29] to 'peak oil *demand*'.[30] Suppliers across the globe have had to go back to the drawing board and reassess their export markets as the United States is increasingly looking at the possibility of turning energy self-sufficient in the coming decade. In their reference care, the US Energy Information Administration (EIA) estimates that the United States will become a net energy exporter by 2026.[31]

US tight oil and gas production has forced OPEC to change its strategy, and played a major role in the unprecedented decision by the Saudi ruling family to sell off a stake in the Kingdom's crown jewel – Saudi Aramco. The US shale revolution has forced a rethinking of a pronouncement held untouchable and sacrosanct, namely, 'oil is an exhaustible resource'. As Spencer Dale, Chief Economist for BP, stated: "*Increases in available oil resources are nothing new. But what has changed in recent years is the growing recognition that concerns about carbon emissions and climate change mean that it is increasingly unlikely that the world's reserves of oil will ever be exhausted.*"[32]

The Russians clearly recognize this possibility that all oil will never be consumed and that prices may never go back to triple digits without long-lasting geopolitical exigencies. Thus, has begun a race to ensure demand security and a pursuit of demand centers in Asia. A second major event has made this pursuit of market share more competitive. This is the expanded Panama Canal.

Panama Canal Expansion – Gas Markets Become More Flexible

Work on the expansion of the Panama Canal commenced in September 2007 with an eye to accommodate larger ships, including LNG vessels.[33] This was the first expansion of the project since it was completed in 1914. The project was completed in June 2016, nearly two years after the original target of October 2014 and an estimated $150 million over the budget of the $5.3 billion that was proposed 10 years ago.[34]

According to the EIA, the expanded Panama Canal can now accommodate more than 90 per cent of the global LNG tanker fleet. This represents almost 4 bcf (113267386.37 cubic metres) of transport capacity.[35] Prior to the expansion, only 30 of the smallest LNG tankers (representing about 6 per cent of current global fleet) could navigate the narrow locks of the canal. While this lack of connectivity between the Atlantic and the Pacific Basins was of limited consequence to Russia when the United States was an importer of gas, the emergence of the United States as an LNG exporter (and the lifting of the crude export ban[36]) has made canal expansion timely and consequential to global gas markets and has added a serious competitor to Russian plans to export gas to Asia.

The opening of the Sabine Pass LNG project in February 2016, with the loading of the first commissioning cargo,[37] allowed companies in the United States to commence exporting a part of the country's significant gas output from the Marcellus and other shale basins. In a world '*awash in oil and gas*' (Dr. Fatih Birol, Executive Director of the IEA, 24 October 2016), the commencement of US gas exports and the expansion of the Panama Canal represent a significant threat for Russian LNG ambitions as its traditional export markets stagnate.

Implications of the Canal Expansion on the Global LNG Market

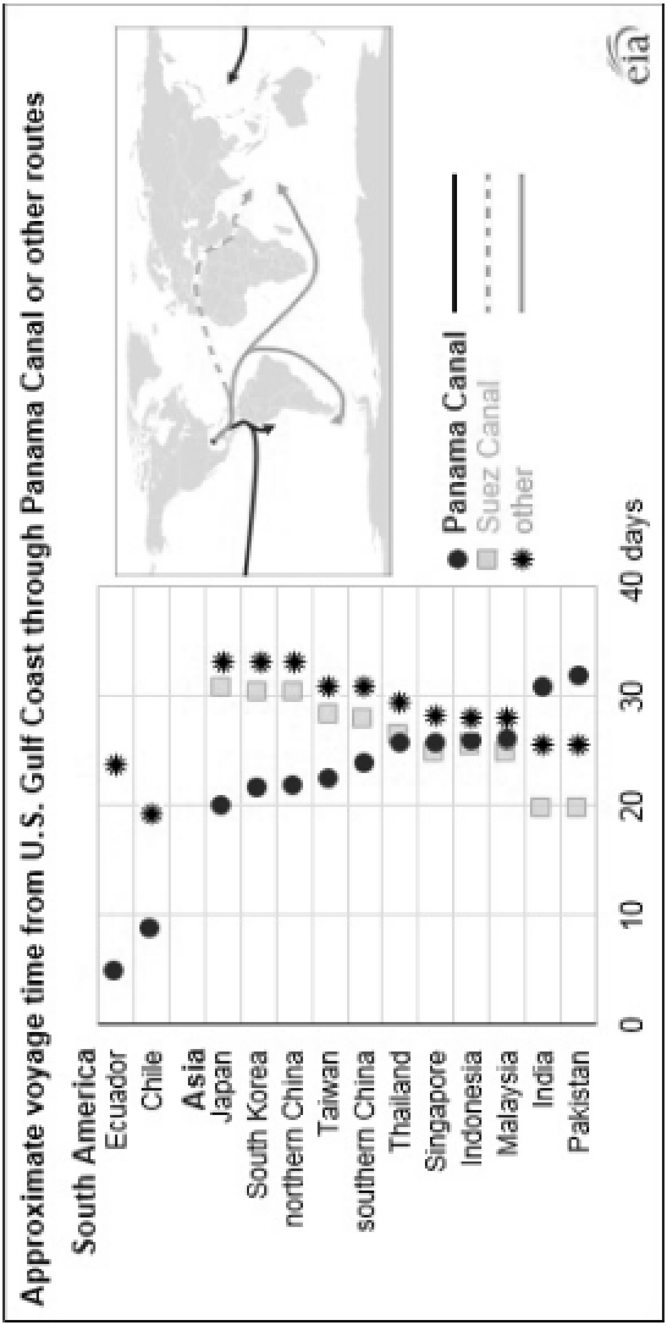
The expanded Panama Canal implies a reduction of voyage of Very Large Gas Carriers (VLGC) to 20 days from 34 days, for tankers headed from US Gulf coast to Japan. US gas exports to South Korea, China and Taiwan also benefit from shorter transit times. Together, these four countries in northern Asia collectively represent almost two-thirds of global LNG imports.

However, US LNG exports to India, Pakistan, and the Middle East will not save on transportation costs as it is profitable to use alternative routes like the Suez Canal or the Southern tip of Africa.

EIA also does not forecast any significant change to crude oil or petroleum product flows. This is because crude oil is largely transported through Very Large Crude Carriers (VLCC) or Ultra Large Crude Carriers (ULCC), both of which are too large to use the Canal when fully loaded (EIA, June 2016).

The largest gas consuming markets in North Asia are now within the reach of American producers who were previously dependent mainly on the Atlantic Basin (i.e. Europe, and Brazil and Argentina) as markets for their LNG. The expanded canal has opened up opportunities in the Pacific Basin,

Approximate Voyage Time from U.S. Gulf Coast through Panama Canal or other Routes



especially in Japan, South Korea, and even China if prices rise. This competition for the Asian market is unprecedented, and in a world awash in LNG makes Russian efforts to court Asian consumers a critical effort to diversify its exports as well as secure demand for its vast reserves in Eastern Siberia and the Far East.

Russia and Asia Oil and Gas M&A – No More a One-Way Street

Historically, the Asian continent has been a major source of investments for Russian upstream and downstream assets. When the Qatari Sovereign Fund (in partnership with Glencore) invested $23.5 billion for the Russian Government's 19.5 per cent stake in Rosneft, the fund followed a long tradition of investing in the lucrative Russian upstream and downstream sector. The Qataris followed the Chinese, the Indians, the Japanese, the Koreans, and the Vietnamese, who have all made significant investments in Russia across the upstream and downstream assets.

Asian investments have seen mixed success. For example, India's ONGC suffered a significant loss of value on its $2.2 billion acquisition of Imperial Energy. The company had underestimated the subsurface difficulties it would face with Imperial's assets, resulting in production that is a fraction of what the company had envisaged.[38] On the other hand, the Sakhalin 1 assets which was ONGC's first international foray (ONGC subsidiary ONGC Videsh Ltd. holds a 20 per cent stake) in 2001, has been a success with total production exceeding 200,000 b/d.[39] Nevertheless, Russia remains open for business, and is attractive especially for Asian NOCs looking to build a large resource base for their growing economies.

Recent deals include Beijing Gas Group Co. buying a 20 per cent stake in Verkhnechonsk field for $1.1 billion from Rosneft, ONGC making multiple acquisitions including 11 per cent in the Vankor field (in addition to a 15 per cent stake acquired in early 2016), and the Government of China signing loan agreements for $12 billion for the Yamal LNG project.

Rosneft's Essar Deal – A Significant Bet on Asia

The $12 billion acquisition by Rosneft and its partners Trafigura and United Capital Partners (a PE fund) of Essar Oil marks a significant shift for Rosneft (and the Russian oil industry overall) – which has historically concentrated on strengthening its hold in the Russian upstream sector. The deal is one of the largest foreign investments by Rosneft and a significant play on the rise of the energy deficit-Indian economy. Rosneft is led by Igor Sechin, who is seen by many as close to President Putin,[40] and considered by many as the *Siloviki* (former and current members of the security services) architect of the post-Soviet rebound of Russia's oil and gas industry.

The deal marks the first significant investment by a large Russian oil and gas company into the Indian oil and gas sector. Rosneft and its partners gain a 98 per cent interest in the Vadinar Refinery, a captive power plant, 2,700 retail sites, as well as related storage and import/export facilities. The deal gives Rosneft not just a foothold in the Indian oil and gas sector, but is also a major outpost in South Asia for its vast logistics and trading operations. Rosneft acquired a 49 per cent stake in Essar so as to not flout western sanctions, with partners Trafigura and United Capital Partners on board acquiring 49 per cent. The Ruia brothers of Essar will hold a nominal 2 per cent in Essar Oil.

Reiterating the game-changing nature of the deal, Sechin commented, *"This is a significant milestone for the Company. Rosneft is entering one of the most promising and fast-growing world markets. At the same time, this project provides unique opportunities for synergies both with the existing assets of the Company and Rosneft's future projects, and opens a big potential for expansion of its presence on the markets of other APR countries, such as Indonesia, Vietnam, the Philippines and Australia."*[41]

Rosneft was particularly active in 2016, completing in swift succession the acquisition of Essar Oil and the acquisition of a 30 per cent stake in Eni's Zohr gas discovery offshore Egypt for $1.5 billion.[42] Commenting on the deal, Sechin said: *"Rosneft participation in the Zohr field, developed jointly by our international partners – is a logical step in the development of our cooperation in Egypt and boosting of the positions of the Company at markets on the rise"*.[43]

The Essar and Zohr deals represent significant outflow of capital for Rosneft at a time when cash is scarce. Combined with Qatar Sovereign Fund's acquisition of the Rosneft stake, these deals are a sign of confidence that Putin has placed in Sechin, and one can infer that Rosneft will be the lever as Russia works on its relationships with Asian consumers.

A Fight for Market Share, and the Risk of 'Stranded Assets'

The Essar acquisition raises stakes in South Asia which is literally and figuratively, Saudi Aramco's backyard. Although Russia and OPEC (influenced by Saudi Arabia) have agreed to coordinate on cutting production in 2017 in order to reduce the overhang of crude oversupply, there is still fierce competition between Rosneft and Aramco for Asian consumers. Saudi Aramco was also rumored to be in the market for the Essar stake, but in the end, Rosneft presented a better offer and completed the acquisition.[44]

As the world gradually moves away from fossil fuels and renewable sources of energy make inroads into traditional industrial sectors, there is an emerging school of thought that believes that the oil and gas industry is likely to face the risk of 'Stranded Assets'.[45] This risk is primarily based upon a world rising in the fight against carbon in an effort to fight climate change. A reference to stranded assets was made by the Bank of England's Governor Mark Carney, who opined that in a climate-change constrained world, three kinds of risks stand out (Bank of England, 2015). They are:

1) physical risks (impact from climate and weather related events),
2) liability (compensation for parties who have suffered loss or damage from the effects of climate change), and
3) transition risks (changes in policy, technology and physical risks prompting a reassessment of a large range of asset values).[46]

The main risk for large oil and gas exporters like Saudi Arabia and Russia is the 'transition risk' – where changes in policy, technology or serious climate-related events force a wholesale reassessment of oil and gas industries, leading to reducing demand for their main export.

In a 'lower for longer' world where efficiency and scale are rewarded, it was imperative for Russia to look east and create relationships in an effort to secure demand for its oil and gas. As the European market stagnates, and tight oil and gas production ring-fence the US consumer markets from the global market, the fight for Asia is only going to get fiercer.

Conclusion

The Russian state has embarked on a serious and ambitious realignment of its interests with the Western sanctions playing a role in having forced its hand on the 'Asian Pivot'. The relationships it will build with Asian countries will play a major role in shaping economic and business interests on both sides. Rosneft's mega acquisition of Essar is an unprecedented attempt at making inroads into the fast-growing Indian market, and along with the company's acquisition of a 30 per cent stake in Eni's giant offshore Zohr gas discovery in Egypt in December 2016, are an indicator of the company's confidence and belief in 'internationalizing'. As global focus shifts to mitigating climate change, big oil and gas will be scrutinized for its carbon footprint. In such a scenario, 'demand security' will matter and Russia will not be immune to competition.

Moscow is correct in making inroads into the Asian markets and despite the fear that the country will be reduced to being a raw material supplier to Asian economies, particularly China, an innovative strategy that utilizes export income to diversify the economy is better than not exploiting the vast resources of the Far East. As the cost of renewables keeps shrinking, and new technologies risk overwhelming demand estimates that look into the future, the oil and gas world has been forced to rethink their strategies and Russia is no different. The risk of 'stranded assets' while not a near-term risk, certainly poses strategic challenges for Russia. Oil and gas play a central role in the government's attempt to strengthen its Asia Pivot, and exploiting these resources will be crucial to bring economic vitality to the sanction-hit Russian economy.

Energy exports have been a strength for Russia and playing to its strength while developing deeper and long-lasting trade relations on the foundation of energy exports will be a win-win for Russia and its partners in Asia. In this regard, the confidence with which the Russian state (through Gazprom and now primarily through Rosneft) has made a play for Asian demand growth is a signature move by President Putin and his advisors, and the clearest sign yet that Moscow is backing up its Asian Pivot with resources on the ground.

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6

Disruption in the Global Energy Order: Geopolitical Ramifications for West Asia

Girijesh Pant

Introduction

The uncertainty in the energy market since 2014, unlike in the past, is not as much a reflection of market volatility as of structural changes characterised by transition and transformation in the global energy system. The twin processes triggered by environmental concerns, calling for clean energy (Paris Agreement) and the revolutionary changes in smart technology, are shifting the strategic leverage amongst the producers and between the producers and consumers at various levels – globally, regionally and within national boundaries. The geopolitics of energy thus is being reconfigured with changing power dynamics. The trends are clear: that hydrocarbons, despite their centrality in the global energy mix, are incrementally losing their prospective market share. The investment flows in renewable energy have outpaced those in hydrocarbons. In power generation, renewables are substituting traditional energy in a big way. Further, of late the market signals are indicating that oil demand is peaking and that the technological fixes are revising the break-even prices downwards. Even the hydrocarbon-rich West Asia is re-configuring its energy mix by bringing in renewable energy in its energy basket. In this chapter, an attempt is made to explore the dynamics of the new power play in the emerging energy market with reference to hydrocarbons, and among the hydrocarbon players, with a focus on the oil exporters from West Asia.

Disruption in Energy Market: Transition and Transformations

The global energy market is passing through a phase where the commitment to Intended Nationally Determined Contributions (INDCs) by 200 countries and the scale and pace of technological changes have unleashed processes that are disrupting the prevailing energy order. The disruption is not of uniform nature and magnitude. It is varied in intensity and impact[1] because its parameters – recourse endowment; technological breakthroughs; climate change; demographic and social change; rapid urbanisation[2] – are not uniformly applicable. Thus, while in some markets the structural change reflects more in terms of transition than transformation, as compared to others, the market in general is reaching the transformation threshold. However, despite the distinctive nature of change, the energy market is also witnessing an active interaction induced by an evolving global supply chain.

The most disruptive impact of technology on the global oil market is reflected in the prospects of peaking of oil demand in the not so very distant future. According to a Mackenzie report, the oil demand growth is going to be flattened to 0.4 per cent by 2050. The World Energy Council has made a more alarming prognosis stating that "per capita energy demand will peak before 2030... This is in stark contrast to historic growth levels, which have seen global demand for energy more than double since 1970".[3] According to reports, the WEC states that "If rapid adoption of new technology and business models disrupts the existing system, demand could peak in 2030 at 103 million barrels a day... More aggressive adoption of low-carbon policies could bring a lower 2030 peak of 94 million barrels a day, while the status quo would mean demand reaching a plateau of about 104 million between 2040 and 2050."[4] According to Royal Dutch Shell, "We've long been of the opinion that demand will peak before supply.... And that peak may be somewhere between 5 and 15 years hence, and it will be driven by efficiency and substitution, more than offsetting the new demand for transport."[5] Clearly, diverse assessments are converging to point out that the global economy is moving towards an energy path where oil will remain the vital player but not the strategic commodity it has been over the years. Therefore, the geopolitical imperatives are going to change consequent to the technological breakthroughs in the oil sector. It may disrupt and rewrite the organising principle of the global energy market.

The magnitude of the disruptive impact of the technology lies with the very nature of technological innovation. The onset of digital technology is bringing revolutionary changes in global energy systems. It is argued that "the combination of the five S's: software, semiconductors, sensors, solar and storage that really is creating an energy revolution. And one of the results of this revolution is that people will move to the centre of the energy system, as this power consumption and generation, becomes digitalised, decentralised and data-driven."[6] World Economic Forum, too, shares the prognosis,

> The digital transformation of energy systems – smart meters, energy management systems, automated demand response or microgrids – could also help people everywhere access a reliable and affordable source of energy. Two-way communication between energy producers and consumers, as well as the increasing number of prosumers – those who both produce and consume energy – means that distributed energy resources can be dispatched to those areas that need it the most. That could include areas encountering supply shortages and grid stability issues, or those where renewable resources provide only an intermittent energy supply.[7]

The technological push to the prevailing energy order is thus manifesting in two distinct patterns. It is transformative in the context of Western economies where,

> (Germany), farmers and private individuals own more than 50 per cent of the solar output in the country ... Over the course of a full week between the 3rd of May 2016 and the 9th of May 2016, UK's solar panels where generating more electricity from the sun than coal. It is thought to be the first time the UK has been without electricity from coal since the world's first centralised public coal-fired generator opened at Holborn Viaduct in London, in 1882.[8]

In case of energy-poor countries of Asia and Africa where 1.2 billion are critically dependent on carbon-based growth, it is more prudent to calibrate the transition to a low carbon regime by changing their energy mix. This means in short to medium term, the global energy market is going to be segmented between two energy regimes, the transformative regime where oil demand will be peaking and digitalisation is redesigning the energy architecture, and the market where due to energy poverty hydrocarbons remain the principal energy source but are substituted incrementally by transition processes. However, the transition regime, being part of the global, is impacted by the pace of developments in the transformational regime as well.

Energy Order in the Shadow of Technological Change

The emerging energy market is going to be driven by revolutionary changes in technology, paving way to new hydrocarbon and non-hydrocarbon resources. Thus, new suppliers of hydrocarbon and non-hydrocarbon energy are in the market. The disruptive impact was felt dramatically when the commercial production of shale gas and oil transformed the American positing in the global energy market. "The shale revolution would not have been possible without sensors and massive computing power which have enabled the game changing drilling technologies such as seismic imaging, horizontal drilling, digital oil fields and measurement while drilling."[9] It is technology that has provided the US strategic leverage, and it will continue to do so. This is very clearly visible in the attrition game that Saudi Arabia has been playing since 2014: not cutting oil supplies in the hope of easing out high-cost players from the market. The assumption was that the break-even price would fall, and the shale wells would become unsustainable. It did play out that way for a while. A number of shale wells were reportedly closed down. At one stage, the number of rigs drilling oil dropped by 46 per cent.[10] It was turning out to be a "high cost game".[11] Technology, however, played it out differently, allowing the break-even price to fall sharply, thus contesting the prevailing assumption of the time that oil price at $75 per barrel will price itself out of the market. Moreover, "The Bakken fields on average dropped from break-even price of over $60 per barrel in 2013 to just under $30 in 2016. During the same time period Eagle Ford production prices dropped from about $80 to about $40, Niobara field production dropped from about $70 to under $40, many Permian fields dropped from about $80 to less than $40. Cost cutting has been severe and successful in many cases."[12] The shale revolution is a direct consequence of experimentation with new technology. The driver disrupting the traditional oil flow is not shale oil and gas deposits but the technology that could produce them at a highly competitive cost, crowding out the traditional players from the market.[13] Clearly, it is the technology that is providing the strategic leverage to energy producers. This is evident in the case of renewables, too.

The renewables are back in the market on the strength of technology. The steep decline in cost of solar and wind energy, and breakthrough in storage technology have made renewables competitive with prevailing energy sources. According to IRENA,

> Between 2009 and 2013, prices for solar PV modules declined by 70%. During this same period, the cost of residential solar PV systems in Germany declined by 53%. This has led to corresponding declines in the levelised cost of electricity (LCOE) for solar PV, making it increasingly competitive for supplying power to the grid. As a result,

> in locations where PV system costs are low and/or excellent solar resources exist, solar PV is often competitive with residential electricity rates today ... Renewable energy has entered into a virtuous cycle of falling costs, increasing deployment and accelerated technological progress.[14]

The decisive acceleration in the pace of renewables was noticed in 2013, "when the world added 143 gigawatts of renewable electricity capacity, compared with 141 gigawatts in new plants that burn fossil fuels ... The shift will continue to accelerate, and by 2030 more than four times as much renewable capacity will be added".[15] Moreover, with the growing application of digital technology, the renewables are gaining a competitive edge to face the pressure from cheap oil as well.[16] Further, the anticipated changes in storage technology could even transform the very fundamentals of the energy regime. It is going to cut down the cost and enhance sustainability by a measure that renewable energy could substitute conventional energy. "Many energy stationary storage applications today cost US$500-1000 per KWh. The day when we can get batteries at around US$100 and we could build applications on top of that for maybe US$200 – this will have major impacts on the business case and market opportunities."[17] Besides the cost, the capacities are going to be enhanced for a longer duration. Breakthrough in battery technology is expected to transform the dynamics of energy storage. According to a Massachusetts Institute of Technology (MIT)-linked company, "it is very close to commercializing a new type of lithium metal battery that has about double the energy density of today's standard lithium-ion battery."[18] Like hydrocarbons, it is renewable technology that is going to provide strategic leverage; hence, those who have control over energy technology are going to define the new energy order. As former US President Obama said, "The countries that lead the clean energy economy will be the countries that lead the 21st century global economy."[19] Moreover, "It's all the innovations that make the energy we use more secure, clean, and affordable".[20] Clearly, technology is going to be the game changer by innovative disruption.

West Asian Energy Geopolitics in the Shadow of Transition and Transformation

From the preceding account, it is clear that even if the oil era is not over, the onset of transition and transformation has reconfigured its geopolitics. It is no longer restricted to the simple bargaining matrix between oil consumers and oil exporters. The arena has not only become wider but differentiated as well. It is complex, and is complicated by the diverse and conflicting interests within the producer and consumer communities. In the emerging power play, the traditional players are losing the advantage to the new producers. Thus, Saudi Arabia, despite its resource endowment is not in a position to be the swing player. Its failed attempt to push high-cost producers out of the market illustrates its limitation and the emergence of a new power dynamics. The supply-demand imbalance could not be corrected. And the prices are settling down at the new normal of US$60-80. As mentioned above, besides the supply side economics, it is the demand economics – peak – that further restricts the possibilities of return of the high price era.[21] Even the Organisation of the Petroleum Exporting Countries (OPEC) admits that its "Reference Basket (ORB) price will average $40 per barrel this year, and the group projects that the price will rise by $5 per barrel each year through the rest of the decade. That only takes ORB prices up to $60 per barrel in 2020"[22] The point that emerges is that the new normal is going to define the geopolitics of oil in the coming times. The old equation between OPEC and non-OPEC exporters is going to be recalibrated by new realities. The old solidarities (OPEC) seemingly are getting undermined by new partnerships. The new normal with given market share will not be adequate to meet the break-even for many of its members. Adjustment with low price would mean a fiscal tightening and an austere regime, which the politics of these countries would find difficult to negotiate with. Ironically, the issue at stake is to maintain the new normal because a disagreement could lead to a price war. This precisely is the reason why new geological equations are being attempted by Saudi Arabia and Russia. Saudi Arabia is not in a position to bring countries on board even if it threatens to create turmoil by expanding its supplies, which it can. Russia too recognises that individually it cannot protect its market share, especially after the loss of Europe. It also knows that its power projection in West Asia hinges on its solvency. Within the OPEC, the low oil prices are affecting the staying power of the countries. OPEC has been finding it difficult to make the members comply with its decisions. OPEC thus maintains that in October 2016 its oil production went up "to a record high led by members hoping to be exempt from the producer group's attempt to curb supply, weighing on prices and pointing to a larger global surplus next year".[23] Iran along with Iraq and Libya would find it difficult to accept the production cut. That precisely has been the reason that the agreement between OPEC and other oil-exporting countries like Russia has exempted them in their effort to cut production in order to rebalance the market.

Besides the price cut, the global demand in traditional market restricts the space for manoeuvre by an oil exporter. The US, one of the largest importers of oil, has not only discovered its own supplies, but its oil consumption is declining as well, enhancing the possibility of it becoming an oil exporter. According to the Energy Information Administration (EIA) estimates in 2003, the consumption of oil was projected to be 47 per cent higher in 2025 compared to 2003, but in 2014 itself, it was lower by 25 per cent: "There is even greater divergence in longer-term projections – the most recent projection for 2025 is 34% lower than the projection made in 2003. This 2025 consumption surprise frees up roughly $250 billion for spending on other things."[24] In fact, despite falling oil prices, the demand has not gone up at the global level. The International Energy Agency (IEA) estimates show that global demand peaked at 1.8 million barrels/day in the first quarter of 2015 and was 1.8 million barrels/day in first quarter of 2016.[25]

Though it can be argued that shrinking Western demand might get neutralised by emerging demand from Asia and Africa, however, the targeted approach to enhance the share of renewables in the global energy mix has a bearing on the hydrocarbon market. According to IRENA, the share of renewables in the global energy mix can be doubled by the given national commitment, and it can be further enhanced by smart strategies.[26] Denmark reportedly harnessed 116 per cent of its energy from wind on a particularly windy day. The point is that incrementally the global energy demand is going to shift to renewables. The shifting balance of power in energy geopolitics thus can be seen at different levels, which includes new coalitions outside the OPEC frame, the strategic leverage enjoyed by non-conventional oil as swing power and the growing share of renewables in the energy mix.

The geopolitics of oil in West Asia presents a new dialectic where the regional supplier is losing market share and the capacity of being a price maker. On the contrary, non-regional suppliers are fixing the price, and the region is a price taker. Consequently, the regional players are now competing for the market share. The Saudi Arabian efforts to bring Russia on the table for collective production cut is recognition of the new reality that the West Asian players have little choice but to come together to defend a price level in order to meet their fiscal need. The aligning of Saudi Arabia's (regional) interest with Russia's against US oil contradicts Saudi and Russian positions on regional conflicts. Apparently, the old convergence between the security of oil exporters and oil deal has lost its rationale. The regional oil exporters are insecure because of the threat emanating from within the region itself. Consequently, regional players are addressing their insecurities as per their mutual perceptions. The two leading regional oil players, namely Saudi Arabia and Iran, are failing to come to terms with oil output primarily because of their mutual rivalries on regional affairs. In the emerging power balance, Saudi Arabia could be a loser because the revised US security approach has been advantageous to Iran. Besides, Iraq's proximity to Iran does have a bearing on Iraqi position on regional oil strategy. Moreover, a crack in the Sunni regional arch could be seen in the recent refusal of Saudi Arabia to export oil to Egypt and the latter going to Iran.[27]

The diminishing return of regional conflicts and the escalating cost of declining oil prices has compelled the countries to reposition themselves strategically. Saudi Arabia, having projected itself as a regional power, is finding it difficult to sustain its position on Syria and Yemen. Possibly, with a legitimate window, it could concede ground on Syria where Russia is the major player, but it would certainly like the Yemen crisis to be resolved on its terms and conditions. Here, too, Russia can play a role by asking Iran to moderate its position. Iran knows that if Saudi Arabia needs oil revenues, it too needs it, perhaps more acutely. Hence, a tacit understanding could be mediated. The de-escalation of Iranian-Saudi tension will certainly strengthen the Russian-Saudi oil alliance, giving Iran room to build its economy. Paradoxically, while Saudi Arabia needs Russian support on oil, the two are competing against each other as well; for example, in the case of Egypt and China. Saudi Arabia cancelled its oil shipment to Egypt as a reaction to Egyptian efforts to build bridges with Iran.[28] It was subsequently resumed, but in the meanwhile, Egypt went to Russia to meet its needs. Egypt and Russia held their first joint military exercise in October 2016. Earlier in September 2016, the Defence Minister of Egypt Sedki Sobhi visited Moscow to promote defence cooperation between the two countries.[29]

The stakes in rebalancing oil supplies to maintain price are equally high in the case of all three countries; however, it is Saudi Arabia which is the most vulnerable. Though the country has enough oil capacity to bring into the market, and it is a low-cost producer, but its fiscal needs from oil revenue are very high – 80 per cent of its oil revenue – to meet domestic needs and power projections. The break-even price for oil in 2015 was estimated at US$92.9; for the year 2016, it was US$79.7. It was expected to be US$66.7, but could not be materialised due to slow diversification. In fact, public expenditure of US$260 billion went 13 per cent above its target.[30] It is estimated that the Gulf Cooperation Council (GCC) oil revenue came down from US$735 billion in 2013 to US$119 billion in 2015, and the combined budgetary deficit was US$150 billion in 2016 as against US$119 billion in 2015.[31] Recognising the depleting role of oil, Saudi Arabia has initiated bold economic diversification plans to reduce its dependence on oil money. It is significant to note that the political class in the country is defining its future by promoting non-oil economy for a smooth transition, especially in political terms; Saudi Arabia and the GCC need a favourable oil market with their say for the next 10 years. In its overseas oil engagement, too, the Kingdom is facing competition due to the new push in Russian energy engagement with Asia, be it China or India. Besides, Iran too is cultivating Asian consumers. Iranian sources claim that their export to Asia has jumped up by 90 per cent. Reportedly, Iran has replaced Saudi Arabia as the oil supplier to India:

> India's oil imports from Iran have shot up this year after those sanctions were lifted in January. In October they surged more than threefold compared with the same month last year, rising to 7,89,000 barrels per day (bpd), according to ship tracking data and a report compiled by Thomson Reuters Oil Research and Forecasts. That compares to 6,97,000 bpd supplied last month by Saudi Arabia.[32]

The Kingdom thus has been feeling the heat and has cut down its price for Asia.[33] It is also engaging Russia to put pressure on Iran to comply with the OPEC production cut which was dismissed by an Iranian minister as a cruel joke.

Iran, too, needs a stable oil market, but it needs to protect its market share as well. Thus, while agreeing in principle for the production cut, it wants to revive its pre-sanction quota. Iranian domestic polity is also critically sensitive to oil money. Iran's president was voted to power and had the country's backing for the nuclear deal primarily so as to ensure economic recovery. However, the resistance economy of Iran is less dependent on oil revenue in comparative terms; it accounts for 42 per cent of the government revenue. Its non-oil sector is recovering fast. The country has recorded non-oil balance of trade in the year ending March 19,2016. It was the first time since the Iranian Revolution that the country recorded a US$916 million trade surplus.[34]

> The positive trade balance can be seen in two ways. First, it shows that Iran finally has moved from an oil-based economy to a mixed economy. It also denotes a worrying trend on the other hand as local manufacturers have tougher external competition. This is likely to be compounded when Iran's application to the World Trade Organization is accepted and tariffs and protectionist policies must make way for fairer treatment of foreign businesses.[35]

Though the Iranian economy is better placed, it certainly needs to monetise its hydrocarbon resources to reboot its economy by mobilising oil revenue.

It is precisely for this reason that it is looking for collaborations. Significantly, one of the leading collaborations is being attempted with Russia which is itself an oil exporter and looking to the Asian market in view of its proximity to the European market. "Russia's leading gas company Gazprom and its oil industry offshoot – Gazprom Neft – are also at the stage of working out several agreements on developing Iran's oil and gas projects. ... Memorandums between Gazprom and the National Iranian Oil Company, as well as between Gazprom Neft and the National Iranian Oil Company on the development of oil and gas fields are at the stage of being agreed."[36] The strategic significance of energy engagement needs to be read against the backdrop of Russia-Iran convergence on regional security especially in view of Syria and the Islamic State of Iraq and Syria (ISIS).

The role of oil exporting countries in the market is determined by their export surplus capacity. While Iraq and Libya are struggling hard to rebuild the capacities, some leading players might feel constrained due to rising domestic consumption. The GCC countries domestically consume nearly 30 per cent of the primary energy produced.

> Since 2000, United Arab Emirates has the highest increase in consumption/production rate. In 1991 total primary energy consumption/production in Kuwait jumped to 0.5 due to the Gulf war. Bahrain has the highest consumption/production ratio and currently consumes almost all its produced primary energy. In 2012, consumption/production ratio was highest in Bahrain followed by the United Arab Emirates, Oman, Saudi Arabia, Kuwait and Qatar respectively. The average consumption/production ratio in the GCC countries is 32%.[37]

Given the high consumption growth, 8 per cent annually, in Saudi Arabia, a prognosis was that the country would become an oil importer by 2030.[38] Earlier Chatham House reported that "domestic consumption could eat into Saudi oil exports by 2021 and render the kingdom a net oil *importer* by 2038".[39] Though the prognosis may be contested, it is clear that the high domestic consumption may restrain oil exporters from being big players in the oil market in the long run. Recognising the stakes in the oil market, as a low-cost producer the region would like to be proactive in the oil arena. Attempts thus are being made to reform consumption patterns by imposing subsidy cuts, efficiency measures and promoting new sources of energy, namely renewables. The oil producers, too, are transitioning.

The geopolitics of hydrocarbons thus is seemingly being mediated by the geopolitics of renewables. The growing share of renewables in the global energy market is changing the character of energy geopolitics by undermining the strategic significance of territoriality because the supply of renewables is not bounded by geography; on the contrary, it is determined by the capacity to harness renewables, which in turn are decided by technology. A new interface between geography and technology has brought geo-economic processes into play. The hydrocarbon exporters from West Asia are richly endowed with solar radiation, but they need to invest in creating technological capacities. It is symbolically significant that IRENA is headquartered in Masdar City, Abu Dhabi. According to an IRENA report, "With the region's consumption expected to continue growing at a fast pace over the next two decades, renewables have become an important consideration in government strategies to diversify the domestic energy mix."[40] Energy exporters from West Asia are under pressure to maximise the monetisation of their hydrocarbons in a time period which allows them to be in the market with their share. Though oil will remain their asset, but the returns are going to be determined by the pace of energy transition globally. Since the transition is gaining momentum, the oil exporters have to calibrate their policy to maintain a price regime that allows for smooth transition and transformation.

The Asian chase by oil exporters is the new dimension of energy geopolitics. Asia, a vulnerable and insecure market, is today witnessing a new pattern of energy engagement with West Asia. The Gulf exporters are keen to move to the Asian market beyond transactional relations. Moves are being made to develop a new supply chain engagement in the sector.[41] The month-long visit of the King of Saudi Arabia to Asia, where Russia and Iran are also trying to raise their profile, illustrates the changing power dynamics. The Gulf oil exporters are looking for energy engagement to move to a non-oil economy. The US$65 billion Saudi Arabia-China deal reflects the expanding profile of engagements. With Asia as a leading economic driver and energy consumer, the Asian power dynamics is going to write the new script of energy geopolitics. If it was the US that defined the energy security nexus – though, seemingly, not on the same scale and volume – it is China that is setting the agenda today. The 'One Belt, One Road' initiative is the wider geopolitical construct to realign the regional power dynamics. Energy is a vital component of it. China is driving not only the hydrocarbon market but also is emerging as a major player in renewable energy too. In the context of changing US energy policy, China will further gain in stature in the Asian theatre. The Chinese move apparently facilitates the making of the Look East policy of the GCC countries.

In the context of energy transition, the geopolitics of global energy market is going to be played out distinctly, as the global energy map is being redrawn by multiple players at different levels. While the hydrocarbon energy geography is expanding spatially, the innovative economy is opening access to 'new sustainable energy'. Consequently, the dynamics of market power are changing, providing the producers and consumers with a degree of autonomy to position and reposition in response to market sentiments. The market itself is segmented with two distinct profiles, namely the segment where demand is peaking and the transition period reaching the transformation threshold, and the rest where the demand is picking up but the climate mandate is necessitating a move away from fossils. The former enjoys a degree of independence from oil, hence, is less sensitive to the hydrocarbon market; but the latter being part of the hydrocarbon market remains susceptible to oil prices. Since oil prices are determined by the global matrix, even oil importers have an advantage in the energy market. Clearly, the ongoing technological disruption in the energy system is repositioning the oil exporters from West Asia in the global energy future beyond hydrocarbons.

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7

Energy Connectivity in Asia: The India-ASEAN Case

Nitya Nanda

Introduction

India, with more than 17 per cent of the global population, accounts for less than 1 per cent of global oil reserves and global natural gas reserves and about 7 per cent of global coal reserves.[1] Consequently, the country has been importing substantial quantities of energy resources. In recent decades, India's import dependence on energy has increased due to the growth in population, faster economic growth and inability of traditional fuels to cope with the growth in energy demand. With reference to all forms of energy, India's dependence on energy imports is about 35 per cent of its total supplies (Table 2). While this is lower than countries such as Japan, South Korea, Taiwan and Singapore, however, at around US$120 billion in 2013-14, India's net energy import bill was about two-fifths of its total exports, which is higher than many countries that rely largely on imported energy products and services, making India among the most energy vulnerable countries.[2]

Given this scenario, it is difficult to imagine that India can become an energy hub and not just an importer of energy products. However, there is the example of Singapore which, in spite of not producing even an ounce of crude oil, succeeded in establishing itself as a hub for petroleum and petroleum products. What went in its favour was not just an excellent trading infrastructure but also its location. Although some of Singapore's neighbours produce crude oil, the island city is located midway between the oil-rich West Asia and oil-hungry East Asia. Replicating the Singapore experience, India is now among the major exporters of petroleum products, and they are also the top export item of India.

The question is whether the same can be replicated in the case of other energy commodities or services, such as natural gas and electricity. As a matter of fact, India is uniquely located in this regard. Interestingly, while most of the global trade in petroleum and petroleum products is sea-borne, trade in natural gas and electricity is best accomplished through land routes. To the west of India, there is West Asia, and Iran in particular, which has substantial natural gas reserves. To its north-west, there are the Central Asian Republics (CARs) which also have substantial gas reserves. Some of the CARs also have substantial hydropower generation potential, which is also available in Nepal and Bhutan located in the north of India. Moreover, to the east of India, there is Myanmar, with substantial oil and gas reserves as well as huge hydropower potential. Such energy sources are available in a few other countries of the Association of Southeast Asian Nations (ASEAN), particularly in Indonesia, Malaysia, Brunei, Vietnam and Lao People's Democratic Republic (PDR).

The need for connecting India with natural gas sources from its neighbourhood was recognised as early as 1989 when The Energy and Resources Institute (TERI) proposed the construction of the Iran-Pakistan-India (IPI) gas pipeline. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline was conceptualised as TAP in 1995. India proposed to join the latter in 2008, following which it was known by its more popular nomenclature TAPI, which is now proposed to be completed by 2019. However, India took a longer time to look east, although its eastern neighbour Myanmar was the first country in the world that produced and used petroleum oil.[3] The Myanmar-Bangladesh-India (MBI) pipeline was first proposed in 1997, but serious discussions on the project took place only in 2005. However, due to the lack of convergence of the energy security policies of Bangladesh and India, as well as lack of coordination among the different ministries within India on some issues that Bangladesh wanted resolved in this context, the pipeline did not materialise. According to some recent reports, however, the countries concerned are interested in reviving the project once again, although a question that has now become relevant is how much gas is Myanmar willing to export. Considering the current political relations between India and Pakistan, the IPI pipeline is unlikely to be revived, at least in the near future, but the MBI pipeline can be revived keeping the broader perspective of energy cooperation in the region.

Table 1: Energy Indicators in India and ASEAN Countries 2014

Country/Region	*Per Capita TPES (toe)*	*TPES/GDP (toe/thousand 2010 US$)*	*TPES/GDP (PPP) (toe/thousand 2010 US$)*	*Per Capita Electricity Consumption (KWh)*
World	1.89	0.19	0.14	3030
OECD	4.16	0.11	0.11	8030
Africa	0.67	0.35	0.15	570
India	0.64	0.38	0.12	800
Brunei	8.52	0.29	0.13	10110
Cambodia	0.42	0.43	0.14	270
Indonesia	0.89	0.24	0.09	810
Malaysia	3.00	0.29	0.13	4650
Myanmar	0.36	0.29	0.08	210
Philippines	0.48	0.19	0.07	710
Singapore	5.12	0.1	0.07	8840
Thailand	1.99	0.35	0.14	2570
Vietnam	0.73	0.46	0.14	1440

Source: International Energy Agency (IEA), 2016.
Note: toe= ton oil equivalent; KWh= kilowatt hour; TPES= total primary energy supplies; GDP= Gross Domestic Product; PPP= purchasing power parity.

India's Approach to Energy Cooperation in the Neighbourhood

Although India is an energy deficit country and has been importing a substantial part of its energy needs, its experience in energy cooperation is quite limited, with the exception of Bhutan. Hence, while India maintained good relations with its major energy supply sources in West Asia and Africa, it did not have any comprehensive energy cooperation covering a broad range of sectors and issues with any of these countries. As a result, the 'cooperation' was limited mainly to the signing of long-term contracts with some of these countries for the supply of oil and gas. It is only in recent years that some Indian companies have invested in some of these countries or are engaged in businesses that go beyond purchasing resources, such as production sharing contracts. In the process, some investments have been made in some ASEAN countries as well.

India-Bhutan

The India-Bhutan energy cooperation however is a success story, and has attracted global attention. In 1967, Bhutan started importing electricity through the Jaldhaka hydropower plant, located in the eastern state of West Bengal in India. However, cooperation on a larger scale started with the development of the 336 MW Chukha hydropower project, which commenced in 1978 and was commissioned in 1989. It immediately became a source of revenue for Bhutan through export earnings and contributed to the country's overall economic development. By 2007, two more hydropower projects were constructed in Bhutan with Indian assistance. Realising the potential of hydropower projects as a means of earning more revenue and promoting economic development, Bhutan signed a Framework Agreement with India in December 2009, whereby India committed to develop 10,000 MW of installed capacity in Bhutan by 2020, of which India was committed to buying at least half the capacity.[4]

India-Nepal

While the India-Bhutan energy cooperation has been deemed a success, the India-Nepal cooperation in this regard, which commenced in the 1950s with the signing of the historical water treaties, e.g. the Kosi (1954) and the Gandak (1959), has not lived up to expectations. One reason was that India was apprehensive of relying too much on Nepal in matters of energy security. Nevertheless, the Tanakpur Agreement (1991) and the Mahakali Treaty (1996) were signed, but any real progress remained elusive. Although the successful cooperation with Bhutan changed India's perception in this regard, there is a strong view in Nepal that India, by according far greater priority to its national interest, has often overlooked Nepal's interest and that the benefits have been one-sided rather than mutual. The unstable political situation in Nepal has also contributed to the slow progress of the projects. Hence, despite its huge hydropower potential, Nepal is a net importer of power from India. And although Indian private companies were involved as well, not much has progressed as far as constructing large power plants are concerned. As a result, India is engaged in constructing small-scale power projects only.[5]

India-Bangladesh

Discussions on India-Bangladesh energy cooperation started in the 1980s when foreign investors producing natural gas in Bangladesh proposed to export gas to India due to a limited domestic market. However, due to political sensitivity in Bangladesh regarding selling its gas to India,[6] this could not be done. In 2005, the countries came close to finalising the MBI gas pipeline, but India's inability to meet Bangladesh's demands for trade concessions due to differences amongst different ministries in India stalled the project. Bangladesh too failed to foresee that someday it would face shortage of gas and that the pipeline could be used to meet part of its own demand as well. In the meantime, Myanmar decided to sell the gas to China. However, the discovery of the offshore North-West Myanmar gas field – estimated to hold reserves of between 4-6 trillion cubic feet (tcf) of gas – has sparked renewed interest in the proposed pipeline.

Recently, however, a major achievement was made when a transmission line with a capacity of 500 MW between Berhampore in India and Bheramara in Bangladesh was completed, and power began flowing from India to Bangladesh from October 2013. Bangladesh also got connected to the eastern Indian state of Tripura from where 100 MW of power is flowing with the possibility of more power to flow in the future. India is also building a coal-based power plant at Rampal near Khulna in Bangladesh as a joint venture. An Indian company has also received an exploration contract for natural gas in Bangladesh.[7]

India-Pakistan

As noted before, there have been negotiations between India and Pakistan on the possibility of a gas pipeline from Iran and the CARs passing through Pakistan, but progress has been elusive. However, talks of energy cooperation between India and Pakistan have taken a different turn now. India is considering proposals to import liquefied natural gas (LNG) at one of its import terminals in Gujarat and move this gas through the Dahej-Vijaipur-Dadri-Bawana-Nangal-Bhatinda pipeline to Punjab and then to Pakistan. Since Pakistan has not built any LNG import terminal so far, this venture would be more feasible for Pakistan to pursue. Similarly, it is now recognised in Pakistan that if it imports gasoline and diesel from India, it would largely benefit Pakistan and would result in a saving of US$300 million. The possibility of India supplying electricity to Pakistan is also being discussed.[8]

The ASEAN Approach to Energy Cooperation

In contrast to South Asia, the ASEAN region is relatively (energy) resource-rich, although some ASEAN countries have a higher dependence on imported energy than India. Appendix 1 shows the energy reserves and resources of the ASEAN countries (and India). As illustrated in Table 2, Singapore (99 per cent), Thailand (44 per cent) and the Philippines (47 per cent) have higher import dependence than India. Yet, ASEAN as a whole is a net energy-surplus region. Taking note of this, ASEAN has long considered energy supply to be an important area of cooperation. Barring Cambodia, Myanmar and the Philippines, the energy supply and consumption scenario in ASEAN is far better than that of India (as shown in Table 1). India has been importing its energy largely from West Asia and Africa without any long-term systematic cooperation framework.

Table 2: Energy Balances in India and ASEAN Countries 2014

	Production (Mtoe)	*Imports (Mtoe)*	*Exports (Mtoe)*	*TPES (Mtoe)*	*Net imports (Mtoe)*	*Import Dependence (Import/TPES)*
India	541.81	356.824	67.10	824.74	289.72	0.35
Brunei	16.26	0.40	12.89	3.55	-12.49	-3.81
Cambodia	4.25	2.18	0.00	6.36	2.18	0.34
Indonesia	457.99	57.11	288.55	225.51	-231.44	-1.02
Malaysia	94.64	51.52	52.70	89.70	-1.18	-0.01
Myanmar	25.67	3.55	10.813	19.3	-7.263	-0.38
Philippines	25.85	26.54	4.24	47.67	22.3	0.47
Singapore	0.65	161.44	85.69	28.01	27.71*	0.99
Thailand	78.74	72.37	12.79	134.75	59.58	0.44
Vietnam	71.19	14.39	17.08	66.62	-2.69	-0.04
ASEAN-1	775.23	389.5	484.753	621.47	-95.25	-0.15

Source: IEA Database; Adjust for huge increase in marine/aviation bunker stocks. http://www.iea.org/statistics/statisticssearch/report/?country=OECDAO&product=balances&year=2014.

Note: Mtoe=million ton oil equivalent.

On the other hand, while ASEAN has been an energy-surplus region for long, its surplus energy has generally moved eastward rather than westward. In recent years, however, India has been importing substantial quantities of coal from Indonesia. The ASEAN region has also made a quiet entry as a supplier of natural gas (LNG) to India. Therefore, it will be interesting to explore if the energy-thirsty India and the resource-rich ASEAN can promote wider cooperation on energy security that can be mutually beneficial to both India and the ASEAN countries. An important element in the 'Plan of Action to Implement the ASEAN-India Partnership for Peace, Progress and Shared Prosperity (2010-15)', adopted at the eighth ASEAN-India Summit held at Hanoi on October 30, 2010, has been cooperation on renewable energy. There has been some progress in this regard since then, and the strengths and complementarities in this regard have also been identified. However, this will depend crucially on energy connectivity within the ASEAN region.

The region-wide energy cooperation in ASEAN started in 1976 when the ASEAN Council for Petroleum (ASCOPE) was established. In the initial phase, the focus was on oil and power grid cooperation. The objective of ASCOPE was to promote active collaboration and mutual assistance in the development of petroleum resources. An important milestone was achieved in the form of ASEAN Petroleum Security Agreement (APSA) in 1986 with a binding agreement imposing obligations on member countries. It established the ASEAN Emergency Petroleum Sharing Scheme (AEPSS) to ensure mutual supply of oil by six countries in case of sudden shortfalls in supplies.

However, power grid cooperation started outside what was then ASEAN. A beginning was made in 1966 when Thailand and Lao PDR concluded a power exchange agreement. This was quite similar to the Bhutan-India cooperation on energy in its objective, scope, modalities and outcome. Similar agreements were signed between Thailand and Malaysia and Malaysia and Singapore in 1978. A more regional ASEAN level cooperation started in 1981 following the establishment of a task force involving the Heads of ASEAN Public Utilities Authorities (HAPUA) with the objective of promoting cooperation on power grid connections. The main focus was on establishing mechanisms to avoid supply disruptions. The mid-1980s saw a further deepening of energy cooperation in the ASEAN region.

In another important development, the ASEAN Energy Cooperation Agreement (AECA) was signed in 1986 whereby the member countries agreed to cooperate on a wide range of issues to foster efficient development and use of all forms of energy. Cooperation activities included planning, development of resources, conservation, security of supply, capacity building and exchange of information. The 1990s saw a series of plans of actions. The 1991 Programme of Action for Enhancement of Cooperation in Energy (PAECE) was followed by the 1995 Plan of Action on Energy Cooperation (PAEC 1995-1999). Both included oil and gas, coal, new and renewable sources, energy efficiency and conservation with coordination bodies for each of the five areas.

The resolve to promote deeper energy cooperation in ASEAN was further reinforced through the ASEAN Vision 2020 that was adopted in 1997 which called for an ASEAN-wide interconnection arrangement for electricity, natural gas and water. ASEAN is currently working towards realising this vision and has initiated several transmission and gas pipeline projects to eventually develop an ASEAN-wide power grid and gas pipeline network. Some of the projects have already been completed.[9]

The 2004 Plan of Action on Energy Cooperation (PAEC 2004-2010) directed action towards more efficient and sustainable management of energy and an appropriate policy framework and implementation for the same. Hence, clean coal technology as well as energy-environment interface received special attention. The current (2010) PAEC 2004-2010 added a new programme – the Civilian Nuclear Energy (CNE) programme – to its framework. Consequently, there are now seven areas of energy cooperation that are being pursued in ASEAN.[10] The major programmes under this plan are as follows:[11]

- ASEAN Power Grid;
- Trans-ASEAN Gas Pipeline;
- Coal and Clean Coal Technology Promotion;
- Energy Efficiency and Conservation Promotion;
- New and Renewable Energy Development;
- Energy Policy and Environmental Analysis; and
- Civilian Nuclear Energy.

India's Energy Engagement with ASEAN Countries

For a long time, the ASEAN countries like Malaysia, Indonesia, Thailand and Brunei were important sources for India's crude oil imports. Until recently, India imported substantial quantities of crude oil from these countries. However, in recent years, these countries have reduced their exports of crude oil due to an increase in their own domestic requirements. As of now, India is importing crude oil from two ASEAN countries, namely Malaysia and Brunei, in small quantities.

In recent years, however, India's trade in energy commodities has undergone some major changes. India has become a major importer of coal, and it has also become a major exporter of refined petroleum products. On both counts, ASEAN is playing an important role. Indonesia is the number one source of coal imports for India, while another ASEAN country, Singapore, is the number one destination for Indian exports of refined petroleum products. The ASEAN region provides an important outlet for India's exports of petroleum products though the importance appears to be gradually decreasing over time.

However, India is quite active in the ASEAN region through investments in the energy sector as well as development of energy infrastructure. While the focus of Indian companies investing in the region are Myanmar, Vietnam, Indonesia and Malaysia, its involvement in energy infrastructure development is by and large limited to Cambodia, Lao PDR, Myanmar and Vietnam (CLMV countries) through development cooperation and construction of facilities. A study by the Ministry of Commerce[12] has identified the energy sector as an important area for collaborative foreign direct investment (FDI) in Myanmar, Vietnam and Lao PDR.

As of December 2016, India's investment in Myanmar stood at about US$733 million, making India the ninth largest foreign investor in Myanmar. Around 98 per cent of Indian investments in Myanmar are in the oil and gas sector, with the remaining 2 per cent in manufacturing.[13] Indian energy companies with operations in Myanmar include ONGC Videsh Limited (OVL), GAIL, Essar Energy, and Jubilant Oil and Gas. While some companies have been there since 2000, PSC-1 onshore block in Central Myanmar worth US$73 million has been awarded to Jubilant Energy of India on the basis of a global tender in 2011.[14] Recently, OVL has successfully bid for two on-shore blocks[15] in the 2013 Myanmar Oil and Gas bids. Punj Lloyd Ltd, an Indian contractor, executed a part of the Myanmar China Oil Pipeline Project and Myanmar China Gas Pipeline Project. Tata Power signed a Memorandum of Understanding (MoU) with the Ministry of Electric Power, Government of Myanmar, on April 11, 2013, for an imported coal-fired power project at Ngayokkaung in Myanmar. It is expected to be commissioned by 2019-20.

Vietnam, too, continues to be an attractive investment destination for Indian companies, and the energy sector occupies a prime place in that. Indian investment in Vietnam is estimated to be about US$1 billion, while Vietnam's investment in India amounts to about US$23.6 million. OVL and Essar Exploration and Production Ltd are the major Indian investors operating in the energy sector in Vietnam. The former has signed an Agreement on Cooperation with PetroVietnam. In 2013, Tata Power was awarded a US$1.8 billion thermal power project in Soc Trang Province, which is the largest Indian investment project in Vietnam.[16]

India is the second largest buyer of coal and crude palm oil from Indonesia and exports refined petroleum products. A number of Indian companies, including Tata Power and Reliance, acquired coal assets in Indonesia (Tata Power gave it up later), while several others are eying more such assets in the country. To facilitate the process, India and Indonesia have a structured dialogue process in the coal sector, having established a Joint Working Group (JWG) in 2010. An Energy Forum was created during the visit of President Yudhoyono to India in January 2011. The Forum is co-chaired by the Ministry of Coal from India and Ministry of Energy and Mineral Resources from Indonesia. Furthermore, in the oil and gas sector too, pursuant to the signing of the MoU on Cooperation in Oil and Gas in January 2011, a JWG mechanism has been instituted to enhance cooperation in this field.[17]

Cumulative Indian investments into Malaysia from 1980-2013 stood at US$2.05 billion. However, in Malaysia, not much of Indian investment is in the energy sector. Malaysian investment in India is less than US$1 billion. However, when Malaysian investment in India routed through a third country is considered, then it exceeds US$6 billion. A significant part of this investment is in energy, as power and oil and gas sectors have been the focus of Malaysian investment in India. Malaysia's national oil and gas company, PETRONAS, has stakes in Cairn India (the Indian arm of the UK-based oil and gas company, Cairn Energy PLC). Ranhill Bhd's US$900 million contract for the construction of a 2x350 MW thermal power plant in Chhattisgarh; Mudajaya Group Berhad's US$150 million E&P power project-related contract in Chhattisgarh; and Asian Gateways Construction Sdn Bhd's US$1.4 billion mega-thermal power project (1600 MW) in Andhra Pradesh are some other examples of involvement of Malaysian companies in India. While Indian investment in Malaysia is relatively more diverse, recently, Indian companies have made forays into the energy sector as well. Aban Offshore Ltd, Mumbai, has been awarded two contracts worth US$55 million to drill nine oil wells in Malaysia. Quantum Sigma Sdn Bhd and ES Electronics (India) Pvt Ltd has signed an agreement to establish a manufacturing facility to produce solar panels and energy-saving plugs by Quantum Sigma in Bentong, Pahang.[18]

As noted earlier, Indian involvement in development in energy infrastructure through development cooperation and construction activities is mainly in CLMV, and Myanmar is the focus in this regard. The Power Grid Corporation of India Ltd (PGCIL) was awarded construction transmission lines and sub-stations, the projects being (i) Oakshitpin – Taungup 230 KV transmission line; (ii) Taungup – Maei-Ann-Mann 230 KV transmission line; and (iii) Maei-Kyaukphyu 230 KV transmission line. The Ministry of Electric Power of Myanmar (MoEP) and PGCIL signed the contract on March 21, 2012. The scope of the work includes design and engineering, the supply of the equipment and supervision of erection of equipment. The renovation of Thanbayakan Petrochemical Complex is another project being financed by US$20 million line of credit signed in 2008-09.[19]

India has been a development partner with Lao PDR for quite some time, where the energy sector has been the focus of the relationship. In June 2004, India provided a line of credit of US$10 million for a 115 KV transmission line from Ban-Na in Champassak to Attapeu. The project was completed in 2006.[20] Similarly, a line of credit was extended for the supply of equipment for rural electrification worth US$4 million, which was completed in September 2009. With India's assistance, the Paksong-Jiangxai-Bangyo transmission line project worth US$18 million was commissioned in September 2010. The Nam Song 7.5 MW hydropower project worth US$11 million was also completed with Indian assistance in October/November 2012. In September 2010, a loan agreement between Export-Import Bank of India (EXIM) and the Ministry of Finance of Lao PDR was signed for a US$72.55 million loan for two projects: (i) 230 KV Double Circuit Transmission Line from Nabong to Thabok and substations worth US$34.68 million and (ii) 15 MW Nam Boun 2 Hydropower Project worth US$37.86 million. The scope of the work included supply of equipments, goods and services for construction.[21]

Indian power equipment manufacturer Bharat Heavy Electricals (BHEL) commissioned the first 100 MW unit at the Nam Chien hydropower project in Vietnam in 2013. The project comprised two Pelton-type hydro generating units of 100 MW each. Equipment supplied by the company included hydro turbines, generators, transformers, controls, monitoring, protection system and switchgear. Funded through a line of credit by the Indian Government, the scope of the contract includes design, engineering, manufacture, supply and supervision of installation, besides commissioning of the entire electro-mechanical equipment package for the project.[22]

The EXIM Bank of India extended a US$35.2 million line of credit to the Government of Cambodia for financing the Stung Tasal Development Project, purchase of the water pumps and construction of the electric transmission line between Kratie and Stung Treng Province in Cambodia.[23]

Prospects for India-ASEAN Energy Cooperation

India and ASEAN have already identified renewable energy as an area for cooperation. The electricity generation sources (see Appendix 2) indicate that India has developed significant capability in wind energy, while Indonesia and the Philippines have the same in geothermal energy. Singapore, too, is generating significant electricity from waste. India and Thailand have some experience in solar power as well. India is also the only country to generate nuclear power and use bio-fuel to generate significant quantities of electricity. These countries can help others in developing energy production capabilities in the respective sub-sectors. While India-ASEAN energy cooperation focuses on renewable energy only, India, along with some of its South Asian neighbours and some members of ASEAN (Myanmar and Thailand) is part of the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), where energy has been identified as one of the important sectors for comprehensive cooperation, including all types of energy. ASEAN-India energy cooperation would depend very much on BIMSTEC energy activities, as it could work as a bridge between South Asia and ASEAN in promoting a comprehensive energy cooperation regime.

While ASEAN has been moving towards comprehensive regional energy cooperation with full force and significant progress has already been made in this regard, regional energy cooperation in South Asia has been slow and on a piecemeal basis. India has promoted energy cooperation with some of its neighbours, albeit at a bilateral level only and limited to the power sector. Efforts to gain access to natural gas by pipeline through its neighbours, namely Bangladesh and Pakistan, have not been successful so far. Thus, India will be very keen to strengthen its energy cooperation with ASEAN countries.

India is already involved in the development of energy infrastructure in the ASEAN region, especially in CLMV. India is building power plants, power transmission lines and sub-stations, and oil and gas pipeline lines. On the other hand, Malaysia has made significant investments in the energy sector in India. Indian companies have invested in energy resources such as coal, oil and gas sector in the ASEAN countries. When it comes to trade in energy products, India imports coal from Indonesia and exports petroleum products to ASEAN countries. A look at the resource positions in India and ASEAN, however, indicates that there is significant scope for trading in energy products and services, particularly natural gas and electricity.

The development of the region-wide natural gas pipeline and electricity transmission lines in the ASEAN region is almost complete. India can easily connect to the electricity transmission grid and natural gas pipeline grid in ASEAN by connecting to Myanmar. India's electricity grid is already connected to Bangladesh's electricity grid, and Bangladesh, in turn, is planning to link its electricity grid with that of Myanmar. Thus, India will soon get connected to ASEAN electricity transmission grid. Bangladesh is now facing a shortage of gas, and the discovery of new gas fields in north-west Myanmar have encouraged Bangladesh to renew its interest in the Myanmar-Bangladesh-India gas pipeline with a whole new perspective as it expects to not only provide transit facility to India but also to access gas from Myanmar for its own use. Thus, in the future, it will be possible for India to not only access electricity and gas from Myanmar, but also from faraway fields in Indonesia and Brunei as well as electricity from Myanmar and Lao PDR.

Appendix 1

Energy Reserves and Resources in India and ASEAN Countries

Resources/Country	*Coal (Million Ton) End of 2015*	*Lignite (Million Ton) End of 2015*	*Petroleum (Million Ton) End of 2015*	*Natural Gas (Billion Cubic Metre) 2014*	*Technically Feasible Hydropower Potential (GW/year)*	*Hydro Generation (GW/Year) 2011 Data not found*	*Solar Potential (GW Capacity)*	*Wind Potential (GW Capacity)*
India	56100	4500	800	1400	2638000	131643	657	49
Brunei			100	300				
Cambodia					34400	1852		
Indonesia		28017	500	2800	401646	15148	62	63
Lao PDR					232500*			
Malaysia			500	1200	123000	13388	13	36
Myanmar				500	348000*	8829		
Philippines					20334	9137	20	23
Singapore								
Thailand		1239		200	16292	5540	33	67
Vietnam	150		600	600	123000	58544	27	44

* Gross hydropower potential.

Sources: *BP Statistical Review of World Energy 2016*; IEA Database; Intpow; Ölz and Beerepoot (2010); Rashid and Islam (2013).

Note: For hydropower, solar and wind power potential, the assessment is for perpetuity, and hence, no year has been indicated.

Appendix 2

Electricity Generation Sources 2014 (GWh)

Production from	*India*	*Brunei*	*Cambodia*	*Indonesia*	*Malaysia*	*Myanmar*	*Philippines*	*Singapore*	*Thailand*	*Vietnam*
Coal and Peat	966520	0	863	120332	55827	286	33054	542	37579	34563
Oil	22696	43	327	25782	3490	65	5708	345	1721	449
Gas	62929	4461	0	56287	73836	4977	18690	47042	118560	47211
Biofuels	23908	0	14	925	701	0	130	155	8223	59
Waste	1536	0	0	32	0	0	66	1260	317	0
Nuclear	36102	0	0	0	0	0	0	0	0	0
Hydro	131643	0	1852	15148	13388	8829	9137	0	5540	58544
Geothermal	0	0	0	10038	0	0	10308	0	1	0
Solar PV	4909	2	3	11	227	0	17	36	1385	0
Wind	37155	0	0	0	0	0	152	0	305	87
Total Prod	1287398	4506	3059	228555	147469	14157	77262	49380	173631	140913
Imports	5008	0	1803	9	23	0	0	0	12260	4128
Exports	0	0	0	0	-12	0	0	0	-1594	-1507
Domestic Supply	1292406	4506	4862	228564	147480	14157	77262	49380	184297	143534

Source: IEA Database.

NOTES

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8

The Asian Nuclear Power Landscape: A Contemporary Examination

Manpreet Sethi

Introduction

Countries in Asia began to recover from the crippling financial crisis of 1997 by the middle of the first decade of the 2000s. Recovery was marked by a surge in electricity demand and soaring energy prices (petroleum prices rose to $100 a barrel), and also by an increasing consciousness about climate change. All these factors raised the attractiveness of nuclear power as a viable and environmentally sustainable source of electricity. Indeed, a 'nuclear renaissance' appeared on the anvil, and Asia was feted as its new frontier. The International Atomic Energy Agency (IAEA) in its Annual Report of 2010 reflected this optimism when it claimed that "60 Member States have expressed interest in the introduction of a nuclear power programme".[1] Fifteen new nuclear projects were started in 2010. The Agency even set up an Integrated Nuclear Infrastructure Group (INIG) to respond to the growing interest and to provide assistance in technical cooperation, training, legislative guidance, and capacity building to nuclear first timers.

Many of these were expected to be in Southeast Asia. In 2007, at the annual Association of Southeast Asian Nations (ASEAN) Summit in Singapore, the Southeast Asian states had signed a Declaration on Climate Change, Energy and Environment that committed them to "urgently act to address the growth of global greenhouse gas emissions" by improving energy efficiency and use of cleaner energy, and by "cooperating for the development and use of civilian nuclear power".[2] About the same time, India was negotiating its inclusion in the international nuclear commerce. The conclusion of a nuclear agreement with the US was followed by the grant of a waiver to the members of the Nuclear Suppliers Group (NSG) to engage in nuclear trade with India. These actions were premised on the prospect of a promising nuclear energy market in India. Even more ambitious growth was projected in China. Japan and South Korea were anyway major users of this source with ambitious future plans.

However, the optimism lasted only for a bit. The unfortunate nuclear accident at Fukushima on March 11, 2011, following an unprecedented earthquake and tsunami, shook public faith and the nuclear industry. While no fatalities were attributed to the nuclear accident, it nevertheless scarred human psyche enough to raise questions on the need to pursue nuclear power. Japan's transparency has been admirable, and many lessons have been learned, but it has not helped matters that Japan has shut down all its nuclear reactors and has been excruciatingly cautious in bringing them back into operation. Many nations that were planning to start nuclear programmes have also opted to suspend, stall or stop them. It is telling that the IAEA Annual Report of 2015 stated that "around 30 Member States were actively considering or planning a nuclear power programme".[3] Between 2010-15, the number of states interested in nuclear power had fallen by half.

More recently, the IAEA Director General, Yukiya Amano, in an address in August 2017, said, "There are now 447 nuclear power reactors in operation in 30 countries. Another 58 reactors are under construction, mostly in Asia."[4] Most of these are being constructed in two major Asian countries that remain the poster boys of nuclear power in Asia – China and India. But there is no doubt that six years after the accident at Fukushima, the prospect for nuclear power in Asia presents a mixed picture. There are nations that are staunch loyalists that are going ahead with ambitious expansion plans, but there also are the sceptics and the naysayers. This chapter examines the current state of the nuclear power programmes in the region. Which countries have thought it fit to continue their nuclear power programmes and why? What are the specific challenges facing the nuclear industry in Asia? The chapter identifies certain contemporary trends to understand the future of the nuclear landscape in Asia.

Where It All Started

Japan

The country that experienced an immediate downturn in nuclear energy obviously was the one where the nuclear accident took place. Japan was generating about 30 per cent of its electricity from nuclear power in 2011. The plan was to take this up to 41 per cent by 2017 and even double that share by 2050.[5] Unfortunately though, Fukushima laid to rest all such ambitions. Instead, the share of nuclear electricity fell to 0 per cent in 2014, and it has not even risen to 1 per cent since then. Only five nuclear reactors have slowly gone online since the total shutdown. Japan is hopeful of slowly making its entire fleet of close to 50 reactors operational after thorough safety reviews and inspections by the Nuclear Regulatory Authority (NRA). But, for the moment, even as the NRA is clearing the reactors for the restart, domestic politics and public concerns are still obstructing them from becoming operational. Even though their sudden closure resulted in a huge energy deficit that has been filled by import of expensive liquefied natural gas (LNG), oil and coal, with average electricity prices up by 25 per cent for households and 40 per cent for the industry, the public mood is still sceptical of nuclear power. In deference to this, the overall national plan in 2017 has announced a gradual reduction in the share of nuclear power to close to 20 per cent by 2030. This would be achieved by increasing the share of renewable energy and through more aggressive energy conservation measures.

Certainly, the nuclear industry in Japan is in turmoil. In fact, TEPCO, the country's largest electricity utility had come under criticism from early 2000s onwards for having "concealed several minor safety findings from the State regulator". TEPCO even "admitted that safety inspection records and procedures had been manipulated".[6] However, in the absence of any major mishap, operations continued with a business-as-usual attitude, until Fukushima happened. This severely harmed not just TEPCO's reputation and credibility, but also that of the Japanese regulatory authority, which was criticised for not performing its responsibilities with the necessary rigour and stringency.

There is no doubt that Japan has taken several steps post the accident to clean up its regulatory system and safety processes. It has been extraordinarily transparent in admitting its lapses and has even taken it as an obligation to enhance nuclear safety awareness in other countries. Indeed, six years after Fukushima, much of the technical fixes have been achieved, but public sentiment has not really softened towards nuclear power. It is likely that over time this attitude will change enough to allow the reactors cleared by the NRA to once again produce electricity. However, it remains to be seen if new reactors that were earlier planned will be constructed. Rather, the trend appears to be towards a gradual phase-out of nuclear power as the existing reactors complete their lifetime without being granted any extensions. Japan has also retracted from its reprocessing and fast breeder programmes. Though for now, Prime Minister Shinzo Abe remains committed to nuclear power as a means of long-term energy security, but how the industry stabilises itself and who succeeds Abe will determine the future of nuclear power in Japan over the next decade.

The Asian Nuclear Poster Boys

China

China embarked on a rapid induction of nuclear electricity from the early 2000s. Reeling under the deleterious effects of air pollution caused by widespread proliferation of coal-fired plants built quickly to fuel a phenomenally growing economy, Beijing understood the need to quickly change course towards low carbon sources such as nuclear power. By 2010, China had decided to "actively promote nuclear power" to increase nuclear generating capacity to 40 GWe by 2020. However, in the wake of Fukushima, Beijing too announced a temporary suspension of approval for new projects as it carried out a safety assessment of all its reactors. A national inspection group comprising the National Energy Administration (NEA), National Nuclear Safety Administration and China Earthquake Administration was instituted for the purpose. Based on its recommendations, a series of research and development (R&D) projects were launched by the NEA in February 2012 to improve plant safety-related technology and emergency preparedness. The dictum changed from 'actively promoting nuclear power' to 'steady development with safety'. In May 2012, a new safety plan was issued, and in October 2012, speaking on the occasion of the release of a White Paper on Energy Policy, Premier Xi Jinping laid utmost emphasis on safety standards for new reactors. He was rightly pre-empting public concerns on nuclear safety, which was starkly brought out when the plan to build a US$6 billion uranium processing plant in Guangdong province had to be cancelled in July 2013 owing to public protests over health and environmental fears. This was attributed to a "breakdown of trust, post Fukushima, in official assurances of public safety".[7]

However, Chinese officialdom has made it clear that the country needs nuclear energy to meet its rapidly increasing electricity demand owing to industrial production and economic growth. Indeed, the Communist Party of China realises the centrality of electricity generated from environmentally friendly sources, in order to sustain an economy that relies on energy-intensive manufacturing.[8] Accordingly, China's 12th Five Year Plan projects expenditure of US$13 billion on improving nuclear safety.[9] With these efforts and emphasis, China appears confident of staying the course on its nuclear plans. It is indeed showing the biggest ambition and appetite for nuclear reactors at this time. With 36 reactors already in operation, it has a record number of 21 new units under construction, with plans for nearly four dozen more. It also has some other impressive figures to demonstrate its commitment to nuclear power. For instance, of the 22 GWe nuclear generating capacity that was added to the existing global nuclear generation worldwide in 2009-15, 18 GWe was added in China alone. With its eyes firmly set on a grand target of reaching 58 GWe by 2020-21 and 150 GWe by 2030, China is certainly bullish on rapid domestic expansion.[10]

China is also emerging as a serious nuclear exporter. It has already won stakes in the Hinkley Point C Project in the UK, and is building more reactors in Pakistan. China has also signed nuclear cooperation agreements with Argentina, Romania, South Africa and Turkey. Able to offer financing, and basing its nuclear credibility on rapidly growing domestic nuclear capacity, China projects itself as a worthy contender to US nuclear industry which has shown no new domestic reactor construction for decades now. China also appears to be outrunning other established nuclear players such as the French Areva, which has run into problems and a portion of it has since been acquired by EdF. Another Chinese idea which is being explored for exports is that of floating power stations. Essentially small nuclear reactors built on barges, China is publicising these as an option for countries that have large populations but scarce land resources, such as Bangladesh. It also has the South China Sea in mind. However, many legal and regulatory aspects of this remain to be ironed out.

In order to sustain its expansive domestic and international commitments, China has embarked on an aggressive uranium purchase strategy from major uranium producers such as Kazakhstan, Namibia, and Australia. It is also reaching out to Niger, Mongolia, and Canada for the same. As it seems, the future of China's overall nuclear power programme appears set to enhance its clout on the international stage.

India

In India, meanwhile, 22 operational nuclear reactors produced about 6 GWe electricity in 2017. This accounts for less than 4 per cent of the total electricity production of the country. Technology denials and isolation from international nuclear commerce since 1974 stymied the potential for growth of the nuclear sector in the country. While indigenous growth was evident in the construction of several 220 MWe, and subsequently 540 MWe, and now 700 MWe reactors, the pace was slow and riddled with financial and techno-industrial quality and capacity constraints. Just as the situation was about to change with the grant of the NSG waiver in 2008, Fukushima cast a pall over the situation. Concerns on nuclear safety compelled the government to institute safety reviews of all reactors. The nuclear establishment, too, has had to scale back its expansion plans. For instance, the 12th Five Year Plan (2012-2017) that was to reach the target of 9 GWe installed capacity through a mix of indigenous and imported reactors is nowhere close to this figure. It also appears unlikely that the country will be able to achieve the target of 14 GWe by 2020.

Missing these targets, however, does not imply that the commitment to the growth of nuclear power has been diluted. Rather, several significant developments have taken place for the Indian nuclear power programme over the last five years. The period immediately following Fukushima and the passing of the stringent Civil Liability for Nuclear Damages Act (CLNDA) in India saw a lull as the nuclear industry expressed concerns about its investments. In order to assuage the mood, the government took several steps. It provided clarifications on the liability issues of concern to the nuclear industry in 2015.[11] In 2016, it set up an insurance pool to facilitate confidence by covering the risk of the suppliers. This was through the creation of a Nuclear Liability Fund of ₹2,000 crore (cr) meant to cover damages resulting from a nuclear accident in case they exceeded the limit specified at ₹1,500 cr for nuclear power operators under the CLNDA. Soon after the setting up of the pool, Nuclear Power Corporation of India Limited (NPCIL) bought the first Operators and Suppliers insurance policy at ₹100 crore premium from the consortium of General Insurance Corporation of India and the Nuclear Risk Insurers of the UK. India also ratified the IAEA Convention on Supplementary Compensation in February 2016. This enables the availability of additional funds from an international pool in the unfortunate case of an accident.

Another major development has been the finalisation of the bilateral agreement with Japan in November 2016. The agreement enables India to import nuclear material, technologies, and reactors from Japan, a nation with advanced nuclear technology and which is a major player in the global nuclear supply chain. In fact, Japan Steel Works (JSW) is amongst the only five companies in the world that have the capacity to manufacture large-sized single-piece pressure vessels used in large-capacity nuclear reactors, the kind that India plans to import. Westinghouse Electric, with which India has signed a memorandum of understanding (MoU) and which is owned by Toshiba, uses components from JSW. In the absence of an Indo-Japan agreement, Westinghouse would have found it difficult to authorise transfers to India.

In 2016, India also imported a record amount of 3,000 metric tonnes of Uranium from Russia, Canada and Kazakhstan. The availability of imported Uranium for its safeguarded reactors has enabled a jump in their capacity factors. While the Uranium Corporation of India Ltd, too, has re-started Uranium prospecting and exploitation within the country, the availability of imported Uranium will be a big help as new indigenous nuclear reactors, seven of which are currently under construction, and 10 more have been approved that are likely to go online by 2018.

In March 2017, the start of commercial electricity production by Kudankulam 2 led to a straight jump of 1,000 MW.[12] Awaited next is the start of operation of the first of the 700 MWe reactors at Kakrapar. After the 540 MWe reactors at Tarapur, these are the biggest-capacity reactors indigenously built in India and are expected to become the standard reactors in the future. In fact, in May 2017, the government approved 10 more such reactors. Another much awaited development is the attainment of criticality by the Prototype Fast Breeder Reactor (PFBR) at Kalpakkam. Given that nearly all countries working on fast reactor technology have given it up (Japan being the latest to put its Monju reactor to rest in December 2016), the eyes of the world are on India to gauge the success of the PFBR technology.

India has a strong case for understanding the role of nuclear energy in the future energy mix. Demographic growth, rising aspirations of a young and aspiring populace, lack of indigenous fuel resources, and mounting proof of climate change are challenges that call for a long-term vision and commitment to safe generation of nuclear power.

Meanwhile, India must explore export options too. It has proven expertise in designing, building, and operating nuclear plants of varied capacities, and also mastery over the full fuel cycle. It has also already been providing training assistance and capacity building either individually or through the IAEA. However, India has not exported its nuclear technology yet despite the fact that its 220 MWe small-capacity reactors could be of particular interest to smaller Asian countries embarking on new nuclear efforts where available national electric grid capacity is a constraint. It is generally understood that, "An industry rule of thumb is that an additional unit should not make up more than 10 per cent of the total installed capacity of the grid in question. When a given unit produces too large a portion of the load, maintaining stable electrical service becomes impossible."[13] Smaller reactors that have long been the workhorse in India can be found suitable in such situations. In case India feels constrained by an inability to provide financing or assured fuel supplies along with reactor exports, a solution can be explored in the creation of joint ventures or consortia with other established nuclear players. This could prove to be a win-win situation for all, and additionally, Indian nuclear exports could also help to strengthen its case for membership of the NSG.

The Steady Movers

Pakistan

In Pakistan, an electricity demand-supply mismatch has sustained interest in nuclear power. Currently, four reactors are producing 1,040 MWe electricity. But the Pakistan Atomic Energy Commission has expressed its ambition to construct five more nuclear plants to generate 5,500 MW electricity by 2019. China is the only country supplying nuclear technology to Pakistan in contravention of its NSG membership guidelines. Citing the grandfather clause, it has justified the transfer of new reactors to Chashma, as well as to Karachi, based on a cooperation agreement that it had signed with Pakistan before it became a member of the NSG in 2004. A Pakistani physicist, A.H. Nayyar, has described the relationship as a "marriage of convenience" since "no other country in the world is ready to sell a nuclear power reactor to Pakistan, and no other country has shown any interest in buying nuclear power reactors made in China so far."[14]

Concerns in Pakistan have been raised by some scholars, scientists and the public on the kind of reactors being supplied by China as well as on the location of two reactors just 40 km from Karachi. The city has a population of 18 million, and an accident at the plant could quickly turn into a disaster. However, citing the energy deficit rationale, Pakistan persists with its nuclear power programme, whose growth though will be driven by Chinese assistance.

Bangladesh

Nuclear power ambitions of Bangladesh go back several decades. It had long planned for two nuclear units of 1,200 MWe capacity each to start its nuclear power programme with Russian help. Feasibility studies, site selection and the final conclusion of the agreement took an inordinately long time given the political upheavals in the country through the first decade of the new millennium. However, in 2015, Bangladesh established the Rooppur Nuclear Power Plant Company to operate the country's first nuclear power plant and started negotiations on the credit, engineering and construction contract. Russia's Rosatom has committed to constructing and maintaining the plant for its first year of commercial operation before handing it over to Bangladesh, which has invested in human resource development and capacity building. The date for the first of these plants to become operational is placed at 2021-22.

The Long-Time Fence Sitters

Thailand

In pre-Fukushima years, Indonesia and Thailand were seen as the 'advancers' who had floated proposals for setting up nuclear plants. Indeed, Thailand had drawn a Power Development Plan in 2010 that envisaged the inclusion of 5,000 MWe nuclear energy in its electricity mix from 2036 onwards. Given the limited availability of indigenous energy resources and growing electricity demand, nuclear power was considered a viable option worthy of pursuit. The World Energy Outlook Special Report from the Organisation for Economic Cooperation and Development (OECD) and International Energy Agency (IEA) for 2013 saw promise in Thailand and projected that it would start producing nuclear electricity around 2030. Thailand has been sending its personnel to receive training and study nuclear industry, including public acceptance issues at Russia, China and Japan. The country, however, has not yet firmly committed to a nuclear power programme.

Indonesia

With its large economy, growing population and severe under-electrification, Indonesia had identified a strong rationale to go nuclear in 1995 after a feasibility study was conducted with Japanese help. However, the Asian slowdown in the 1990s and public protests did not allow the plans to progress till an agreement was concluded with Russia in 2005. Keen on developing a nuclear capacity, Indonesia investigated options for site selection, plant design and for creating the necessary regulatory infrastructure. The IAEA then described its nuclear effort as the most advanced. The plan was to begin construction in 2010 and to have the first plant completed by 2017. The plant, however, never started as scheduled since it came in for criticism from environmental groups, geological experts, legislators and vocal locals. After Fukushima, the government announced a slowdown in its nuclear efforts. Given that Indonesia had chosen its nuclear plant site near a dormant volcano, Mt Muria, and the country is in the Ring of Fire, an area that suffers from periodic earthquakes and volcanic eruptions, it is not surprising that Fukushima impacted its decisions. As of 2015, it had indicated a change in focus from "building large units for the Java-Bali grid to building an initial small reactor near Jakarta".[15]

Malaysia

In 2008, Malaysia decided to undertake a feasibility study and site investigation for a nuclear plant that it hoped to be operational from 2024. Malaysia Nuclear Power Corporation expressed a desire to work with the IAEA to evaluate setting up of plants so as to have as much as 10-15 per cent electricity from nuclear plants by 2030. The Integrated Nuclear Infrastructure Review (INIR) took place in October 2016, and it concluded that strengthening government commitment and enhancing public awareness were necessary to help the country make a decision. However, according to reports, as late as May 2017, the decision is yet to be taken.[16]

The Philippines

Interestingly, while it had completed a nuclear plant in 1984, the Philippines never operated it due to concerns of safety deficiencies and reports of bribery. "For over 20 years, until meeting obligation in April 2007, Filipino taxpayers paid 155,000 dollars a day in interest on the plant that never produced a kilowatt of power."[17] Faced with the white elephant, the government of President Arroyo in 2007 tried to find options of utilising the plant to recover the investment. South Korea's Korea Electric Power Corporation (KEPCO) offered to revive the plant and in 2008, the IAEA after due study advised the government that the plant could be refurbished and safely operated. This revived the interest of the government. But then the Fukushima impact pushed this down in the list of government priorities. Most recently, in 2016, at the IAEA conference in Manila on the Prospects for Nuclear Power in the Asia-Pacific Region, issues related to the legal, regulatory, waste management, human resource development and capacity building were discussed. On the occasion, the Philippines Energy secretary once again spoke about reviving the mothballed 620 MWe Bataan plant.[18] How, if at all, will this happen is still doubtful though, especially since South Korea itself has raised doubts on the sustenance of its own domestic programme.

The Surprising Naysayers

Vietnam

Long recognised as the Asian nuclear frontrunner, Vietnam had built the rationale for nuclear energy as a viable means to fulfil its base-load electricity requirements that were increasing at a rapid pace. An economy growing at a rate of 7 per cent through the 2000s and an expanding population with higher incomes made it necessary to find clean options for meeting the rising aspirations. The agreement with Russia was accordingly firmed up in 2006 wherein Moscow agreed to finance and build two units of 1,200 MWe each. Another agreement for similar capacity construction was concluded with Japan in 2010. By 2013, Vietnam was undertaking site preparation in the Ninh Thuan province, human resource training and the creation of the necessary legal framework. Construction was due to begin by 2015, and the plant was to be operational by 2025.

However, in a sudden development in November 2016, Vietnam announced that it was abandoning its nuclear power programme. The reasons cited for doing so were overestimation of electricity demand and the doubling of the estimated cost of reactors since the signing of the agreement. It remains to be seen if this decision would really mark the end of Vietnam's tryst with nuclear energy, or whether future governments might revive the programme again. The problem with such abrupt reversals, however, is that it lowers the morale of the nuclear establishment and dissipates the human expertise that has been painstakingly built over time. It may be recalled that Vietnam does have a research reactor, which it has been operating successfully since 1984. Scientists and engineers working in the nuclear sector were upbeat about having an operational nuclear power plant. But the recent decision has killed such hopes, and it will mean that fewer young engineers will be attracted towards this technology, hampering the continued operation of the Research Reactor (RR) too.

South Korea

Nuclear energy in South Korea had seen a steady upward trend from 2000 onwards. Of its total electricity requirements, 38 per cent was being met by nuclear power in 2003 from 18 nuclear power plants producing 15 GWe. The government's commitment to nuclear power was steadfast during this time in order to balance the country's growing economy and consequent electricity demands along with climate change compulsions. In January 2007, the Ministry of Education, Science and Technology (MEST) adopted the Third Comprehensive Nuclear Energy Promotion Plan (CNEPP),[19] which highlighted the importance and vision of nuclear expansion. CNEPP focused on the nation's need to secure energy to enhance its economy, improve the human development index, to escalate its science and technology and to protect the environment. In 2008, President Lee Myung-bak introduced "Green Growth" as part of the national development strategy. Accordingly, nuclear power expansion led to 23 GWe installed capacity from 25 reactors by 2013. Plans then were to increase nuclear share to 45 per cent by 2015 with the addition of another 10 units and to expand to 36 nuclear reactors by 2030.

Besides domestic growth, the nuclear sector was also expanding its external footprint. In 2009, KEPCO beat other established nuclear suppliers to win the competitive bid for the construction of the first four nuclear units in the UAE. The design of its APR 1400 reactor proved to offer tough competition to the likes of AREVA's EPR and other similar generation reactors of Westinghouse. Its plans for domestic nuclear construction, a government-level commitment to export and consistent technology advancement, were seen as factors that would help South Korea develop a highly efficient nuclear supply chain in the coming years.

Not surprisingly then, most IAEA and World Nuclear Association (WNA) reports of 2010 made optimistic projections on nuclear build-up based on the programmes of China, India, Japan and South Korea. The WNA stated, for instance, that between 2010-20, the addition to nuclear power generating capacity would be to the tune of 56 GWe per year. "Much of this growth is expected to be considerable in four countries – China, Japan, India and South Korea."[20]

However, Fukushima did not leave South Korea untouched. Trouble began brewing in the South Korean nuclear sector in 2012-2013 when safety reviews in the wake of Fukushima threw up safety and certification issues on the use of sub-standard components in five operational plants, leading to their shutdown. Need for regulatory oversight led to the establishment of an independent commission to take care of nuclear safety. The commission started functioning from October 26, 2011, as an independent presidential commission, looking after the areas of nuclear safety, security and non-proliferation.[21] Though the matters were resolved, the seed of public discontentment had been sown. As the country saw its neighbour Japan struggle with the containment of radioactive leaks at Fukushima, the country's own commitment to nuclear power took a hit too. Environmental groups, religious groups and professional associations joined anti-nuclear protests. Given the mood in the country, the current administration of President Moon Jae-in has indicated its decision to steadily reduce the share of nuclear power by not building any new plants. Time will tell whether the future administrations will stick to this decision or revoke it.

Challenges for Nuclear Power

The future of nuclear power in Asia today appears to be at an important crossroads. Indeed, the countries facing a growing electricity demand as a result of expanding economies and populations are caught in a tough dilemma. They must be able to meet their national energy requirements while holding on to stringent commitments to reducing global greenhouse gas emissions. The climate change situation is dire enough to require an almost total decarbonisation of energy supply in the coming decades. But dependence on proven low carbon technologies such as nuclear power has taken a serious hit after Fukushima. As is evident from the broad overview of country positions, less than a handful of Asian countries appear to be firmly committed to nuclear power. Many have put their nuclear plans on hold and many others are moving slowly to reduce its role. A positive turnaround, if it has to happen, will depend on how a few challenges, as listed in the following paragraphs, are met.

Public Acceptance

This has emerged as the biggest challenge to nuclear power expansion in most countries of Asia. As is seen in the case of Japan, the NRA has cleared several reactors for start of operations after the necessary checks, but governors of the prefectures are unwilling to take the decision in favour of restart owing to an adverse public sentiment. Moreover, given the active social media and communications, critics of nuclear power are more easily able to connect across countries and continents to feed each other's insecurities. Anti-nuclear protests have been seen not only in democratic countries like India and South Korea but also in more authoritarian systems like in China.

The pressing challenge before the nuclear industry and national nuclear establishments is to arrest the mood of public opinion that appears to be swinging in favour of choosing the easy option of abandoning nuclear energy, though the need of the hour is to maintain a balanced approach towards nuclear energy by undertaking a calculated analysis of its risks and benefits and to distil and assimilate the right lessons from Fukushima.

The battle has to be won on two counts: one, to make people understand the need for nuclear power; and two, to explain the safety aspects of nuclear electricity generation. This calls for a more proactive approach from the nuclear establishment. Until now, such programmes have worked in a closed manner – in decision-making and operations. But in the changed environment after Fukushima, the only way to win public support for nuclear energy will have to include a far greater interaction with the people to explain to them the reasons for selection of a particular site, the basics of the reactor technology, the safety redundancies built into operations, etc.

In fact, it would be a good idea to invite the public – school and college students, organised groups of women's associations, the corporate sector, the media, and generally, the common man – to visit the plants and to see and feel for themselves. A special effort must also be made to engage with non-governmental organisations (NGOs) and local community groups at plant sites since they have the advantage of directly interacting with the local populace and also have a huge capacity for mobilising public opinion. The more approachable the nuclear plants seem, the greater will be the confidence that will be engendered over time. Tellingly, a global online public opinion poll of 10,000 people, which was conducted by the UK-based Accenture firm in November 2008 revealed that nearly 40 per cent of the respondents felt that they could vote in favour of nuclear energy if provided with more information. This finding is even more relevant today.

Nuclear Safety

Indeed, safety is most critical for the nuclear industry since it deals with materials that are radioactive and hence potentially dangerous, and with systems and technologies that are extremely complex. Nuclear accidents have widespread implications, not only in terms of geographical expanse but even more so in terms of shaking public confidence. In no other industry does an accident in one plant have comparable impact on the international industry as a whole.

In fact, after each untoward incident, new technical processes and design changes have been incorporated into nuclear reactors, and modern power plants are the result of refinement of several decades of reactor operating experience. Over the last two decades, the international safety record of Nuclear Power Plants (NPPs) has been remarkable given that the complex nuclear technology is today employed in about 40 countries, with some 40-year-old reactors still in operation. Over time, all the processes involved in reactor siting, design, construction and operation have evolved best practices under the watchful eye of national and international regulatory agencies. Several new design features such as double containment for the reactor, core catcher in case of a meltdown, passive safety features, etc. have been derived from past accidents. Similarly, better emergency planning and conduct of independent peer reviews help operators share information and build a safety culture.

Yet, achieving unimpeachable safety standards is a continuous journey and not a destination. Given the widespread impact that safety can have on the fate of nuclear power worldwide, as is evident in Asia, relevant procedures and their regular improvement need to be imbibed as an organisational culture so that safety is not imposed but inborn. Only such measures will help to change public perception and raise confidence in favour of nuclear power again.

Stringent Regulatory Oversight

The role of independent and effective regulation of national nuclear programme cannot be overstated. Given the risks involved in the technology, it is only natural that a special organisation be tasked to perform diligent supervision with utmost objectivity and rigour based on a set of clearly established guidelines. The IAEA has also evolved such benchmark guidelines for the creation and functioning of regulatory organisations. In fact, for any country embarking on a nuclear power programme, first putting in place the necessary legal and regulatory mechanisms is a must. Post-Fukushima, regulatory oversight mechanisms in all countries came into question with the surfacing of the phenomenon of 'regulatory capture' – a situation in which a regulatory agency created to act in public interest, instead starts advancing commercial or political concerns of special interest groups dominating the sector it is supposed to be regulating. The conflict of interest involved in having the same set of people engaged in promotion and regulation of nuclear programmes was identified as a major drawback of existing regulatory systems in many countries. After the Fukushima experience, many countries have worked towards clearing this mess. It must be remembered that public confidence can only be restored if the regulatory organisations prove their independence in functioning, and do so with effectiveness and transparency.

Nuclear Waste Management

A key reason for public concern about nuclear power is the nature of nuclear waste, which is radioactive with a very long life. Environmental and public interest groups have whipped up opposition to nuclear power by highlighting the difficulties involved in dealing with spent fuel and its safe storage. Aspects of safety and security are both involved in this dimension. Fortunately, the nuclear industry is well aware of this challenge and has been managing waste disposal successfully for more than half a century. Dozens of facilities for low-level and intermediate-level nuclear waste are in operation throughout the world. As far as the long-term management of high-level radioactive waste and spent fuel is concerned, nations are experimenting with ideas of construction of deep geological repositories as well as reduction of high level waste through separation of actinides and disposal of each depending on their chemical nature and composition. Given technological advancement and human ingenuity, it is quite possible that adequate solutions to the challenge of radioactive waste disposal will be found sooner rather than later.

Management of the Global Nuclear Supply Chain

As the major nuclear construction activity is happening in Asia, managing the quality and capability challenges along the supply chain in order to ensure reliability and efficiency are significant challenges. Until now, nuclear components and systems manufacturing has been based in American and European industries. But in the current times, the nuclear industry in the Western world appears to be in a state of flux. In March 2017, Westinghouse Electric Company, the subsidiary of Japanese company Toshiba, filed for bankruptcy owing largely to financial and construction challenges faced in the context of two AP1000 power plants that it was building in the US states of Georgia and South Carolina. When Toshiba acquired Westinghouse from British Nuclear Fuels Ltd in 2006, it was premised on the expectation that "By 2020, the global market for nuclear power generation is expected to grow by 50% compared with today".[22] That estimate proved to be false as the promised nuclear renaissance never materialised. Neither was Westinghouse design of AP1000 as amenable to quick construction as had been originally thought. Implications of this on investor confidence in nuclear power can be well understood.

Meanwhile, cost concerns and ease of transportability will require local industries in countries anticipating major nuclear build-up. Obviously, China and India would like to develop their own nuclear supply chains. But these will need to keep stringent nuclear quality requirements in view. Given the high technology and costs involved, it might be a good idea to explore possibilities of nuclear industries of Asian countries, such as in China, India, Japan and South Korea, to link up on nuclear supplies based on their core specialisation. Some trends of the like, though within the Chinese domestic sector, are visible. The China National Nuclear Power has formed a joint venture with Zhejiang Zheneng Electric Power, Shanghai Guosheng Group, Jiangnan Shipyard and Shanghai Electric to build floating power plants, undertake maritime nuclear power research, development, building, operation and management.[23] Cross-country linkages in the nuclear industry in Asia are yet to emerge, but it is an idea ripe for exploration.

Safe Decommissioning

Nuclear power plants have long lifetimes. Extensions granted by regulatory authorities after due checks can further extend operational spans beyond those originally envisaged. But as the reactors face shutdown, it must be noted that decommissioning is a serious business, involving financial resources and technical expertise. Most nuclear reactors account for the cost of decommission in the operating cost of the plant. However, no real exercises of this nature have yet been undertaken in Asia. With the decommissioning of reactors at Fukushima, Japan is likely to be the first to undertake this task and the country does see new industrial opportunities in this sector.

Safe decommissioning of a few reactors will boost confidence in nuclear power and address the public concern on how nations will deal with the issues related to removal and disposal of radioactive systems and components. A few successful cases in this direction would raise confidence in the safe exploitation of nuclear power for electricity generation and have an impact on the future of the nuclear industry.

Conclusion

The mixed nature of nuclear prospects in Asia is amply evident. Nuclear power programmes are unevenly scattered across the region. While China and India boast of ambitious programmes, Japan and South Korea have indicated a desire to gradually reduce the share of nuclear energy even as other likely first-timers are treading with utmost caution. Yet, it may be said with some certainty that nuclear power will not completely exit the region in a hurry for two reasons. One, because developing economies will be compelled to use all electricity generating options to meet rising demand; and, two, they will also be obliged to move towards environmentally sustainable sources in order to meet international emission reduction targets. These two drivers will provide the basic rationale for national nuclear power efforts and underpin the choice that many nations may still make.

Of course, after Fukushima, nations will have to also make adequate investments in the construction of necessary legal, regulatory and emergency preparedness infrastructure, besides technical manpower and expertise to operate the plants. Countries that go in for nuclear power programmes will have to have the ability to carry a certain burden of risk. These risks may be varied – ranging from those associated with the possibility of failure to earn a return on investment if a plant were to never become operational owing to political, economic or social factors, or the risk of a nuclear accident involving payment of compensation. Only those governments that have an appetite for such risks and a modicum of public support will go for nuclear power.

To sum up, domestic political environment, reactor construction costs, and risk management capacity and capability will determine the future of nuclear power programmes across Asia. Individual nations will make their own choices based on their energy requirements and risk calculations. Clearly, a nuclear renaissance in Asia is no longer on the anvil in the near term, but neither is nuclear phase out a possibility in the same time frame.

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9

Renewable Energy and Critical Minerals: Access to Resources in Asia's Energy Paradigm

*Swati Ganeshan**

Introduction

The world is transcending through a slow economic growth, managing significant political transitions such as Brexit, escalating civil wars in Syria and combating terrorism that is spreading like wildfire throughout the globe.

Growth in Asia will expand by 5.7 per cent in 2016 and 2017, down from 5.9 per cent, due to the slowdown in the Chinese economy and an overarching slow growth rate globally. However, the region was able to ensure that there were no significant downturns as India has been witnessing a strong growth rate and Southeast Asia had a promising year in the middle of the global economic gloom. According to the Asian Development Bank (ADB) 2016, the region will contribute to 60 per cent of the global growth in the forthcoming two years.[1] While fuel, food and commodity prices have been low in the past few years with many Asian economies benefiting from it, at the other end of Asia, countries dependent on commodity exports, such as Kazakhstan, Azerbaijan and Timor-Leste, among others, are expected to face a slow economic growth.

Within this economic context, the energy demand in the Asia-Pacific

*Disclaimer: The opinion and comments in the chapter are those of the author and not of TERI.

region is also set to increase. According to the BP Statistics 2016, the region's energy consumption would rise by 54 per cent, while production will grow by 46 per cent. Asia's energy mix would be largely fossil fuel-based, according to ADB report 2013 energy outlook for Asia and the Pacific's, the region's primary energy demand is projected to increase at 2.1% per year till 2035.[2] Fossil fuels will remain the primary energy source for Asia dominating the energy mix with around 83% share in 2035. Coal and oil both would have the largest share in the Asia and the Pacific primary energy demand with more than 40% and 20% share respectively. Natural gas would experience the fastest growth in projection period of 2035 with a growth rate of 3.9% per year followed by nuclear at 3.5% per year.

Renewable energy has a promising future and would become a vital source of energy for the region. With increasing demand, there is a need to ensure a sustained supply of energy sources. Additionally, due to climate change and the decreasing reserves of fossil fuels, the pursuit of renewables and other non-conventional sources of energy would transform the mix with cleaner and renewable sources of fuel.

Critical and Strategic Minerals – Historical Context

The discussion on critical and strategic minerals has been going on for over a century. The most notable discussions on strategic minerals and their importance are evident in the literature emanating from around the First World War era when the need of minerals for weapons and ammunitions was recognised early leading to the establishment of national stockpiles and departments to procure strategic and critical minerals. The same phenomenon was evident during the Second World War as well. Since then, various scholars, e.g. C. Leith and A. Knopf, have discussed strategic minerals from different perspectives. In recent literature, the National Research Council's 2008 report, *Managing Materials for a Twenty-first Century Military*, highlights the historical significance of strategic and critical minerals. Technological innovation and rapid economic changes has also transformed the use of materials, with the array of minerals becoming wider with different uses. From the Iron Age to the Rare Earth frenzy, technological innovation and the need for more resources with high efficiency has led to the discovery of new resources, amalgamation of many metals and minerals to create alloys and super alloys. However, changing environment and climate pose risks that can only be solved with strategic cooperation among resource users.

Asia is home to producers, consumers and transit countries in energy production and trade. China, Kazakhstan, Indonesia and India are some of the largest producers of both fuel and non-fuel minerals. China, India, Japan and South Korea are also among some of the largest consumers, with many other Asian countries such as Singapore considered to be essential transit countries largely from a fossil fuel perspective. With regard to non-fuel minerals, China is the largest producer and consumer of the resources, with other countries such as India and Kazakhstan following suit. According to a report by the World Economic Forum on *Mining & Metals Scenario to 2030*, published in 2010, many Asian countries would contribute significantly to mineral production in the future according to various scenarios of the report.[3] The report projected that China, Kazakhstan, India, Indonesia, Uzbekistan, Iran and Indonesia would become key producers of mining and minerals in the coming decade. According to CSTEP report, China alone accounts for major share in the production of many minerals and metals such as Rare Earth Elements, Antimony and Germanium, with almost more than 60 per cent of world production of certain minerals coming from that country.[4]

Asia is continuing its pace towards rapid economic development, and such development requires energy. Because of climate change concerns and to intensify energy access and availability in the developing region, the need to enhance the role of renewable energy is paramount. Asia has shown promising growth in the renewable energy sector; however, just as the fossil fuel sector is affected by supply risks (trade, geopolitics and security), a similar trend is possible in the renewable energy sector. Like any other industry, the renewable energy sector is dependent on various minerals and metals such as Steel, Aluminium, Copper, etc. for its crucial equipment. Additionally, in order to increase their efficiency and performance, many specialty minerals or energy critical elements are also utilised to provide the edge to technology. Though many minerals are available in abundance, with increasing economic growth and consumption patterns, the use of minerals has also escalated. This increasing use of minerals, and specifically, the use of energy critical elements or strategic minerals, has emerged as a major concern. Since the non-conventional energy sources such as solar and wind depend on these minerals along with other clean energy interventions, such as electric vehicles, the importance of such minerals and metals has become evident for the continued growth of the sector.

In this context, the chapter focuses on the minerals and metals that are essential for the non-conventional energy sources (specifically, solar and wind) and the future impact of such minerals on Asia as a whole. As Asia is projected to drive the global economic growth, its energy demand and consumption will increase further. With countries aiming to achieve their renewable energy targets to ensure energy security and combat climate change concerns, the secure supply of minerals for the sector would be a priority. There is also need to understand the major players in the renewable energy sector – major raw material producers, major manufacturers, technology owners and major consumers, and their individual stakes in the sector – who are the key determinants of supply risks such as trade, geopolitics and security.

The chapter discusses the following key aspects: Asia's energy scenario with specific reference to renewable energy, the major players in the minerals sector, the importance of minerals in the renewable energy sector and the geopolitics of minerals, and its impact on Asia's clean energy future.

Energy in Asia

Post the Paris Agreement, which entered into force in November 2016, the contours of energy across the globe will have to be changed to ensure a domestic energy framework that would include renewable energy and clean energy transitions, along with the shift of energy mixes towards a higher share of renewable energy in the future.

Due to increasing competition over resources, price volatility in resource trade, rising supply risks and a geopolitical tug of war occurring around conventional energy sources, the need to escalate the share of renewable energy in the energy matrix of countries has become a major goal of all nations. As highlighted in the World Energy Outlook (WEO) 2016, Asia's energy demand and consumption is likely to increase as it is at the helm of global economic growth.[5] Hence, rapid progress in the renewable energy sector in the region is imperative to achieve energy security.

The shift to unconventional energy sources, such as solar, wind, geothermal and nuclear energy, has become significant for all countries; however, in order to shift to these sources, there is a need to ensure that these sources are not affected by the competition over raw materials, volatile prices, geopolitical concerns and technological hurdles, among other issues.

As highlighted, the scope of the chapter focuses on the two rapidly progressing unconventional energy sources, namely solar and wind energy. According to the WEO 2016, in its scenario to 2040 and in accordance to the pledges undertaken by all governments, electricity is the key focus in the Paris Agreement pledges. According to the WEO 2016, 60 per cent of the power generation would be from renewable energy in the 2040 scenario and more than half of this is from wind and solar photovoltaics (PV). According to the REN21 Global Status Report 2016, in 2015, solar PV and wind energy accounted for 77 per cent of the new installations in the global power sector.[6]

Renewable Energy and Raw Materials/Minerals – Understanding the Need

Although Solar PV and wind energy are renewable and clean sources of energy, to utilise these renewable sources various manufacturing inputs are required. These include solar panels, batteries, storage systems, etc. for solar energy, while for wind energy, wind turbines, blades, nacelle, and tower are among the critical components.

Component details

Solar PV is of three types – first generation crystalline silicon, second generation thin film and the third generation emerging technologies. These are further categorised into various subsets (see Table 1):

Table 1: Categorisation of PV

Types of Solar PV	*Key Issue*
First generation crystalline Silicon	92 per cent of the market share.
Monocrystalline Silicon	Primary Material – Silicon. High efficiency, complicated process of manufacturing resulting in higher costs. 45 per cent market share.
Polycrystalline Silicon	Cheaper to produce but less efficient than monocrystal line. 55 per cent market share.
Ribbon Silicon	Lower cost and lower efficiency.
Second generation thin film	7 per cent market share.
Amorphous Silicon	-
Thin film Silicon	-
Amorphous and micromorph Silicon multijunctions	-
Cadmium-Telluride	Dependent on critical minerals. 5 per cent market share.
Copper-Indium-[Gallium]-[di]selenide- [di]sulphide	Dependent on critical minerals. 2 per cent market share. Indicated to gain market share in the future.
Emerging and novel	Research and development is still occurring and the current market share is less than 1 per cent.
Concentrating PV	
Dye-sensitised solar cell (organic)	

Sources: IRENA – Solar Photovoltaics – Technology Brief, 2013; End of Life management of Solar Photovoltaic Panels, 2016; *ADB Handbook for Development of Solar Rooftop in Asia*, 2014.

There are various minerals and metals that are utilised in the production of solar PV, including Copper, Steel, Aluminium, Glass, Zinc, Graphite and Silver. Solar PV also has mounting systems, inverters, wiring and monitoring systems. According to IRENA (2016), a typical crystalline silicon panel weighs approximately 19 kg, Cadmium-Tellurium (Cd Te) weigh around 12 kg and the Copper-Indium-Gallium-Selenium (CIGS) weigh around 20 kg, while Glass is the most major component of the solar PV technologies.[7] In the cumulative weight of these PV technologies, the use of critical minerals is minuscule. However, their properties provide an edge to the technologies. While research and development in the Solar PV are evolving rapidly, the substitution of these critical minerals is also being tested.

Wind energy system also requires various materials and metals. The tower of a wind system is largely made of Steel, Aluminium, Copper and Glass reinforced plastics. The nacelle is largely made up of Steel, Copper and Iron ore. In recent years, the use of permanent magnets in the generators inside the nacelle imply that critical minerals including Rare Earths are also in use in the generators to reduce the weight of the generator. Glass reinforced plastics and Carbon reinforced plastics are utilised for the rotors and the hub.[8]

Major Minerals and Metals in Energy Applications

Since 2000, there have been many studies that focused on identifying critical and strategic minerals that are essential for certain important sectors such as defence, electronic, energy and energy efficiency, among others. Many studies have focused on country-specific or sector-specific analyses; however, in almost all studies, the list of minerals that have been highlighted as critical are similar.

The 2009 UNEP report on critical metals and their recycling potential[9] and other reports on critical minerals that were identified to be significant for the energy sector are listed in Table 2, as follows:

Table 2: Minerals in Energy

Electrical and Electronic Equipment	*PV*	*Batteries*	*Catalysts*
Tantalum	Gallium	Cobalt	Platinum
Indium	Tellurium	Lithium	Palladium
Gallium	Selenium	Rare Earths	Rare Earths
Germanium	Germanium		
Palladium	Indium		
Ruthenium	Silver		

Source: UNEP, 2009; McLellan, 2016.

Along with the above-mentioned metals and minerals, there are various metals that are considered critical depending on their economic importance, import dependency and their scale of substitutability. The continued utilisation of the minerals and their demand depend upon their current usage and their future potential, specifically in the renewable energy sector. In correlation, the minerals reduction or increase in use in other sectors would also have an impact on the criticality of the materials.

The next section focuses on the major issues from the global mineral scenario with particular reference to the issues that have an impact on critical minerals.

Global Mineral Scenario – Key Issues for Resource Access

Diffused Global Supply Chain

The global supply chain of the minerals is distributed with the mining, refining, processing and manufacturing – all occurring in different countries. The social, political environment of each country also has an effect on the criticality of minerals. Minerals from countries with political stability, access to technology, suitable infrastructure and compatible legislation are major factors in how the sub-sector in the value chain would develop within the country. For instance, the research and development environment for Rare Earths in China for the past few decades has been a crucial factor for the country's ability to establish many of the sub-sectors of the Rare Earth value chain, while turning it into the largest producer of the minerals. According to Smith, China has been able to establish an integrated supply chain for permanent magnets and is currently the only country with the capacity to process Rare Earths.[10] Hence, other countries would have to export the raw resource to China to recover heavy Rare Earths. Such a trend also highlights the high dependence on a single country for an essential component in many renewable energy technologies.

Mine to Minerals/Metal Recovery

The gestation period for a mine to begin producing minerals is quite long, ranging from 10-20 years. This long gap in the culmination and the commencement of the mine would act as a deterrent for the end-use manufacturer from utilising the mineral, citing supply risks without continued access to the resources or lead the manufacturers to initiate the research and development for alternatives.[11] Additionally, the sector would invariably continue to transform, which would reduce the demand for a mineral or increase its use thereby creating a complex situation for the end-use manufacturer.

Enhancing Reserves

The reserve to production ratio (r/p ratio) of many minerals globally has not been assessed due to lack of information and the r/p ratio of Gold, Silver and Platinum group of metals. There is also no data available on Tellurium, Antimony, Tungsten and Rare Earth. From the perspective of how long the resources would last, most minerals are in a comfortable position except Molybdenum and Zirconium.[12] Additionally, the exploration of such resources is still to be undertaken in many countries to find new and additional resources. For instance, in India there is further need for exploration and also the acceleration of the exploration budget to seek new resources.[13]

Single Producer Concerns

Many minerals are produced in large volume by a single producer with a significant share in world production leading to a monopolistic structure in the mineral trade. There are many minerals where a single producer accounts for more than 50 per cent of production share, leading the country to be a critical factor in pricing and also in control of global supply. Many of these minerals are also currently being utilised in energy efficient technologies as well as for electric vehicles. A primary consumer of the critical materials are batteries and catalysts utilised in many clean energy technologies, including renewable energy.

Table 3: World Share of Minerals

Country	*Percentage Share (World) Mine Production*	*Country*
Cobalt	49%	Congo
Copper	32%	Chile
Gallium	74%	China
Indium	52%	China
Lithium	70%	Australia
Manganese	23%	South Africa
Nickel	30%	Indonesia
PGMs	-	-
Platinum	71%	South Africa
Palladium	41%	Palladium
Other PGMs	77%	South Arica
Rare Earths	88%	China
Selenium	29%	Japan
Tellurium	34%	USA
Zinc	37%	China
Silver	22%	Peru

Sources: WWF 2014; McLellan 2016; BP 2014.

Primary and Secondary Sources/By-products

Minerals that are recovered as primary ore have a structured process for mining, processing and refining. Additionally, many minerals are also recovered as by-products of the primary ore and are dependent on the primary ores market with regard to mining and production. For instance, Silver is a metal, which is largely mined as a by-product to Zinc and Lead deposits. Indium is a by-product of base metals such as Zinc and Copper concentrates and only 30 per cent of the Indium from these concentrates is utilised, as many of the smelters are deficient in Indium collection technology.[14] The same is visible in Tellurium as well, which is a by-product of Copper. Many of the by-product minerals and metals can be recovered through various mineral resources; hence, it is difficult to ascertain their reserves and reserve to production ratio.

Refining and processing are major concerns that have significant implication on prices and could further complicate access to these resources. Various acid and solvent extraction steps need to be employed to recover the individual elements. As each element has its own extraction steps coupled with chemical processes, the process is complex. Besides the separation process, further reprocessing is required to achieve ideal purity. Once the elements are transformed into oxides, they can be stored and shipped for further processing into metals. To convert the metal into alloys more processing is required and in context to specific applications, such as for magnets, further processing is required. Around 10 days are required to recover the oxides from the ores.[15]

The mining and extraction process of Rare Earth Elements is complex and could pose environmental hazards, as in the case of China. In cases of minerals such as Monazite, the presence of Thorium and at times Uranium makes it radioactive, creating difficulties in the extraction of Rare Earths. The intensively long processes that require specific procedures for processing of each ore body and of each element has been a key deterrent for many companies to engage in the mining and processing of Rare Earths. This has also at times led to the closure of operational mines due to the capital-intensive process requiring US$30,000 per tonne of annual separate capacity.[16] Along with the high operation costs, the extraction of Rare Earth Elements face another challenge as the mining process could lead to the recovery of those elements that may not be required or those that have sufficient supply. Due to their collective occurrence and complex processes, elements that are in abundance are still recovered, and at times those with high demand that are relatively less abundant may not be sufficiently procured. Additionally, the complex process also poses environmental stresses if the extraction process is not conducted with caution.

Substitutability and Suitability

One of the key factors that determine the future direction of critical minerals in context of the supply and demand is their substitutability. For instance, in the permanent magnet industry, Ferrite and other type of magnets currently have a large chunk of the market, but the properties of Neodymium-Iron-Boron magnets is gaining ground as their properties would lead to a lighter weight and smaller size coupled with higher magnetic output. The Lanthanum-Nickel-hydride batteries are currently in high demand as well. In certain applications, such as in the defence sector, the properties of the elements make them non-substitutable as they are responsible for the functionality of the component and their replacement may lead to inadequate performance.[17] Another key aspect that would additionally affect the demand for minerals is suitability, that is, determining if the mineral/element would function appropriately even if the product is redesigned with other alternate minerals.[18] This aspect needs to be studied intensely for all minerals that have substitutes or potential substitutes, especially for energy critical minerals.

Resource Concentration and Cartels

Some countries have a major share in reserves and production of certain minerals such as in the case of Copper. Chile, Peru, China and Indonesia account for almost 56 per cent of the world's Copper production, and more than 50 per cent of these reserves are concentrated in China, Australia and Peru. Historically, Copper-producing countries and companies have attempted to create cartels to regulate prices and the global market, such as the International Copper Cartel and the Intergovernmental Council of Copper Exporting Countries.[19] There is a high geographical concentration of resources in one or a few countries. 95 per cent of the Platinum group of metal resources are in South Africa, 57 per cent of Lithium resources are found in China, and 47 per cent of Cobalt reserves are in the Congo.[20] Due to the high concentration of Rare Earth Elements in China and as the sole producer of the mineral, China imposed export restrictions on these resources leading import-dependent countries and regions, such as the US, European Union (EU) and Japan, to seek World Trade Organisation (WTO) intervention. China is also the leading producer for Iron ore, Tungsten, Vanadium, Antimony, Cadmium, Gallium, Germanium, Lead, Tin, Selenium, Zinc, Baryte, Gold and Phospors, with significant reserves.

Inter-Sectoral Demand for Critical Minerals

As the demand for energy increases so will the demand for resources and minerals utilised in the solar and wind energy sectors. However, the demand for the metals is also increasing in other sectors such as information and communications technology (ICT) and electronics and defence, among others. For instance, the ICT sector alone consumes 50-60 per cent of Tantalum, 26 per cent of Tin and 9 per cent of Gold.[21] The permanent magnets sector is one of the largest consumers of Rare Earths and the need for the resource will increase in the future.

Rate of Innovation

In the case of access to raw materials, it has been observed by scholars[22] that if domestic firms procure raw materials from local suppliers, then there is an increase in the rate of innovation as they play an important role in supporting technological change. In the case of Rare Earths, post the reduction in the mining of Rare Earths in the US and the subsequent halt on all production of Rare Earths, a slow movement of research and development and other manufacturing facilities was evident, which led to the US becoming critically dependent on imports for materials and also losing the technological advantage over Rare Earth-based innovations.[23] However, patenting is being used as a proxy for Rare Earth innovation activity. It has been observed that in the case of Rare Earth technology innovation, the patenting activity is dominated by countries like China and the US. This trend may also take a toll on the rate of innovation in the national economy.

Mineral Trade

The global trade framework for the resource is separated into two modes, one regulated and the other traded without terminal markets. Most base metals are traded to metal exchanges; however, many of the specialty metals are traded through the latter route which is opaque, without much regulation and the prices are also not regulated, with price hikes during the transaction process itself being an accepted practice. Many metals such as Rare Earth Elements, Germanium and Rhodium are traded through this mode. A new form of trade is long-term, bilateral contracts among countries and companies or major manufacturers, such as Toyota and Siemens, investing directly in mining.[24] There is also a major concern of conflict minerals such as Cobalt and Coltan entering the supply chain leading to the unwarranted fuelling of wars in resource-rich economies. The recent efforts by many telecommunication companies to undertake supply chain analyses or audits to ascertain that conflict minerals are not utilised in their products have ensured strict monitoring of the supply chain. However, such measures should also be undertaken in other sectors, especially in clean energy transitions, as clean energy technologies are the milestone towards reducing environmental stress and enhancing the effective utilisation of resources

Geopolitics of Minerals and Its Impact on Asia

In the past decade, it has become evident that countries would be dependent for imports on a few countries for certain minerals or for a particular process of the supply chain. While the risk of depending on a single country for a mineral could pose short- and medium-term risks, the increasing dependence among countries for minerals or throughout the supply chain of a sector leads countries to be inter-dependent and more responsible in their geopolitical relations.

Since the 2010 Rare Earth case with China imposing trade restriction on the elements, the concern regarding unfair trade practices have emerged as a major debate. Although the export restrictions imposed by China were then removed through WTO intervention, the move by China had already created short-term supply disruptions, creating a panic among the importer countries. Additionally, with the market being uneven and some metals being sold in regulated markets, there is a need to establish a formal platform to discuss the minerals trade at the Asian and global level. This platform should bring together producers and consumers of minerals along with the players from the supply chains of important sectors such as energy, defence and ICT. Such platforms would assist in reducing uneven trade practices and also help in controlling prices.

Recycling and Resource Efficiency

A net assessment of the supply chain for major energy sources needs to be conducted to understand the recycling potential that can be tapped to ensure the optimum utilisation of critical minerals. Appropriate technology measures should be ensured to undertake de-commissioning of renewable energy products to recover the critical minerals and ensure that they are not converted into waste.

Substitutions and Alternatives

Countries need to invest more in research for substitutions and alternatives to different minerals. The adaptation of technologies to different material and minerals would also provide a greater list of options when choosing raw materials. However, where there is a lack of substitution, the need of the hour would be to ensure the optimum utilisation of such resources for achieving greater efficiency and simultaneously conduct research and development to reduce the volume utilised over a period of time to decrease dependence.

Reducing Imports

Asian economies are largely importers of energy, and the higher share of renewable energy could reduce dependence on imported conventional fuels. However, to avoid a repetition of dependence on imported renewable energy components, there is a need to create a robust supply chain within Asia that would enable countries to enhance regional trade and also reduce supply risks faced by them.

Energy-Climate Nexus

With countries gearing up to fulfil their Nationally Determined Contributions post the Paris Agreement, the need to reinforce the supply chain for renewable energy technologies within Asia would be a precursor to the successful implementation of climate and energy goals.

Seeking New Resources

Recent studies have highlighted the need to enhance research and development of deep-sea mining for critical minerals as a method to ensure resource availability and to reduce the resource concentration. Additionally, exploration of new resources in various developing countries could be a possible solution to enhance reserves. However, deep-sea mining is still a developing sector and requires both financial and technological impetus.[25] Asian economies can undertake integrated efforts to undertake deep-sea mining for such minerals and reduce their dependency on imports in the future.

Stockpiling

While stockpiling may not necessarily be a solution for all minerals, this mechanism should be undertaken for certain critical and strategic minerals for which the country is 100 per cent import dependent and which are traded through the unregulated market. Stockpiling would reduce the impact of price fluctuations and trade restrictions on these minerals.

Geopolitical Engagements

In the near future, geopolitical relations will not be shaped based on ideological and security concerns alone and resources will play a major role in geopolitical alignments. A 2013 study by The Hague Centre for Strategic Studies highlights the importance of engaging with the primary suppliers of critical minerals such as China, South Africa, Chile, Australia, Congo and other countries.[26] This particular strategy needs to be adopted by Asian economies in order to proactively engage with major mineral producers and ensure a continued supply of such resources for their domestic sectors.

An Asia mineral security platform to engage in a continuous discussion on the issue of critical minerals should be established to regulate prices and the market, ensure fair trade practices, enable sustainable development of mineral resources, data collection and exchange of knowledge, increase resource and material efficiency and promote recycling. With major producers such as China, on the one hand, and major consumers like Japan, South Korea and India, on the other, such a platform would be an important factor in shaping the Asian discourse on the issue of minerals security. With the exception of Japan, South Korea and China, most other Asian economies, including India, have not laid out a formal strategy to secure mineral resources and ensure sustained access to the global supply chain. There is a need to conduct a country-based assessment of mineral needs till 2050 to ensure a strategic step-by-step approach to mineral security.

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10

Ensuring Asia's Energy Security: Role of Energy Storage Technology

*Bhupendra Kumar Singh**

Asia's Energy Security

With recent major shifts in global energy markets, the prospects for advancing Asia's long-term energy security have improved dramatically. For decades energy security has been a key strategic concern for Asia. However, now the region is facing an even more challenging period characterised by a growing sense of energy scarcity, historically high prices and severe strategic and economic insecurity for import-dependent economies. However, the continued resilience of the United States' unconventional oil output and the return of Iranian oil – and potentially gas – have been viewed positively by the region's major importers and has resulted in a modest but steady growth of global oil demand leading to an extended outlook of lower oil and natural gas prices.

The demand for energy in the Asian subcontinent is increasing rapidly, driven by population and economic growth, especially in emerging market economies. A rapidly expanding economy, with the shift from agriculture to manufacturing and services sector, has also been a key player in leading to the increase in energy intensity, which has resulted in an unprecedented hike in demand for energy sources in the region. According to BP Statistical Review of World Energy, 2017, Asia is the leading consumer of oil, coal, and hydroelectricity and, for the first time in 2016, the leading consumer of renewables in power generation, overtaking Europe and Eurasia, which

* This chapter has been written on the basis of the inputs provided by the Energy Storage Industries.

still remain the leading consumers of natural gas and nuclear power. Asia dominates global coal consumption, accounting for almost three-quarters of global consumption (73.8 per cent). Coal is the dominant fuel in the Asia-Pacific region, making up 49 per cent of the regional energy consumption.

Electricity Scenario in Asia

Access to Electricity

Access to modern energy is essential for the provision of clean water, sanitation, healthcare, reliable and efficient lighting, heating, cooking, mechanical power and transport, and telecommunications services. It is an alarming fact that currently billions of people in the region lack access to the most basic energy services. As the World Energy Outlook, 2016, shows, 512 million people are without access to electricity in Asia and 1.9 billion people still depend on traditional biomass for cooking and heating.

Table 1: Electricity Access in Developing Asia – 2016

Region	*Population without Electricity (millions)*	*National Electrification Rate (%)*	*Urban Electrification Rate (%)*	*Rural Electrification Rate (%)*
China	NA	NA	NA	NA
India	244	81	96	74
Southeast Asia	102	84	94	74
Brunei	0	100	100	99
Cambodia	10	34	97	18
Indonesia	41	84	96	71
Laos	1	87	97	82
Malaysia	0	100	100	99
Myanmar	36	32	59	18
Philippines	11	89	94	85
Singapore	0	100	100	100
Thailand	1	99	100	98
Vietnam	2	98	100	97
Rest of Developing Asia	166	66	84	56
Bangladesh	60	62	84	51
DPR Korea	18	26	36	11
Mongolia	0	90	98	73
Nepal	7	76	97	72
Pakistan	51	73	90	61
Sri Lanka	0	99	100	98
Other Asia	29	35	66	24
Developing Asia	**512**	**86**	**96**	**79**

Source: IEA, World Energy Outlook, 2016.

At current estimates, more than 50 million people will still be without access to energy in 2040. Electricity access remains a critical challenge in regions like Sub-Saharan Africa and developing Asia, including India. The Asian region continues to face significant challenges in delivering universal access to affordable, reliable, sustainable and modern energy services.

Reasons for Lack of Electricity Access

In Asia, the largest electricity access deficit countries are India, Bangladesh, Pakistan, Indonesia and Myanmar. Additionally, countries like China, India, Bangladesh, Indonesia, Cambodia, Myanmar, Mongolia, Laos and Vietnam are heavily dependent on inefficient and unhealthy cooking techniques. Most of the governments in these countries face energy challenges on the following fronts:

1) The presence of an energy-poor majority lacking access to modern energy carriers.
2) Need for expanding the energy system to bridge this access gap as well as to meet the requirements of a fast-growing economy.
3) The desire to partner with global economies in the effort to mitigate the threat of climate change.
4) Significant gaps in investment for energy access, wherein the majority of this investment is required for the development of electricity generation and transmission.

Energy Storage for Electricity Access

Efforts are underway to improve ways to store and distribute energy, as the electricity generation mix is shifting towards more sustainable but intermittent forms of energy generation, such as wind and solar power. The rapid growth in variable renewable energy has helped catalyse efforts to modernise the electricity system and has increased the need for resources that contribute to system flexibility. In Asia, countries – including some that are highly industrialised and geographically large – are pushing for massive growth in electricity generation capacity from renewable sources. The deployment of renewable-based power generation projects has gained momentum across the region.

Battery storage is one of the options for enhancing system flexibility in these circumstances by managing electricity supply fluctuations. It can also increase the local penetration and self-consumption from small solar photovoltaic (PV) facilities installed at commercial facilities and households. Energy storage is increasingly becoming an important tool for, and will probably play a major role in, providing energy to island systems and access in remote areas of the developing regions.

As Asia builds up its renewable energy capacity, the case for installing energy storage systems (ESS) is also becoming more compelling. Countries in the region that are scaling up their solar rooftop programmes and attempting to connect far-flung regions to the power grid are starting to appreciate the boons of an integrated ESS.

Energy Storage in Asia

Japan

Japan is a world leader in smart-grid and energy storage technology and device, both in terms of infrastructure and software. It has set ambitious targets to produce half the world's batteries by 2020 and has a subsidy programme for 66 per cent of the cost for homes and businesses that install Lithium-ion (Li-ion) batteries. Against the backdrop of the Fukushima earthquake in 2011, Japan shut down over 60 GW of nuclear capacity, and significantly increased the deployment of renewable energy, adopting a target of 30 per cent renewable energy by 2030. Japan's 2014 Fourth Strategic Energy Policy specifically mentions the importance of solar, wind and hydropower as strategic energy generation technologies, and makes explicit mention of energy storage markets. Furthermore, it sets an explicit target of capturing 50 per cent of the world's projected global storage battery market by 2020, which the Plan estimates to be valued at ¥20 trillion (Japanese yen).

China

China's electric power network is the largest in the world, both in terms of installed generation capacity and total electricity produced. China is home to some of the world's largest wind and solar farms, and has set aggressive renewable energy targets. The development of the energy storage industry began relatively late in China; however, the industry has seen rapid development in the last two years. While the global energy storage market is steadily developing, China's energy storage industry is growing rapidly. In March 2015, the Chinese Communist Party (CCP) Central Committee and the State Council issued the "Guiding Opinions on Deepening Electricity System Reforms", which have spurred intense activity in developing and deploying new energy and advanced energy storage technology, and has been a major boost for the industry. China Energy Storage Alliance (CNESA) data shows that by the end of 2014, China had 84.4 MW of energy storage installed capacity on the grid (not including pumped hydro, compressed air energy storage (CAES) and thermal storage), an increase of 31 MW, a growth rate of 58 per cent. Li-ion batteries make up 74 per cent of China's installed energy storage capacity, followed by Lead Acid batteries and Sodium Sulphur (NaS) batteries at 14 per cent and 10 per cent, respectively. These three technologies make up about 98 per cent of China's market.

India

India, at the moment, is witnessing an exciting time from the standpoint of economic growth and rapid development. The past year has been marked by a number of remarkable initiatives from the government such as "Make in India". Prospects for renewable energy in the country appear more than promising. The country's Nationally Determined Contribution (NDC) has initiated the world's largest Renewable Energy Programme by increasing its targets five-fold from the existing 35,000 MW to 175 GW capacity by 2022, which includes 100 GW of solar power, 60 GW of wind power, 10,000 MW of biomass and 5000 MW of small hydro.

The Energy Storage System (ESS) market in India is in its infancy with significant market potential. India has pumped hydro storage facilities with a total of just 7,000 MW of installed capacity. The Government of India has planned to increase the installed capacity to 10 GW by 2020. Central Electricity Authority (CEA) of India has been asked to take initiatives in this direction. Apart from these facilities, there are a few other utility scale storage projects currently operating in India. Recently India has been encouraging developments in distributed ESS. Although India presents a huge market for emerging ESS, there are also significant challenges. There is no existing legal framework or regulation currently in place that specifically identifies ESS as an asset to interact with the electric grid. Since ESS devices both consume and supply power to the grid, their participation in the system needs to be carefully designed.

Some of the existing barriers in India that have prevented wide-scale adoption of ESS technologies include poor financial conditions of various state-owned distribution companies; new electricity markets being currently limited to day ahead and short-term energy trading; power quality (such as stable grid frequency) being viewed as a luxury by some of the regulators; and lack of awareness about successful implementation of state of the art technologies.

Despite all the above challenges, ESS is gaining importance in India as it is starting to gain the attention of the policymakers for its role in enabling the integration of higher levels of renewables while maintaining grid reliability and power quality.

India's ESS

India has embarked on an ambitious mission to increase its renewable energy generation capacity by 175 GW by 2022. While this represents a huge opportunity for the stakeholders of the renewable energy sector, it also raises the challenge of integrating this new capacity with the national grid.

Hydro Storage

India currently has only about 4400 MW of pumped hydro storage available schemes. Many of these schemes have multiple purposes and priorities such as irrigation as well as affecting the availability of the storage capacity to the grid. Understandably, the available storage capacity is grossly inadequate to support the future grid, and strong measures are necessary to support energy storage given the ambitious renewable energy target. Although there are no specific policy incentives for energy storage in India, significant policy reforms are expected with the launch of the much-anticipated National Energy Storage Mission. The existing regulatory frameworks and incentives are grossly inadequate to support the commercial deployment of energy storage. While behind-the-meter energy storage and smart power management systems can benefit from incentives under the smart grid and National Electric Mobility Mission Plan (NEMMP), large-scale grid-linked energy storage, which will be critical to future renewable energy integration, has no support mechanisms in place. In terms of energy storage ecosystems, India has little or no manufacturing base in energy storage technologies.

Moreover, India has limited experience with energy storage technologies and has traditionally relied on mixed pumped hydro storage projects mainly for load shifting applications. The first pumped storage hydroelectric plant of 700 MW was set up in Nagarjunasagar, Andhra Pradesh, around 1985. The current pumped hydro storage capacity is about 4,804 MW. An additional 1,000 MW of pumped hydro storage is under commission as a part of the Tehri Hydropower project.[1] Table 2 summarises the installed pumped hydro storage capacity.

However, out of the aforementioned pumped hydro energy storage (PHES) plants (see Table 2), Nagarjunasagar, Panchet and Sardar Sarovar are working as conventional hydro generating stations due to inflow needs and other commitments related to irrigation, water supply, etc. The rest of the PHES plants are operating for fewer hours in pumping mode than anticipated at the project conceptualisation stage, and most of the projects have recorded utilisation of about 40-50 per cent of designed capacity.

Table 2: Installed Pumped Hydro Storage Capacity

PHES Plants (State)	*Capacity (MW)*	*Commissioned*
Nagarjunasagar (AP)	700	1980-85
Paithan (MAH)	12	1984
Kadamparai (TN)	400	187-89
Kadana (GUJ)	240	1990-98
Panchet (JH)	40	1990-91
Ujjain (MP)	12	1990
Bhira (MAH)	150	1995
Srisailam (AP)	900	2001-03
Sardar Sarovar (GUJ)	1200	2006
Purulia (WB)	900	2007-08
Ghatgar (MAH)	250	2008

Apart from pumped storage, some notable operational projects include a 40 kW Lead Acid battery-based storage project at Khareda, Rajasthan, and 45 kW Vanadium redox flow battery storage at the SunCarrier Omega Net Zero Energy Building in Bhopal.

Application of Energy Storage

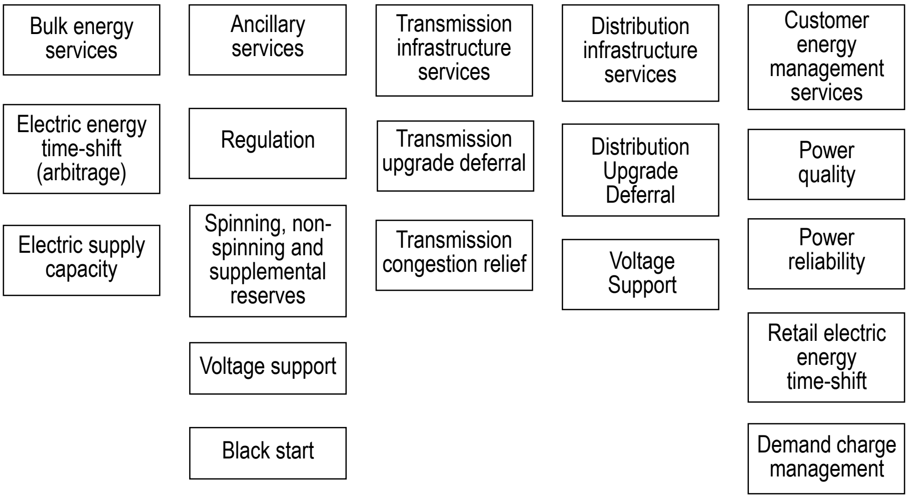
Energy Storage technologies working together can provide nearly the complete range of power regulation services across different network locations for time scales ranging from milliseconds to days and/or months. Their versatility to work as a generator, consumer and system manager makes them suitable for many power system operation functions.

The key services that can be provided by energy storage technologies are captured in Figure 1.

Time Shift Operations (Arbitrage)

A typical time shift application would involve a charge cycle through cheap off-peak/low variable cost energy and a discharge cycle at peak load times. This is especially important for generation in renewable energy. For example, the seasonal wind power generation peak (in the monsoon months) does not correlate well with the grid demand, and therefore, large duration storage (longer time-shifts) may be beneficial. On a diurnal basis, wind power generation usually picks up at night (at time of low loads) and tapers off before the morning peak demand. On a typical sunny day, solar power generation reaches a peak at noon when the system demand may be low. These mismatches across the day can also be managed through time shift applications. Forecasting requirements for solar and wind power plants could also necessitate smaller duration time shift operation through distributed storage in some cases.

Figure 1: Range of Services that Energy Storage Can Support



Source: IRENA.
Note: The following services: Time shift operations (arbitrage); Electric supply capacity; Regulation; Power reliability (consumer end); and Retail end time shift (consumer end) – represent energy storage services that directly support renewable energy integration and these will be the focus applications for the chapter.

Electric Supply Capacity

This refers to the ability of storage technologies to defer or reduce the need for procuring new central power or buying of capacity through the open market. Energy storage dedicated for supply capacity could typically be 'seen' as a generation source available to the grid operator through the issue of appropriate triggers at required times (typically system peak).

Regulation

Regulation involves managing momentary differences in supply and demand. The most basic regulation service will be regulation up and regulation down service, which would correspond to a discharge and charge cycle, respectively. This service would be very useful to have in conjunction with forecasting. Fast ramping storage technologies, particularly batteries and flywheels, can provide this regulation service more efficiently than conventional generators as the switch-over between charge and discharge cycles is smoother.

Power Reliability (Consumer End)

Storage systems can support and sustain power supply to the consumer even in the event of grid unavailability. Such an application can support both customer-owned as well as utility-owned storage systems that can be used as distribution assets. The key area of applications would be solar/ renewable energy integrated behind-the-meter storage, micro-grids and other decentralised energy systems.

Retail End Time Shift (Consumer End)

Retail time shift mainly means the use of storage for arbitrage at the consumer level. Typically, consumers, subject to time of day (TOD) tariffs, can use stored energy during peak tariff times and charge during off-peak tariff hours. This will be beneficial for consumers who are subjected to TOD metering (very large domestic consumers, commercial and industrial consumers). However, in order for this to work, the difference between peak and off-peak tariff has to justify the investment in the storage technology. In addition, as a consumer-end application, a major requirement for this type of storage will be availability in small sizes and high energy density (mainly battery storage).

Although the focus of this chapter will be on these five applications, other applications related to spinning and non-spinning reserves, infrastructure upgrade deferral will also be considered if these applications can justify a robust business model case in India.

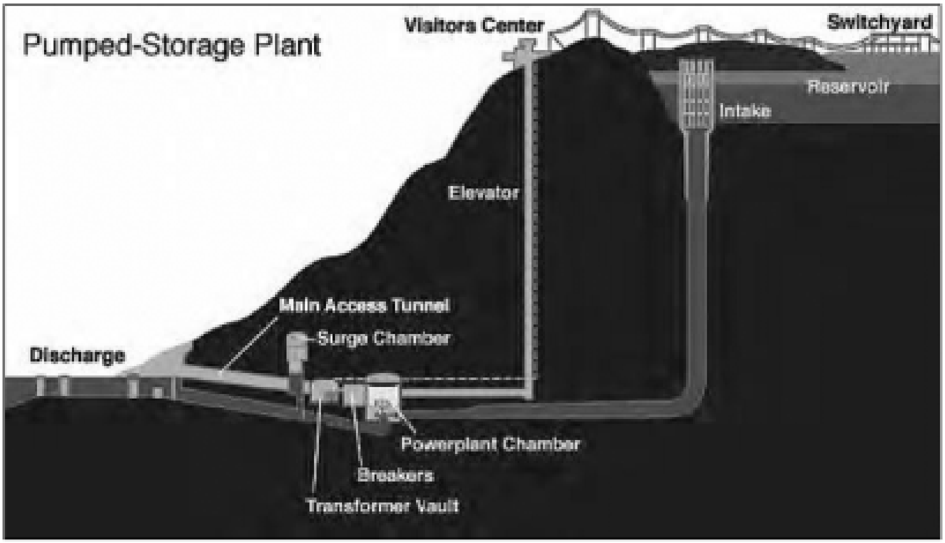
Important Energy Storage Technologies Suited for Asia

Pumped Hydro Storage

Pumped hydro storage (PHES) represents over 95 per cent of the worldwide energy storage capacity. A pumped hydro storage system is similar to reservoir-based hydro storage systems and has a lower reservoir that can be used for pumping operations. A pumped hydro storage system uses pumping operations during the time of charge to pump water from the lower reservoir into the upper reservoir. During the discharge cycle, the pumped volume in the upper reservoir can be used to generate and supply energy through the normal turbine operation mode. A pumped hydro plant typically uses reversible turbines that can work both in pumping and turbine modes. Figure 2 provides a pumped hydro storage schematic.

As pumped hydro storage needs reservoirs for storage, the typical scale is in megawatts and gigawatts (MW-GW), and although smaller plants (multi-kilowatts, kW) can also be conceptualised, the economies of scale typically work only with large capacities.

Figure 2: Schematic of a Pumped Hydro Storage Plan



Source: Renewable Energy Association (REA), 2016

One of the largest pumped hydro storage plants in the world is Dinorwig in the UK. Its 1,720 MW capacity stores nearly 9.1 GWh of energy and can provide an average ramp rate of nearly 100 MW/sec. In the UK power system, it is mostly used as a short-term operating reserve (STOR) plant.[2]

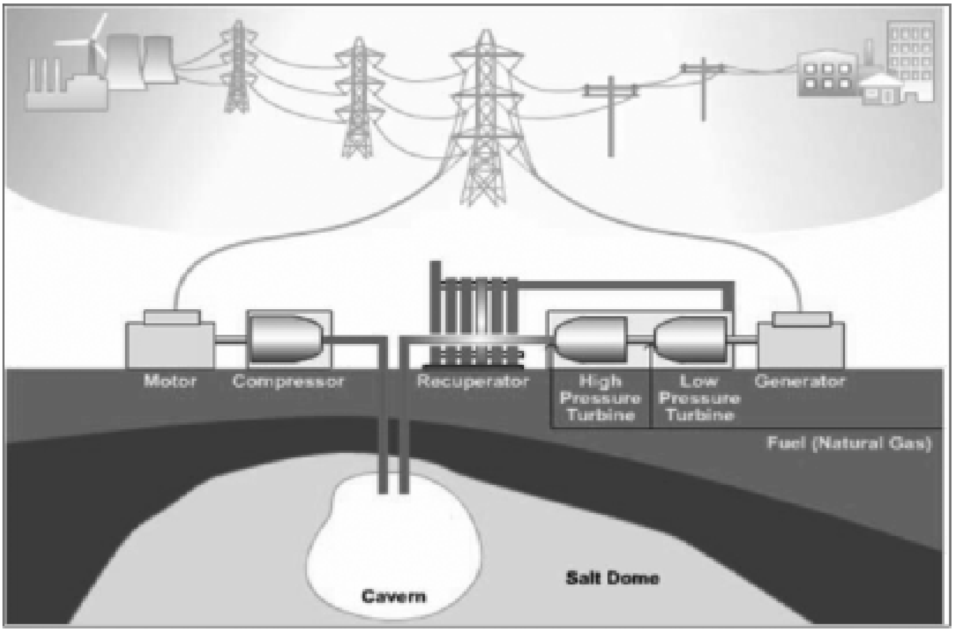
The capital cost for PHES is highly site specific, but the average energy rate could be in the range of £150-270/kWh at a normative cycle efficiency of 70-80 per cent.[3]

Considering its relatively fast response time and large size, pumped hydro storage can provide nearly all types of services including fast acting reserve, time shift, black start, etc.

Compressed Air Energy Storage (CAES)

CAES uses the charge cycle (off-peak electricity) to power a compressor that stores air at high pressure in underground caverns. During the discharge cycle, this compressed air is heated, expanded and directed through an expander or conventional turbine-generator to produce electricity. Figure 3 shows a schematic representation of a CAES plant.

Figure 3: Schematic of a CAES Plant



Source: EPRI

CAES, using natural geological reservoirs or caverns, can provide large-scale storage capacity of several hundred MW-GW with discharge time of up to 8-26 hours, depending on the size of the natural storage. Operational plant in Germany with a capacity of 290 MW and a discharge cycle of four hours has been running successfully since 1978. Small-scale CAES can also be designed using above-ground storage, but these plants would typically range from 3-50 MW in capacity with discharge times of two to six hours.[4] Typical cycle efficiency of CAES is comparable to closed cycle gas turbines.

The typical cost of CAES could range from £80-250/kWh.[5]

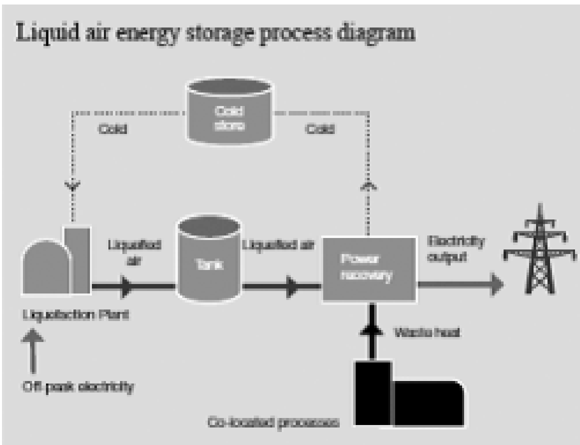
CAES is typically used for load levelling operation, although it can also be used as a fast-response technology too.

Liquid Air Storage

In liquid air storage, the charge cycle uses a liquefaction plant to liquefy air and store it under low pressure at cryogenic temperatures in insulated storage tanks. During the discharge cycle, the liquid air is allowed to expand and the heat released in the expansion is used via a heat exchanger to drive a turbine generator unit like a conventional operation. The main advantage of this technology is that it can provide large-scale storage and is not geographically constrained like pumped hydro or CAES that require specific geological sites. Further, the basic technology used in this type of storage is established and proven (liquefaction), and therefore, the risks related to technology performance and longevity is minimal. At present, only two pilots are operational in the UK.[6] A liquid air storage plant is shown in schematic form in Figure 4.

Normative cycle efficiency of this technology can be in the range of 55-75 per cent. The expected energy cost could be £166-360/kWh. The main application area for this technology could be time shift operations and balancing services.[7]

Figure 4: Schematic of a Liquid Air Storage Plant



Source: ARUP, 2015

Lead Acid Batteries

Lead Acid is one of the oldest battery storage technologies with a history of over 150 years. A simple Lead Acid battery is the backbone of some major visible storage applications at present like car batteries, inverter/ uninterruptible power supply (UPS) batteries, and power storage for electrical operations. A typical design of a Lead Acid battery involves two electrodes (Lead dioxide and metallic Lead) with sulphuric Acid as the electrolyte. Lead Acid batteries come in three configurations: flooded electrolyte, low-maintenance flooded electrolyte, and valve-regulated Lead Acid.

Commercially available Lead Acid batteries have typical cycle efficiency of 80-85 per cent, and despite their low life discharge cycles (few hundreds) and low energy density, they are preferred for most applications where weight and volume are secondary considerations. The main disadvantages of Lead Acid batteries are their low life, susceptibility to high depth of discharge and use of Lead.

The energy cost varies from about £395-730/kWh. The main application areas for Lead Acid batteries could be for ancillary services as well as medium duration time shift applications.[8]

Advanced Lead Acid Batteries

Advanced Lead Acid batteries mainly incorporate incremental improvements over standard Lead Acid batteries. These changes are mainly in terms of new materials used in the batteries to enhance their performance characteristics related to energy density and life discharge cycles.[9] The number of variations in the advanced Lead Acid batteries are too numerous to cover; however, many manufacturers are specifically targeting new configurations that can support renewable energy integration. For example, Hitachi (Japan) is developing an advanced Lead Acid product for renewable integration, with the intent of competing with NaS and Li-ion batteries. Some of their advanced Lead Acid batteries have already been integrated with wind-generation sites in Japan.[10]

Considering the multiplicity of research happening in this advanced Lead Acid technology, a generic analysis of this technology is not undertaken. For the purpose of the chapter, opportunities related to advanced Lead Acid technologies will be considered on individual merit.

Li-ion Battery Storage

Li-ion batteries work on the ionic flow of Lithium ions from the negative electrode to the positive electrode during and discharge and back again to the negative electrode during the discharge cycle. Li-ion chemistry exhibits very high cycle efficiency (nearly 100 per cent), long life discharge cycles and very high energy densities of up to 400 Wh/l.[11]

These features make this battery configuration highly suitable for applications that face space and volume constraints (consumer durables, portable devices, EVs). Although the majority of applications for Li-ion are in consumer durables at present, Li-ion chemistry is also seen as a potential contender for large-scale grid storage and for electric vehicles (EVs) and vehicle-to-grid (V2G) applications.

The energy cost of Li-ion battery ranges from £570-1100/kWh, but substantial cost reductions can be expected in the near to medium future.[12] The total cycle efficiency can be as high as 95 per cent, although 85 per cent would be the average value. The life discharge cycle for this technology could be as high as 5,000 under optimum charge-discharge operations.[13]

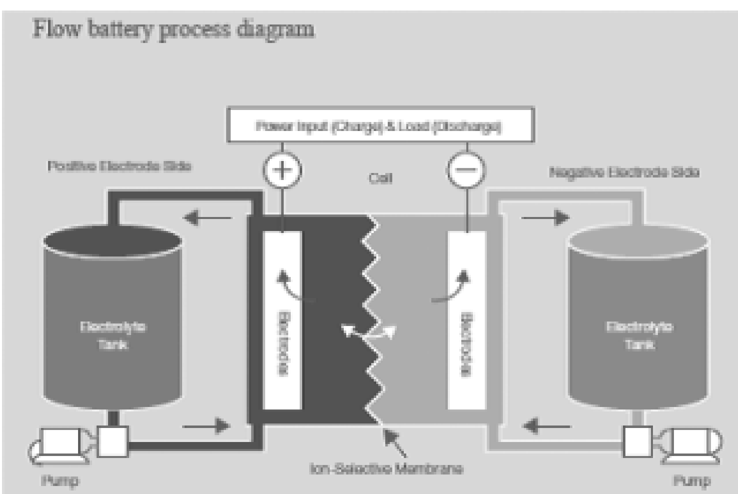
Numerous large-scale grid storage projects are in the construction phase or near completion worldwide, and with a drastic reduction in battery cost, this technology is already being seen as a superior alternative to the ubiquitous Lead Acid battery that has dominated grid storage applications. A 20 MW Li-ion battery based storage for providing regulation services is already operational in the US, and a 10 MW system in the UK.[14]

Large-scale Li-ion battery storage is suitable for almost all applications, but could add the most value in providing frequency support services (as it is fast acting), voltage support and renewable energy integration.

Redox Flow Battery Storage

Flow batteries use liquid electrolytes as energy carriers. In the standard configuration, two electrolytes, stored separately, are pumped into a battery unit that has an ion-selective membrane that allows particular ions to pass through during the charge and discharge operation to complete the chemical reaction. As the battery operation requires pumping of electrolytes into the cell, the battery assembly has mechanical components such as pipes, pumps and flow tanks. The most common chemistry in flow batteries comprises of redox couple Vanadium-Vanadium although other chemistries (Iron Chromium, soluble Lead redox) are also developed.[15] Figure 5 shows the schematic of a redox flow battery.

Figure 5: Schematic of a Flow Battery Process



Source: ARUP, 2015

A big advantage of flow batteries is that their energy and power capacities are independent and can be increased: energy capacity can be increased by increasing the size of storage, and power capacity by increasing the size of the battery.[16] Although they have very low energy densities (35-50 Wh/kg), they can last through thousands of operation cycles and can have an operational life of 30-50 years.[17] The cycle efficiency for these batteries is in the range of 65-75 per cent and the energy cost of about £475 – 575/kWh.[18]

Flow batteries can be used in a variety of applications, including operating reserve, load balancing and integration of renewable energy. They can also provide extremely fast response by ramping up from zero to 100 per cent capacity in a matter of milliseconds, and the limiting factor in these batteries is not the electro-chemistry but the control and communication equipment.[19] For fast-acting voltage support applications, these batteries can act instantaneously even without the need of pumping and the cell stack can provide three times the rated power output if the charge is between 50-80 per cent.[20]

NaS Battery Storage

The NaS battery storage has proven its utility for large-scale energy storage applications. In an NaS battery, the battery core itself acts as the positive electrode separated by an ion-selective membrane from molten sodium, which acts as the negative electrode. During a charge cycle, the Sodium ions move through the ion-selective membrane to the anode reservoir, and during discharge, the process is reversed. The operating temperature of these batteries is about 300-350°C.

NaS batteries can provide a discharge period of about six hours with fast-acting response that makes them suitable for almost any grid application. It can support life discharge cycles of around 4,500 (15 years of average life in grid applications). Typical cycle efficiency for these batteries ranges from 75-85 per cent, and it has an energy density of 117 kWh/ ton.[21] Energy cost is in the range of £280-350 /kWh.[22]

NaS is the most proven battery storage for grid installations. The largest NaS project is the 34 MW Rokkasho wind farm stabilisation project, operational since 2008. There are over 160 MW of NaS installations in Japan alone, making this storage technology the second largest in terms of installed base after pumped hydro storage.[23]

NaS energy storage technology finds applications in electric utility distribution grid support, wind power integration and high-value grid services.

Thermal Energy Storage (TES)

There are three main types of TES – sensible heat storage, latent heat storage, and thermo-chemical storage. TES allows waste thermal energy from industry to be stored and converted into useful heat or electricity when needed. Additional key applications include seasonal storage (e.g. storing heat in the summer to use in the winter through underground TES systems).[24]

Copper/Zinc (Cu/Zn) Rechargeable Battery

A UK energy storage company has recently developed a rechargeable Cu/Zn battery, combining a 200-year old battery technology with processes from the mining industry. Although still developmental, rechargeable Cu/Zn batteries provide a large-scale storage option, capable of delivering grid-scale levels of power from 1 MWh to 100 MWh. These batteries are stationary, with potential applications including time-shifting for commercial renewable electricity generation and security and stability of supply. Main advantages of this technology are its low cost, simplicity, scalability, and sustainability.

Conclusion

Storage technologies can prove to be the most effective instruments for integrating renewables in the grid. The present scale of storage capacity in India is grossly inadequate, and except for a few operational pumped storage units available with state utilities, no other large-scale projects are operational. However, changing regulation and policy landscape in the background of the ambitious renewable energy capacity addition targets has resulted in increased interest in storage technologies. Renewable Energy developers and stakeholders in India are keen to explore and understand more about these technology options.

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11

Asia's Energy Security: An Uncertain Outlook

Shebonti Ray Dadwal

Introduction

Rapid technological changes and environmental concerns arising out of global warming are transforming the global energy landscape. For those Asian nations – in West, Central, South, Southeast and East Asia – whose economic growth has transformed them into some of the largest consumers of energy, the emerging energy environment presents them with major challenges as they struggle to ensure adequate, affordable and sustainable energy resources to their people, even as the demand for energy is increasing incrementally. Hence, while in 1990, the countries in the Asian region accounted for around 27 per cent of total global energy consumption as compared to 64 per cent by Europe and North America, by 2013, the region as a whole accounted for around 49 per cent of global energy consumption against Europe and North America's 41 per cent.[1] According to a report by BP, growth in energy demand is increasingly coming from developing economies particularly within Asia rather than the traditional markets in the OECD. While overall energy consumption grew slowly in 2016 that is, by less than 1 per cent, most of this growth came from China and India.[2] However, given the rapid urbanisation that is taking place in the entire Asia-Pacific region, the demand for energy is expected to increase many fold. According to a United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) report, the energy supply for the region needs to be increased by over 60 per cent by 2035 to meet the growing demand associated with rapid urbanisation, industrialisation and economic growth. The report states that with over 420 million people lacking access to electricity and an additional 2.1 billion people relying on traditional biomass for cooking and heating, a shift to low-carbon energy resources and diversification of the energy mix is required, both to enhance the region's energy security as well as to reduce the impact on the environment and meet global commitments pertaining to climate change.[3] Moreover, the Asia-Pacific region is the most energy-intensive region, and although the energy intensity levels have shown some improvement from 222 kgoe/$1,000 gross domestic product (GDP) in 1990 to 145 kgoe/$1,000 GDP in 2014,[4] it remains an area of concern.

At the same time, many opportunities are embedded in the challenges, which could deliver these countries – long at the mercy of an energy market whose rules have by and large been dictated by the developed world – from the pressing dependence on imported fossil fuels, as well as convert their energy sectors into clean and sustainable resources, thereby not only increasing their energy security but also cleaning up their environment. In the mid-2000s, the high price of hydrocarbons forced many of the regional countries to move towards alternative forms of energy. As a result, renewable energy capacity worldwide grew from an estimated 1,320 GW in 2011 to around 2,017 GW at the end of 2016, making it the fastest-growing energy sector.[5] Despite this spurt in growth, the share of renewable energy in the energy market was less than 20 per cent. Now, with the dramatic fall in the price of oil and gas following the advent of the shale revolution in North America and the sudden influx of huge supplies of shale oil and gas in the market, which has led to a drop in the price of oil and gas, a resurgence in the share of hydrocarbons is not unexpected. Hence, fossil fuels (i.e. oil, gas and coal) will continue to dominate the energy mix of the developing Asian economies for the next two decades, albeit marginally lower than what was projected in 2014. BP's 2017 Energy Outlook for 2035 states that fossil fuels will account for around 80 per cent of total energy supply, of which imports will comprise more than half for many of the countries.

Although the Asian region is privy to some of the world's largest reserves of oil and gas, as well as coal, in the interest of the countries' national and energy security, apart from climate change factors, there is a need to reduce the dependence on energy imports as well as revenues that accrue from energy exports in the case of the supplying countries. No doubt, the West Asian region holds the largest reserves of conventional oil and natural gas, but thanks to the subsidies on domestic energy prices that are in place, the region is set to become the most energy-intensive region in the world by 2030,[6] with the demand for energy growing at a swift pace. According to the 2017 BP Energy Outlook report, interestingly, the demand for and consumption of energy in the West Asian region alone, which continues to hold the largest residual conventional reserves of oil and gas, is projected to rise by almost 50 per cent by 2035, with natural gas accounting for more than half of the growth.[7]

Given that many of these countries do not have sufficient volumes of energy resources to feed their growing demand, one of the greatest challenges with regard to the Asian countries' energy security is their growing dependence on energy imports. For example, India's crude oil and liquefied natural gas (LNG) imports increased in 2015-16 due to the continued fall in domestic production, which in turn saw India's oil import dependency increasing from 80.9 per cent in 2015 to 82.1 per cent in 2016. Similarly, its domestic production of natural gas, too, decreased by over 1 per cent to 31.9 billion cubic meters (bcm), its lowest in a decade, necessitating LNG imports, which have already doubled over the last six years, to go up by 15.5 per cent to 24.61 bcm. Similarly, domestic production of energy in China is expected to drop from 84 per cent in 2015 to 79 by 2035. Although many other Asian economies are also projected to witness a huge growth in energy demand, China is expected to remain the world's largest net importer of energy,[8] while India is projected to overtake China as the largest growth market for energy over the next two decades.[9] Several other Asian economies, too, are projected to see a rise in their energy consumption and hence demand.

Not only does this have an impact on the national economies of the countries that are dependent on these imports, but it also has immense geopolitical implications that spread far beyond the national borders of these countries. Moreover, the dependence on hydrocarbons, which shows little sign of dissipating in many Asian countries, carries a high environmental load. For example, several Southeast Asian countries are reverting to coal-fired power generation. In fact, coal-based generation grew by 80 per cent from 2010 to 2015, with developed economies like Japan, too, trying to make coal cleaner. On the other hand, China has reduced its coal usage, having introduced policies to reduce over-capacity in coal-fired power plants and to encourage coal conversion for industries, and the current Indian Government is pursuing a policy that is focused on increasing the share of cleaner energy resources, including solar, wind and hydropower, in its fuel basket. India, Indonesia, Vietnam, Thailand and the Philippines, have suspended new plans for coal plants to meet their commitments to the Paris accords. Nonetheless, according to the International Energy Agency (IEA), a sharp increase in coal demand is expected through 2040, although most of the new plants will be of the ultra-supercritical coal-fired genre.[10]

Similarly, in the case of oil and gas, notwithstanding the prevailing low prices of oil and gas, the impact of less capital being invested in drilling for new production may see a tightening in supplies over the next decade and a concurrent rise in prices, which will impact on the economies of large energy importers. On the other hand, the technological revolution that is taking place in the renewable energy sector, and which has seen previously commercially unviable renewable energy resources becoming increasingly affordable, has led many of the Asian countries to turn increasingly to renewable energy resources and consequently reduce their intake of hydrocarbons. This will impact the main hydrocarbon producers in the West Asian region, who being dependent on revenues accruing from hydrocarbon exports are increasingly coming under fiscal pressure, which may translate into greater political turmoil.

As a result, the future of Asia's energy security will have a direct impact on the global energy and climate system. The twin challenges of dealing with growing dependence on hydrocarbon imports from regions that are politically volatile and the need to drastically reduce carbon emissions in order to comply with commitments under the Paris Agreement will require these countries to take decisions and adopt policies that will have an impact far beyond the energy landscape.

Dealing with Challenges

Tackling multiple energy-related challenges requires the developing Asian economies to transform the way energy is acquired, transported and consumed. Although the energy sectors of many of the countries are gradually undergoing transformation, the pace of the change needs to be accelerated across the board, be it in fuel choice, infrastructure upgrade across the energy spectrum or policies and regulatory mechanisms. Moreover, given the high energy intensity levels in these countries, better management of demand, such as energy efficiency technology and implementation need to be adopted, and robust efforts to enhance energy access and connectivity across the region need to be made. However, each Asian region has its distinct set of energy challenges.

East and Southeast Asia

The countries in East and Southeast Asia are some of the world's largest energy consumers (and importers). Even China, with its huge reserves of fossil fuels, has been import dependent since the early 1990s due to its galloping demand for energy to feed its high economic growth. On the other hand, while nuclear energy comprised a substantial portion of their energy sectors, after the Fukushima Daiichi reactor disaster, Japan and the other regional countries have replaced much of the nuclear generation with gas-based or coal-based generation.

The Southeast Asian economies are by and large fossil-fuel based, and they do not have sufficient indigenous oil and gas reserves to meet the growing demand. As a result, both regions are huge carbon emitters; with the cities in the regions being among the world's most polluted and therefore vulnerable to associated climate change risks, such as drought, which has affected power generation in diverse ways such as water scarcity, changing precipitation patterns, rising sea levels and frequency and intensity of extreme weather events.[11] Moreover, recent tensions in the region over territorial disputes have as much to do with energy security concerns as with the right to freedom of navigation. Barring China, the other countries in the region are almost entirely dependent on energy imports.

One of the factors contributing to growing imports is the lack of oil and gas exploration. A combination of low hydrocarbon prices, and the tense political climate due to the territorial disputes in the South and East China Seas between China, Japan and the countries of the Association of Southeast Asian Nations (ASEAN), as well as the North Korean crisis, has resulted in international oil companies being reluctant to invest in the region as it is currently seen as a mature hydrocarbon basin where the returns may not be worth the risks. Even the national oil companies (NOCs) of these countries are opting to go overseas rather than invest in the region. Consequently, oil and gas production in the region is declining and is expected to decline further until 2023 without more exploration and sanctioning of new projects.[12]

Another factor that has contributed to the increase in fossil fuel-based power and hence growing imports is the reduction in hydro-based power generation due to droughts, which in turn are a fallout of climate change.[13] As a result, the East Asian and ASEAN countries are focusing on increasing the share of renewable energy in their energy baskets.

Thus far, regional dialogue on energy security issues has focused mainly on attempts to defuse conflicts, real and potential, including concerning claims over hydrocarbon-rich territory in maritime waters, among others, with limited success. However, several initiatives have been initiated between East Asia and the ASEAN countries, under the aegis of ASEAN+3, which encompass dialogues, among others, to increase the use of natural gas as well as energy efficiency, renewable energy and regional energy policy and planning. Some progress has been achieved, with a proliferation of renewable energy co-operation programmes.[14] However, given the rise in tension between two of the main regional states, namely China and Japan, energy cooperation remains limited.

South Asia

South Asia comprises countries with high-energy production potential; however, given their dependence on hydrocarbons, which are limited and disparately available in the region, these countries are highly dependent on energy imports, particularly crude oil, and more recently gas from other regions. Moreover, these countries are also among those with the highest energy intensity levels, and combined with a huge and growing population with low per capita energy consumption, the demand will grow exponentially. The governments are therefore confronted with the huge challenge of not only securing affordable energy to sustain the region's rapid economic growth to meet the rising aspirations of the people, but also spending foreign exchange to purchase these energy imports. Despite growing imports, access to energy is poor. Millions of people of the region have no access to modern forms of energy, nor do they have access to grid-based electricity generation; most of the rural areas, therefore, rely on traditional sources of fuel such as biomass. Moreover, with the population in these countries expected to multiply over the next few decades, even the annual addition to generation will be insufficient.

Ironically, barring Sri Lanka, Afghanistan and Maldives, the other regional countries have substantial reserves of various energy resources. These include coal (India), natural gas (Bangladesh) and hydropower (Nepal and Bhutan). Pakistan, too, has discovered coal recently and has hydropower potential as well. However, until recently any attempt at pooling their individual resources to establish a regional energy trade has been unsuccessful, even under the aegis of the South Asian Association for Region Cooperation (SAARC), due to political differences between some of the states, chiefly India and Pakistan. Recently, however, there have been efforts by some of the South Asian governments to look at energy cooperation, albeit from a sub-regional perspective. Led by India, Bangladesh, Nepal and Bhutan have established a sub-regional power grid, which was launched a few years ago with the hope of increasing its capacity and extending it to other countries within the region as well as beyond.

However, plans to construct a regional gas pipeline, with imports from Iran, Myanmar and most recently Turkmenistan, have not been successful thus far, although there is optimism with regard to the Turkmen pipeline project.

But given that there will be a large gap between the potential of hydrocarbon supply and the demand for energy in the South Asian countries, as well as the commitments undertaken by them under the Paris Agreement to cut greenhouse gas (GHG) emissions, particularly carbon dioxide, the replacement of coal and oil in particular with low carbon technologies are being increasingly looked at by these countries. Not surprisingly, given the climate and natural resources that abound in the region, renewable energy – such as solar power, wind power, hydroelectricity, including micro hydro, biomass and biofuels – has been the focus of these governments for their electricity supply and transport sector in order to increase energy self-sufficiency as well as to facilitate GHG mitigation. However, despite the huge potential in the non-traditional energy sector, there are several challenges that have to be overcome before they can make the relevant impact.

West Asia

With the demand for oil and gas continuing to increase for the projected future, the Middle East is expected to remain the principal region to meet this demand growth due to its large reserves (around 60 and 40 per cent of the world's oil and gas, respectively) and, more importantly, relatively low production costs.[15] However, the slump in oil and gas prices since 2014 – the chief revenue sources for the region – and falling demand in their hitherto principal markets, i.e. the developed economies, have taken a toll on these economies. A combination of low prices, which have seen a fall in investment in energy exploration, and continuing political turmoil in the region due to a number of factors such as regime change, terrorism and conflict in Syria and Iraq pose a risk to regional stability and the free flow of energy resources that are a major source of concern to the West Asian governments, as well as to the rest of the world. In addition, the demand for energy has been growing incrementally in these states, thanks to subsidised pricing. According to BP's 2016 World Energy Outlook, the region will become the most energy-intensive by 2030. Certainly, failure to meet demand growth projections by several key producers due to a variety of political, economic and security issues will have an impact on global energy security, with the market tightening and the impact of security incidents in the region being magnified.

As a result, the West Asian economies are making several changes to their energy policies. Apart from undertaking fiscal austerity measures and cutting subsidies, many are implementing policies that in the medium to long-term are aimed at reducing their overt dependence on energy revenues. For example, Saudi Arabia has launched its Vision 2030, which is based on three pillars, including "building an education system aligned with market needs and creating economic opportunities for the entrepreneur, the small enterprise as well as the large corporation".[16] The Kingdom means to use its vast resources, earned by years of oil exports, for diversifying the economy, creating jobs in non-energy sectors, such as education, tourism, health and finance, and encouraging privatisation. Other oil exporting countries like the UAE and Kuwait are also revamping their policies similarly. Interestingly, all the countries are investing deeply in renewable energy, mostly for use in the domestic sector, while reserving most of the hydrocarbon resources for exports to earn revenue for their diversification plans.

The rationale behind this change in policy by the West Asian energy exporters is best explained by a look at a study developed by the IEA, which states that if there were no change in the energy policies of the Asian energy importers, global demand for oil would continue to increase. However, even under the IEA's 450 scenario, which "sets out an energy pathway consistent with the goal of limiting the global increase in temperature to 2°C by limiting concentration of GHG in the atmosphere to around 450 parts per million of CO_2",[17] the IEA expects the global oil demand to fall sharply only after 2020 and probably until the 2040s. Gas, which is cleaner than oil and coal, is expected to continue to be in demand, particularly in Asian countries like India, Japan and Korea, as it will be used to substitute coal-based power as a part of these countries' decarbonisation strategies. Hence, the West Asian countries are putting in place their mid- to long-term plans for dealing with a less fossil fuel dependent future.

Towards Collective Inter-Dependence

Each Asian region has its own energy-related challenge to deal with; however, there are certain similarities in energy sectors across Asia. All the nations, be they hydrocarbon producers or importers, will need to rethink their energy policies in the light of the climate change challenges and the impact on their economies thereof. Moreover, every country must adopt policies that will reduce their energy supply vulnerabilities as well. Some of the issues that all Asian nations should therefore consider are as follows:

Growing Import Dependence

Almost all of Asia is dependent mainly on hydrocarbons for its energy sectors. At the same time, apart from the West Asian region, and to some extent the Central Asian region, most of the rest of Asia has insufficient indigenous hydrocarbon reserves, both due to a high rate of consumption as well as high energy intensity and low energy efficiency standards. As a result, one of the biggest challenges these countries face is growing hydrocarbon imports. This not only has implications for their economies, but also makes them vulnerable to global and regional energy geopolitics with little or limited influence in global energy decision-making, including in energy pricing. A significant example is the presence of the 'Asian Premium', which is a premium charged on Asian countries for oil imports from West Asia, as against the substantial discounts offered to the US and Europe.[18]

The energy consuming and import-dependent countries have also been attempting to increase their energy security by diversifying imports from various energy sources. Many of them have robust overseas equity and asset acquisition strategies, wherein their state oil firms are tasked to acquire hydrocarbon blocks or equity stakes in energy-producing countries. However, other than offering some price advantages if and when the stakes are acquired during low price regimes, to be sold at a profit later, or the resources are utilised during high price regimes, such equity stakes do not add substantially to a country's energy security.

On the other hand, both energy producing and consuming countries should work collectively towards stabilising the energy market in order to ensure that the prices remains balanced as per market forces like supply and demand, which in turn will discourage price volatility. A case in point is oil producing governments investing in oil refining and marketing firms in major oil consuming countries, thereby creating partnerships that foster reliable flows of oil and enhance each other's energy security. Such joint ventures could be initiated in upstream sectors as well, e.g. in exploration and production projects as well as in joint infrastructure such as pipelines, ports and LNG terminals.

Joint Stocks

The case for developing strategic petroleum reserves (SPRs) by the Asian oil importing countries has often been suggested by the IEA ostensibly to prevent supply disruptions. While Japan, South Korea, Australia and New Zealand maintain mandatory stocks of oil equivalent of at least 90 days of net oil imports, and Taiwan and Singapore also maintain substantial reserves, the former for strategic reasons and the latter because it is a regional refining centre and oil-trading hub and therefore has large commercial stocks on hand at any given time, China is developing a 500 million barrel strategic storage facility, and India, too, is in the process of filling up its SPR. However, the high cost of constructing and maintaining oil storage facilities makes it difficult for smaller countries to develop and maintain such reserves. Hence, the suggestion that neighbouring countries develop joint stocks.[19] Although the validity of maintaining such stocks has been questioned, given an over-supplied oil market since 2014 on the one hand, and the uncertain future of oil on the other, particularly under the Paris Agreement commitments, oil in Asia will continue to remain a major energy source for the foreseeable future.

Upgrading Power Infrastructure

The developing Asian countries have seen dramatic improvements in their power sectors. Nevertheless, significant gaps remain, compared to more developed countries. There are also considerable variations across the developing economies in Asia. For example, over 400 million Asians still lack electricity, while existing infrastructure is of poor quality in many of the countries, where power outages constrain economic growth.[20] Moreover, most of the Asia-Pacific countries are committed to transiting to a low carbon energy mix under the Paris Agreement on Climate Change, and this will entail major changes in their energy sectors. For these countries, fossil fuels account for around three-quarters of electricity generation. Hence, transforming their energy sector, particularly requiring the transport and power sectors to adopt cleaner energy, would require massive investments, both in terms of finance as well as technology. According to an Asian Development Bank (ADB) report, the developing countries of Asia would require to invest around $14.7 trillion between 2016 and 2030 for a climate-adjusted power infrastructure.[21]

Some countries like India and China have made huge strides in incorporating renewable energy into their power sectors. Both have adopted ambitious targets in renewable energy in their energy mix. However, several other countries are still struggling to make the transition. Neighbouring and regional countries should work together to accelerate the incorporation of clean and renewable energy resources into their strategies. Power trade through cross-border power grids, comprising clean and/or renewable energy whenever possible, as well as gas pipeline grids would not only go a long way to meet their decarbonisation targets but also allow economic gains in the longer term. Regional power grids would allow member states to meet the growth in energy demand, improve access to energy services and reduce the costs of developing energy infrastructure by individual countries as surplus generation from one region/country could be supplied to deficient consumer centres. An interconnected power system could also enhance the development and integration of variable renewable power generation capacity. However, along with cross-border power grids, flexible market mechanisms capable of responding to demands as well as disruptions should also be developed.

Leveraging Market Power

The oil price slump since mid-2014 has given the Asian oil and gas importers some respite from high import bills. However, over time, supply may tighten as producers are cutting back on investments due to the low prices. As a result, oil prices are expected to begin climbing again. In fact, according to the IEA, oil prices may begin to recover by the end of 2017. For the import-dependent countries in the Asia-Pacific, the challenge is daunting, as they need low-priced energy. Hence, apart from the strategies mentioned earlier, they will need to use energy more efficiently until they can develop the technology for using alternative sources of energy more economically. In the interim, they could consider collectively bargaining with exporters to get energy at lower prices and better terms. This concept is not new, and some of the larger Asian companies, namely (South) Korea Gas Corp (KOGAS), Japan's JERA and China National Offshore Oil Corp (CNOOC), who together represent about a third of the world's LNG purchases, formed a group to exchange information and cooperate in the joint procurement of LNG as well as solve common challenges such as destination restrictions for LNG contracts.[22] India, too, has evinced an interest in joining the forum.

Some Asian countries have also shown an interest in developing an energy exchange that will reflect Asian prices, as against the two existing exchanges – the New York Mercantile Exchange (NYMEX), which trades in West Texas Intermediate (WTI), and the London-based ICE Futures Europe, which trades in Brent. After postponing its launch scheduled for the beginning of 2017, China is now planning to launch crude oil futures in Shanghai in mid-2017 to give itself global pricing power and better allocation of world resources and hedging against market risks.[23]

Conclusion

Given the transformation that is taking place in the global energy market, both due to the advent of extra barrels from North America and the urgent need to address climate change concerns and meet commitments made under the Paris Agreement, the developing economies in Asia face the twin challenges of ensuring energy access for their people to meet their socio-economic goals as well as reducing their growing dependence on energy imports caused by a rapid increase in demand. At the same time, they need to ensure that any transformation that takes place in their energy sectors should be environmentally sustainable. Combining all these factors is a challenge that the governments have to deal with by adopting the best available technology for investment. Given that some of the emerging energy technologies may be in conflict with affordability, the developing countries should implement policies according to their respective development stages. In this context, they could take lessons from the successful and unsuccessful precedents in developed countries to arrive at acceptable solutions, and thereby avoid the problems more efficiently than the developed countries did in the past.

The scale of this challenge calls for cooperation within the region, and beyond, and the engagement of multiple stakeholders. This is essential in order to improve the security and efficiency of energy supply, optimise the use of available resources, increase the market size in order to improve competitiveness and gain access to emerging technologies and manufacturing capabilities. As mentioned above, the challenge of energy security is an issue that encompasses all nations, but nowhere more urgently than in the Asian countries whose pace of economic growth has made them more vulnerable in terms of energy access than the other regions. It is a common challenge that requires to be dealt with collectively.

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