Challenge of Economic Growth and the Concern for Energy Security: A Comparative Analysis of South and South-East Asia

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CHALLENGE OF ECONOMIC GROWTH AND THE CONCERN FOR ENERGY SECURITY
A COMPARATIVE ANALYSIS OF SOUTH AND SOUTH-EAST ASIA

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Rapidly increasing dependence of the economic growth process on energy and the depletion of fossil fuel reserves at a fast pace have raised concerns for securing energy supply across the world. The developing nations remain the worst affected on at least two counts: first, they are at the lower levels of economic development and thereby have the pressing need for growth; second, they have the limited affordability to finance their energy imports in the face of rapid surge in the prices of fossil fuels. In such a context, this study provides a comparative analysis of South and South-east Asia – the major economies of India, Pakistan and Bangladesh are selected from the former region and Indonesia, Malaysia and Thailand are selected from the latter for focused analytical inquiry into energy supply situation and energy policy framework.

1. Introduction

In today's era when each and every economic activity has become increasingly dependent on the usage of energy, it has been the relative access to energy resources that has played a key role in shaping the contours of economic growth especially for the developing world. A rapid exhaustion of non-renewable energy resources and the consequent spurt in the prices of fossil fuels in international energy markets have made the attainment of economic growth a more challenging task for these nations especially when they remain in severe shortage of funds to finance their energy imports. In view of the limited indigenous reserves of fossil fuels and the relative lack of access to alternate technologies, they have attached a prime significance to the enhancement of energy security in their policy framework. In this context, they have adopted a variety of strategies such as securing energy supplies through bilateral agreements, fuel diversification, moderation of energy demand by enforcement of energy conservation and efficiency regulations and so on. A good effort is also made to enhance the share of renewable forms of energy like hydro, biomass, geothermal etc. in total energy supply.

Being an important element in any nation's policy framework, the analysis of energy security concerns assumes significance per se. So in this paper, our main objective is to have a comparative analysis of energy security concerns across two sets of nations differing significantly from each other in terms of their levels of per capita energy consumption. We wish to mention at the outset that in our analysis, we do not venture into the issues related with bilateral agreements across nations; rather we are primarily concerned with understanding the nature of energy policy framework in these nations. Moreover, a detailed inquiry into the energy intensity of the economic growth process and the pattern of energy supply highlighting the traces of energy insecurity is envisaged to facilitate the understanding of adopted energy policy framework.

A comparative analysis of nations belonging to South and South-east Asia fits well to our requirements as the major economies in the former group has lower levels of per capita energy consumption than the latter group. Similarly, there are differences in terms of their other energy related indicators like energy intensity, household electrification status etc. In order to have a more focused comparative analysis of energy security concerns in these two regions, we select three major economies (in terms of their contribution to regional GDP) of India, Pakistan and Bangladesh from South Asia and Indonesia, Thailand and Malaysia from South-east Asia.

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Including this introductory section, there are seven sections in this paper. In next section, we provide a brief review of literature on energy and economic growth. Section three introduces the domain of the study. Section four provides insights into the energy dependence of economic growth process in selected economies. Section five discusses the pattern of energy supply along with highlighting the emerging traces of energy insecurity. Section six makes an appraisal of initiatives and attainments made by these nations in their attempt for finding a way out of energy insecurity. The final section briefs on some of the emerging lessons from this analysis along with upholding the significance of regional cooperation in these nations' quest for securing the supply of energy.

2. Literature on Energy and Economic Growth: A Review

Neo-classical theory holds labour, capital and technology as the main factors of production. For it, the contours of economic growth are largely dependent on the optimal usage of these factors of production. In such a framework, there are no limits to growth and expansion of market economies.[2] The element of energy is merely an intermediate input whose provision is taken for granted. It does not appear explicitly in the Neo-classical production function. Nonetheless, it has assumed significance in the discussions on economic growth due to its increasing scarcity in coming times. Empirically, the experience of two oil crises in the 1970s and the emerging concern over rising energy costs and import bills have led economists to believe that energy can be a limiting factor to economic growth as without energy, other factors of production will not be able to contribute anything and the positive influence of technological progress on them may remain unfruitful. But, such a belief has led to the qualification of the implicit relation between economic growth and energy consumption. Economists have largely used the econometric tools like Granger Causality, Co-integration, Error-correction models etc. on the time series data to infer the casual relation between energy consumption and economic growth – a consequent of which has been a plethora of research with varying conclusions. We focus on some of the recent studies so as to highlight the major concern of most of the available literature on energy consumption and economic growth.

Being concerned with finding the feasibility of restraining energy consumption without compromising economic growth in the industrialised countries, Lee (2006) finds that there is no neutral relationship between energy consumption and GDP across all the countries except United Kingdom, Germany and Sweden. It observes bi-directional causality in United States and uni-directional causality running from energy consumption to GDP in Canada, Belgium, the Netherlands and Switzerland. It finds uni-directional but reversed causal relationship for France, Italy and Japan. It concludes that any effort at energy conservation may hinder economic growth in some countries. Similarly, Chontanawat, et al. (2006) in their analysis of causal relationship between energy and GDP for 30 OECD and 78 non-OECD countries find that the causality from aggregate energy consumption to GDP and GDP to energy consumption is more prevalent in the advanced OECD countries compared to the developing non-OECD countries. Another study by Hye and Mashkoor (2010) by considering the case of Bangladesh finds that there is a positive causation between both the economic growth and energy consumption. But, a contrary result has been arrived by Ghosh (2002) who has found

[2] Georgescu-Roegan provides a critique of neo-classical approach to growth in his 1971 work titled *The Entropy Law and the Economic Process*. Similarly, Herman Daly in his 1977 work *Steady State Economics* has brought in the ecological limits of the growth process postulated by market-driven Neo-classical paradigm of growth. URL http://www.eoearth.org/article/Environmental_and_ecological_economics?topic=58074 provides a detailed discussion on this aspect.

the absence of a long-run equilibrium relationship between per capita electricity consumption and per capita gross domestic product in case of India over the 1950-1997 period though it finds some unidirectional Granger causality running from economic growth to electricity consumption. It concludes that electricity conservation policies can be initiated without deteriorating side effects.

Similarly, Asafu-Adjaye (2000) has estimated the causal relationship between energy consumption and income for India, Indonesia, the Philippines and Thailand. It finds that in the short-run, the unidirectional Granger causality runs from energy to income for India and Indonesia, while bidirectional Granger causality runs from energy to income for Thailand and the Philippines. Hwang et al. (1992) have found a bi-directional causality between growth of energy consumption and GNP growth in Taiwan Province of China. Yoo (2005) has examined the short- and long-run causality between electricity consumption and economic growth in Korea over the 1970-2002 period. It has found the existence of bi-directional causality between electricity consumption and economic growth. Similarly in the case of Korea, Oh and Lee (2004) has found bidirectional causality between energy consumption and GDP in the long run and unidirectional causality from energy consumption to GDP in the short run.

Differences in causal relationship between energy and economic growth are found to be led by differences in fuel mix. Aqeel and Butt (2001) in case of Pakistan finds that economic growth leads to growth in petroleum consumption while on the other hand, neither economic growth nor gas consumption affect each other. In case of power sector, it finds that electricity consumption leads to economic growth. Zou and Chau (2006) finds that both the oil consumption and economic growth in China tend to move together in the long run. It finds oil consumption having great effects on the economy than vice versa as economic growth is found to be having small effects on oil use – an outcome much attributed to the energy consumption structure where coal constitutes a major part.

Thus, there remains a lack of unanimity on the precise relationship between energy consumption and economic growth. The emerging evidence has remained mixed and varied. Such lack of coherence in arrived results has been due to the countries' difference in terms of levels of development, economic structure, fuel mix and so on. However, it needs to be stressed that in all this discussion of the relation between energy consumption and economic growth, there is not much effort to explore the nature of energy policy framework in different countries as it is by this apparatus only, the relation between energy and economic growth gets streamlined. This comparative analysis of the energy situation and policy framework in the context of developing world gains further significance as the emerging insights may provide valuable guidelines for a number of developing nations who are experiencing multi-faceted energy insecurity in one way or the other. So in this paper, we attempt to fill this research gap by examining the energy situation and policy framework in a few developing economies – an introduction to some of their key characteristics is provided in next section.

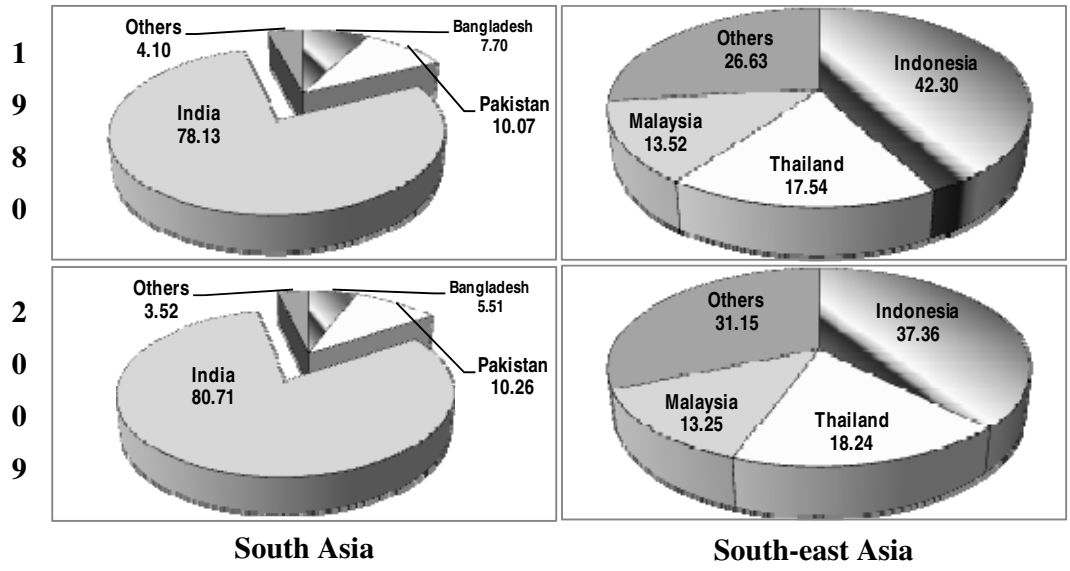
3. Domain of the Study: South & South-East Asia

This study is primarily focused on understanding the energy security concerns in South and South-east Asia. There are at least three main reasons for studying these regions from an energy security point of view. First, these regions in 2009 have inhabited 31.71 percent of the world population[3] and being one of the largest energy consumers (both actual and potential),

[3] The share of South Asia is as high as 23.13 percent in world population.

they assume significance in world energy markets. Second, some of the major economies in these regions have recorded, in recent past, a high rate of economic growth which has further resulted in a high demand for energy.[4] Third, these regions have huge potential for renewable energy but how far is it developed and what is the nature of adopted policy framework is a major question that has gained a lot of attention.

Figure 1: Share of Selected Economies in Regional GDP



Source: World Development Indicators, accessed online at http://data.worldbank.org/indicator

There are eight and ten nations respectively in these regions. But, we consider only the major ones for having a more focused attention. Adopting the criteria of major contribution to the regional gross domestic product (GDP), we select the economies of India, Pakistan and Bangladesh from South Asia and Indonesia, Thailand and Malaysia from South-east Asia. For illustrative purposes, we depict the contribution of these economies to regional GDP in Figure 1 for both the 1980 and the latest available. It can be observed that across both sets of nations, there has not taken place a major change in their contribution pattern over the period of time. In the case of South Asia region, India remains the major contributor and the contribution of Pakistan and Bangladesh has remained relatively small. In fact, India's contribution in the latter period has got increased by about 2.58 percent. Similarly, the contribution of Pakistan has increased marginally but the share of Bangladesh has declined by about 2 percent. But in the case of South-east Asia, the differences in the contribution of selected economies are not that wide. Here, Indonesia makes the highest contribution to the regional GDP followed by Thailand and Malaysia. Over the period of time, there has been a substantial decline in the contribution made by Indonesia. Its share in regional GDP has declined by about 5 percent whereas in case of Malaysia and Thailand, it has remained almost similar.

Table 1 provides some selective indicators to illustrate better the comparative profile of these economies. Among them, India inhabits the largest population followed by Indonesia,

[4] See, table 2 and 3.

Pakistan and Bangladesh. India accounts for about 17 percent of the world population. But in terms of population density, it remains much behind Bangladesh. If we consider these countries in terms of their per capita GDP, we find sharp divide. All the selected South-east Asian economies have relatively high per capita GDP than the selected South Asian economies. Bangladesh is the poorest country whereas Malaysia is the richest one. In comparison to the 1980 level, we find that the per capita GDP has increased manifold in case of Thailand followed by Indonesia and India whereas in case of Bangladesh, this increase has been the lowest.

Table 1: Comparative Profile of Selected Economies

		Year	Bangladesh		Pakistan		India		Malaysia		Thailand		Indonesia	
			Value	M*	Value	M*	Value	M*	Value	M*	Value	M*	Value	M*
Population	Million	2009	162.22		169.71		1,155.35		27.47		67.76		229.96	
	Density*	2009	1246		220		389		84		133		127	
	Share*	2009	2.39		2.5		17.05		0.41		1		3.39	
GDP per capita (current US $)		1980	200	2.76	286	3.34	267	4.25	1812	3.88	685	5.68	532	4.42
		2009	551		955		1,134		7030		3893		2349	
Energy use per capita (KgOE)		1980	93	1.75	301	1.7	302	1.75	880	3.11	466	3.33	391	2.17
		2007	163		512		529		2733		1553		849	
Fossil Fuel Share in Total Energy Consumption (%)		1980	32.2	2.06	40.7	1.53	41.6	1.68	85.7	1.11	50.8	1.6	45.2	1.52
		2007	66.2		62.1		70		95.5		81.2		68.8	
Net Energy Import (% of Total Energy)		1980	20	0.85	16	1.5	10	2.4	-52	0.58	49	0.88	-121	0.61
		2007	17		24		24		-30		43		-74	

Note: * indicates that the density implies population per square km; share implies share in world population; M implies multiple change since 1980.
Source: Same as Figure 1.

Similar sharp divide among the selected economies is observed in terms of their per capita energy usage. It has been the highest in all the South-east Asian economies. Malaysia followed by Thailand and Indonesia is the largest consumer of energy (in per capita terms). The level of per capita energy consumption in the South Asian economies remains very low. Similarly over the period of time, the South Asian economies, in contrast to Thailand, Malaysia and Indonesia do not record much sharp increase in per capita consumption of energy. A consideration of the share of fossil fuels in total energy mix further reveals that all these economies are significantly dependent on fossil fuels for their energy needs. This share remains very high for Malaysia and Thailand but in case of other economies as well, it is within the range of 60-70 percent. This share of fossil fuel in total energy mix has increased across all the economies. What is more worrying is the net import of energy especially in case of Thailand, India, Pakistan and Bangladesh. Indonesia and Malaysia remain the net exporters of energy. Nonetheless, there has been a decline in their export of energy over the period of time.

Thus, it is clear that the selected economies are considerably different from each other. Such varied profile urges us to delve into two basic questions. First, what is the pattern of energy supply and how severe are the traces of energy insecurity in these economies? Second, in the face of heavy dependence on imported energy what is the nature of the adopted energy policy framework and how well it has taken the nations towards their attainment of energy security objectives? As both of these questions need a priori an understanding of the economic growth process and the consequent dependence on energy, we find it appropriate to discuss this aspect in the subsequent section.

4. Economic Growth and Energy Dependence in Selected Economies

Estimates of economic growth as presented in Table 2 indicate that the growth profile of all the selected six economies has been much dynamic. Till the onslaught of economic crises in 1997, the economies of South-east Asia have recorded a relatively high rate of economic growth since 1971. The onslaught of economic crises has shattered the South-east economies to a large extent and as a consequence, there has been a marginal growth for the South-east Asia region as a whole over the 1997-1999 period. Among the selected economies, Indonesia and Thailand have recorded negative growth. Malaysia's growth rate has witnessed large decline as well. In terms of growth of per capita GDP, all these economies have recorded a negative growth. In the post-crises period as well, the growth rate of selected South-east Asian economies has remained relatively lower than that recorded by them in the 1971-96 period.

Table 2: Average Annual Growth Rate (%) of Total GDP and Per Capita GDP, 1971-2008

Country / Region	Growth Rate of GDP (%)					Growth Rate of GDP Per Capita (%)				
	1971 to 1980	1981 to 1990	1991 to 1996	1997 to 1999	2000 to 2008	1971 to 1980	1981 to 1990	1991 to 1996	1997 to 1999	2000 to 2008
Bangladesh	5.8	4.1	4.2	5.2	5.8	NA	1.7	2.6	4.0	4.6
Pakistan	5.2	6.2	5.1	3.0	5.2	NA	3.1	1.9	0.5	3.4
India	3.7	5.6	5.5	5.9	7.2	NA	3.6	3.1	4.0	5.5
South Asia	**4.0**	**5.5**	**5.4**	**5.5**	**6.8**	**NA**	**3.3**	**2.8**	**3.5**	**5.2**
Malaysia	7.8	5.2	9.0	2.1	5.3	NA	2.8	5.5	-0.2	3.7
Thailand	7.9	7.9	8.2	-2.6	4.8	NA	5.3	6.9	-3.7	4.1
Indonesia	7.7	5.8	7.8	-2.5	5.1	NA	3.1	6.0	-3.9	3.6
Southeast Asia	**7.4**	**5.4**	**7.5**	**0.3**	**4.9**	**NA**	**2.9**	**5.2**	**-1.3**	**3.3**
Asia & Pacific	**6.8**	**7.6**	**7.9**	**4.6**	**7.3**	**NA**	**5.3**	**6.2**	**3.4**	**6.3**

Note: the growth rates are the averages of annual growth rates for the specified period
Source: Based on Asian Development Outlook, Various Issues

Though all the selected South Asian economies have grown at a modest rate during the 1971-96 period, there have been variations. Pakistan, for example, has surpassed India during the pre-1991 period but after that India has emerged as the fastest growing economy. Bangladesh has also performed well than Pakistan in the post-1997 period. In terms of per capita GDP, India's growth has been the highest among the selected South Asian economies over the period of time. In fact, this growth rate except 1991-96 period has increased over the period of time. One may take it as a crude indicator of the improvement in living standard. Much better pattern of improvement in growth of GDP per capita is recorded by Bangladesh whereas no such improvement is witnessed in case of Pakistan.

Table 3: Growth and Elasticity Pattern of Primary Energy Consumption*

	Growth Rate (%)					Elasticity w.r.t. GDP				
	1971 to 1980	1981 to 1990	1991 to 1996	1997 to 1999	2000 to 2008	1971 to 1980	1981 to 1990	1991 to 1996	1997 to 1999	2000 to 2008
Bangladesh	17.54	8.65	8.58	1.61	6.06	3.02	2.11	2.04	0.31	1.04
Pakistan	5.72	6.52	5.97	5.92	5.54	1.10	1.05	1.17	1.97	1.07
India	4.94	5.94	5.47	3.6	5.08	1.34	1.06	0.99	0.61	0.71
Malaysia	10.58	9.3	7.11	0.38	2.67	1.36	1.79	0.79	0.18	0.50
Thailand	7.05	10.14	11.11	-1.74	4.86	0.89	1.28	1.35	0.67	1.01
Indonesia	13.5	6.46	6.53	3.77	3.28	1.75	1.11	0.84	-1.51	0.64

Note: *Primary energy comprises only the commercially traded fuels such as oil, natural gas, coal and hydro. It does not include traditional fuels such as wood, peat and animal waste despite their significance in some economies. It also excludes other renewable forms of energy such as wind, geothermal and solar energy.
Source: Based on Table 2 and BP Statistical Review of World Energy, June 2009

Table 3 provides estimates of average annual growth in primary energy consumption across these selected economies. It can be observed that during the pre-1997 period, all the South-

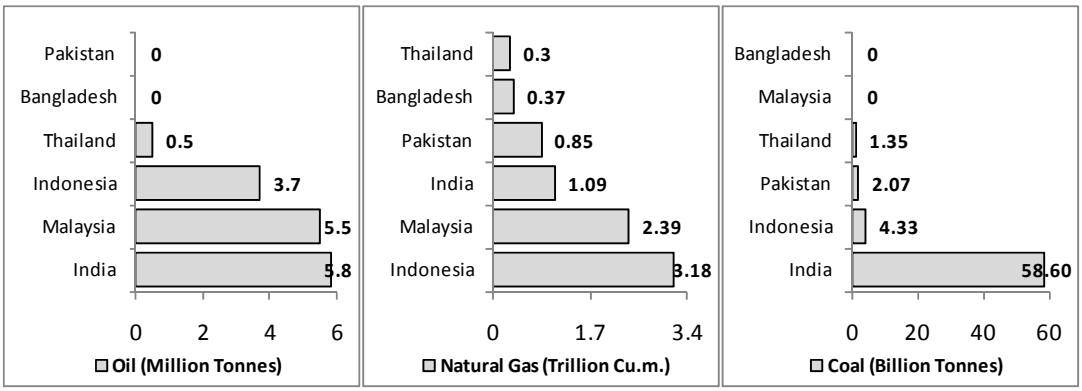
east Asian economies have recorded a relatively high growth rate of primary energy consumption than their South Asian counterparts except Bangladesh who have recorded the highest growth rate in this respect. Such a result has emerged due to the very low level of primary energy consumption in Bangladesh. Pakistan has also recorded a relatively high growth rate of primary energy consumption than India over the period of time.

With a comparison of this growth rate of primary energy consumption with the earlier discussed growth rate of GDP (see Table 2), we've arrived at elasticity estimates. By this exercise, it is found that up to 1990s, the elasticity has remained above unity across all the economies except Thailand in 1970s. Similar pattern has continued in 1991-96 period as well but with the exception of India, Indonesia and Malaysia. During the crises period of 1997-99, this elasticity for all the economies except Pakistan has become below unity which implies that the growth in primary energy consumption has been less than the growth in GDP. Since 1981, a declining pattern of elasticity has been observed in case of Bangladesh, India, Indonesia and Malaysia. The decline has been the highest in case of Malaysia followed by Bangladesh, Indonesia and India.[5] Having understood the process of economic growth and the positive responsiveness of primary energy consumption to economic growth, we examine the pattern of energy supply among these economies in the subsequent section.

5. Pattern of Energy Supply and Traces of Energy Insecurity

Given the positive responsiveness of the primary energy consumption vis-à-vis economic growth and vice-versa,[6] it is difficult to deny that the contours of economic growth are largely determined by the access to energy. Though access to energy can be secured through numerous ways, it is the indigenous reserves that assume a prime significance as a nation without significant reserves of energy has to meet its total energy demand through imports which have further implications towards foreign exchange and balance of payments. As the foreign exchange can alternatively be used for importing technology, essential raw materials etc., an undue dependence on energy import has a debilitating impact on economic growth – due to which, most of the nations have adopted a range of policies to reduce their dependence on imported energy - Thailand is a classic example (as we'll see in section six).

Figure 2: Proved Reserves of Fossil Fuels, by the end of 2008



Source: Based on BP Statistical Review of World Energy, June 2009

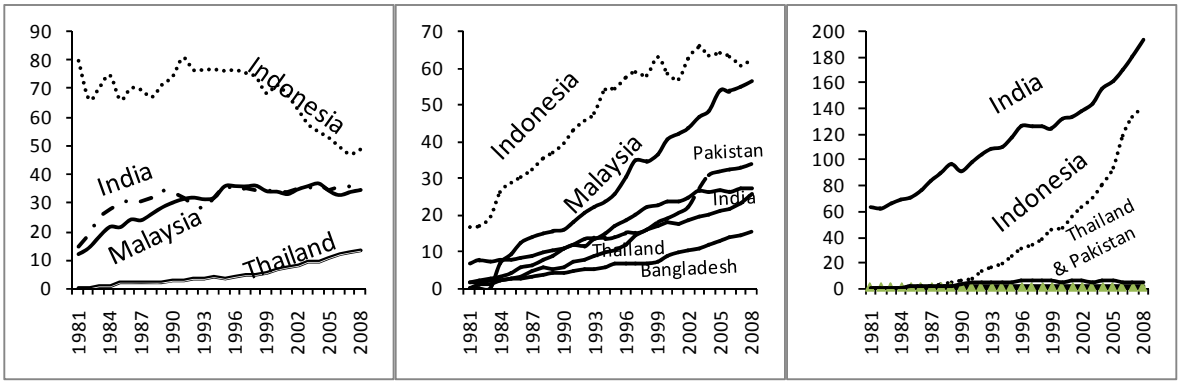
[5] While interpreting these elasticity estimates, one must keep into mind the share of fossil fuels in total energy mix. By this, we imply that a decrease or increase in elasticity in case of Malaysia is much different from that of South Asian economies as they are also dependent on other forms of energy.

[6] As indicated by some of the studies discussed in review section 2.

Figure 2 reveals that all the selected economies vary considerably in terms of their indigenous reserves of fossil fuels like oil, natural gas and coal. Focusing only on proved reserves[7], we find that among the selected South-Asian economies, only India has relatively better proved reserves of coal, oil and natural gas. India's proved coal reserve by the end of 2008 has been found to be 58.60 billion tones which correspond to 7.1 percent of total world reserves of coal. Its oil proved reserves are found to be 5.8 million tones which correspond to 0.5 percent of world's total oil reserves. Among the selected economies, India has the highest reserve of oil. In terms of natural gas reserves, it comes at a third position. In another two South Asian economies of Pakistan and Bangladesh, there are no reserves of oil. Pakistan has both natural gas and coal but Bangladesh has only natural gas reserves. Studies indicate that till 2005, as many as 24 fields of natural gas have been discovered in Bangladesh (Miyan and Richards, 2004).

Similarly, among the selected South-east Asian economies, Thailand does not have much reserve of indigenous fossil fuels. Malaysia has some reserves of coal but these coal reserves are found in inland areas where due to infrastructure, the extraction cost is very high. It has a considerably high share of proved oil and gas reserves. In terms of the former, it has 0.4 percent of world's proved oil reserve. It has 2.39 trillion cubic meters of natural gas. Similarly, Indonesia is the largest holder of fossil fuel reserves among the selected economies. Its oil reserves are found at 3.7 million tones which correspond to 0.3 percent of world proven reserves. Its natural gas reserves at 3.18 trillion cubic meters make it the 11th largest holder of natural gas in the world. It has large reserves of coal as well and it is second to India among the selected economies in this respect.

Figure 3: Indigenous Fossil Fuel Production (Million Tones)Trend in Selected Economies



Oil Natural Gas Coal

Source: Same as Figure 2

Similar to the holding of reserves, the production of these fossil fuels, as presented in Figure 3, also vary in our selected countries. During 2008, Indonesia is the largest producer of oil and natural gas and it is the second largest producer of coal after India which is also producing oil and natural gas significantly. Malaysia is the second largest producer of natural

[7] BP Statistical Review of Energy defines proved energy reserves as those quantities which, as indicated by given geological and engineering information, can be recovered with reasonable certainty in the future from known reservoirs under existing economic and operating conditions.

gas and oil. Thailand despite being short in fossil fuel reserves produces considerable amount of oil and natural gas. The production of coal in Thailand and Pakistan is almost negligible. Pakistan is the third largest producer of natural gas. Bangladesh has also produced a significant amount of natural gas.

Production trend since 1981 reflects a large variation across the selected countries. During this period, Indonesia has recorded a considerable reduction in the production of oil. It was producing 80 million tonnes of oil during 1981 but by the year 2008, it has got reduced to 49 million tones. India and Malaysia have recorded a similar level of oil production over this period. It is noteworthy that Thailand has also increased its production manifold. In 1981, it was producing only 0.1 million tonnes of oil but by 2008, its production level has increased to 13.4 million tonnes.

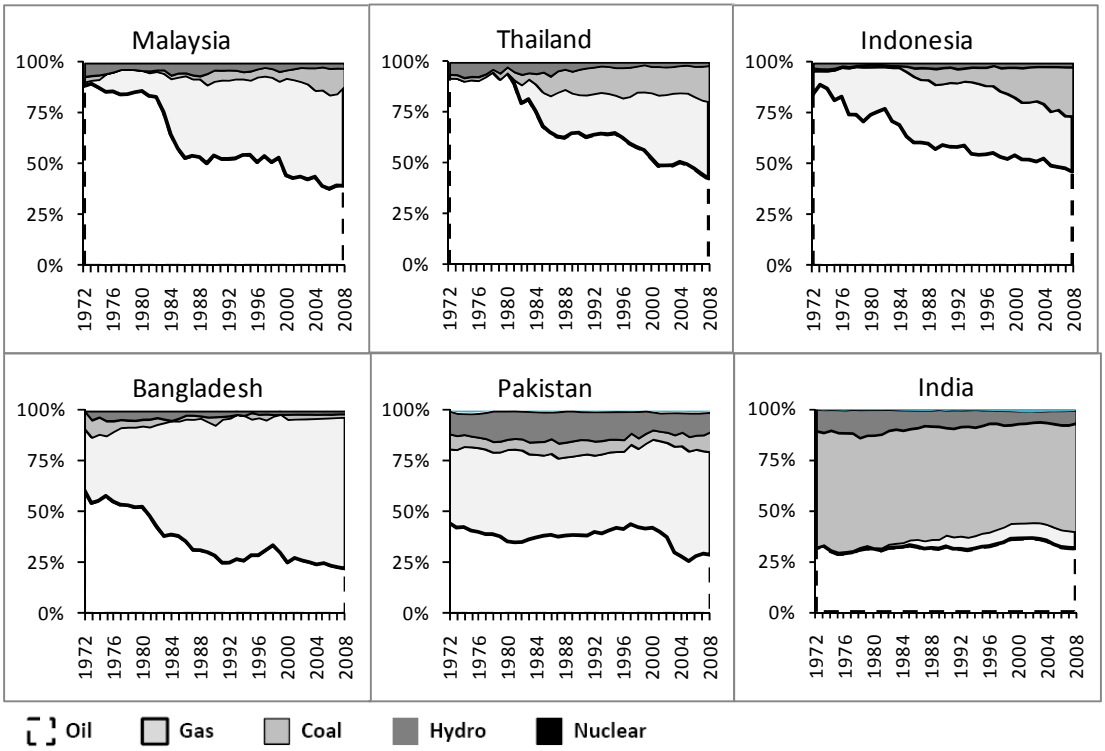
During 1981, the production level of natural gas has been very low in all the selected economies except Indonesia, which has been producing 16.9 MTOE but over the period of time, its production of natural gas has got increased to 62.7 MTOE. Malaysia and Thailand have made the highest growth in the production of natural gas during this period. It is noteworthy that Malaysia has started the production of natural gas from 1983 onwards. Among South Asian economies as well, the level of natural gas production has remained very high in Pakistan. In 1981, it was producing 7 MTOE – a figure much higher than India and Bangladesh who were producing 1.8 and 1.5 MTOE respectively. But, over the period of time, both of these economies have made a fast growth in the production of natural gas. India has made the highest growth followed by Bangladesh and by 2008, the level of natural gas production in India, Pakistan and Sri Lanka have stood at 27.5, 33.8 and 15.6 MTOE respectively.

In terms of coal, India remains the largest producer among the selected economies. In 1981, it was producing 63 MTOE of coal which has got increased considerably over the period of time. In 2008, it has produced 194 MTOE of coal. It is also noteworthy that in the initial years of 1980s, the production of coal in Indonesia has remained negligible. But, it has made substantial improvement in coal production over the period of time. In 2008, it has produced coal equal to 144 MTOE which amount to 41.23 percent of the total coal production in selected economies. Such growth in coal production is the result of policy change by which the government aspired for substituting coal for oil. In two other economies of Thailand and Pakistan, the production of coal remains negligible.

Above discussed differences in the production of different fuels are also reflected in nation's respective energy mixes[8] (Figure 4). It is found that oil remains a significant constituent of the energy mix in all the selected economies. In 1972, its share remains very high in Thailand (91.9 percent), Malaysia (87.9 percent) and Indonesia (84.2 percent). But over the period of time, all these economies have showed a declining dependence on oil except India whose dependence on oil has remained almost uniform over the period of time. As we have seen that the production of natural gas has increased in all the economies, they have increasingly substituted oil with natural gas. Such substitution has been the largest in case of Bangladesh, followed by Malaysia and Pakistan. In case of Thailand, this substitution by natural gas has started in 1981. From 1990 onwards, Indonesia has started increasingly substituting oil with coal.

[8] By energy mix, we imply the share of different fuels in total energy consumption.

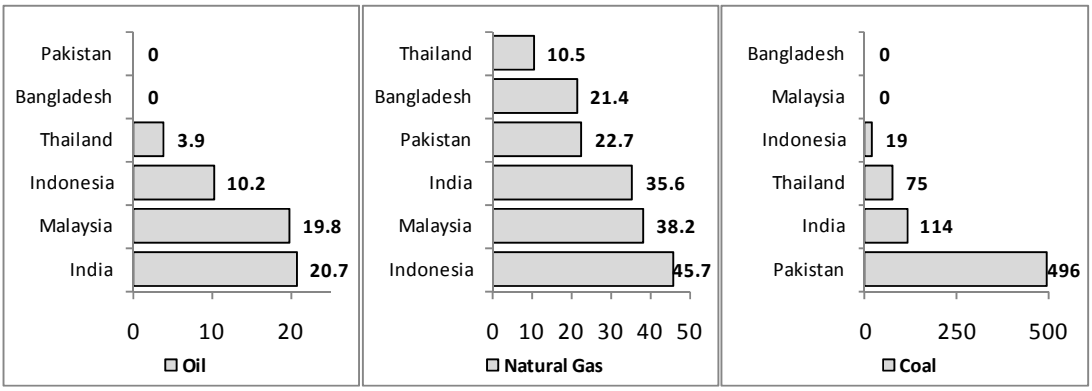
Figure 4: Energy Consumption Mix



Source: Same as Figure 2

Other than oil, natural gas and coal, hydro energy and nuclear energy are other sources of commercial energy. It is found that in all the selected economies except Pakistan and India, the share of hydro energy in total energy mix has remained minimal. Pakistan and India have the good potential of hydro energy. The potential of hydro energy in Bangladesh is not so good because the origin of all its rivers is in the neighboring countries. So due to political reasons it is not much beneficial for Bangladesh to develop this resource. Similarly all the three South-east Asian countries have somewhat good potential of hydro energy, but still a very less part of this energy has been developed. Due to this, the share of hydro energy remains limited in the energy mix of these countries. Nuclear energy is also used by only India and Pakistan but its share is very minimal.

Figure 5: R/P Ratio of Fossil Fuels in Selected Economies



Source: Same as Figure 2

From above analysis of indigenous production and consumption mix, it can be easily inferred that these countries except Indonesia and Malaysia are the net importers of energy. What is more worrying is the fact that in the coming years, this dependence on imported energy is bound to increase as in all these economies, indigenous reserves of fossil fuels are going to deplete soon. From the R/P ratio[9] as presented in figure 5, it can be observed that oil is the fastest depleting fossil fuel in almost all the selected countries. It will last till next 20 years in India and Malaysia. In Indonesia it will last for next 10 years. Owing to this, all these countries have started reducing their dependence on oil by shifting to natural gas and coal. But natural gas is also depleting. It will last for next 35 to 45 years in Indonesia, Malaysia and India but it will remain for 21-22 years only in Pakistan and Bangladesh due to high dependence of both of these countries on natural gas. It'll deplete completely within next 10 years in Thailand. But the situation of coal is better in Pakistan, India and Thailand. Pakistan is currently using very less amount of coal. Coal is the main source of energy in India, but it uses imported coal as well.

6. Finding A Way Out of Energy Insecurity: An Appraisal of Initiative & Outcomes

As evident from above analysis, all the selected economies are short of energy reserves. They are going to face energy shortages in near future – some are already experiencing so. They have to either depend on imported energy or have to explore other renewable forms of energy like hydro, biomass, wind etc. or both. The former choice is going to be dearer and unaffordable due to high volatility of the energy prices in international markets. As such a situation is going to have further implications for their economic growth, it is the ability to design and implement energy policy effectively that will enable these nations to have a sustainable pattern of growth. So, it needs to be learned how best these selected economies could initiate steps in this direction. We'll focus on the major policy initiatives. Such an attempt in a comparative framework holds significance not only for suggesting corrective actions but also to derive lessons of much use for rest of the developing world. First of all, we discuss the major initiatives undertaken by each country to promote its energy security. Then, we have a reflection on these initiatives so as to derive lessons and to suggest corrective actions, if any.

Indonesia

Indonesia is having enough reserves of oil, natural gas and coal. But, it has reduced the production of oil and has become a net importer. In its National Energy Policy launched in 2006, the government of Indonesia has aspired for coping with energy insecurity in the long run through energy conservation and energy diversification. A main idea behind energy conservation and diversification has been to reduce dependence on oil by reducing national oil consumption rate and by substituting it with coal, gas and renewable sources such as geo-thermal, bio-fuels etc.

Earlier in 2004, it has launched national coal policy with the ambition of developing its own coal resources. Since then, there has been a significant increase in the production of coal. Simultaneously the government has also made efforts to promote the usage of coal. But, the domestic demand has remained limited. As a consequence, the remaining coal is largely exported to other nations (Sambodo, 2008). It needs to be noted that the initiative of promoting the usage of coal has been a major step in coping with energy insecurity.

[9] Reserves-to-production (R/P) ratio is arrived at by dividing the remaining reserves in 2008 by the production in that year. It is a crude estimate of the length of time that the remaining reserves would last if production will continue at the same rate.

Recognizing the large potential for geothermal energy (around 27 GW), the government of Indonesia has enacted the geothermal Law No. 27 in 2003. A major usage of geothermal energy is to generate electricity. Similarly, it has a good potential of hydro power (around 75 GW) but only 4200MW power capacity has been installed. Being a tropical country, it has a good potential for solar energy. To develop this resource, the Government has promoted the use of solar home systems. But still its use is very limited. Similarly, the use of wind energy is also very low in the country. Nonetheless, it needs to be stressed that the government is providing financial and technical assistance for developing all these renewable sources in the country.

Malaysia

Like Indonesia, Malaysia has introduced various policies for the sustainable development of the country by ensuring reliability and security of energy supply in the long run. Before 1970, it was meeting its entire petroleum demand with imports from other countries. At this juncture, the government has laid emphasis on the development of own petroleum resources and due to various initiatives, it has become a net exporter of petroleum products.

Various other energy policies have been introduced by the government. National Energy policy has been introduced in 1979 for ensuring adequate, secure and cost effective energy supply and to promote efficient utilization of resources. Energy resource conservation and fuel diversification has remained the major concerns of Malaysia's energy policy. National Depletion Policy has been initiated in 1980 for conserving nation's energy resources. By this policy, it has limited the production of crude oil to an average of 630,000 barrels per day and the extraction of gas in peninsular Malaysia to 32,000 million standard cubic feet per day.

To reduce the dependence on the single source of energy, the government has introduced 'Four Fuel Diversification Policy' in 1981 by which it has identified oil, natural gas, coal and hydro power as the preferred energy mix. Later on in 2001, this policy has been termed as the 'Five Fuel Diversification Policy' with the addition of renewable energy. Malaysia has good potential of various renewable resources like biomass, hydropower, biogas and solar energy. Palm oil waste industries and mini hydro systems are very popular in the country. It has substantial potential of hydro-energy as well which is estimated at around 29,000 MW but still only 2,000 MW is currently utilized. It has also abundance of solar energy which is currently used to generate electricity and heat in the country especially in the remote areas, villages and isolated islands which are not connected to the national grid. In 2005, it has introduced biodiesel for the transport sector.

In its 8^{th} and 9^{th} Malaysia Plan, it has devoted attention to the development of renewable energy and in this regard, it has launched the Small Renewable Energy Power (SREP) Program. Biomass Based Power Generation and Cogeneration Programme (BIOGEN) and Malaysian Building Integrated Photovoltaic (MBIPV) projects are launched under this program. In its Ninth Malaysia Plan, it has also focused explicitly on energy efficiency. Specific guidelines and fiscal incentives are given to companies for providing energy saving consulting services. It gives fiscal incentives such as exemption from sales tax and import duty, investment tax allowance etc. to the energy saving companies.

Thailand

Energy policies in Thailand in their effort to reduce the dependence on imported energy aim at conserving and developing indigenous energy resources, promoting efficient use of energy and providing significant support to the promotion of clean and alternative energy sources. A major initiative towards energy security in Thailand has been made in 1992 with the enactment of Energy Conservation Promotion Act, 1992. This legislation guiding Thailand's energy conservation and renewable energy policy outlines both compulsory and voluntary programmes.[10] It has also established the Energy Conservation Promotion Fund (ENCON Fund) as a working capital to provide financial support to energy conservation related activities. The revenues for this fund are derived mainly from the contributions collected from domestically sold petroleum products like gasoline, diesel, kerosene and fuel oil.[11]

In 2005, Thai government has implemented new Energy Strategic Plan with aggressive targets. It has aimed at reducing oil consumption in transport sector by 25 percent in 2009 with the use of natural gas, gasohol and biodiesel along with increasing the contribution of biodiesel to 8.5 million liter per day (10 percent of diesel consumption) by 2012. With the creation of National Committee on Biofuel Development and Promotion in 2005, it has devoted attention to the promotion of biofuel. Under its Biodiesel Strategic Plan, it has promoted the expansion of palm oil plantations and since February 2008, a 2 percent blend of biodiesel is made mandatory nationwide (Morgera et al., 2009). In February 2009, Thailand has adopted Alternative Energy Development Plan (2008-2022) which gives priority to production and use of alternative energy i.e. RE.

Along with these measures, Thai government has provided various tax incentives for the promotion of Renewable Energy projects. It has provided financial incentives to boost foreign investments, duty-free imports of plant & equipment, multi-year tax holidays and generous tax deductions. Grants up to $ 1.5 million are given to eligible biogas, municipal waste and solar hot water projects. Government-subsidised debt financing at low interest rates and government equity participation of up to 20 percent of the total investment is also available. Subsidized tariffs called 'adder' tariffs are another attractive investment subsidy. Thailand has reduced considerably the import duties on energy conservation equipment and materials. Small Power Producer Program introduced in 1992 has become very effective policy instrument in promoting investment in RE and cogeneration.

Fuel diversification has been another major initiative in Thailand. It has opted for fuel switching, i.e. from oil to natural gas such as CNG, Gas fired power plants etc. and from oil to bio fuel. Natural gas is increasingly used for generating electricity with highly efficient combined cycle and cogeneration.

India

Owing to the limited capacities for energy production, a major effort of the energy policy framework has been towards the expansion of production capacities. It has made a sound effort towards the exploration of oil and gas fields. It has also expanded generation capacities in hydro and thermal plants mostly run with coal. It has also tried to develop nuclear power but the shortage of nuclear fuel acted as the major bottleneck. India has significant reserves of

[10] The compulsory program is for designated facilities comprising approximately 4500 large commercial and industrial facilities. The voluntary program targets small and medium sized enterprises.
[11] Since October 1998, the contribution rate has been 0.04 Baht/litre.

Uranium (70 Kilotons) and Thorium (360 Kilotons) but it lacks the access to technology needed for fissioning this radioactive elements. India is trying to have technology cooperation with the developed world especially the USA. It is noteworthy that following the testing of nuclear weapons by India in late 1990s, India has been cut off from nuclear fuel and technology supply as part of an international embargo.

In view of the huge renewable energy potential and the consequent ambition for promoting this energy source, India has developed the Ministry of Non Conventional Energy Sources (MNES) in 1992. Since then, it has made some progress in this respect. It has emerged as one of the top five wind energy generating countries in the world (Herbert, G et al., 2006) but still a large potential remains unutilized. Similarly, a large potential of solar and biomass energy remains unutilized. It is noteworthy that the small biomass plants have been a good success. But, still a large proportion of the biomass remains unutilized. Unlike other countries (e.g. Thailand), it has not tried to develop biofuel at a significant scale.

On the fronts of energy conservation, it has enacted Energy Conservation Act, 2001. By this legislation, it has set minimum energy standards for appliances and equipments besides promulgating energy conservation building codes. It has also urged for energy use monitoring, verification and reporting by large energy users and the establishment of energy consumption norms for large consumers.

Pakistan

In its effort to promote energy security, Pakistan has made efforts for encouraging private sector participation and its efforts in this respect date back to 1985. These efforts have found significant place in its Power Policy of 1994. Its more refined version has appeared in 2002 as Policy for Power Generation. Under this policy, it has encouraged private, public-private and public sector projects. In this policy, it has attempted to include renewable energy generation as well but the outcomes have not been that significant. So, the government has established a central national body, viz. Alternative Energy Development Board (AEDB) for the development of renewable energy. Subsequently, it has launched the Policy for Development of Renewable Energy for Power Generation in 2006. In this policy, it has laid emphasis on the adoption of modern technology in renewable energy generation besides encouraging the participation of the private sector in renewable energy projects. It is noteworthy that Pakistan has good potential for solar, mini hydro and wind energy but till now, this potential remains largely under-utilised.

In order to enhance energy supply through the optimum use of all energy sources, it has envisaged an Energy Security Action Plan (2005-2030). Its main focus is to reduce the dependence on imported fuels through a better utilization of indigenous sources. Similarly, it has launched the Energy Conservation Policy in 2005 with an ambition of promoting energy conservation practices at the national level.

Bangladesh

Bangladesh has adopted the National Energy Policy in 1995 for promoting the commercial use of energy. By this policy, it has encouraged the participation of private sector in energy development and management programs. Subsequently, a number of fiscal incentives have been provided through the Private Power Generation Policy in 1996. Similarly, the government has encouraged Bangladesh Power Development Board and several other Independent Power Producers for supplying electricity to the national grid. It has also

introduced Small Power Generation Policy in 1998 for encouraging the private sector to produce electricity from small generation capacity projects.

The National Energy Policy has been revised in 2004 with a main focus on the provision of energy for sustainable economic growth and to ensure optimum development of all indigenous energy sources. In this policy, the government has emphasized the rational use of all energy sources and the protection of natural resources through renewable energy development and energy efficiency. In 2007, the government has approved captive power policy which allowed captive power plants to sell their excess electricity to the electric utility.

In 2008, Bangladesh has passed the renewable energy policy which aims at increasing the potential of renewable resources. It has set a target of generating 5 percent of total electricity by 2015 and 10 percent by 2020 from renewable resources. Bangladesh has significant potential of renewable energy. Biomass is the main source of energy consumption in the country. Wood and wood wastes, agricultural residues and animal dung are the traditional sources used to produce biomass. Moreover, the location of Bangladesh is ideal for solar energy utilization. In the 5^{th} five year plan, the government has exempted import duty and value added taxes on the solar PV modules. Micro credit program of Grameen Shakti and Infrastructure Development Company Limited has promoted the solar home systems with financing from government and international organizations. Subsidies are provided to promote the solar PV and biogas technologies in the country.

It is also noteworthy that Bangladesh has very limited scope of hydro power generation. There is only one hydro plant in the country on Karnafulli River which has the installed capacity of 230 MW. Besides this, there is some potential of small scale hydropower generation. The potential of wind energy is also limited. However, some wind turbines of 50 KW capacity have been installed in coastal areas. Despite all such efforts, the country is facing high energy insecurity due to the lack of technology and skill for the efficient utilization of these resources.

7. Concluding Remarks

Thus, this paper has explored its two basic questions related with energy supply scenario and the energy policy framework to a considerable length. With a thorough understanding of the energy situation and the adopted energy policy framework in the selected economies, it has come to the conclusion that the selected South-east Asian economies, viz. Indonesia, Thailand and Malaysia have taken the issue of energy security very seriously and as a result, they have not only undertaken various measures but they have also been successful in attaining the desired outcomes. In fact, Thailand's case is very interesting as this nation have very minimal reserves of fossil fuels in comparison to other counterparts like Indonesia and Malaysia. Despite this handicap, it has grown at par with other South-east Asian economies. Its consumption of energy is also at par with them. Such an attainment in energy security is a result of sound energy policy. Similarly, the policy initiatives made by Indonesia and Malaysia are also found to be important.

A little broader perspective reveals that besides sound policy interventions at the domestic level, these economies have also tried to enhance their energy security through sound regional cooperation. Some of the key examples in this respect are ASEAN Power Grid and Trans-ASEAN Gas Pipeline Project.

Given this state of energy security in the South-east Asia, it can be observed that this comparative analysis leads a number of lessons for the South Asia region. Foremost among all is the idea of regional cooperation as the South Asia region can solve its problems of energy insecurity to a large extent. In this respect, it is worth emphasizing that Bangladesh must come forward for securing its energy needs. It can gain very well from this cooperation as about 90 percent of its rivers have their origin in its neighboring countries. By having their cooperation it can increase its hydro energy resource. Similarly, India and Pakistan can have large benefit if they cooperate and facilitate the development of Indo-Iran gas pipeline project (Alam, 2006: 52).

Another major issue related to the persistence of energy insecurity in the South Asia region is related to the lack of technology. India has emerged as the 4th largest producer of wind energy. Other countries should take its help in developing their wind energy plants. Similarly, there is also a lack of investment in R & D in the energy sector especially the small-scale energy production. Drawing lessons from Thailand's investment in R & D for converting its abundant biomass into biofuels, these agricultural economies must use their agricultural waste for the development of biofuel. Malaysia's experience with Five Fuel Diversification Strategy is also encouraging and all the countries should adopt this model earnestly if they are really concerned with ensuring their energy security. Similarly, the South Asian economies can develop a fund similar to Thailand's ENCON fund. From this fund, they can encourage the usage of renewable energy.

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