SECURING INDIA'S ENERGY NEEDS

The Regional Dimension

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SECURING INDIA'S ENERGY NEEDS
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Executive Summary

India's economic transformation after 1991 has put energy supply at the center of its economic agenda. To continue the growth record of the past decade, India will need to expand its commercial energy supplies by at least 6 percent per year or more if it is to reach the government's more ambitious growth target. When one considers that commercial energy sources are likely to take over some part of the substantial supply that today is met by non-commercial sources (30 percent of total energy consumed), the needed expansion of supply becomes even greater, and the increase in need for imported oil and gas is larger still.

Energy security has already become a central element in India's foreign policy – growing oil and gas investments abroad, focus on sea lanes, political ties with oil suppliers and who those suppliers are, etc.

Tracing the connection between India's decade-long fast paced economic growth, population growth, rise in living standards and rising commercial energy demand, the paper concludes that the near unitary elasticity is likely to continue in the short term pushing India to fourth place in terms of energy consumption behind the US, China and Japan. Current government strategy to bridge the growing gap between demand and supply of oil and gas focuses on restructuring of state-owned oil and gas companies, opening up the upstream and gradually the downstream sectors to private and foreign participation, enhancing capability for fuel switching, accessing overseas exploration and production opportunities and limited price rationalization. Other elements of the strategy; include reform of the power and coal sectors, renewed emphasis on hydropower generation, and greater attention to nuclear and other renewable sources.

This paper advocates formulation of an energy philosophy for India, the core of which is reliable, affordable and sustainable power for all homes, offices, work places and factories, fuel for cooking and oil and gas to keep the transportation system going. Involvement of people at the grassroots in a national energy mission would make up for the shortfall in the India's effort at energy conservation and pollution control, which are also important components of a nation's energy security policy. Emphasis on technology development and use, including for enhancing energy efficiency, building up a strategic petroleum reserves (SPR), security of supply lines of communications and energy installations and regional and global dialogue and cooperation are also critical aspects of a comprehensive energy policy. The paper also calls for focused reflection on India's use of coal, its most abundant primary energy source, and the application of Clean Coal Technologies (CCTs), and other technologies and processes like coal gasification and liquefaction (GTL) so that resources available within India's borders are better utilized to reduce dependency on foreign sources to the extent possible.

This paper looks at India's current policies on energy and energy security, their relevance to an Asian and South Asian collective security model, the India-China rivalry, and US role in the evolving energy situation in the region. This paper recommends a multi-faceted strategy for managing India's energy needs at home and the geopolitics of energy abroad.

Drawing upon the abundant public knowledge available on Asia's booming economic growth and consequent energy demand, the paper goes on to identify Asia's skewed oil and gas import dependency on West Asia/ Middle East. The main importers, Japan, China, South Korea and India have followed more or less the same strategy of trying to break out of the Middle East stranglehold by scouting for oil and gas assets, near and far, with mixed results. Despite other developments, in the immediate future, Asian energy consumers will be primarily dependent on hydrocarbons, which will in turn feed the demand not only for massive imports, but also for capital and technological inputs from within and outside the region, and collective security measures for supply lines of communication.

A central feature of India's energy security strategy should be a cooperative structure, for both Asia and the SAARC countries, that involves all phases of energy supply. Congruence of Asian energy interests is propelling major Asian importers towards a dialogue and cooperative agenda, quite unlike some doomsday forecasts that had envisaged energy insecurity leading to conflict. The meeting of major Asian oil importing countries in New Delhi in January 2005 was important not only because Japan, China, South Korea and India were represented at the highest levels, but also because all these countries' major suppliers from West Asia/Middle East – Saudi Arabia, Kuwait, UAE, Oman, Iran, and others were there in full strength. The conference expressed the desire to move towards an Asian oil market, an Asian benchmark crude, regional cooperation in exploration and production (E&P), strategic petroleum reserves (SPR), energy sustainability, stability and security. The Indian Minister of Petroleum and Natural Gas subsequently called for an Asian gas grid. Such collective thinking, despite unresolved territorial issues and deficit of trust between countries, is new to this region and will need to be properly handled so that there is benefit to all and no clash of interests with other regions or collective organizations like IEA and OPEC.

India is playing a catalytic role in this effort. This paper encourages India to continue to do so, and urges it to look closer home in the context of South Asia. This bustling region contains 23 percent of the world's population but enjoys only 2 percent of its GDP and consumes 4 percent of the world's energy supplies. Both demand and supply of energy are growing at a fast pace in the region, but luckily the energy dependency mix of the countries are varied which makes an allowance for exchanges rather than debilitating competition only. Some exchanges mainly between India and Bhutan (hydro power), Nepal (oil and coal), Bangladesh (coal) and Indian investments in Sri Lanka's downstream sector are taking place, but there is clearly more on the table, including a yet to be implemented South Asia Energy Forum under the aegis of SAARC and a regional SPR suggested in this paper.

A challenging part of this strategy will be to manage energy relations between India and China. The accent has traditionally been on rivalry between these two rapidly growing economies. I believe that a more cooperative posture, whether in bidding for the same oil and gas assets abroad or in establishing an Asian oil/gas market, could pay dividends for both. There is a marked similarity in the two Asian countries' energy strategy and realization at the highest government levels that some form of dialogue and cooperation will result in a win-win game.

Asia is in direct competition with Europe and North America for the world's oil and gas surplus in the Middle East, Central Asia and Russia, Africa and Latin America. Asia also needs the capital and technology available from its two competing regions. Therefore, Asia, Europe and North America, including the world's biggest energy user, the United States, need to make some adjustments to accommodate each other's interests. The paper suggests that the US can directly help the countries in the region, both multilaterally and bilaterally, by maintaining its leading role in maintaining stability in the Middle East, help in the Asian SPR program and in setting up an Asian dialogue and cooperation platform, in the technological transformation process and in providing collective security guarantees for the sea lines of communication.

Despite India's interest in diversifying its sources of foreign oil and gas imports from other regions, the Persian Gulf region will remain the world's and India's largest source for at least a generation. This is clearly stamped in India's recent deals with the countries of the region, including Saudi Arabia, Iran, Oman and Qatar. In particular, India's direct engagement with Iran's oil and gas sector has brought it into a conflict of interest situation with the United States, which is trying to isolate Iran through political and economic means. Managing their differences on the Iran issue without substantially hurting bilateral ties will be another major challenge for both New Delhi and Washington.

Introduction

The Indian economy underwent a basic transformation starting in 1991, when the government of the day decided to make major structural changes in response to an acute foreign exchange crisis and other difficulties in economic development. Sporadic attempts in the '80s had produced unimpressive results. The country's rulers embarked on a course of dismantling the "license raj" (rigid government control over production and distribution of manufactured products) and greater integration of the Indian economy with the global trading and investment system.

In the course of this transformation, India has achieved moderately satisfactory results, which have pushed upwards GDP growth rates and other economic and social sector indicators (Table I). The country finally escaped from the four-decades-old "hindu rate of growth", which kept economic and social development very low while the country grappled with a high population growth rate. Poverty reduction suffered during this period and left the country on the sidelines of the global political and economic order dominated for the most part by the two superpowers, Europe and Japan.

Table I

Indian Economy Indicators						
	Unit	1999-00	2000-01	2001-02	2002-03	2003-04
GDP at Factor Costs (constant prices)	% change	6.1	4.4	5.8	4.0	8.2
GDP at Factor Costs (current prices)	Rupees (Rs) billion	17618	19030	20910	22495	25239
Per capita GDP/PPP	Dollar ($)	2580	2730	2840		
Gross Domestic Savings	% of GDP	24.2	23.7	23.5	24.2	
Total Food grain Production	million tons	209.8	196.8	212	174.2	212.1
Index of Industrial Production	% change	6.6	5.1	2.6	5.8	7
CPI-General (IW)	% change	3.4	3.8	4.3	4	3.9
Total Exports	$ million	36760	44147	43976	52856	63623
Total Imports	$ million	49799	50056	51588	61572	77237
Foreign Direct Investment	$ million	2167	4029	6131	4660	4675
Foreign Exchange Reserves	$ million	35058	39554	51049	71890	107448
Rupee Exchange Rate	Rupee/dollar	43.28	45.61	47.53	48.27	45.83

(Source: Center for Monitoring Indian Economy, www.cmie.com)

Energy consumption in India, during this period of lethargic economic growth up to early 1990s, was nevertheless high due to its large and rapidly growing population. Much of the energy need, especially in rural India was met from 'non-commercial' sources such as burning fuel-wood and animal and other waste. India's energy matrix has since undergone significant changes along with the economic dynamism of the country, which leads to the issue of **energy security**, a concern engulfing all major producers and consumers of energy.

At the outset, we have tried to map India's emerging energy scenario, both current and for the near future, so to understand why India needs a multi-faceted and integrated energy policy *[Annex I]*.

Coal, Oil, and Gas Deficit

It is clear from the Table II that of the three main carbon-based sources of energy supply in India, coal will remain as the most abundantly available locally and therefore the source on which India will rely the most in the immediate future. India will become more dependent on natural gas supplies from outside its borders than oil, but there is a safety valve in the fact that with some technical adjustments, gas can be replaced by oil and coal in its major use in the production of power, fertilizers and other major industrial products. Moreover, since the gas supplier and buyer are inter-connected through mutual large scale investments on infrastructure, such as LNG conversion plants and gas pipelines for transportation, it is in the seller's interest to keep the supply of gas to the buyer on a steady path without disruption and market imbalances as faced by buyers in the short term and spot market purchases of oil. Thus almost all gas purchase agreements tend to be of long-term duration to protect both the sellers' and the buyers' interests.

Table II
Demand and Indigenous Supply Projections

	2006-07			**2010-11**			**2025-26**		
	D*	S**	Def %+	D	S	Def %	D	S	Def %
Coal (Mt)	461	405	*12.1*	*n.a.*	*n.a.*	*n.a.*	669	450	*32.7*
Oil (Mt)	134.5	34	*74.7*	190	*n.a.*	*n.a.*	257	80	*68.9*
Natural Gas (mmcmd)	166	64	*61.5*	216	78	*64*	322	84	*73.9*

* Demand **Supply +Deficit (%)
(Source: Report of the Group on India Hydrocarbon Vision – 2025, Government of India, pub 20 February, 2000)

As the population of automobiles and road vehicles jump—200 million cars in India by 2030 according to a TERI study (1), the country's dependency on foreign oil will hover somewhere between the current 65 percent and a worst case scenario of 90 percent, depending on new discoveries and on potential replacement by other fuels that can propel automobiles efficiently and at an affordable cost and conservation. The lower deficit rate indicated in the table is based on the optimistic scenario of potential oil field discoveries.

Part of the deficit in oil and gas is to be met from anticipated increase indigenous output arising out of better utilization of existing fields, especially Bombay High and new finds. With access to better technology, India hopes to maximize recovery from currently producing fields and future discoveries through technology support, improved reservoir engineering and production practices and energy recovery ratios (ERR). India hopes to develop low cost production systems for marginal fields and take up development of all discovered fields.

Under India's New Exploration Licensing Policy (NELP), four rounds of open bidding for 90 blocks have been held since 1997 and a fifth round is to be completed this year. Though major international oil companies have not actively participated in the past open bids, 17 new recent oil and gas discoveries (Rajasthan, Gulf of Cambay, Krishna-Godavari basin, shallow Mahanadi-NEC offshore) by private and joint venture companies, as also improved terms, will hopefully attract more interest in the 20 blocks on offer in the fifth round. Private and joint venture investments stands today at $3.22 billion, since the opening up of the oil and gas exploration, and their contribution to India's oil and gas production is 17 percent and growing. (2) Much of India's oil and gas potential reserves are believed to exist beneath the "Deccan Traps", thick rock structures in central India, which have not be explored so far due to lack of appropriate technology. Now that such technology has become available, it is hoped that India's oil and gas finds will go up substantially. If not, the country may face 85 percent or more oil and gas dependency on foreign sources by 2025.
Indigenous supply increases for oil can also to a small extent be increased if India is able to harness technologies for commercial production of oil from coal, through coal to liquid (CTL) technology first used commercially in Germany in the 1930s and later in South

Africa. According to sources, China is already producing 10 million tons from one US-designed plant located in its coal rich area in the northwest and a couple of more plants are in the planning stage. India has also opened up demarcated areas for exploration and exploitation of Coal bed Methane (CBM) by private and joint venture companies. A National Gas Hydrate Program (gas production from hydrates found offshore) hopes to tap into this exploitable energy source in the near future which, according to some energy experts has good potential.

India's Current Energy Strategy

India has identified the main issues concerning energy and how those impact on the security of the country. In 1997, the Indian Parliamentary Committee on Energy pointed out that the "The major issues in the energy sector are the absence of an integrated long-term policy; inefficiencies in energy supply and utilization; an unsustainable energy mix; acute scarcity of developmental capital; a lack of rational energy pricing; insufficient environment conditions…" Though there is no single official document which spells out India's energy policy, government became somewhat active in 1999 on this and related issues, and the India Hydrocarbon Vision-2025 report was presented by a special group, consisting of government and non-government experts in February 2000. While this document examines in detail and makes specific recommendations on issues related to oil and gas demand and supplies in India up to the period 2025, it does not go into much detail about the other sources of energy in India - coal, hydropower, nuclear power and renewable sources. It is also silent on other important issues related to energy security, such as energy mix, energy conservation, environmental pollution, technological innovation, security of supply lines and the entire question of regional and global cooperation and dialogue, all which are critically interdependent. While we will examine all the listed issues, this paper will look at the regional geo-strategic dimension in greater detail.

Elements of India's energy strategy as gleaned from various official sources may be summed up as:

- re-structuring and consolidation of state owned oil and natural gas companies into large and powerful entities to participate in an internationally competitive environment
- further opening up of the petroleum industry, both upstream and downstream to more private competition
- creation of greater capacity and flexibility in Indian refining capacity
- diversification of imported supply sources, including accessing overseas upstream opportunities and equity participation in oil and natural gas assets worldwide
- oil and gas price rationalization; dismantling of the Approved Price Mechanism (APM)
- reform of the power sector thorough unbundling of generation,, transmission and distribution functions; more private sector participation, including foreign participation of Independent Power Producers (IPP)

- rationalization of price of power, coal, natural gas, naphtha, liquefied natural gas (LNG) and fuel oils through duty and tax cuts to bring them in accordance with World Trade Organization (WTO) commitments
- reform of the coal sector through private participation in captive mines and deregulation of distribution and pricing
- change in the energy mix, with increasingly greater use of natural gas for power generation and fertilizer and other industrial processes
- further emphasis on nuclear power generation, with six new reactors under construction
- fiscal and policy incentives for adopting non-conventional and renewable technologies – wind, solar, biogas

Reform in the power and coal sector has been primarily consumer driven, resulting from public dissatisfaction with the state of affairs in these sectors. In the oil and gas sector, the changes have been driven mainly by India's vulnerability to the international situation, including price and supply disruptions. In short, India's unpublished energy security policy has essentially concentrated on oil and gas security, the underlying theme and direction of which is available in the report of the Group on India Hydrocarbon Vision – 2025. Sudha Mahalingam, writing in the Hindu newspaper on energy security says, "The country still does not have a national energy policy but for some time now, it has been pursuing a series of measures that should reduce vulnerability." (3) At the inauguration of Petrotech-2005 in New Delhi on 16 January 2005, Prime Minister Manmohan Singh pointed out that China was ahead of India in planning for energy security. (4)

Even in the limited domain of oil and gas security, the question of foreign oil and gas supplies, including acquisition of assets abroad has received far more public attention than all the others factors combined. Issues relating to exploration and production of oil and gas from domestic onshore and offshore shelves; increasing the efficiency and productivity of currently producing oil and gas fields; pricing; role of government owned oil and gas majors and private and foreign capital and technology; conservation of oil and gas usage and demand restraint; reduction of environmental degradation arising out of oil and gas usage are all factors that contribute equally significantly to the country's energy security scenario. The Ministry of Petroleum and Natural Gas is very much alive to these issues but public education and perception is woefully inadequate. Only the rise of oil prices at the pump and OVL's (ONGC Videsh Ltd - India's state owned E&P company which acts as the nodal point for foreign upstream projects) forays into the far corners of the earth for oil and gas assets make for headline news. For the rest, most people treat them as "official matters" with little or no connection to their lives. Such a state of affairs must change.

Treating "Energy" as a Holistic and Grassroots Issue

The price paid or not paid by a farmer in rural India for every unit of power consumed is as important for India's energy situation as the establishment of strategic petroleum reserves (SPR). Energy security must take into account not just oil and gas demand and

supplies, but also demand and supply of electricity, including supply of power from thermal (coal, lignite, naphtha and gas) plants, hydro, nuclear, wind and bio-waste sources. Energy conservation and control of environmental pollution arising out of energy usage, which have a major impact on a country's economic and social development, are unfortunately relegated to seminars and departmental annual reports, with little or no understanding or enthusiasm among the masses. People have to be mobilized on a wider scale to impact on India's energy usage and consequent vulnerability. At Petrotech – 2005, Prime Minister Singh remarked, "I am told that with better energy conservation and more efficient use, we could save up to 10 million tons of oil per year, which is significant." (5) Though the remarks were made at an event concerning technology in the hydrocarbon sector, hopefully they will spark debate and action on energy conservation across the entire spectrum, which we shall discuss in detail later.

India has to consider a fundamental change in the fragmented manner in which energy is handled, starting at the government level. Some effort has been made in the past, with the establishment of separate committees on petroleum and natural gas, coal and lignite and power in India's Planning Commission. However, the Commission seems to lack the political clout necessary to espouse and implement a national energy vision and policy and more importantly to coordinate the activities of the various ministries and agencies responsible for implementation of such policy. Perhaps it is time to study how other major consuming countries, including the United States, deal with energy issues both at the policy and implementation levels. At the central/federal level, one could envisage the possibility of a super political entity, which oversees the functioning of the separate entities in the fields of petroleum and natural gas, power, coal and non-conventional/renewable energy sources. At the state level, there could be separate agencies/authorities which independently implement the aims and targets set by the central energy agency, which will have a handle on resources disbursements to the state levels agencies, for effective monitoring and course correction, if necessary. Though very ambitious and perhaps politically difficult, India has to make some hard choices now to obviate major difficulties later. Additionally, energy today has wide international implications especially for a major oil and gas importing country like India. There is a move towards creation of an overseas operations cell within India's Ministry of Petroleum and Natural Gas, staffed with officials from the Ministry of External Affairs (Foreign Ministry). If the Petroleum and Natural Gas Ministry is to become the focal point or nodal point of <u>all</u> energy issues in India then such a move makes sense. Otherwise, India should look at other options, such as the Energy Resources Division within the Japanese Ministry of Foreign Affairs, for dealing with all energy diplomacy related issues.

Correspondingly, "energy" has to be taken out of the ivory tower where it is now ensconced and popularized at the street level. People have to be encouraged and galvanized to participate in a national energy mission, including energy conservation and environmental protection. *The core of the national energy mission should be focused on reliable and affordable supply of electricity and fair pricing of gasoline, diesel, kerosene and cooking gas*. After all, if these basic goals are not met, then all talk of a national

energy policy and energy security will have little on no impact on the masses. When a person's basic energy needs are met, he will willingly participate in programs which may require giving up a part of his non essential consumption, which is likely to happen in any energy conservation and environmental preservation program.

Why should the Indian villager cut down trees or burn smoky coal in his kitchen if there is easy-to-use technology available for healthier combustion or affordable supply of alternative fuel for cooking? This may not be possible though piped cooking gas or LPG in steel containers as in Indian cities, but perhaps cleaner coal or methane gas from the community "gobar (cow dung)" gas plant. If, in the ultimate analysis, there is no alternative to burning fuel wood or coal, then he must be taught and helped to use such fuel more efficiently and in a way that minimizes damage to health. If the village is located some distance from the nearest electricity distribution grid, the community could be assisted to run its own electricity generating plant based on bagasse, or sugar cane or other plant and animal waste. Such gas and power plants for rural areas will have to be based on simplified technology, which can be maintained and run by the village community itself. The community in consultation with the local government can determine the per unit price to be paid by each consumer and can be made responsible for bill collections, the entire proceeds of which should go towards repair, maintenance and capital accumulation. Examples of such local responsibility exist in Bangladesh. Local governments can help the community find commercial sources for funding the construction of such projects and in rare cases where the community is too poor to pay the per unit cost of gas or power generated, subsidize the same for a limited time period and on the express underwriting by the community to conserve surrounding forest acreage and community policing of forest assets. A similar price arrangement could be worked out for villagers who get their power supply from the local electricity agency/authority. But on its part, the local distributor must ensure steady and uninterrupted supply of power. Such innovative price and supply mechanisms could be worked out for the urban poor also, who remain outside the purview of the urban cooking gas supply system and who burn coal for cooking fuel at great health risk to themselves and in some cases resort to outright electricity theft to fulfill their power needs. India's poor do not want to have to cut down trees for firewood, use coal inefficiently or to steal electricity for their light bulbs and fans, but they do need fuel for their kitchens and power for their homes efficiently and at an affordable price. This has to become the heart or the guiding philosophy of India's energy policy.

Once energy is viewed in this grassroots manner, realization dawns that the soul of India's energy policy lies as much in securing primary sources of energy as in harnessing technology, practicing energy conservation and making real effort at pollution control. Thus far, India's focus has been on the oil and gas, but coal, hydropower, nuclear and renewable sources have no lesser a role in providing the two basic needs of the vast majority of the Indian population – fuel for cooking and power to light up the home. Of course, oil is at the heart of India's transportation sector (except for the growing electrified railway system), and this sector is critically important for India's economic development, but before we start planning for the day when every second Indian will own a pair of motor driven wheels, let us first provide for his basic needs at home. Thus,

India's energy policy will have to find more space for coal, gas, hydro, nuclear and other renewables and new and evolving technologies, including simple ones that suit her villages.

Energy Security Policy as an Outcome of National Energy Policy

Once the guiding philosophy of India's energy policy is settled, other aspects, including an energy security policy will follow. Adoption of such a strategy does not necessarily mean downgrading the importance of or curtailing the steps already taken in the petroleum sector, such as New Exploration Licencing Policy (NELP), introduction of private and foreign capital in the upstream and downstream sectors, re-organization of the state-owned companies and investments in upstream projects overseas and acquisition of assets abroad. What it does entail is additional focus on gas, coal, hydro, nuclear and renewable sources. Gas is already on most radar screens, since it fortunately happens to be the subject matter of the same ministry as oil. But, coal which is India's principal carbon asset, has unfortunately been relegated to political inattention and wishy-washy reform attempts. The industry is beset with investment shortages, shoddy management and poor labor relations. Of course, the negative image that has got stuck on coal as a menacing and life-threatening source of combustion and pollution, allows it to slide into obscurity without a whimper. Most Indians too have this "dirty" image of coal, and believe that coal needs to be replaced by something cleaner like gas or electricity. This is true of urban households, which are converting to gas for cooking fuel, and this is a welcome trend.

Coal is the most important source of electricity generation and the foremost fuel in some major industries like steel and cement, and will remain so in the foreseeable future. However, the coal available locally is of low thermal efficiency and as per current combustion processes, contributes the most towards greenhouse gas emissions, particularly of carbon dioxide, and releases other pollutants into the atmosphere, which is a drag on the nation's health and development. India is following the worldwide trend of trying to replace coal, especially for industrial production processes with cleaner fuels, particularly natural gas. Looking at the situation from an energy supply security point of view, it is perhaps prudent to examine the possibility of using coal more efficiently and cleanly and in ways other than coal combustion, simply because it is the primary energy source available abundantly. Unless huge quantities of natural gas are found in commercially recoverable fields within the country or in neighboring countries, close to the principal consumption centers in India, the country will continue to be dependent on coal at least for the rest of this century as the primary source of energy. Other than some gas in Myanmar, which could flow into India in the near future, and uncertain volumes in Bangladesh, which it could decide to sell to India at some stage in the future, the nearest sources of large volumes of natural gas for India are Iran, Qatar, Turkmenistan and Indonesia. Political uncertainties of the Middle East and Central Asia aside, the cost-benefit factor of increasing dependence on foreign sources of natural gas needs to be looked at anew, especially since this is happening somewhat at the expense of coal which can been locally sourced. Since coal combustion in India suffers from low thermal efficiency, we need to find, with the help of overseas partners, better processes. Such

processes already exist, but tend to be ignored on the plea that they are very expensive. Combustion of gas too is of much lower thermal efficiency than that of the same volume of oil, but certainly higher than that of coal in its present form. Ironically, India spends billions of additional dollars to fund its growing appetite for oil and gas from abroad, even when the price of oil crosses $ 55 per barrel. If only a portion of these additional funds were spent in developing appropriate technologies for coal combustion, and other uses of coal, India could save many more billions in lower production costs with less damage to the environment.

Look Anew at Clean Coal and Other Technologies

There is no disputing the fact that coal combustion per capita is the highest contributor to particulate pollution and emission of greenhouse gases, though carbon dioxide emission from use of oil is of a higher proportion worldwide. 41.8 percent of CO_2 emission in 2002 was from oil as compared to 37.5 percent from coal, according to the International Energy Agency (IEA). It is also a fact that the pollution problem in coal combustion can be tackled and the levels of pollution reduced significantly by applying known and developing clean coal technologies (CCT) and zero emission technologies (ZET). The standard argument against this tactic is that these technologies as adopted by western European countries, Japan or even the lower threshold used in the US, are too expensive for a developing country like India. This is true, but it is also a fact, as a UNDP/World Bank ESMAP (Energy Sector Management Assistance Program) study in China has shown, that adopting lower thresholds of the CCT methods can reduce pollution in coal-fired power plants, other industrial uses and coal burnt in households significantly, with only a marginal increase in the per unit cost of electricity generated. (6)

According to the ESMAP study, in the power sector, as a result of policies and legislation adopted in China since 1997, particulate emission by power plants is expected to decline due to utilization of higher quality coal, retirement of small inefficient power plants and utilization of higher efficiency ESP (Program Electrostatic Precipitators) power plants. It was found that in Henan Province of China use of the above methods to reduce particulate emission results in the average cost of electricity increase from 0.262 Yuan/kWh to 0.264 Yuan/kWh, which is less than one percent. Similarly, for sulphur dioxide (SO_2) control, by a combination of simplified and wet FGD (Flue Gas Desulphurisation), the average cost of electricity will increase by about 10 percent from 0.262 Yuan/kWh to 0.289 Yuan/kWh. For oxides of nitrogen (NOx) control, by utilization of low NOx burners in new power plants, combustion/tuning optimization and low NOx burners in existing plants, the cost of electricity increases only marginally from 0.262 Yuan/kWh to 0.265 Yuan/kWh. Advanced technologies such as IGCC (Integrated Gasification Combined Cycle) and PFBC (Pressurized Fluidized Bed Combustion) which have a much higher cost but are also more effective in the removal of particulates, SO_2, NOx and CO_2 can be adapted when costs are reduced substantially. According to sources, if the plant and equipment for these advanced processes are manufactured on a mass scale in a lower-cost manufacturing center, total costs could become affordable to developing countries like India and China to adopt.

Power plants are the biggest users of coal and thereby the largest contributors to the environmental pollution, but they are not the only ones. Pollution is also caused by combustion of coal in industries for their production process and by households, mainly in smaller cities and villages, which burn coal for cooking and heating homes. According to the ESMAP study, just in Henan Province alone, switching from raw coal to briquettes in households has the potential to reduce particulates by a total of 6 million tons at a cost of only $100 per ton. Switching industrial facilities from raw coal to briquettes or washed coal (10-15 percent ash instead of the commonly used coal of 30-35 percent ash) has a cost of approximately $ 600 per ton. Use of briquettes and washed coal also reduces significantly SO_2 emission. The study suggested a graduated replacement of raw coal with briquettes for all combustion uses.

The reason we have referred to the ESMAP study in China in some detail is because there are many similarities with the situation in India and we could examine the possibility of adopting some of these suggested measures. UNDP and the World Bank have not done such a study for India, and as far as we are aware, nor has any other agency, Indian or foreign. Perhaps, it is time to examine this issue in a structured and scientific manner. This proposal for review of coal usage in the country emanates from the reality that coal will be the principal source of energy in India for a long time to come and so India needs to learn how to use it better, minimizing health damage to its people and to the environment. As and when a real alternative emerges, whether it is hydrogen or some other element, India's energy policy can take in to account such a scenario and make adjustments accordingly.

The ESMAP study deliberately does not focus on significant reductions in carbon dioxide emissions for which more advances in "carbon sequestration" or other technologies are necessary for an effective solution. Carbon dioxide emission is a major problem not just for coal but also from burning of petroleum products and natural gas. According to the Energy Information Administration (EIA) of the US Department of Energy (DOE), "Energy related carbon dioxide emissions, resulting from petroleum and natural gas, represent 82 percent of total US human-made greenhouse gas emissions." (7) So, while India and China and other major coal consuming nations can adopt appropriate technology to reduce particulate, SO_2 and NOx emissions, the global community will have to make greater advances in finding solutions to the menacing CO_2 emissions.

Gasification of coal at the mine head has been another area that the Indian coal sector has looked at in some detail with assistance from the DOE. India seems not to have pursued initial leads towards application, possibly because of the risks involved in trying to develop technology to suit India's high ash content coal. All the commercial coal gasification plants in operation in the world today in the US, Europe, Japan use higher-grade coal. There have been technological advances made since India last took a look at this issue. The fact that creating and testing a costly prototype plant can be skipped by using Indian coal in an on-going operation (plant) in the US and then re-engineering to suit Indian coal, a suggestion made in the past by DOE, it is now possible to achieve commercial production of gas from coal in the shortest possible time. Since this gas can be used both by power plants and industrial units, mainly the chemical industry, such a

strategy will have to run concurrent to the establishment of a gas pipeline infrastructure in the country. Most of the coal mines are located in the eastern part of India, while the major portion of the chemical industry is in the west and so pipeline linkages must be available to transmit the gas produced at the mine head to the consumer located at some distance. Since it is essential to find more efficient and cleaner uses for India's abundant coal deposits, such ideas need to be followed up as an essential component of India's energy security policy. As discussed earlier, China's success with coal liquefaction at affordable cost should be examined to see whether there are similar opportunities for India.

Security of Energy Supplies and Acquisition of Assets Abroad

Currently, energy from non-commercial biomass (fuel-wood, plant and animal waste) is the dominant source of primary energy in rural areas, where commercial supplies have not reached or is unaffordable to a section of the urban population. However, this form of energy use, especially as cooking fuel, is inefficient and poses a serious health hazard to those exposed to the smoke and fumes from the burning of fuels such as cow dung cakes and is depleting India's forest resources. On the other hand, the use of commercial energy per capita is a very low 300 kilograms of oil equivalent (kgoe) in 2001 as compared to 886.5 kgoe for China and 7920.9 kgoe for the US. Therefore, India's commercial energy demand is expected to increase by at least two and a half times from today's level. (8)

Of the commercial sources of energy supply in India, 70 percent is met from hydrocarbons. According to the Secretary, Indian Department of Science and Technology this level is not sustainable. (9) Optimistic estimates indicate that the world's proven oil reserves will last around 40 years, natural gas for 61 years and coal for 227 years at the current rate of increase of production. When calculated on reserves to consumption ratio, the outlook is even bleaker. Given this supply scenario, it is no wonder that large and growing consumers of energy, mainly the USA, Western European countries, Japan, China, and India are scrambling to secure their supplies of energy, whether from domestic or foreign sources. Currently, India's oil imports are sourced primarily from the West Asia/ Middle East region – Saudi Arabia, Iran, UAE, Kuwait, and Qatar, with Saudi Arabia, the topmost source, supplying about a quarter of India's oil imports of 1.4 million bbl/d (barrels per day). Crude oil is purchased through three types of contracts, namely long term inter-governmental contracts of one-year duration, three month supply contracts and spot purchases. Like other major importers in this region, the Indian economy has been subjected to severe jolts resulting from oil price shocks and supply disruptions. It is obvious that India has to diversify its sources, especially of crude oil and gas especially from closer home in South Asia, and other nearer Asian sources – Myanmar, Malaysia, Indonesia, Brunei, Vietnam and the Central Asian countries.

Acquisition of oil and gas assets and participation in E&P activities abroad should be considered on the basis of both commercial and security considerations. OVL has joined partnerships in oil and gas exploration and production (E&P) projects in Vietnam, Myanmar, Russia, Libya, Ivory Coast, Sudan, Iran and Australia, of which the only producing fields are offshore gas in Vietnam and offshore oil in Australia. All these

projects other than the one in Vietnam have been finalized in the last four years. OVL has also reportedly bid for or is in negotiations for projects in Russia, Syria, Iraq, Angola, Venezuela and Ecuador. The private sector Reliance Industries has reportedly a stake in oil exploration projects in Yemen and Oman. Such assets in the immediate neighborhood make sense both in terms of transportation costs and security of supply. However, before plunging in to competition with Japan, South Korea, China and other buyers of distant oil and gas interests, India should make a proper assessment of the usefulness of such investments and whether it provides the country with any leverage which can be used to enhance its energy security. The Korean National Oil Corporation has eighteen E&P projects in 12 countries overseas, and 4 producing fields. *The net contribution from all these investments to South Korea's oil imports is only 50,000 bbl/d*. (10) Similarly it has been estimated that Japan's $41 billion investments in the oil sector overseas contributes only 13 percent of its total imports. Perhaps that is why the Japan National Oil Corporation is being dismantled. Such a discouraging scenario in India's neighborhood calls for proper assessment, and even dialogue with Japan and South Korea. Otherwise, there is a danger that the country's huge investments overseas could become white elephants, with the country neither being able to use their output due to transportation and or technical problems, nor being provided the cushion needs during periods of oil and gas supply disruptions and/or volatile price fluctuations. If, on the other hand, an investment is made in an overseas asset purely on commercial grounds, i.e., to achieve a fair rate of return on capital invested, then there might be a case for such investments. Thus, overseas investments made by state owned companies should be subjected to parliamentary oversight and those unlikely to be profitable should be offloaded.

The country also has to actively alter its mix of energy consumption, so that its vulnerability to foreign sources of supply and types of energy it consumes are also diversified. As pointed out earlier, *coal* is the source of energy that is available in abundance locally. Unfortunately, coal combustion in India faces the twin problems of low thermal efficiency and high pollution. India needs to take a closer to look at how it uses its abundant supply of coal more efficiently and cleanly. *Hydro* electricity potential of the country has not been tapped sufficiently due to the problems of large capital cost, inter-state water disputes and environmental and rehabilitation concerns. This is another area that needs rethinking. *Nuclear* power does not emit carbon dioxide and can be built close to populations they serve, without risk of interrupted supply of fuel. Nuclear power plants of today are designed to be inherently safe with infinitesimally small risk of meltdown and thanks to breeder technology they can produce their own fuel. However, nuclear power production is almost twice as expensive as fossil fuel energy [$1000 to 1200 capital cost per kilowatt for an advanced LWR plant, as compared to $600 per kilowatt for a gas-fired combined cycle plant with gas delivered at $4-5 per million BTU] (11), and poses certain security risks. Moreover, breeder reactors produce a lot of highly radioactive waste, chiefly plutonium for which safe storage for the tens of thousands of years required for it to become harmless is yet to be found. Despite these shortcomings, the country will have to enlarge the contribution of nuclear power to the national total, which is currently around 2.4% of power generated. *Solar* power is clean and harmless to generate, but it cannot be produced in huge volumes because of the large amounts of land and money required to do so. At present, solar power costs three to eight times more than

coal or gas power. However, optimists believe that prices of solar energy may become competitive with that of conventional energy within 10 to 20 years especially as nano-technology reduces land space requirements. The country's strategy to harness solar power for hot water and heat requirement of commercial buildings and housing complexes should be redoubled. *Hydrogen* is clean, but it is not a primary source of energy. It requires large quantities of electricity to make hydrogen from water, so unless we figure out a way to generate the power required at low cost and with zero emission, use of hydrogen for energy purposes is limited. In industrial applications, hydrogen is made by combining steam with natural gas and then changing the mixture to hydrogen, but the process emits carbon dioxide. India has been successful in producing power from *wind energy*, but its contribution to the country's total power generation is limited due to the power-density issue as in the case of solar power. *Geothermal, fusion* and *space based solar power* all face hurdles due to cost, deployment, supply or technology. Traditional biofuels like *biodiesel* and *ethanol* while neutral in terms of carbon dioxide emission, also face cost, land use and water requirement limitations.

With coal, oil and gas as the base of local energy supply, a vast and resourceful country like India has to harness other viable energy sources. A medium sized country like Spain is able to generate 5% of its power needs through wind energy, and Germany even more than that. It should not be all that difficult for India to find the resources and technology to boost its wind energy source to at least 5% in the shortest possible time. Similarly, despite the drawbacks noted for use of the sunlight, it should be possible to find greater use for solar energy than merely for water heating purposes.

India thus has to depend on its own sources of coal, oil and natural gas to meet the major share of its energy needs. The shortfall in oil and gas will continue to be filled from imports. The shortfall in coking coal and high quality steam coal, though not a very large percentage as compared to total coal consumption, will also be met through imports. There is considerable hydropower potential available, but in future, the country may have to be dependent somewhat on the spare hydropower production capacity of its neighbors, particularly Bhutan and Nepal. The country needs to set up more nuclear power plants, especially with technology to use the considerable deposits of thorium available locally. The country will have to make greater effort to increase the share of non-conventional sources and other renewable sources, like wind, solar, biomass, geothermal, etc, by linking up with partners worldwide to achieve breakthrough in technology and processes so that costs are reduced and such sources of energy become commercially viable. India must quickly plug on to new sources such as hydrogen as and when they are viable.

Strategic Petroleum Reserves

India's Cabinet decided on 7 January 2004 to establish strategic petroleum reserves (SPR) of 5 million tons of oil, equivalent to 15 days of the country's consumption. This would be in addition to the existing storage of crude oil and petroleum products available with oil companies. The initial plan suggests storage of crude oil in rock caverns (suitable salt caverns are not available in India) at two sites near Mangalore in Karnataka and one site near Vishakapatnam in Andhra Pradesh. The capital cost of the projects has been

estimated at Rupees (Rs.) 1650 crores ($ 370 million) for construction of the caverns and Rs. 5000 crores ($ 1.1 billion) towards inventory build up. It is not clear when work will actually start on these projects. It may be prudent to build up an SPR at the earliest, to provide a real cushion in case of a sudden disruption of supply. Perhaps at some point the SPR could also be looked on as a regional facility, since in the event of a major breakdown of oil supplies, as a security measure, India would need to help in replenishing oil stocks of her smaller neighbors in addition to keeping the country running. If so, India would need to look at a larger SPR within the country or in assisting the regional organization, SAARC to coordinate in the setting up of smaller SPRs in the region linked to India's set up. Such a system would require pipeline linkages, between the countries of the region.

Security of Supply Lines and Energy Installations and Disaster Combating Preparedness

Any energy security policy must also address the security of energy supply lines, including from outside the country, oilrigs and other installation, especially those offshore and security of pipelines.

P.K. Ghosh a research fellow at the Institute of Defence Studies and Analysis (IDSA), New Delhi, estimated that at the turn of the century, India required at least one Very Large Crude Carrier (VLCC) crude oil delivery each day of the year. By 2020 this will jump to three to four VLCCs per day. (12) The Indian shipping fleet is not capable of catering to demand of this magnitude, nor would it be an economic proposition for India to maintain such a large fleet. Indian oil companies will have to mainly depend on the world market for their shipping needs. However, port infrastructure is an area government and industry need to pay greater attention to otherwise this will become a major bottleneck. The average ship turn around period in 1999-00 was 4.7 days, which definitely has to be improved substantially. On the western seaboard, the Gulf of Kutch handles the bulk of India's oil imports from West Asia. According to Ghosh, by 2010 it is estimated that the Gulf of Kutch would be handling over 7000 ships of all types with about 15-20 VLCCs traversing between the Persian Gulf and the narrow deep-water channels of the Gulf at any given time. This requires state of the art vessel traffic management system.

The political uncertainty in West Asia, where the bulk of India's crude oil and petroleum imports originate and the fact that the sea lines of communication to western ports of India pass through a region in which India has had to deal with conflict situations in the past, gives rise to some concern about the security of its oil supplies. The Straits of Hormuz, through which India's imports from West Asia is one of the seven identified choke points for oil supplies. These considerations need to be dealt with perhaps in conjunction with regional and global partners, an issue we will deal with later in the paper. Offshore oil platforms and other installations like submarine pipelines connecting them to onshore systems, are vulnerable to collision, sabotage and attack and so necessary security arrangements should be made so that major disruptions do not affect oil supplies. Oil related disasters at sea not only affect the environment but also affect the

security of supply. Oil spill response centers, perhaps in coordination with the Indian Coast Guard could be formed to combat such occurrences. Onshore, oil companies in cooperation with local authorities will have to make arrangements for security of installations, including pipelines and for rapid response to pipeline breach and oil fires. The security and safety of thermal and nuclear power plants and of coal mining activity is no less important, given that in the past, major accidents have devastated human, animal and plant life have posed a serious bottleneck in the energy supply scenario of the affected country. As a major producer, importer and consumer of energy, India has to put in place sufficient resources to tackle such security issues.

Energy Conservation, Pollution Control, and Pricing

As discussed earlier, India's energy policy must comprehensively address the issues of energy conservation and pollution control, so as to avoid the pitfall of only looking at the supply side of security as the answer to all of the country's energy needs.

The Indian Prime Minister has commented that wider oil conservation practices will bring about savings of about 10 million tons per annum. Similarly, best practices in electricity usage will bring about huge changes, by switching to energy saving electrical equipment whether on the factory floor, inside office and commercial buildings and in homes. The Ministry of Power has set up a Bureau of Energy Efficiency (BEE), which is working on specifying electrical equipment and appliances for labeling, specifying energy consumption norms and standards, display of labels on specified appliances and enforcing minimum efficiency standards by prohibiting manufacture, sale and import of products not meeting the minimum standards. BEE is working with industry and other stakeholders in high power consuming industries like, textiles, cement, pulp and paper, fertilizers, chemicals and aluminium for sharing best practices, adoption of voluntary targets and benchmarking. Energy audit studies conducted in several office buildings, hotels and hospitals indicate energy saving potential of 20-30%. Government owned buildings by themselves, constitute a large target market. The central government is undertaking energy audit of some of its high profile buildings in Delhi, like Rashtrapati Bhawan, Parliament House, North Block and South Block and then implementing energy saving measures. While the central government is the guide and mentor, enforcement on the ground will depend to a great extent on the enthusiasm of the state and local governments, and other large consumers. India's fledgling consumer awareness movement and vibrant NGO movement could be mobilized to bring pressure on trade and industry to play by the rules. At a Washington, D.C., energy seminar on 18 January 2005 a panelist said that application of electrical appliances standards in the US has reduced electricity consumption by 2.5% since legislation was enacted. It is estimated that energy conservation measures will bring about savings of $1750 per household in the US by 2030. This gives rise to hope that a large consuming country like India too could save substantially by adopting and enforcing energy conservation measures. On the supply side some technical improvements to stem the huge transmission and distribution (T&D) losses in the system are being implemented, but real change in T&D losses will occur when the distribution companies, mainly the State Electricity Boards (SEBs), are able to stop the large scale pilferage and theft of power that takes place all over the country.

Montek Singh Ahluwalia, currently India's Deputy Chairman of the Planning Commission, remarked at an India Policy Council meeting at CSIS in November 2001, that the single most crippling influence on India's development policies are the SEBs. Rectifying the malaise affecting the SEBs would improve governance, reduce the budget deficit and improve energy efficiency.

In the transport sector, India started a program from January 2003 of blending 5 percent ethanol with motor gasoline supplied initially in nine states and four union territories. This will be gradually extended to most parts of the country. Production of ethanol using sugarcane as feedstock and its blending contributes to reduction in oil use. Research and development (R&D) work and application of direct injection engines for gasoline run cars, which save between 15-20 percent on fuel consumption, should be encouraged. Production and sale of hybrid gas-electric vehicles should be explored and perhaps encouraged through tax and other incentives, as in the US, Europe and Japan. Greater use of CNG (compressed natural gas) to run public service transport vehicles, initiated by Delhi, should be extended to all large cities and eventually to mid-sized cities The central government will have to nudge state and local governments to take action in the field at the earliest.

The BEE and the Ministry of Non-Conventional Energy Sources have some distance to cover in persuading state and local governments to adopt energy conservation building codes, which mandate energy saving methods in the construction of factories, offices, homes and townships, such as compulsory use of solar panels for water heating and street lighting. Energy audit for large industries and other consumers should be made mandatory. In planning urban expansion and new townships, Indian planners need to cater to the requirement of the bulk of the work force to live as close to their work place as possible in order to avoid long distances of travel. India should not encourage suburban living to the extent adopted in the United States, firstly because the country cannot afford to convert more agricultural land to homestead or other use, and secondly, putting so many millions of people on the road everyday commuting to and from work over long distances will only add to India's growing dependency for oil imports. Finally, India's growing consumer oriented society has to be educated and encouraged to form energy saving habits like turning off power points, light bulbs, fans and air conditioners when not in use. This campaign could start with suitable education at the school level just as environment is now part of every child's learning curve, and supplemented by non-governmental organizations (NGO) working among the populace at large to popularize such concepts.

The subject of environmental protection and pollution in the Indian context immediately conjures up images of burning coal and smoke-belching trucks. Prime Minister Manmohan Singh has pointed out that according to some studies, the cost of environmental damage in the country, when assessed in terms of potential GDP lost, comes to about 10 percent of GDP. (13) This alarming situation needs concerted effort to reverse the trend. As mentioned earlier, there are indications that the share of coal in total carbon dioxide emissions is declining while that of oil and gas is increasing, reflecting their increasing use as energy sources and some measure of emission control adopted in

this sector. As discussed in the section on clean coal technologies, coal combustion whether for power production, industrial processes or as cooking fuel has to be made more efficient and clean, using known processes and technologies and developing newer ones both indigenously and where necessary with the help of international partners.

Thanks to public awareness and judicial activism, India has adopted European emissions standards for its passenger cars, light commercial vehicles and heavy duty diesel trucks and bus manufactures (currently at Euro II level in eleven mega cities) and is phasing out older vehicles still on the road. These cities are expected to upgrade to Euro-III standards by April 2005 and to Euro-IV by April 2010. By 2006 Euro-II norms would have been adopted over the entire country for these categories of motorized vehicles. New two and three-wheeler vehicles manufactured after April 2005 are also required to meet Euro-II emissions standards. In 2002, New Delhi became the first city in the world to replace its entire diesel bus fleet with 10,200 vehicles that run on CNG, which is less expensive than diesel and emit fewer pollutants. Since the late 1990s the Indian capital has in addition converted 60,000 three-wheel motorized rickshaws, an inexpensive mass-transit option, as well as more than 5000 minibuses and 16,000 cars to CNG. Conversion efforts have allowed more than 250,000 gallons of diesel and gasoline to be replaced by natural gas each day. (14) New Delhi's lead in converting its public transport system on the roads to use CNG, is being emulated by other major metros in India. Plans are being drawn up for mixing up to 20 percent bio-diesel with petroleum diesel to reduce pollution. According to an Indian Planning Commission study, bio-diesel can be produced from 'jatropa' a plant bearing oilseed that can grow on arid and dry land, which also contributes nutrients to the soil, it is grown on. With the implementation of the Kyoto Protocol on 16 February 2005, it is hoped that many industries will take the advantage offered to non-Annexure-I countries, including India, and implement emission saving measures funded under the Clean Development Mechanism (CDM). Substitution of raw coal burning in households and small industries with gas, washed coal and briquettes needs to be pursued more vigorously.

Environmental damage, like energy conservation should lead us to formulate a strategy aimed at improving the efficiency of energy use and reducing the adverse environmental impact of excessive energy consumption. To do so requires demand projection model and a relevant energy pricing mechanism. As Prime Minister Singh explained, pricing is "…the critical factor that would help us not only in ascertaining the correct pattern of energy mix but also enable a better demand forecast for energy type. This would set the long-term investment decisions in each of these sectors. That's why I have repeatedly said that rational pricing of energy is a critical aspect of energy policy and a vital element of energy security for us." (15) According to an IEA study, estimated rate of subsidy as a percentage of reference price was 52.6 percent for kerosene, 42.3 percent for coking coal, 31.6 percent for LPG, 24.2 percent for electricity and 22.5 percent for natural gas. Gasoline and auto diesel (HSD) do not enjoy any subsidy. An effort was made in 2004 to reduce subsidies by 5 percent each year on LPG to eliminate it altogether within a specified time limit, but the announced exercise was abandoned in the face of political opposition. For the same reason, no government in power has been able to touch the subsidy on kerosene, which is used mainly for cooking fuel by the poor in India. The

subsidies on coking coal, steam coal and natural gas used mainly for industrial purposes should be done away at the earliest, while reducing in phases the subsidies on LPG and kerosene.

A bipartisan panel of energy experts in the US called the National Commission on Energy Policy has observed, "…future energy security will require billions of dollars in government investment in clean coal technology, a new generation of nuclear power plants and promotion of renewable energy and conservation." (16) The agenda suggested for the US sounds very much like one India would need to adopt for enhancing its energy security.

Other Factors in India's Energy Security

Like other major consumers, India has already taken a number of other steps, which will help, in its overall quest for fulfilling current and future energy needs without major imbalances in the country's quest for economic and social growth and development. Some of these measures as also others which India could take up in earnest, are discussed briefly below:

- Enhance local E&P work in the oil and gas sector, by opening up further to private and foreign capital and technology. This has been a continuous process since the first NELP in 1997, but is weighed down by non-participation of the larger international oil companies (IOC) who have the financial and technological capability to unravel the largely unexplored or poorly explored fields, including the "Deccan trap". Large US-lead IOCs have some doubts about the safety of and returns on their investments in India, particularly after the Dabhol fiasco and these constraints need to be addressed by the Indian government and industry. It would help if the Dabhol arbitration process were to conclude at an early date that is satisfactory to all parties involved.
- Open more channels to oil and gas imports and trading by private and foreign participation. Incentive to do so can come in the form of opening up of India's downstream sector to such participation also. Some steps have already been taken in this direction, but if the response is not enthusiastic then government needs to look into how barriers can be removed. With multiple players in the market, state-owned companies, private Indian companies and foreign companies, either as JVs or stand alone, India's oil and gas sector too will need an independent market regulator, like in the telecom and electricity fields. If and when an oil futures market develops in India, the proposed regulator will have an additional task on hand.
- Improving the public transport system and increased movement of passengers and goods by the railway system will lead to saving on transportation fuel, including gasoline and diesel. Promotion of information technology will help reduce the need to travel overall.

Asian Energy Outlook

India is a growing regional power with a large and fast growing economy, which impacts on and is impacted by the larger geographical area of Asia. Hence, as a major producer and consumer of energy in Asia, India will also have to look at the broader Asian scenario in order to enhance its own energy security. The total primary energy consumption (PEC) in Asia rose by over 550 percent in the period 1965-1997. The region's share of the world's PEC rose from barely 10 percent in 1965 to 15 percent in 1980 to 25 percent in 1997. Japan, China, South Korea and India account for about 86 percent of the region's energy consumption. (17)

The growth and development of Asian economies requires a stable supply of energy. Asia's rapid economic growth, massive urbanization, dramatic expansion of the transportation sector and quest for electrification programs will have a particularly strong effect on global consumption of oil and natural gas and the region's dependence on oil supplies from outside the region. Asia is home to only 4 percent of the world's known oil reserves, but generates 40% percent of total demand of about 84 million bbl/d. The region is almost entirely dependent on OPEC countries to meet the shortfall between demand and supply, with most imports, 12 million bbl/d in 2002, coming from Middle East, and only a small portion of one million bbl/d from Africa. Among the region's major consumers, currently Japan is dependent to the extent of 95 percent of its oil needs on imports, South Korea 99 percent, India 70 percent and China 30 percent. These dependencies will only rise in the near future, in the absence of major oil finds and tapering off of existing fields in these countries. Total Asian oil production is expected to rise only marginally from about 6.3 mm bbl/d in 1998 to about 7.1 mm bbl/d in 2010 (Figure 1) Indonesia and Malaysia, the two main oil exporting countries in the region are expected to become net oil importers in the near future. On the other hand, due to rapid economic growth and a growing population, the region's oil imports are expected to rise from about 10 mm bbl/d to 17 mm bbl/d during the same period. (Figure 2) Therefore, Asia's major oil importers will have to keep looking for larger imports from outside the region, which in the short term will be mainly from the Middle East and Gulf region as at present.

Figure 1

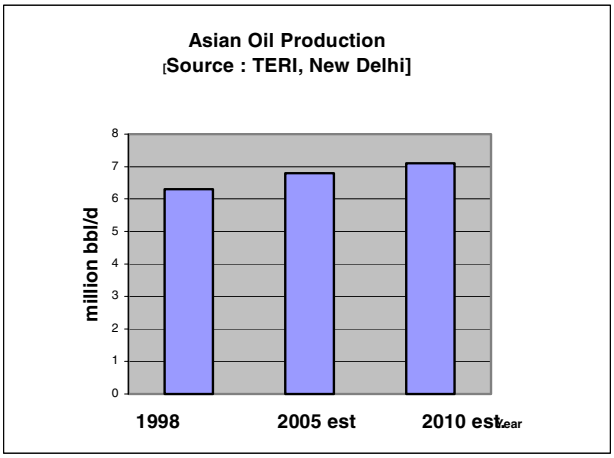
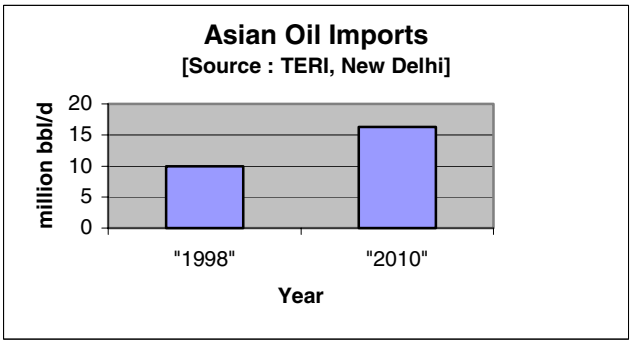


Figure 2



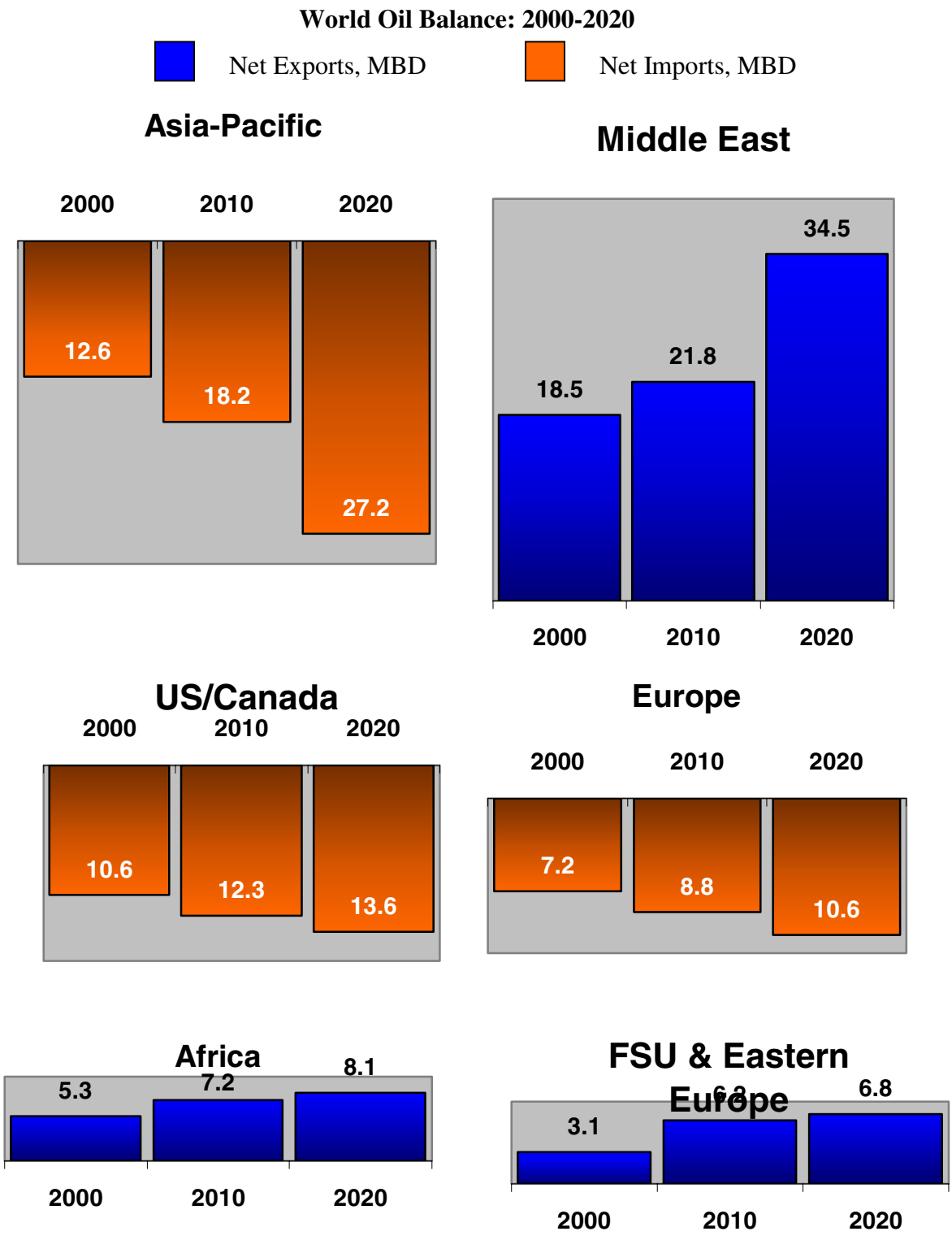
The natural gas scenario is more optimistic with Asia having 55 percent of the world's gas reserves, if one counts Central Asia and Russia's Far East as part of Asia. Indonesia and Malaysia, though running out of bountiful sources of oil, have plenty of gas to satisfy their own needs and also to meet a part of the rest of Asia's galloping demand. Unfortunately, the major gas consuming countries of Japan, China, South Korea and India do not have enough local production to meet their increasing demand. Therefore the challenge in Asia is to bring gas resources to the consuming centers either by pipeline or as LNG at an affordable cost and by a secure system – secure from both technical, and political mishaps. While the North East Asian countries have some access to natural gas supplies from Australia and Indonesia and may be able to tap into future supplies from the Russian Far East and Central Asia, India is almost entirely dependent on supplies from the Middle East and Iran, with some supplies expected to flow from neighboring Myanmar.

According Amb. William Ramsay, Deputy Executive Director of the International Energy Agency (IEA) who made a presentation at the first roundtable conference of Asian oil ministers held on 5-6 January 2005 in New Delhi, developing Asia (excluding Japan and South Korea) is projected to account for 42 percent of the increase in world primary demand between 2002 and 2030. Developing Asia's oil demand will exceed that of the United States and Canada combined and will account for 26 percent of the world's total. Oil production in China is expected to start declining very soon. Output elsewhere in the region, including Indonesia will be more or less flat over the projection period. The region will account for 21 percent of the world's incremental gas demand by 2030.

China and India are among the large energy consumers in Asia who depend on their considerable coal reserves for more than 50 percent of their total commercial energy needs. 80 percent of the growth in world coal demand over the period 2002 to 2030 will come from developing Asia, according to IEA. However, Asian coal consuming nations are increasingly faced with the twin problems of low thermal efficiency and high level of pollution resulting from coal combustion, and are under pressure to change their energy mix radically to support sustainable development. Asia's share of nuclear energy supply is skewed by Japan's and South Korea's high proportion, which may be difficult to hold on to due to local opposition arising out of safety concerns. China and India on the other hand are committed to increasing their respective share of nuclear power generation in the total electricity supply in these countries, and so Asia's share of nuclear power may actually rise slightly in the coming two decades. The share of hydropower is not expected to alter significantly in the near future. Japan has made significant advances in renewable energy use, but China and India are yet to commit themselves to a mandatory 10 percent or thereabouts for renewable energy as a source of power supplies. Indonesia and the Philippines get a substantial portion of their energy needs from geothermal sources. Like other regions around the globe, Asia will be mainly dependent on hydrocarbons for its principal energy needs for some time to come, but unlike some other regions, Asia cannot depend on its own future oil or gas finds to make up for part of the growing hydrocarbon deficit. Asia will have to depend on other net exporting regions, namely the Middle East, Central Asia and Russia, Africa and Latin America. It will be competing for these

resources with the two other net importing regions of Europe and North America. (Figure 3)

Figure 3



Improving energy efficiency is another area that binds several large Asian consumers. China's energy intensity (unit of energy expended to produce one dollar of GDP) is 0.09 compared to India's 0.11 and 0.12 for the rest of South Asia and the ASEAN countries. Pricing subsidies on energy products, including oil, has distorted the market in several Asian countries, providing further encouragement for wasteful consumption. An important security issue for Japan, South Korea, China and other importers east of the Malacca Straits, is the growing number of piracies in this narrow channel of water with shallow reefs and thousands of islands. The Malacca Straits could also become a major terrorist attack point of the shipping traffic, including of oil. Around 11 million bbl/d of oil flow through the Straits today and is expected to double to 22 million bbl/d in 2030.

Towards an Asian Energy Cooperation Agenda

The New Delhi roundtable conference in January 2005, which brought the oil/energy ministers of major oil consuming and producing nations of Asia together, is perhaps the first formal attempt at fostering a common platform in this region, on a vital component of the energy sector. The importance of this conference lies in the fact that not only were major Asian consuming countries represented at the highest levels, but the organizers also roped in major West Asia/ Middle East producers who supply most of the region's deficit. Saudi Arabia, Iran, Kuwait, UAE, Oman and Qatar were also present at the roundtable, as was IEA. The conference adopted certain goalposts such as, development of an Asian oil market and creation of an Asian marker or price signal mechanism. The Asian oil leaders agreed to a continuing agenda including regular meetings of its oil/energy ministers.

Unlike, the US and Europe, Asia does not have a developed oil and natural gas market and feels it is being shortchanged in the absence of one. Asian consuming countries want to "convert that underlying stability in production into stability in oil markets…" according to the Indian Minister for Petroleum and Natural Gas, who hosted the conference. (18) He said that stability in the Asian trade could be maintained when long-term contracts become longer, price discovery through the market is more transparent and spot purchases occupy a progressively larger share of market transactions. This view has some consonance with that of IEA, whose representative at the conference, said that arbitrage in spot and futures markets make premiums less likely. He was referring to what is known as the "Asian premium" a sore point with Asian importers, particularly Japan, South Korea and China, who generally have to shell out an additional $1 to $1.50 per barrel for Middle East oil as compared to buyers from other regions. Iran favors establishment of an Asian bank for energy development for financing energy projects in Asia and said that price of energy supplies from Asian producers to consumers in the region should be lower than that of others.

The conference called for inter-region cooperation for investment in exploration and strategic storage of hydrocarbons, yet another idea endorsed by IEA, which feels that "co-coordinated use of strategic oil stocks and close cooperation with key oil producers are the most effective means to mitigate an oil supply disruption…" (19) There was general agreement on regional cooperation to promote energy sustainability, stability and

security. Oil producing countries at the conference gave an assurance that supply would be maintained. Saudi Oil Minister Ali Al Naimi informed his Asian partners that Saudi Arabia is "dedicated to maintaining spare production capacity in the range 1.5-2 million barrels per day to meet additional demand should the need arise." (20) This was in response to importing countries demand for creation of storage capacities and an emergency mechanism to guard against disruption of supply.

The Indian Minister of Petroleum and Natural Gas once again took the lead at the inauguration of the "Third Asia Gas Buyers Summit" in New Delhi on 14 February 2005 where he proposed the formation of an Asian gas grid. Since Asia contains 55 percent of the world's known natural gas reserves and is also the destination for incremental consumption with natural gas consumption of China and India estimated to grow at 5 percent annually, the Indian Minister asked representatives of Asian countries to initiate a pan Asian dialogue for laying of a network of pipelines for accessing gas supplies from Iran in the west to Myanmar in the east.

Separately, there are other intra-regional efforts at cooperation, which can be tied to a broader pan-Asian platform. ASEAN has a program to establish an undefined energy grid. The Thai-Malaysian Joint Development Area in the Gulf of Thailand is an example of energy cooperation among former adversaries in disputed territorial waters. A similar effort has begun in the South China Seas with China, Vietnam and the Philippines taking the first steps towards joint exploration of another disputed territory. The Institute of Energy Economics, Japan is promoting a "Northeast Asia Petroleum Forum" in collaboration with the oil industries of Japan, South Korea and China. Despite strong adversarial rhetoric and public displays of annoyance, China has proposed to Japan joint exploration in the disputed East China Sea areas. There is a proposal to form a South Asia energy forum. These separate strands can be woven together in a greater Asian effort at cooperation instead of conflict as predicted by some analysts. The New Delhi oil ministers conference was also an attempt to bridge East, Southeast and South Asia with West Asia / Middle East, a region which also happens to be the major oil supplier to the other three parts of Asia.

Thus, we find that in two vital energy sectors, oil and gas, there is a conscious attempt to bring about an Asian cooperation platform. It is no surprise that India has taken a leading role in both these efforts, because it clearly sees its own energy security in terms of the collective security of the region, which is increasingly facing the volatility of the global energy systems and has thus far been only a spectator in the sidelines.

Elements of an Asian Energy Cooperation Platform

There are many elements and areas where cooperation between the countries of Asia is possible, which will lead to enhanced national security arising out of the collective energy security effort. Of course, Asia does not live in isolation nor does it operate in a vacuum and so its move toward a common energy platform will have to be done in coordination with the other regions and entities (OPEC, IEA) so that none feels threatened by such a movement. In the aftermath of the break up of the Soviet Union, the

countries of Eurasia (western and eastern Europe, the Balkans region, Caspian region and central Asian countries) came together under the umbrella of the Brussels-based Energy Charter Conference to promote multilateral cooperation on transit, trade, investments, environmental protection and energy efficiency. The Energy Charter Treaty and Protocol provides a legal framework whereby the members of the Conference subscribe to a common set of "rules of the game" for such cooperation. The proposed Asian energy cooperation platform will find some useful tips from the Energy Charter Conference. Japan, Mongolia and the central Asian countries are already members of the Conference while, China and the ASEAN Center for Energy have joined in recent years as observers. Thus, there is already expertise and links available in Asia to this grouping, which could provide some useful leads in intra-Asia energy cooperation as also in building bridges between Asia and other regions.

An Asian oil market, which has been endorsed at the New Delhi conference, will probably contain some of the following features:

- information on demand, supply and inventory positions among Asian consumers and producers, to be shared transparently
- an Asian benchmark crude price
- longer term price and volume agreements
- consumers making upstream investments in oil producing countries and suppliers making downstream investments in refining and gas grids
- joint research on energy technologies relevant to Asia
- jointly addressing environmental priorities like standardizing specifications for gasoline and diesel across Asia
- coordination of national strategic oil reserves
- promoting energy efficiency programs
- broader sharing of mutual capabilities including human resources
- expertise on inter-governmental agreements for transnational pipelines
- sponsorship of studies and projects of relevance to Asia, such as supply diversity, energy development financing, security of transportation, etc.

Such an agenda would require the establishment of a secretariat. IEA could serve as a model and a cooperative partner. The role of current IEA members, Japan and South Korea, who would form part of an Asian forum, will have to be worked out in consultation with IEA so that there is no conflict or duplication. India has shown interest in working with international energy groups. It holds membership in the London-based International Energy Council and has applied for a status in the Brussels-based Energy Charter Conference. If IEA decides to admit new members, India could take up membership as well.

Strategies available to major Asian oil importers are maintenance of strategic reserves, diversification of energy supply, increased capacity for fuel switching, demand restraint and development of renewable energy sources. Japan and South Korea, which are in the IEA, already have built up SPRs, with Japan's stock reportedly exceeding the IEA mandated minimum of 120 days. It is estimated that an SPR of 120 days inventory will

cost the non-IEA nations in Asia, cumulatively about $ 30 billion for import level projected for 2010, including cost of storage and other facilities. This is perhaps too high a cost for developing Asia to afford at this stage. A lower level of stock combined with demand restriction would probably be more pragmatic. China has reportedly started construction of the first of its four oil tank farms to store the SPR, while India has only a decision in principle. Coordination of the use of SPRs could be undertaken by the Asian oil forum. According to IEA arrangements, in the event of a crisis, the US is required to share all its oil imports with OECD countries. Perhaps a similar sharing arrangement could be worked out among Asian countries. Energy efficiency, such as fuel efficiency of automobiles has to be achieved by technological intervention with international cooperation. Development of alternative sources can be encouraged by a combination of tax incentives and preferential pricing. Here again, the proposed Asian oil forum could act as the coordinator between the different countries.

Diversification of oil supplies requires refinery configuration adjustments. Asia has been traditionally a high middle distillate and fuel oil consumer, which accounts for the relatively high proportion of hydroskimming refineries. The bulk of the increased demand from Asia will come from the transportation industry. However, incremental supplies from the Middle East are expected to get heavier and sourer. Fortunately, Asian refining capacity is moving towards a European model with a higher proportion of cracking activity. However, the move toward more rigorous emission standards will ultimately force a shift towards a US-style refinery composition, which is a mix of cracking and coking activity. (21) All of this require substantial investment, a considerable proportion of which has to be tapped from outside sources – cash-rich producer-suppliers, IOCs and multilateral lending agencies. Asian countries will have to improve their investment climates, liberalize markets and rationalize pricing in order to attract the level of foreign investment needed to fulfill such a strategy. For Asian countries, most of the diversified sources will be in Central Asia and Russia. Oil from far off destinations like West Africa and South America can only be useful to a limited extent, most likely for swap trade. Creation of pipelines for flow of oil and gas from Central Asia and Siberia to different destinations in Asia, or on the west-east axis from Iran to Myanmar, requires regional cooperation rather than competition. Cross-border pipeline agreements will have to be studied carefully and suitably amended to fit the Asian situation. Fortunately, much work in this field has already been done by the Energy Charter Conference, and so Asia could tap into such available expertise. Similarly, Asian countries may like to reflect on whether or not the competition, sometimes in a rather unhealthy mercantilist manner, to acquire oil and gas assets abroad is in fact a zero sum game. Here too cooperation, which will require a great deal of transparency, would perhaps lead to a win-win situation. Japan and South Korea, can play lead roles in this area, since they have considerable experience in overseas assets acquisition and could guide others in this area. Their experiences, positive and negative, would provide an invaluable beacon to the others.

Cooperation on combined oil purchases and fleet operations, especially by the sub-regional countries such as in South Asia, ASEAN and North East Asia may also lead to greater bargaining power and flexibility. Security of sea lines of communications,

including choke points, will become a vital part of any Asian cooperative effort. India has already joined with some countries in South East Asia and other countries with influence in the region, such as Australia and the US to tackle piracy and terrorism on the high seas. Indonesia, Malaysia and Singapore are cooperating in the Malacca Straits. These activities need to be coordinated for greater effect.

Cooperation on the technological front among countries in Asia is another area of promise in an Asian energy platform. Japan could take the lead in sharing with the rest of Asia its experience and technologies for clean coal power plants, coal gasification and gas to liquids processes, as also automobile and other energy conservation measures. Referring to the hydrocarbon sector, Indian Prime Minister Manmohan Singh said that technology today is "driving business in the hydrocarbon sector and has transformed the oil industry from a commodity business that it once was to a high-tech industry." (22) The same logic applies to the broad spectrum of the entire energy industry and this provides an opportunity for Asia to take a more prominent position than it has done so until now in developing and adapting technology to suit its needs. Qatar has sourced foreign technology to convert part of its huge gas reserves to liquid (GTL) as an alternative to petroleum oil. Now that global oil prices are likely to remain at $40 and above (23), GTL, coal liquefaction, and extraction of energy from renewable sources, seem more feasible.

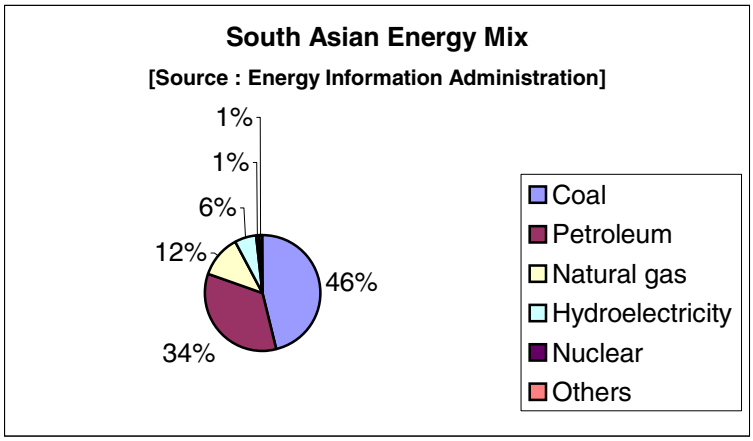
Energy Cooperation in South Asia

South Asia (Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and Sri Lanka) is today home to over 1.4 billion of the global population of over 6 billion. Despite rapid growth in the 1990s, the nations in the region have among the lowest per capita incomes in the world. As a result, over one-fifth of the global population residing in this region has a share of only two percent of the global output, leaving vast swathes in poverty and under development. To add to its woes, political and geographical divisions, some superimposed during the withdrawal of British rule, left the nations of the region on a tangential and often confrontational path, making regional cooperation and mutually beneficial growth a difficult uphill task.

India, as the largest country with the biggest economy in the region is the driving force behind the region's economic and social development. India's GDP increased by 8.2 percent in 2003-04 and is expected to grow around 6.9 percent in 2004-05. Pakistan and Bangladesh, the other two countries with large populations and land area, experienced 5.5 percent and 5.2 percent growth respectively in 2003.

Though South Asia is rich in fossil and renewable energy sources, the individual nations of the region have low per capita availability of energy. On the other hand, energy consumption from commercial sources has increased nearly 50 percent between 1990 and 1997, mainly due to increased economic growth and concurrent high population growth. Bridging the growing gap between consumption and availability is the challenge facing this region.

Figure 4



The South Asian region holds nearly 23 percent of the world's population consumed 4.1 percent of the worlds energy, up from 2.8 percent in 1991. South Asia also accounts for 4.8 percent of the global carbon emissions. Due to the huge population of the region, *per capita energy consumption* is low, though level of energy consumption per unit of GDP or *energy intensity* is among the highest levels. (24) Discounting non-commercial sources of energy, the energy mix of the region in 2002 was 46 percent coal, 34 percent petroleum, 12 percent natural gas, 6 percent hydro electricity, 1 percent nuclear and 0.3 percent others (Figure 4). Bangladesh's energy mix is dominated by natural gas; India is heavily dependent on coal, Sri Lanka and the Maldives on petroleum, Nepal and Bhutan on hydropower and Pakistan equally dependent on petroleum and natural gas. The region's rapidly rising energy demand is coupled with increasingly inefficient energy supplies, mostly manifested in recurring and lengthy electricity outages. Therefore, improving the supply of energy, particularly electricity is the number one priority in all the countries of South Asia. The countries are looking to diversify their traditional energy supplies, promote additional foreign investment for energy infrastructure development, improve energy efficiency and lower pollution levels, reform and privatize the energy sectors and promote and expand regional energy trade and investment.

Exchanges in the energy field are already taking place. India supplies coal to Nepal and Bangladesh and petroleum products to Nepal, Bhutan and Sri Lanka. India is getting electricity supply from Bhutan from the latter's hydro projects at Chuka, Kurichhu and Tala built with Indian assistance. India has made huge investments in the petroleum sector in Sri Lanka, through Oil Lanka, a subsidiary of the Indian Oil Corporation (IOC), the largest Indian state-owned oil company. India is in talks with Nepal for buying electricity generated from potential hydropower plants in Nepal. Bangladesh has expressed a desire to tap into electricity supplies from Nepal and Bhutan and according to a recent Bangladesh newspaper report, India has agreed to transmission access for the same through India. (25) In January 2005, the oil ministers of Bangladesh, India and Myanmar met in Yangon and jointly agreed on a long standing Myanmar proposal for supply of natural gas from southern Myanmar to India by a pipeline that will run through Bangladesh before entering eastern India. According to the joint press statement issued after the meeting, Bangladesh and India would have the right to "access the pipeline as

and when required, including injecting and siphoning off their own natural gas…" (26) A scheduled follow-up meeting of this tri-nation pipeline project concluded in Yangon in February. This gives rise to hope that not only will natural gas from Myanmar flow into India in the near future, but the proposed pipeline also provides an opportunity for Bangladesh to sell its excess gas production to India. During the November 2004 visit of the Sri Lankan President to India, the two countries agreed to explore the possibilities of cooperation in the power sector. This may be encouraging for the proposal made by Nextant Inc at a seminar in Washington DC, of setting up a power plant in Sri Lanka, for export of its entire or partial output to India. Of course, before such power exchanges can take place, the grid systems of the countries involved will have to synchronized.

There are a number of other proposals on the table such as sale of Indian diesel to Pakistan and transmission of Iranian natural gas by pipeline to Pakistan and India, which will require greater political will and perhaps a cost-benefit analysis before they can crystallize. On the Iran pipeline issue, lately India and Pakistan seem to be displaying the political will needed to begin talks on the issue, but growing US opposition to dealings with Iran, discussed in detail later, could derail the process.

According to the South Asia Association for Regional Cooperation (SAARC) website, (27) the regional organization at its summit meeting in Islamabad in January 2004 mandated modalities for creation of a South Asia energy cooperation program. The first working group on energy recommended the following plan of action, which was subsequently endorsed by the SAARC Council of Ministers:

- formation of a South Asia Energy Forum at the *ministerial level*
- exploring the possibility of a SAARC Energy Center
- studying the options, benefits and constraints of energy trade in the region
- exchange of information and technical discussions
- evolution of joint strategies at global energy forums
- exchange of each other's experiences in institutional and pricing reform in the energy sector
- transnational energy lines (electricity, gas and oil) in the long term
- special focus on energy availability, both conventional and non-conventional, in rural areas
- sharing of manpower, expertise, know-how and training programs regarding non-conventional and renewable energy sources
- possible establishment of a regional fund for promoting non-conventional energy use
- promotion of least cost energy efficiency and conservation programs
- cooperation on CNG use in transport
- lessons learned from innovative projects such as Nepal electric rickshaw, Bangladesh rural electrification cooperative societies, etc.
- quarterly internet-based SAARC energy newsletter

However, it is not clear to what extent, if any, these proposals have moved forward on the ground. The most important proposal is creation of an SPR, involving all the contiguous

countries in the region perhaps as a SAARC project, with India providing the lead. Moreover, since this region is now negotiating the construction of cross border pipelines for gas, it may be prudent to look at model intergovernmental and host government agreements concerning cross-border pipelines, developed by the Energy Charter Conference. This would not only save valuable time in developing language for such agreements, but may also be more politically acceptable to the fructuous neighbors of the region, rather than some document that originates in one or other capitals of the region. Perhaps the proposed South Asian energy forum could also seek observer status at the Conference to draw on its expertise and experience. In future, South Asian countries could also look at joint oil purchase and fleet operation, since this provides greater bargaining power and lifting flexibility. The program drawn up by SAARC is impressive, but it will take enormous amounts of political goodwill to be implemented.

South Asia also has the opportunity to cooperate with its adjoining region through BIMST-EC, an intra-regional mechanism with membership of some South Asian and some South East Asian countries.[*] In addition, there is a South Asia Regional Initiative for energy program (SARI/Energy), which features bilateral partnerships between the US Energy Association (USEA)[**] and power regulators in Bangladesh, India, Nepal and Sri Lanka, with Pakistan also to be included soon. This program has been useful to power regulators and utilities in South Asia to interact and learn from the experiences of their counterparts in the U.S. so as to develop best practices in their own countries. Perhaps when the SAARC energy program gets going there will be an opportunity for the SARI/Energy program to expand into a regional program.

Regional cooperation in the energy sector in South Asia needs to move forward since it can help improve the region's access to energy and will contribute to economic growth and the well-being of the people of the region. Cooperation can also help in balancing regional demand and supply of various energy sources. On balance, one could visualize that both cooperation and healthy competition are likely to remain as the main trends in the foreseeable future. Fortunately, the diversified energy mix of the countries of the region and availability of technological skills, makes cooperation immensely viable and profitable. Though not specifically on the radar at present, Indian strategists will have to take into account regional cooperation and specifically South Asian energy cooperation in its energy security matrix. India cannot reap the benefits of a secure environment, if the countries and peoples around it feel insecure, and therefore, as the largest country in this region, India will have to take the lead.

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[*] BIMSTEC—Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka, & Thailand.

[**] USEA—United States Energy Association is a non-profit association of public and private energy-related organizations, corporations and academic institutions representing the U.S. energy sector. With funding from U.S. Agency for International Development (USAID), USEA created the Energy Partnership Program to organize volunteer-based multi-year year partnerships between U.S. utilities and regulatory agencies and their counterparts in developing countries.

India-China

When viewing the regional dimension of energy security in Asia and India's role in the region, one must inevitably shed some light on why China and India hog headlines whenever energy, oil and gas feature in the media. China and India dominate developing Asia's energy consumption statistics. Together, they accounted for 52 quads of the region's 85 quads of energy consumption in 2001.

China is the fastest growing among the larger economies of the globe and its energy consumption is also growing by leaps and bounds to fuel that growth. Until the early nineties, China's domestic oil and coal supplies were sufficient for fulfilling most of her energy needs. Since then China has become a growing and major importer of the global supply of oil and gas, and especially in this century, its import growth has become even more spectacular. China's 120 million tons oil purchases in the global markets in 2004 have definitely contributed to the upward movement of oil prices. However, as the Chinese Foreign Minister at a press conference in Beijing on 6 March 2005 reasoned, one should not lay all the blame at China's door for the high oil prices prevailing, since she accounted for only about 6% of the international oil trade volume in 2004. China has also followed the Japanese and South Korean strategy of diversifying sources of oil and gas, including investments in assets across the globe wherever possible and to participate in as many oil and gas development projects outside her boundaries as permissible. It has suitably configured its foreign and economic policies to achieve these goals through all out state support, whether in Africa, Latin America, Central Asia or South East Asia. It has ventured into areas once thought of as the natural preserve of the United States and its allies only. Naturally, such a bold strategy has attracted worldwide attention and circumspection.

India is among the largest economies in the world that has also grown at a fast pace over the last decade and half, fuelling additional energy demand. Moreover, its growing population's need for commercial energy is also increasing, and industrial activity is taking off in the last couple of years, adding to the pressure of rising energy demand. India has traditionally faced oil and gas deficits, though like China it is blessed with abundant coal though of inferior quality. India's oil dependency on foreign sources has expanded in the last decade since there has been no major new oil find at home. India too has adopted a policy of purchase and cooperation for oil and gas assets abroad, in addition to long-term contract purchases and some spot purchase of oil. Indian companies have been just a few steps behind China in their search for oil and gas abroad and this has at times lead to competition in which India has had to concede to the superior Chinese offer, usually with government backing. Thus, while Japan seems to be taking a breather from this policy of rapid acquisition of oil and gas assets abroad, after more than two decades in the picture, China and India seem to have more than taken up the slack left by Japan.

Such strategies being followed independently by China and India may not have the best result for either, leading to unnecessary competition where both lose. Instead some sort of prior dialogue or some other form of cooperation perhaps joint bidding could lead to

better results. Of course, such cooperation requires sufficient trust and transparency on both sides. Fortunately, India and China are already engaged in multi-layered partnerships in ongoing projects in Sudan, Ivory Coast and Iran. Working together in these projects will hopefully guide the oil companies of the two countries on how to work together rather than against each other. Moreover, since both the governments of China and India are involved in policy decisions they will inevitably see the need for desisting from any zero-sum game in this sector. As a matter of fact there is already hint of such a move. During the visit of the Chinese Premier to India in April 2005, energy sector cooperation was an important feature in the Joint Declaration issued at the end of the visit. An India-China Joint Study Group on further economic engagement, which submitted its report to both governments during the visit, has made some concrete cooperation proposals, including joint bidding in third countries. Details may be seen at Annex II.

India and China have certain similar features in their energy profile, such as rapidly growing demand, rising deficit of internal sources of oil and gas, abundant supply of domestic coal, further potential for small hydropower stations, quest for greater role of nuclear power in the energy mix and desire for non-conventional and renewable sources of energy, which should make cooperation in these and other areas possible, both bilaterally and through multilateral channels.

Asia–United States

According to Mikkal Herburg of the National Bureau of Asian Research (NBR), energy security concerns will propel China, India and others in Asia to become major players in global energy geo-politics. Energy is also drawing Russia back into Asia as a key strategic and commercial player. Therefore, The United States has a vital stake in how energy insecurity impacts Asia's future geopolitical architecture, either aggravating regional tensions and rivalries or providing a platform for greater regional cooperation. Herburg believes that on balance. Asia's powers are showing a marked inclination towards a relatively narrow, zero-sum, mercantilist approach to energy security that has the potential to be a major source of future tension and conflict in the region. (28) The US needs to help Asia with technology to slow energy demand, boost domestic supplies and support energy market reforms. Earlier, Kent Calder in his book, Asia's Deadly Triangle had argued that a combination of fast economic growth, scramble for the world's limited energy resources and political rivalry are stoking the flames of conflict in Asia. Therefore, the US needs to act as the stabilizing force in the region.

On the other hand, Robert Manning in his book The Asian Energy Factor has argued that Asia's rising energy demand need not necessarily lead to conflict and can result in strengthening of ties in the region and between Asia and its major suppliers such as the Middle East countries and Russia, and between Asia and the US. Manning states that "…rather than being a source of conflict, energy has the capacity to become an integrative force, creating a larger share of shared interests and stake in cooperation." (29) The challenge of trillions of dollars of capital needed for Asia's energy infrastructure will encourage regional cooperation and alliance building with the US. Regional

cooperation will be manifest in specific projects like cross-border gas pipelines, electricity grid link-ups and cooperative strategic stockpiling associations. Joint activities in fighting maritime piracy and establishing sea-lane security and cooperation in nuclear energy, including management of nuclear waste will lead to partnerships with the US.

Securing overseas supplies of oil and gas has lead to rivalry, sometimes very public and bitter, between Asian giants. This was evident in the Russian gas pipeline project in Siberia that was keenly sought by both Japan and China. Competition between China and India for the same oil and gas fields in third countries has, according to industry sources, lead to higher than normal value realized for the asset. However, rivalry has not resulted in conflict. As a matter of fact the opposite trend is now visible. Asian oil consumers and producers are joining hands to form a cooperative venture. Territorial disputes between China, Vietnam and the Philippines have not prevented them from taking the first steps towards joint exploration in the South China Seas. Thailand and Malaysia are partners on territory, which they once disputed. India and Pakistan are examining o how to join hands in gas pipeline despite unresolved disputes between the two countries. Even in North East Asia it is conceivable to visualize the realization of a China-Russia-Japan-Korea pipeline, which would be important not only for energy security but also for geopolitical stability. In every recent major government document India has jointly issued with neighboring countries and with other countries and regions of the world, including the US and the European Union, cooperation in the energy sector is a recurring byline.

There is no doubt that as a major player in the region, the US has a vital interest in the security stability of Asia and hence Asia's energy security trends have attracted much attention in this country. Fortunately, the doomsday scenario of Asian gas-guzzlers in a debilitating rivalry or conflict situation has been largely avoided. Instead the trends towards cooperation bode well for the USA and the world. It would be in US interests to encourage such cooperative ventures and for the IEA to help the fledgling Asian oil cooperation forum. We find this reality being acknowledged by the new Administration. During her March 2005 visit to India, Secretary of State, Dr. Condoleezza Rice said the US "looks forward to an energy dialogue because the demands for energy of growing economies like India and the United States are demands that will have to met in order to keep prosperous and growing and expanding economies that can serve the needs of the people." (30) This took concrete shape in April when India's Deputy Chairman of the Planning Commission met with the US Energy Secretary to kick-start the dialogue process.

The US has expressed concerns about Asia's growing energy ties with countries like Iran, which the US wishes to isolate politically, diplomatically and economically. It would be beneficial for the US and its partners in Asia to focus on areas where there is a convergence of interests – maintaining stability in West Asia/ Middle East so that oil and gas supplies from that region are not disrupted; assisting Asia in building up a coordinated strategic oil supply system so that the countries in the region can help each other during periods of grave oil shocks; securing the sea lines of communication from piracy and terrorist activities; assisting in technological innovation and absorption so as to decrease dependence on hydrocarbon sources; and joint action to reduce pollution and

reduce environmental degradation. Manning also suggests that the US should assist in the establishment of an Asian version of EURATOM, to manage common problems like nuclear safety, an early warning/monitoring system for radioactivity and for managing nuclear waste. These are some of the areas where Asia can work together with the US to enhance its collective security.

Recent Developments in India-US Energy Ties

Indo-US relations which have been on an upward curve since the early 1990s, is similarly reflected in the energy sector, where the US Department of Energy has run a cooperative program, designed to help India's effort at energy resources development. It has been somewhat restricted since 1998 after the imposition of sanctions following India's nuclear tests, especially in the transfer of technology for India's civilian nuclear power program. At the start of President George Bush's second term, there has been a clear effort by both sides to upgrade the entire relationship including a fresh component in the energy sector.

Following the visit of Secretary of State Condoleezza Rice and the return visit of Indian External Affairs Minister Natwar Singh to the US in April 2005, both sides have been attempting to ratchet up the bilateral energy cooperation agenda. An energy dialogue has just started between the US Energy Secretary and India's head of the Planning Commission, which, has three main components - civil nuclear energy, hydrocarbons and cleaner technologies.

An emerging challenge to the growing India-US ties is India's increasing engagement with Iran, especially in the hydrocarbon sector. With a recent LPG gas deal under wraps, India's involvement in Iran's upstream sector and renewed talks on a possible gas pipeline from Iran to India, via Pakistan, Washington's antennae have been raised as this may contribute to undermining its effort to isolate the Iranian regime in its effort to contain a suspected secret nuclear weapons program. India, on the other hand views its deals with Teheran as straightforward commercial pacts made in the light of its growing energy needs, with a regime it has no particular difficulties with. If there were an international sanctions regime imposed on Iran at some point in the future, India would certainly abide by its obligations as a responsible member of the UN and global multilateral system. Meanwhile, the US continues to express its concern on the issue to India, without going beyond that, a posture it has adapted with other friends and allies who have similar ties with Iran.

Conclusions

Securing India's energy supplies requires serious work both inwards and outwards. Much has been achieved, but much more is required in terms of coordination. To start with, India should now be spell out a national energy policy in the public domain. The government could identify an agency or perhaps a specialized think-tank to formulate a draft paper on the subject and then subject the document to vigorous debate and deliberation, before adoption. Once adopted, the specific agency/agencies charged with

implementation need to be monitored both by the executive wing and through Parliamentary oversight.

Summing up the various proposals made in the course of this study, one could include the following issues in a discussion paper:

- Re-defining the starting point and purpose of energy policy: it should start from the primary goal of reliable, affordable, and sustainable energy supply to all, including power and cooking fuel at home, in the office and factory, and fuel for transportation.
- Creation of a political super entity in government to coordinate the policies and activities now independently and separately administered by the Ministries of Petroleum and Natural Gas, Power, Coal, and Non-Conventional Energy Sources; closer partnership with State and Union Territory agencies, including revamping of the State Electricity Boards.
- Establishment of a national energy modeling system to ascertain cost effective and optimized supply of various energy sources , both domestic and overseas. Such a model would inter alia include production, imports, consumption and pricing, subject to assumptions about macro-economic and financial factors, world energy markets, behavioral and technological choice criteria, cost and performance characteristics of energy technology and demography and environmental aspects of energy supply; the goal is to reduce energy intensity and use cleaner fuels.
- Renewed focus on optimal use of resources available or recoverable within the country – onshore and offshore, whether oil, gas, coal, hydropower, nuclear energy or other renewable sources.
- Greater emphasis on technological innovation, including collaboration with foreign partners to the extent possible.
- Re-examining strategy on overseas E&P activities, including acquisition of interests in oil and gas assets.
- Starting a national energy mission at the grassroots level – introducing subject in school curricula, involving NGOs and consumer forums in nationwide campaigns, especially on energy conservation and environmental protection.
- Organizing an Asian energy dialogue and cooperation forum.
- Activating SAARC to put more substance in to the South Asia Energy Forum.
- Dialogue with the US and other major energy consuming countries/regions with the aim of avoiding an energy insecurity conflict.

Taking the cue from Mahatma Gandhi's exhortation, "There is a sufficiency in the world for man's need but not for man's greed" India should take the lead in formulating and implementing a need-based energy policy, which is dependent both on internal resources and regional and global cooperation.

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ANNEX I. OVERVIEW OF INDIA'S ENERGY SITUATION

India ranks sixth in the world in terms of energy demand. Per capita energy consumption in India was only 300 kg of oil equivalent (kgoe) in 2001, according to a former Indian Minister for Oil and Natural Gas, as compared to the world average of 1500 kgoe. (1). However, non-commercial biomass is still the dominant source of primary energy for cooking in 65 percent of rural households, who are yet to receive secure electricity supplies or cooking gas. In the 1990s as India's economy grew at about 6.5 persent per annum on the average, the demand for commercial energy grew by about 6 percent per annum, signifying a near unitary elasticity ratio. (2) As India perseveres with sustained economic growth, achieving levels of 6-7 percent of GDP growth per annum, its demand for energy, particularly oil and gas, continues to soar. To fuel this growth, India's energy consumption, at a conservative estimate, will increase at 5 percent per annum up to 2010, when India is expected to emerge as the fourth largest consumer of energy after the US, China and Japan. (3) As the country develops at a fast pace, by 2025, India's demand for commercial energy is expected to increase by two and a half times today's level.

The share of 'commercial' energy has risen from hardly 28 percent in 1950 to nearly 70 percent today. Non-commercial or household use of energy occurs mainly in poor and rural parts of India where fuel-wood, dung cake and agricultural waste is used as fuel for cooking. Among the commercial energy sources, the share of oil has progressively increased over the last 50 years. It is only in the last two decades that gas has played a significant role in new power and fertilizer plants. On the supply side, the share of imported energy has gone up to nearly 25% of commercial energy supplies in India.

Oil

Oil was first struck in India near Jaypore in Upper Assam in 1866, barely seven years after Col. Drake struck oil in Pennsylvania. The first commercial production of oil began in 1889 in Digboi in Assam and the fields are still active. Though India possesses only 0.5 percent of the world's known oil reserves, oil accounts for about 30 percent of India's total energy consumption. The majority of India's roughly 5.4 billion barrels in oil reserves are located in the Bombay High, Upper Assam, Cambay, Krishna-Godavari and Cauvery basins. The offshore Bombay High field is by far India's largest producing field, with current output of around 260,000 barrels per day (bbl/d). India's average oil production level (total liquids) for 2003 was 819,000 bbl/d, of which 660,000 bbl/d was crude oil. India had net oil imports of over 1.4 million bbl/d in 2003. Oil consumption is expected to grow rapidly to 2.8 million bbl/d by 2007 from 2.2 million bbl/d in 2003. (4) According to the latest estimates available, India's net recoverable reserves of crude oil was estimated to be 732.79 million of metric tons (MMT). Production in 2002-03 was 33.045 MMT, and is expected to go up to 190 MMT in 2011-12. (5)

India thus had to import nearly 65 percent of its total oil requirements in 2003. If major recoverable oil reserves are not found in the next few years, given that the Bombay High would have reached its peak output by then, and that the economy is growing at a fast pace, some analysts have suggested that India could be 85 percent or more dependent on

foreign oil imports over the next twenty years. (6) The government is attempting to limit the dependence on oil imports, by expanding domestic exploration and production. To this end it has been pursing a New Exploration Licensing Policy (NELP) first announced in 1997, which permits private and foreign involvement in exploration and production (E&P) of oil. NELP offers advantages like tax incentives, rebates on royalty payments and international oil price for discoveries. Four rounds of bidding of oil exploration blocks under NELP have been held so far, but have failed to attract the majority of the international oil companies. A few smaller independents such as Cairn Energy and Tullow of Britain and Niko Resources of Canada have ventured into this field in India, either independently as in the case of Cairn, or in partnership with local private partners such as that between Niko and Tullow and Reliance Industries. The state-owned Oil and Natural Gas Corporation (ONGC) holds the majority of the oil exploration blocks so far awarded. The Ministry of Oil and Natural Gas is now canvassing for greater foreign participation for the fifth round of bidding under NLEP that will be finalized in 2005. Impressive road shows were organized in London, Dubai, Houston and Calgary.

The problem of low oil recovery rates of around 30% is being tackled by bringing in foreign capital and technology. Cairn has had promising returns on its exploration blocks in western Rajasthan and plans to bring its assets there into production by 2007 with an expected volume of 60,000 to 100,000 bbl/d. (7) ONGC is attempting to increase recovery rates for its production assets from 28 percent to 40 percent. Technical experts believe that India is substantially endowed with "old" oil in sedimentary basins, which have not been explored until now due to lack of technology and equipment. These reserves, very little of which has been tapped so far (only about a third according to some estimates) hold out the promise that India's domestic production could increase substantially once the country is able to tie up technological and financial resources with its foreign partners. With extended use of 3D seismic surveys, secondary and tertiary recovery systems, "horizontal drilling and deep water capability" could reveal missed opportunities of the past and focus E&P in more prospective areas. (8)

For most of the 1990s, India imported large quantities of refined petroleum products, due to a shortage of refining capacity. By 1999, additional refinery construction had reduced the gap. At the end of 2003, India had a total of 2.1 million bbl/d in refining capacity, an increase of almost a million barrels per day since 1998. The largest increase came from the private sector Reliance Industries Jamnagar Refinery which a capacity of 540,000 bbl/d. Another major downstream infrastructure is the construction of pipelines by Petronet India, a joint venture of India's state-owned refineries. New pipelines between refineries and major urban areas are expected to add about half a billion barrels per day pipeline capacity, replacing rail cars as the main mode of oil transportation in India. (9)

Though the downstream sector is still overwhelmingly controlled by state-owned companies, private Indian companies have just entered the retail gasoline and diesel market and foreign companies have a presence in the retail lubricants market. (10) Eventually, foreign multinationals could become substantial stakeholders in the Indian retail oil sector, with Shell's first retail outlet opened in Bangalore in November 2004. However, planned sell-off of two profit-making state-owned oil majors, HPCL and

BPCL, has been put on hold. Thus the market is likely to continue with state-owned companies in the dominant position with gradually increasing presence of Indian and foreign oil majors in the retail sector.

The Indian government officially ended the Administered Pricing Mechanism (APM) for petroleum product prices in April 2002. Prior to this deregulation, the government tried to offset the effects of price changes in crude oil by maintaining an "oil pool account", which built financial reserves when crude oil prices fell and released them back as increased subsidies when crude oil prices rose. In practice, the April 2002 deregulation has not completely removed government influence on petroleum product prices, especially subsidies maintained on kerosene, which is commonly used as a cooking fuel by low-income families. Also prices changes contemplated by the state-owned retailers have to submitted to government for prior approval, which has not always been granted due to political opposition against raising prices at the pump.

Energy demand for transportation is projected to grow at an average rate of 4.4 percent a year from 1.9 quadrillion BTU in 2001 to 5.3 quadrillion BTU in 2025 and the transportation sector is expected to account for 20 percent of the country's total energy consumption. (11)

Natural Gas

Natural gas has been utilized in India's Assam and Gujarat regions since the 1960s. There was a major increase in the production and use of natural gas in the late 1970s with the development of the Bombay High fields and again in the late 1980s when the South Bassein field off India's west coast came into production. In December 2002, the private Reliance Industries announced discovery of a large amount of natural gas, estimated at 7 tcf (trillion cubic feet) in the Krishna-Godavari Basin offshore from Andhra Pradesh along India's southeast coast. Reliance reported another offshore find off Orissa in July 2004 estimated at 1 tcf. Cairn Energy also announced substantial natural gas finds in recent years offshore from Andhra Pradesh as well as Gujarat (2 tcf) and most recently in southern Rajasthan.(12)

Table I
Natural Gas Production in India
(in million standard cubic meters per day - mmcmd)

Scenario	1998	2001	2002	2007	2012	2020
As given	73	80	70	58	45	36
Optimistic				64*	78*	84*
Pessimistic				54	33	28

* Includes production from new fields and CBM (coal bed methane)
(Source : Report of the Group on India Hydrocarbon Vision – 2025, Government of India, pub 20 February, 2000)

According to previous analysis, production of natural gas in India was expected to decline steadily after 2001 until the Bombay High gas cap is brought into production sometime between 2015 and 2020. However, some new finds have since been announced

and with their production coming on stream in the coming years, the optimistic scenario for natural gas production is likely. On this premise, the likely future demand supply gap scenario is as under:

Table II
Natural Gas Deficit (mmcmd)

Demand & supply scenarios	2006-07	2010-11	2025-26*
Demand scenario 1	166	216	322
Supply scenario – given	58	45	36
Supply scenario – optimistic	64	78	84
Gap (given)	**108**	**171**	**286**
Gap (optimistic)	**102**	**138**	**238**
Demand scenario 2	231	313	391
Supply scenario – given	58	45	36
Supply scenario – optimistic	64	78	84
Gap (given)	**173**	**268**	**355**
Gap (optimistic)	**167**	**235**	**307**

* In the absence of supply projects for 2025, it is assumed that natural gas supply in 2025 is the same as for 2020
(Source: Report of the Group on India Hydrocarbon Vision – 2025 Government of India, pub 20 February 2000)

Demand scenario 1 is based on projected natural gas based electric power generation units and fertilizer production units with an import price of $ 4/MMBtu (million metric tons of British Thermal Units). Demand scenario 2 is based on import price of natural gas of $ 3/MMBtu. Demand scenarios given above could have changed since these estimates were calculated in 1999 and demand for power and other projects may have escalated in the intervening years.

80 percent of India's natural gas supply is consumed by the power and fertilizer sectors and 10 percent by sponge iron units. The rest goes to industrial units where it replaces mostly fuel oil and some LPG (liquefied petroleum gas). Natural gas is also supplied to residential and commercial units in parts of Mumbai, Delhi, and a few towns of Gujarat, Assam and Tripura. Majority of cooking fuel supplied in urban India is LPG. Future use of natural gas is expected to follow these trends. Given that even the optimistic supply scenario leaves a gap of between 60 to 70 percent of India's burgeoning natural gas demand and domestic supply, dependence on foreign sources of supply will be an important factor when considering the energy security angle.

To meet this demand-supply gap, government and industry hope to tie up long and short term supply arrangements from a number of foreign sources, including Qatar, Oman, Iran, Turkmenistan, Bangladesh, Myanmar and Indonesia. Petronet LNG, a state-owned joint venture, has one LNG terminal at Dahej (operational since January 2004) on the west coast and is scheduled to construct another facility in Kochi, in south-western India. Dahej is getting its supplies from Qatar. Iranian LNG, for which a 25-year agreement was reached between India and Iran in January 2005, (13) is expected at the Kochi terminal. Shell is fast completing a 2.5 million tons per annum (MMTPA) terminal on the west coast in Hazira, Gujarat for contracted LNG supplies from Oman. Another LNG terminal

at Dabhol, Maharashtra was about 90 percent complete when the project was halted in mid-2001 due to the collapse of the Enron power project supply agreement with the Maharashtra State Electricity Board. When international arbitration/negotiation is completed, hopefully by this year, work on completing the facility will resume. A BP-led consortium has proposed an LNG terminal on India's east coast at Krishnapatnam, with supplies expected from Indonesia. Imports of natural gas by pipeline may also take place from Myanmar, after a January 2005 agreement in principal between India, Myanmar and Bangladesh for a cross-border pipeline from southern Myanmar, through Bangladesh into eastern India. Piped gas supply from Iran through Pakistan at India's western borders also looks hopeful if political questions are resolved. However, the gestation period of gas pipeline projects is very long and the first supplies of gas from Myanmar or Iran into these systems is at 5 to 10 years away, even if agreement is reached today.

Natural gas pricing in India is likely to affect the growth of the natural gas industry. Prior to 1987, the two state-owned E&P agencies, ONGC and Oil India Limited (OIL) fixed the price charged to consumers. From 1987, government fixed the price charged at rates lower than alternative fuel oil and naphtha, but this led to losses in production and transportation. From October 1997 to March 2000, the government price formula provided for graduated escalation so that natural gas selling prices reflected 75 percent of the price of a basket of fuel oils. Since then the state-owned gas transmission utility, Gas Authority of India Ltd (GAIL) sets prices with government approval, based on quarterly average price of a basket of fuel oils. Deregulation of natural gas prices is on the agenda since buyers from state-owned sources are currently paying less than from private sources. According to the US Energy Information Administration (EIA), with a shortage of natural gas and some consumers willing to pay more, deregulation is likely to lead to higher prices. (14) However, other sources claim that with the supply of Reliance Industries gas, which will be priced substantially cheaper than imported LNG, prices will be lower than at present.

The import of natural gas or LNG calls for large investments in handling terminals and gas transmission networks. While GAIL and the state-owned oil companies are expected to play a leading part in setting up these facilities, participation by the private sector, including foreign investors is being encouraged. Developers of small and medium sized gas fields have to make their own arrangements for marketing. Government hopes to introduce a regulatory framework and mechanism to encourage private investment and provide a level playing field.

Coal

As the third largest coal producer after China and the United States, India mined over 360 million metric tons (MT) of coal and lignite in 2002-03, accounting for nearly 55 percent of India's energy supply. India's share in the global coal consumption is 7.2 percent, the second highest in the region after China. Power generation accounts for over 67 percent of India's coal consumption followed by 13 percent in the iron and steel industry and 4 percent by the cement industry. Other industrial consumers include the textile, fertilizer and brick industries. (15) Coal and lignite production is projected to increase to 460 MT

by 2006-07. Total estimated coal reserves in India is 246 billion tons of which 92 billion tons is proven, which should last at least until the end of the next century at current rate of consumption and projected increase.

Indian coal generally is low in sulphur, but high in ash content and low in net calorific value (Indian steam coal 0.441 toe/ton as compared to 0.541 for Chinese equivalent and 0.659 for US). Domestic coking coal requires intensive washing to make it suitable for coke making. Even then it is only marginally acceptable because of its inert material content. For this reason, India imports much of its coking coal. Major coalfields are found in the eastern states of Bihar, Jharkhand, Orissa, West Bengal and Chhatisgarh. Substantial deposits are also mined in the south-central regions of Andhra Pradesh and Madhya Pradesh and lignite is found in southern Tamil Nadu. Main consumers are located far from production sites and this adds to the transportation costs, overwhelmingly by rail car. Indian coal is also often uncompetitive with imported steam coal.

State-owned, Coal India and Singareni Collieries Company Ltd produce about 94% of the coal mined in India. Productivity in Coal India mines is extremely low ranging from 152 tons to 2621 tons per miner per year, compared with 12,000 tons in Australia and the US. This low productivity is mainly due to low level of mechanization of underground mines, obsolete techniques and inadequate investment in replacement equipment. (16) Employment policies, and poor labor relations also contribute to low productivity. Coal prices are also affected by high transportation costs by rail in India and shortage of port facilities. Private investment in ports is now allowed and new private ports planned, which will mitigate this problem. However, the multiple gauges of the rail network, and expansion of the network along with new rolling stock needs to be put in place in order to address the problem of rising costs and increased demand for coal in India.

Coal use for electricity generation in India is projected to rise by 2.3 percent per year from 5.0 quadrillion Btu in 2001 to 8.6 quadrillion Btu in 2025. At the beginning of 2001, India's total coal-fired generating capacity amounted to 66 gigawatts (GW). By 2025 it will need to build 57 GW of additional coal-fired capacity. Later in this decade demand from the power sector is expected to outstrip indigenous production target levels, overwhelming majority of which is in the state-owned sector, and so India will have to tap the international markets. (17) Due to use of high-ash run-of-mine coal, many of India's power plants have low-load factors and efficiency. Coal use by India's steel industry, which mainly uses imported coking coal, has not expanded as quickly as anticipated, but demand is expected to rise in the near future. Coal use in the cement industry is rising faster than can be met from domestic supply, and lower quality domestic lignite is replacing hard coal in some cases.

Prices of coking and higher quality steam coal were deregulated in 1996. Complete deregulation of prices of all types of coal took place in 2000. Prices now vary according to quality, but mining companies are often unable to get prices that fully reflect production costs. Import quotas were lifted in 1993 and import duties have been slashed from a high of 85 percent to 10 percent at present. Distribution of coal to core users such

as the power stations and steel plants is controlled by the Ministry of Coal and Mines, while the rest is left to the coal companies. Private investment is permitted in 'captive' mines – those dedicated to supplying a particular consumer, such as a power plant or an industrial unit. Foreign investment is allowed on a case-by-case basis, with up to 50 percent of the equity of an Indian firm.

Rehabilitation of mined sites, and dust, noise and underground fires are important environmental issues in the coal-mining sector. In case of burning of coal by power and industrial units, there are currently no limits on sulphur dioxide (SO_2) or nitrogen oxide (NOx) emissions, though there are emission limits on particulates (150 mg/Nm3), standards for liquid effluents and stack height/limit. It is cited that the the high cost of clean coal technologies (CCT) and zero emission technologies (ZET) currently available, is a major inhibiting factor in the adoption of these measures. Companies, which use up at least 25 percent of their ash as end products, such as bricks, are exempt from excise duty. India is a participant of the Kyoto Protocol, but as a developing economy, it does not have any greenhouse gas reduction obligation.

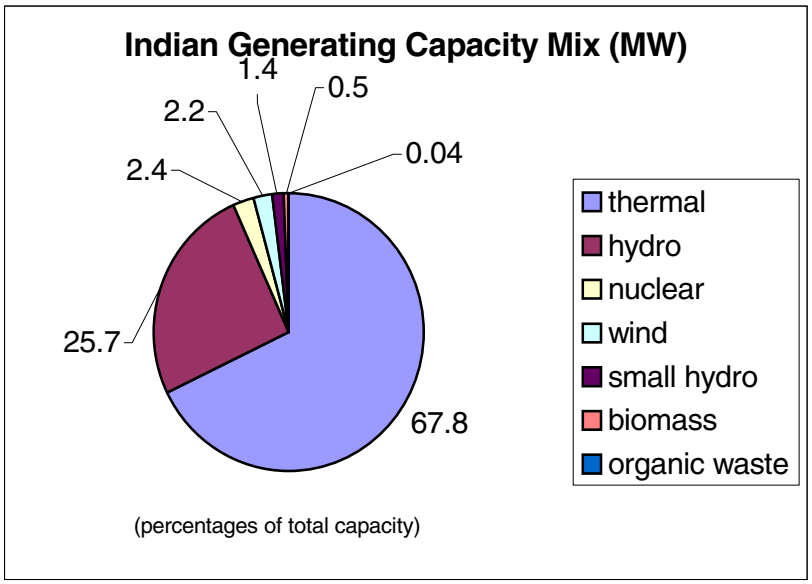
In the days ahead, along with the ongoing electricity liberalization, use of coal, with its price advantage and local availability, will become increasingly important for the electricity generation sector in India, despite ongoing effort to increase use of gas, nuclear, hydro and renewable sources to generate power.

Thermal Electricity and Hydro Power

The growth of the economy calls for a matching rate of growth in infrastructure facilities. The growth rate of demand for power in India has generally been higher than GDP growth. The elasticity was 3.06 is the First Plan period (1951-55) and peaked at 5.11 in the Third Plan period (1961-65) and came down to 1.65 in the eighties. In the nineties, estimates suggest that the elasticity was 1.5. At that level, in order to support a GDP growth rate of about 7 percent per annum, the rate of growth of power supply needs to be over 10 percent annually. (18) Although 84 percent of India's villages had been electrified by the turn of the century, according to the official 2001 Census Report, only about 45 percent of the total population of India actually has electricity connections. Power supply failure is common in many parts of the country and the unreliability of electricity supply is a constraint on the country's overall economic development. Power shortages may be costing between 1 to 3 percent of national income in India, according to an estimate in the Economist magazine cited by Robert Manning in his book The Asian Energy Factor.

Current installed capacity in India is 113,000 MW, of which 89 percent is in the state-owned sector. Transmission capacity is 99 percent in the state sector, while distribution is 90 percent. (19) Of the installed generating capacity, nearly 70 percent is by thermal plants, while the share of hydropower is a little over 25 percent (Figure I). Peak demand in 2012 has been estimated to be 157,107 MW, for which government has planned to install new capacity totaling 100,000 MW over the ten year period up to 2012. To meet

Figure I



the objective of "power for all" by 2012 with reliable supply and quality power of international standards at reasonable prices, an estimated investment of $ 150 billion would be required to finance generation, transmission, sub-transmission, distribution and rural electrification projects. Public or government investments, both at the Central and State levels will be stepped up, but it is recognized that a sizable part of the investments will have to come from the private sector, including from foreign sources. Towards this end government opened up the power generation sector to the private sector, including for limited foreign partnership, from 1991 along with other aspects of economic liberalization. In July 1998, the Indian government announced that proposals for investment up to 15 billion rupees ($350 million) involving up to 100 percent equity was to be approved automatically, for generation or distribution from hydroelectric, coal, lignite, oil or gas plants. Nuclear power plants and associated distribution networks are not open to foreign investors.

From the mid to the late nineties, government approved a large number of "mega-projects" (capacity of over 1000 MW for thermal plants and over 500 MW for hydroelectric plants). However, other than the Dabhol power project, most of the proposals fizzled out. This was mainly due to delay in getting regulatory approvals, failure to secure adequate financing, especially after the central government's withdrawal to provide counter-guarantees, and the poor financial health and payment record of the State Electricity Boards (SEB), which are the main buyers of the power generated by the independent power producers (IPP) in India. Phase I of the 740 MW Dabhol LNG-fired power plant came on stream in May 1999 and Phase II which is 90 percent complete would have added 1440 MW capacity. Payment and pricing problems with the Maharashtra State Electricity Board (MSEB), prompted the Enron-backed Dabhol Power

Corporation (DBC) to serve breach of contract notice in May 2001 and halt generation. Construction of Phase II was halted in the following month. GE and Bechtel, which had each owned 10 percent of the original project, have acquired Enron's 65 percent equity, following the latter's bankruptcy. International arbitration of the financial settlement over the Dabhol issue is pending, and officials hope it can be concluded this year. Most new projects since then have been financed from domestic capital and with loans from international financial institutions, including the Asian Development Bank (ADB).

Despite the Dabhol setback, the central government has continued to try to encourage the states to reform the power sector. The Electricity Regulatory Commission Act of 1998, set up separate central and state regulators, mainly for granting and controlling licensing, setting pricing policy and levels and for providing a level playing field for all the players in the evolving market mechanism. Separate state reform acts, have been enacted to unbundle the generation, transmission and distribution roles of the state electricity boards (SEB). The central government tried to clean up the financial problems of the SEBs by resorting to a onetime settlement of their outstanding dues (about $ 7 billion), which were securitized by the Government of India. Out of the twenty-nine SEBs, ten have turned themselves around by this move so far, and have been corporatized.

The Electricity Act of 2003, comprehensive legislation replacing the Electricity Act 1910, Electricity Supply Act 1948 and Electricity Regulatory Commission Act 1998, is the most ambitious reform move so far. The Act clearly demarcates the role and responsibility of the government in policy making, of the regulatory commissions in granting and controlling licenses, price setting and providing a level playing field and of other statutory bodies like the Central Electricity Authority (CEA) in providing expertise on technical matters. Under the 2003 Act, generation by coal, lignite, oil and gas does not require a license. There is full freedom for captive generation. Hydroelectric generation requires concurrence from CEA on account of dam safety and inter-state sharing of waters issues. The Act also promotes generation from non-conventional renewable sources/co-generation (wind, solar, tide, biomass). The Act envisages the transmission utility at the center (Power Grid Corporation of India) and in the states to undertake planning and development of transmission systems. Five regional load dispatch centers run by the Power Grid Corp will ensure integrated operation of the system. Distribution is to continue to be licensed activity, for which retail tariff to be charged to consumers will be determined by the state electricity regulatory commissions. The Act envisages some competition in the distribution sector by 2008 when consumers drawing one MW and above of power will be able to choose their distributor. For this purpose the Act also foresees trading activity in power to be regulated by the Central Electricity Regulatory Commission.

India has theoretically and technically feasible hydropower generating capacity of 1,48,701 MW. Current installed generating capacity is 29,500 MW and it is estimated that this will increase to 40,700 MW by 2006-07. (20) A 50,000 MW hydro power initiative was launched in May 2003 to tap the known potential for hydro power generation and stop the slide in the 25:75 hydro/thermal generation ratio. Preparation of pre-feasibility reports (PFR) on 162 identified projects began immediately, of which 62

PFRs were received my mid-2004. It was decided that instead of waiting for all the PFRs to be turned in, detailed project reports (DPR) for these 62 projects should commence immediately. A DPR takes about two years for completion. Since private funding has not been forthcoming for such projects, it has been decided to give the lead to central state-owned units to form joint ventures with private entrepreneurs. The state-owned company unit thus provides the cover sought by the IPP for issues relating to payments by the SEBs, land acquisition, security, etc.

Nuclear Power

India's Department of Atomic Energy (DAE) is in overall charge of nuclear power generation. The Nuclear Power Corporation of India (NPCIL) currently owns and operates 14 reactors at six locations in India with installed capacity of 2770 MW, which is about 2.4% of total installed generating capacity. There are eight more reactors under construction with installed capacity of 3960 MW. The largest project (2 x 1000 MW) at Kudankulam in Tamil Nadu is with Russian collaboration. The other smaller projects are being indigenously implemented. NPCIL plans to increase installed capacity to 20,000 MW by 2020.

Fusing the strength of the Indira Gandhi Center for Atomic Research (IGCAR) and the NPCIL, a new state-owned company, Bharatiya Nabhutiya Vidyut Nigam Limited (BHAVINI) has been formed to carry construction and operation of DAE's first 500 MW proto-type fast breeder reactor (FBR) at Kalpakkam in Tamil Nadu. Expected grid synchronization for the project is 2009.

Non-Conventional/Other Renewable Forms of Energy

Today, India is still substantially dependent on non-commercial forms of energy such as burning of fuel wood and animal and agricultural waste, and on commercial fossil fuels especially crude oil, the market for which often faces volatility and uncertainty. Moreover, both forms of combustion result in unacceptable levels of pollution and environmental degradation, leading to increasing health hazards. This has led the country, like the rest of the world, to search for alternative fuels such as solar, wind, biomass and small hydro that would ensure sustainable development. In 1981, the Indian government established a Commission for Additional Sources of Energy (CASE) to promote research and development (R&D) activities for development of various renewable energy technologies/systems. In 1982, CASE was incorporated in the newly created Department of Non-Conventional Energy Sources (DNES), which in 1992 was upgraded into a Ministry (MNES).

Government has actively encouraged research and commissioning of renewable energy sources of power, by arranging for soft bank loans, direct subsidy and tax incentives. As of March 2004, India had about 4800 MW of power generating capacity based on renewable energy sources such as wind, small hydro (up to 25 MW), biomass (mainly bagasse cogeneration in sugar mills) and urban municipal waste. This constitutes 4.5 percent of India's total installed power generating capacity from all sources and has

largely come about through private investments. Gross potential for wind power generation is estimated as 45,000 MW on-shore, of which technical potential is estimated at about 13,400 MW assuming grid penetration of about 20 percent. There is another 454 MW of small hydro power plants under construction, as also 644 MW of optimum bagasse cogeneration in sugar mills. Potential generating capacity from urban and municipal waste has been estimated at 1700 MW and from industrial waste at 1000 MW. (21)

India has thus used its limited financial resources to effectively promote power generation from renewable energy sources quite effectively, and future trends indicate fast paced growth in this sector. Government is also encouraging research work, including with overseas cooperation in new and emerging technologies like hydrogen energy, fuel cells, biofuels, electric and hybrid electric vehicles, geo-thermal energy and ocean energy. The Planning Commission has constituted an exclusive Group on Hydrogen Energy to examine and promote different aspects of this sector. MNES is also tasked with providing electricity through non-conventional means to 18,000 villages located in remote and difficult areas, which cannot be served by conventional grid extension.

India receives solar energy equivalent of more than 5000 trillion kWh per year, which is more than its consumption. Solar energy is mainly being used for water heating systems in housing estates and building. Builders are encouraged to install such systems through access to soft loans. The central government is also pursuing with state and local governments to make solar assisted heating mandatory in certain category of buildings through amendments in the building byelaws.

Biogas is derived from cattle dung and human waste containing about 55 to 70 percent methane, which is inflammable and burns as a blue flame in specially designed stoves. When burnt in silk mantle lamps, it serves as a source of lighting. It can also be used in dual-fuel engines to substitute up to 75 percent diesel oil for motive power and when attached with alternators for generation of electricity. It is produced in a “biogas (gobar gas) plant” where organic waste mixed with water is decomposed in the absence of air. Biogas is collected from the tank and piped to the household for use as fuel. The left over digested slurry is used as enriched manure in agriculture and pisciculture. Due to direct government encouragement and financial help, today India has 3.65 million biogas plants in the country out of an estimated potential of 12 million.

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ANNEX II. EXTRACT FROM THE "REPORT OF THE INDIA-CHINA JOINT STUDY GROUP ON COMPREHENSIVE TRADE AND ECONOMIC COOPERATION"*

Cooperation in Energy Resources

5.40 Both China and India are short of energy resources, particularly hydrocarbon based resources. With the rapid economic development of the two countries, the energy shortage problem is becoming increasingly acute. Ensuring energy supply and improving the efficiency of energy utilization are the key issues faced by both countries. They are also actively engaged in seeking energy sources in other countries to secure their energy security.

China's strategy and policy of energy resources development

5.41 To resolve the problem of energy shortage in the course of economic development, the Chinese government formulated an energy resources development plan on the basic principle that energy supply should based on the domestic production and imports at an appropriate level, and that clean energy has priority in production and utilization. The main targets of energy resources development are: to regulate the energy structure and improve the efficiency of energy utilization with the objective that total energy supply is sufficient for domestic economic and social development in general; to establish an international competitive system of design, production, construction and management for development and utilization of energy resources, and to achieve coordinated development of energy, economy and development.

Proposal for India-China Cooperation in Energy Resources

5.42 Cooperation in development of nuclear energy: By 2008, the annual installed capacity in India is likely to increase from 2700 megawatts at present to 6700 megawatts. Both India and China are rapidly developing their electricity production by nuclear energy to meet their large electricity requirements. Pressurized Heavy Water Reactors (PHWRs) and the Light Water Reactors (LWRs) are being developed for electricity generation in both the countries. Both the countries have important position among developing countries in nuclear energy applications. There are similar interests in development of advanced technologies for electricity production. Because of their rapid development and large population, both India and China, accord high priority to electricity generation using nuclear energy with a view to reduce potential carbon dioxide emission. The two countries can cooperate in the field of nuclear energy including R&D in a mutually beneficial manner.

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* www.mea.gov.in.

5.43 The two countries should encourage their enterprises to work together to exploit the petroleum and natural gas resources in third countries. The combined energy requirements of India and China would exceed those of EU and Japan by 2020. A joint India-China bid in third countries will make such bids globally powerful and go a long way in ensuring energy security. The JSG recommends that relevant Ministries of the two countries could consider establishing an institutional mechanism aimed at promoting joint efforts in sourcing energy supplies, including Petroleum and Natural gas in third countries as also commercial exploitation of other energy resources in third countries.

5.44 The two countries can cooperate in developing the technologies for renewable resources. Both India and China are developing and promoting the application of renewable resources including wind energy, solar energy, tide energy and bio-energy, etc. The two countries can jointly develop the new energy technologies through cooperative projects.

5.45 It is recommended that the relevant governmental departments should conduct research, formulate policies and take measures to encourage Indian and Chinese enterprises to strengthen their investments and cooperation in mining of such mineral resources as iron ore, coal and bauxite.

5.46 The two countries can exchange experience in energy management. Both India and China are reforming their domestic energy management systems, relaxing state controls and trying to be more open to both the private and foreign investors. The two countries should conduct more exchanges and share useful experiences in establishing a more efficient energy management system.