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India's Energy Security Concerns

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Abstract: India's Energy Security, at its broadest level, has to do with the continuous availability of primary commercial energy at an affordable price. Reducing energy requirements and increasing energy use efficiency are the most important measures presented in this paper, to enhance energy security for India.

Keywords: Energy Security, Energy efficiency, Energy Model, Environment.

I. INTRODUCTION

"The country is energy secure when we can supply lifeline energy to all our citizens as well as meet their effective demand for safe and convenient energy to satisfy various needs at affordable costs at all times with a prescribed confidence level considering shocks and disruptions that can be reasonably expected". It is important that energy is supplied to all citizens. When the energy needs of only some citizens are met, it cannot be a sustainable situation.

It is necessary to provide "lifeline" energy to all the citizens irrespective of their paying capacity. Energy up to a certain level is a basic necessity and whether the state supplies it or not people will procure it in any way. If the state does not provide it environmental degradation can be expected. Lifeline energy consumption for those who cannot afford energy at the market driven price has to be made through subsidies. Energy security requires that the lifeline energy needs of the Nation are met in full.

Safe and convenient energy is desirable as use of traditional fuels such as wood or dung cakes cause indoor air pollution and lead to adverse impact on the health, particularly of women and children. Energy should be available at all times. Interruptions in energy availability can impose high costs on the economy and also on human well-being.

To ensure energy security at all times, shocks and disruptions that can be reasonably expected must be anticipated. Ability to withstand shocks and disruptions is essential for energy security. However, since anything is possible, one cannot guard against all possible shocks at affordable costs. The surety of energy supply cannot be 100 percent. One can ensure supply only within a certain prescribed confidence level.

II. NATURE OF THE PROBLEM

Energy security has become a growing concern because India's energy needs are growing rapidly with rising income levels and a growing population. At the same time our dependence on imported energy has increased. From a level of 30% of Total Primary Commercial Energy Supply (TPCES) in 2003, imports accounted for 55% of our TPCES in 2016. What is of particular concern is that imports comprise largely of oil. Oil imports constitute 80% of our total oil consumption and 39% of our TPCES.

The dependence on imports of oil causes two concerns. The first is the uncertainty regarding availability of oil. India's requirements as a proportion of global energy availability are expected to increase substantially (Fig. 1).

The second concern is not disruption of supply but market risk of a sudden increase in oil price. While we may be able to pay for imports, the high oil price can cause inflation, slow down the economy and impose hardship on our people. The adverse impact on the economy of sudden

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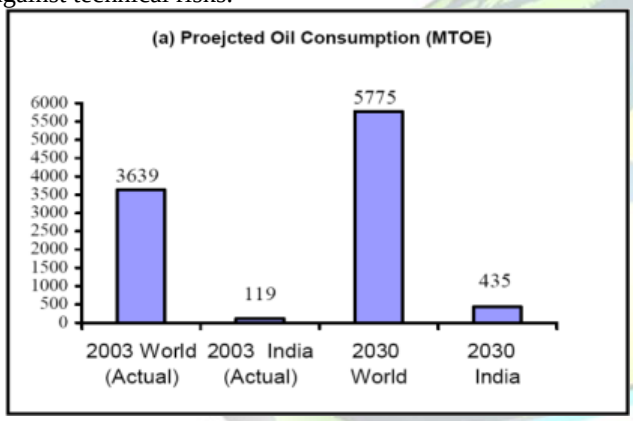
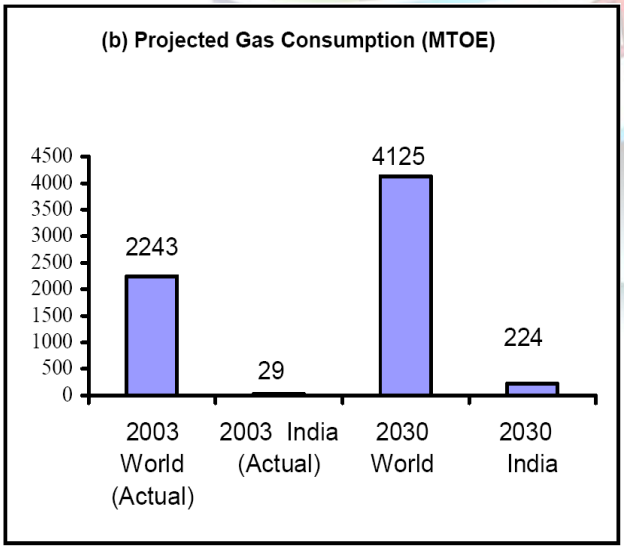
and large increase in oil price may be perceived as a more likely risk that we face compared to the risk of supply disruption. World oil prices have fluctuated substantially over the years (Fig. 2).

An increase in the price of oil or a disruption of oil supply or erratic power supply forces farmers to reduce the use of their pumps and tractors, the consequent reduction in agricultural output and employment can have serious adverse impact on the poor.

Even when the country has adequate energy resources, technical failures may disrupt the supply of energy to some people. Generators fail; transmission line trip or oil pipeline may spring a leak. There may be many such accidents that disrupt the supply of energy. One needs to provide security against technical risks.





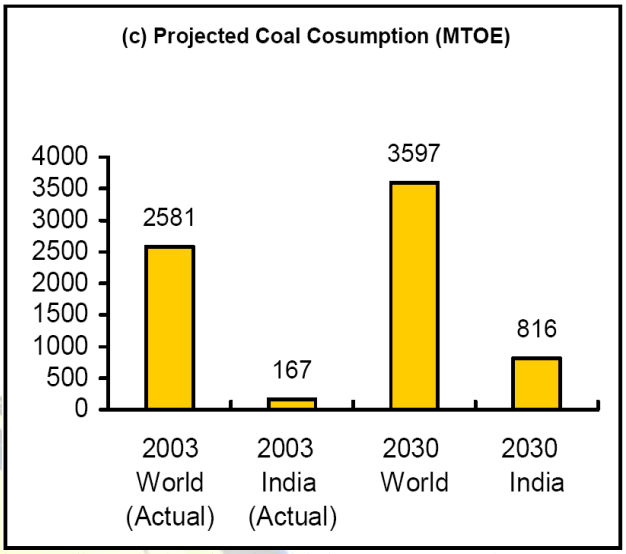


Fig. 1: India's Growing Share in Global Energy Consumption (Projections for India are based upon GDP Growth Rate of 8%)

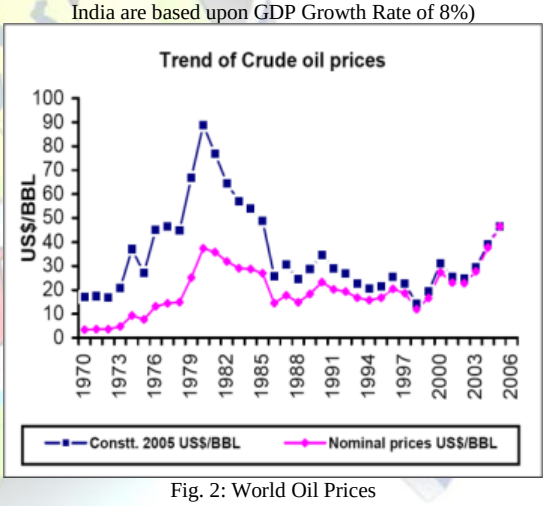


Fig. 2: World Oil Prices

III. POLICIES AND INITIATIVES FOR ENERGY SECURITY

The effectiveness of measures to enhance security depends on the nature of disruption. The costs of the various measures also differ. One wants to minimize the expected cost for a desired level of confidence. The measures are reducing need for energy and imports, diversification of supply sources, maintenance of strategic reserve and obtaining equity oil or gas abroad that help in reducing the consequences of both supply risk and market risk.

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The action to improve energy security can be classified broadly in two groups, one that reduces risks and another that deals with the risks. The major policy options are:

(a) Reducing Risks
- Reduce the requirement of energy by increasing efficiency in production and use of energy;
- Reduce import dependence by substituting imported fuels by domestic fuels;
- Diversify fuel choices and supply sources
- Expand domestic energy resource base.

(b) Dealing with Risks
- Increase ability to withstand supply shocks;
- Increase ability to import energy and face market risk;
- Increase redundancy to deal with technical risk.

A. Reduce Energy Requirements

Major opportunities exist in reducing energy requirements without reducing energy services. Improvement in energy efficiency or conservation is akin to creating a domestic energy resource base. Such efficiency improvements can be made in energy extraction, energy conversion, energy transmission, energy distribution and end-use of energy. All of these efficiency improvements can come from currently commercial technologies. Some such examples are:

(a) Advanced mining techniques and Enhanced Oil Recovery (EOR) techniques.
(b) Improving fuel efficiency of Coal Power Plants [1].
(c) Energy efficiency and demand side management have also large scope to reduce energy requirement. These include energy efficient appliances, energy efficient automobiles, hybrid cars, energy efficient buildings, efficient lighting, cogeneration, distributed generation for Combined Heat and Power (CHP) generation, energy efficient and well-maintained irrigation pumps, smokeless improved woodstoves, etc.
(d) Develop effective and attractive mass transport such as underground, elevated trains, light rail or dedicated bus lanes in existing metros.

B. Substitute Imported Energy by Domestic Alternatives

Energy security can be increased by reducing the need for imported energy by substituting it with other forms of energy. Though this does not reduce the need for total energy, it reduces import dependence. If the domestic substitute increases dependence on one particular fuel it can increase domestic supply risk. However if substitutes diversify domestic energy mix, it can also reduce supply risk, particularly if the substitutes are local renewable [2]. Some important options are the following:

(a) Electrification of railways can substitute diesel. Wood plantations with a potential of generating up to 20 tonnes of wood could significantly expand the domestic energy resource base.
(b) Bio-diesel and Ethanol can substitute diesel and petrol.
(c) Use of hybrid vehicles and/or of electric vehicles, cars, scooters and motorbikes can significantly reduce requirements of petrol.
(d) Hydrogen based vehicles can be another option to reduce dependence on oil imports.
(e) Coal can be converted into oil as the South Africans do. The technology is well-developed and in use for years. Sasol is routinely available at filling stations along with petrol and diesel.

C. Diversify Supply Sources

(a) For increasing energy security, the first measure is to diversify our sources of supply both domestic as well as for import of oil or gas [3].
(b) Energy security can be increased not only by diversifying sources of import of a particular fuel but also diversifying the energy mix by using different types of fuels. An economy that uses coal, oil, gas, nuclear, hydro, and renewable of various kinds naturally is less dependent on one particular fuel, and hence less vulnerable to supply disruption of either domestic or imported energy sources.

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Table I: *Sources of India's Oil Imports- 2004-05*

Country		Oil Imports (mmt)	% of Total Imports
Middle East Region	Iran	9.61	10.03
	Iraq	8.33	8.69
	Kuwait	11.36	11.85
	Neutral Zone	0.15	0.15
	Oman	0.14	0.14
	Qatar	1.19	1.24
	Saudi Arabia	23.93	24.96
	UAE	6.43	6.71
	Yemen	3.51	3.66
	Sub Total	**64.64**	**67.43**
Other Regions	Angola	2.44	2.55
	Brazil	0.29	0.30
	Brunei	0.81	0.84
	Cameroon	0.35	0.36
	Congo	0.14	0.14
	Egypt	2.12	2.21
	Equador	0.15	0.16
	Equitorial Guiena	1.66	1.73
	Gabon	0.28	0.29
	Libya	1.47	1.53
	Malaysia	3.43	3.58
	Mexico	2.28	2.38
	Nigeria	15.08	15.73
	Russia	0.16	0.16
	Sudan	0.33	0.34
	Thailand	0.27	0.28
	Sub Total	**31.23**	**32.57**
Total		**95.86**	**100.00**

(c) Apart from sourcing oil or LNG imports from different countries, diversification can also be achieved by importing gas through pipelines or hydropower from neighbouring countries.

(d) Substantial scope exists for import of hydro-power from Nepal and Bhutan.

D. Expand Resource Base and Develop Alternative Energy Sources

Resource base can be expanded in many ways: Enhance recovery from existing resource base, explore to find new reserves, obtain equity energy abroad and develop new sources of energy through R&D.

(a) Enhanced oil or gas recovery from existing fields is an obvious option.

(b) In-situ Gasification may permit much higher recovery of coal than can be economically mined by conventional techniques.

(c) Methane extraction from Coal Bed.

(d) New technology efforts for exploration can be stepped up to find new reserves.

(e) Obtaining equity abroad for oil, gas, and coal increases energy security against supply risk.

(f) A comprehensive study evaluating technology, available resources and economics would be necessary prior to entering into collaborative arrangement for Gas to Liquid Conversion.

(g) New Domestic Sources can be expanded through Gas Hydrates, Nuclear Power based on Thorium fuel, Wind, Solar, and Energy Plantations.

E. Increase Ability to Withstand Supply Shocks

Once the imports are minimized and diversified, the shortage due to disruption of supply from any one country would be small and can be dealt with by maintaining a strategic reserve. The reserve could be that of oil or of dollars to facilitate import from alternative sources. The stock of oil can be kept either in storage tanks or it can be in the form of oil wells underground which are kept in reserve and which may be brought under production at short notice. This, however, is a very expensive alternative.

"Strategic reserves [4] of crude oil and petroleum products were first recognized as a policy tool in the aftermath of first oil shock in 1973. Major industrialized nations got together and formed the International Energy Agency (IEA), which was charged with the task of coordinating the purchase of oil during a future shock and off coordinating the drawdown of reserves during the hour of crisis. Currently, IEA member countries hold strategic stock of about 90 day of net imports and there are already talks of increasing the cover to 120 days. Strategic reserves do not come cheap. According to an estimate prepared by the Engineers India Limited (EIL), the capital cost of building a strategic reserve of 5 MMT of crude oil at Rajkot (2.5), Mangalore (1.5) and Vishakhapatnam (1.0) are Rs.1225.2 crores with a mixture of concrete tanks and rock caverns. The maintenance cost of crude, which at $25/bbl will come around Rs. 4214 crores and this will provide cover of only 24 days".

F. Increase Ability to Import Energy and Face Market Risks

To guard against the market risk of sudden price increase, the country needs to keep its energy import bill within a certain proportion of its foreign exchange earnings or maintain a stock of foreign exchange to address such volatility.

(a) Options contract and futures market can be used to reduce the risk of price volatility. Equity oil or gas abroad may provide security against sudden price increases.

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(b) Strategic reserves can also help in reducing the impact of transient fluctuations in prices as instead of importing stock may be depleted. However, treating the strategic reserve as a buffer stock this way can reduce the effectiveness of strategic reserve against supply risk.

G. Increase Redundancy to Deal with Technical Risk

The obvious solution against technical risks is to provide redundancy. Thus, for example, electrical networks minimize loss of load probability by providing alternate routes. Similarly, power plants carry standby capacity or a spinning reserve to address the technical risk of some station going off the grid or a sudden increase in demand. Some redundancy must be built into the design of all energy installations to address technical risks.

IV. ENERGY SECURITY FOR THE POOR

Even when the country has adequate energy and even when there are no technical failures, the poor should get clean, safe and convenient energy at affordable cost at all times.

V. NATIONAL ENERGY MODELING SYSTEM

National Energy Modelling System (NEMS) shown in Fig. 3 is an energy-economy modelling system [5] which projects the production, imports, conversion, consumption, and prices of energy, subject, to assumptions on macroeconomic and financial factor, world energy markets, resource availability and costs, behavioural and technological choice criteria, cost and performance characteristics of energy technologies, and demographics. The planning horizon is typically 20-25 years.

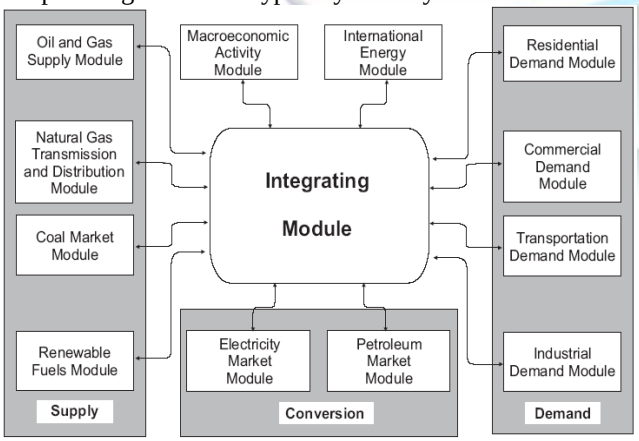

Fig. 3: National Energy Modelling System

NEMS should be designed to capture important fundamental interactions of macroeconomic activity, energy demand and supply in the country's energy markets. The modules for various sub-sectors interact simultaneously, to provide optimal solution.

The importance of NEMS both as a concept and tool has been recognized by the planners of many countries, and such integrated analytical systems are actively being developed for arriving at cost effective and optimized supply of various energy sources.

Importance of such a system for the optimum development of the energy sector in a capital scarce economy like India hardly needs any emphasis.

VI. CONCLUSIONS

The actions to improve energy security are: To reduce the requirement of energy by increasing efficiency in production and use of energy; Decrease import dependence by substituting imported fuels by domestic fuels; Diversify fuel choices and supply sources; Expand domestic energy resource base; Increase ability to withstand supply shocks; Enhance Oil Pool Reserves and Technology Management'; Preparation of National Energy Modelling System.

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Dr. M. Venkaiah, received B.Tech and M.Tech in Mechanical Engineering from KLU and IIT Delhi respectively. He got PhD from PtRS University, Raipur on the topic Economic efficiency, Energy security and Environment protection. He is now working as principal in MNR College of Engineering and Technology, Sangareddy, T.S., India.