

# Analyzing India's Oil Security: MOSES Application and Evidences from Indian Economy

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**Abstract – Authors applied IEA model of Short Term Energy Security (MOSES) to analyze Indian energy security profile with respect to ‘Crude Oil’, the 2<sup>nd</sup> largest component in country’s energy basket. The analysis was based on 8 quantitative indicators of External and Domestic Risk and Resilience. The MOSES indicator against each parameter was calculated and later collaborated against the rage of indicators resulting in identification of crude oil security profile of the country. The subject analysis of MOSES resulted in placement of India in GROUP-C of the energy security profile. Author also analyzed that completion of 3 Strategic Crude Oil Storage facilities and the establishment of dedicated ‘Sovereign Wealth Fund’ for asset acquisition will reduce the risk profile and will result in graduation of country’s oil security profile from GROUP-C to GROUP-B.**

## INTRODUCTION

Supply side equation of the energy security has emerged as one of pre-requisite for the sustainable economic growth of the country. This is especially true for energy deficient country like India, an emerging economy with close to 82% dependence on the imports for one of the vital energy constituent – Crude Oil, the 2nd most dominant source of primary energy in country’s energy basket with 30% share and with projected share of 29% by 2032. (BP 2012, MoPNG 2011, IEP 2006)

Over the last decade, India, while registering a sustainable growth, has emerged as one of the fastest growing economies of the world. One of the pre-requisites for the sustained growth of any economy is fulfillment of its energy requirements. It is estimated that for emerging economy to grow at rate of 8-9% the annual increment in the energy requirements are expected to be in the range of 6-6.5% (Working Group

Report 2012). In Indian context, to maintain this growth trajectory it is imperative that country secures its supply of energy constituents both from domestic as well as from international sources. Oil, with share of close to 30% in the energy basket of India, has emerged as one of the major energy constituent after Coal in Indian Primary Energy Basket. (BP, 2012).

With 0.45% of the World’s crude oil reserves, 1% of share in World Crude Production and 3.8 % of the World’s Consumption (BP, 2012), India, which is net exporter of the petroleum products since 2003, has emerged as one of the biggest importer of crude oil in the World with import dependence of close to 82% (MoPNG, 2012). Further, due to stagnated production of domestic oil fields, the import dependence is bound to increase to more than 90% in near future (IEP, 2006). The supply side of Energy Security is matter of policy concern for emerging economies like India. (IEP,2006) projected that requirement of primary commercial energy is expected to increase from 551 MToE in FY2012 to 1823 MToE by FY2032.

It is observed from the projection of Integrated Energy Policy of Government of India that Oil will continue to be the 2nd most dominant source of energy after coal till 2032.

### *Short Term Energy Security*

After, more than 40 years of OPEC oil embargo, Energy Security still remains a delusive concept. There is no clear definition of definitions of ‘Energy Security’ which can accommodate producers and consumers perspective. The definition of ‘Energy Security’ differs as the context in it is used changes.

(Integrated Energy Policy, 2006) provided the definition of Energy Security in the broadest form with respect to

Indian perspective as; “...ensuring the continuous availability of commercial energy at competitive prices to support its economic growth ..... “. The key takeaways in the definition are “Continuous Availability” and “Competitive Price” which indicates the supply side economic dynamics.

*Short Term-* Energy Security has been an issue of constant debate. Number of energy economists has raised this energy security issue in Indian context. However, no empirical application or evidence is available for India which can capitalize its current and future energy security requirement.

To ensure supply side security of crude supply, and to maintain economic growth engine ‘well oiled’, number of pertinent issues like diversification of supply source, augmentation of domestic production, increased production through Enhanced Oil Recovery processes, revamp of depleting E&P infrastructure, increase in proportion of equity oil in countries crude basket are being addressed

*Model of Short Term Energy Security (MOSES)*

Model of Short Term Energy security (MOSES) is a quantitative tool developed by International Energy Agency (IEA,2011). MOSES is based on set of indicators that measure energy security in term of;

- a) Risk of supply disruption and
- b) Resilience to cope with such disruption

MOSES analyzes vulnerability of 7 primary energy source (Crude Oil, Natural Gas, Coal, Hydropower, Nuclear Power, biomass and waste and geothermal energy) and how these affect the security of 2 secondary fuels (Oil Products, liquid bio fuel). It uses all value chain of energy system and measure the vulnerability of these strata of energy system. Domestic Risk, Domestic Resilience, External Risk and external resilience are the 4 dimensions analyzed in MESES using 35 indicators. Each indicator relates to at least one of the four dimensions of energy security Categorization is used to measure the energy security profile for 28 member countries of IEA. Countries are grouped in 5 energy profile for each energy source or fuel. The energy security profiles are marked by letters A to E, moving from lower risk/high resilience profile (higher energy security) to higher risk/lower resilience profile (lower energy security).

*Crude Oil Security Profile-MOSES analysis*

The analysis of crude oil using MOSES is based on eight indicators as below

|          | Risk  | Resilience   |
|----------|---|--|
| External | Import Dependence<br>Political stabilit(supplier)     | No of Ports<br>No of P/L<br>Diversity of suppliers |
| Domestic | Share of Offshore Pro.<br>Volatility of domestic Pro. | Av. Storage level                                  |

SOURCE-IEA

Each of these 8 quantitative indicators are calculated below

i. *Import Dependence:* Share of import in the total crude requirement of the country

$$= \text{Crude Import} / \text{Total Crude requirement}$$

*Indicator Range:* ≥80%- High, 40-65%- Medium, ≤15%- Low

ii. *Political Stability of Supplying Country:*

= wt. Average of political stability of supplier based on proportion of crude oil imported from each supplier

$$= X_1.P_1+X_2.P_2+X_3.P_3.....+X_n.P_n. \text{ where } X= \text{Proportion of crude oil import, } P= \text{Political stability rating from 0 to 7 where 7 is the most politically unstable}$$

*Indicator Range-* ≥ 2.9 – High, < 2.5 - Low

iii. *No of Ports / No of Pipelines:* Entry Points for crude import like Ports and Pipelines. More entry point country has, less vulnerable it is to supply disruption.

*Indicator Range-* Ports: >5 – High, 2-4, Medium, 0-1-Low

*Indicator Range-* P/L: >9 – High, 3-8, Medium, 0-3-Low

iv. *Diversity of Suppliers:* Calculated using Herfindahl-Hirschman Index as measurement of concentration of supply. The index range from 0.1 (for high diversity) to 1 (for no diversity).

*Indicator Range-* <0.30- high, 0.3-.08- moderate, >0.80-Low.

v. *Average Storage Level* = Average level of crude oil storage / maximum refinery intake

*Indicator Range* - ≥55- High, 20-50-Medium, ≤15-Low

- vi. *Volatility of domestic production* = Standard Deviation of monthly crude oil production in an year / average monthly crude oil production

*Indicator Range*- >20%- High, < 20% -Low

*Security Profile*: Overall risk and resilience of individual country is calculated and the countries are placed in five group A to E. A being most energy secured and E being least energy secured nation based on following profile

| Group | Country that   |
|-------|--|
| A     | Export Crude Oil or $\leq 15\%$  |
| B     | Import 40-60% of crude oil or<br>Import $\geq 80\%$ of crude oil and have <ul style="list-style-type: none"> <li>• <math>\geq 5</math> crude oil ports, high supplier diversity and <math>\geq 55</math> days of crude oil storage</li> </ul>  |
| C     | Import $\geq 80\%$ of crude oil and have <ul style="list-style-type: none"> <li>• <math>\geq 5</math> crude oil ports, high supplier diversity and &lt;50 days of crude oil storage Or</li> <li>• 2-4 Crude oil Ports, high supplier diversity and &gt;20 days of crude oil storage</li> </ul>   |
| D     | Import $\geq 80\%$ of crude oil and have <ul style="list-style-type: none"> <li>• 2-4 crude oil ports, high supplier diversity and <math>\leq 15</math> days of crude oil storage Or</li> <li>• 2Crude oil Ports or 3 crude oil P/L, low supplier diversity and &gt;15 days of crude oil storage</li> <li>• 1-2 crude oil P/L or 1 Crude oil Port and either               <ul style="list-style-type: none"> <li>○ Medium to high supplier diversity and <math>\geq 15</math> days of crude oil storage</li> <li>○ Low supplier diversity and <math>\geq 55</math> days of crude oil storage</li> </ul> </li> </ul> |
| E     | Import $\geq 80\%$ of crude oil and have <ul style="list-style-type: none"> <li>• 1-3 crude oil P/L or 1 crude oil port and <math>\leq 15</math> days of crude oil storage Or</li> <li>• 1-2 Crude Oil pipeline, low supplier diversity and &lt;50 days of crude oil storage</li> </ul>  |

SOURCE- IEA

MEASURING INDIAN OIL SECURITY: MOSES APPLICATION

As first part of the research paper series to apply MOSES to the Indian hydrocarbon industry starting with application to Crude Oil, which is the 2<sup>nd</sup> most dominating primary fuel with 31% of the share in Indian Energy Basket.

All the 8 quantitative indicators are calculated with to estimate Crude Oil Security of the Country. The brief of the indicator measurement both on Risk and Resilience parameters is presented below

## RISK

### A. EXTERNAL

*Import Dependence*- India is net importer of crude oil. The dependence on the imports to bridge the production and consumption gap has widened since 2002. The import of crude oil has augmented at a 10 year CAGR of 8% since FY 2002 and as of FY2012, India is importing 82.5% of its crude oil requirement.

*Import Dependence* – 82.5% (FY2012)

*MOSES Indicator* - HIGH

*Political Stability of the suppliers*- India with crude oil import from 29 countries has a diversified basket in terms of crude supplier with 69.06% dependence on Middle East suppliers, 18.13% on African, 9.78% on Latin America and rest on other countries. Table 1 in the annexure lists the countries, the proportion of crude oil import in Indian basket and the details the country's political stability. The indicator is calculated as discussed in above section as the weighted average of the political stability of the supplier based on the proportion of crude imported and OECD political stability rating.

*Political Stability of Suppliers*= 4.46

*MOSES Indicator* = HIGH

### B. DOMESTIC

- i. *Share of Offshore Production*- As of FY2012, the share of offshore production is estimated at around 80%

*MOSES Indicator*= HIGH

- ii. *Volatility of Domestic Production*- The share of domestic production in the total crude requirement of the country has stagnated over the last 5 years has stagnated at levels of around 39 MMTPA. The monthly production data for FY2010 is presented at table 2. This volatility in the production is calculated as discussed in the prevision section.

*Volatility of Domestic Production*= 12.87%

*MOSES Indicator* = LOW

## RESILIENCE

### C. EXTERNAL

- i. *Number of Ports*- This is the measure of import infrastructure and in India there are currently 9 ports

at Kandla, Vadinar, Bombay, Cochin, Tuticorin, Madras, Vizag, Haldia and Paradip that are undertaking of import/export of crude and refined product.

Number of Ports = 9

MOSES Indicator = HIGH

- ii. *Number of Pipelines*- Currently India does not operates/possess any crude import pipelines.

Number of Pipelines =0

MOSES Indicator = LOW

- iii. *Diversity of suppliers*- Calculated using Herfindahl-Hirschman Index as measurement of concentration of supply. India has a diverse supplier base with from 29 countries.

HH Index = 0.101

MOSES Indicator = HIGH

#### D. DOMESTIC

- i. *Average Storage Level*- For the Financial year 2010, the average level of crude oil storage in India was around 22.20 MMT while the refining intake of 19 operating refineries is around 160 MMTPA

Average Storage Level= 51 days

MOSES Indicator= MEDIUM

#### *Assessment Methodology: India*

IEA assigned countries in 5 groups (from A to E) with different crude oil security profile as discussed above. Similar, methodology is followed for purpose of assessment of oil security profile of India. In line with the assessment on the above 8 indicators, India will be placed in Group C due to following rationale.

- Import > 80%
- 9 Crude Oil Ports
- High supplier diversity (HHI=0.101)
- 51 days of crude oil storage

#### *Data Source*

Data has been sourced from IEA research papers, Ministry of Petroleum and Natural Gas, Statistical review of World Energy by British Petroleum

#### *Finding and Discussions*

The analysis of Indian Crude Oil data and parameters based on external and domestic risk and resilience dimensions according to the MOSES model of

energy security resulted in placement of India in Group C of the Energy Security Profile.

- a. It is analyzed that India runs *high external risk* on import dependence and political stability of the suppliers as major proportions of the supplies originates from countries which scores high on country risk classification as indicated by OECD
- b. India also runs *high domestic risk* on share of offshore production but the volatility of domestic production is low due to stagnated level of domestic production.
- c. On the dimensions of *external resilience* India score *high* on the supply side due 9 numbers of ports and high on diversity of suppliers measured through Herfindahl-Hirschman Index of 0.101 which is close to perfect.
- d. The average level of storage at 51 days places India at medium level of resilience on this parameter.

#### CONCLUSION AND RECOMMENDATIONS

India according to author calculation is placed in Group C of the IEA security profile. However, it is imperative that high external risk factor of imports and political stability is mitigated to improve the oil security profile of the county another area of improvement is the increase in average storage level. Following are the steps that are being taken and are recommended to improve the energy security profile of the country.

1. Phase -1 of strategic crude oil storages of cumulative capacity of 5.33 MMT being implemented at Vizag (1.33), Manglore (1.50) and Padur (2.50) will improve the parameter of 'average storage level' which will result in overall improvement in the oil security profile from Group C towards Group B
2. Another imperative to improve the oil security profile of country is to reduce the import dependence from current level of 82% through improving performance on contribution of 'Equity Oil' in the crude oil basket of the country. The proposed establishment of 'Sovereign Wealth Fund' with objective of foreign asset acquisition will result in reduction of import dependence thus improving the oil security profile of the country.

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| Country    | Crude Oil Import % | Un-Stability Factor |
|------------|--------------------|---------------------|
| Iran       | 10.55              | 7                   |
| Iraq       | 14.04              | 7                   |
| Kuwait     | 10.32              | 2                   |
| Oman       | 1.51               | 2                   |
| Qatar      | 3.78               | 3                   |
| KAS        | 18.92              | 3                   |
| UAE        | 9.19               | 3                   |
| Yemen      | 0.75               | 7                   |
| Brazil     | 2.21               | 3                   |
| Columbia   | 0.52               | 4                   |
| Ecuador    | 0.17               | 7                   |
| Mexico     | 1.33               | 3                   |
| Venezuela  | 5.55               | 7                   |
| Australia  | 0.37               | -                   |
| Braunei    | 0.64               | 2                   |
| Malaysia   | 1.36               | 2                   |
| Algeria    | 1.22               | 3                   |
| Angola     | 5.26               | 5                   |
| Cameroon   | 0.29               | 6                   |
| Congo      | 0.29               | 7                   |
| Egypt      | 1.65               | 5                   |
| Eq. Guinea | 0.52               | 7                   |
| Gabon      | 0.087              | 5                   |
| Iv' Coast  | 0.087              | 7                   |
| Libya      | 0.087              | 7                   |
| Nigeria    | 8.23               | 5                   |

|            |      |   |
|------------|------|---|
| Sudan      | 0.41 | 3 |
| Azerbaijan | 0.61 | 5 |
| Norway     | 0.38 | - |

Source- OECD

| FY 2010 Month | Crude Production MMT |
|---------------|----------------------|
| Jan           | 3.631                |
| Feb           | 3.376                |
| Mar           | 3.652                |
| Apr           | 2.85                 |
| May           | 2.945                |
| Jun           | 2.945                |
| Jul           | 3.077                |
| Aug           | 3.191                |
| Sep           | 3.1149               |
| Oct           | 3.1871               |
| Nov           | 3.2684               |
| Dec           | 4.388                |

Source- MoPNG

