Energy Needs of Growing Economy

Economic growth is desirable for developing countries, and energy is essential for economic growth. However, the relationship between economic growth and increased energy demand is not always a straightforward linear one.

Massive investment in energy sector is required to deliver a sustained GDP growth rate of 8.0% till the year 2031- 2032. The requirements of energy sector are:

- Growth in primary energy supply by 3-4 times over current consumption
- Increase in electricity installed capacity by 6-7 times
- Increase in annual coal requirement by nearly 3 times over the current demand

Where, GDP - Gross domestic product

Particulars	2010-11	2011-12	2012-13
Per Capita Consumption (kWh)	819	884	917

Source: Growth of Electricity in India from 1947-2013: CEA Document

Energy Needs of Growing Economy

Requirement of coal, the dominant fuel in India's energy mix will need to expand to over 2 billion tonnes/annum based on domestic quality of coal given India's targeted GDP growth.

India's oil requirements also will increase at a significant rate. India already imports about 75% of its crude oil requirements which are likely to go up more than 90% in the near future as production in existing oil and gas fields are declining as a result of years of use.

The share of natural gas in the energy mix is expected to go upto 20-25% by the year 2030-32.

Nuclear power plant capacity targets as envisaged by the Department of Atomic Energy (DAE) are 20,000 MWe by 2020, 50,000 MWe by 2030 and 250,000 MWe of nuclear power by 2050.

Energy Intensity

Energy intensity on PPP:

Energy intensity is the ratio between the gross inland consumption of energy and the gross domestic product (GDP) for a given calendar year. It measures the energy consumption of an economy and its overall energy efficiency.

$$EI = \frac{FC}{GDP}$$

Where:

EI = Energy intensity, national level, toe per million US $
FC = Total final consumption, national level, toe
GDP= Gross domestic product, million US $

Energy Intensity

What is Purchase Power Parity (PPP)?

An egg in India costs Rs.3/- whereas it costs 30 Yens/- (equivalent to Rs.15) in Japan. The PPP for an egg between Japan and India is 30 Yens to Rs.3 or 10 Yens to a rupee. In other words, for every rupee spent on egg in India, 10 Yens would have to be spent in Japan to obtain the same quality of egg.

Applying actual exchange rates of Yen to Rupee in this process would overestimate the GDP of Japan with high price levels relative to India with low price levels. The use of PPPs ensures that the GDP of all countries is valued at a uniform price level and thus reflects only differences in the actual volume of the economy. Adjustments are required to give a better picture than comparing gross domestic products (GDP) using market exchange rates.

Long term energy scenario for India

Coal

Apart from meeting the energy needs of the industry, coal is the predominant energy source for power production in India accounting for about 60% of the installed capacity. Energy demand in India is expected to increase heavily over the next 10-15 years. Coal will continue to remain the dominant fuel in the Indian economy.

Despite significant increases in the total installed generation capacity during the last decade, the gap between the electricity supply and demand continues to increase. The resulting shortfall has had a negative impact on the industrial output and economic growth.

The coal production stood at around 551.71 Million tonnes by the end of 2013.

Long term energy scenario for India

Oil

India's demand for petroleum products rose from 97.7 million tonnes in 2001-02 to around 175.2 million tonnes by 2013. Domestic crude oil production was 37.788 million metric tonnes (MMT) for the year 2013-14.

India's self sufficiency in oil has consistently declined from 60% in the 1950s to 25% currently. Same is expected to go down to 8% by 2020. About 90% of India's total oil demand by 2020 would have to be met by imports.

Long term energy scenario for India

Natural Gas

In keeping with the world wide trend, the demand for natural gas in India has been on the increase. The production of natural gas which was negligible at the time of independence is now at the level of 35.407 Billion Cubic Meters. To meet the future requirements of natural gas, trans-national gas pipelines are being planned.

While gas pipeline projects would yield results only in long term, immediate relief can come in the form of LNG. Import of LNG will require special terminals to handle them at the ports. The constructions of such terminals have already started and some of them have been commissioned. The world trade in LNG is around 150 Billion Cubic Metres (BCM). Geographically, India is strategically located and is flanked by large gas reserves on both East and West. India is located relatively near to four of top five countries in terms of proven gas reserves viz. Iran, Qatar, Saudi Arabia and Abu Dhabi. The large natural gas market of India is a major attraction to the LNG exporting countries. In order to encourage gas imports, Government has kept import of LNG under Open General License (OGL) and permitted 100% Foreign Direct Investment (FDI)

LNG – Liquified Natural Gas

Long term energy scenario for India

Electricity

With India already reeling under peak demand and energy shortage, increasing economic growth is expected to put heavy pressure on the power sector. For sustaining the current economic growth rate, the capacity will have to be doubled every 10 years.

Accelerated Power Development & Reforms Programme was introduced by the Ministry of Power in 2002-03 in order to improve the power reliability at the distribution level and to achieve commercial viability of State Electricity Boards. The strategies include technical, commercial, financial and IT interventions to achieve the following objectives

- Targets towards the commercial viability of the utilities by reducing their Aggregate Technical & Commercial (AT&C) losses to 15%
- Improvement in quality, supply and reliability of supply
- Improved revenue collection and customer satisfaction

APDRP was later restructured as R-APDRP, the focus of which is on actual, demonstrable performance in terms of loss reduction.

Energy Pricing (in India)

In terms of purchasing power parity, power tariffs in India for industries and commercial establishments are among the highest in the world. The average tariff on PPP basis in India is 30.8 cents/kWh, while it is 7.7 in US, 15.3 in Japan and 20.6 in China.

Electricity tariffs in India are structured in a relatively simple manner. While high tension consumers are charged based on both demand (kVA) and energy (kWh), the low-tension (LT) consumer pays only for the energy consumed (kWh) as per tariff system in most of the distribution companies. The price per kWh varies significantly across States as well as customer segments within a State.

Introduction of Availability Based Tariffs (ABT) and unscheduled interchange charges for power, introduced in 2003 for inter-state sale of power, have reduced voltage and frequency fluctuations.

Energy Pricing (in India)

What is ABT?

- It is a performance-based tariff system for the supply of electricity by generators owned and controlled by the central government
- It is also a new system of scheduling and dispatch, which requires both generators and beneficiaries to commit to day-ahead schedules.
- It is a system of rewards and penalties seeking to enforce day ahead pre-committed schedules, though variations are permitted if notified one and half hours in advance.
- The order emphasises prompt payment of dues. Non-payment of prescribed charges will be liable for appropriate action.

Energy Security

The basic aim of energy security for a nation is to reduce its dependency on the imported energy sources for its economic growth. Energy security is defined as **"The continuous availability of energy in varied forms in sufficient quantities at reasonable prices".**

Energy security is a serious concern because India's energy needs are growing with rising income levels and a fast growing population. The dependence on imported energy is also increasing rapidly due to increasing energy needs. A special concern is that the import of oil is about 75% of total oil consumption. The domestic oil wells are all over 30 years old and the yield from these wells have started reducing. Oil demand is rising at a rate of about 5% every year leading to huge oil import bills.

Poor coal quality and high prices of domestic coal will drive the increase in coal imports from present level of 25%. The imports of gas and LNG (liquefied natural gas) are likely to increase in the coming years. Thus the energy import dependence implies vulnerability to external price shocks and supply fluctuations, which in turn threaten the energy security of the country.

Energy Security

Some of the strategies that can be used to meet future energy requirements include:

- Reducing energy requirements
  - Improving the efficiency of extraction of fossil fuels
  - Improving fuel efficiency of new coal-fired power plants by adopting new technology (i.e. super critical pulverized fuel fired boilers)
  - Adopting energy efficiency and demand side management
  - Promotion of public transport / mass transport (e.g. metro rail, light rail, monorail etc.) in urban areas
  - Developing renewable energy sources especially solar and wind
- Substituting imported oil/gas with domestic alternatives
  - Ethanol / Biodiesl as substitute for petrol / diesel
  - Biomass gasification for heat or power as alternative to gas / coal
  - Coal-to-oil technology as done in South Africa

Energy Security

- Diversifying energy supply sources
  - Mix of fuel comprising of coal, gas, nuclear, hydro and renewables with no dependence on any particular fuel
  - Sourcing oil / LNG from different countries
  - Importing gas through pipelines passing through countries who also benefit
- Expanding energy resource and developing alternative energy sources
  - Improved Oil Recovery (IOR) and Enhanced Oil Recovery (EOR) for improving exploitation of reserves
  - Recovery of oil and gas from abandoned or marginal fields
  - In-situ coal gasification
  - Capturing Coal Bed Methane (CBM) which escapes from coal seams during mining
  - Conversion of coal to oil

Energy Security

- Gas to Liquid (GTL)
- Stepping up exploration to find new reserves (only one-third of oil bearing area explored so far)
- Equity oil, gas, coal from other countries
- Setting up energy intensive units (i.e. fertilizer plants) abroad
- New domestic sources (nuclear –fast breeder reactor, thorium reactors, gas hydrates etc.)
- Promoting Community Biogas Plants
- Energy plantations

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Energy Conservation and its importance

Coal and other fossil fuels, have taken hundreds of millions of years to form, are likely to deplete soon. In the last two hundred years, we have consumed 60% of all resources. For sustainable development, we need to adopt energy efficiency measures.

Today, 85% of India's primary energy comes from non-renewable and fossil sources (coal, oil, etc.). These reserves are continually diminishing with increasing consumption and will not exist for future generations (see Figure).

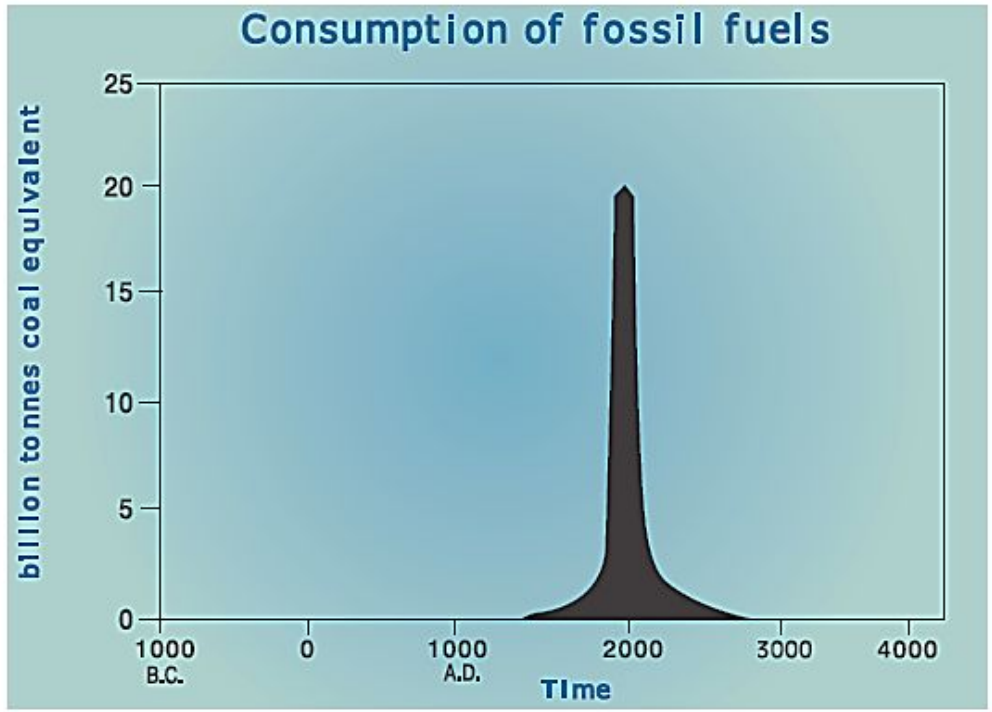


Figure. Consumption of Fossil Fuels

Energy Conservation and its importance

Energy Conservation and Energy efficiency:

Energy Conservation and Energy Efficiency are separate, but related concepts. Energy conservation is achieved when growth of energy consumption is reduced in physical terms. Energy Conservation can, therefore, is the result of several processes or developments, such as productivity increase or technological progress. On the other hand Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels. Promotion of energy efficiency will contribute to energy conservation and is therefore an integral part of energy conservation promotional policies.

Energy Conservation and its importance

Energy efficiency is often viewed as a resource option like coal, oil or natural gas. It provides additional economic value by preserving the resource base and reducing pollution. For example, replacing Incandescent lamps with LED's means will require 1/8th of the energy to light a room. Pollution levels also reduce by the same amount

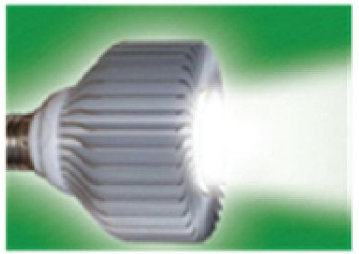
Energy Efficient Equipment uses less energy for same output and reduces CO_2 emissions

Incandescent Lamp
60W

Light output = 800 Lumens

Life span = 1200 hours

CO2 emissions = 48.4 g/hr



LED Lamp
8 W

Light output = 800 Lumens

Life span = 25000 hours

CO2 emissions = 6.4 g/hr

Energy Conservation and its importance

Energy Efficiency Benefits

Industry

- Reduced energy bills
- Increased Competitiveness
- Increased productivity
- Improved quality
- Increased profits !

Nation

- Reduced energy imports
- Avoided costs can be used for poverty reduction
- Conservation of limited resources
- Improved energy security

Globe

- Reduced GHG and other emissions
- Maintains a sustainable environment

GHG – Green-House Gas

Energy Audit

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial Energy Audit is fundamental to a comprehensive energy management programme and is defined in EC Act 2001 as follows:

"Energy Audit" means the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption.

Need for Energy audit:

In any industry, the three top operating costs are often found to be energy (both electrical and thermal), labour and materials. Among the three, energy has the highest potential for cost reduction. Energy audit will help to understand more about the ways energy is used in the industry, and help in identifying the areas where waste can occur and where scope for improvement exists.

Energy Audit

Types of Energy audit:

The type of energy audit to be performed depends on the type of industry, the depth to which final audit is needed, and the potential and magnitude of cost reduction desired. Thus energy audit can be classified into the following types: Preliminary Audit, Targeted Energy Audits and Detailed Audit.

Preliminary Energy Audit

Preliminary energy audit, which is also known as Walk-Through Audit and Diagnostic Audit, is a relatively quick exercise and uses existing, or easily obtained data. The scope of preliminary energy audit is to:

- Establish energy consumption in the organization (sources: energy bills and invoices)
- Obtain related data such as production for relating with energy consumption
- Estimate the scope for energy savings
- Identify the most likely and the easiest areas for attention (e.g. unnecessary lighting, higher temperature settings, leakage etc.)
- Identify immediate (especially no-/low-cost) improvements/ savings
- Set up a *baseline* or *reference point* for energy consumption
- Identify areas for more detailed study/measurement

Energy Audit

Some example of no-cost energy management measures are:

- Arresting leaks (steam, compressed air)
- Controlling excess air by adjusting fan damper

Some examples of low-cost energy management measures are:

- Shutting equipment when not needed (e.g. idle running of motors)
- Replacement with appropriate lamps and luminaires

Areas for detailed study/measurement are:

- Converting from direct to indirect steam heated equipment and recovery of condensate
- Installing / upgrading insulation on equipment
- Modifying process to reduce steam demand
- Investigating scheduling of process operations to reduce peak steam or water demands
- Evaluating waste heat streams for potential waste heat recovery

Energy Audit

Targeted Energy Audits

Targeted energy audits often results from preliminary audits. They provide data and detailed analysis on specified target projects. For example, an organization may target its lighting system or boiler system or steam system or compressed air system with a view of effecting energy savings. Targeted audits therefore involve detailed surveys of the target subjects and analysis of the energy flows and cost associated with the targets. Final outcome is the recommendations regarding actions to be taken.

Detailed Energy Audit

Detailed energy audit is a comprehensive audit and results in a detailed energy project implementation plan for a facility, since it accounts for the energy use of all major equipment. It considers the interactive effects of various projects and offers the most accurate estimate of energy savings and cost. It includes detailed energy cost saving calculations and project implementation costs.

One of the key elements in a detailed energy audit is the energy balance. This is based on an inventory of energy-using systems, assumptions of current operating conditions, measurements and calculations of energy use.

Energy Audit

Ten Steps Methodology for Conducting Detailed Energy Audit

Step No	PLAN OF ACTION	PURPOSE / RESULTS
PHASE I –PRE AUDIT PHASE		
Step 1	• **Plan and Organise** • **Walk through Audit** • **Informal Interview** with Energy Manager, Production / Plant Manager	• Establish/organize a **Energy audit team** • Organize Instruments and time frame • Macro data collection (suitable to type of industry.) • Familiarization with process / plant activities • First hand observation and Assessment of current level of operation and practices
Step 2	• **Introductory Meeting** with all divisional heads and persons concerned with energy management (1-2 hrs.)	• To built up cooperation and rapport • Orientation, awareness creation • Issue questionnaire tailored for each department

Energy Audit

PHASE II –AUDIT PHASE		
Step 3	• **Primary data gathering, Process Flow Diagram and Energy Utility Diagram**	• Historic data collection and analysis for setting up **Baseline energy consumption** • All service **utilities system diagram** (e.g. Single line power distribution diagram, water, and compressed air and steam distribution). • Prepare **process flow charts** • Design, operating data and schedule of operation • Annual Energy Bill and **energy consumption pattern** (Refer manual, logbook, name plate etc.)
Step 4	• **Conduct survey and monitoring**	• **Measurements** : Motor survey, Insulation, lighting survey etc. with portable instruments for operating data. Confirm and compare operating data with design data.
Step 5	• **Conduct of detailed trials** / tests for selected major energy equipment	• **Trials / Tests** - 24 hours power monitoring (MD, PF, kWH etc.). - Load variations trends in pumps, fan compressors etc. - Boiler Efficiency trials for (4-8 hours) - Furnace Efficiency trials - Equipments Performance tests etc

Energy Audit

Step 6	• **Analysis of energy use**	• **Energy and Material balance** • **Energy loss/waste analysis**
Step 7	• **Identification and development of Energy Conservation (ENCON) opportunities**	• Conceive, develop and refine ideas • Review ideas suggested by unit personnel • Review ideas suggested in previous energy audit report if any • Use brainstorming and value analysis techniques • Contact vendors for new / efficient technology
Step 8	• **Cost benefit analysis**	• Assess technical feasibility, economic viability and prioritization of ENCON options for implementation • Select the most promising projects • Prioritise by low, medium, long term measures
Step 9	• **Reporting and Presentation** to the Top Management	• Documentation, draft Report Presentation to the top Management. • Final report preparation on feedback from unit
PHASE II –POST AUDIT PHASE		
Step 10	• **Implementation and Follow-up**	**Implementation of ENCON recommendation measures** and Monitor the performance • Action plan, schedule for implementation • Monitoring and periodic review

Energy Audit

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