

## Session 2



## Unit – 1 : Present Energy resources in India and its sustainability

### Syllabus

#### Session

1. Present Energy resources in India and its sustainability:
2. Energy Demand Scenario in India,
3. Different type of conventional Power Plant, Advantage and Disadvantage of conventional Power Plants,
4. Conventional vs Non- conventional power generation.

# Types of Energy and Classification

## 1.1 Introduction



- Energy is defined as the ability to do work or as the ability to carry a heat transfer. Energy has many different forms (thermal, electrical, chemical, nuclear etc.)
- All forms of life and society require Energy
- We also need energy for society to function and live
- Energy is one of the major **inputs for the economic development** of any country. But critical requirement for developing nations for basic needs
- Energy can be classified as
  - Primary energy and secondary energy
  - Commercial and non commercial energy
  - Renewable and non-renewable energy

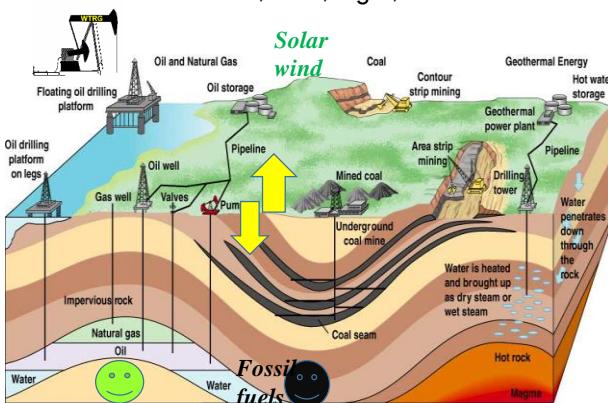
© 2020 EnSave consultancy and Training Pvt. Ltd

3



## 1.2 Primary Energy

Energy resources removed from the earth's crust include: Oil, Coal ,N. gas, and uranium



- ❑ Primary energy : All types of energy extracted or captured directly from natural resources.
- ❑ It is classified into two distinctive groups
  - Renewable ( Ex. solar, wind, biomass etc.)
  - Non-renewable (fossil fuels: oil , coal, N.Gas, etc.)
- ❑ Primary energy contributes, over 85% from fossil fuels. Non-renewable
- ❑ Fossil fuels, is not sustainable in the long term as it affects the natural environment and clear evidence for Climate change caused by human activity
- ❑ Primary Energy Content of all the fuel is expressed as toe (tonne of oil equivalent).

$$1\text{ toe} = 1 \times 10^7 \text{ kcal} = 11630 \text{ kWh} = 41868 \text{ MJ}$$

© 2020 EnSave consultancy and Training Pvt. Ltd

4

## Major Primary and Secondary Energy Sources

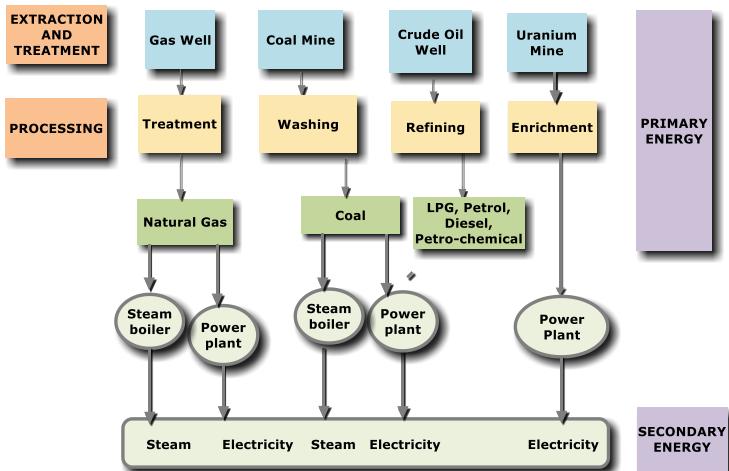


Fig 1.1

- Primary energy are mostly converted into secondary energy sources in industrial utilities
- Primary energy can **also be used directly.** Ex. coal or natural gas is used as a **feedstock in fertilizer plants**

Secondary Energy Sources are derivatives from Primary Energy Sources.  
(ex: **electricity, steam etc.**)

© 2020 EnSave consultancy and Training Pvt. Ltd

5

## Commercial Energy and Non Commercial Energy

### Commercial Energy

- Energy that is available in the market for a definite price

• Commercial fuels are predominant sources of energy not only for industrial use, but also for many household needs.

### Example.

1. **Electricity**
2. **Coal**
3. **refined petroleum products**
4. **natural gas**



### Non-Commercial Energy

- Energy which is sourced within a community and its surrounding area, and which is not normally traded in the commercial market

### Example.

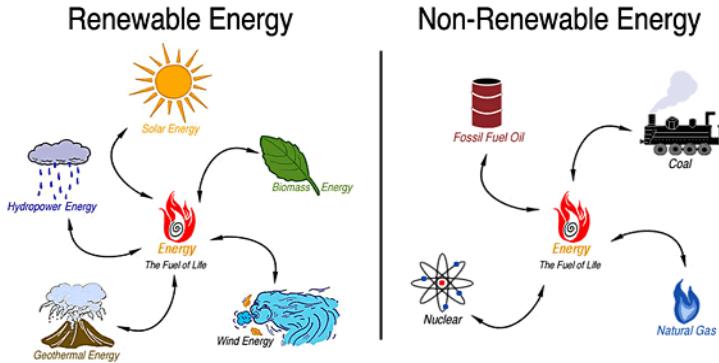
1. **Firewood, agro waste** in rural areas,
2. **solar energy** for water heating, electricity generation, drying grain, fish
3. **Animal power** for transport, threshing, lifting water
4. **wind energy** for lifting water and electricity generation.



© 2020 EnSave consultancy and Training Pvt. Ltd

6

## 1.4 Renewable and non-renewable energy



Renewable energy is the energy **obtained from natural sources** which are essentially **inexhaustible**.

It is a natural **\_resource which cannot be produced, grown, replenished.**

© 2020 EnSave consultancy and Training Pvt. Ltd

7



### 3. Major Renewable energy: Solar & Wind

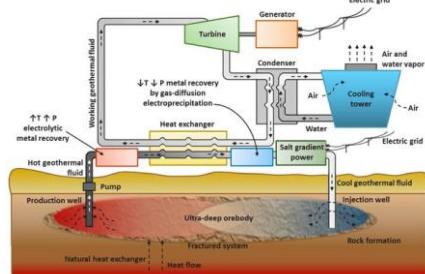
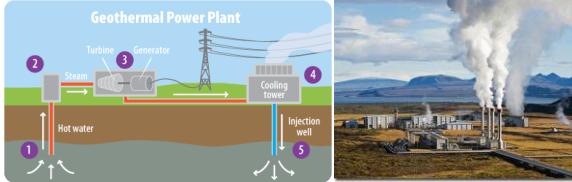


- **Solar energy** is radiant light and heat from the **Sun** that is harnessed into thermal or electrical energy
- It is the cleanest ,most abundant ,fastest growing and cheapest renewable source in the world
- Ex **solar heating, photovoltaics, solar architecture , molten salt power plants**



- **Wind energy** refers to capturing the **energy** from moving air, i.e., **wind**, and converting it into electricity
- Wind is caused by the uneven heating of the atmosphere by the sun, variations in the earth's surface, and rotation of the earth.
- Ex: windmill, wind pump, or wind charger.
- Wind energy is known to be used as early as 200 B.C

### 3.Major Renewable energy: Geothermal energy



- Geothermal energy is heat derived within the sub-surface of the earth. Water or steam carry the geothermal energy to the Earth's surface. It can be used for heating and cooling or to generate clean electricity

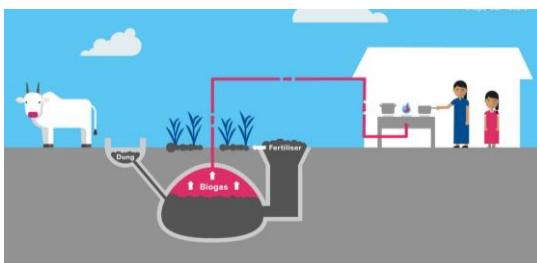
- Hydrothermal power generation, also known as [ocean thermal energy conversion](#) (OTEC) is the practice of producing electric power from the potential energy of water temperature differences of at least 20°C
- Hydrothermal energy is the process of obtaining heat from a large body of water. It is a kind of geothermal energy on seabed. Organic Rankine Cycle (ORC) is a method of exploiting heat energy to become electricity

9

### 3.Major Renewable energy : Bio-fuels & Bio-gas



- Biofuels can be produced from plants, agricultural and industrial wastes
- Biofuel is a cost-effective and environmentally [benign alternative](#)



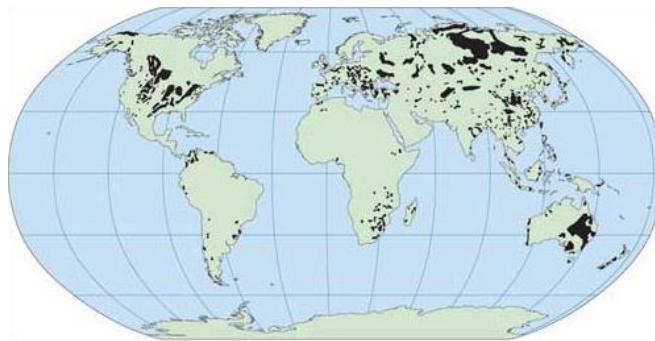
- **Biogas** is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen (methane and carbon dioxide).
- Biogas is environment friendly and has various applications in cooking, drying, cooling, heating etc. It is used in the production of electricity, methanol and steam.

10

## Quiz

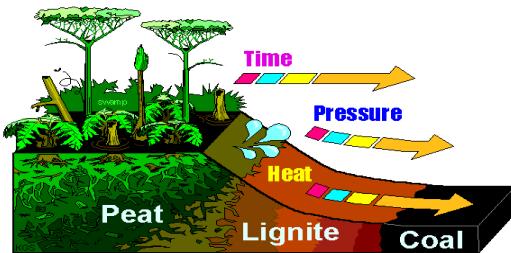
1	<b>Which one of the following is not a Renewable energy ?</b>	
	a) solar      b) wood      c) nuclear      d) wind	
2	<b>Which one of the following is Non-Renewable energy?</b>	
	a) Bio mass      b) Geothermal      c) Hydropower      d) Natural Gas	

## World Energy Scenario Global Energy Reserves, production and Consumption



## 1.5 Global Primary Energy Reserves and Commercial Energy Production

### How coal formed ?



**Coal** : Coal is the most abundant and geographically dispersed fossil fuel and exists as **peat**, **brown coal (lignite)**, **sub-bituminous**, **bituminous** and **anthracite**

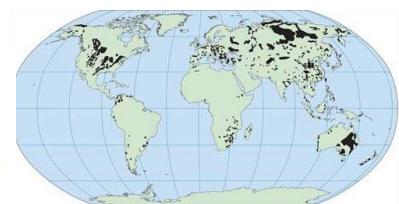
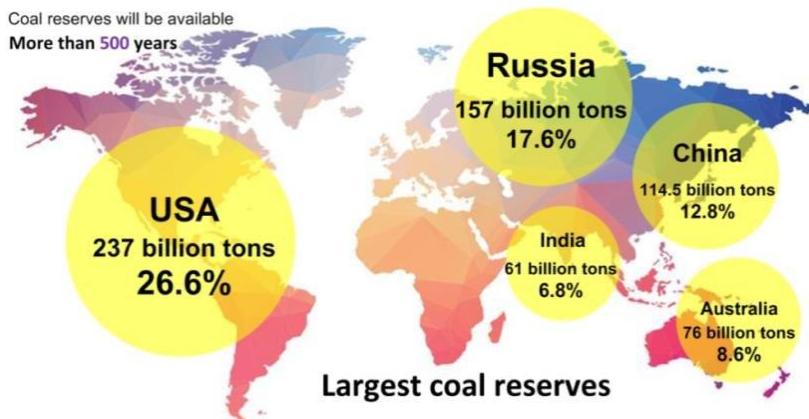
Estimated that there are around 892 billion tonnes of proven coal reserves worldwide. **Proved coal reserves are shown for anthracite and bituminous (including brown coal) and sub-bituminous and lignite.**

There is enough coal to last around 113 years at current rates of production

© 2020 EnSave consultancy and Training Pvt. Ltd

13

**Proven Coal reserves** are available in almost every country worldwide with recoverable reserves in around 75 countries. The largest coal reserves are available in the USA followed by Russia, China, Australia and India



India is fifth largest coal reserves in the world.

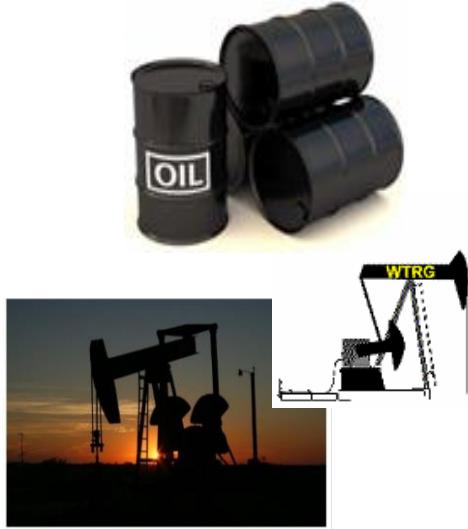
➤ India is second largest in coal consumption after China

© 2020 EnSave consultancy and Training Pvt. Ltd

14

# Oil

## How Oil Formed ?



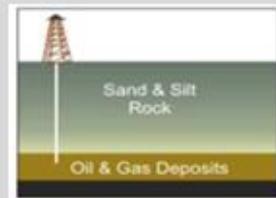
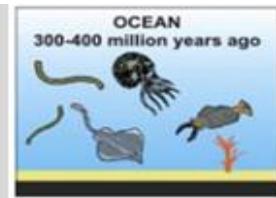
© 2020 EnSave consultancy and Training Pvt. Ltd

15

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of silt and sand

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down the layers of sand, silt and rock to reach the rock formations that contain oil and gas deposits.

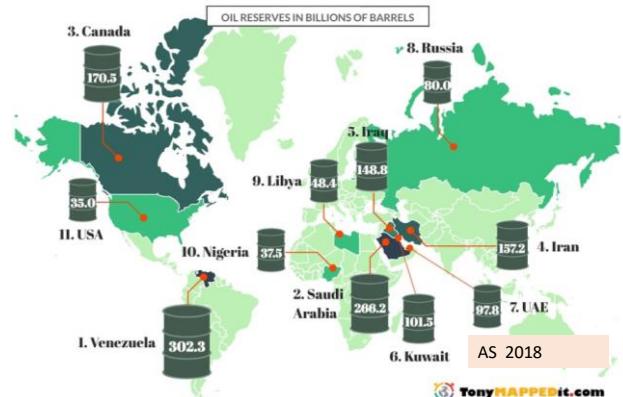


## Proven World OIL Reserves

- The **global proven oil (crude) reserve** was estimated to be **1687.9 billion barrels** by 2013.
- Middle East** alone has about **48 % of the proven oil reserves**
- Saudi Arabia** has the largest reserve of 15.8%.

Country	Billion tonnes	Billion barrels	Share of total, %	R/P years
Venezuela	56.6	298.3	17.7	> 100
Saudi Arabia	36.5	265.9	15.8	63.2
Canada	28.1	174.3	10.3	> 100
Iran	21.6	157	9.3	> 100
Iraq	20.2	150.0	8.9	> 100
India	0.8	5.7	0.3	17.5
Others	74.4	636.7	37.7	-
<b>World</b>	<b>238.2</b>	<b>1687.9</b>	<b>100</b>	<b>53.3</b>

## Proved Oil Reserves



© 2020 EnSave consultancy and Training Pvt. Ltd

16

# World OIL Production

Table: Top Oil Producing Countries by End of 2013

(Source: BP Statistical Review of World Energy June 2014)

Region	Million tonnes per year	Share of total, %
Saudi Arabia	542.3	13.1
Russia	531.3	12.9
USA	446.2	10.8
China	208.1	5.0
Canada	193	4.7
Iran	166.1	4.0
Iraq	153.2	3.7
Nigeria	111.3	2.7
Others	2351.5	43.1
<b>World</b>	<b>4130.2</b>	<b>100</b>

The top oil producing countries **Saudi Arabia was the largest oil** (end of 2013) followed closely by Russian Federation and USA. Although the United States ranks third in terms of oil production, it only ranks tenth in terms of proven oil reserves.

As against the top producing countries (end of 2013), **India's share is 42 million tonnes and share of total is 1%.**

© 2020 EnSave consultancy and Training Pvt. Ltd

17

## World Oil Import



# NATURAL GAS

**Natural gas resources** are large, but, like oil, they are highly concentrated in a few countries.

- Global proved gas reserve was estimated of **186 trillion cubic metres** by the end of 2013.
- **Iran has the largest share of the reserve followed by Russia and Qatar.**
- **India has only about 0.7%** of global natural gas reserves.



## Top Natural Gas Consumers

USA is the world's largest **natural gas consumer** at around 22% followed by **Russia** at around 12%..



© 2020 EnSave consultancy and Training Pvt. Ltd

18

# Indian Energy Scenario

## Indian Energy Reserves, production & Imports and Consumption



© 2020 EnSave consultancy and Training Pvt. Ltd

19

## 1.7 Indian Energy Scenario

**primary energy consumption mix in India**

Energy Type	Mtoe	% share in total primary Energy Consumption
Oil	175.2	29.5%
Natural Gas	46.3	7.8%
Coal	<b>324.3</b>	<b>54.5%</b>
Nuclear energy	7.5	1.3%
Hydro Power	29.8	5.0%
Renewable energy	11.7	2.0%
<b>Total Primary Energy consumption</b>	<b>595</b>	<b>100.00</b>

- Coal dominates the energy production mix in India, contributing to about **55% of the** total primary energy production.
- There is a gradual **increase in the share of natural gas** in primary energy production

© 2020 EnSave consultancy and Training Pvt. Ltd

20

# Energy Supply-Coal Sector

- India has huge coal reserves of about 60.6 billion tonnes
- This amount to about 6.8 % of the world reserves and it may last for about 100 years
- India is one of the largest producers of coal and lignite in the world.
- Majority of the coal (**over 80%**) is mined only upto 150 - 300 m depth with open cast mining and balance 20% of coal is mined from underground mines.



© 2020 EnSave consultancy and Training Pvt. Ltd

21

## Oil Sector

### Importing 30% of coal consumption

Coal use: Coking 10%, non coking 90%

76% of electricity generated from coal

Avg power plant efficiency: 28-32% Most efficient- 45%

India is the fourth largest oil-consuming country in the world. India **imports over 82%** of its crude oil needs, mainly from Gulf nations. In terms of sector wise petroleum products consumption, transport sector is the largest followed by domestic and industry sector. Table below gives the crude oil import bill trend over the last few years.

India has 0.3% of world Oil reserves  
India consuming 4.8% of world oil consumption.

© 2020 EnSave consultancy and Training Pvt. Ltd

22

## Natural Gas Sector

- Natural gas (mainly [methane](#))- **environmentally friendly**, greater efficiency and cost effectiveness.
- Termed as the **fuel of the 21st century**.

### Liquefied Natural Gas (LNG)

- When natural gas is cooled to **-161°C**, it is transformed into **Liquefied Natural Gas (LNG)** for **ease of storage and transportation**.
- Liquefaction reduces the volume occupied by the natural gas **by 600 times** and LNG is transported in specially built ships with cryogenic tanks.

### Compressed Natural Gas (CNG)

- [Natural gas](#) is compressed to less than 1% of the volume it occupies at std [atmospheric pressure](#).
- CNG can be used in petrol vehicles / converted into [bi-fuel vehicles](#) (petrol/CNG).

India's **gas reserves** are estimated at 1.4 trillion cubic metres by end of 2013 which amounts to about **0.7%** of the total World reserves.

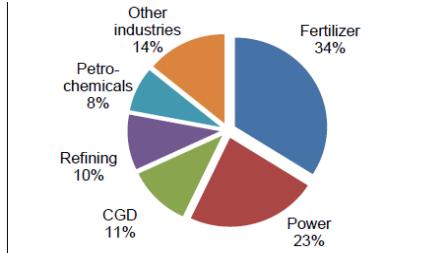


Figure 1.11: Gas Demand by Sector FY 2015-16  
Source: MoPNG

© 2020 EnSave consultancy and Training Pvt. Ltd

23

## Installed Power Generating Capacity of India



**Thermal -64.8%**



**Hydro -13.2%**



**Renewable-20.1%**



**Nuclear -2.0%**

**Total = 3,70,106 KW**

- India is the **world's third largest producer and consumer of electricity** with capacity of 344 GW as on 31 Mar 2020.
- India's electricity sector is dominated by coal-based power plant for meeting about **76.2%** of all electricity.

© 2020 EnSave consultancy and Training Pvt. Ltd

24

## Nuclear Power Supply

- India currently operates 21 nuclear power units at seven locations..
- The installed capacity of nuclear power plant is 6780 MW
- Nuclear power contributes to only about **2 % of the total installed capacity in India.**
- The Uranium produced in India is **2-3 times costlier** since **Indian ores contain only about 0.1% Uranium compared to 12-13% in the Uranium ores mined abroad.**



© 2020 EnSave consultancy and Training Pvt. Ltd

25

## Hydro Power Supply

Indian hydro power capacity of over **84,000 MW at 60% load factor**. Around 80% of this has been identified in the Brahmaputra, Indus and Ganges basins.

The **share of hydropower in the country's** total generated units has steadily decreased over time and it stands at about 17% by 2013 Development of **small and mini hydro power** at an accelerated ( for 15000MW) .

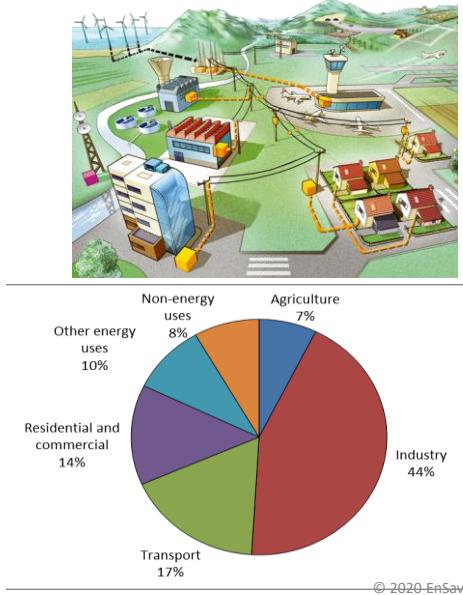
Projects up to 25 MW have been brought under the domain of the **MNRE**, while projects beyond 25 MW continue to remain under the **Ministry of Power**.



© 2020 EnSave consultancy and Training Pvt. Ltd

26

## 1.8 Sector wise Energy Consumption in India



The major commercial energy consuming sectors in the country are shown in the figure.

**The industrial sector consumes almost 44 % of the total commercial energy consumption followed by transport.**

## 7. Sectors that use energy :Residential & Commercial sector

Residential sector



- The **rural households** in India uses biomass to meet 85% of their cooking needs, while the urban meet 56% of their cooking through LPG.
- Almost **70% of the population** in India is rural household, which accounts for only 42% of the demand for oil, gas and electricity.
- The use of electricity is growing rapidly in the residential sector.

Commercial sector



The energy consumption for **commercial building** and services activities is growing rapidly due to high growth rate in commercial establishments, hotels, shopping malls, IT parks and hospitality industry.

## 7. Sectors that use energy : Transportation and Agricultural sector

**Transportation sector**



- Energy consumption in transportation sector is **growing at 16% per annum**.
- **This sector almost consumes around 40% of the petroleum products.**
- By the end of 2030, out of the total transport energy demand, Road vehicles would account for 86% followed by aviation at 9%. Railways, marine and others are expected to consume 5%.

**Agricultural sector**



- Both electricity and diesel consumption increases in agriculture sector due mechanized farming.
- The electricity consumption in **agriculture sector** has increased at faster rate compared to other sectors during the last four decades

29

## 9 Strategies to meet energy needs –Energy Security

**Reducing energy requirements**



- Improving the efficiency of extraction of fossil fuels
- Installing super critical boilers
- Adopting **energy efficiency & DSM**
- Promotion of mass transport & **renewable energy sources**



**Diversifying energy supply sources**

- Modify the Energy Mix with no dependence on any particular fuel
- Sourcing oil / LNG from different countries
- Importing gas through pipelines from neighbouring countries



**Substituting imported oil/gas with domestic alternatives**

- Ethanol / Biodiesel as substitute for petrol / diesel
- Biomass gasification for heat or power as alternative to gas / coal.
- Conversion of coal to oil ,Gas to Liquid (GTL)
- Biogas Plants, Energy plantation

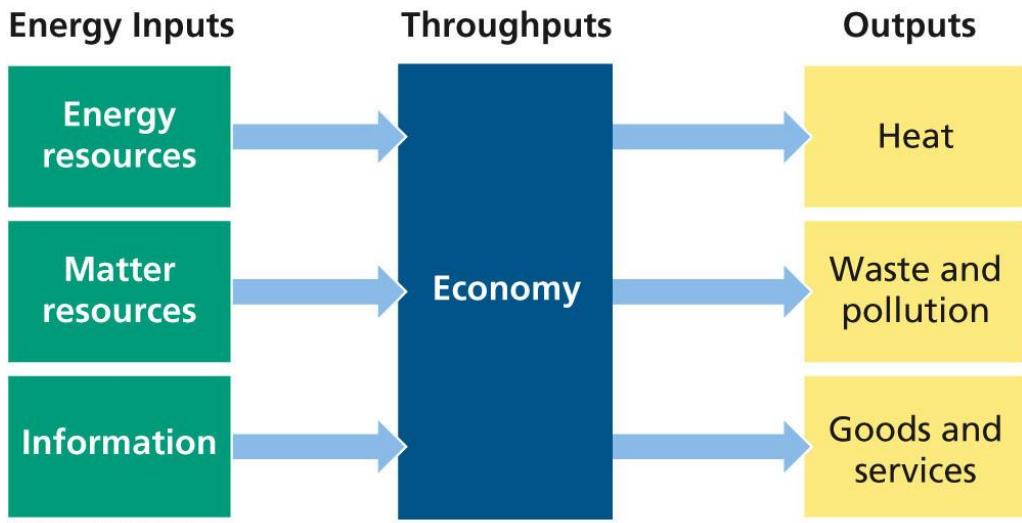


**Expanding and developing alternative energy sources**

- Improved Recovery of oil and gas from abandoned or marginal fields
- In-situ coal gasification/Capturing Coal Bed Methane
- Stepping up exploration to find new reserves

30

# Inputs, Throughput, and Outputs of an Economic System



Manufacturing Chain

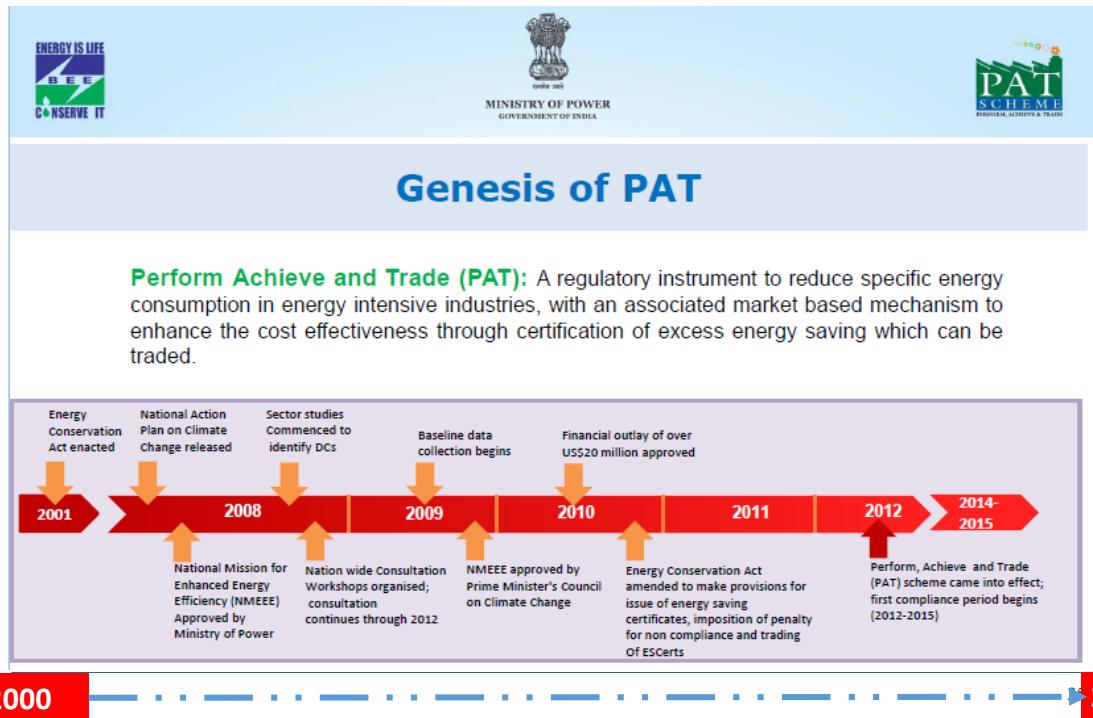
connected thinking in core engineering





## Knowledge Check

7. The major source of electrical power generation in India is
- a) thermal      b) hydel      c) nuclear      d) wind
8. Nuclear energy development in India is constrained by
- a) low % of Uranium in the ore      b) inadequate supply of Uranium
  - c) constraints in import of Uranium      d) all of the above



## 2.3 Schemes of BEE under the Energy Conservation Act-2001



1. Energy Conservation Building Codes (**ECBC**)
2. Standards and Labeling (**S & L**)
3. Designated Consumers (**DCs**)
4. Demand Side Management (**DSM**)
5. Bachat Lamp Yojana (**BLY**)
6. Promoting Energy Efficiency in Small and Medium Enterprises (**SMEs**)
7. Certification of energy auditors and energy managers, **CEM/CEA**

## Appliances/equipment notified under S&L program

### Mandatory labelling & under Voluntary labelling

Products notified under **mandatory labelling**  
As of September 2018,

1. Frost Free (no-Frost) Refrigerators
2. Tubular Fluorescent Lamps
3. Room Air Conditioners
4. Distribution Transformers
5. Room Air Conditioners (Cassette, Floor Standing Tower, Ceiling, Corner AC)
6. Direct Cool Refrigerators
7. Electric Geysers
8. Color TV
9. Room Air Conditioners (Inverter type)
10. LED lamps

- The BEE S&L scheme is invoked for 22 equipment/appliances including 10 for which it is mandatory (sep 2018)



Products under **voluntary labelling** As on September 2018,

1. Induction Motors
2. Agricultural pump sets
3. Ceiling fans
4. Domestic Liquefied Petroleum Gas Stoves
5. Washing machine (Presently process of revising)
6. Computer (Notebook/Laptops)
7. Ballast (Electronic/Magnetic)
8. Office equipment's (Printer, Copier, Scanner)
9. Diesel Engine Driven Monoset Pumps for Agricultural
10. Solid State Invertor
11. Diesel Generator
12. Chiller

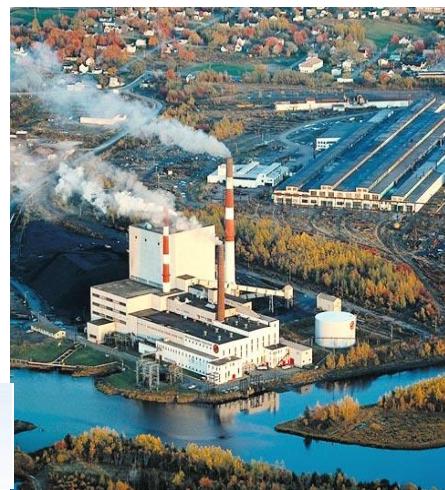
© 2020 EnSave consultancy and Training Pvt. Ltd

37

## Energy Audit in Industry-Mandatory

- Electrical system, Transformers
- Lighting
- Motors
- HVAC systems
- Pumps and blowers
- Compressed air system
- Heating and cooling processes
- Boilers/Furnaces
- Refrigeration
- Drying
- Waste Treatment

Conduct Energy Audit in Industry



Fuel & Power bill in  
Rs.....Crores/yr

38

# Building energy audit +Green Buildings Initiatives



Electricity  
Oil & Gas  
Water  
Embedded energy material

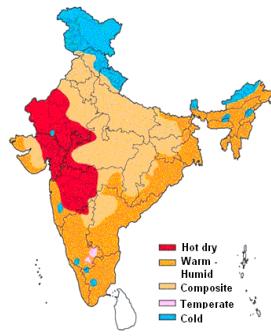
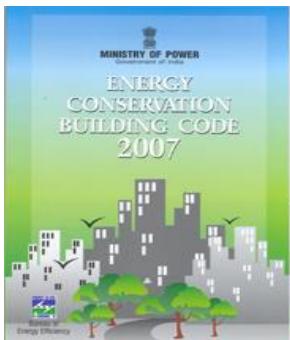
- Lighting and fan
- Air conditioning
- Refrigeration
- Water pumps
- Boiler & steam
- Invertors/DGSets

- Washing machines
- Electric heater, Iron box
- Kitchen equipments
- Computer
- UPS
- Transport

ECBC / Green buildings ?

39

## ENERGY CONSERVATION BUILDING CODE [ECBC]

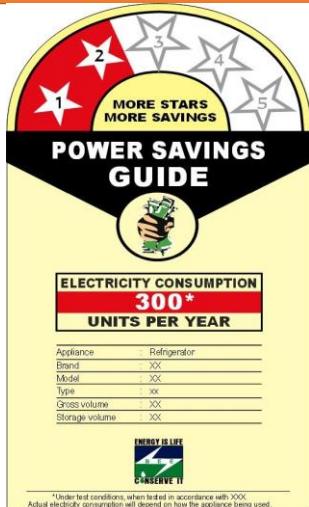


### Energy Use for buildings

Building would get a 5-Star rating if its EPI falls below **90 kWh/sq m/year** and 1 Star if it is between **165-190 kWh/sq m/year**

# Standards and Labeling of Appliances

- Energy labeling to enable consumers to make informed choice
  - Domestic devices
  - Agriculture pumps and motors
  - Industrial equipments



Products notified under **mandatory labelling**

As of September 2018, the following products have been notified under mandatory labelling:

1. Frost Free (no-Frost) Refrigerators
2. Tubular Fluorescent Lamps
3. Room Air Conditioners
4. Distribution Transformers
5. Room Air Conditioners (Cassette, Floor Standing Tower, Ceiling, Corner AC)
6. Direct Cool Refrigerators
7. Electric Geysers
8. Color TV
9. Room Air Conditioners (Inverter type)
10. LED lamps

S&L scheme is invoked for 21 equipment/appliances mandatory.

41

## Energy Management

**Energy management** is the process of monitoring, controlling, and **conserving** energy in an Industry or organization



### Energy conservation

- Behavior that results in the use of less energy
- e.g. Turning the lights off when leaving the room
- Stop idling machine, motors

- Starting point is [Employee Awareness](#) and Behavioural change



### Energy Efficiency

- Using technology that requires less energy to perform the same function
- Using LED bulb instead of CFL
- USE Energy efficient motor, pumps etc

It will save energy without any human involvement

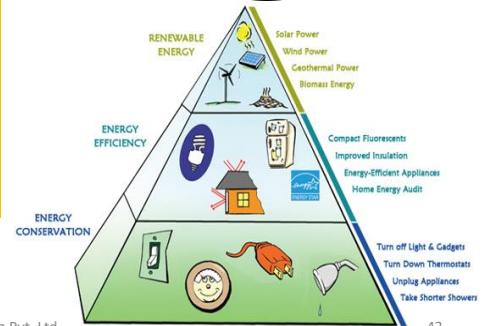
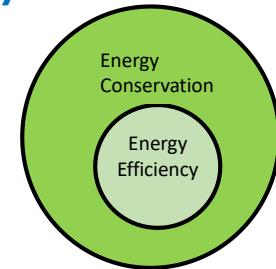


## What is the Difference between Energy Conservation and Energy Efficiency?

**Energy conservation** is achieved when growth of energy consumption is reduced in physical terms  
Energy Conservation is the result of several improvements such as productivity improvement or Technological advances.

**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.

In simple terms, energy efficiency means using less energy to perform the same function



© 2020 EnSave consultancy and Training Pvt. Ltd

43

## Energy Conservation and its Importance

Promotion of energy efficiency will contribute to energy conservation and is therefore an integral part of energy conservation promotional policies.

LED ,BLDC fan IE4 motors

### Example

Replacing Incandescent lamps with LEDs will require about 1/8<sup>th</sup> of the energy to light a room. Pollution levels also reduce by 1/8<sup>th</sup> the initial pollution amount.

Energy Efficient Equipment uses less energy for same output and reduces CO<sub>2</sub> emissions



Incandescent Lamp  
60 W

Light output= 800 Lumens

Life span = 1200 hours

CO<sub>2</sub> emissions = 48.4 g/hr



LED Lamp  
8 W

Light output= 800 Lumens

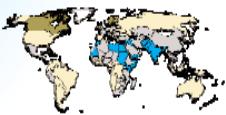
Life span = 25000 hours

CO<sub>2</sub> emissions = 6.4 g/hr

Figure 1.6 Energy Efficient Equipment

© 2020 EnSave consultancy and Training Pvt. Ltd

44

Energy Efficiency Benefits		
Industry	Nation	Globe
 <ul style="list-style-type: none"> <li>• Reduced energy bills</li> <li>• Increased Competitiveness</li> <li>• Increased productivity</li> <li>• Improved quality</li> <li>• Increased profits !</li> </ul>	 <ul style="list-style-type: none"> <li>• Reduced energy imports</li> <li>• Avoided costs can be used for poverty reduction</li> <li>• Conservation of limited resources</li> <li>• Improved energy security</li> </ul>	 <ul style="list-style-type: none"> <li>• Reduced GHG and other emissions</li> <li>• Maintains a sustainable environment</li> </ul>

What nation can do?

EC Act 2001, ECBC, PAT ETC

What Industry/ Individual can do?

Do energy audit & take action to conserve energy

© 2020 EnSave consultancy and Training Pvt. Ltd

45



# Q & A

## Thank You

*Save energy and water for Sustainable Life*

