CH2356 Energy Engineering

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Energy Efficient Measures

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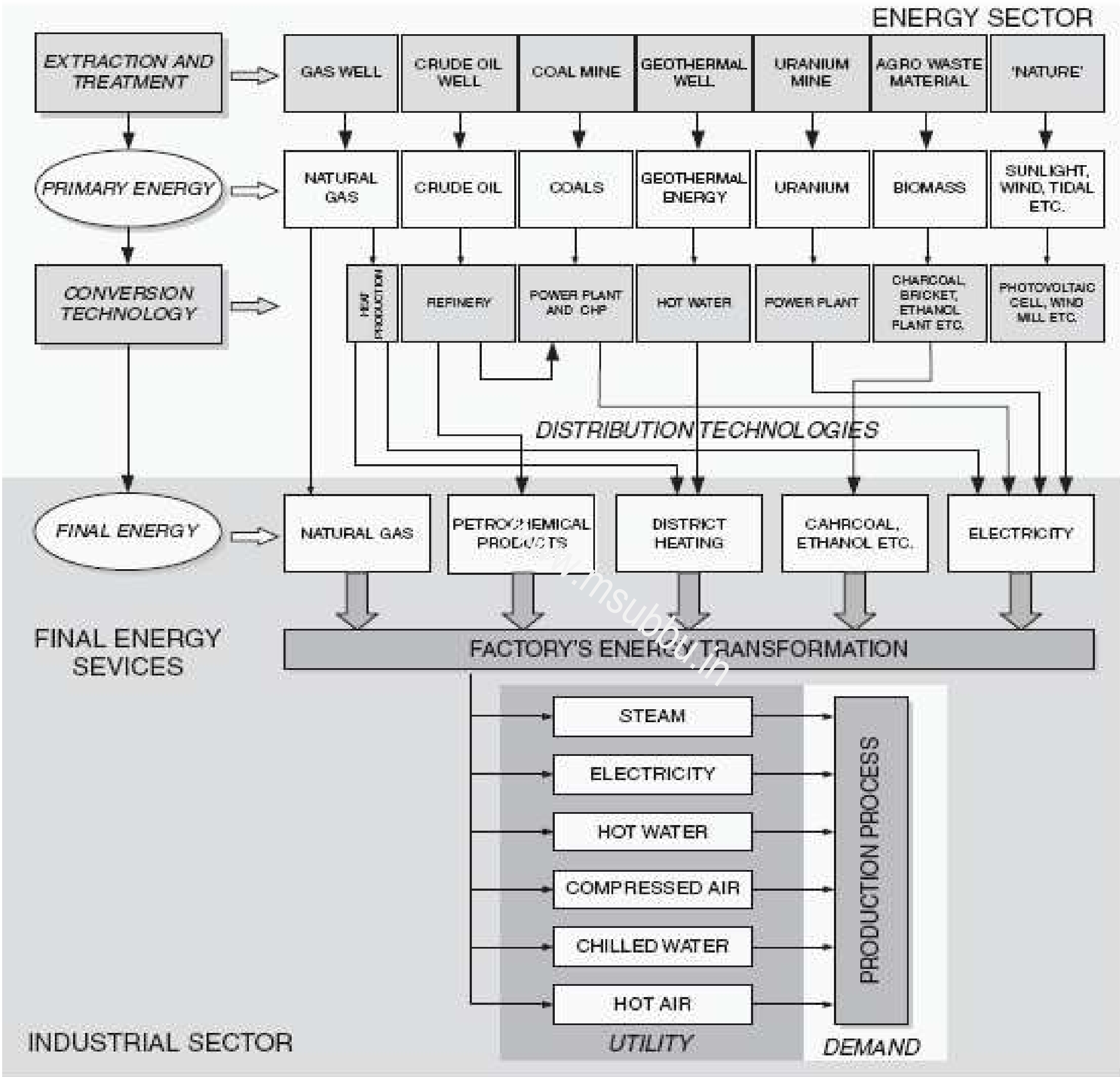


Energy conversion steps from primary energy to end users

India’s Status

- By 2031-32, the power generation capacity must increase to nearly 800 GW from the current capacity of 160 GW.
- There is huge potential for saving energy through different mechanisms. It is estimated that nearly 25 GW of energy could be saved through energy efficiency measures (*The Bulletin on Energy Efficiency, Vol. 8, 2008*)
- The economy has an energy saving potential up to 23 percent as a whole.

Energy Saving Potential of key sectors	
Agricultural sector	30 %
Industry	25 %
Domestic sector	20 %
Commercial sector	20 %

	Sector	Power & Fuel cost as % of Production cost
1	Cement	43.7
2	Caustic Chlor	40.7
3	Aluminium	33.4
4	Glass	30.9
5	Ceramic	25.3
6	Copper	24.0
7	Paper	23.7
8	Fertiliser	18.4
9	Foundry	13.7
10	Steel	13.3
11	Sponge Iron	12.8
12	Synthetic Textiles	11.3
13	Textile	10.3
14	Engineering	6.0
15	Tyre	7.7
16	Drugs & Pharma	4.6
17	Dairy	4.2
18	Sugar	2.0*
19	Petro Chemical	2.0
20	Refinery	2.0

Source: Investors Manual for Energy Efficiency (IREDA)

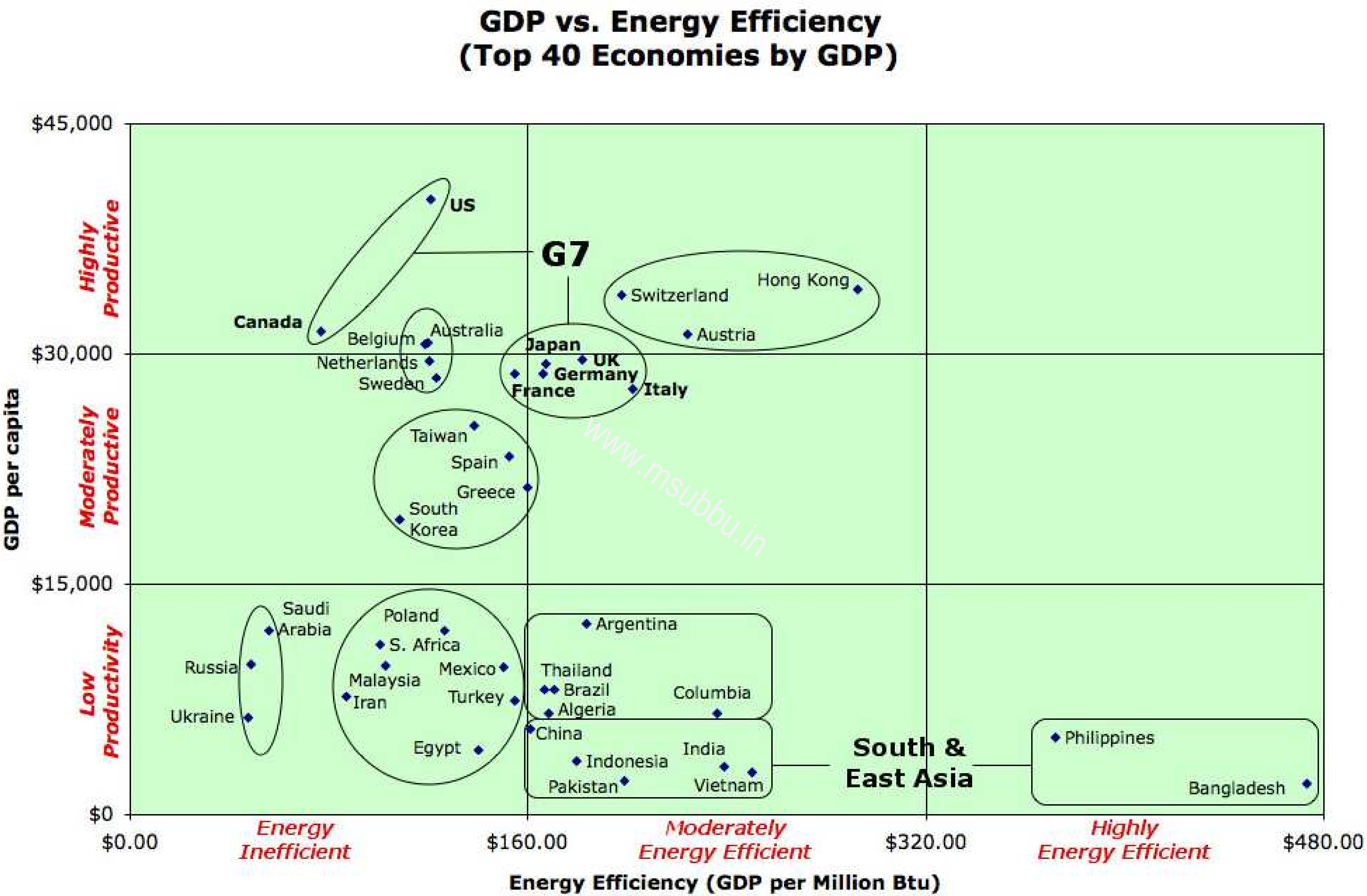
Energy Intensity

- The energy intensity is a statistical concept which is defined as the energy consumption per unit of output
- Energy intensity of a nation:

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

where:

EI = Energy intensity, national level
FC = Total final consumption, national level
GDP = Gross domestic product

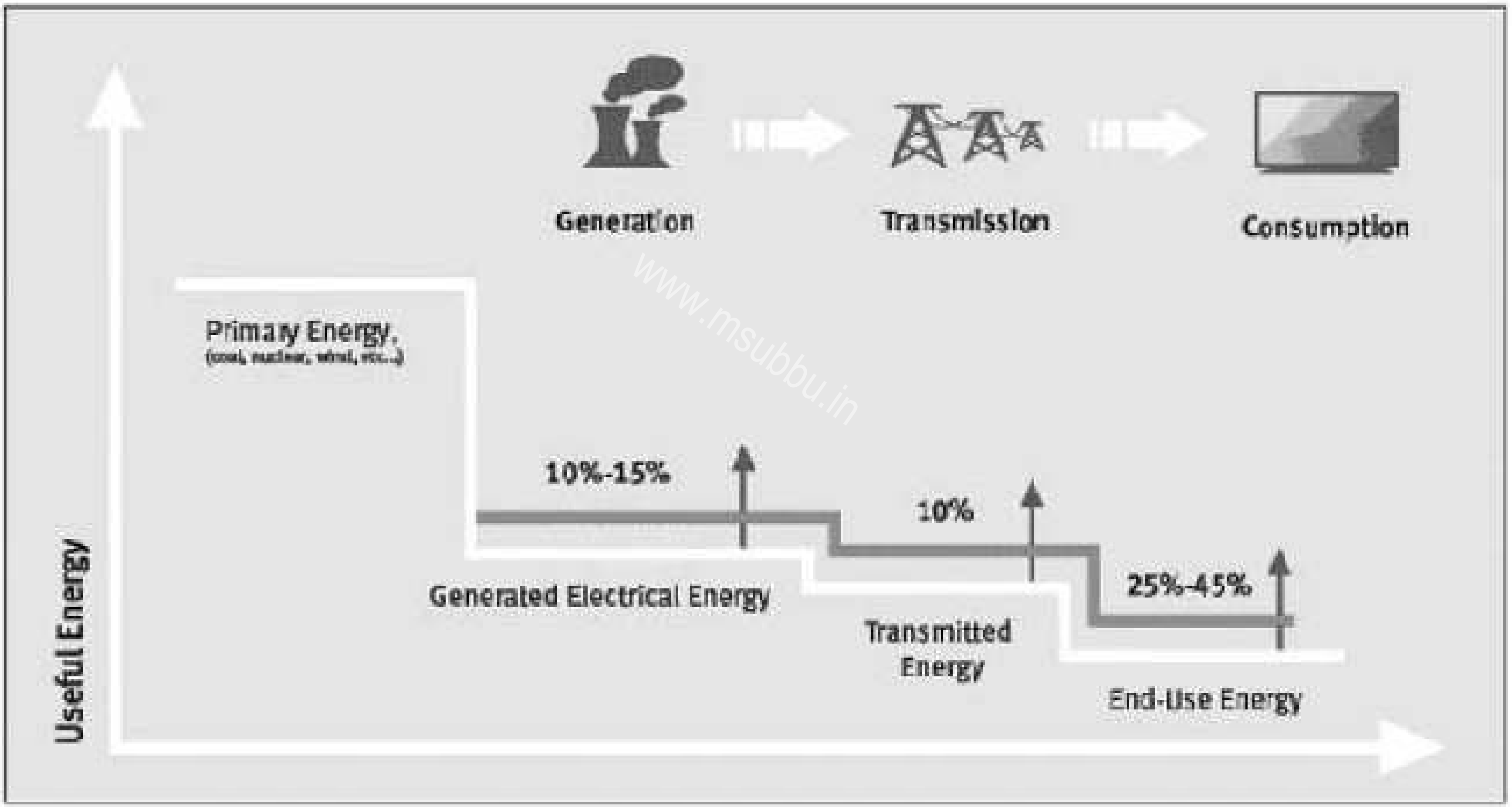


http://upload.wikimedia.org/wikipedia/commons/7/70/Gdp-energy-efficiency.jpg 14-Sep-2010

Fuels use in Industry

- To produce heat and electricity
- To produce utilities like compressed air, chilled water, hot water, etc.
- As raw material input to production processes

Possibilities to increase energy efficiency in electrical energy



Compressed Air

Compressed Air System

- The generation of compressed air is one of the major energy consuming activities in any typical industrial operation.
- Often 'Compressors' are referred to as 'power guzzlers' and it is a known fact that only 10 percent of the input energy manifests as energy in the output compressed air.
- An approximate estimate indicates that around 1500 MW is consumed nationwide (India) just to compress air for industry applications (*The Bulletin on Energy Efficiency, Vol. 7, 2007*)
- Moreover, the use of compressed air is seen to be increasing linearly with our industrial growth
- Based on NPC's energy audit experience in compressed air systems, it is possible to save 25 to 30 percent of energy in compressed air systems

Compressed Air Usage

- Process Air
- Instrument Air
- Pneumatic conveying
- Drying

Components of Compressed Air System

- Compressed air systems consist of the following major components:
  - intake air filters
  - inter-stage coolers
  - after-coolers
  - air-dryers
  - moisture drain traps
  - receivers
  - piping network
  - filters
  - Regulators, and
  - lubricators

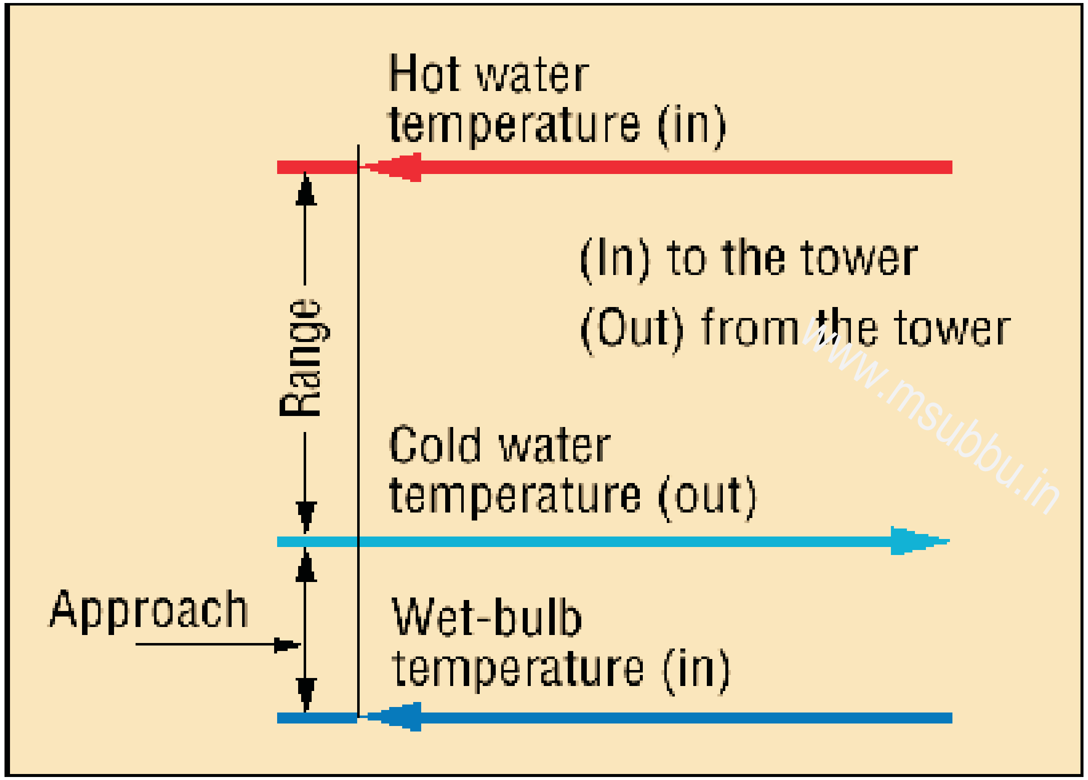
Assessing the Performance of Air Compressors

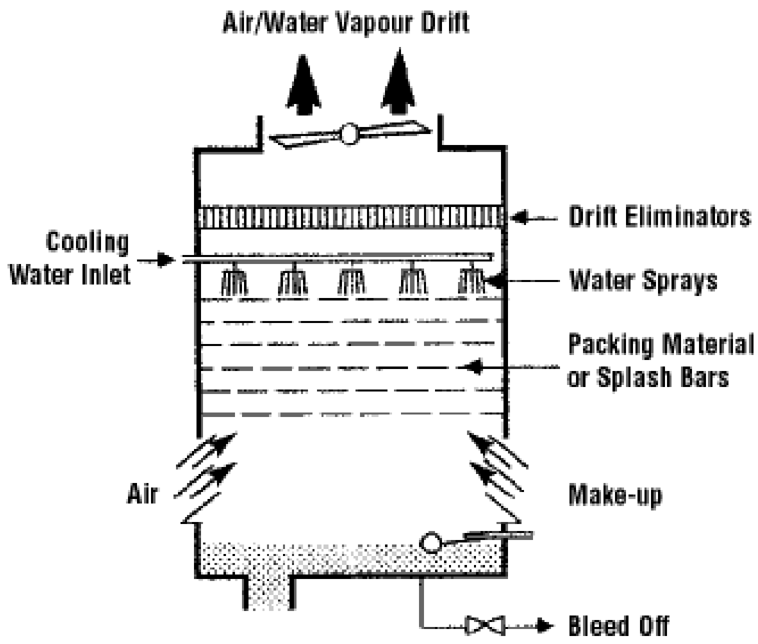
- The best way to assess the performance of air compressors is by evaluating specific energy consumption (SEC)
- For typical reciprocating air compressors or screw compressors, the SEC's values vary between 7.5 – 8.5 kWh/Nm^3.
- The present genre of modern modular screw compressors has SEC's as low as 6.7 kWh/Nm^3.

Best Practices for Reducing Power Consumption in Compressed Air System

- Reduction of air leaks
- Optimizing discharge pressure by modulating down as per needs
- Regular assessment of inter-cooler/ after-cooler performance and periodic cleaning of tubes
- Use of demand controller for optimal pressure setting and No-load power consumption reduction
- Installation of screw compressors with built-in variable speed drives
- Segregation of HP/LP compressed air system
- Installation of flat belts for reciprocating compressors, etc

Cooling Towers





Cooling tower effectiveness = Range / (Range + Approach)

Measures in General

- Optimize cooling tower fan blade angle on a seasonal and/or load basis
- Consider energy efficient FRP blade adoption for fan energy savings
- Install new nozzles to obtain a more uniform water pattern
- Periodically clean plugged cooling tower distribution nozzles
- Cover hot water basins to minimise algae growth that contributes to fouling
- Optimise blow down flow rate, as per cycle of concentration (COC) limit
- Replace slat type drift eliminators with low pressure drop, self extinguishing, PVC cellular units

Adjusting Fan Speed

- Generally cooling tower fans are designed for maximum process load and the worst ambient conditions. These two conditions may not occur all the time.
- Generally, majority of the time either process load may be less or the ambient conditions may be favourable. Under these conditions, an excess capacity of the fan is available. A control system which optimizes the capacity of cooling tower fans or minimizes the operating hours of the cooling tower fan gives substantial energy savings.
- Decreasing the speed of cooling tower fan according to the load and at night time

Use of FRP Fans in Cooling Towers

- Improved Fan Efficiency: the fan efficiency in turn is greatly dependent on the profile of the blade. An aerodynamic profile with optimum twist is preferred

- As the metallic fans are manufactured by adopting either extrusion or casting process it is always difficult to generate the ideal aerodynamic profiles. The FRP blades are normally hand moulded which facilitates the generation of optimum aerodynamic profile to meet specific duty condition more efficiently

- Also, due to lightweight, FRP fans need low starting torque resulting in use of lower HP motors. The lightweight of the fans also increases the life of the gear box, motor and bearing is and allows for easy handling and maintenance

- Cases reported where replacement of metallic or Glass fibre reinforced plastic fan blades have been replaced by efficient hollow FRP blades, with resultant fan energy savings of the order of 20–30% and with simple pay back period of 6 to 7 months.

Electrical Systems

General Energy Saving Measures

- Using maximum demand controllers
- Using Power factor controllers
- Using energy efficient motors
- Using VFD for speed control with AC motors
- Using electronic ballasts for Fluorescent lambs
- Using CFLs in place of fluorescent lamps and incandescent lamps

Maximum Demand Controllers

- High-tension (HT) consumers have to pay a maximum demand charge in addition to the usual charge for the number of units consumed. This charge is usually based on the highest amount of power used during some period (say 30 minutes) during the metering month.
- The maximum demand charge often represents a large proportion of the total bill and may be based on only one isolated 30 minute episode of high power use.
- Considerable savings can be realised by monitoring power use and **turning off or reducing non-essential loads** during such periods of high power use

Power Factor Controllers

- Various types of automatic power factor controls are available with relay / microprocessor logic. Two of the most common controls are: Voltage Control and kVAr Control

- Linear loads with low power factor (such as induction motors) can be corrected with a passive network of capacitors or inductors

Variable Frequency Drives (VFD)

- Induction motor is the workhorse of the industry. It is cheap rugged and provides high power to weight ratio. On account of high cost-implications and limitations of D.C. System, induction motors are preferred for variable speed application, the speed of which can be varied by changing the supply frequency.

- The VFD operates on a simple principle. The rotational speed of an AC induction motor depends on the number of poles in that stator and the frequency of the applied AC power. Although the number of poles in an induction motor cannot be altered easily, variable speed can be achieved through a variation in frequency. The VFD rectifies standard 50 cycle AC line power to DC, then synthesizes the DC to a variable frequency AC output

- Motors connected to VFD provide variable speed mechanical output with high efficiency. These devices are capable of up to a 9:1 speed reduction ratio (11 percent of full speed), and a 3:1 speed increase (300 percent of full speed).