

# **THERMODYNAMIC ANALYSIS OF COAL BASED THERMAL POWER PLANTS WITH CO<sub>2</sub> CAPTURE**

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# Green House Gases (GHG)

GHG: CO<sub>2</sub>, Methane, Halocarbons, Nitrous oxide, Water vapour

GHG leads to “Global Warming”

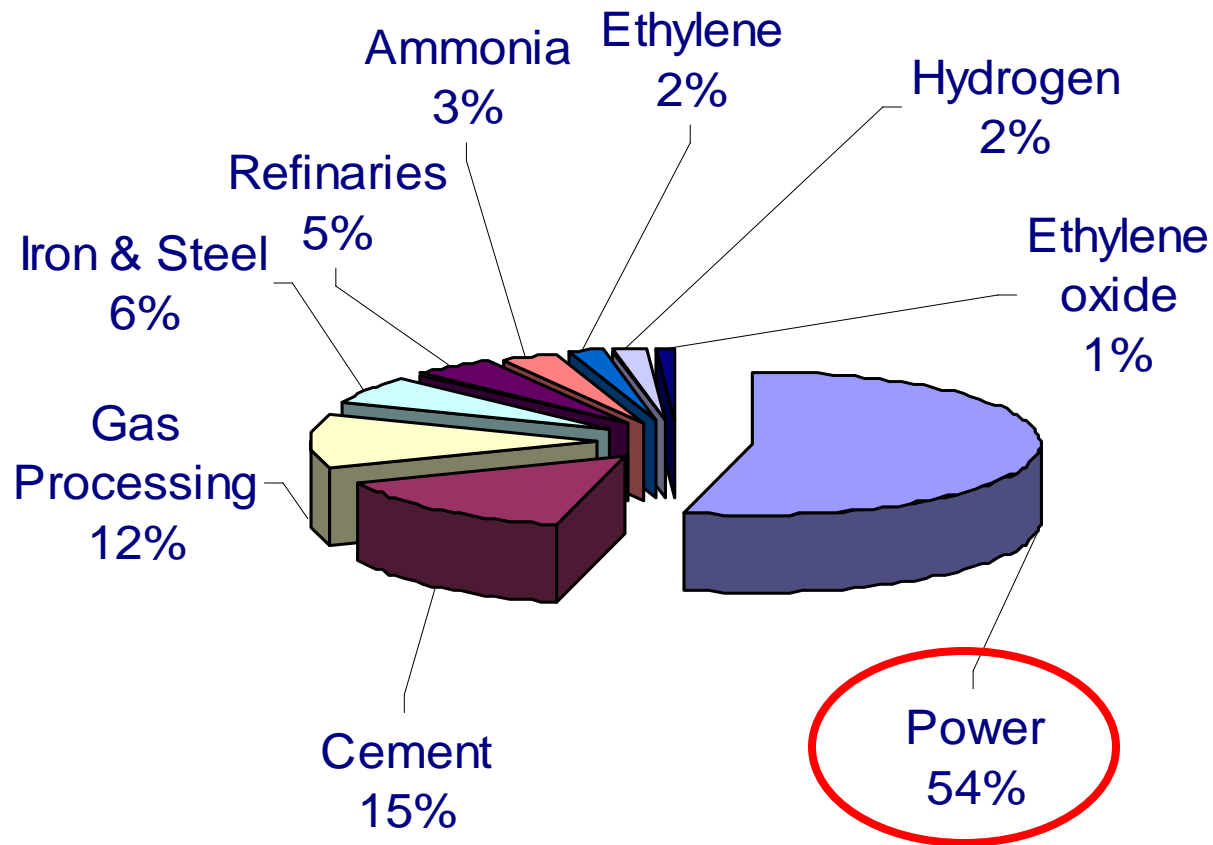
## GLOBAL WARMING POTENTIALS (GWP) OF GHG

Greenhouse gas	Concentration 1800s-2000	Atmospheric source	GWP	Proportion of total effect
CO <sub>2</sub>	280 - 370 ppm	Fossil fuel burning, Deforestation	1	60%
Methane	0.75 - 1.75 ppm	Agriculture, fuel leakage	21	20%
Halocarbons	0 - 0.7 ppb	Refrigerants	3400+	14%
Nitrous oxide	275 - 310 ppb	Agriculture, Combustion	310	6%

*(Ref: Department of Energy and Process Engineering, Norwegian University of Science and Technology (NTNU), Trondheim)*



# Industry wise CO<sub>2</sub> Emissions



*(Source: Ref: Department of Energy and Process Engineering, Norwegian University of Science and Technology (NTNU), Trondheim)*

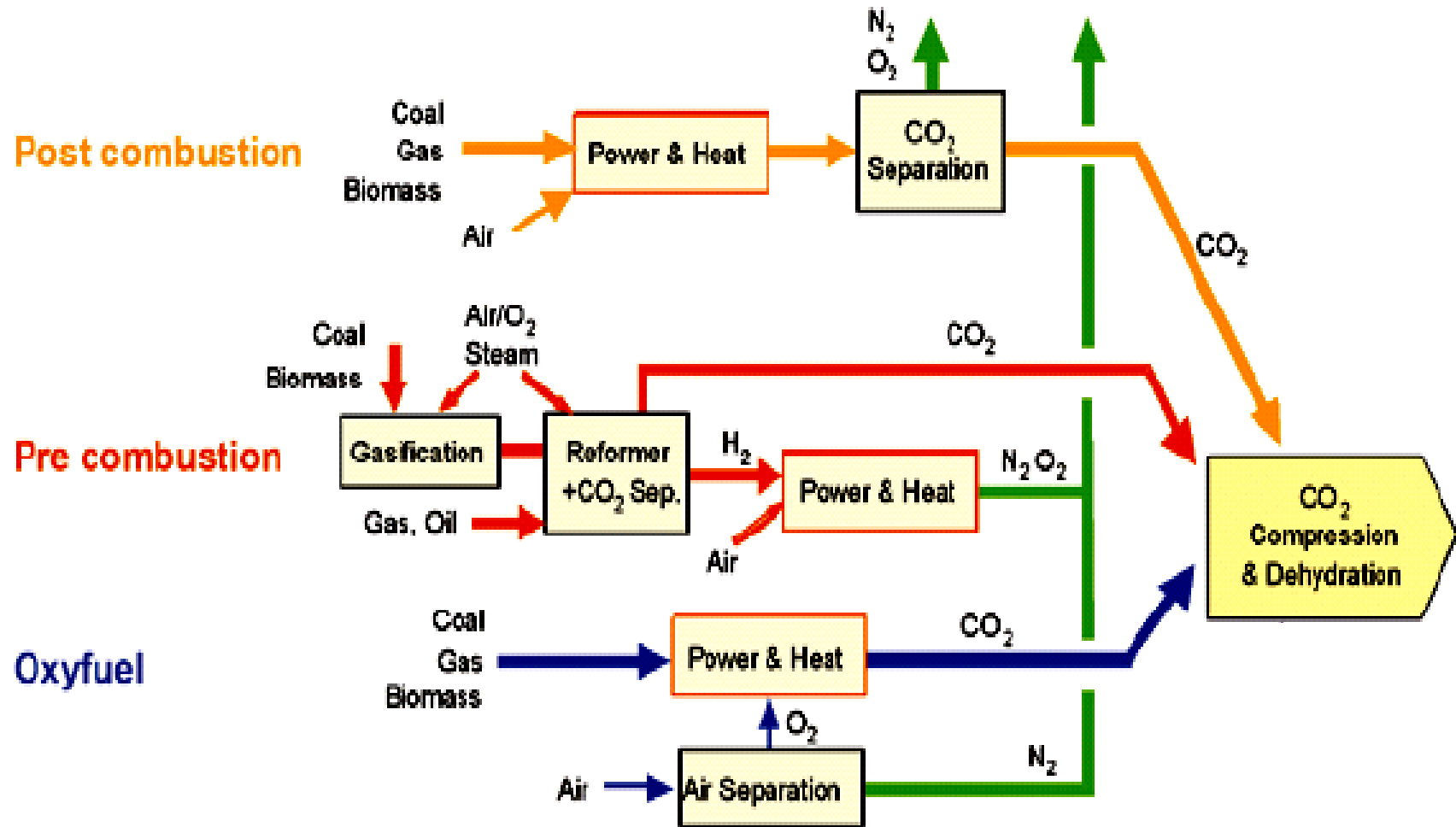


# CO<sub>2</sub> Mitigation Techniques

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- **Improve energy efficiency**  
(e.g.: improved turbines, combined heating, cooling and electric-power generation systems)
- **Switch to less carbon-intensive fossil fuels**  
(e.g.: From Coal to Natural Gas)
- **Increased use of low- and near-zero-carbon energy sources**  
(e.g.: renewable energy, nuclear power, Hydro-electric power)
- **Sequester CO<sub>2</sub> through the enhancement of natural, biological sinks**  
(e.g.: Agriculture, forest)
- **CO<sub>2</sub> capture and storage**

# CO<sub>2</sub> Capture



(Source: IPCC special report on Carbon dioxide capture and storage)



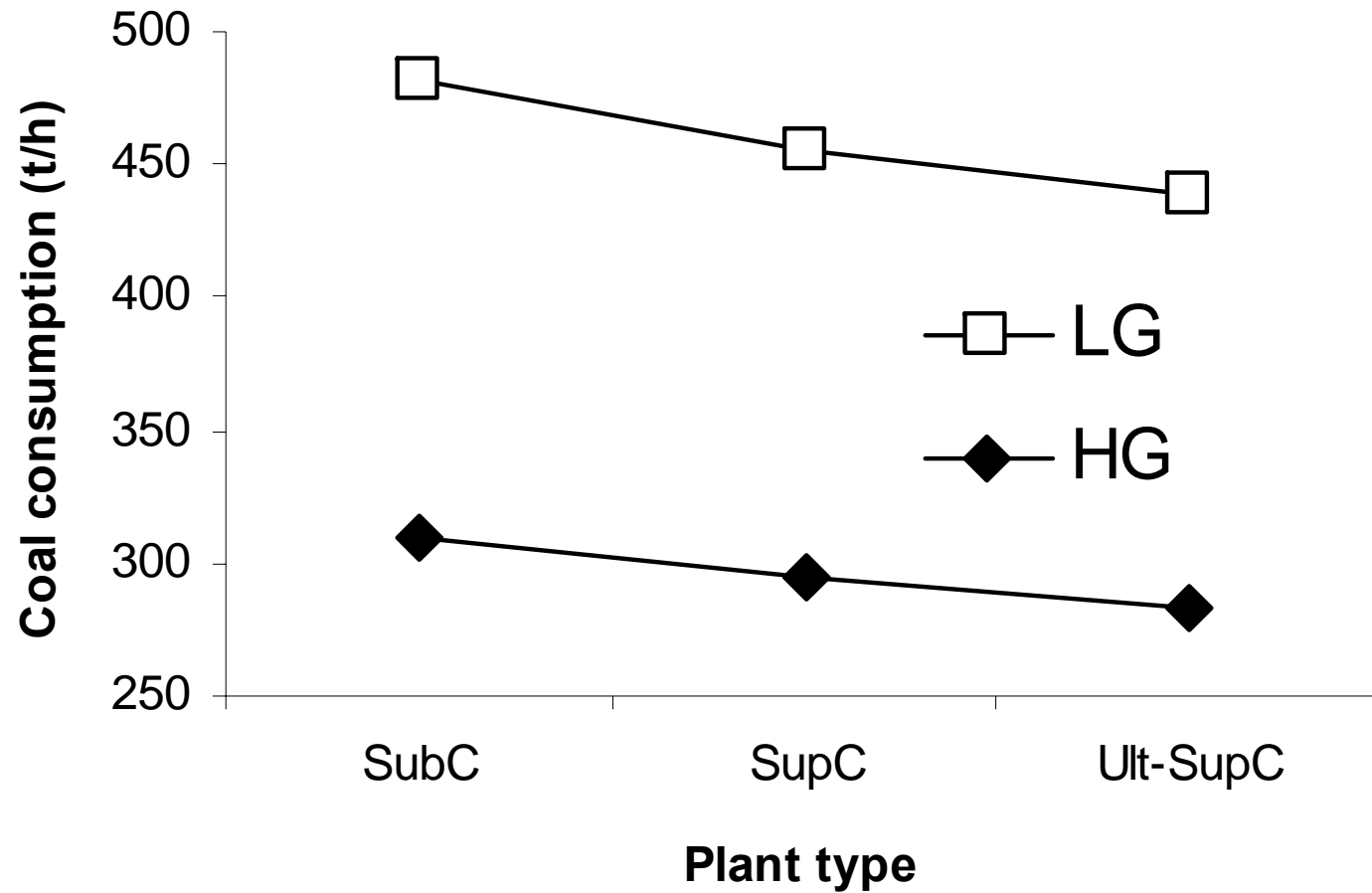


# Fuel Characteristics

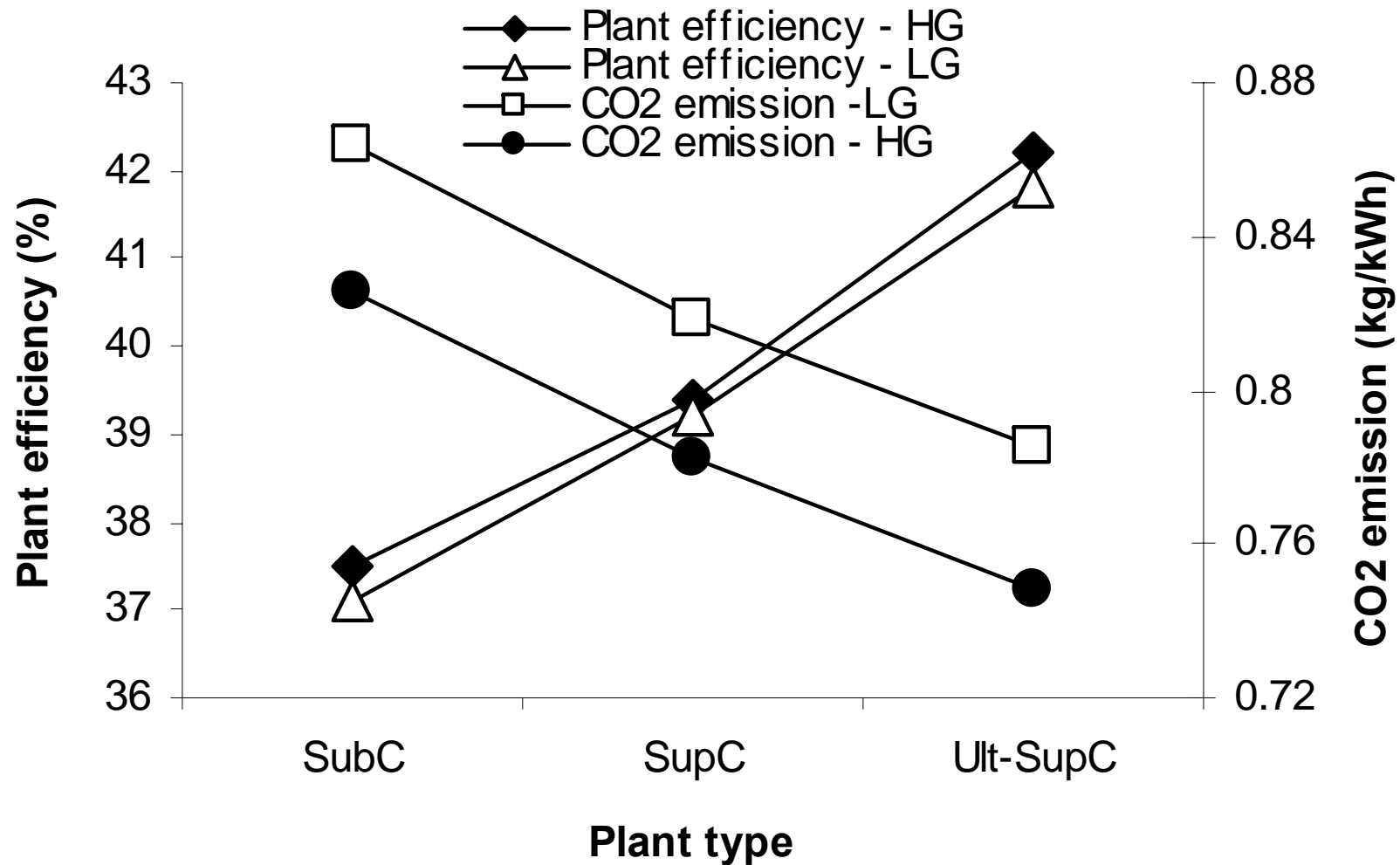


Type	India (LG)	South Africa (HG)
<b>Proximate analysis (% by weight)</b>		
Fixed carbon	24.0	59.0
Moisture	5.7	2.3
Volatile matter	29.7	22.0
Mineral Matter (Ash)	40.6	16.7
<b>Elemental analysis (% by weight)</b>		
Carbon	38.9	68.2
Hydrogen	3.6	3.5
Oxygen	9.8	7.3
Nitrogen	0.8	1.5
Sulphur	0.6	0.5
Lower Heating Value (MJ/kg)	14.5	25.7

# Results



# Results (Contd..)



# Results (Contd..)



Sl. No.	Plant	Steam Parameters	With CO <sub>2</sub> Capture		Without CO <sub>2</sub> capture	
			$\eta_{\text{plant}}$ (%)		$\eta_{\text{plant}}$ (%)	
			LG	HG	LG	HG
1	SubC	170 bar / 537°C / 537°C	37.1	37.5	30.0	30.4
2	SupC	247 bar / 537°C / 565°C	39.2	39.6	30.7	31.3
3	Ult-SupC	350 bar / 700°C / 720°C	41.8	42.2	33.1	33.8

# CO<sub>2</sub> Capture Technology for Indian Power Plants?

Thank you for attention

# Contents

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- **Introduction**
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# Introduction

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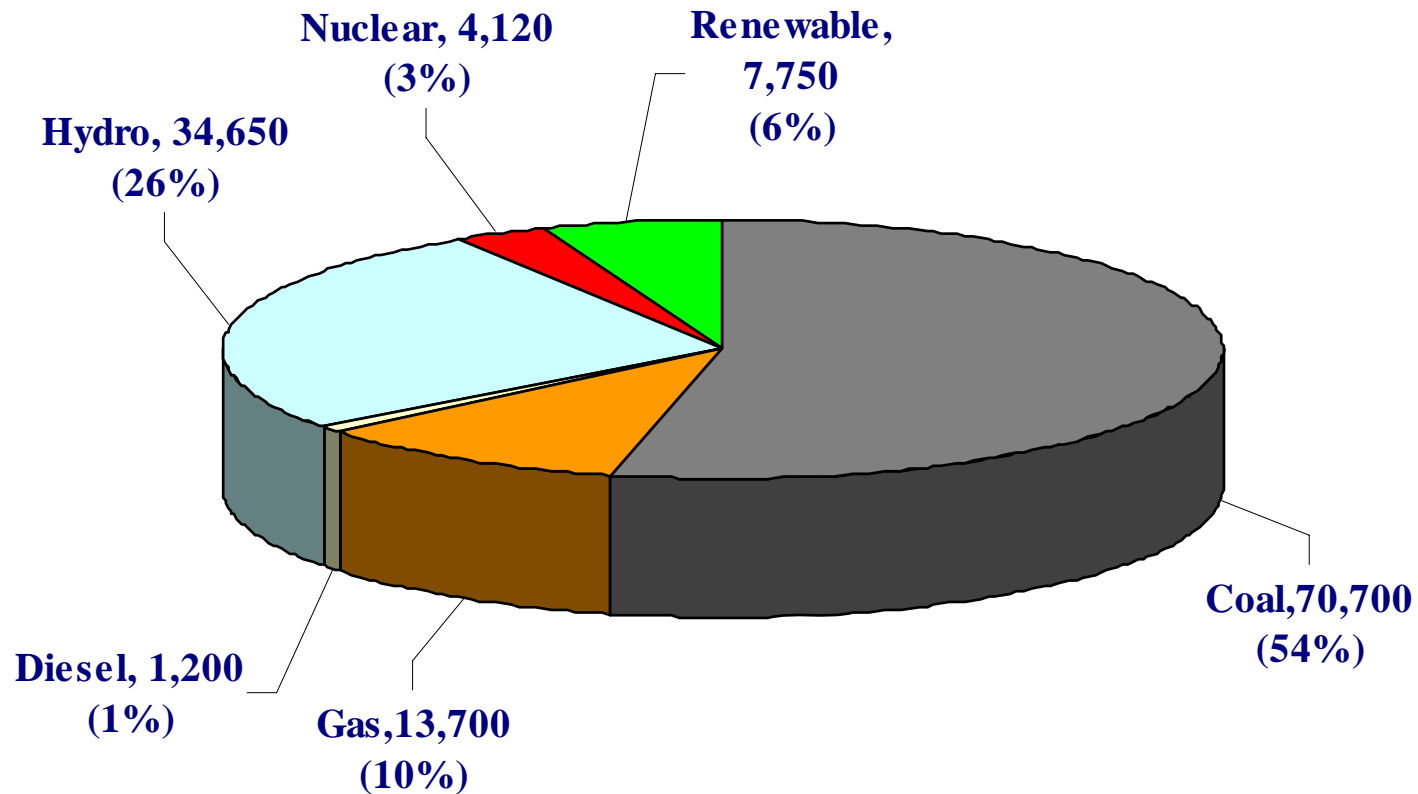


- **Installed capacity** in India (April 30, 2007) is 1,32,000 MWe
- The **annual power generation** (2006-07) is about 660 billion units (kWh)
- The present **per capita annual consumption** of electricity:
  - India : ~ 450 to 500 units
  - Developed Countries : ~ 12,000 to 15,000 units
  - World average : ~ 2,500 units

*Source: Ministry of Power, India and Human Development Report , UN - 2006*



# Sourcewise Installed Capacity



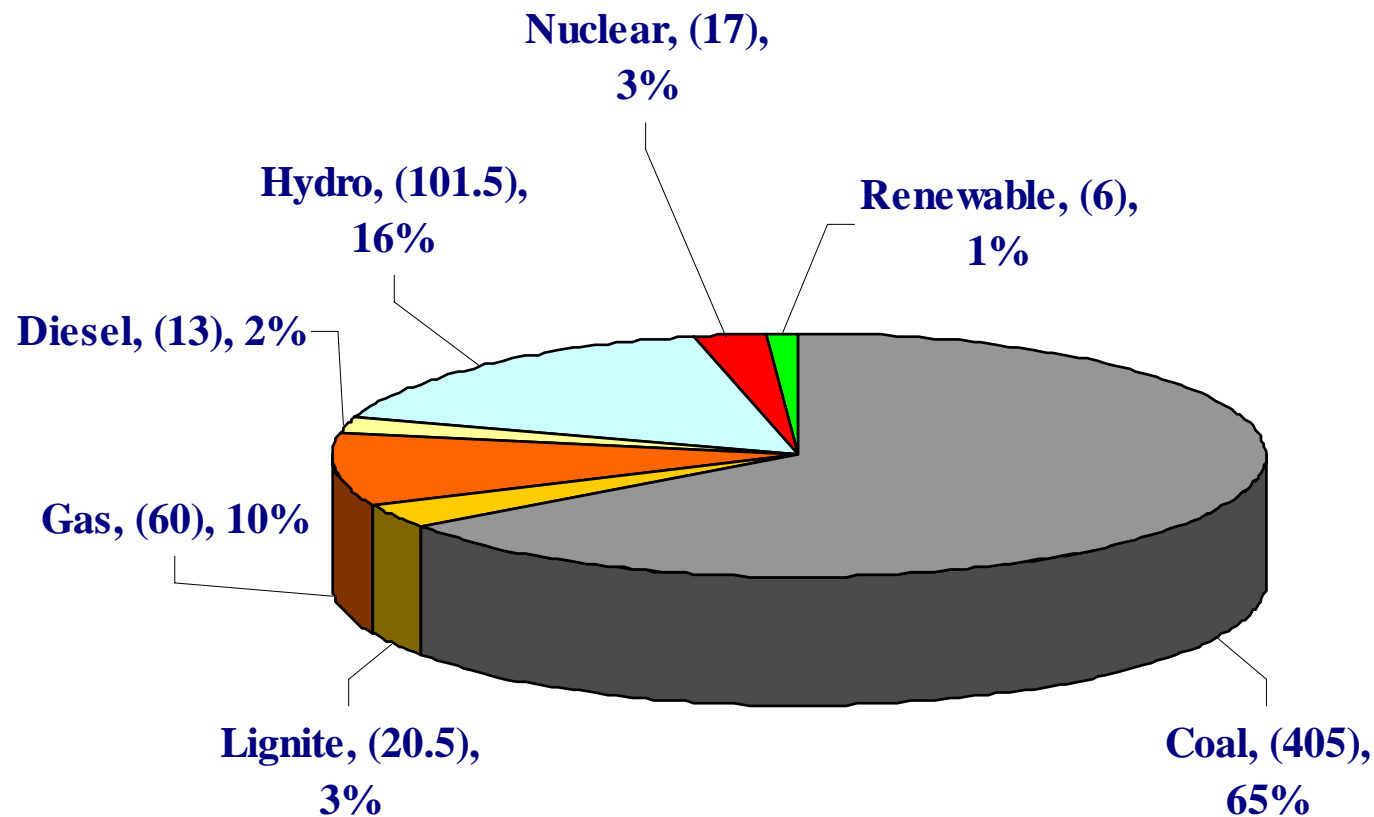
Total installed capacity as on April 30, 2007 = 1,32,120 MWe

Base shortage : 9.9%

Peak shortage :13.5%

*Source: Ministry of Power and Central Electricity Authority*

# Sourcewise Distribution of Electricity Generated



BU: Billion Units; 1 Unit = 1 kWh

Total electricity generated (2005-06) = 623 BU

Source: Central Electricity Authority and Planning Commission

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# CO2 Emissions

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- **World CO2 emissions (2004) : 26.5 BT**
- **India's per capita carbon dioxide emissions are relatively low - at 1.2 tones in 2003, which is less than one-quarter of the world average and about 20 times less than the United States**
- **India is currently the fourth greatest carbon emitter in the world behind the United States, China and Russia and accounts for about 5.1% of the world's carbon dioxide emissions**

*Source: IEA Key World Energy Statistics, 2006*