

# Lecture 27: Environmental Aspects of Power Plants

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**Course:** MECH-422 – Power Plants

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BUITEMS – DEPARTMENT OF MECHANICAL  
ENGINEERING



# Different Pollutants Due to Thermal Power Plant and Their Effect on Human Health

◆ The most commonly observed pollutants from fossil power plants (oil or coal based) are the following:

- (a) Sulphur oxide (SO<sub>x</sub>)
- (b) Nitrogen oxides (NO<sub>x</sub>)
- (c) Carbon oxides (CO<sub>x</sub>)
- (d) Particulate matter or PM
- (e) Thermal pollution

These emissions of PM in conjunction with SO<sub>x</sub> and NO<sub>x</sub> increase the ambient concentration of PM less than 2.5 μm in diameter (PM<sub>2.5</sub>).

Continuous exposure to PM<sub>2.5</sub> may lead to increased mortality from cardiopulmonary diseases, lung cancer and numerous other respiratory illnesses

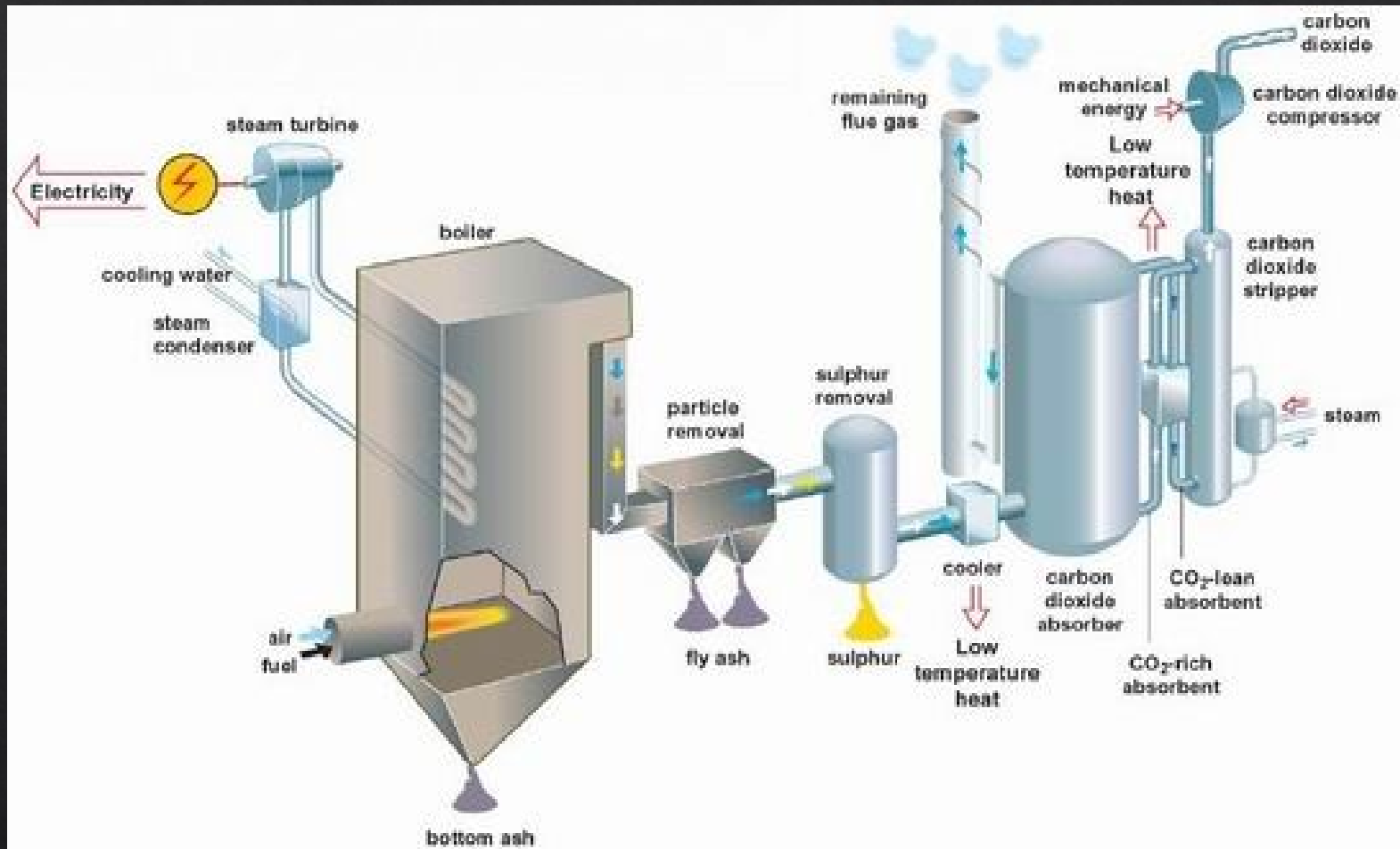
# Impacts

Air pollution from coal-fired power plants includes sulfur dioxide, nitrogen oxides, particulate matter (PM), and heavy metals,

leading to

smog, acid rain, toxins in the environment, and numerous respiratory, cardiovascular, and cerebrovascular effects.

# PC Plants: Post-combustion Capture

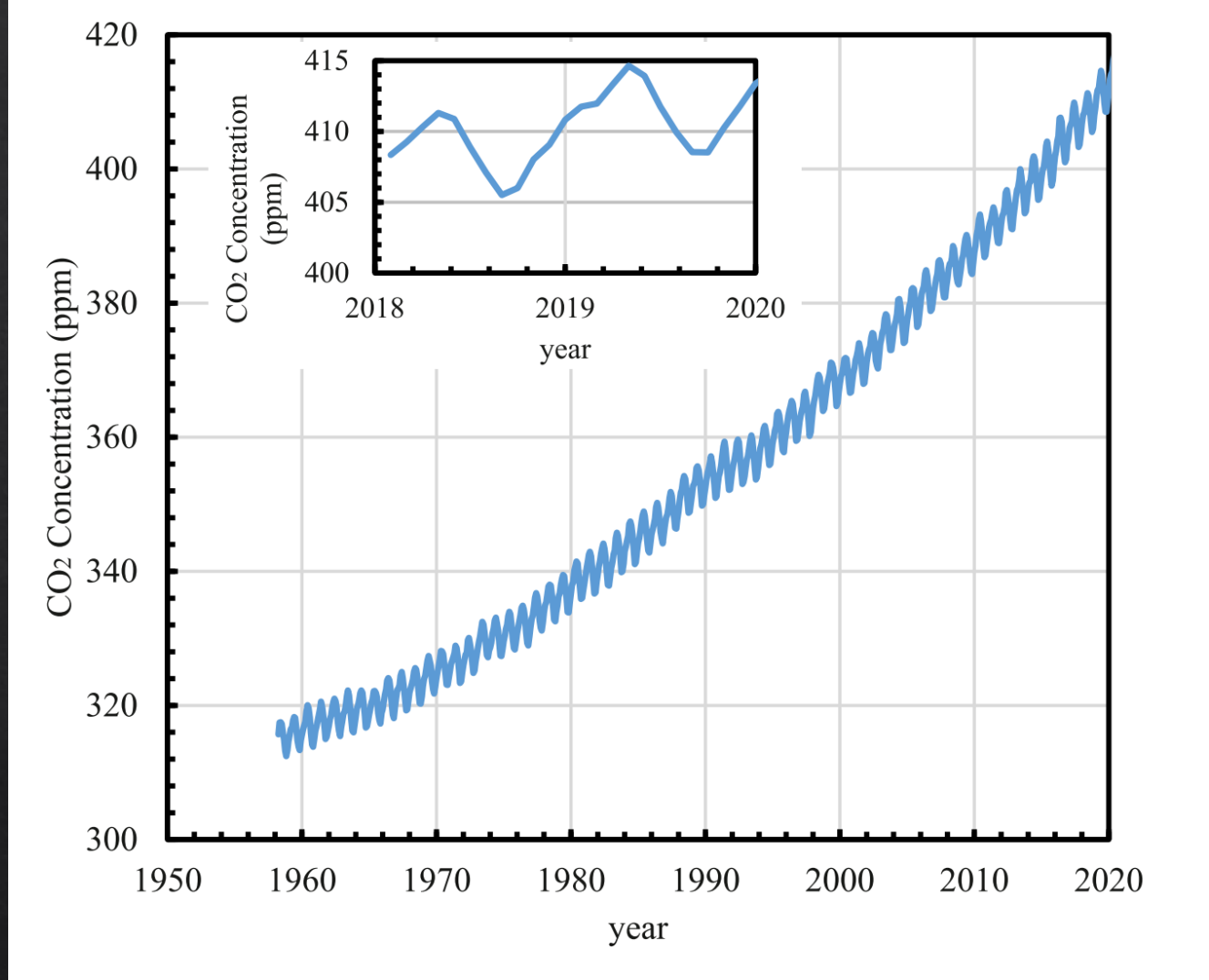




# Carbon Capture and Storage (CCS)

CCS refers to the capture and disposal of CO<sub>2</sub> released from industrial processes

- ◆ This has also been referred to as **Carbon Sequestration**, but this term has also been applied to the removal of CO<sub>2</sub> from the atmosphere through the buildup of biomass (above-ground vegetation) and/or soil carbon
- ◆ Geological carbon sequestration
  - ◆ CCS involving burial of captured CO<sub>2</sub> in geological strata (either on land or under the sea bed)
- ◆ Biological carbon sequestration
  - ◆ buildup of soil or plant Carbon

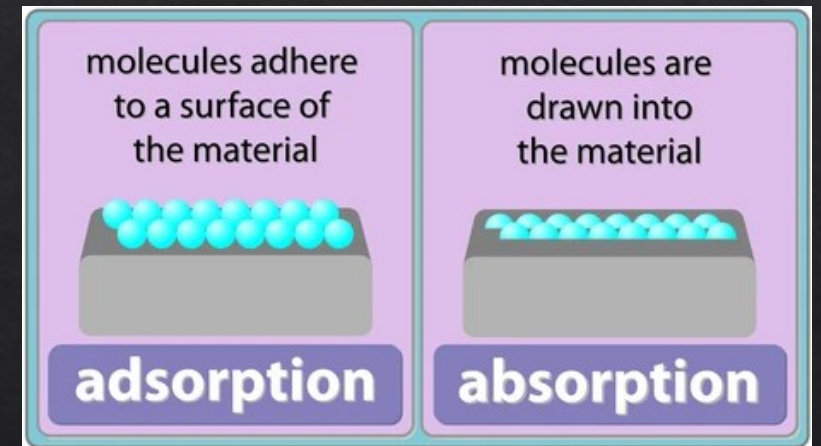


CO <sub>2</sub> source	CO <sub>2</sub> concentration	Pressure (atmospheres)
Natural gas turbine	3-4%	1
Coal powerplant	12-14%	1
Oil refinery	8%	1
Blast furnace	27%	1
Cement kiln	14-33%	1
Ammonia plant	18%	28
Ethylene plant	8%	25
Natural gas processing	2-65%	9-80

Source: Gale et al (2005, 'Sources of CO<sub>2</sub>', in IPCC *Special Report on Carbon Dioxide Capture and Storage*, Cambridge University Press, Cambridge, UK)

# Processes for separating CO<sub>2</sub> from other gases (applicable to capture after combustion in air or during gasification)

- ◆ Absorption
  - chemical (if low CO<sub>2</sub> concentration)  
(MEA is a common solvent)
  - physical (if high CO<sub>2</sub> concentration)  
(Selexol is a common solvent)
- ◆ Adsorption
- ◆ Membrane-based separation
- ◆ Liquefaction

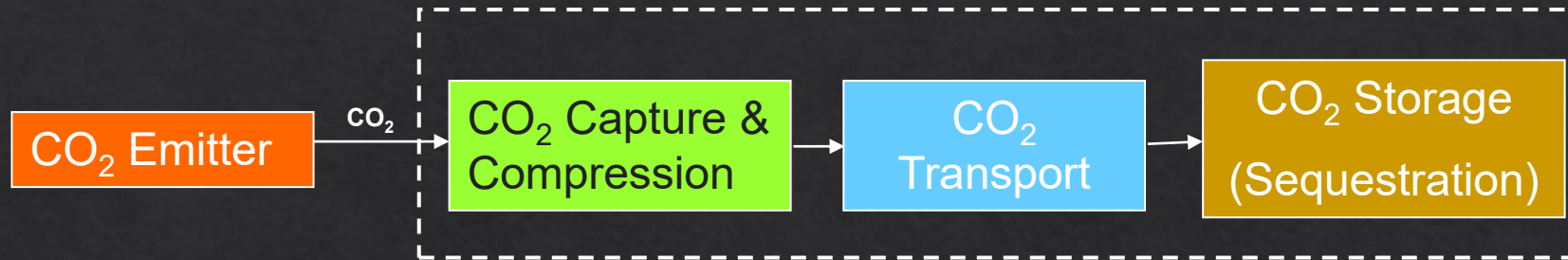




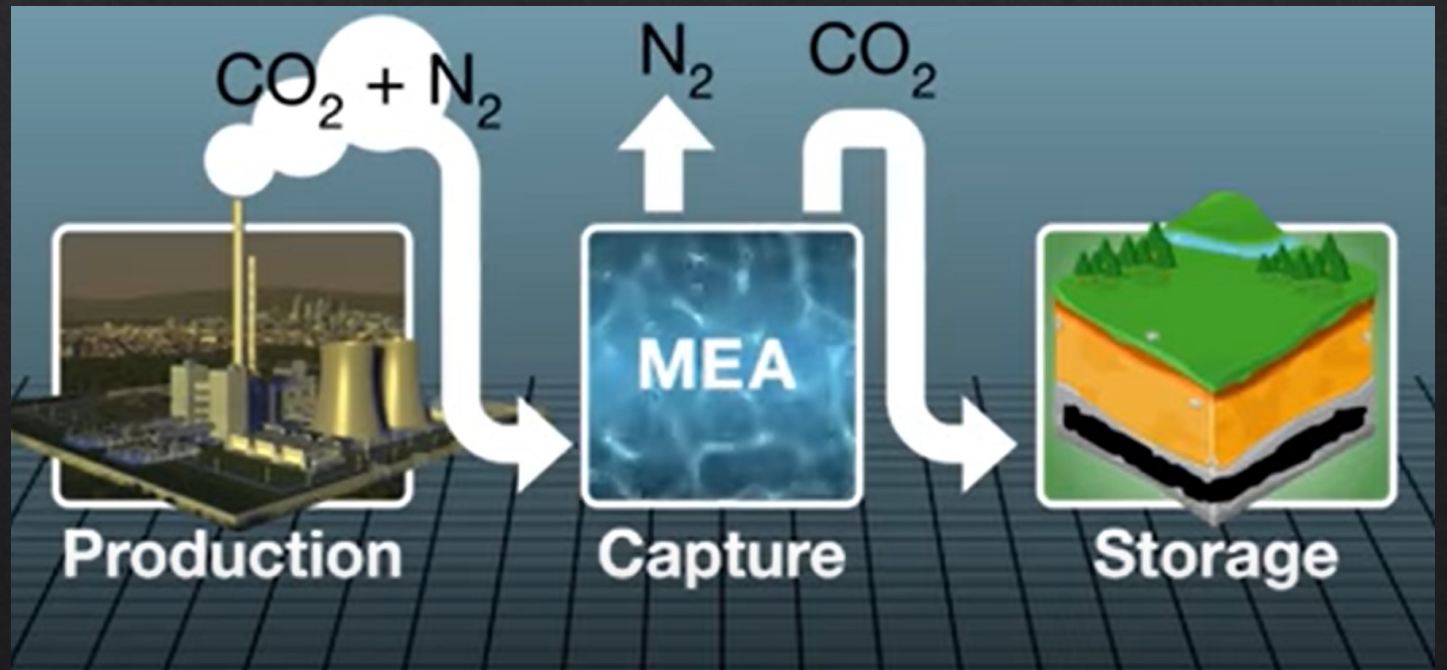
# Energy is required

- ◇ Chemical solvents require heat to drive off the CO<sub>2</sub> (in concentrated form) and regenerate the solvent
- ◇ Physical solvents require heat or a pressure drop for regeneration
- ◇ Adsorbants require heat or a pressure drop for regeneration
- ◇ Membrane systems require electrical energy to maintain a high P on one side of the membrane
- ◇ Liquefaction requires cooling the exhaust gas to as low as ~ 220 K

# Carbon Capture and Sequestration (CCS)



Aqueous monoethanolamine (MEA) solution is commonly used for post-combustion carbon capture via chemical absorption.





**A chemical solvent-based plant that captures a mere 200 tCO<sub>2</sub>/day**



**Source: Thambimuthu et al (2005, *IPCC Special Report on Carbon Dioxide Capture and Storage*, Cambridge University Press, Cambridge, UK)**





**End of Lecture!**