Life Cycle Assessment Overview of Carbon Capture and Storage Technologies

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CCS TECHNOLOGIES

Post - combustion

Pre - combustion

Oxyfuel
POST – COMBUSTION CAPTURE

Power plant

Fossil fuel and air

Absorbent and water

Exhaust gas with CO₂

Energy

Cooling

Cleaned exhaust gas

Scrubber column

Heat exchanger

Regeneration

Cooling

CO₂

• CO₂ captured by monoethanolamine (MEA)

Heating
**Pre – Combustion Capture**

- **Steam reforming**
  - Fossil fuel
  - Steam
  - CO₂, H₂

- **Absorbent**
  - CO₂ captured by selexol

- **Scrubber column**
  - H₂
  - Energy

- **Power plant**
  - Air
  - O₂
  - N₂

- **Regeneration**
  - CO₂
  - Absorbent
OXYFUEL CAPTURE

- CO₂ captured by condensation and separation

Air separation unit

Air

O₂

N₂

Power plant

CO₂

H₂O, CO₂

Condensation

H₂O

Fossil fuel

Energy
LCA AND CCS TECHNOLOGIES
CCS Chain

1. Mining of fuel
   - Shaft mine
   - Open cast coal mine
   - Unmineable coal seams

2. Coal- or gas-fired power station with CO2 capture plant
   - CO2 transport by pipeline

3. CO2 transport by pipeline
   - Saline aquifers
   - Depleted oil and gas fields

4. CO2 injection
   - Gas field

5. CO2 storage sites

www.sccs.org.uk
- CCS – essential for CO₂ emissions reduction
- LCA powerful tool for environmental performance

- Different effects of CCS technologies caused by different kind of power plants

- In the Czech Republic: coal fired power plant vs natural gas – fired power plants

- Different operational cycle:
  1. Pulverized coal plants (PC)
  2. Integrated coal gasification combine cycle plants (IGCC)
  3. Combined cycle gas turbine plants (CCGT)
Coal fired vs Natural gas fired power plants

Post-combustion system

Coal fired PP:
- Significant increase in eutrophication and acidiphication potential (42-50%)
  - Consequence of NH$_3$ emission during MEA degradation
  - Heat – stable salts production – reduction of CO$_2$ absorption capacity of solvent

Natural gas PP:
- Lower increase in acidiphication and eutrophication potential as coal (15%)
COAL FIRED VS NATURAL GAS FIRED POWER PLANTS

Pre – combustion system

- **Reduces** GWP: 78% from coal, 64% from natural gas systems
- **Contributes** to higher freshwater eutrophication (FEP)

Infrastructure for the fuel production, transport and storage

Disposal of solid waste from steel manufacturing
COAL FIRED VS NATURAL GAS FIRED POWER PLANTS

*Oxyfuel system*

- Increase freshwater eutrophication (60% for coal, 100% natural gas systems)

→ no reduce of particulate fraction and SO$_2$ emissions
GWP OF DIFFERENT TYPES OF PLANTS

CONCLUSION

- CCS technologies contribute to **reduction of GWP**
- Different plants present different LCA results
- Infrastructure, transport and storage main contributors to FEP
- MEA production and degradation – **increase of acidiphication potential**
- Oxyfuel technology represents the **biggest depletion of GWP**
- Post combustion the most used but the **worse environmental results**
- Oxyfuel, the **best environmental results**, but needs further research and application into practice
THANK YOU FOR YOUR ATTENTION

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