Application in coal fired power stations

- Australian coal fired power station
- Integration into coal fired power plants
- Energy penalty of PCC
- Cost electricity and CO_2-emission avoided

Australian coal fired power stations

- Generation capacity ~ 28 GW
- Electricity production 170 TWh/a
- Average generation efficiency
  - Black coal: 35.6% - 0.9 tonne CO_2/MWh
  - Brown coal: 25.7% - 1.3 tonne CO_2/MWh
- CO_2-emissions ~ 170 Mtonne CO_2/a from ~ 60 flue gas streams
- SO_2 levels:
  - Black coal: 200 - 600 ppm
  - Brown coal: 100 - 300 ppm
- NO_x levels:
  - Black coal: 300 - 700 ppm
  - Brown coal: 100 - 200 ppm
- Cooling water: 1.5 - 3.0 m^3/MWh
- Typical flue gas stream: ~2.5 10^6 m^3/h at 120 ^oC (0.5 GW)

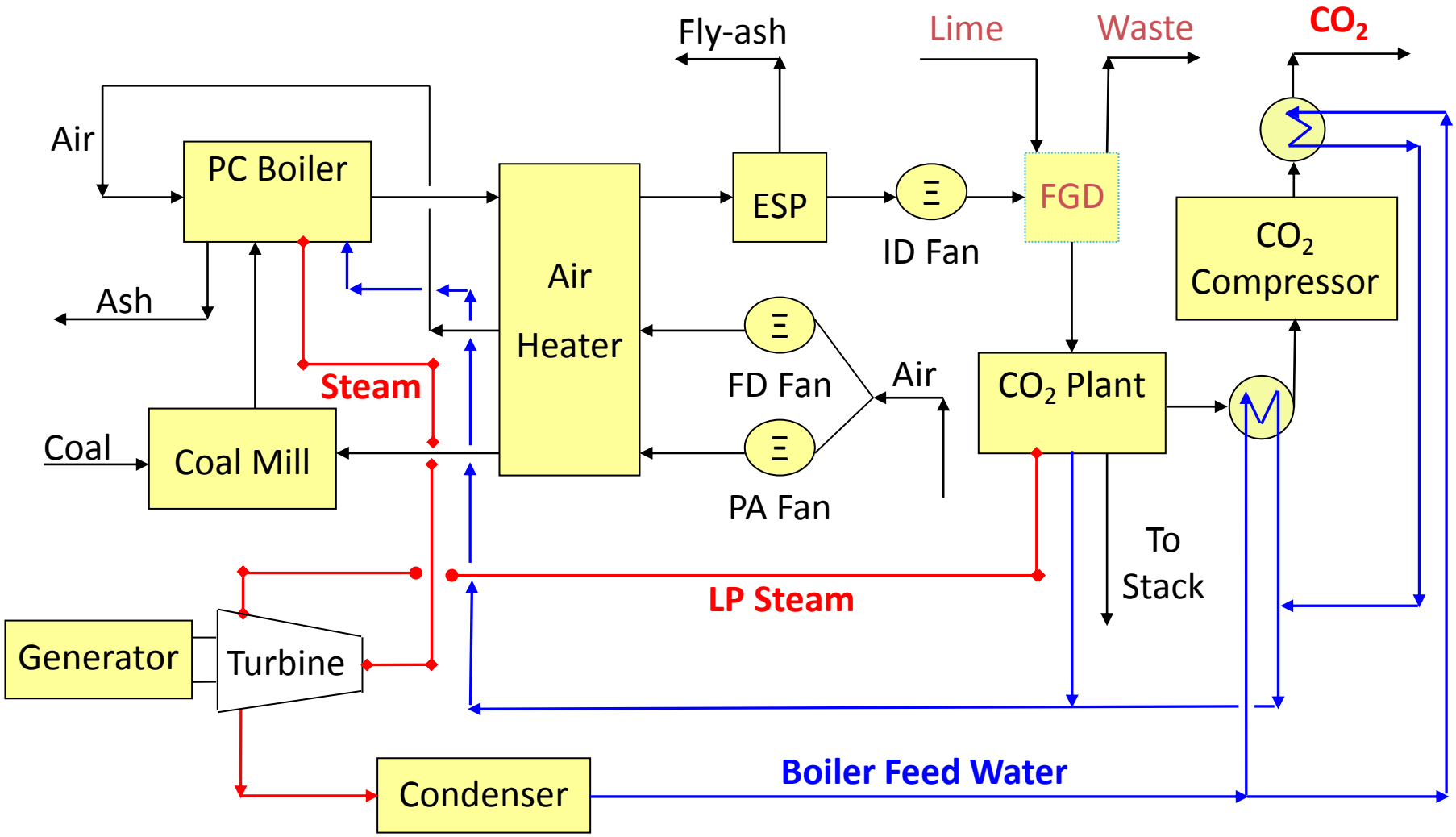
Data used from CCSD – technology assessment report 62

Integration into coal fired power plants

Integration relates to:

- Heat
  - Use of a reboiler extracting steam from the power station steam cycle; This requires modifications to the steam cycle
  - Alternative: Use a separate coal or gas fired boiler to generate the required heat and steam
  - Boiler feedwater preheating using heat from capture plant and compressors
- Flue gas treatment
  - Amine based process will capture all acid gases; not desired
  - Pretreatment requirements (SOx, NO_X, etc.)
- Cooling water
  - Additional cooling for PCC plant
  - Air cooling is option

CO_2 Capture Process Integration

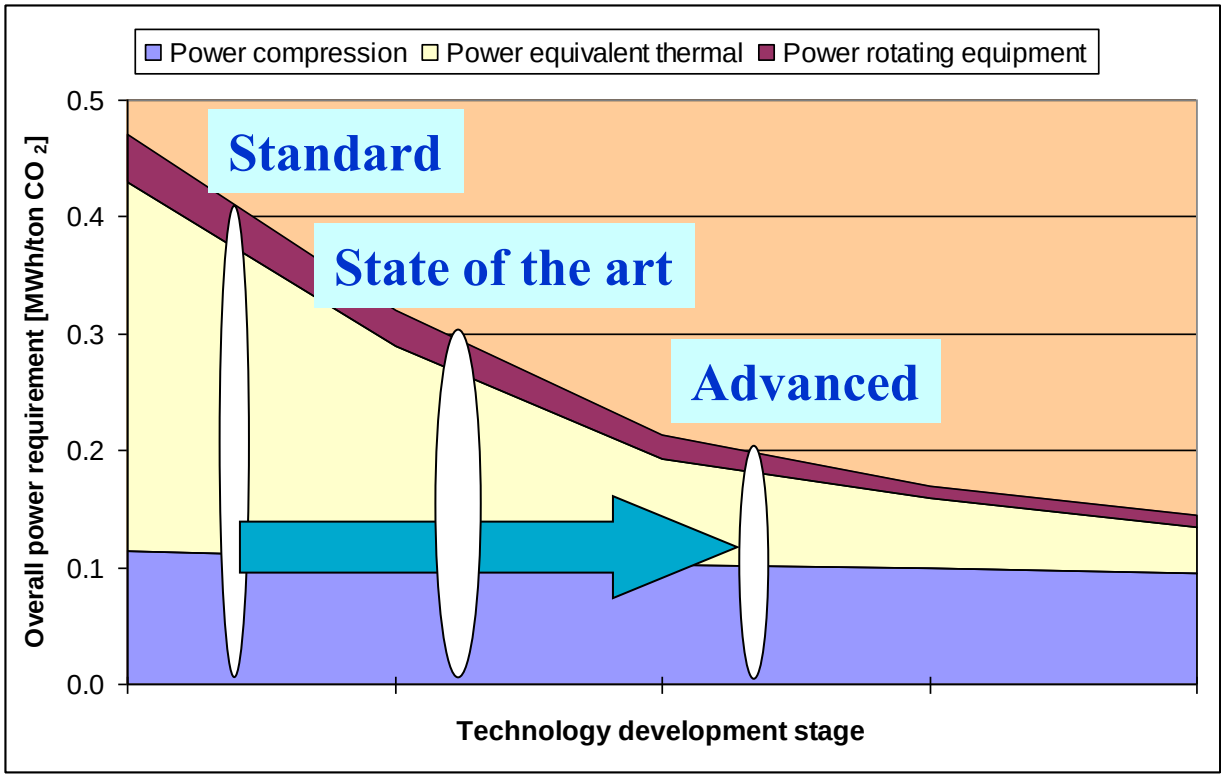


Energy penalty of PCC

- The total energy requirement for the capture and compression of CO_2 to 100 bar for a state-of-the-art PCC process is ~ 0.3 MWh_e/tonne CO_2.
- At a power plant CO_2 emission of 0.9 tonne CO_2/MWh_e and 90% capture efficiency the penalty is 0.9x0.3x0.9 ~ 0.243 or ~ 24 %
- 2/3 of the penalty is due to the capture process; 1/3 is due to compression of CO_2.

Improvement potential in energy performance

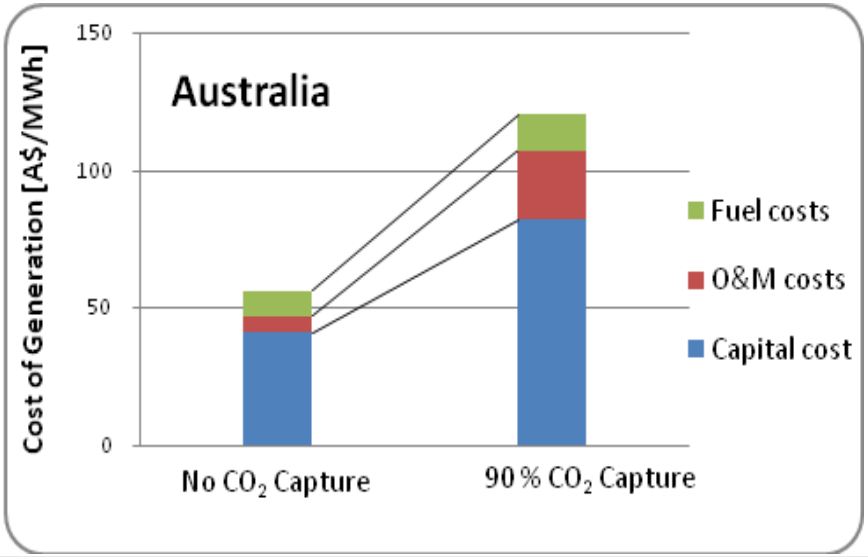
- Thermal energy
  - Regeneration of solvents; Extracted from steam cycle in power plant
- Electricity
  - Flue gas fans, Solvent pumps, CO_2 compressor



Derived from Feron, proceedings of GHGT-9, November 2008, Washington

Case study for new power station

	No Capture	90 % Capture
Efficiency (HHV)	38.1 %	28.0 %
CO_2- emissions	810 kg/MWh_e	105 kg/MWh_e
Capital costs	2529 A$/$kW_e$	5046A$/$kW_e$
Generation cost	56.4 A$/MWh	120 A$/MWh
CO_2 Avoided Cost	91 A$/tonne CO_2	



➢Capital costs dominant

Dave N., et al, Energy Procedia 4 (2011) 1869-1877).

Cost of electricity and CO_2-emissions avoided – Summary

- In Australia the cost of electricity generation will roughly double following installation of 90% CO_2 capture (from 56 to 120 A$/MWh)
- The biggest contribution to cost is capital, followed by operation and maintenance and lastly fuel (coal is cheap)
- In Australia the total estimated cost for CO_2 capture, transport and storage is 80 – 140 A$/tonne CO_2

P. Feron and L. Paterson, *Reducing the costs of CO_2 capture and storage*, CSIRO (2011).

Acknowledgements

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