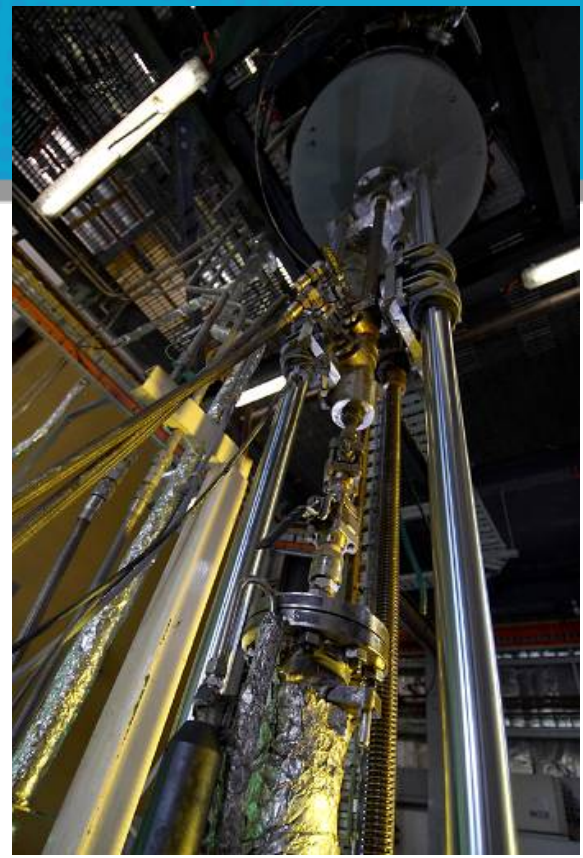
Integrated gasification combined cycle

Dr Louis Wibberley

Principal Technologist

CSIRO

Gasification



- Gasification is the conversion of hydrocarbons to syngas (CO and H_2) at high temperature and partial oxidising conditions
  - coal is not the only feedstock
  - biomass, petroleum coke, tars etc
  - natural gas for gas to liquids/ammonia
- Syngas can be used for many applications
  - chemicals production
  - liquid fuels (coal to liquids)
  - power generation (most recent)
- Gasification reactions and conditions are significantly different to combustion systems
  - reduced O_2, higher pressures
  - complex C-CO_2 and C-H_2O reactions affect process kinetics

CSIRO

Gasification is not new… but the use for electricity (IGCC) is

- First commercial coal gasification was in London in 1812 for town gas (lighting, heating, cooking)
- Modern gasification began in the 1930s with the development of large scale cryogenic air separation units for low cost oxygen
  - peak in the US in the 1930s with ~11,000 gasifiers
  - then declined with natural gas availability increased
- Large, high pressure gasification systems for production of liquid fuels and synthetic natural gas from coal in 1970's
  - Sasol ~90 Lurgi gasifiers for liquid fuels production in South Africa
- Rapid increase in gasification projects in China
  - most for chemicals and liquid fuels production
- Recent use for power generation
  - promise of higher efficiency, easier CO_2 capture, and underpinning the H-economy
  - challenges are cost and reliability

CSIRO

Modern gasifiers established in the 1980s … with IGCC

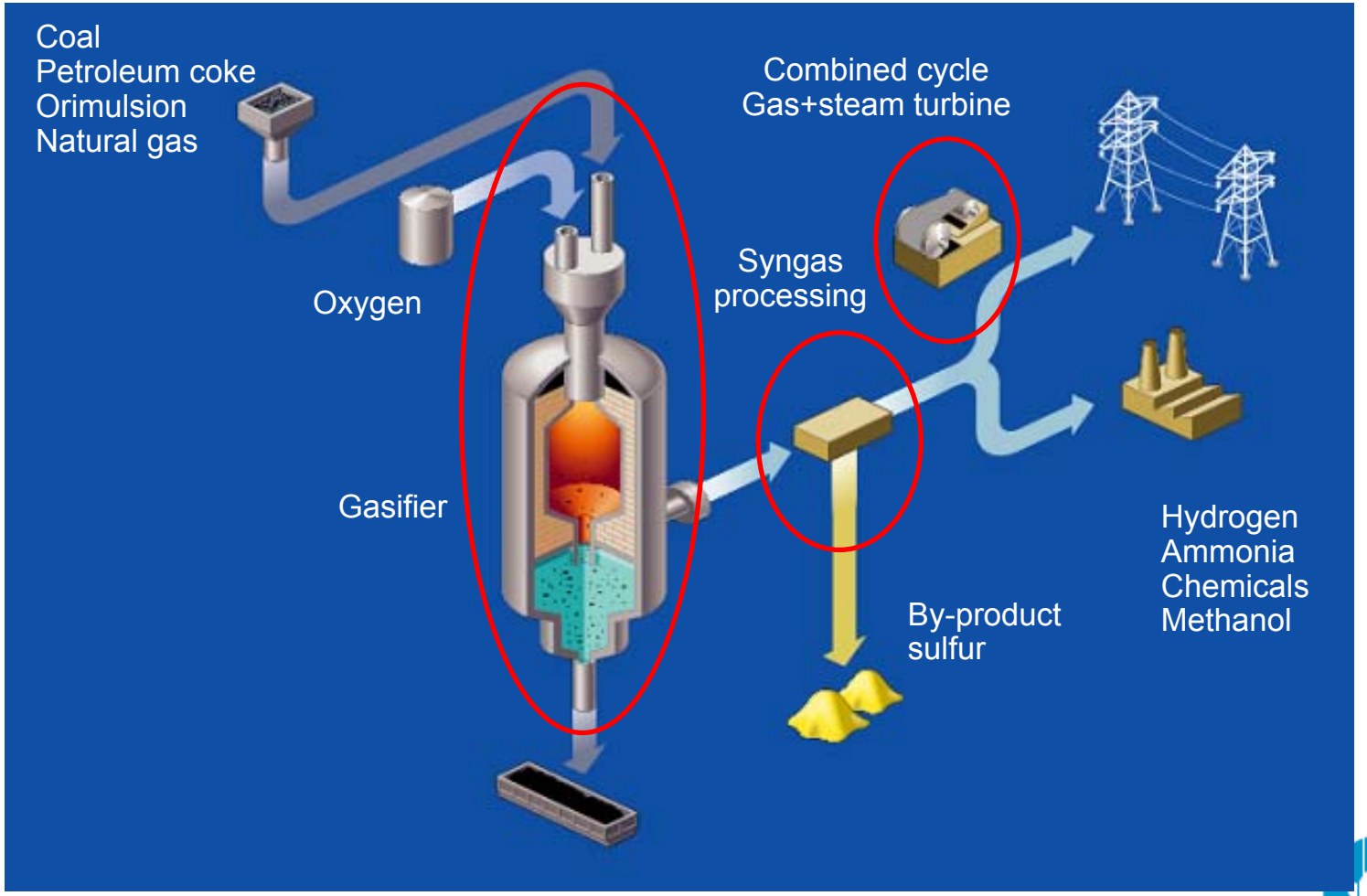
- Use of gasification for power generation emerged as a new opportunity
  - cleaner (low SOx, NOx, particulates)
  - more efficient
  - ability to adapt to polygen and to fuel the H-economy
- Commercial demonstration of high efficiency IGCC in the US
- Commercial gasifiers now all high-pressure, O_2-blown, entrained flow
- All major technologies have demonstration scale IGCC plants >250MW

Tampa Electric IGCC Power Plant (FL, USA)

Polk rated the "cleanest coal-fired power plant in North America"

CSIRO

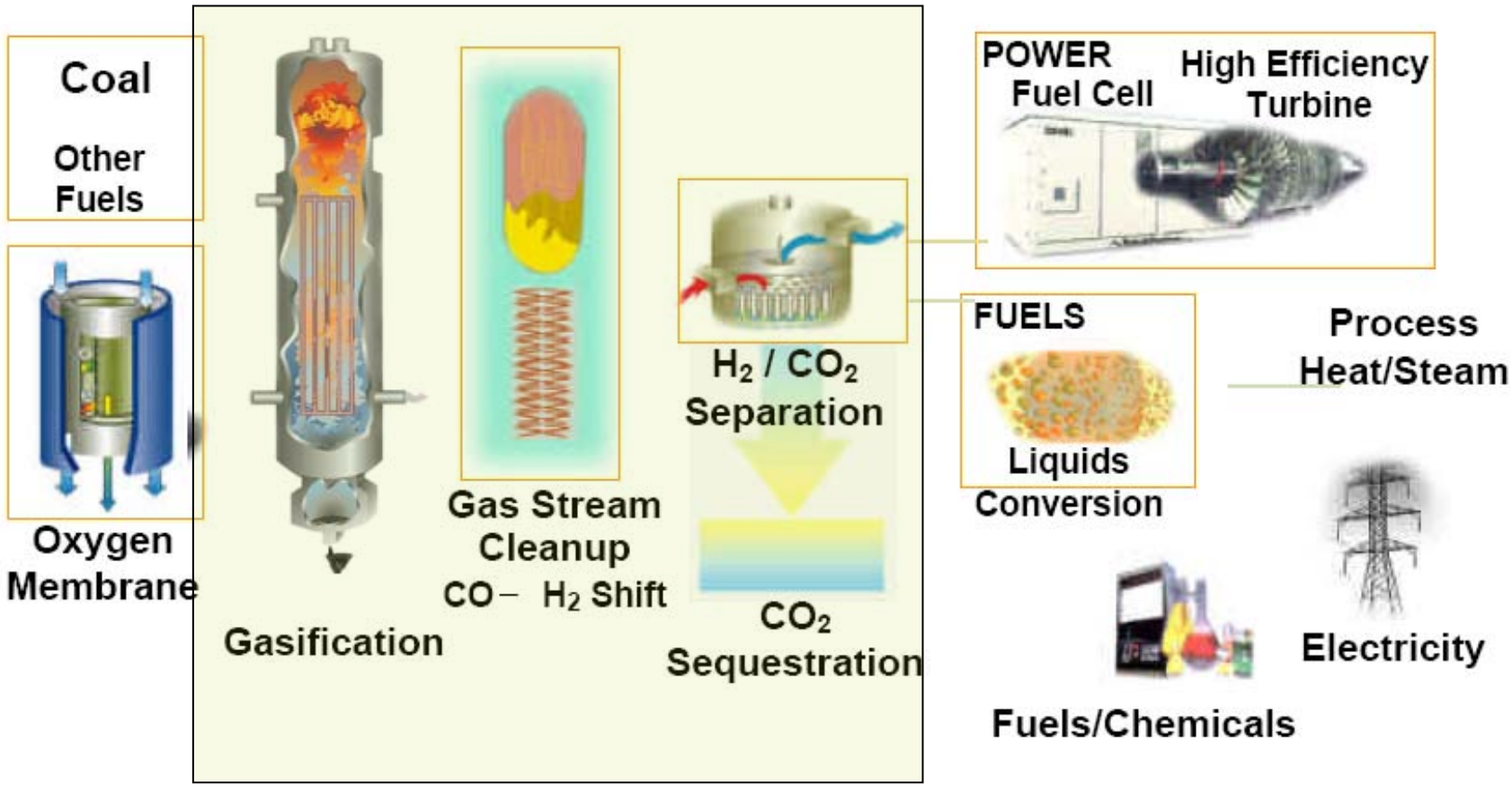
IGCC process – 3 main steps



ChevronTexaco-2003

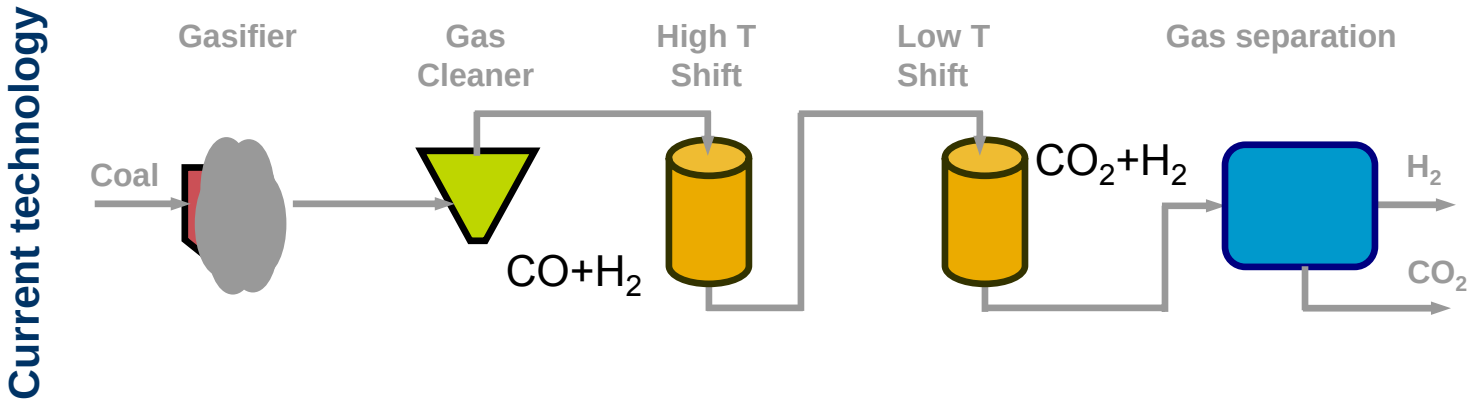
CSIRO

CSIRO R&D focus



Source: US DoE Oak Ridge Laboratories

Membrane reactor for syngas processing



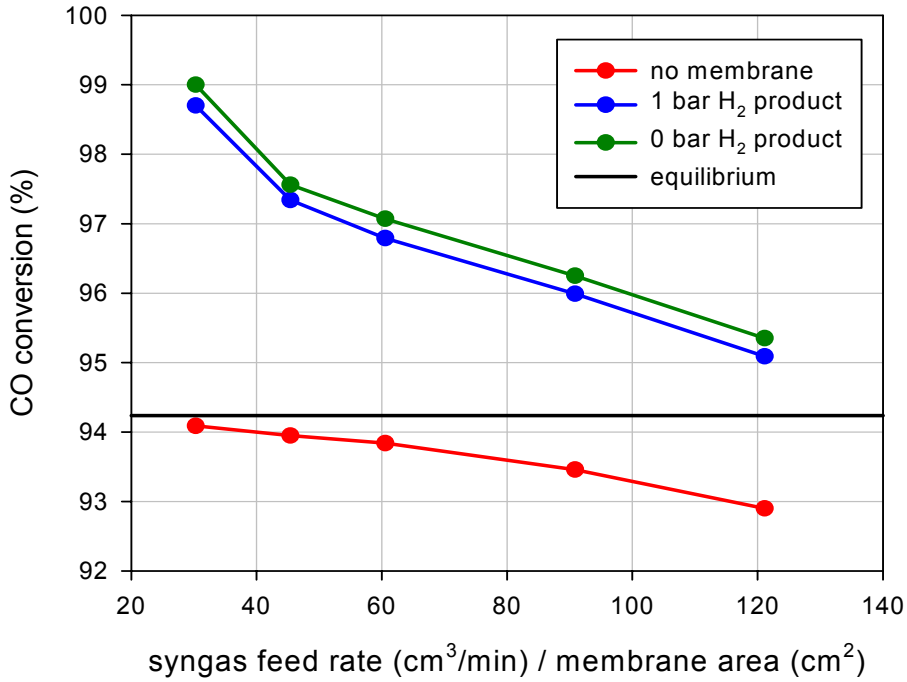
To reduce capital cost and increase efficiency

- increase temperature of gas cleaning and processing
- development and application of membrane separation systems
- integrate gas processing and separation stages with membrane reactors

CSIRO

Catalytic membrane reactor

- Prototype planar
  - proof-of-concept device
  - greater-than-equilibrium conversion achieved
  - pure H_2 product
  - >70% H_2 recovery demonstrated



CSIRO

Summary

- Gasification provides a high efficiency technology platform for development of low emissions power systems
  - development pathway for power, hydrogen & polygeneration systems
  - significant impacts of coal properties on gasification performance can be identified from laboratory scale measurements
- New research in niche areas where breakthroughs are needed to reduct cost and increase reliability
  - syngas cleaning, shift and gas separation (preferably as one step)
  - cost, scale and efficiency are key drivers
- Major national and international government/industry/research partnerships are being established to facilitate research development, demonstration and deployment

CSIRO

CSIRO Coal Technology
Dr Louis Wibberley
Principal Technologist
Louis.Wibberley@csiro.au

www.csiro.au

Thank you

Contact: CSIRO Coal Technology
Dr David Harris
Theme Leader
David.Harris@csiro.au

CSIRO