Session 4A: Case study analysis

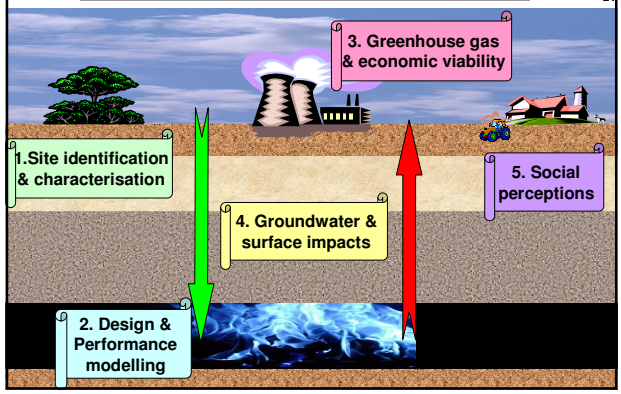
Supported by the Australian Government through the Asia Pacific Partnership (AP6) Coal Mining Task Force

12th December 2006
Kolkata, India

Case study analysis

- **A case study showing the procedures used to develop a process utilising UCG**
- **The target development is a nominally 400MWe electricity generation plant with the option to separate carbon dioxide for Greenhouse emission reduction**

Case study outline

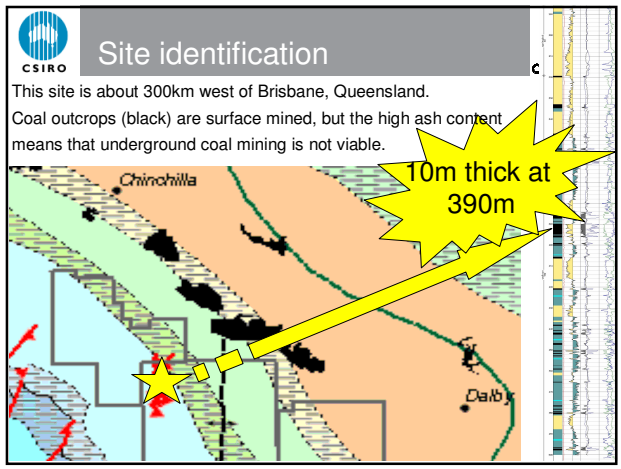


Site identification & characterisation

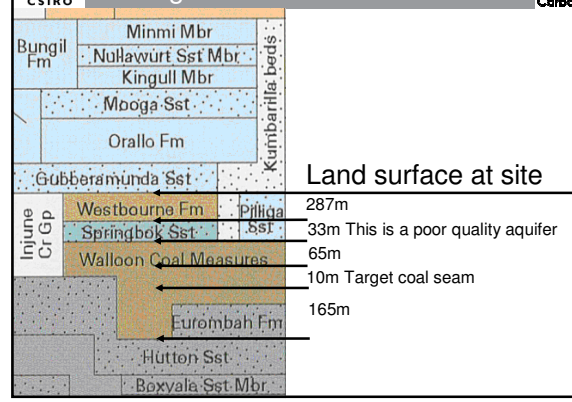
- Objective: A site with deep & thick coal that is not near good water aquifers and is relatively free of geological discontinuities
- The Eastern Surat Basin (Queensland, Australia) was selected for further study and a 3D regional geological model was prepared to assist in identifying a suitable site

Site identification

This site is about 300km west of Brisbane, Queensland.
Coal outcrops (black) are surface mined, but the high ash content means that underground coal mining is not viable.



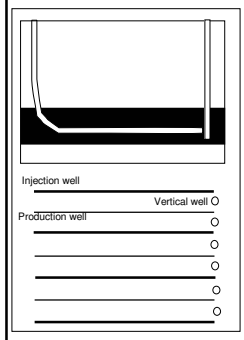
Geological formations



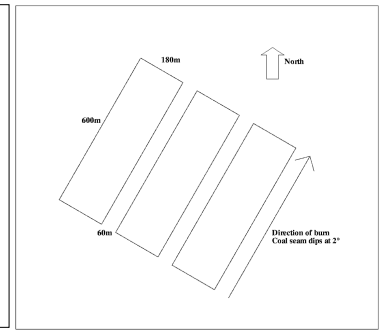
Design and performance modelling

- **A case study is required for the analysis of environmental issues at the selected site**
- **An electricity generation of nominally 400MWe using an IGCC style plant was selected as a significant installation**

UCG design



Module design

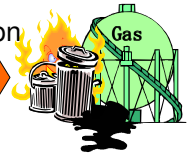


3 Modules as arranged in base case
(Module life 2.3 years)

Performance modelling:

Coal, Water, & Oxygen

Reaction T,P



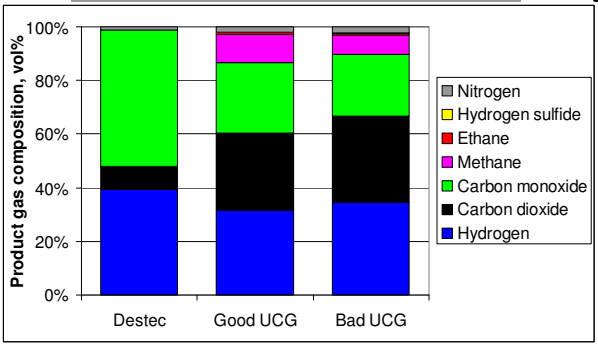
Heat, Char, Gas, & Tar

- **Output is influenced by the site, reactor design and the operating conditions**
- **Performance is strongly affected by the water inflow**

UCG and gas turbines

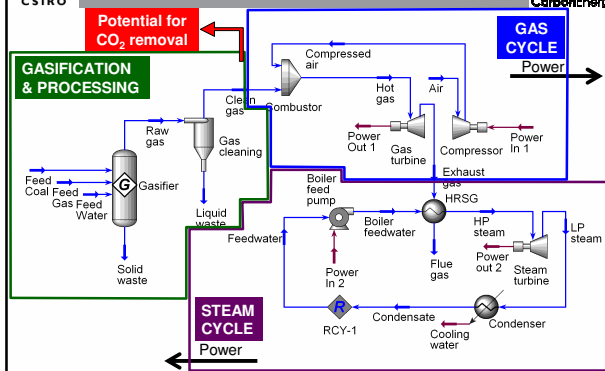
- **UCG product gas has a different composition for every site and varies significantly from that of entrained flow gasifiers for IGCC systems**
- **This has an impact on the design of the turbine combustor and the turbine**
- **Turbines are typically specified on mass flow, so the different gas composition can impact on operation**

UCG modelling



The 'Good UCG' case is the expected performance and the 'Bad UCG' case is an alternative prediction with some negative assumptions degrading performance.

Combined cycle electricity generation



Note: Simplified for presentation the real simulation involves 50+ unit processes

Process options

Process	Feed gas
Gas turbine combined cycle (IGCC)	**Surface coal gasifier (Destec)**
IGCC with CO_2 removal (IGCC-CO_2)	**UCG base case (Good UCG)**
IGCC with Shift and Removal (IGCC-Shift)	**UCG "worst" case estimate (Bad UCG)**

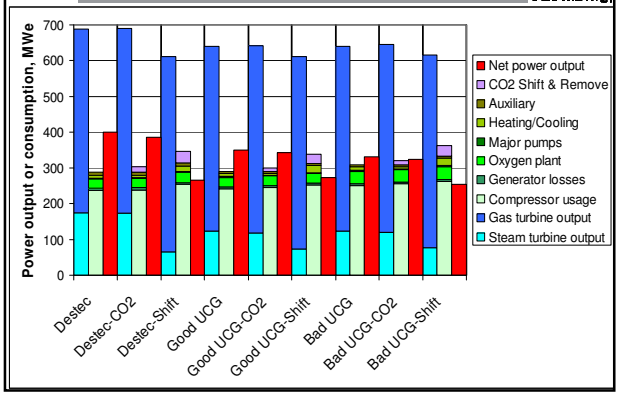
Note: All processes use commercially available technologies

Variation in gas usage

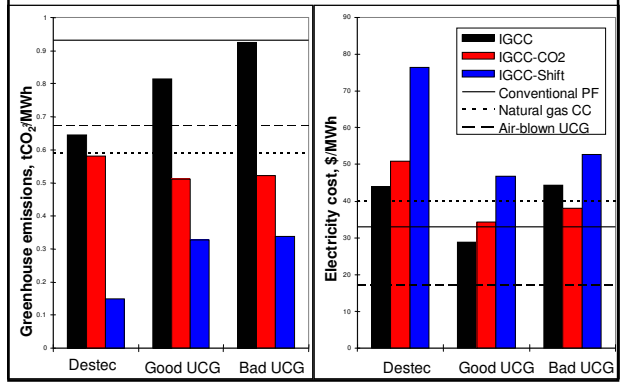
Mass flow to combustor	Destec kg/hr	Good UCG kg/hr	Bad UCG kg/hr
No CO2 removal	192705	220835	251500
90% of CO2 removed	192483	219270	249242
Shift then 90% of CO_2 removed	220636	234040	265760

The different gas composition results in different requirements for the gas turbine to operate at maximum efficiency. In this case, the turbine design is not optimal for UCG and is more suitable for the Destec gas.

Power characteristics of the systems



Greenhouse gas & economic viability



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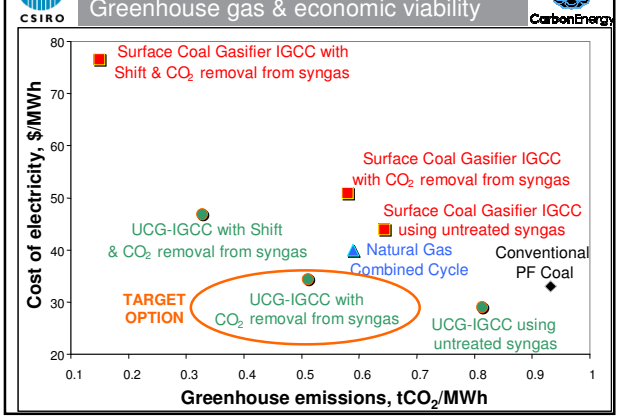
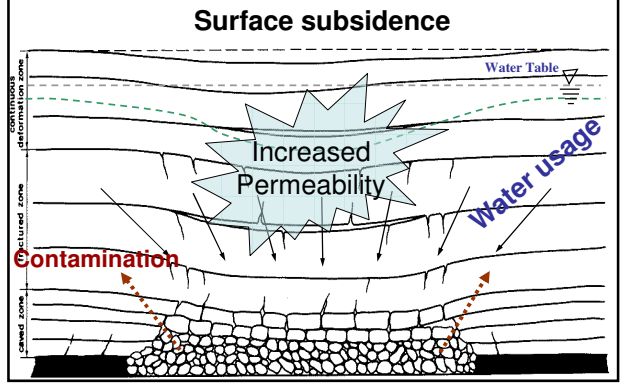
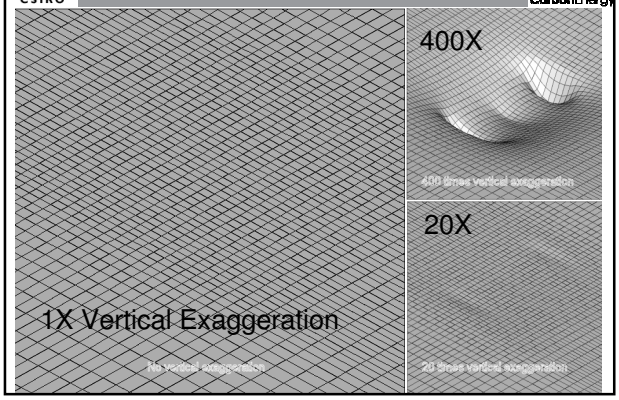


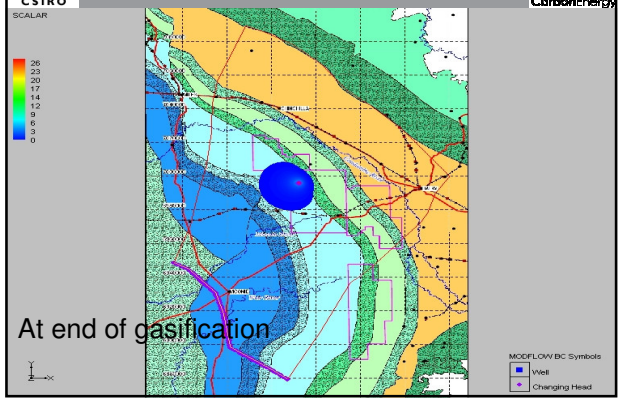
Groundwater & surface impacts



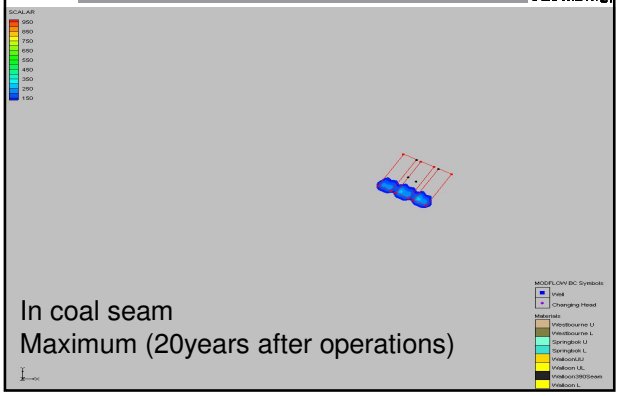
Subsidence



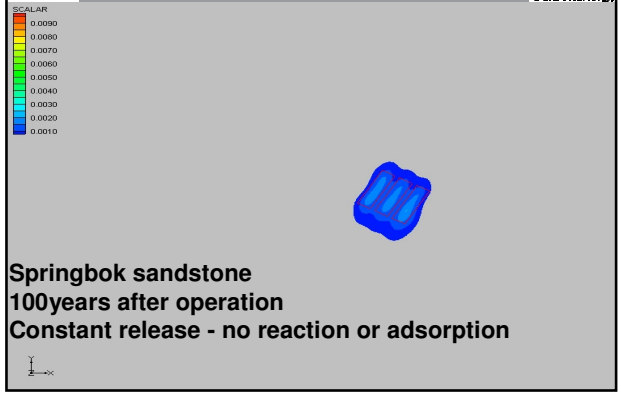
Groundwater drawdown



Salt contamination



Benzene contamination



Public perception survey

Issues raised by members of the public from the region after a discussion of the potential for UCG in the region

Benefits of UCG	Prospective concerns
❖**Better way of coal utilisation** ❖**Economic benefits** ❖**Environmentally beneficial** ❖**Benefits to regional community**	❖**Safety** ❖**Environment** ❖**Cost** ❖**Information** ❖**Alternatives** ❖**Lack of trust in politicians, scientists & business**

Summary of case study

- ❖**Evaluated the Surat Basin for UCG sites**
- ❖**Modelled a 400MWe UCG power plant for:**
  - o Comparative cost of electricity
  - o GHG emissions
  - o Environmental impacts
    - ▪ Subsidence
    - ▪ Groundwater depletion and contamination
- ❖**Examined public perceptions of UCG**

How does this relate to other sites?

- Each site is unique, so all modelling must be repeated for the specific size of installation at the actual site
- A general finding is that it appears possible to develop and environmentally sound and operationally efficient plants at suitable sites

Session 4B: Discussion

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Outline of today's activities

9:00 Session 1:
- Introductions
- Fundamentals & UCG design

10:45 Morning tea

11:00 Inauguration of Workshop by Shri Shibu Soren, Hon'ble Minister of Coal, India & Keynote address by :Shri H.C. Gupta, Secretary (Coal)

11:20 Session 2:
- Behaviour prediction
- Process performance & economic viability

1:00 Lunch

2:00 Session 3:
- Groundwater & surface impacts
- Site selection & characterisation
- Social perceptions

3:30 Afternoon tea

3:45 Session 4:
- Case study
- Discussion

5:00 Finish

The End

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