What is the Role of CCS in the Power Generation Industry

by:

Stanley Santos
IEA Greenhouse Gas R&D Programme

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CO$_2$ Capture and Storage (CCS) – A Global Business Vision
(Indonesia CCS National Workshop)
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*Corresponding Author’s Email: stanley.santos@ieaghg.org

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Presentation Outline

• IEA Greenhouse Gas R&D Programme
• Challenges of Reducing Greenhouse Gas Emissions
  o Briefly provide the key message of the IEA’s ETP and Energy Outlook Report
  o Macro level analysis to the prospect of CCS in Indonesia
• Options of CO2 capture technologies for power generation
  o Post-Combustion Capture
  o Oxy-Combustion Capture
  o Pre-Combustion Capture
• Challenges of CCS
• Conclusions

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Brief Introduction to

IEA Greenhouse Gas R&D Programme
(IEAGHG)

• http://www.ieagreen.org.uk
Introduction to IEAGHG

- IEA Greenhouse Gas R&D Programme (IEAGHG)
  - An R&D collaborative programme having an implementing agreement with the International Energy Agency.
  - A collaborative research programme that started in 1991.

- Our main role is to evaluate (without any bias) technologies that could provide significant reduction to the greenhouse gas emissions.

- Our main aim is to provide our members with an up to date information on the role that technology can play in reducing greenhouse gas emissions.

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IEA GHG is one of 40 organisations having an implementing agreement with IEA.
IEA Greenhouse Gas R&D Programme

http://www.ieagreen.org.uk
What do we do?

- New phase (5) started at end of 2004:
  - 3 Main activities:
    - A1: Technology and Market information
    - A2: Confidence building
    - A3: Information dissemination
  - Aimed at answering:
    - How do different technology options compare?
    - Can the option be done safely and legally?
    - What needs to be done to introduce the technology and be confident it will work?
Technology and Market Information

Implementation Support
- Methodology for CCS projects under CDM
- Guidelines for CCS site characterisation
- CCS Project Financing
- Regional capacity for CO2 storage in India

Technical Assessments
- Improved solvent scrubbing processes for CO2 capture
- Capture of CO2 from medium scale installations
- Improved Oxygen production processes
- Collection of CO2 from distributed sources
- CO2 Capture in the cement industry
- Co-production of hydrogen and electricity
- Remediation of leakage from geological storage
- Fuel Cells for CHP
- CO2 Pipeline transmission costs

Regulatory Support
- Risk assessment and regulatory needs
- Environmental impact assessment for CCS
- Capture-ready power plant
- Monitoring Selection Tool

http://www.ieagreen.org.uk
IEAGHG Research Network

• Objectives
  o To provide an avenue for discussion on specific issues toward development of CCS and support any confidence building activities
  o [http://www.co2captureandstorage.info/networks/networks.htm](http://www.co2captureandstorage.info/networks/networks.htm)

• IEAGHG manages 6 Research Networks
  o International CO₂ Capture Network
  o International Oxy-Combustion Network
  o Biofixation Network
  o Monitoring Network
  o Risk Assessment Network
  o Well Bore Integrity Network

Participants from 2nd Oxy-Combustion Workshop (CT, USA – Jan. 2007)
IEA Greenhouse Gas R&D Programme

- Provide a forum for Governments and Industry to cooperate
- Collaborate with other international bodies
  - International Energy Agency & G8
  - CSLF and APEC

http://www.ieagreen.org.uk

GHGT-9
16th – 19th November 2008
Washington D.C.
http://mit.edu/ghgt9
What is role of CCS in the Power Generation Sector?
World’s Source of Power Generation

Total Generation Capacity
(4 054 GW)

Total Electricity Generation
(17 408 TWh)

Doubling of capacity by 2030

Source: IEA Energy Outlook 2006

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Growth in the Power Generation Sector

Cumulative power sector investment by the region for 2005 -2030

Source: IEA Energy Outlook 2006
Type of Investment in Power Generation between 2005 and 2030

An opportunity for the developing countries to adapt and use more energy efficient and less GHG emission technologies…

Source: IEA Energy Outlook 2006

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Emissions challenge (-50% of 2005) in 2050

Baseline Emissions 62 Gt

BLUE Map Emissions 14 Gt

Source: IEA ETP 2008

http://www.ieagreen.org.uk
Average Annual Power Generation Capacity Additions in the 450 ppm CO₂ Stabilisation Case, 2013-2030

- Coal CCS: 22 CCS coal-fired plants (800 MW)
- Gas CCS: 20 CCS gas-fired plants (500 MW)
- Nuclear: 30 nuclear reactors (1000 MW)
- Hydropower: 2 Three Gorges Dams
- Biomass and waste: 400 CHP plants (40 MW)
- Wind: 17,000 turbines (3 MW)

Source: IEA ETP 2008
http://www.ieagreen.org.uk
What is role of CCS in the Power Generation Sector?

CCS Prospects and Business Opportunities in Indonesia

• http://www.ieagreen.org.uk
Why CCS could be an important business opportunity for Indonesia…

- Indonesia is ASEAN’s largest oil producer.
  - Production of 1.1 million barrel of oil equivalent per day (~ 895K barrel per day is crude oil) – 2006 data.
  - Crude oil production has been declining over the past decade due to mature fields. (~ 32% decline as compared to 1996 production level)
  - This should be seen as opportunity for CCS especially in EOR application.
  - Challenges:
    - Is it feasible (i.e. this means that this require the evaluation of possibility of CO₂ flooding in various offshore fields)?
    - How should the power generation sector participate?

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Oil Production in Indonesia (US DOE – EIA)

Indonesia’s Oil Production and Consumption, 1986-2006

Source: EIA International Energy Annual; Short-Term Energy Outlook

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**Why CCS could be an important business opportunity for Indonesia...**

- Indonesia is ASEAN’s largest gas producer.
  - NG pipeline infrastructure
    - Domestic NG pipeline will be operational by 2010.
    - Existing pipeline connection to Singapore and Malaysia
  - Currently there are concerns on declining of major gas fields. (i.e. Arun and Bontang)
    - In the short/medium term, the Tangguh field could cover the decline in the other gas field.
    - More gas exploration has been initiated.
  - Will there be an opportunity for Enhanced Gas Recovery (probably via flue gas injection)?
  - Surely, depleted gas fields are future potential storage site.
  - Challenges: Safety consideration of the storage site in seismically active region is one of the important considerations.

[http://www.ieagreen.org.uk](http://www.ieagreen.org.uk)
Natural Gas Production

Indonesia's Natural Gas Production and Consumption, 1984-2004

Source: EIA International Energy Annual 2004

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Why CCS could be an important business opportunity for Indonesia...

- Indonesia is the World’s second largest net exporter of coal.
- 85% of your coal resources are classified as lignite and sub-bituminous coal.

Source: EIA, International Energy Annual 2004

http://www.ieagreen.org.uk
**Why CCS could be an important business opportunity for Indonesia...**

- Indonesia’s power sector faces shortages on electricity due to underinvestment in new generating capacity.
  - It is expected generating capacity from coal and NG will increase its share.

- The future of CCS in Indonesia’s Power Generation sector would depend on future government policy!
  - A CCS friendly policy option in this sector should encourage Capture Ready Plant for near term investment.
  - A well developed national plan on future deployment of CCS should be beneficial and could tap any future business opportunity benefits.

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The Different Options of CCS in the Power Generation Sector

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There are Still Several Technical Challenges of the Different CCS Options for Power Generation

Techno-Economic Operational Performance

The Technical Aspects of these options will be discussed in more details in my second presentation

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Technology Maturity of CCS

- **Mineral carbonation**
  - Research phase

- **Ocean storage**
  - Demonstration phase

- **Oxyfuel combustion**
  - Post-combustion
  - Pre-combustion

- **Enhanced Coal Bed Methane**
  - Transport

- **Gas and oil fields**
  - Industrial separation

- **Saline formations**
  - Industrial utilization

- **Enhanced Oil Recovery**
  - Economically feasible under specific conditions

- **Economicallly feasible under specific conditions**
- **Mature market**

Derived from the IPCC SRCCS 2005
1000 MW
- Siemens
- Kingsnorth
- GreenGen Phase 2

500 MW
- Mongstad
- Karsto
- Abu Dhabi
- Kern County
- Janschwalde
- RWE
- Oolagah
- UK Competition
- Nordylland
- GreenGen Phase 1
- Stanwell
- Boundary Dam
- ZeroGen Phase 2

100 MW
- SEQ
- Mongstad
- Lacq
- Karlslahn
- Schwarze Pumpe
- Callide, Mountaineer
- Ciuden
- CATO/Castor/Brindisi

0 MW
- SEQ
- Mongstad
- Lacq
- Karlslahn
- Schwarze Pumpe
- Callide, Mountaineer
- Ciuden
- CATO/Castor/Brindisi

Courtesy of J. Price (CSLF)
Snapshots to the Techno-Economic Performance of CCS options for Power Generation.

• http://www.ieagreen.org.uk
Power Generation Efficiency

Efficiency, % LHV

Source: IEA GHG studies

http://www.ieagreen.org.uk
Capital Cost

US $/kW

Source: IEA GHG studies

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What are the Challenges Ahead of Us in the Current Development of CCS Technologies for Power Generation Industry
## Non-ferrous metal prices

<table>
<thead>
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<th>Prices/US$/tonne</th>
<th>Jan-2003</th>
<th>Jan-2008</th>
<th>Peak price</th>
<th>Date of peak</th>
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<tr>
<td>Nickel</td>
<td></td>
<td></td>
<td></td>
<td>54000</td>
<td>June-2007</td>
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<td></td>
<td></td>
<td>8000</td>
<td>28000</td>
<td></td>
<td></td>
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<tr>
<td>Copper</td>
<td></td>
<td>1700</td>
<td>6800</td>
<td>8800</td>
<td>May-2006</td>
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<tr>
<td></td>
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<tr>
<td>Aluminium</td>
<td></td>
<td>1350</td>
<td>2400</td>
<td>3250</td>
<td>May-2006</td>
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http://www.ieagreen.org.uk
Chemical Engineering Plant Cost Index

http://www.ieagreen.org.uk
Natural gas prices

http://www.ieagreen.org.uk
THE MESSAGE!!!

• ....... In the time we have spent talking about CCS plants, the costs have decreased and then increased – we are now in need of real plants in order to reduce both CO₂ emissions and costs.......
Concluding Remarks

• CCS will play an important role in reducing greenhouse gas emissions from the power generation sector.

• Several activities have been initiated worldwide in the development of Carbon Capture for Power Generation industry.

• We need large scale demonstration of the CO2 capture technologies to build the confidence necessary for a rapid deployment.

• We need to overcome the challenges that CCS should face toward its path to commercialisation.
One 500MW coal-fired power station

In Salah (2005)
Weyburn (2000)
Sleipner (1996)
Concluding Remarks

• Indonesia’s per capita carbon emissions remain low by regional comparisons, but should expect to face a severe environmental challenges.

• Indonesia should have a good potential to benefit from the deployment of CCS worldwide.
  o In the short term – considerations of EOR application to increase oil production of mature fields.
  o In the medium to long term – depleted gas/oil fields are potential storage sites and this should be evaluated for its viability and safety. This is a valuable assets to the ASEAN region.
Concluding Remarks

- Indonesia is one of the leading coal exporters...
  - It should be expected that the World’s effort to curve greenhouse gas emissions would require new coal plant to be equipped with CCS.
  - Indonesia’s support to CCS should have long term mutual benefits to your coal industry and buyer of your coal.

- Indonesia is one of the leading proponents of Trans-ASEAN NG pipeline.
  - Would this be also an opportunity for Indonesia to lead the discussion of Trans-ASEAN CO₂ pipeline?
  - This should give an opportunity to access your future potential storage sites.

- Power generation sector should have an important role to play in Indonesia’s CCS scenario option.
  - Under investment in the power generation sector means that new generating capacity is required in the near future.
  - Thus - Near term investment of generation capacity should consider CCS friendly features. (i.e. Capture Ready Plant).

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Thank You
Any Questions?

CCS – [http://www.co2captureandstorage.info](http://www.co2captureandstorage.info)

Email – [stanley.santos@ieaghh.org](mailto:stanley.santos@ieaghh.org)