



# postcombustion captureconferenceone

17<sup>th</sup>-19<sup>th</sup> may 2011



IEA GREENHOUSE GAS R&D PROGRAMME



**Masdar**  
CARBON



### International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. The IEA fosters co-operation amongst its 28 member countries and the European Commission, and with the other countries, in order to increase energy security by improved efficiency of energy use, development of alternative energy sources and research, development and demonstration on matters of energy supply and use. This is achieved through a series of collaborative activities, organised under more than 40 Implementing Agreements. These agreements cover more than 200 individual items of research, development and demonstration. IEAGHG is one of these Implementing Agreements.



**Doosan Power Systems**



**GASSNOVA**

#### Disclaimer

IEAGHG supports and operates a number of international research networks. This report presents the results of a workshop held by one of these international research networks. The report was prepared by IEAGHG as a record of the events of that workshop.

#### Copyright And Citations

Copyright © IEA Environmental Projects Ltd. (IEAGHG) 2011. All rights reserved.

The report should be cited in literature as follows:

'IEAGHG, "Post Combustion Capture Conference 1", 2011/16, November, 2011.'

Further information or copies of the report can be obtained by contacting IEAGHG at:

IEAGHG, Orchard Business Centre, Stoke Orchard, Cheltenham, GLOS., GL52 7RZ, UK

Tel: +44(0) 1242 680753 Fax: +44 (0)1242 680758

E-mail: [mail@ieaghg.org](mailto:mail@ieaghg.org)

Internet: [www.ieaghg.org](http://www.ieaghg.org)

Copyright © IEA Greenhouse Gas R&D Programme 2011

All rights reserved.

Date Published: October 2011, Review compiled by John Topper, design and layout by Toby Aiken and Becky Kemp.

Front Cover Image: Yas Hotel. Image Courtesy of Yas Island.ae



# Background

Since the inception of the International Capture Network in 2000, IEAGHG have organised 12 successful meetings in the series, and it has proved to be a very important gathering for post-combustion capture experts to share their knowledge, findings and expertise. As a result of the increasing interest and number of operating projects in the post-combustion capture area, the number of attendees and submitted abstracts for this network has grown dramatically.

Due to this success, it was decided to respond to this growing interest by developing the network into a full Post-Combustion Capture Conference; PCCC1.

PCCC1 aims to be a forum to discuss the various issues related to post-combustion capture technologies status and development. PCCC1 will provide an opportunity to encourage technology providers and developers to share their experiences and knowledge.

The Conference content was overseen by a Steering Committee comprising of the following members:

Mohammad Abu Zahra, IEAGHG / MASDAR Institute,  
John Topper, IEAEPL  
Hallvard Svendsen, NTNU  
Paul Feron, CSIRO  
Gary Rochelle, University of Texas  
Paitoon Tontiwachwithikul, University of Regina

There was also an Organising Committee established to manage the logistical issues of the event, and this Committee comprised of the following members:

Mohammad Abu Zahra, IEAGHG / MASDAR Institute,  
Sian Twinning, IEAGHG,  
Keristofer Seryani, MASDAR Carbon  
Anca Westly, MASDAR Carbon



# Introduction

Over a series of 12 successful workshops spanning 200-2009 on the topic of post combustion capture, interest had grown so much that it has been decided to move into full conference format. This event in May 2011 was the first full Post Combustion Capture Conference (PCCC1) organised under the auspices of the IEA Greenhouse Gas Programme. It was also the first held in the Middle East. Over 100 registrants came from 14 OECD and 6 non-OECD countries. The only continent not present was South America.

The programme ran for 3 full days split into 14 sessions; in two parallel streams on the first two days. Scheduled were 47 technical presentations and 19 posters. All presentations are available for inspection and download from the IEAGHG website – link below:

<http://www.ieaghg.org/index.php?/technical-programme.html>

*Delegates during the poster session*





# The Meeting

## Solvent Development in 3 sessions

Novel solvents, further development of amine mixtures, catalysts and inhibitors, oxidative and thermal degradation and use of amino acid salt solutions for CO<sub>2</sub> capture were the topics covered. Alongside the process development stream this topic had most presentations with 11 podium speeches.

## 2<sup>nd</sup> and 3<sup>rd</sup> Generation Capture Technologies

There were 3 papers in this single session covering use of aqueous ammonia, some non-aqueous solvents with reduced thermal penalties in the recovery stage and a paper on membranes for CO<sub>2</sub> capture.

## Environmental impacts and Chemical Emissions in 2 sessions

These sessions included several presentations related to degradation and volatility of methanolamine and other amines. Also covered was gas/particle partitioning of amines in air and monitoring techniques.

Environmental issues are getting greater attention than a few years ago, hence two sessions.

## Process development and Evaluation in 3 sessions

This stream involved 11 presentations. These covered capture on combined cycle gas turbine plant, a variety of submissions by process developers about their technology (HTC Pure Energy, Sulzer, Siemens), control methodologies to cover a range of operating requirements, cost trade offs, analytic measurement techniques, flowsheet optimisation, a techno-economic analysis based on using membranes rather than amines, and process design to allow later adaption for future technology development.

## Capture Process modelling in 2 sessions

Six presentations dealt with simulation of different capture media, including liquid-solid-vapour equilibria, solubility of N<sub>2</sub>O in alkanolamine, absorber modelling and heat of absorption requirements using aqueous ammonia.

## Pilot Plant and Demonstration Projects in 3 sessions

These nine presentations perhaps gave the greatest indication of the status of post combustion capture in terms of its progress towards commercialisation. So, these are all listed below:

- Results from the RWE pilot plant at Niederaussem, Germany
- First results from ENEL's pilot plant at Brindisi, Italy
- Results from several campaigns on the EC supported pilot plant at Esbjerg, Denmark
- CSIRO's pilot plant work in Australia
- Capture with EOR in China
- Testing of membranes at 6 industrial sites
- Characterising of absorber column packing materials
- Development of Toshiba's process
- CO<sub>2</sub> recovery with biomass

What did we learn from all of these presentations and how has the state of the art moved forward since the last event in 2009? In general we can say that greater understanding of the behaviour of mixtures of amines, ammonia based capture methods and the beginnings of membranes as a possible alternative capture method have all moved forward. Process simulation becomes increasingly complex – only for the specialist. More and more pilot plant work is reported and more process developers are taking up the challenge. What is perhaps a little disappointing is that large scale demonstration, at sizes above 100MWe, are still some way from operation. Hopefully, this time gap will have closed considerably by the time of the next meeting in 2013.

The venue and date for the next meeting have yet to be fixed but an offer has been made and will be considered by the IEA GHG Executive Committee at its meeting in November 2011.

Finally, thanks are due to Masdar Carbon for local assistance in setting up the conference, to the YAS hotel for their excellent arrangements, to the steering committee for fixing the conference content and to the sponsors without whose support we could not have mounted the event – Doosan Power Systems, Mitsubishi Heavy Industries, EnBW and Gassnova.

# What Did We Learn?

- A number of pilot plants have established mass transfer and energy performance.
- Energy required for CO<sub>2</sub> capture from coal is settling into a range of 200-250 kwh/tonne CO<sub>2</sub>.  
KS-1, piperazine, AMP/PZ, MDEA/PZ are some of the superior solvents.
- Two issues of secondary environmental impact are receiving major attention:
  - 1) Nitrosamines are made from NO<sub>2</sub> in flue gas, but are probably limited to accumulation in the solvent.
  - 2) Unexpected losses of volatile amine through the water wash as aerosols must be addressed.
- Steady technical progress has been made over 11 years
- There are a number of large pilot plants providing good scale up data but there are still no integrated CCS demonstrations that using post combustion capture
- 2<sup>nd</sup> Generation Technologies are certainly coming on but the process economics that surround them are still unclear
- There are no perceived technical show stopped - environmental impacts are being addressed

## Historical Comparison

- |   |            |
|---|------------|
| • 1 <sup>st</sup> Workshop in Gaithersburg, USA (Spring 2000)       |            |
| • 2 <sup>nd</sup> Workshop, Calgary, Canada(November 2001)          | 23 people  |
| • 3 <sup>rd</sup> Workshop in Apeldoorn; Netherlands (Spring 2002)  | 24 people  |
| • 4 <sup>th</sup> Workshop in Kyoto, Japan (Autumn 2002)            | 34 people  |
| • 5 <sup>th</sup> Workshop in Pittsburgh, USA (June 2003)           | 33 people  |
| • 6 <sup>th</sup> Workshop in Trondheim, Norway, (Spring 2004)      | 40 people  |
| • 7 <sup>th</sup> Workshop in Vancouver, Canada, (Sept 2004)        | 69 people  |
| • 8 <sup>th</sup> Workshop in Austin, USA (Autumn 2005)             | 41 people  |
| • 9 <sup>th</sup> Workshop at offices of E2, Copenhagen (June 2006) | 52 people  |
| • 10 <sup>th</sup> Workshop at IFP in Lyon, France (May 2007)       | 73 people  |
| • 11 <sup>th</sup> Workshop in EVN Forum, Austria (May 2008)        | 100 people |
| • 12 <sup>th</sup> Workshop in Univ Regina, Canada (September 2009) | 150 people |





## IEA Greenhouse Gas R&D Programme

Orchard Business Centre, Stoke Orchard,  
Cheltenham, Glos. GL52 7RZ, UK

Tel: +44 1242 680753      [mail@ieaghg.org](mailto:mail@ieaghg.org)  
Fax: +44 1242 680758      [www.ieaghg.org](http://www.ieaghg.org)