



# GHGT9

## Conference Program

**9th International  
Conference on Greenhouse Gas  
Control Technologies**

Washington, D.C.  
16-20 November 2008

# About the Organizers

## About MIT

The Massachusetts Institute of Technology (MIT) is recognized as a world-class educational institution. The mission of MIT is to advance knowledge and educate students in science, technology, and other areas of scholarship that will best serve the nation and the world in the 21st century. The Institute is committed to generating, disseminating, and preserving knowledge, and to working with others to bring this knowledge to bear on the world's great challenges.

Global climate change is one of the world's great challenges. Researchers at MIT are vigorously pursuing a portfolio of technology and policy approaches to address climate change. For the past 20 years, this has included a major research effort on CO<sub>2</sub> Capture and Storage (CCS). MIT led an effort for DOE in 1992 to produce the first major Research Needs Assessment for CCS, organized and hosted The Third International Conference on CO<sub>2</sub> Removal (ICCDR-3) in 1996 (a precursor to the GHGT series), and, in 2000, launched an industrial research consortium, the Carbon Sequestration Initiative (see [sequestration.mit.edu](http://sequestration.mit.edu)).

In September 2006, the MIT Energy Initiative (MITEI, see [mit.edu/mitei](http://mit.edu/mitei)) was established as an Institute-wide initiative designed to help transform the global energy system to meet the needs of the future and to help build a bridge to that future by improving today's energy systems. The MITEI program now includes research, education, campus energy management and outreach activities that cover all areas of energy supply and demand, security and environmental impact. MITEI interdisciplinary research focuses on innovative energy technologies and underlying policy analysis; transformational technologies to develop alternative energy sources; global systems; and tools to enable innovation, transformation and simulation of these systems.

## About DOE

The United States Department of Energy (DOE) is a cabinet level federal agency charged with developing science and technology to support its goals of energy, economic and national security. Pursuant to this mission, carbon capture and storage (CCS), along with many other areas, has been a component of DOE funded research for more than a decade. DOE's CCS program managed by the Office of Fossil Energy and implemented by the National Energy Technology Laboratory (NETL) leverages applied research with field demonstrations to assess the technical and economic viability of the long-term safe storage of CO<sub>2</sub> as a viable greenhouse gas mitigation option. The Regional Carbon Sequestration Partnerships, that conduct much of the geologic sequestration field research sponsored by DOE, are public-private partnerships. Research conducted in the core part of the Sequestration Program is conducted by National laboratories, universities, and industry. Many industry partners, through the Sequestration Program, Innovations for Existing Plants, and the Clean Coal Power Initiative, perform various stages and scales of research pertaining to carbon capture. The Department also supports international involvement in clean coal technologies with CCS through organizations such as the Asia Pacific Partnership (APP), the Carbon Sequestration Leadership Forum (CSLF) and the IEA Greenhouse Gas program, as well as many others.

**DOE Activities Include:** Regional Carbon Sequestration Partnerships: Public-Private groups that support geologic sequestration research. 23 small scale injection tests are currently at various stages of completion. Seven large scale injection tests are in various stages of planning. In addition, the RCSP has produced the "Carbon Sequestration Atlas of the United States and Canada".

**Clean Coal Power Initiative:** Public-Private funded research aimed at lowering the cost of CCS. Funds projects occurring in the lab, as well as various demonstration projects.

**International Activity:** Through the APP, CSLF, IEA GHG and others, the Department promotes and disseminates clean coal technologies internationally, maximizing their potential impact on GHG emissions.

## About IEA GHG

The IEA Greenhouse Gas R&D Programme (IEA GHG) is a major international collaborative programme undertaking research on greenhouse gas mitigation. IEA GHG members include 18 countries, the European Commission, OPEC and 18 multinational sponsors. IEA GHG is an impartial source of information on technologies capable of achieving deep reductions in greenhouse gas emissions. There are a range of technologies that could be used to substantially reduce emissions of greenhouse gases and IEA GHG seeks to characterise these options on a consistent basis. The important role that fossil fuels play in underpinning world economic development is recognised, and IEA GHG activities have demonstrated the opportunity for their continued use, even under scenarios involving deep reductions.

IEA GHG activities include: The production of technology and market information. Deliverables include: Technical and economic assessments, technology reviews and presentation of papers at key conferences.

Confidence building by promotion of technology development. Deliverables include: Support, by facilitation of and provision of advice, for practical R&D programmes, and organisation of thematic networks.

Information dissemination to governmental and other policy makers, industry leaders and technology developers, and public audiences such as environmental NGO's. Deliverables include: Public summary reports, the bi-annual international GHGT conference series, a quarterly newsletter, two websites and various information databases.

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SPONSORS AND SUPPORTERS	INSIDE BACK COVER

# Welcome



Howard Herzog



Jay Braitsch



John Gale



Bob Kane



Sean Plasynski

## Organizing Committee Members

### **Howard Herzog, Chair**

Massachusetts Institute of Technology

### **Jay Braitsch**

US Department of Energy, Office of Fossil Energy

### **John Gale**

IEA Greenhouse Gas R&D Programme

### **Bob Kane**

US Department of Energy, Office of Fossil Energy

### **Sean Plasynski**

US Department of Energy, National Energy Technology Lab

## Program Committee Members

**Howard Herzog**, MIT (USA), Co-Chair

**John Gale**, IEA GHG (UK), Co-Chair

**Jay Braitsch**, US DOE (USA), Co-Chair

**Sally Benson**, Stanford University (USA)

**Olav Bolland**, NTNU (Norway)

**John Bradshaw**, Greenhouse Gas Storage Solutions – GGSS (Australia)

**Jim Dooley**, JGCRI (USA)

**Gardiner Hill**, BP (UK)

**Anhar Karimjee**, US EPA (USA)

**Arthur Lee**, Chevron (USA)

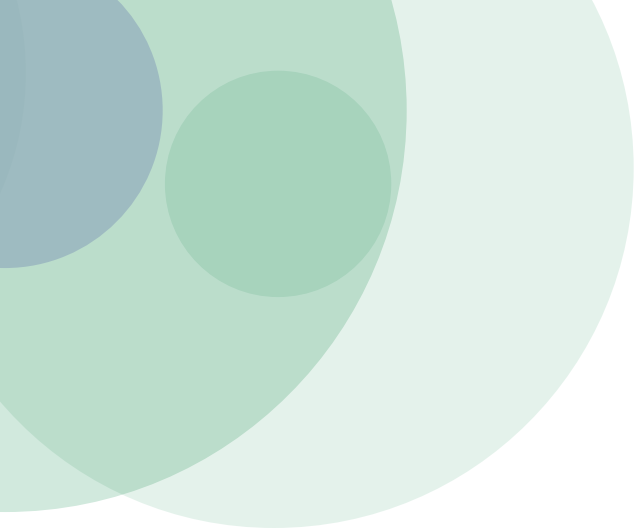
**Pierre LeThiez**, IFP (France)

**Takashi Ohsumi**, RITE (Japan)

**David Reiner**, Cambridge University (UK)

**Ed Rubin**, Carnegie Mellon (USA)

**Malcolm Wilson**, University of Regina (Canada)



## Welcome to GHGT-9

The Organizing Committee welcomes you to Washington, DC and the 9th International Conference on Greenhouse Gas Control Technologies. The GHGT conference series has established itself as the principal international conference on greenhouse gas mitigation technologies and has become a focal point for innovative international research on CO<sub>2</sub> Capture and Storage (CCS). Interest in this topic has grown considerably in recent years, as witnessed by the growth in abstracts submitted – 875 this year compared to 565 two years ago at GHGT-8 in Trondheim, Norway. We are expecting well over 1000 delegates to register for GHGT-9, setting a new attendance record for the conference.

The IEA Greenhouse Gas R&D Programme (IEA GHG) is the guardian of the conference series. The GHGT conferences are held every two years in an IEA GHG's member country. Financing and organizing the conference is the member country's responsibility. For GHGT-9, the United States of America (USA) is proud to serve as host, with the US Department of Energy (DOE) serving as the main sponsor and the Massachusetts Institute of Technology (MIT) serving as the conference organizer. The conference was last held in the USA in 1996 (then called the 3rd International Conference on Carbon Dioxide Removal), with MIT and DOE once again teaming up to host the meeting in Boston, Massachusetts.

We have an exciting four days planned. There will be 269 oral presentations, over 400 poster presentations, 6 distinguished keynote speakers, 5 issue forums, and a closing panel discussion. Since the GHGT conference series is the one meeting that brings together the world's CCS community, we have built in plenty of time for renewing old friendships, making new friends, and networking. This includes the Sunday evening welcoming reception, Monday's poster reception, and Wednesday's gala banquet. Note that it is a tradition at the GHGT meetings to make the gala event a very special evening. This year's venue is the Smithsonian Institution's National Air and Space Museum and we feel confident that it will live up to the GHGT tradition. Finally, we have purposely left Tuesday night open to afford delegates a chance to explore the many sights and restaurants in Washington, DC.

Many people have put in long hours to make GHGT-9 come to life. The list is too long to recognize everyone here, but we want to thank the GHGT-9 Program Committee, the conference Secretariat housed at MIT, and the staff at IEA GHG. We want to offer a special thank-you to the US DOE and the conference's 17 sponsors and 12 supporters, whose generous support have allowed us to plan such an ambitious meeting. These organizations are the world leaders in the research and development of GHG control technologies. Please visit the sponsor booths in the Exhibit Hall and read the sponsor and supporter handouts in your delegate bags.

In closing, we thank you for participating in GHGT-9 and we hope you enjoy the next four days.

Howard Herzog  
Jay Braitsch  
John Gale  
Bob Kane  
Sean Plasyński

# Conference at a Glance

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SUNDAY 16 NOV	MONDAY 17 NOV	TUESDAY 18 NOV
	<p>7:30–8:30 <b>Continental Breakfast</b> Exhibit Hall</p>	<p>7:30–8:30 <b>Continental Breakfast</b> <b>Poster Session A</b> Exhibit Hall</p>
	<p>8:30–10:15 <b>Opening Plenary</b> Regency Ballroom</p>	<p>8:30–10:15 <b>Technical Session 3</b></p>
	<p>10:15–11:00 <b>Break</b> Exhibit Hall / Bird Cage Walk</p>	<p>10:15–10:45 <b>Break</b> Exhibit Hall / Bird Cage Walk</p>
	<p>11:00–12:30 <b>Technical Session 1</b></p>	<p>10:45–12:15 <b>Technical Session 4</b></p>
	<p>12:30–2:30 <b>Lunch (Sponsored by Chevron)</b> <b>Keynote Talk</b> Regency Ballroom</p>	<p>12:15–2:15 <b>Lunch (Sponsored by Shell)</b> <b>Keynote Talk</b> Regency Ballroom</p>
<p>3:00 <b>Registration Opens</b> West Registration Desk</p>	<p>2:30–4:15 <b>Technical Session 2</b></p>	<p>2:15–3:45 <b>Technical Session 5</b></p>
<p>4:00–8:00 <b>Welcome Reception (Sponsored by BP)</b> <b>Welcoming Remarks at 6:00</b> Diplomat Terrace/Ballroom/Foyer Bird Cage Walk</p>	<p>4:15–6:30 <b>Poster Reception</b> Poster Session A (4:30–5:30) Poster Session B (5:30–6:30) Exhibit Hall</p>	<p>3:45–4:15 <b>Break</b> Exhibit Hall / Bird Cage Walk</p> <p>4:15–6:00 <b>Technical Session 6</b></p>
		<p>6:15–7:30 <b>Student Session</b> Palladian Ballroom Reception follows in Diplomat Ballroom</p>

**WEDNESDAY 19 NOV**

7:30–8:30

**Continental Breakfast**  
**Poster Session B**  
 Exhibit Hall

8:30–10:15

**Technical Session 7**

10:15–10:45

**Break**  
 Exhibit Hall / Bird Cage Walk

10:45–12:15

**Technical Session 8**

12:15–2:15

**Lunch**  
**Keynote Talk**  
 Regency Ballroom

2:15–3:45

**Technical Session 9**

3:45–4:15

**Break**  
 Exhibit Hall / Bird Cage Walk

4:15–5:45

**Technical Session 10**

6:30

**First buses leave hotel for Gala Banquet**

7:00–11:00

**Gala Banquet**  
**(Sponsored by Alstom)**  
 Smithsonian Institution's  
 National Air and Space Museum

**THURSDAY 20 NOV**

7:30–8:30

**Continental Breakfast**  
 Exhibit Hall

8:30–10:15

**Technical Session 11**

10:15–10:45

**Break**  
 Exhibit Hall / Bird Cage Walk

10:45–12:15

**Technical Session 12**

12:15–2:15

**Lunch**  
**Keynote Talk**  
 Regency Ballroom

2:15–4:15

**Closing Plenary**  
 Regency Ballroom

**EXHIBIT HALL**

The Exhibit Hall will house the posters and the sponsors' booths. It will be open as follows:

**Monday, November 17** 7:30 am – 12:30 pm | 2:30 – 6:30 pm

**Tuesday, November 18** 7:30 am – 12:15 pm | 2:15 – 6:00 pm

**Wednesday, November 19** 7:30 am – 12:15 pm | 2:15 – 5:45 pm

**Thursday, November 20** 7:30 am – 12:00 noon

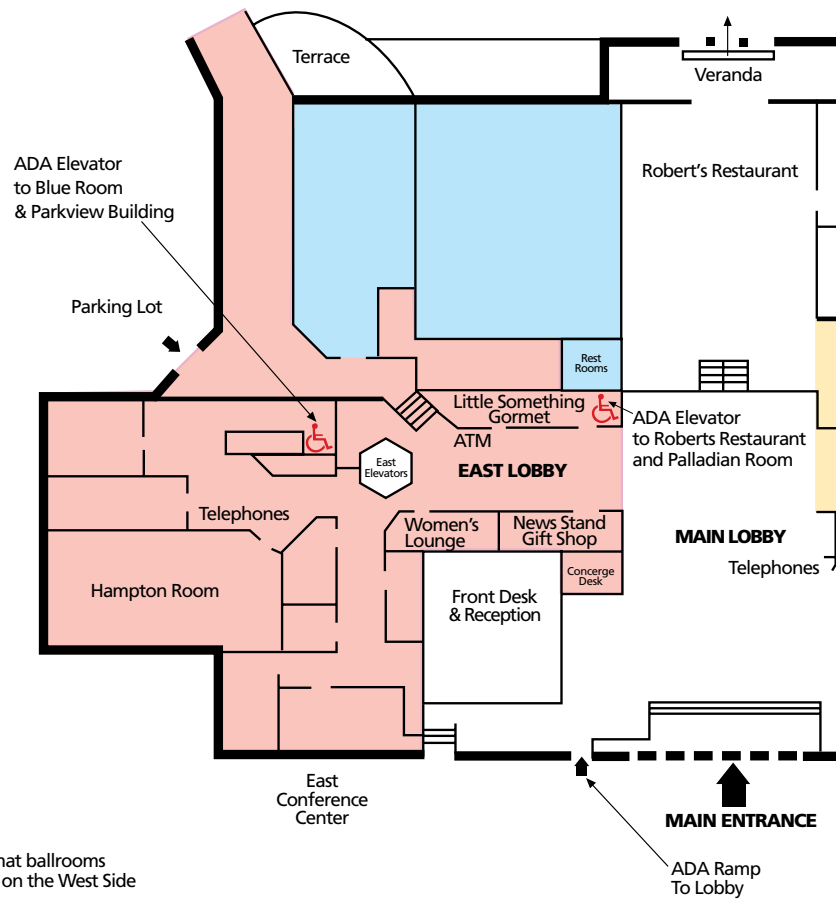
Continental breakfast will be served each day in the Exhibit Hall from 7:30–8:30 am

The Exhibit Hall will host the poster reception beginning at 4:15 pm on Monday, November 17

All breaks will be served in the Exhibit Hall (breaks will also be available in the Bird Cage Walk).

# Hotel Floor Plan

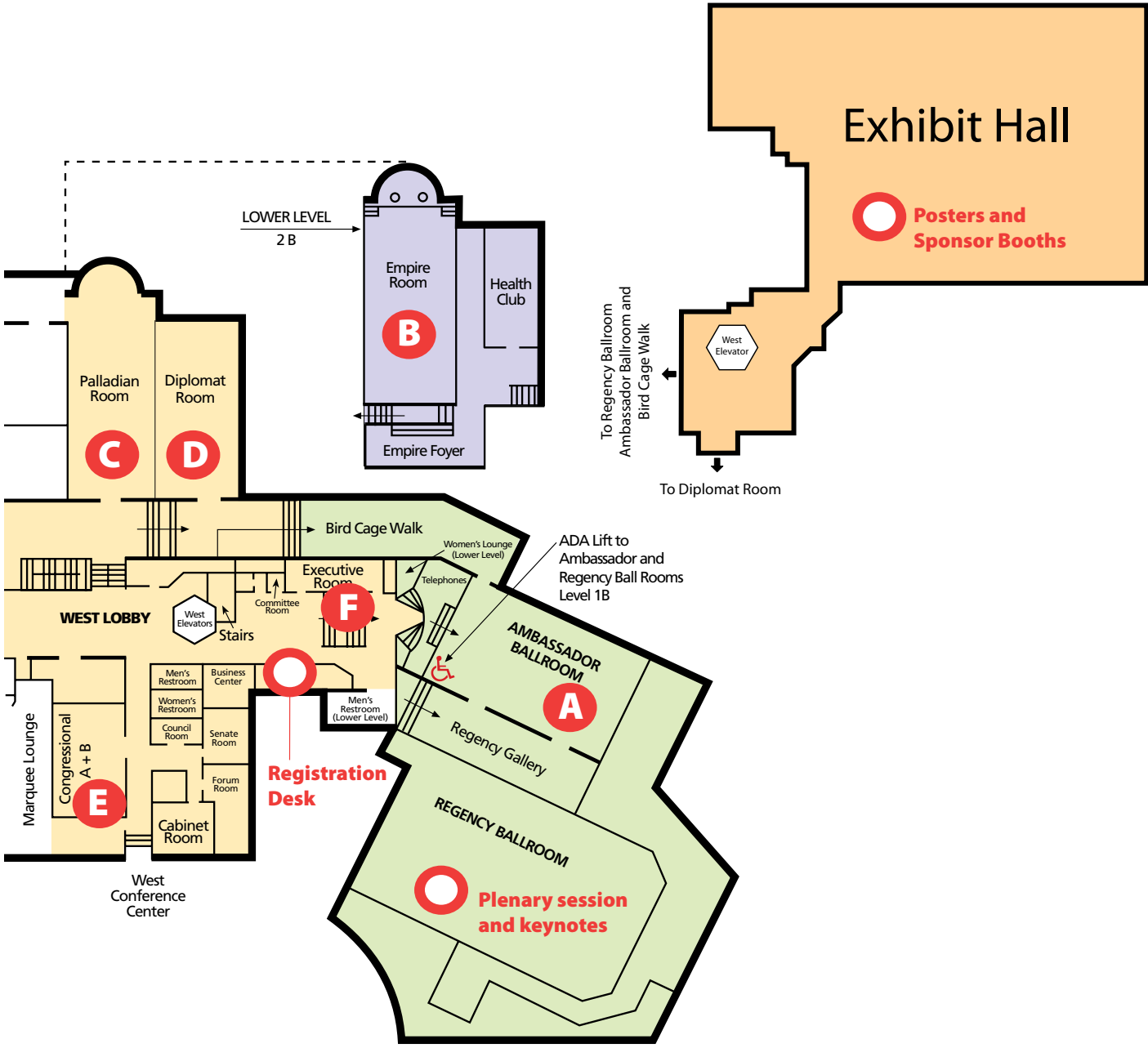
**Letters in red circles refer to Technical Session rooms. See pages 10-11.**



For Access to Diplomat ballrooms  
Please use elevators on the West Side  
and go to level 1B.

For Access to the Empire Ballroom  
and Health Club/Outdoor Pool  
Please use elevators on the West Side  
of the Hotel and go to level 2B.





# Plenary Sessions

## OPENING PLENARY

Co-chairs:

**Howard Herzog**, MIT

**John Gale**, IEA GHG

## WELCOME ADDRESS

**Ernie Moniz**, Director, MIT Energy Initiative

## OPENING ADDRESS

**Samuel Bodman**, (invited), Secretary, US Department of Energy

## OPENING PLENARY KEYNOTE TALK 1

*The Potential Role of CCS in Climate Stabilization*

**Jae Edmonds**

Chief Scientist and Laboratory Fellow

Pacific Northwest National Laboratory's (PNNL)

Joint Global Change Research Institute

## OPENING PLENARY KEYNOTE TALK 2

*The Status of CCS Technology and the Challenges Ahead*

**Kelly Thambimuthu**

Chief Executive Officer

Centre for Low Emission Technology (cLET)

Australia

## MONDAY LUNCH KEYNOTE TALK

*Prospects for Post-2012 Climate Policy*

**Henry Jacoby**

Professor of Management

Massachusetts Institute of Technology

## TUESDAY LUNCH KEYNOTE TALK

*A World of Change: Climate Yesterday, Today, and Tomorrow*

**Susan Solomon**

Research Scientist

National Oceanic and Atmospheric Administration

## WEDNESDAY LUNCH KEYNOTE TALK

*Developing Country Perspectives toward Climate Change and CCS*

**Ogunlade Davidson**

Professor, University of Sierra Leone

## THURSDAY LUNCH KEYNOTE TALK

*The Role of Communication in Making CCS a Reality*

**David Ropeik**

Instructor, Harvard University

Consultant in Risk Communication

## CLOSING PLENARY PANEL DISCUSSION

*The Challenges Ahead*

Chair: **John Gale**, IEA GHG

Panelists:

**Sally Benson**, Stanford University

**Jim Dooley**, Joint Global Change Research Institute

**David Reiner**, Cambridge University

**Ed Rubin**, Carnegie Mellon University

## SPECIAL STUDENT SESSION

Tuesday evening, Palladian Ballroom, 6:15 pm

We would like to invite all current students and recent graduates to a panel discussion on navigating the world of CCS careers.

Early and mid-career professionals will offer insights into their experiences finding CCS jobs and the market for young CCS professionals. A reception will follow at 7:30 pm in the Diplomat Ballroom.

Panelists:

**Brendan Beck**, IEA Greenhouse Gas R&D Programme

**Mark Bohm**, Suncor

**Ruben Juanes**, Massachusetts Institute of Technology

**Susan Nordrum**, Chevron



**JAE EDMONDS** is a Chief Scientist and Laboratory Fellow at the Pacific Northwest National Laboratory's (PNNL) Joint Global Change Research Institute, and Adjunct Professor of Public Policy at the University of Maryland at College Park. Dr. Edmonds is the principal investigator for the Global Energy Technology Strategy Program to

Address Climate Change, an international, public-private research collaboration. His research in the areas of long-term, global, energy, economy, and climate change spans three decades, during which time he published several books, numerous scientific papers and made countless presentations. His most recent book, *Global Energy Technology Strategy, Addressing Climate Change*, distills more than a decade of research on the role of technology in addressing climate change. Dr. Edmonds has served in the capacity of Lead Author on every

major IPCC assessment to date and presently serves on the IPCC Steering Committee on "New Integrated Scenarios". He serves on numerous panels and advisory boards related to energy, technology, the economy and climate change. He received his Ph.D. in the field of Economics from Duke University in 1975.



**DR KELLY THAMBIMUTHU** has been the Chairman of the IEA Greenhouse Gas R&D Program since 1995. He was also the editorial panel member and coordinating lead author of The IPCC Special Report on CO<sub>2</sub> capture and storage. He is currently the Chief Executive Officer of the Centre for Low Emission Technology (cLET) in Pullenvale,

Queensland. cLET is a partnership between world-class research and development providers. cLET is working to make it possible for Australia to continue using its abundant coal resources to

provide economical energy and power in an environmentally acceptable and sustainable manner. Before joining cLET in 2004 Dr Thambimuthu worked with CANMET Energy Technology Centre in Ottawa, Canada. While there Dr Thambimuthu worked with industry, universities and government on energy solutions for the commercial and industrial sectors.



**HENRY D. JACOBY** is Professor of Management in the M.I.T. Sloan School of Management and Co-Director of the M.I.T. Joint Program on the Science and Policy of Global Change, which is a world leader in integration of the natural and social sciences and policy analysis in application to the threat of global climate change. He is

director of the design and application of the social science component of the Joint Program's Integrated Global System Model – which is a comprehensive research tool for analyzing potential anthropogenic climate change and its social and environmental consequences – and he is a leader of M.I.T. research and analysis of national climate policies and the structure of the international climate regime.

An undergraduate mechanical engineer at the University of Texas at Austin, Professor Jacoby holds a Ph.D. in Economics from Harvard University where he also served on the faculties of the Department of Economics and the Kennedy School of Government. He has been Director of the Harvard Environmental Systems Program, Director of the MIT Center for Energy and Environmental Policy Research, Associate Director of the MIT Energy Laboratory, and Chair of the MIT Faculty. He has made extensive contributions to the study of economics, policy and management in the areas of energy, natural resources and environment, writing widely on these topics including seven books. He currently serves on the Scientific Committee of the International Geosphere-Biosphere Program and of Climate Research Committee of the U.S. National Research Council.



**SUSAN SOLOMON** is widely recognized as one of the leaders in the field of atmospheric science. Since receiving her PhD degree in chemistry from the University of California at Berkeley in 1981, she has been employed by the National Oceanic and Atmospheric Administration as a research scientist. Her scientific papers have

provided not only key measurements but also theoretical understanding regarding ozone destruction, especially the role of surface chemistry. In 1986 and 1987, she served as the Head Project Scientist of the National Ozone Expedition at McMurdo Station, Antarctica and made some of the first measurements there that pointed towards chlorofluorocarbons as the cause of the ozone hole. In 1994, an Antarctic glacier was named in her honor in recognition of that work. In March of 2000, she received the National Medal of Science, the United States' highest scientific honor, for "key insights in explaining the cause of the Antarctic ozone hole."

She is the recipient of many other honors and awards, including the highest awards of the American Geophysical Union (the Bowie Medal), the American Meteorological Society (the Rossby

Medal), and the Geochemical Society (the Goldschmidt Medal). She is also a recipient of the Commonwealth Prize and the Lemaitre Prize, as well as the ozone award and Vienna Convention Award from the United Nations Environment Programme. In 1992, R&D magazine honored her as its "scientist of the year". In 2004 she received the prestigious Blue Planet Prize for "pioneering research identifying the causative mechanisms producing the Antarctic ozone hole."



**OGUNLADE R. DAVIDSON** has been Professor of Mechanical Engineering since 1993 and is currently the Dean of Post-Graduate Studies at University of Sierra Leone. In 1985 he became the first Director of Research at the University of Sierra Leone. Between 1992 and 2000, he was Head of Department of Mechanical and Maintenance

Engineering, and 1996-2000 was Dean of the Faculty of Engineering. Internationally, he is recently elected Vice-Chair of the Intergovernmental Panel on Climate Change (IPCC), and is the Co-Chair of Steering Committee of the Global Network on Energy for Sustainable Development (GNESD).

His research interests include African Energy Systems and Policies, Power sector reform, Renewable Energy policy, Climate Change-GHG Mitigation and National Climate Change strategy. He has been and still is a member of many international bodies. He has worked as a Consultant in Energy, Technology, Climate Change and Environment for several national and international bodies including UNESCO, UNIDO, ILO, UNECA, UNDP, UNEP, GEF, UNFCCC, NEPAD, ADB, World Bank, Battelle laboratories and Carnegie Corporation New York. He has published over 300 books, chapters in books, journal articles, and conference papers and has undertaken many national and international funded R&D projects on Energy, Environment, Climate Change and Science and Technology Policy. He is a member of the U.S. National Research Council.



**DAVID ROPEIK** is an Instructor at Harvard University and an international consultant and speaker on risk communication to government, business, consumer groups, and educational institutions. He is a former Instructor of risk communication at the Harvard School of Public Health, and was co-director of the school's professional

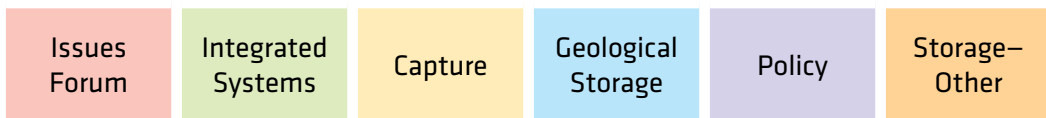
education course 'The Risk Communication Challenge'. He is co-author of RISK, A Practical Guide for Deciding What's Dangerous and What's Safe in the World Around You. He is creator and director of the program "Improving Media Coverage of Risk", a training program for journalists. Mr. Ropeik was a television reporter for WCVB-TV in Boston from 1978-2000. He specialized in reporting on environment and science issues. He twice won the DuPont-Columbia Award, (often cited as the television equivalent of the Pulitzer Prize), and seven regional EMMY awards. He was a Knight Science Journalism Fellow at MIT 1994-95, and a member of the Board of Directors of the Society of Environmental Journalists from 1991-2000. He has taught journalism at Boston University, Tufts University, and MIT.

# Technical Sessions at a Glance

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			A	B
Session			Ambassador Ballroom	Empire Ballroom
<b>Monday, Nov. 17</b>	1	11:00–12:30	Recent Advances in CO2 Storage	Recent Advances in CO2 Capture
	2	2:30–4:15	CO2 Storage Capacity I	Pilot Plant Experience
<b>Tuesday, Nov. 18</b>	3	8:30–10:15	Long Term Storage Integrity: Trapping Mechanisms	CO2 Transport Infrastructure
	4	10:45–12:15	Long Term Storage Integrity: Caprocks and Seals	Industrial Operating Experience
	5	2:15–3:45	Long Term Storage Integrity: Wells	Modeling Industry Pilot Plants
	6	4:15–6:00	CO2 Storage Capacity II	Solvent Alternatives
<b>Wednesday, Nov. 19</b>	7	8:30–10:15	Monitoring: Geophysical Techniques	Ammonia Capture Processes
	8	10:45–12:15	Monitoring: Geochemical Techniques	Oxyfuel Flue Gas Treatment
	9	2:15–3:45	Monitoring: Surface Methods	Oxyfuel Developments for Power Plants
	10	4:15–5:45	Environmental Impacts of CO2 Storage	Updates on Planned Demonstration Projects
<b>Thursday, Nov. 20</b>	11	8:30–10:15	Saline Aquifer Storage	Chemical Looping Systems
	12	10:45–12:15	Coal-bed Storage and ECBM	Assessments of Advanced/ Novel Systems

C	D	E	F
Palladian Ballroom	Diplomat Ballroom	Congressional A + B	Executive Room
Recent Developments in CCS Policy			
Emerging Large Scale Storage Projects	CCS at Scale	National Programs	
Policy and Regulatory Developments I	CCS Retrofits for Power Plants	Geological Storage: Lessons Learned	Absorption: Fundamentals
What We have Learned from Demonstration Projects	Fuel Production and Conversion with CCS	Pilot and Demonstration Projects	Stakeholder Perspectives
Designing and Implementing Regulatory Frameworks	Modeling CCS Deployment in Europe	Pore and Core Scale Processes I	Capacity Building through Education and Training
Incentives and Financing	Integrated Assessment of CCS Deployment	Pore and Core Scale Processes II	Membranes for Capture
Public Acceptance and the Role of Information	Moving Beyond Source-Sink Matching	Novel Options for Geological Storage	Solvent Management
Moving Forward to Large-Scale Deployment of CCS	Opportunities for Significant Cost Reduction	Model Development	Novel Processes for Pre-Combustion Systems
The View from Wall Street	CCS in Refining	Site Characterization	Ocean Storage
Addressing Long-term Liability	Economics of Advanced Capture Systems	Storage Engineering	Mineral Carbonation
Policy and Regulatory Developments II	Techno-Economic Comparisons	Risk Assessment for Geological Storage	
Carbon Policy Post Kyoto	Capture Developments in China and India	Best Practices for Geological Storage	



# Technical Session Details

## Technical Session 1

### 1A RECENT ADVANCES IN CO<sub>2</sub> STORAGE

Session Chairs: Sally Benson and Peter Cook

#### **Advances in Global and Regional Capacity Assessment**

Sam Holloway, British Geological Survey (BGS)

#### **Long Term Fate and Environmental Risks of Geological Sequestration**

Larry Myer, Lawrence Berkeley National Laboratory (LBNL)

#### **Getting Large-Scale Geological Sequestration Projects Started: What Does it Take?**

Trude Sundset, StatoilHydro ASA

### 1B RECENT ADVANCES IN CO<sub>2</sub> CAPTURE

Session Chairs: Ed Rubin and Yoichi Kaya

#### **Capture at New Coal-fired Power Plants**

Stu Dalton, EPRI

#### **Retrofitting Capture to Existing Plants**

Dale Simbeck, SFA Pacific

#### **Outlook for Advanced Capture Technology**

Olav Bolland, Norwegian University of Science and Technology (NTNU)

### 1C RECENT DEVELOPMENTS IN CCS POLICY

Session Chairs: David Reiner and Anhar Karimjee

#### **Financing the First CCS Projects**

Kate Hampton, Climate Change Capital

#### **Assembling the CCS Value Chain**

David White, Schlumberger

#### **Twelve Years after Sleipner: Moving CCS from Hype to Pipe**

George Peridas, Natural Resources Defense Council; David Hawkins, Natural Resources Defense Council; John Steelman, Natural Resources Defense Council

## Technical Session 2

### 2A CO<sub>2</sub> STORAGE CAPACITY I

Session Chairs: Stefan Bachu and John Bradshaw

#### **CO<sub>2</sub> Storage Resources, Reserves, and Reserve Growth: Toward a Methodology for Integrated Assessment of the Capacity of Oil and Gas Reservoirs and Saline Formations**

Robert Burruss, US Geological Survey

#### **Screening CO<sub>2</sub> Storage Options in The Netherlands**

Andrea Ramirez, Utrecht University; Saskia Hagedoorn, Ecofys BV; Leslie Kramers, TNO; Ton Wildenborg, TNO; Chris Hendriks, Ecofys BV

### **A Regional Assessment of the CO<sub>2</sub> Storage Potential in the Indian Subcontinent**

Sam Holloway, British Geological Survey; Amit Garg, Indian Institute of Management; Manmohan Kapshe, Maulana Azad National Institute of Technology; Aashish Deshpande, Maulana Azad National Institute of Technology; Ali Pracha, Sustainable Development Policy Institute; Shaheen Khan, Sustainable Development Policy Institute; Mahbub Mahmood, Bangladesh University of Engineering and Technology; T N Singh, Dhanbad, India; Karen Kirk, British Geological Survey

### **Methodology of CO<sub>2</sub> Aquifer Storage Capacity Assessment in Japan and Overview of the Project**

Shigetaka Nakanishi, Electric Power Development Company; Yasunobu Mizuno, Research Institute of Innovative Technology for the Earth; Tadahiko Okumura, Engineering Advancement Association of Japan; Hideaki Miida, Engineering Advancement Association of Japan; Takumi Shidahara, Central Research Institute of Electric Power Industry; Shin-ichi Hiramatsu, Oyo Corporation

### **Subsurface Design Considerations for Carbon Dioxide Storage Projects**

John Wilkinson, ExxonMobil Upstream Research Company; Robert Szafranski, ExxonMobil Upstream Research Company; Kean Seng Lee, ExxonMobil Production Company; Cliff Kratzing, Esso Australia Production

### 2B PILOT PLANT EXPERIENCE

Session Chairs: John Topper and Johannes Heithoff

### **Current Status of MHI's CO<sub>2</sub> Recovery Technology and Optimazation of CO<sub>2</sub> Recovery Plant with a PC Fired Power Plant**

Tsuyoshi Ohishi, Mitsubishi Heavy Industries, Ltd; Shinya Kishimoto, Mitsubishi Heavy Industries, Ltd; Kazuo Higaki, Mitsubishi Heavy Industries, Ltd; Takuya Hirata, Mitsubishi Heavy Industries, Ltd; Masaki Iijima, Mitsubishi Heavy Industries, Ltd; Ronald Mitchell, Mitsubishi Heavy Industries, Ltd

### **Evaluation of the Performance of Various Aqueous Amine-based Solvents in an Optimized Multi-purpose Technology Development Pilot Plant**

Raphael Idem, University of Regina; Don Gelowitz, University of Regina; Paitoon Tontiwachwuthikul, University of Regina

### **Experience with CO<sub>2</sub> Capture from Coal Flue Gas in Pilot-scale: Testing of Different Amine Solvents**

Jørgen Nørklit Jensen, DONG Energy; Jacob Nygaard Knudsen, DONG Energy; Poul-Jacob Vilhelmsen, DONG Energy, Fredericia; Ole Biede, Vattenfall

### **Post-combustion Capture R&D and Pilot Plant Operation in Australia**

Paul H M Feron, CSIRO; Aaron Cottrell, CSIRO; James McGregor, CSIRO; Yuli Artanto, CSIRO; Narendra Dave, CSIRO; Scott Morgan, CSIRO; Pauline Pearson, CSIRO

### **Update on Vattenfall's 30 MWth Oxyfuel Pilot Plant in Schwarze Pumpe**

Marie Anheden, Vattenfall Research and Development; Lars Strömberg, Vattenfall AB; Göran Lindgren, Vattenfall AB; Jürgen Jacoby, Vattenfall Research and Development; Rainer Giering, Vattenfall Research and Development; Uwe Burchhardt, Vattenfall; Hubertus Altmann, Vattenfall; Frank Kluger, Alstom Power Systems; Georg-Nikolaus Stamatiopoulos, Alstom Power Systems

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## 2C EMERGING LARGE SCALE STORAGE PROJECTS

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Session Chairs: Bill Koppe and Tore Torp

### **Subsurface Development of CO2 Disposal as Part of the Gorgon Project**

Matthew Flett, Chevron Australia; Jeroen Brantjes, Chevron Australia; Randal Gurton, Chevron Australia; Seb Leigh, Chevron Australia; Jason McKenna, Chevron Australia; Terrell Tankersley, Chevron Australia; William Robinson, Chevron Australia

### **Integration and Deployment of Geologic Storage and Monitoring across Two Deep Saline Reservoirs with Post-Combustion Capture at American Electric Power Mountaineer Plant**

Neeraj Gupta, Battelle; Philip Jagucki, Battelle; Joel Sminchak, Battelle; Mark Kelley, Battelle; Gary Spitznogle, American Electric Power; Brian Sherrick, American Electric Power

### **Status Report on the First European On-shore CO2 Storage Site at Ketzin (Germany)**

Frank Schilling, GeoForschungsZentrum Potsdam; Hilke Würdemann, GeoForschungsZentrum Potsdam; Michael Kühn, GeoForschungsZentrum Potsdam; Günter Borm, GeoForschungsZentrum Potsdam; Fabian Möller, GeoForschungsZentrum Potsdam

### **Exploring Geological Storage Sites for CO2 from Norwegian Gas Power Plants: Johansen Formation**

Per Eirik Strand Bergmo, SINTEF Petroleum Research

### **CCS Project in Recôncavo Basin**

Yann Le Gallo, IFP; Rodolpho Dino, Petrobras

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## 2D CCS AT SCALE

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Session Chairs: Jae Edmonds and Jaco Liebenberg

### **CCS Market Perspectives: Are Climate Needs Beyond Industrial Reason?**

Philippe Paelinck, ALSTOM; Jean-François Leandri, ALSTOM; Frédéric Da Silva, ALSTOM

### **CCS Legal & Regulatory Developments: A Global Round-up**

Tom Kerr, International Energy Agency; Tim Dixon, IEA GHG; Ian Havercroft, University College London

### **CCS at Pace and Scale: Implications of the Supply Chain**

James McFarland, MIT; Howard Herzog, MIT

### **Comparing Existing Pipeline Networks with the Potential Scale of Future U.S. CO2 Pipeline Networks**

James Dooley, Joint Global Change Research Institute; Robert Dahowski, Pacific Northwest National Laboratory; Casie Davidson, Pacific Northwest National Laboratory

### **Investigation of Water Displacement Following Large CO2 Sequestration Operations**

Jean-Philippe Nicot, Bureau of Economic Geology, The University of Texas at Austin; Susan Hovorka, Bureau of Economic Geology, The University of Texas at Austin; Jong-Won Choi, Bureau of Economic Geology, The University of Texas at Austin

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## 2E NATIONAL PROGRAMS

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Session Chairs: Rachel Crisp and Allyson Anderson

### **US Department of Energy's Regional Carbon Sequestration Partnership Program: Overview**

John Litynski, US DOE National Energy Technology Laboratory; Sean Plasynski, US DOE National Energy Technology Laboratory; Lee Spangler, Montana State University; Robert Finley, Illinois State Geological Survey; Edward Steadman, University of North Dakota; David Ball, Battelle; Kenneth Nemeth, Southern States Energy Board; Brian McPherson, New Mexico Institute of Mining and Technology; Larry Myer, Lawrence Berkley National Laboratory

### **Near Zero Emissions Coal: A China-UK Initiative to Develop CCS in China**

Keith Burnard, AEA Energy & Environment; Gao Li, ACCA21, China; Jiutian Zhang, ACCA21, China; Philippa Harris, AEA Energy & Environment; Matthew Webb, UK Department for the Environment, Food and Rural Affairs; Xuedu Lu, Chinese Ministry of Science and Technology

### **Masdar Driving the Progress to a Low-carbon Economy**

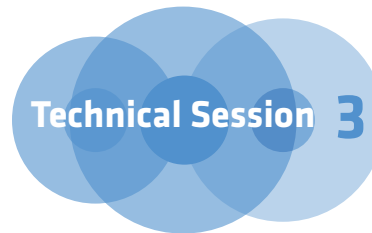
Sam Nader, Abu Dhabi Future Energy Company

### **The Role of CCS in the EU**

Directorate-General for Research, European Commission; Gardiner Hill, European Technology Platform for Zero Emission Fossil Fuel Power Plants

### **Demonstration and Deployment of Carbon Dioxide Capture and Storage in Australia**

Peter Cook, CO2CRC



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## 3A LONG TERM STORAGE INTEGRITY: TRAPPING MECHANISMS

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Session Chairs: Lynn Orr and Bert Van der Meer

### **Post-closure Migration for CO2 Geological Storage and Regional Pressure Inferences**

Yann Le Gallo, IFP

### **Simple Models for Residual Trapping of CO2**

Marc Hesse, Brown University; Franklin Orr Jr, Stanford University; Hamdi Tchelepi, Stanford University

### **Effect of Capillary Heterogeneity on Buoyant Plumes: A New Local Trapping Mechanism**

Ehsan Saadatpour, The University of Texas at Austin; Steven L. Bryant, The University of Texas at Austin; Kamy Sepehrnoori, The University of Texas at Austin

### **A Basin Scale Perspective on CO2 Storage – Short and Long Term Risks**

Harald Johansen, Institute for Energy Technology

### **Geochemical Assessment of the Injection of CO2 into Rouse Depleted Gas Reservoir**

Sylvain Thibeau, TOTAL; Pierre Chiquet, TOTAL; Gérard Mouronval, TOTAL; Marc Lescanne, TOTAL

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## 3B CO2 TRANSPORT INFRASTRUCTURE

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Session Chairs: Sean McCoy and Chris Hendriks

### **Returns to Scale and Density for Carbon Capture and Storage Deployment**

Jeffrey Bielicki, Harvard University

### **Transport Infrastructure Rationale for Carbon Dioxide Capture & Storage in the European Union to 2050**

David Coleman, Shell International Renewables, BV

### **Large Scale CCS in Canada: A Canadian Environmental Superpower Opportunity**

Mark Bohm, Suncor Energy Inc; Stephen Kaufman, Suncor Energy Inc; Eric Beynon, ICO2N Group of Companies; Robert Craig, ICO2N Group of Companies

### **An Integrated GIS-MARKAL Toolbox for Designing a CO2 Infrastructure Network in The Netherlands**

Machteld van den Broek, Utrecht University; Evelien Brederode, Utrecht University; Andrea Ramirez, Utrecht University; Leslie Kramer, TNO; Muriel van der Kuip, TNO; Ton Wildenborg, TNO

### **Assessing Issues of Financing a CO<sub>2</sub> Transportation Pipeline Infrastructure**

Arthur Lee, Chevron Corporation

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## **3C POLICY AND REGULATORY DEVELOPMENTS I**

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Session Chairs: David Keith and John Kessels

### **International Marine Regulation of CO<sub>2</sub> Geological Storage. Developments and Implications of the London and OSPAR Conventions**

Tim Dixon, UK Dept for Business and Enterprise; Andy Greaves, UK Dept of Environment (Defra); Oyvind Christophersen, Norway Pollution Control Authority

### **The EU Enabling Legal Framework for Carbon Capture and Geological Storage**

Scott Brockett, European Commission

### **Carbon Capture and Storage (CCS) in Context: The Importance of State Policy and Perceptions in Deploying Emerging Energy Technologies**

Elizabeth Wilson, University of Minnesota; Jennie Stephens, Clark University; Tarla Rai Peterson, Texas A&M University

### **The Legal and Political Framework for CCS and its Implications for a German Utility**

Peter Radgen, E.ON-Energie AG; Samuel Kutter, E.ON-Energie AG; Jörg Kruhl, E.ON-Energie AG

### **'Capture Readiness' – Lock-in Problems for CCS Governance**

Nils Markusson, The University of Edinburgh; Stuart Haszeldine, The University of Edinburgh

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## **3D CCS RETROFITS FOR POWER PLANTS**

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Session Chairs: Philippe Paelinck and Marie Anheden

### **Evaluating Potential Options for US Pulverized Coal (PC) Power Plants in the Face of Uncertain Greenhouse Gas (GHG) Caps and Natural Gas Supply: The Economics of Refurbishing, Retrofitting, Repowering, and Retirement**

Rodney Geisbrecht, National Energy Technology Laboratory; Michael Matuszewski, National Energy Technology Laboratory; Phil DiPietro, National Energy Technology Laboratory

### **Dynamic Operation of Amine Scrubbing in Response to Electric Demand and Pricing**

Sepideh Ziaii, The University of Texas at Austin; Stuart Cohen, The University of Texas at Austin; Gary T. Rochelle, The University of Texas at Austin; Thomas F. Edgar, The University of Texas at Austin; Michael E. Webber, The University of Texas at Austin

### **Optimization of Carbon Capture Percentage for Technical and Economic Impact of Near-Term CCS Implementation at Coal-Fired Power Plants**

Ashleigh N Hildebrand, Massachusetts Institute of Technology; Howard J Herzog, Massachusetts Institute of Technology

### **Scenario Analysis of Carbon Capture and Sequestration Generation Dispatch in the Western US Electricity System**

Gary Shu, Massachusetts Institute of Technology; Mort Webster, Massachusetts Institute of Technology; Howard Herzog, Massachusetts Institute of Technology

### **Valuing Flexible Operation of Power Plants with CO<sub>2</sub> Capture**

Hannah Chalmers, University of Surrey; Matt Leach, University of Surrey; Mathieu Lucquiaud, Imperial College; Jon Gibbins, Imperial College

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## **3E GEOLOGICAL STORAGE: LESSONS LEARNED**

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Session Chairs: Malcolm Wilson and John Tombari

### **Storage of CO<sub>2</sub> in Saline Aquifers – Lessons Learned from 10 years of CO<sub>2</sub> Injection into the Utsira Formation in the Sleipner Area**

Christian Hermanrud, StatoilHydro; Terje Andresen, StatoilHydro; Ola Eiken, StatoilHydro; Hilde Hansen, StatoilHydro; Aina Janbu,

StatoilHydro; Jon Lippard, StatoilHydro; Hege Nordgård Bolås, StatoilHydro; Gunn Mari Grimsmo Teige, StatoilHydro; Svend Øatmo, StatoilHydro

### **Evaluating the Impact of Fractures on the Long-term Performance of the In Salah CO<sub>2</sub> Storage Site**

Martin Iding, StatoilHydro; Philip Ringrose, StatoilHydro

### **Case Study: Trapping Mechanisms at the Pilot-scale CO<sub>2</sub> Injection Site, Nagaoka, Japan**

Ziqiu Xue, Kyoto University; Saeko Mito, Research Institute of Innovative Tech for the Earth; Keigo Kitamura, Research Institute of Innovative Tech for the Earth; Toshifumi Matsuoka, Kyoto University

### **A Vision of a CCS Business – the ZeroGen Experience**

Howard Morisson, Stanwell Corporation; Marcus Schwander, Shell; John Bradshaw, Greenhouse Gas Storage Solutions – GGSS

### **Risk Analysis for Future CO<sub>2</sub> Sequestration Projects Based on over 35 years of CO<sub>2</sub> Enhanced Oil Recovery in the US**

Ian Duncan, Bureau of Economic Geology; Jean-Philippe Nicot, Bureau of Economic Geology; Jong-Won Choi, Bureau of Economic Geology

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## **3F ABSORPTION: FUNDAMENTALS**

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Session Chairs: Paul Feron and Thor Mejdell

### **Measurements and Modelling of Enthalpies of Absorption of CO<sub>2</sub> in Aqueous Alkanolamine Solutions**

Inna Kim, The Norwegian University of Science and Technology; Hallvard F. Svendsen, The Norwegian University of Science and Technology

### **The Extended UNIQUAC Model for Prediction of Vapor-liquid Equilibria of Carbon Dioxide in Alkanolamine Solutions**

Leila Faramarzi, Technical University of Denmark; Georgios Kontogeorgis, Technical University of Denmark; Kaj Thomsen, Technical University of Denmark; Erling Stenby, Technical University of Denmark

### **Molecular Interactions between Amine and Carbonate Species in Aqueous Solution – Kinetics and Thermodynamics**

Marcel Maeder, University of Newcastle; Graeme Puxty, CSIRO; Nichola McGann, University of Newcastle; Duong Phan, University of Newcastle; Moetaz Attalla, CSIRO

### **A New Aqueous Solvent Based on a Blend of N-Methyldiethanolamine and Triethylene Tetramine for CO<sub>2</sub> Recovery in Post-Combustion: Kinetics Study**

Chakib Bouallou, Centre Energétique et Procédés; Jean-Marc Amann, Centre Energétique et Procédés

### **Kinetics, Modeling, and Simulation of the Experimental Kinetics Data of Carbon Dioxide Absorption into Mixed Aqueous Solutions of MDEA and PZ using Laminar Jet Apparatus with a Numerically Solved Absorption-Rate/Kinetic Model**

Raphael Idem, University of Regina; Mohamed Edali, University of Regina; Ahmed Aboudheir, HTC Purenergy



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## **4A LONG TERM STORAGE INTEGRITY: CAPROCKS AND SEALS**

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Session Chairs: Isabelle Czernichowski and Cal Cooper

### **Caprock and Overburden Processes in Geological CO<sub>2</sub> Storage: An Experimental Study on Sealing Efficiency and Mineral Alterations**

Jens Wollenweber, RWTH Aachen University; Sascha Alles, RWTH Aachen University; Andreas Busch, Shell International Exploration and Production; Helge Stanjek, RWTH Aachen University; Bernd M. Krooss, RWTH Aachen University



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#### **Effects of Physical Sorption and Chemical Reactions of CO<sub>2</sub> in Shaly Caprocks**

Andreas Busch, Shell International Exploration and Production; Sascha Alles, RWTH Aachen University; Bernhard M. Krooss, RWTH Aachen University; Helge Stanjek, RWTH Aachen University; David Dewhurst, CSIRO Petroleum

#### **Mineral Reaction Kinetics in CO<sub>2</sub> Rich Subsurface Systems: Constraints from Measurements on Natural Waters**

Niko Kampman, University of Cambridge; Mike Bickle, University of Cambridge; Nelly Assayag, University of Cambridge; John Becker, University of Cambridge

#### **Water Reactivity in the Liquid and Supercritical CO<sub>2</sub> Phase: Has Half the Story Been Neglected?**

Peter McGraill, Pacific Northwest National Laboratory; Todd Schaeff, Pacific Northwest National Laboratory; Liem Dang, Pacific Northwest National Laboratory; Vanda Glezakou, Pacific Northwest National Laboratory; Paul Martin, Pacific Northwest National Laboratory; Toni Owen, Pacific Northwest National Laboratory

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#### **4B INDUSTRIAL OPERATING EXPERIENCE**

Session Chairs: Peter Douglas and Frank Kluger

#### **European CO<sub>2</sub> Test Centre Mongstad – Testing, Verification and Demonstration of Post-combustion Technologies**

Gelein De Koeijer, StatoilHydro; Yngvill Enge, StatoilHydro; Cyril Thebault, Vattenfall AB; Svein Berg, StatoilHydro; Julia Lindland, Gassnova SF; Sverre Overå, StatoilHydro

#### **Pressure Drop and Effective Area of a High Capacity Packing**

Pascal Alix, IFP; Ludovic Raynal, IFP

#### **Influence of Viscosity and Surface Tension on the Effective Mass Transfer Area of Structured Packing**

Robert Tsai, University of Texas at Austin; Peter Schultheiss, University of Texas at Austin; Andreas Kettner, University of Texas at Austin; J Christopher Lewis, University of Texas at Austin; R Bruce Eldridge, University of Texas at Austin; A Frank Seibert, University of Texas at Austin; Gary Rochelle, University of Texas at Austin

#### **Corrosion in MEA Units for CO<sub>2</sub> Capture: Pilot Plant Studies**

Jean Kittel, IFP-Lyon; Raphael Idem, University of Regina; Don Gelowitz, University of Regina; Paitoon Tontiwachwuthikul, University of Regina; Gilbert Parrain, IFP-Lyon; Alexandre Bonneau, IFP-Lyon

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#### **4C ISSUES FORUM: WHAT WE HAVE LEARNED FROM DEMONSTRATION PROJECTS**

Session Chair: John Gale, IEA GHG Programme

CO<sub>2</sub> has been captured and transported in North America for over 20 years and injected into geological formations for EOR operations. The first dedicated commercial CO<sub>2</sub> capture and storage operation was Sleipner in the North Sea which has now been injecting and monitoring the fate of the injected CO<sub>2</sub> for 13 years. Other commercial scale (>1 Mt/yCO<sub>2</sub>) projects have come on stream on-shore since then including Weyburn, Canada (2000) and In-Salah, Algeria (2004). The on-shore projects offer different challenges to off-shore storage. The session aims to discuss the experiences that these projects have gained to date and how they help build confidence that CO<sub>2</sub> capture and storage can be a secure and safe mitigation option.

#### *Panelists:*

Chuck Fox, Kinder Morgan  
Iain Wright, BP  
Andy Chadwick, BGS  
Lynn Orr, Stanford University

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#### **4D FUEL PRODUCTION AND CONVERSION WITH CCS**

Session Chairs: Randall Field and Steve Kleespie

#### **Large Scale US Unconventional Fuels Production and the Role of Carbon Dioxide Capture and Storage Technologies in Reducing Greenhouse Gas Emissions from this Potential New Industry**

James Dooley, Joint Global Change Research Institute; Robert Dahowski, Pacific Northwest National Laboratory

#### **Evaluation of Flexible CCS Integrated Gasification Polygeneration Facilities**

Hans Meerman, Utrecht University

#### **Optimizing Energy Production with Integrated CCS Technology for CO<sub>2</sub> Emissions Mitigation in the Canadian Oil Sands Industry**

Guillermo Ordorica-Garcia, University of Waterloo; Peter Douglas, University of Waterloo; Ali Elkamel, University of Waterloo; Eric Croiset, University of Waterloo; Murlidhar Gupta, CANMET – Natural Resources Canada

#### **Biofuel Production with CCS as a Strategy for Creating a CO<sub>2</sub> Neutral Road Transport Sector**

Erik Lindfeldt, Royal Institute of Technology (KTH); Mats Westermark, Royal Institute of Technology (KTH)

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#### **4E PILOT AND DEMONSTRATION PROJECTS**

Session Chairs: Nick Otter and Neeraj Gupta

#### **Integrated Geophysical and Geochemical Monitoring Programs of the IEA GHG Weyburn-Midale CO<sub>2</sub> Monitoring and Storage Project**

Donald White, Geological Survey of Canada; James Johnson, Lawrence Livermore National Laboratory

#### **Acid Gas Injection and Monitoring at the Zama Oil Field in Alberta, Canada: A Case Study in Demonstration-Scale Carbon Dioxide Sequestration**

Steven Smith, Energy and Environmental Research Center

#### **Comparing Carbon Sequestration in an Oil Reservoir to Sequestration in Brine Formation – Field Study**

Susan Hovorka, Bureau of Economic Geology; Hongliu Zeng, Bureau of Economic Geology; Fred Wang, Bureau of Economic Geology; Timothy Meckel, Bureau of Economic Geology; Ramon Trevino, Bureau of Economic Geology; Masoumeh Kordi, University of Uppsala; Hesam Kasimieni, University of Uppsala; Bob Butsch, Schlumberger

#### **WESTCARB Large Volume CCS Test**

Larry Myer, Lawrence Berkeley National Lab; Terry Surlis, University of Hawaii

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#### **4F STAKEHOLDER PERSPECTIVES**

Session Chairs: Peta Ashworth and Sarah Wade

#### **Understanding and Improving NGO Positioning on CCS**

Jason Anderson, Institute for European Environmental Policy; Joana Chiavari, Institute for European Environmental Policy

#### **Learning about Carbon Capture and Storage (CCS): Changing Perceptions and Technology Experts**

Jennie Stephens, Clark University; Gabriel Rand, Clark University; Jeffrey Bielicki, Harvard University

#### **Stakeholder Attitudes on Carbon Capture and Storage – An International Comparison**

Filip Johnsson, Chalmers University of Technology; David Reiner, University of Cambridge; Kenshi Itaoka, Mizuho Information and Research Institute; Howard Herzog, Massachusetts Institute of Technology

#### **Informed Public Opinion on CCS in Comparison to Other Mitigation Options**

Marjolein de Best-Waldhober, Leiden University; Dancker Daamen, Leiden University; Andrea Ramirez, Utrecht University; Andre Faaij, Utrecht University; Chris Hendriks, Ecofys; Erika de Visser, Ecofys

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## 5A LONG TERM STORAGE INTEGRITY: WELLS

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Session Chairs: Toby Aiken and Walter Crow

### **CO2 Capture Project Field Study of a Wellbore from a Natural CO2 Reservoir**

Walter Crow, BP Alternative Energy; Brian Williams, BP Alternative Energy; James Carey, Los Alamos National Laboratory; Michael Celia, Princeton University; Sarah Gasda, University of North Carolina

### **An Estimate of the Time to Degrade the Cement Sheath in a Well Exposed to Carbonated Brine**

Andrew Duguid, Schlumberger Carbon Services

### **Numerical Simulation of CO2 Leakage through Abandoned Wells: Model for an Analog Site with Observed Gas Migration in Alberta, Canada**

Rajesh Pawa, Los Alamos National Laboratory; Theresa Watson, T. L. Watson & Associates Inc

### **The Influence of Confining Stress and Chemical Alteration on Conductive Pathways within Wellbore Cement**

Nicolas Huerta, The University of Texas at Austin; Steven Bryant, The University of Texas at Austin; Brian Strazisar, US DOE, National Energy Technology Laboratory; Barbara Kutchcko, US DOE, National Energy Technology Laboratory; Lauren Conrad, The University of Texas at Austin

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## 5B MODELING INDUSTRY PILOT PLANTS

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Session Chairs: Paitoon Tontiwachwuthikul and Kevin McCauley

### **Comparison of Process Simulations of Post Combustion Capture with MEA and Validation with Pilot Plant Data**

Hallvard F. Svendsen, Norwegian University of Science and Technology; Xiao Luo, Norwegian University of Science and Technology; Pascal Alix, IFP; David Montigny, University of Regina; Hans Hasse, Universität Stuttgart; Ralf Notz, Universität Stuttgart; Sebastian Hoch, Universität Stuttgart; Jacob Knudsen, Dong Energy; Olav Juliussen, SINTEF

### **Absorber Model for CO2 Capture by Monoethanolamine – Application to CASTOR Pilot Results**

Ross Dugas, IFP-Lyon; Pascal Alix, IFP-Lyon; Eric Lemaire, IFP-Lyon; Paul Broutin, IFP-Lyon; Gary Rochelle, The University of Texas at Austin

### **Modeling of CO2 Capture by Aqueous Monoethanolamine to Evaluate Better Process Configurations**

Jorge Plaza, University of Texas at Austin; David Van Wagener, University of Texas at Austin; Gary Rochelle, University of Texas at Austin

### **Pilot Plant Experimental Studies of Post Combustion CO2 Capture by Reactive Absorption with MEA and New Solvents**

Hari Prasad Mangalapally, Universitaet Stuttgart; Sebastian Hoch, Universitaet Stuttgart; Ralf Notz, Universitaet Stuttgart; Hans Hasse, Universitaet Stuttgart; Norbert Aspriorn, BASF; Georg Sieder, BASF; Hugo Garcia, BASF

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## 5C ISSUES FORUM: DESIGNING AND IMPLEMENTING REGULATORY FRAMEWORKS

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Session Chair: Anhar Karimjee, US EPA

Regulatory frameworks for CCS are under development throughout the world. There are amendments to international treaties, regional

directives, and country-specific regulations being designed by a number of institutions. Policymakers and regulators are working to identify how existing frameworks could be used and/or modified to address CCS. As regulatory frameworks for CCS are developed and put into practice, their success will be measured by their technical soundness, compatibility with other laws, cost-effectiveness, and ease of implementation. This session is designed to inform the CCS community on challenges in designing and implementing CCS regulatory frameworks with a focus on practical considerations such as building communication/relationships between jurisdictions, training and capacity building, data management, public participation, and working in an environment where research and demonstration are still underway.

### *Panelists:*

Stefan Bachu, Alberta Research Council  
John Bradshaw, Greenhouse Gas Storage Solutions  
Makoto Akai, National Institute of Advanced Industrial Science and Technology  
Scott Brockett, European Commission

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## 5D MODELING CCS DEPLOYMENT IN EUROPE

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Session Chairs: Jurgen Freidrich Hake and Wim Turkenburg

### **The Role of CCS in the European Electricity Supply System**

Mikael Odenberger, Chalmers University of Technology; Filip Johnsson, Chalmers University of Technology

### **How May CCS Deployment Affect Wholesale Electricity Prices in North-Western Europe?**

Ad Seebregts, Energy research Centre of the Netherlands; Heleen Groenenberg, Energy research Centre of the Netherlands

### **Scenario for Large-scale Implementation of CCS in Europe**

Ton Wildenborg, TNO; Aggelos Doukelis, PPC; Clas Ekström, Vattenfall; Gelein de Koeijer, StatoilHydro; Muriel van der Kuip, TNO; Leslie Kramers, TNO; Erik Lindeberg, SINTEF; Øyvind Nordbø, SINTEF; Sylvain Serbutoviez, Institut Français du Pétrol

### **Greenhouse Gas Mitigation in a Carbon Constrained World – The Role of CCS in Germany**

Katja Schumacher, Institute for Applied Ecology; Ron Sands, Joint Global Change Research Institute, Pacific Northwest National Laboratory

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## 5E PORE AND CORE SCALE PROCESSES I

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Session Chairs: Gunter Borm and Ziqui Xue

### **Geotechnical Investigations of Cap Rocks above CO2-Reservoirs**

Thomas Mutschler, Universitaet Karlsruhe; Theodoros Triantafyllidis, Universitaet Karlsruhe; Sascha Ruebel, Universitaet Karlsruhe; Karl Balthasar, Universitaet Karlsruhe

### **Experimental and Modeling Study of Geochemical Reactivity between Clay Minerals and CO2 in Geological Conditions**

Anthony Credo, LMTE, CEA Cadarache; Olivier Bildstein, LMTE, CEA Cadarache; Michel Jullien, LMTE, CEA Cadarache; Guy Geniaut, LMTE, CEA Cadarache; Michel Lillo, LMTE, CEA Cadarache; Jean-Claude Petronin, LMTE, CEA Cadarache; Claudine Pozo, LMTE, CEA Cadarache; Joel Raynal, LMTE, CEA Cadarache; Laurent Trotignon, LMTE, CEA Cadarache

### **Scaling of Capillary Trapping in Unstable Two-phase Flow: Application to CO2 Sequestration in Deep Saline Aquifers**

Michael Szulczewski, Massachusetts Institute of Technology; Luis Cueto-Felgueroso, Massachusetts Institute of Technology; Ruben Juanes, Massachusetts Institute of Technology

### **Measurement and Modeling of Gas Trapping in Carbon Dioxide Storage**

Christopher Holst Pentland, Imperial College; Saleh Al-Mansoori, Imperial College; Stefan Iglauer, Imperial College; Olumide Talabi, Imperial College; Martin Blunt, Imperial College

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## 5F CAPACITY BUILDING THROUGH EDUCATION AND TRAINING

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Session Chairs: Pamela Tomski and Malti Goel

### **Training Carbon Management Engineers: Why New Educational Capacity is the Single Biggest Hurdle for Geologic CO<sub>2</sub> Storage**

Steven Bryant, The University of Texas at Austin; Jon Olson, The University of Texas at Austin

### **Capacity Building in Developing Economies: Building on the APEC and CSLF Experience**

Stefan Bachu, Alberta Research Council

### **Improving the Global Carbon Capture and Storage Educational Capacity**

Brendan Beck, IEA GHG; John Gale, IEA GHG

### **Development of Collaborative Training and Capacity Building in Carbon Capture and Storage**

Mercedes Maroto-Valer, Centre for Innovation in Carbon Capture and Storage (CICCS)



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## 6A CO<sub>2</sub> STORAGE CAPACITY II

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Session Chairs: John Bradshaw and Stefan Bachu

### **Geologic and Operational Factors Affecting CO<sub>2</sub> Plume Distribution**

Scott Frailey, Illinois State Geological Survey

### **Sensitivity of CO<sub>2</sub> Migration Estimation on Reservoir Temperature and Pressure Uncertainty**

Preston Jordan, Lawrence Berkeley National Laboratory; Christine Doughty, Lawrence Berkeley National Laboratory

### **The Hydrogeological Footprint of Basin-scale CO<sub>2</sub> Injection in Saline Aquifers: Impact on Storage Capacity of the Continental United States**

Ruben Juanes, Massachusetts Institute of Technology; Michael Szulczewski, Massachusetts Institute of Technology

### **Combining Geologic Data and Numerical Modeling to Improve Estimates of the CO<sub>2</sub> Sequestration Potential of the Rock Springs Uplift, Wyoming**

Philip Stauffer, Los Alamos National Laboratory; John Jiao, Wyoming State Geological Survey; Ronald Surdam, Wyoming State Geological Survey

### **CO<sub>2</sub> Storage Capacity Calculations for the Dutch Subsurface**

L G H van der Meer, TNO

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## 6B SOLVENT ALTERNATIVES

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Session Chairs: Gary Rochelle and Ole Biede

### **CO<sub>2</sub> Capture with Concentrated Aqueous Piperazine**

Stephanie Freeman, University of Texas at Austin; Thu Nguyen, University of Texas at Austin; Ross Dugas, University of Texas at Austin; Jorge Plaza, University of Texas at Austin; Qing Xu, University of Texas at Austin; David van Wagener, University of Texas at Austin

### **Absorption of Carbon Dioxide into Aqueous Potassium Carbonate Promoted by Boric Acid**

Ujjal Ghosh, CRC for Greenhouse Gas Technologies; Geoff Stevens, CRC for Greenhouse Gas Technologies; Sandra Kentish, CRC for Greenhouse Gas Technologies

### **Synthesis, Solubilities, and Cyclic Capacities of Amino Alcohols for CO<sub>2</sub> Capture from Flue Gas Streams**

Raphael Idem, University of Regina; Kreangkrai Maneeintr, University of Regina; Paitoon Tontiwachwuthikul, University of Regina; Andrew Wee, University of Regina

### **Development of an Economic Post-Combustion Carbon Capture Process**

Tobias Jockenhoevel, Siemens; Ruediger Schneider, Siemens; Joerg Kruhl, E.ON Energy

### **The Potential for Improvement of the Energy Performance of Pulverised Coal Fired Power Plants with Post-combustion Capture of Carbon Dioxide**

Paul H M Feron, CSIRO Energy Technology

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## 6C INCENTIVES AND FINANCING

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Session Chairs: Jeff Chapman and Haroon Kheshgi

### **Strategies for the Deployment of CCS Technologies in the UK: A Critical Review**

Jim Watson, University of Sussex; Ivan Scrase, University of Sussex

### **Project Financing of Coal Power Plants with Carbon Capture and Sequestration**

Michael Hamilton, Massachusetts Institute of Technology; Howard Herzog, Massachusetts Institute of Technology; John Parsons, Massachusetts Institute of Technology

### **Behavioral Issues in Financing Lower Carbon Power Plants**

Xi Liang, University of Cambridge; David Reiner, University of Cambridge

### **Progress on Including CCS Projects in the CDM: Towards Increased Awareness and Better Methodologies**

Heleen de Coninck, Energy research Centre of the Netherlands (ECN); Stefan Bakker, Energy research Centre of the Netherlands (ECN); Heleen Groenenberg, Energy research Centre of the Netherlands (ECN)

### **Infrastructural Challenges for CCS in Germany**

Katja Schumacher, Institute for Applied Ecology (Öko-Institut); Felix Chr. Matthes, Institute for Applied Ecology (Öko-Institut); Ralph O. Harthan, Institute for Applied Ecology (Öko-Institut)

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## 6D INTEGRATED ASSESSMENT OF CCS DEPLOYMENT

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Session Chairs: Peter Versteegh and Francisco Paco de la Chesnaye

### **Low-Stabilisation Scenarios and Technologies for Carbon Capture and Sequestration**

Nico Bauer, Potsdam-Institute for Climate Impact Research; Ottmar Edenhofer, Potsdam-Institute for Climate Impact Research; Marian Leimbach, Potsdam-Institute for Climate Impact Research

### **Energy Technology Modelling of Major Carbon Abatement Options**

Kamel Bennaceur, International Energy Agency; Dolf Gielen, International Energy Agency; Jacek Podkanski, European Investment Bank

### **Economics of Geological CO<sub>2</sub> Storage and Leakage**

Bob van der Zwaan, ECN; Reyer Gerlagh, Manchester University

### **The Impact of Electric Passenger Transport Technology on the Demand for Coal-fired Power with CCS under a Climate Policy**

Marshall Wise, Battelle, JGCRI; G. Page Kyle, Battelle, JGCRI; Son Kim, Battelle, JGCRI; Jim Dooley, Battelle, JGCRI

### **The Role of CCS and Renewables in Tackling Climate Change**

Tiina Koljonen, VTT Technical Research Centre of Finland; Martti Flyktman, VTT Technical Research Centre of Finland; Antti Lehtilä, VTT Technical Research Centre of Finland; Katri Pahkala, MTT Agrifood Research Finland; Esa Peltola, VTT Technical Research Centre of Finland; Ilkka Savolainen, VTT Technical Research Centre of Finland

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## 6E PORE AND CORE SCALE PROCESSES II

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Session Chairs: Grant Bromhal and Anna Korre

### Direct Measurement of Trapped Gas Bubbles by Capillarity on the Pore Scale

Tetsuya Suekane, The University of Tokushima; Hoan Thanh Nguyen, The University of Tokushima; Takuya Matsumoto, The University of Tokushima; Masumi Matsuda, The University of Tokushima; Masanori Kiyoya, The University of Tokushima; Akiharu Ousaka, The University of Tokushima

### Comparison of Simulation and Micromodel Predictions of Flow in 2-D Networks

Martin Ferer, US DOE/NETL; Shelley Anna, US DOE/NETL; Paul Tortura, US DOE/NETL; Grant Bromhal, US DOE/NETL; Duane Smith, US DOE/NETL

### Core- and Pore-scale Experimental Study of Relative Permeability Properties of CO<sub>2</sub> and Brine in Reservoir Rocks

Jean-Christophe Perrin, Stanford University; Mickael Krause, Stanford University; Chia-Wei Kuo, Stanford University; Ljuba Miljkovic, Stanford University; Sally Benson, Stanford University

### Numerical Simulations of Laboratory Core-scale CO<sub>2</sub> Displacement Experiments

Ljuba Miljkovic, Stanford University; Chia-Wei Kuo, Stanford University; Jean-Christophe Perrin, Stanford University; Michael Krause, Stanford University; Sally Benson, Stanford University

### Wellbore Integrity and CO<sub>2</sub>-brine Flow Along the Casing-cement Microannulus

J. William Carey, Los Alamos National Laboratory; Robert Svec, New Mexico Tech; Reid Grigg, New Mexico Tech; Peter Lichtner, Los Alamos National Laboratory; Jinsuo Zhang, Los Alamos National Laboratory; Walter Crow, BP Alternative Energy

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## 6F MEMBRANES FOR CAPTURE

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Session Chairs: Daan Jansen and Krzysztof Warmuzinski

### Recent Development in the HMR Pre-combustion Gas Power Cycle

Knut Aasen, StatoilHydro; Jens B. Smith, StatoilHydro; Kjersti Wilhelmsen, StatoilHydro; Daniel Käck, StatoilHydro; Turid Risdal, StatoilHydro; Anita Berglund, StatoilHydro; Michael Budd, StatoilHydro

### Integration Gas Separation Membranes for IGCC Application

Jared Ciferno, U.S. D/National Energy Technology Laboratory; John Marano, Consultant/Technology Management Services

### Optimization of Multi-stage Membrane Systems for Carbon Dioxide Recovery in Post Combustion Process

Li Zhao, IEF-3

### Novel Cycles for Power Generation with CO<sub>2</sub> Capture using OMCM Technology

Rahul Anantharaman, NTNU; Olav Bolland, NTNU; Knut Åsen, StatoilHydro

### Hydrogen Membrane Reactors for CO<sub>2</sub> Capture

Daniel Jansen, Energy research Centre of the Netherlands (ECN)



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## 7A MONITORING: GEOPHYSICAL TECHNIQUES

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Session Chairs: Don White and Kevin Dodds

### Latest Time-lapse Datasets from Sleipner Yield New Insights into CO<sub>2</sub> Plume Development

Andy Chadwick, British Geological Survey; Rob Arts, TNO; Ola Eiken, Statoil; Dave Noy, British Geological Survey

### Results of Geophysical Monitoring over a "Leaking" Natural Analogue Site in Italy

Rob Arts, TNO; Sergio Persoglia, OGS; Jean-François Girard, BRGM; Annalisa Zaja, University of Padova; Salvatore Lombardi, University of Rome; Gary Kirby, BGS

### Satellite Imaging to Monitor CO<sub>2</sub> Movement at Krechba, Algeria

Iain Wright, BP

### Seismic Monitoring and Verification for the CO<sub>2</sub>CRC Otway Basin Project, Part 1: Program Overview

Donald Sherlock, Cooperative Research Centre for Greenhouse Gas Technologies; Milovan Urosevic, Cooperative Research Centre for Greenhouse Gas Technologies; Anton Kepic, Cooperative Research Centre for Greenhouse Gas Technologies; Tom Daley, Cooperative Research Centre for Greenhouse Gas Technologies; Shoichi Nakanishi, Schlumber Oilfield Australia; Tony Siggins, Cooperative Research Centre for Greenhouse Gas Technologies; Sandeep Sharma, Cooperative Research Centre for Greenhouse Gas Technologies

### Experimental Study on Monitoring and Quantifying of Injected CO<sub>2</sub> from Resistivity Measurement in Saline Aquifer Storage

Yoshihiro Nakatsuka, Kyoto University; Ziqiu Xue, Kyoto University; Yasuhiro Yamada, Kyoto University; Toshifumi Matsuoka, Kyoto University; Kyosuke Onishi, Kyoto University

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## 7B AMMONIA CAPTURE PROCESSES

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Session Chairs: Hallvard Svenson and Barry Hooper

### Chilled Ammonia Process Field Pilot Operation at WE Energies

Fred Kozak, Alstom Power; Arlyn Petig, Alstom Power; Richard Rhudy, EPRI; David Thimsen, EPRI; Ed Morris, WE Energies

### Testing of Ammonia based CO<sub>2</sub> Capture with Multi-Pollutant Control Technology

Christopher McLarnon, Powerspan

### Aqueous Ammonia Process for CO<sub>2</sub> Capture

Victor Darde, Technical University of Denmark; Kaj Thomsen, Technical University of Denmark; Willy J M van Well, DONG Energy Power; Erling H. Stenby, Technical University of Denmark

### Kinetics of Absorption of Carbon Dioxide in Aqueous Ammonia Solutions

Peter W J Derks, Procede Gas Treating BV; Geert F Versteeg, Procede Gas Treating BV

### Quantitative Evaluation of the Aqueous-Ammonia Process for CO<sub>2</sub> Capture Using Fundamental Data and Thermodynamic Analysis

Paul Mathias, Fluor Corporation; Satish Reddy, Fluor Corporation; John O'Connell, University of Virginia

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## 7C – PUBLIC ACCEPTANCE AND THE ROLE OF INFORMATION

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Session Chairs: George Peridas and Dancker Daamen

### **Engaging the Public on Carbon Dioxide Capture and Storage: Does a Large Group Process Work?**

Peta Ashworth, CSIRO; Naomi Boughen, CSIRO; Simone Carr-Cornish, CSIRO; Kelly Thambimuthu, Centre for Low Emission Technology

### **Building Confidence in CCS through On-line Deliberation**

Norio Shigetomi, Mitsubishi Research Institute, Inc; Tsukasa Kumagai, JGC Corporation; Hiroyasu Takase, Quintessa Japan

### **Influential Information and Factors for Social Acceptance of CCS: the 2nd Round of Survey of Public Opinion in Japan**

Kenshi Itaoka, Mizuho Information & Research Institute; Yuki Okuda, Mizuho Information & Research Institute; Aya Saito, Mizuho Information & Research Institute; Makota Akai, AIST

### **Communication Strategy for a Public Information Campaign on CO2 Geological Storage and on CCS as a Whole: the Case History in Italy from 2003 to 2008**

Fedora Quattrocchi, INGV

### **The Role of Social Factors in Shaping Public Perceptions of CCS: Results of Multi-State Focus Group Interviews in the US**

Isha Ray, University Of California, Berkeley; Tarla Peterson, Texas A&M University; Judith Bradbury, Battelle Northwest; Sarah Wade, AJW, Inc; Gabrielle Wong-Parodi, University Of California, Berkeley; Andrea Feldpausch, Texas A&M University

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## 7D MOVING BEYOND SOURCE-SINK MATCHING

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Session Chairs: Sam Holloway and Brent Lakeman

### **Optimisation Economics for CO2 Capture and Storage (CCS) in Central Queensland (Australia)**

Olga Bukhteeva, CO2CRC

### **Variability and Uncertainty in the Cost of Saline Formation Storage**

Sean McCoy, Carnegie Mellon University; Edward Rubin, Carnegie Mellon University

### **CCS Scenarios Optimisation by Spatial Multi-criteria Analysis: Application to Multiple Source-sink Matching in the Bohai Basin (North China)**

Ruina Xu, Tsinghua University; Xing Xiang, Tsinghua University; Kim Domptail, BRGM; Delphine Allier, BRGM; Wenyang Chen, Tsinghua University; Yves-Michel Le Nindre, BRGM; Fei Teng, Tsinghua University; Rongshu Zeng, IGGCAS

### **Energy-Economic, Structural, and Industrial Policy Analysis of Re-fitting Coal Fired Power Plants with CO2-Capture in North Rhine-Westphalia / Germany**

Peter Viebahn, Wuppertal Institute of Climate; Manfred Fischeidick, Wuppertal Institute of Climate; Andrea Esken, Wuppertal Institute of Climate; Dietmar Schuewer, Wuppertal Institute of Climate

### **Analysis of Geologic CO2 Sequestration Costs for the United States and Implications for Climate Change Mitigation**

Christa Clapp, US Environmental Protection Agency; Harry Vidas, ICF International; Bob Hugman, ICF International; Francisco de la Chesnaye, US Environmental Protection Agency

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## 7E NOVEL OPTIONS FOR GEOLOGICAL STORAGE

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Session Chairs: Pete McGrail and Neil Wildgust

### **A Global Assessment of Deep-Sea Basalt Sites for Carbon Sequestration**

David Goldberg, Lamont-Doherty Earth Observatory; Angela Slagle, Lamont-Doherty Earth Observatory

### **Carbon Microbubbles Sequestration: A Novel Technology for Stable Underground Emplacement of Greenhouse Gases into Wide Variety of Saline Aquifers, Fractured Rocks and Tight Reservoirs**

Hitoshi Koide, Waseda University; Jyunji Shinoda, Mizuho Information and Research Institute

### **Effects of Salinity on Hydrate Stability and Implications for Storage of CO2 in Natural Gas Hydrate Reservoirs**

Bjørn Kvamme, University of Bergen

### **Surface Dissolution: Minimizing Groundwater Impact and Leakage Risk Simultaneously**

McMillan Burton, University of Texas at Austin; Steven Bryant, University of Texas at Austin

### **The Geomechanics & Injection Feasibility of Storing CO2 in Deep-Sea Sediments**

Kurt House, Harvard University; Daniel Schrag, Harvard University; Charles Harvey, Harvard University

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## 7F SOLVENT MANAGEMENT

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Session Chairs: Jon Gibbins and Nick Booth

### **Amine Degradation Mechanisms – Lessons Learned from Other Oxidative Gas Treating Processes**

Steve Bedell, The Dow Chemical Company

### **Thermal Degradation of Monoethanolamine at Stripper Conditions**

Jason Davis, University of Texas at Austin; Gary Rochelle, University of Texas at Austin

### **Oxidative Degradation of Monoethanolamine with Dissolved Metals and Inhibitors**

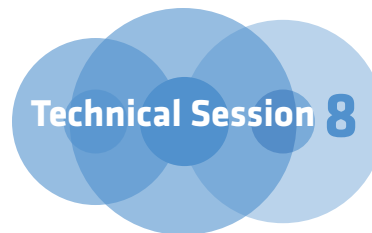
Andrew Sexton, University of Texas at Austin; Gary Rochelle, University of Texas at Austin

### **Degradation Study of New Solvents for CO2 Capture in Post-combustion**

Pierre-Louis Carrette, IFP

### **Foaming in Amine-based CO2 Capture Process: Experiment, Modeling and Simulation**

Bhurisa Thitakamol, University of Regina; Amornvadee Veawab, University of Regina; Adisorn Aroonwilas, University of Regina



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## 8A MONITORING: GEOCHEMICAL TECHNIQUES

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Session Chairs: Linda Stalker and Robert Burruss

### **Geochemical Interpretation of Produced Fluid Compositions from the Pennwest CO2-EOR Pilot, Drayton Valley, Alberta**

Ernest Perkins, Alberta Research Council; Stephen Talman, Alberta Research Council

### **CO2 Ionic Trapping by Water-rock Interactions during a Push-pull Test in a Basaltic-metasedimentary Aquifer**

Nelly Assayag, Institut de Physique du Globe de Paris; Juerg Matter, Columbia University; Magali Ader, Institut de Physique du Globe de Paris; Dave Goldberg, Columbia University; Pierre Agrinier, Institut de Physique du Globe de Paris

### **Geochemical Detection of Carbon Dioxide in Dilute Aquifers**

Susan Carroll, Lawrence Livermore National Laboratory; Yue Hao, Lawrence Livermore National Laboratory; Roger Aines, Lawrence Livermore National Laboratory

### **Continuous/Discrete Geochemical Monitoring of CO2 Natural Analogues and of Diffuse Degassing Structures (DDS): Hints for CO2 Storage Sites Geochemical Monitoring Protocol**

Fedora Quattrocchi, INGV; Barbara Cantucci, INGV; Daniele Cinti, INGV; Gianfranco Galli, INGV; Luca Pizzino, INGV; Alessandra Sciarra, INGV

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**8B** OXYFUEL FLUE GAS TREATMENT

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Session Chairs: Rodney Allam and Markus Wolf

**Considerations for Treating Impurities in Oxy-Combustion Flue Gas Prior to Sequestration**

Bruce Sass, Battelle; Hamid Farzan, The Babcock & Wilcox Company; Rajeev Prabhakar, Air Liquide; Jacqueline Gerst, Battelle; Joel Sminchak, Battelle; Bruce Nestleroth, Battelle; José Figueroa, US DOE/NETL

**Purification of Oxyfuel-Derived CO<sub>2</sub>**

Vince White, Air Products

**Air Separation and Flue Gas Compression and Purification Units for Oxy-Coal Combustion Systems**

Rajeev Prabhakar, Air Liquide; Arthur Darde, Air Liquide; Jean-Pierre Tranier, Air Liquide; Nicolas Perrin, Air Liquide

**CO<sub>2</sub> Capture and Development of an Advanced Pilot-scale Cryogenic Separation and Compression Unit**

Kourosh Zanganeh, Natural Resources Canada; Ahmed Shafeen, Natural Resources Canada; Carlos Salvador, Natural Resources Canada

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**8C** ISSUES FORUM: MOVING FORWARD TO LARGE-SCALE DEPLOYMENT OF CCS

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Session Chair: Sally Benson, Stanford University

The growing urgency to reduce greenhouse gas emissions requires rapid adoption of CO<sub>2</sub> control technologies. Large-scale deployment of CCS is needed—increasing from the 3 commercial scale projects operating today to hundreds of projects by 2030. Are we on track to achieve this goal? How can we accelerate the pace of deployment? What are the most important technical, financial, environmental, institutional and societal challenges that must be overcome? What the most important actions for governments, industry, academia to initiate now to pave the way for rapid adoption of CCS?

*Panelists:*

Gardiner Hill, BP  
Darlene Ratcliffe, Duke Power  
Rachel Crisp, UK BERR  
Bill Koppe, Anglocoal  
David Hawkins, NRDC

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**8D** OPPORTUNITIES FOR SIGNIFICANT COST REDUCTION

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Session Chairs: John Davison and Jay Braitsch

**Redesign, Optimization, and Economic Evaluation of a Natural Gas Combined Cycle with the Best Integrated Technology (BIT) CO<sub>2</sub> Capture**

Cristina Botero, General Electric Global Research; Matthias Finkenrath, General Electric Global Research; Michael Bartlett, General Electric Global Research; Daniel Chinn, Chevron Energy Technology Company

**The Potential of Advanced Technologies to Reduce Carbon Capture Costs in Future IGCC Power Plants**

Julianne Klara, US DOE/National Energy Technology Laboratory

**Techno-economic Prospects for Solid Oxide Fuel Cell with CO<sub>2</sub> Capture up to 2030**

Takeshi Kuramochi, Utrecht University; Hao Wu, Utrecht University; Andrea Ramirez, Utrecht University; André Faaij, Utrecht University; Wim Turkenburg, Utrecht University

**Membrane-based, Enzyme Facilitated, Efficient, Carbon Dioxide Capture**

Robert M Cowan, Carbozyme; David A Smith, Carbozyme; Melanie D Jensen, University of North Dakota; Jason Laumb, University of North Dakota; Haibin Chen, Carbozyme; Liping Wang, Carbozyme; Xiaoqi Wu, Carbozyme; Michael C Trachtenberg, Carbozyme

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**8E** MODEL DEVELOPMENT

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Session Chairs: Jim Johnson and Jonathan Ennes-King

**Coupled Reservoir-Geomechanical Analysis of CO<sub>2</sub> Injection at In Salah, Algeria**

Jonny Rutqvist, Lawrence Berkeley National Laboratory

**CO<sub>2</sub> Thermodynamic Model in a Leaking Well**

Frédéric Wertz, BRGM; Pascal Audigane, BRGM; Olivier Bouc, BRGM

**The Effects of Gas-Fluid-Rock Interactions on CO<sub>2</sub> Injection and Storage: Insights from Reactive Transport Modeling**

Yitian Xiao, ExxonMobil; Tianfu Xu, Lawrence Berkeley National Laboratory; Karsten Pruess, Lawrence Berkeley National Laboratory

**Effect of Vertical Heterogeneity on Long-term Migration of CO<sub>2</sub> in Saline Formations**

Jonathan Ennis-King, CO<sub>2</sub>CRC, CSIRO Petroleum; Chris Green, CO<sub>2</sub>CRC, CSIRO Petroleum; Karsten Pruess, Lawrence Berkeley National Laboratory

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**8F** NOVEL PROCESSES FOR PRE-COMBUSTION SYSTEMS

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Session Chairs: Olav Bolland and Takashi Kiga

**Novel Processing to Improve Cost and Efficiency of CO<sub>2</sub> Capture in Power Generation**

Frank Hershkowitz, ExxonMobil Research and Engineering Co; Harry Deckman, ExxonMobil Research and Engineering Co; Jeffrey Frederick, ExxonMobil Research and Engineering Co; John Fulton, ExxonMobil Research and Engineering Co; Richard Socha, ExxonMobil Research and Engineering Co

**High Temperature Materials for CO<sub>2</sub> Capture**

Gongkui Xiao, Monash University; Ranjeet Singh, Monash University; Kaustubh Joshi, Monash University; Ram Reddy, University of Queensland; Joe da Costa, University of Queensland; Simon Wilson, Monash University; Paul Webley, Monash University

**Performance of Sorption Enhanced Water Gas Shift as a Pre-combustion CO<sub>2</sub> Capture Technology**

Edward van Selow, Energy research Centre of the Netherlands; Paul Cobden, Energy research Centre of the Netherlands; Ruud van den Brink, Energy research Centre of the Netherlands; Andrew Wright, Air Products; Jeffrey Hufton, Air Products

**Further Development of a Gas Turbine Burner for the Combustion of H<sub>2</sub>-Rich Fuels**

Richard Carroni, ALSTOM Switzerland



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**9A** MONITORING: SURFACE METHODS

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Session Chairs: Lee Spangler and Julie West

**Detection of CO<sub>2</sub> Leakage by Eddy Covariance During the ZERT Project's CO<sub>2</sub> Release Experiments**

Jennifer Lewicki, Lawrence Berkeley National Laboratory; George Hilley, Stanford University; Marc Fischer, Lawrence Berkeley National Laboratory; Lehua Pan, Lawrence Berkeley National Laboratory; Curtis Oldenburg, Lawrence Berkeley National Laboratory; Laura Dobeck, Montana State University; Lee Spangler, Montana State University

**Atmospheric Monitoring of the Penn West Pembina Cardium CO<sub>2</sub> EOR Monitoring Pilot Using Open Path Laser Technology**

Stephanie Trottier, Alberta Research Council; William D Gunter, Alberta Research Council; Bernice Kadatz, Alberta Research Council; Mark Olson, Alberta Research Council; Ernie H Perkins, Alberta Research Council

### **On-line Greenhouse Gas Detection from Soils and Rock Formations**

Jacques Pironon, CNRS; Philippe De Donato, CNRS; Christophe Garnier, INPL; Cristelle Cailteau, INPL; Odile Barres, CNRS; Giovanni Radilla, INPL

### **Development of an Innovative Marine Monitoring System for CO<sub>2</sub> Leaks: System Testing at the Natural Analogue of Panarea Island (northern Sicily, Italy)**

Aldo Annunziatellis, Sapienza University of Rome; Stan Eugene Beaubien, Sapienza University of Rome; Giancarlo Ciotoli, Sapienza University of Rome; Maria Grazia Finoia, Sapienza University of Rome; Stefano Graziani, Sapienza University of Rome; Salvatore Lombardi, Sapienza University of Rome

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## **9B OXYFUEL DEVELOPMENTS FOR POWER PLANTS**

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Session Chairs: Kourosh Zanganeh and Stanley Santos

### **Commercialization of OxyCoal Combustion: Applying Results of 30MWth Large Pilot**

Kevin McCauley, Babcock & Wilcox; Hamid Farzan, Babcock & Wilcox; Dennis McDonald, Babcock & Wilcox; R Varagani, Air Liquide; R Prabhakar, Air Liquide; J-P Tranier, Air Liquide

### **Conversion of Existing Coal-fired Power Plants to Oxyfuel Combustion: Case Studies with Experimental Results and CFD-Simulations**

K-D Tigges, Hitachi Power Europe; F Klauke, Hitachi Power Europe; C Bergins, Hitachi Power Europe; M Ehmman, Hitachi Power Europe; C Kuhr, Hitachi Power Europe; Song Wu, Hitachi Power Systems America; Orest Walchuk, Hitachi Power Systems America; Allan Kukoski, Hitachi Power Systems America

### **Comparative Thermodynamic Analysis and Integration Issues of CCS Steam Power Plants Based on Oxy-Combustion with Cryogenic or Membrane Based Air Separation**

Imo Pfaff, Hamburg University of Technology; Alfons Kather, Hamburg University of Technology

### **The Oxy-combustion Burner Development for the CO<sub>2</sub> Pilot at Lacq**

Ivan Sanchez-Molinero, Air Liquide; Denis Cieutat, Air Liquide; Remi Tsiava, Air Liquide; Nicolas Aimard, Total; Claude Prebende, Total

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## **9C ISSUES FORUM: THE VIEW FROM WALL STREET**

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Session Chair: Jim Dooley, JGCRI

In addition to establishing the technical viability of CCS technologies, the commercial deployment of CCS technologies will be strongly influenced by how these technologies are viewed by the financial and insurance communities. This session is designed to elucidate how the CCS technical community can address the information and data needs of the financial community. This session will address what kinds of firms are active in the CCS market place and what areas are they focused on. The session will also focus on the availability and applicability of various financial instruments (including insurance) that can be used to address CCS-specific financial liability issues.

#### *Panelists:*

Chiara Trabucchi, Industrial Economics Incorporated  
Lindene Patton, Zurich Financial Services  
Jeff Miller, The Tremont Group, LLC

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## **9D CCS IN REFINING**

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Session Chairs: Luc de Marliave and Charles Christopher

### **GHG Profiles for Distillate Fuels Produced from Conventional Petroleum, Oil Sands, Shale Oils and Xtl**

John J Marano, JM Energy Consulting; Robert R Freerks, Rentech

### **CO<sub>2</sub> Capture for Refineries – A Practical Approach**

Jiri van Straelen, Shell Global Solutions International; Frank Geuzebroek, Shell Global Solutions International; Liam Mahony, Shell Global Solutions International; Nicholas Goodchild, Shell Global Solutions International; Georgios Protopapas, Shell Global Solutions International

### **A Technical and Economical Evaluation of CO<sub>2</sub> Capture from FCC Units**

Leonardo Mello, Petrobras; Ricardo Pimenta, Petrobras; Gustavo Moure, Petrobras; Oscar Pravia, Petrobras; Loren Gearhart, Randall Gas Technologies; Paul Milios, Randall Gas Technologies; Torgeir Melien, StatoilHydro

### **Technology Comparison of CO<sub>2</sub> Capture for a Gas-to-Liquids Plant**

Sandra Heimel, Chevron Energy Technology Company; Clifford Lowe, Chevron Energy Technology Company; Sunil Vyas, Fluor Enterprises; Satish Reddy, Fluor Enterprises

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## **9E SITE CHARACTERIZATION**

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Session Chairs: Julio Friedman and Brendan Beck

### **Geological Model and Hydrogeological Framework of an Active CO<sub>2</sub> Sequestration Project in the Weyburn-Midale Area, Saskatchewan: Leading to a Further Understanding of Possible CO<sub>2</sub> Migration**

Gavin Jensen, Saskatchewan Ministry of Energy and Resources; Erik Nickel, Saskatchewan Ministry of Energy and Resources; Steve Whittaker, Canada Capital Energy Corp; Ben Rostron, University of Alberta

### **Hydrodynamic Interpretation of the Waarre Formation Aquifer in the Onshore Otway Basin: Implications for the CO<sub>2</sub>CRC Otway Basin Project**

Allison Hennig, CO<sub>2</sub>CRC/CSIRO Petroleum Resources; Josh Xu, CO<sub>2</sub>CRC; Tess Dance, CO<sub>2</sub>CRC/CSIRO Petroleum Resources

### **CO<sub>2</sub> Storage Risk Minimization through Systematic Identification and Assessment of Faults: A Williston Basin Case Study**

Charles Gorecki, EERC; James Sorensen, EERC; Edward Steadman, EERC; John Harju, EERC

### **Addressing Uncertainties in Cap Rock Integrity Assessment through a Response Surface Methodology**

Jeremy Rohmer, BRGM; Olivier Bouc, BRGM

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## **9F OCEAN STORAGE**

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Session Chairs: Takashi Ohsumi and Eric Adams

### **An Updated Assessment of the Acute Impacts of Ocean Carbon Sequestration by Direct Injection**

Peter H Israelsson, Massachusetts Institute of Technology; Aaron C Chow, Massachusetts Institute of Technology; Eric E Adams, Massachusetts Institute of Technology

### **Electrochemical Acceleration of Chemical Weathering for Carbon Capture and Sequestration**

Kurt House, Harvard University; Christopher House, Pennsylvania State University; Daniel Schrag, Harvard University; Michael Aziz, Harvard University

### **The Fate of CO<sub>2</sub> Bubble Leaked from Seabed**

Baixin Chen, Heriot-Watt University; Altynbek Kabdolov, Heriot-Watt University; Masahiro Nishio, National Institute of advanced Industrial Science & Technology; Yongchen Song, Dalian University of Technology; Makoto Akai, National Institute of advanced Industrial Science & Technology

### **A Case for Ocean Sequestration of Captured Carbon Emissions**

Kathryn Sheps, MDS Research, LLC; Michael Max, MDS Research, LLC; John P. Osegovic, MDS Research, LLC; Shellii Tatro, MDS Research, LLC; Leslie Brazel, MDS Research, LLC

## 10A ENVIRONMENTAL IMPACTS OF CO<sub>2</sub> STORAGE

Session Chairs: Michael Stenhouse and Heleen DeConinck

### The Impact of Controlled Injection of CO<sub>2</sub> on the Soil Ecosystem and Chemistry of an English Lowland Pasture

Julia M West, British Geological Survey; Jonathan M Pearce, British Geological Survey; Patricia Coombs, British Geological Survey; Jon R Ford, British Geological Survey; Cathy Scheib, British Geological Survey; Jeremy J Colls, University of Nottingham; Karon L Smith, University of Nottingham; Michael D Steven, University of Nottingham

### Modeling the Effects of Topography and Wind on Atmospheric Dispersion of CO<sub>2</sub> Surface Leakage at Geologic Carbon Sequestration Sites

Patrick Granvold, University of California at Berkeley; Fotini Chow, University of California at Berkeley; Curt Oldenburg, Lawrence Berkeley Laboratory

### 2D and 3D Simulations of Groundwater Quality Changes in Response to CO<sub>2</sub> Leakage from Deep Geological Storage

Liang Zheng, Lawrence Berkeley National Laboratory; John Apps, Lawrence Berkeley National Laboratory; Yingqi Zhang, Lawrence Berkeley National Laboratory; Tianfu Xu, Lawrence Berkeley National Laboratory; Jens T Birkholzer, Lawrence Berkeley National Laboratory

### Assessing the Impacts of Future Demand for Saline Groundwater on Commercial-scale Deployment of CCS in the United States

Casie Davidson, Pacific Northwest National Laboratory; James Dooley, Pacific Northwest National Laboratory; Robert Dahowski, Pacific Northwest National Laboratory

## 10B UPDATES ON PLANNED DEMONSTRATION PROJECTS

Session Chairs: Paul Broutin and Tim Hill

### RWE's 450 MW IGCC CCS Project – Status and Perspective. Part 1: Power Plant

Werner Renzenbrink, RWE Power; Johannes Ewers, RWE Power; Dietmar Keller, RWE Power

### The Latrobe Valley Post Combustion Capture Project

Barry Hooper, Cooperative Research Centre for Greenhouse Gas Technologies (CO<sub>2</sub>CRC); Paul Feron, CSIRO Energy Technology

### Scale-up Demonstrations of CO<sub>2</sub> Capture

Colin Ryan, Cansolv Technologies Inc; Devin Shaw

### Demonstration of an Oxyfuel Combustion System

Euan Cameron, Doosan Babcock Energy Ltd; David Fitzgerald, Doosan Babcock Energy Ltd; David Sturgeon, Doosan Babcock Energy Ltd

## 10C ADDRESSING LONG-TERM LIABILITY

Session Chairs: Tim Dixon and Wolf Heidug

### Paper To Be Determined

### CCS-Bonds as a Superior Instrument to Incentivize Secure Carbon Sequestration

Hermann Held, Potsdam Institute for Climate Impact Research (PIK); Ottmar Edenhofer, Potsdam Institute for Climate Impact Research (PIK)

### Pore Space Ownership Issues for CO<sub>2</sub> Sequestration in the US

Scott Anderson, Environmental Defense; Ian Duncan, Bureau of Economic Geology; Jean-Philippe Nicot, Bureau of Economic Geology

### Tipping Fees Can't Save Us from the Tipping Point: The Need to Create Durable, Rational Approaches to Risk Management that Motivate the

## Development and Adoption of Geologic CO<sub>2</sub> Storage Best Practices

James Dooley, Joint Global Change Research Institute; Chiara Trabucchi, Industrial Economics; Lindene Patton, Zurich Financial Services

## 10D ECONOMICS OF ADVANCED CAPTURE SYSTEMS

Session Chairs: Bob Stobbs and Brice Freeman

### On the Performance and Operability of GE's Dry Low NO<sub>x</sub> Combustors Utilizing Exhaust Gas Recirculation for Post-Combustion Carbon Capture

Andrei Evulet, General Electric Global Research; Ahmed Elkady, General Electric Global Research; Daniel Chinn, Chevron Energy Technology Company; Anthony Brand, General Electric Global Research

### Integration of CO<sub>2</sub> Capture Unit Using Blended Mea-Amp Solution into Coal-Fired Power Plants

Adisorn Aroonwilas, University of Regina; Amornvadee Veawab, University of Regina

### Technical and Economic Assessment of an Integrated Coal Gasification Fuel Cell Combined Cycle

Eric Grol, US DOE National Energy Technology Laboratory

### Simulation of a Process to Capture CO<sub>2</sub> From IGCC Syngas Using a High Temperature PBI Membrane

Gopala Krishnan, SRI International; Daniel Steele, SRI International; Kevin O'Brien, SRI International; Richard Callahan, Enerflex Inc; Kathryn Berchtold, Los Alamos National Laboratory; José D. Figueroa, National Energy Technology Laboratory

## 10E STORAGE ENGINEERING

Session Chairs: Erik Lindeberg and Stuart Haszeldine

### Using Reservoir Architecture to Maximize CO<sub>2</sub> Storage Capacity

Vello Kuuskraa, Advanced Resources International; George Koperna, Advanced Resources International; David Riestenberg, Advanced Resources International; Richard Esposito, Southern Company Services

### Semi-analytical Model to Determine Perforation Interval for Secure CO<sub>2</sub> Storage in Saline Aquifers

Navanit Kumar, University of Texas at Austin; Steven Bryant, University of Texas at Austin

### Feasibility of Injection Large Volume of CO<sub>2</sub> in Aquifers

Yuri Leonenko, University of Waterloo; David W. Keith, University of Calgary; Seyyed M. Ghaderi, University of Calgary

### A Coupled Reservoir-geomechanical Simulation Study of CO<sub>2</sub> Storage in a Nearly Depleted Natural Gas Reservoir

Ji Quan Shi, Imperial College London; Sevket Durucan, Imperial College London

## 10F MINERAL CARBONATION

Session Chairs: Ron Zevenhoven and To Be Determined

### A Continuous Process for Manufacture of Magnesite and Silica from Olivine, CO<sub>2</sub> and H<sub>2</sub>O

Ingrid Anne Munz, Institute for Energy Technology

### Enhancing Process Reaction Kinetics for Mineral Carbon Sequestration

Sam Krevor, Columbia University; Klaus Lackner, Columbia University

### Comparison of Different Reaction Routes for Carbonation of APC Residues

Renato Baciocchi, University of "Tor Vergata"; Giulia Costa, University of "Tor Vergata"; Alessandra Polettoni, University of Rome; Raffaella Pomi, University of Rome; Valentina Prigiobbe, ETH Zurich, Swiss Federal Institute of Technology

### Basalt-CO<sub>2</sub>-H<sub>2</sub>O Interactions and Variability in Carbonate Mineralization Rate

H Todd Schaefer, Pacific Northwest National Laboratory; B Pete McGrail, Pacific Northwest National Laboratory; A Toni Owen, Pacific Northwest National Laboratory



## 11A SALINE AQUIFER STORAGE

Session Chairs: Susan Hovorka and TS Ramakrishnan

### CO<sub>2</sub> Storage in Aquifers I – Current State of Scientific Knowledge

Karsten Michael, CO<sub>2</sub>CRC & CSIRO; Malcolm Arnot, CO<sub>2</sub>CRC & GNS Science; Sally Benson, Stanford University; Peter Cook, CO<sub>2</sub>CRC; Lincoln Paterson, CO<sub>2</sub>CRC & CSIRO; John Kaldi, CO<sub>2</sub>CRC & University of Adelaide; Rob Funnell, CO<sub>2</sub>CRC & GNS Science; Dirk Kirste, CO<sub>2</sub>CRC & Simon Fraser University

### Determination of the Total Storage Capacity of the Utsira Formation

Erik Lindeberg, SINTEF Petroleum Research; Jean-Francois Vuillaume, SINTEF Petroleum Research

### CO<sub>2</sub> Sequestration: CO<sub>2</sub> Injection Impairment due to Halite Precipitation

Nadja Muller, Shell International Exploration and Production; Ran Qi, Imperial College; Karsten Pruess, Lawrence Berkeley National Lab; Martin Blunt, Imperial College

### CO<sub>2</sub> Injectivity into Brine Aquifers: Why Relative Permeability Matters as Much as Absolute Permeability

McMillan Burton, University of Texas at Austin; Navanit Kumar, University of Texas at Austin; Steven Bryant, University of Texas at Austin

### Factors Affecting the Chromatographic Partitioning of CO<sub>2</sub> and H<sub>2</sub>S Injected into a Water-saturated Porous Medium

Stefan Bachu, Alberta Research Council; Brant Bennion, Hycal Energy Research Laboratories Ltd; Mehran Pooladi-Darvish, Fekete Associates Inc; Huifang Hong, Fekete Associates Inc

## 11B CHEMICAL LOOPING SYSTEMS

Session Chairs: Pierre LeThiez and Monica Lupion

### Chemical-looping Combustion CO<sub>2</sub> Ready Gas Power

Tobias Mattisson, Chalmers University of Technology; Juan Adanez, Instituto de Carboquímica; Tobias Proell, Institute of Chemical Engineering; Rein Kuusik, Laboratory of Inorganic Materials; Corinne Beal, ALSTOM; Jan Assink, Shell Global Solutions; Frans Snijkers, VITO-Flemish Institute for Technological Research; Anders Lyngfelt, Chalmers University of Technology

### Operating Experience with Chemical Looping Combustion in a 120kW Dual Circulating Fluidized Bed (DCFB) Unit

Philipp Kolbitsch, Vienna University of Technology; Tobias Pröll, Vienna University of Technology; Johannes Bolhar-Nordenkampf, Vienna University of Technology; Hermann Hofbauer, Vienna University of Technology

### Capturing CO<sub>2</sub> from Combustion Flue Gases with a Carbonation Calcination Loop. Experimental Results and Process Development

Juan Carlos Abanades, CSIC-INCAR Spanish Research Council; Mónica Alonso, CSIC-INCAR Spanish Research Council; Nuria Rodríguez, CSIC-INCAR Spanish Research Council; Belén González, CSIC-INCAR Spanish Research Council; Gemma Grasa, CSIC-ICB Spanish Research Council; Ramón Murillo, CSIC-ICB Spanish Research Council

### Zecomix: A Zero-Emissions Coal Power Plant Based on Hydro-gasification, CO<sub>2</sub> Capture by Calcium Looping and Semi-Closed High Temperature Steam Cycle

Matteo Romano, Politecnico di Milano; Giovanni Lozza, Politecnico di Milano

### On the Development of Novel Reactor Concepts for Chemical Looping Combustion

Richard Blom, SINTEF Materials and Chemistry; Ivar M Dahl, SINTEF Materials and Chemistry; Egil Bakken, SINTEF Materials and Chemistry; Aud I Spjelkavik, SINTEF Materials and Chemistry; Jasmina Hafizovic, SINTEF Materials and Chemistry

## 11C POLICY AND REGULATORY DEVELOPMENTS II

Session Chairs: Arthur Lee and Jennie Stephens

### Monitoring and Reporting Rules for CCS Operations in the EU Emissions Trading Scheme

Heleen Groenenberg, Energy research Centre of the Netherlands; Sina Wartmann, Ecofys Germany; Scott Brockett, European Commission, DG Environment

### Trials and Tribulations of Getting CCS in an ETS. Principles for CCS in an ETS from UK Work for the EU ETS

Tim Dixon, UK BERR and IEA GHG R&D Programme; Paul Zakkour, ERM

### CCS – Perceptions Concerning Contributions to Sustainable Development

Kenneth Möllersten, Malardalen University; Mikael Roman, Swedish Environment Institute

### Developing Policy for Geologic Carbon Sequestration in California

Elizabeth Burton, Lawrence Livermore National Laboratory; Kelly Birkinshaw, California Energy Commission; Larry Myer, Lawrence Berkeley National Laboratory; Richard Myhre, Bevilacqua-Knight, Inc; Mary Jane Coombs, California Institute for Energy and Environment

### CCS as Part of a Global Cultural Development for Environmentally Sustainable Energy Production

Samuela Vercelli, Sapienza Università di Roma; Salvatore Lombardi, Sapienza Università di Roma

## 11D TECHNO-ECONOMIC COMPARISONS

Session Chairs: Ram Narula and Nils Rokke

### eCO<sub>2</sub>: Post-combustion or Oxyfuel – A Comparison between Coal Power Plants with Integrated CO<sub>2</sub> Capture

Pierre-Antoine Bouillon, IFP; Sophie Hennes, ALSTOM Power Systems; Celine Mahieux, ALSTOM Power Systems

### Techno-Economic Evaluations and Benchmarking of Pre-combustion CO<sub>2</sub> Capture and Oxy-fuel Processes Developed in the European ENCAP Project

Clas Ekström, Vattenfall Research and Development AB; Frank Schwendig, RWE Power AG; Ole Biede, Vattenfall A/S Generation Nordic; Flavio Franco, Alstom Power Technology Centre; Günther Haupt, Siemens AG; Gelein de Koeijer, StatoilHydro ASA; Charalambos Papapavlou, Public Power Corporation; Petter E. Røkke, Sintef Energiforskning A/S

### The CO<sub>2</sub> Reduction Potential of Coal-to-Liquids Plants with Carbon Capture and Sequestration

Hari Chandan Mantripragada, Carnegie Mellon University; Edward S Rubin, Carnegie Mellon University

### Co-production of Hydrogen and Electricity with CO<sub>2</sub> Capture

John Davison, IEA Greenhouse Gas R&D Programme; Silvio Arienti, Foster Wheeler Italiana; Paolo Cotone, Foster Wheeler Italiana; Luca Mancuso, Foster Wheeler Italiana

### Climate Friendly Hydrogen Plant

Ian Lindsay, Chevron Energy Technology Company; Cliff Lowe, Chevron Energy Technology Company; Mukund Bhakta, Fluor Enterprises; Sander Balkenende, Fluor Enterprises; Satish Reddy, Fluor Enterprises

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## 11E RISK ASSESSMENT FOR GEOLOGICAL STORAGE

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Session Chairs: Ton Wildenburg and Scott Imbus

### **Current Status of Risk Assessment and Regulatory Frameworks for Geological CO<sub>2</sub> Storage**

Michael Stenhouse, Monitor Scientific LLC; John Gale, IEA GHG; Wei Zhou, Monitor Scientific LLC

### **Environmental Impact Study of a Power Plant with CCS Located near the UK Coast**

Tim Hill, E.ON; Marie-Jo Booth, E.ON; Chris Dorren, E.ON

### **Practical Application of the Vulnerability Evaluation Framework for Geological Sequestration of Carbon Dioxide**

Lisa Bacanskas, USEPA; Anhar Karimjee, USEPA; Kaylene Ritter, Stratus Consulting

### **Risk of Leakage versus Depth of Injection in Geological Storage**

Michael Celia, Princeton University; Jan Nordbotten, University of Bergen; Stefan Bachu, Alberta Energy Resources Conservation Board; Benjamin Court, Princeton University; Mark Dobossy, Princeton University

### **Modeling and Simulation of Mechanisms for Leakage of CO<sub>2</sub> from Geological Storage**

Alv-Arne Grimstad, SINTEF Petroleum Research; Sorin Georgescu, SINTEF Petroleum Research; Erik Lindeberg, SINTEF Petroleum Research; Jean-Francois Vuillaume, SINTEF Petroleum Research



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## 12A COAL-BED STORAGE AND ECBM

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Session Chairs: Henk Pagnier and Ian Potter

### **CO<sub>2</sub> Storage through ECBM Recovery: An Experimental and Modeling Study**

Ronny Pini, ETH Zurich; Ottinger Stefan, ETH Zurich; Burlini Luigi, ETH Zurich; Storti Giuseppe, ETH Zurich; Marco Mazzotti, ETH Zurich

### **Assessment of CO<sub>2</sub> Storage Performance of the Enhanced Coalbed Methane Pilot Site in Kaniow**

Frank van Bergen, TNO; Pascal Winthaegen, TNO; Henk Pagnier, TNO; Pawel Krzystolik, Central Mining Institute; Bartek Jura, Central Mining Institute; Jacek Skiba, Central Mining Institute; Niels van Wageningen, Shell

### **Matrix Shrinkage and Swelling Characteristics of European Coals**

Sevket Durucan, Imperial College London; Mustafa Ahsan, Helix RDS; Ji Quan Shi, Imperial College London

### **Natural Helium as a Screening Tool for Assessing Caprock Imperfections at Geologic CO<sub>2</sub> Storage Sites**

Jason Heath, New Mexico Institute of Mining and Technology; Brian McPherson, University of Utah; Fred Phillips, New Mexico Institute of Mining and Technology; Scott Cooper, Cooper Geological Consulting LLC; Thomas Dewers, Sandia National Laboratories

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## 12B ASSESSMENTS OF ADVANCED/NOVEL SYSTEMS

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Session Chairs: Mike Haines and George Richards

### **Comparison of Coal IGCC with and without CO<sub>2</sub> Capture and Storage: Shell Gasification with Standard vs Partial Water Quench**

Thomas Kreutz, Princeton University; Emanuele Martelli, Politecnico Di Milano; Stefano Consonni, Politecnico Di Milano

### **Reduction in the Cost of Pre-Combustion CO<sub>2</sub> Capture through Advancements in Sorption Enhanced Water Gas Shift**

Andrew Wright, Air Products; Vince White, Air Products; Jeff Hufton, Air Products; Peter Hinderink, Process Design Center; Ed van Selow, ECN

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## **Cryogenic CO<sub>2</sub> Capture in Natural Gas: Recent Demonstration Plant Experience**

Allan Hart, Cool Energy Limited; Nimalan Gnanendran, Cool Energy Limited

## **Natural Gas Oxy-Fuel Cycles – Part 3: Economic Evaluation**

Sina Rezvani, University of Ulster; Ye Huang, University of Ulster; Olav Bolland, NTNU; Alain Feraud, ALSTOM Power UK; Flavio Franco, ALSTOM Power UK; Jens Keyser, Siemens; Frank Sander, University of Paderborn; Roland Span, University of Paderborn

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## 12C ISSUES FORUM: CARBON POLICY POST KYOTO

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Session Chair: David Reiner, Cambridge University

The deployment of CCS depends critically on both national programs and the fate of the Kyoto Protocol beyond 2012. The rules and modalities regarding the treatment of CCS as well as the stringency of the emissions targets that will be negotiated at Copenhagen in 2009 will be critical to the pace of deployment of CCS technologies in both developed and developing countries. This forum offers an overview of the prospects for success at Copenhagen and seeks to identify areas of common interest as well as obstacles to a potential agreement.

### *Panelists:*

Scott Barrett, Johns Hopkins University  
Mark Brownstein, Environmental Defense  
To Be Determined

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## 12D CAPTURE DEVELOPMENTS IN CHINA AND INDIA

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Session Chairs: Gardiner Hill and Ningshan Cai

### **Assessing the Value of Capture Ready in New-built Coal Fired Power Plants in China**

Xi Liang, University of Cambridge; David Reiner, University of Cambridge; Jon Gibbins, Imperial College London; Jia Li, Imperial College London

### **Capture Studies in Phase 1 of the UK-China Near Zero Emissions Coal Project**

Jon Gibbins, Imperial College London

### **Economic Analysis of the Coal-Based Polygeneration System for Methanol and Power Production with CO<sub>2</sub> Capture**

Hongguang Jin, Chinese Academy of Sciences; Lin Gao, Chinese Academy of Sciences; Hu Lin, Chinese Academy of Sciences

### **Recent Approaches in CO<sub>2</sub> Fixation Research in India and Future Perspectives towards Zero Emission**

Malti Goel

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## 12E BEST PRACTICES FOR GEOLOGICAL STORAGE

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Session Chairs: Vello Kuuskra and Heleen Groenenberg

### **The CO<sub>2</sub>CRC Otway Project: Overcoming Challenges from Planning to Execution of Australia's First CCS Project**

Sandeep Sharma, CO<sub>2</sub>CRC; Peter Cook, CO<sub>2</sub>CRC; Thomas Berly, CO<sub>2</sub>CRC; Carmel Anderson, CO<sub>2</sub>CRC

### **WRI CCS Guidelines and Emerging Geologic Sequestration Regulations: A Comparative Assessment**

Sarah Forbes, World Resources Institute; Preeti Verma, World Resources Institute; Thomas E Curry, M J Bradley and Associates LLC; Julio Friedmann, Lawrence Livermore National Lab; Sarah Wade, AJW, Inc; John Venezia, ICF

### **A Technical Basis for CO<sub>2</sub> Storage Practices and Regulations**

Cal Cooper, ConocoPhillips

### **Towards Best Practice Guidelines for Selection, Characterization, and Qualification of Sites and Projects for Geological Storage of CO<sub>2</sub>**

Jørg Aarnes, Det Norske Veritas; Ståle Selmer-Olsen, Det Norske Veritas; Todd Allyn Flach, Det Norske Veritas; Michael Carpenter, Det Norske Veritas; Semere Solomon, Det Norske Veritas

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