# CO2 Summit III: Pathways to Carbon Capture, Utilization, and Storage Deployment

An ECI Conference Series Volume 17AY

Calabria, Italy 22-26 May 2017

# **Editors:**

Jen Wilcox Simona Liguori Holly Krutka Niall Mac Dowell

ISBN: 978-1-5108-5735-3

### Printed from e-media with permission by:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571



Some format issues inherent in the e-media version may also appear in this print version.

Copyright© (2017) by Engineering Conferences International All rights reserved.

Printed by Curran Associates, Inc. (2018)

For permission requests, please contact Engineering Conferences International at the address below.

Engineering Conferences International 32 Broadway, Suite 314 New York, NY 10004 USA

Phone: (212) 514-6760 Fax: (212) 514-6030

info@engconfintl.org

### Additional copies of this publication are available from:

Curran Associates, Inc. 57 Morehouse Lane Red Hook, NY 12571 USA Phone: 845-758-0400

Fax: 845-758-2633

Email: curran@proceedings.com Web: www.proceedings.com

## Tuesday, May 23, 2017

07:30 - 08:30	Breakfast
08:30 - 08:50	Conference welcome and opening ceremony Introduction to conference format and goals – Jen Wilcox and Niall Mac Dowell
08:50 - 09:30	Plenary 1 The Role of CCS for Attaining Long-term Climate Stabilization1 Massimo Tavoni, Politecnico Milano, Italy
09:30 - 10:10	Plenary 2 Research Opportunities for Negative Emissions and CO₂ Utilization at the Gigatonne Scale2 Arun Majumdar, Stanford University, USA
10:10 - 10:30	Open discussion
10:30 - 11:00	Coffee Break
	Technical Session 1: Communication, Policy, and Economics Around CCUS Deployment
11:00 - 11:20	A Preliminary Political Economy of Net-negative Emissions Technologies3 David M. Reiner, University of Cambridge, United Kingdom
11:20 - 11:40	Manufacturing our Future: Industries, European Regions and Climate Action4 Jonas Helseth, Bellona Europa, Belgium
11:40 - 12:00	Towards Industry, Policy, and Civil Society Action on Carbon Removal24 Noah Deich, Center for Carbon Removal, USA
12:00 - 12:30	Pathways to CCS Commercialization25 Wilfried Maas, Shell, Netherlands
12:30 - 12:50	Open discussion
12:50 - 14:20	Lunch and open time
14:20 - 15:00	Plenary 3 Carbon Dioxide Removal26 Howard J. Herzog, Massachusetts Institute of Technology, USA
15:00 - 15:40	Plenary 4 Land Use Implications of Negative Emissions from BECCS27 Sabine Fuss, Mercator Research Institute on Global Commons and Climate Change, Germany

# Tuesday, May 23, 2017 (continued)

15:40 - 16:00	Open discussion
16:00 - 16:30	Coffee break
	Technical Session 2: Opportunities and Examples of CDR
16:30 - 16:50	The Transition of CCS from Fossil Fuel CO <sub>2</sub> Control to Negative Emissions28 Roger D. Aines, Lawrence Livermore National Laboratory, USA
16:50 - 17:10	Can BECCS Deliver Sustainable and Resource-efficient Negative Emissions?29 Mathilde Fajardy, Imperial College London, United Kingdom
17:10 - 17:30	Sustainable BECCS Pathways Evaluated by an Integrated Assessment Model30 Etsushi Kato, Institute of Applied Energy, Japan
17:30 - 17:50	Negative Emissions on South East Asia: Renewable Energy Optimization with BECCS for Indonesia31 Florian Kraxner, International Institute for Applied System Analysis, Austria
17:50 - 18:10	Slicing the Pie: How Big Could Carbon Dioxide Removal Be?52 Peter Psarras, Colorado School of Mines, USA
18:10 - 18:30	Open discussion
18:30 - 19:30	Reception and poster session (5-minute presentations by poster presenters) Wine, beer, and light snacks
19:30 - 21:00	Dinner

## Wednesday, May 24, 2017

07:30 - 08:30	Breakfast
08:30 - 09:10	Plenary 5 Adsorption Processes for CO <sub>2</sub> Capture: An Overview53 Paul Webley, The University of Melbourne, Australia
09:10 - 09:50	Plenary 6  A Membrane Approach to CO <sub>2</sub> Capture75  Richard W. Baker, Membrane Technology Research, USA
09:50 - 10:10	Open discussion
10:10 - 10:40	Coffee break
	<u>Technical Session 3: Advanced Conversion and CO<sub>2</sub> Separation</u> <u>Processes</u>
10:40 - 11:00	Membrane Condenser: Direct and Indirect Support to CO₂ capture94 Enrico Drioli, ITM-CNR, Italy
11:00 - 11:20	Advanced Membrane Operations in CO <sub>2</sub> Capture95 Giuseppe Barbieri, ITM-CNR, University of Calabria, Italy
11:20 - 11:40	Designing Materials and Processes for CO <sub>2</sub> Capture with Solid Sorbents96 Adam H. Berger, Electric Power Research Institute, USA
11:40 - 12:00	Carbon Dioxide Reforming with Natural Gas and Coal using Chemical Looping97 Andrew Tong, The Ohio State University, USA
12:00 - 12:20	Open discussion
12:20 - 13:40	Lunch and open time
13:40 - 14:20	Plenary 7 International Efforts of the National Carbon Capture Center98 Roxann Laird, Southern Company Services, USA
14:20 - 15:00	Plenary 8 Carbon Management at Shenhua – R&D Initiatives and CCUS Demonstrations99 Anthony Ku, National Institute of Clean-and-Low-Carbon Energy, China
15:00 - 15:20	Open discussion
15:20 - 15:50	Coffee break

# Wednesday, May 24, 2017 (continued)

	<u>Technical Session 4: System Integration Approaches</u> Sponsored by Beijing-based National Institute of Clean and Low-Carbon Energy (NICE)
15:50 - 16:10	On the Operation of CCS Within a Diverse Energy System100 Niall Mac Dowell, Imperial College London, United Kingdom
16:10 - 16:30	Carbon Capture and Geologic Sequestration from Intermittent Use of Fossil Fuels101 Susan D. Hovorka, University of Texas at Austin, USA
16:30 - 16:50	Reversible Solid Oxide Cells as a Flexible, Dispatchable Resource for Grid-Energy Storage and Natural Gas Production Using CO <sub>2</sub> and CH <sub>4</sub> 102 Robert Braun, Colorado School of Mines, USA
16:50 - 17:10	Integration of carbon capture with renewable energy in power generation and steel manufacturing103 Ali Abbas, The University of Sydney, Australia
17:10 - 17:30	A bio-physical and net-energy comparison of CCS and renewable energy baseload systems104 Sgouris Sgouridis, Masdar Institute, United Arab Emirates
17:30 - 18:00	Open discussion
18:00 - 19:30	Reception and poster session (5-minute presentations by poster presenters) Wine, beer, and light snacks
19:30 - 21:00	Dinner

## **Thursday, May 25, 2017**

07:30 - 08:30	Breakfast
08:30 - 09:10	Plenary 9 Cement, CCS and CO₂ Uptake, Including an Update on the EU LEILAC Project105 Paul Fennell, Imperial College London, United Kingdom
09:10 - 09:50	Plenary 10  To Utilize or Not to Utilize? A Life-Cycle Assessment Perspective on Carbon Dioxide Utilization106  Andre Bardow, Aachen University, Germany
09:50 - 10:10	Open discussion
10:10 - 10:40	Coffee break
	Technical Session 5: CO <sub>2</sub> Capture from Industrial Sources and CO <sub>2</sub> Utilization
10:40 - 10:55	What We Talk About When We Talk About CCUS: New Tactics for Communicating the Opportunities and Risks107 Marcius H. T. Extavour, XPRIZE, USA
10:55 - 11:15	CO <sub>2</sub> Capture from Industrial Sources by High-temperature Sorbents108 Matteo C. Romano, Politecnico di Milano, Italy
11:15 - 11:35	Lifecycle CO <sub>2</sub> emissions from US bioethanol production with CCS128 Sean T. McCoy, Lawrence Livermore National Laboratory, USA
11:35 - 11:55	CCUS as a Regional Economic Development Tool: Planning and Design Considerations129 Kevin O'Brien, Illinois Sustainable Technology Center, USA
11:55 - 12:15	Metastable hydrated carbonates for algae biofuel production144 Valentina Prigiobbe, Stevens Institute of Technology, USA
12:15 - 12:35	Catalyzing a CO <sub>2</sub> -neutral Society145 Mark Saeys, Ghent University, Belgium
12:35 - 12:50	Maximizing the Mitigation Potential of Curtailed Wind: A Comparison Between Carbon Capture and Utilization, and Direct Air Capture Processes for the UK146 Habiba A. Daggash, Imperial College London, United Kingdom
12:50 - 13:10	Open discussion

# Thursday, May 25, 2017 (continued)

13:10 - 15:30	Lunch and open time
15:30 - 16:10	Plenary 11 Harnessing Peridotite Alteration for Carbon Capture and Storage147 Peter Kelemen, Columbia University, USA
16:10 - 16:50	Plenary 12 Status, Challenges, and Potential Capacity of Reliable Geologic Storage of CO <sub>2</sub> 148 Susan D. Hovorka, University of Texas at Austin, USA
16:50 - 17:10	Open discussion
17:10 - 17:40	Coffee break
	Technical Session 6: Reliable CO₂ Storage Technologies
17:40 - 18:00	Technical Session 6: Reliable CO₂ Storage Technologies  The Potential of Carbon Storage in the Ocean as Bicarbonate149  Phil Renforth, Cardiff University, United Kingdom
17:40 - 18:00 18:00 - 18:20	The Potential of Carbon Storage in the Ocean as Bicarbonate149
	The Potential of Carbon Storage in the Ocean as Bicarbonate149 Phil Renforth, Cardiff University, United Kingdom  Pathways to Accelerated Carbon Mineralization in Mine Tailings150
18:00 - 18:20	The Potential of Carbon Storage in the Ocean as Bicarbonate149 Phil Renforth, Cardiff University, United Kingdom  Pathways to Accelerated Carbon Mineralization in Mine Tailings150 Gregory M. Dipple, University of British Columbia, Canada  Carbonation of Industrial Residues for CCUS: Fundamentals, Energy Requirements and Scale-up Opportunities151

## Friday, May 26, 2017

07:30 - 08:30	Breakfast
08:30 - 09:00	Closing remarks and next steps - Jen Wilcox and Niall Mac Dowell
09:00 - 10:30	Technical Session 7: Frontiers Special Issue Development
10:30 - 11:00	Coffee break
11:00 - 12:00	Technical Session 7 continued: Frontiers Special Issue Development
12:00 - 13:30	Lunch
13:30	Conference conclusion

### **Poster Presentations**

1.	Cost-effective, near-term deployment of carbon capture and storage from biorefineries in the United States152 Daniel L. Sanchez, Carnegie Institution for Science, USA
2.	Opportunities for industrial CO <sub>2</sub> capture and utilization in the US154 Peter Psarras, Colorado School of Mines, USA
3.	Analysis of reversible solid oxide cell technology for grid-energy storage and synthetic natural gas production with CO <sub>2</sub> 155 Evan P. Reznicek, Colorado School of Mines, USA
4.	What are the key processes of CO <sub>2</sub> storage to represent in energy systems models? A dynamic model of CO <sub>2</sub> storage in the UK Bunter Sandstone156 Clea Kolster, Imperial College London, United Kingdom
5.	Can BECCS efficiently and sustainably remove CO <sub>2</sub> from the atmosphere?157 Mathilde Fajardy, Imperial College London, United Kingdom
6.	Power-to-transport: Using curtailed wind to run CCU processes158 Habiba A. Daggash, Imperial College London, United Kingdom
7.	CO <sub>2</sub> capture from the industry sector159 Praveen Bains, Stanford University, USA
8.	Design and operations optimization of membrane separation for flexible carbon capture from natural gas combined cycle systems160 Mengyao Yuan, Stanford University, USA
9.	Geospatial analysis of BECCS deployment potential in the U.S161 Ejeong Baik, Stanford University, USA
10.	Applying potential BECCS solutions to the US coal sector: New coal boom or bust?162 Florian Kraxner, International Institute for Applied Systems Analysis (IIASA), Austria
11.	The water-energy-carbon-land nexus: Optimising the BECCS supply chain163 Solène Chiquier, Imperial College London, United Kingdom
12.	Photocatalityc membrane reactor for CO <sub>2</sub> conversion164 Giuseppe Barbieri, ITM-CNR, Italy
13.	H2 production in Palladium-based Membrane Reactor165 Nora Buggy, Colorado School of Mines, USA
14.	Mineral carbonation opportunities in the western United States166 Christopher M. Caskey, Colorado School of Mines, USA