International Conference on Negative CO_2 Emissions
Gothenburg, May 22-24 2018

http://negativeco2emissions2018.com/

Links to PDFs of presentation and to YouTube VIDEOS of presentations.
Direct link to Youtube channel

Keynote/plenaries

	Title / Link to video	Link to PDF	Who
1	*Negative CO_2 emissions - why, when and how much?*	PDF	James Hansen
2	*The Necessity and the Allure of Negative CO_2 Emissions – A Question of Balance*	PDF	Anders Lyngfelt
3	*Geological storage of carbon dioxide for negative emissions*	PDF	Sally Benson
4	*CO_2 capture technologies status in the real world and the road for negative emissions*	PDF	Mike Monea
5	*What we know and do not know about negative emissions*	PDF	Sabine Fuss
6	*An integrated assessment modeling perspective on negative CO2 emissions: Why do most models find NETs so attractive?*	PDF	Detlef van Vuuren
7	*Integration of Carbon Dioxide Removal into the European Union's climate policy*	PDF	Oliver Geden
8	*Direct Air Capture*	PDF	Jen Wilcox
9	*Negative emissions from soil management*	PDF	Pete Smith
10	*Afforestation/reforestation and global biomass resources for negative CO2 emission*	PDF	Almut Arneth
11	*Enhanced Weathering*	PDF	Phil Renforth

Oral presentations

see following pages

1A BECCS in Sweden

Tuesday, May 22, 11:00-12:20

INVITED LECTURE:

Swedish Climate Policies and the Role of Negative CO_2

Policy Eva SVEDLING

Swedish Ministry for Foreign Affairs

Cost effectiveness of BECCS: policy implications and the case of Stockholm **VIDEO**

Fabian LEVIHN[1,2], Linus LINDE[3],
Kåre GUSTAVSSON[1,2], Erik Dahlén[1]

[1] Stockholm Exergi AB, Stockholm, Sweden

[2] Royal Institute of Technology (KTH), Stockholm, Sweden

[3] 2050 Consulting AB, Stockholm, Sweden

Mapping policy incentives for bioenergy with carbon $_2$ capture and storage at different scales **VIDEO**

Mathias FRIDAHL[1,3], Rob BELLAMY[2],
Anders HANSSON[1], Simon HAIKOLA[4]

[1] The Centre for Climate Science and Policy Research (CSPR), Department of Thematic Studies – Environmental Change, Linköping University, Sweden

[2] Institute for Science, Innovation and Society (InSIS), University of Oxford, UK

[3] Forum for Reforms, Entrepreneurship and Sustainability, Stockholm, Sweden

[4] Department of Thematic Studies – Technology and Social Change, Linköping University, Sweden

Techno-Economic Assessment of Bio-Energy with CO_2 Capture - Applications to the Swedish Process Industry **VIDEO**

Stefania Osk GARDARSDOTTIR, Fredrik NORMANN, Filip JOHNSSON

Department of Space, Earth and Environment, Chalmers University of Technology, Sweden

1B Policy

Tuesday, May 22, 11:00-12:20

Tracking progress to "well below 2°C" in overshoot scenarios

Glen PETERS[1], Oliver GEDEN[2,3],
Andreas LÖSCHEL[4]

[1] CICERO Center for International Climate Research, Oslo, Norway

[2] German Institute for International and Security Affairs (SWP), Berlin, Germany

[3] Max Planck Institute for Meteorology (MPI-M), Hamburg, Germany

[4] Center for Applied Economic Research (CAWM), University of Münster, Münster, Germany

'Full' vs. 'limited CDR' – how to get EU climate policymakers on Board

Oliver GEDEN[1,2], Glen PETERS[3], Vivian SCOTT[4]

[1] Max Planck Institute for Meteorology (MPI-M), Hamburg, Germany

[2] German Institute for International and Security Affairs (SWP), Berlin, Germany

[3] Centre for International Climate and Environmental Research (CICERO), Oslo, Norway

[4] University of Edinburgh, School of Geosciences, UK

The politics of anticipation: The IPCC and the Negative Emissions Technologies experience

Silke BECK , Martin MAHONY

[1] Department of Environmental Politics, Helmholtz Centre for Environmental Research – UFZ, Leipzig, Germany

[2] School of Environmental Sciences, University of East Anglia, UK

The evolving promises of NETs: a cultural political economy perspective on the problem of mitigation deterrence

MCLAREN, TYFIELD, MARKUSSON

Lancaster Environment Centre, Lancaster University, UK

1C Biospheric storage – Agriculture

Tuesday, May 22, 11:00-12:20

Biomass production in plantations: Land constraints increase dependency on irrigation water

Yvonne JANS[1,2], Göran BERNDES[3], Jens HEINKE[1],
Wolfgang LUCHT[1,2], Dieter GERTEN[1,2]

[1] Potsdam Institute for Climate Impact Research, Germany

[2] Department of Geography, Humboldt-Universität zu Berlin, Germany

[3] Department of Space, Earth and Environment, Chalmers University of Technology, Gothenburg, Sweden

Sustainable Feedstocks for Carbon-Negative Bioenergy: A Landscape Design Case Study

John FIELD[1], Keith PAUSTIAN[1,2]

[1] Natural Resource Ecology Laboratory, Colorado State University, CO, USA

[2] Dept. of Soil & Crop Sciences, Colorado State University, CO, USA

Deeply Rooted: Evaluating Plant Rooting Depth as a Means for Enhanced Soil Carbon Sequestration

Jennifer PETT-RIDGE, Erin NUCCIO, Karis MCFARLANE

Lawrence Livermore National Laboratory, Livermore, California, USA

Biochar-N dynamics: Can we solve the N dilemma of C sequestration?
A review and conceptual framework for meeting the SDGs and generating NE

Claudia KAMMANN[1], Nikolas HAGEMANN[2], Maria Luz CAYUELA[3], Constanze WERNER[4], Dieter GERTEN[4,5], Wolfang LUCHT[4,5] und Hans-Peter SCHMIDT[2]

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1D BECCS – CLC pilots/experiments

Tuesday, May 22, 11:00-12:20

Experimental investigation of chemical-looping combustion and chemical-looping gasification of biomass-based fuels using steel converter slag as oxygen carrier

Patrick MOLDENHAUER, Carl LINDERHOLM, Magnus RYDÉN, Anders LYNGFELT

Chalmers University of Technology, Gothenburg, Sweden

Autothermal Chemical Looping Reforming of Bioethanol for Hydrogen Production

Francisco GARCÍA-LABIANO1, Enrique GARCÍA-DÍEZ[1], Luis F. DE DIEGO[1], Juan ADÁNEZ[1], Juan A.C. RUÍZ[2]

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[2] Centro de Tecnologias do Gás e Energias Renováveis (CTGAS-ER), Natal, Brazil

Biomass combustion by Chemical Looping with Oxygen Uncoupling process: experiments with Cu-based and Cu-Mn mixed oxide as oxygen carriers

Iñaki ADÁNEZ-RUBIO[1,2], Antón PÉREZ-ASTRAY[1], Alberto ABAD[1], Pilar GAYÁN[1], Luis F. DE DIEGO[1], Juan ADÁNEZ[1]

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High volatiles conversion in a dual stage fuel reactor system for Chemical Looping Combustion of wood biomass

Johannes HAUS[1], Yi Feng[2], Ernst-Ulrich HARTGE[1], Stefan HEINRICH[1], Joachim WERTHER[1]

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1E Other NETs

Tuesday, May 22, 11:00-12:20

Carbon Dioxide Utilisation and Removal: Promise and Challenges

Cameron HEPBURN[1,2], Ella ADLEN[1], John BEDDINGTON[1], Emily A. CARTER[3], Pete SMITH[4]

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Affordable CO_2 Negative Emission Through Hydrogen from Biomass, Ocean Liming and CO_2 Storage

Stefano CASERINI[1], Beatriz BARRETO[1], Caterina LANFREDI[1], Giovanni

CAPPELLO[2], Dennis ROSS MORREY[2], Mario GROSSO[1]

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Sequestering carbon in solid materials

John MCDONALD-WHARRY

School of Science and Engineering, University of Waikato, Hamilton, New Zealand

Beyond Carbon Dioxide Removal: innovative breakthrough Negative Emissions Technologies for other GHGs Removal

Renaud de RICHTER[1], Franz Dietrich OESTE[2], Tingzhen MING[3], Sylvain CAILLOL[1]

[1] Institute Charles Gerhardt, Montpellier, France

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[3] School of Civil Engineering and Architecture, Wuhan University of Technology, China

2A BECCS in Nordic countries

Tuesday, May 22, 14:00-15:00

INVITED LECTURE:
Carbon Capture and Storage in Norway VIDEO

Kristin MYSKJA

Ministry of Petroleum and Energy

The Nordic Countries Have Excellent Conditions for Bio-CCS

Ana SERDONER[1], Keith WHIRISKEY[1], Gøril TJETLAND[2], Magnus RYDÉN[2,3] and Anders LYNGFELT3

[1] Bellona Europa, Brussels, Belgium

[2] Bellona, Oslo, Norway

[3] Chalmers University of Technology, Gothenburg, Sweden

Don't Panic – Why we believe the Nordics can go Net CO_2 Negative by 2040 VIDEO

Simon BRØNDUM ANDERSEN[1], Kenneth KARLSSON[1], Klaus SKYTTE[1], Julia HANSSON[2], Anders LYNGFELT[2]

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Denmark

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2B NETs – Systematic technology assessment

Tuesday, May 22, 14:00-15:00

Negative emissions – research landscape and synthesis

Jan C. MINX[1,2], William F. LAMB[1], Max W. CALLAGHAN[1,2], Sabine FUSS[1], Jérôme HILAIRE[1,5], Felix CREUTZIG[1,3], Thorben AMANN[4], Tim BERINGER[1], Wagner DE OLIVEIRA GARCIA[4], Jens HARTMANN[4], Tarun KHANNA[1], Dominic LENZI[1], Gunnar LUDERER[5], Gregory F. NEMET[6], Joeri ROGELJ[7,8], Pete SMITH[9], Jose Luis Vicente VICENTE[1], Jennifer WILCOX[10], Maria DEL MAR ZAMORA[1]

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[10] Department of Chemical and Biological Engineering, Colorado School of Mines, Golden, USA

Negative emissions - Costs, potentials and side effects

Sabine FUSS[1], William F. LAMB[1], Max W. CALLAGHAN[1], Jérôme HILAIRE[1,5], Felix CREUTZIG[1,3], Thorben AMANN[4], Tim BERINGER[1], Wagner de Oliveira GARCIA[4], Jens HARTMANN[4], Tarun KHANNA[1], Gunnar LUDERER[5], Gregory F. NEMET[6], Joeri ROGELJ[7,8], Pete SMITH[9],

José Luis VICENTE VICENTE[1], Jennifer WILCOX[10], Maria del Mar ZAMORA[1], Jan C. MINX[1,2]

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Negative emissions - Part 3: Innovation and upscaling

Gregory F. NEMET[1], Max W. CALLAGHAN[2], Felix CREUTZIG[2,3], Sabine FUSS[2], Jens HARTMANN[5], Jérôme HILAIRE[2,6], William F. LAMB[2], Jan C. MINX[2,4], Sophia ROGERS[1], Pete SMITH[7]

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2C Policy

Tuesday, May 22, 14:00-15:00

Land degradation neutrality will deliver large-scale negative emissions

Annette COWIE[1], Barron J. ORR[2], Johns Muleso KHARIKA[2]

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[2] United Nations Convention to Combat Desertification (UNCCD), Germany

New Carbon Economy Consortium Research Roadmap

Noah DEICH, Jane ZELIKOVA

Center for Carbon Removal

An Earth Systems Governance perspective on negative emission technologies

Jesse REYNOLDS[1], Matthias HONEGGER[2]

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[2] Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands

2D Incentives

Tuesday, May 22, 14:00-15:00

Using RPSs and FITs to Accelerate Development of Negative Emissions Technologies

Anthony E. CHAVEZ

Chase College of Law, Northern Kentucky University, USA

Geoengineering and the blockchain: coordinating CDR & SRM to tackle future emissions

Andrew LOCKLEY, D'Maris COFFMAN

Bartlett School, UCL, London, UK

Carbon Dioxide Removal and Tradeable Put Options

Andrew LOCKLEY, D'Maris COFFMAN

Bartlett School, UCL, London, UK

2E BECCS – Regional examples

Tuesday, May 22, 14:00-15:00

Near-term Potential for Carbon-Negative Bioenergy in the United States and Pathways of Meeting the Potential

Ejeong BAIK[1], Daniel L. SANCHEZ[2], Peter A. TURNER[2], Katharine J. MACH[3], Christopher B. FIELD[4], Sally M. BENSON[5]

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[3] Department of Earth System Science, Stanford University, USA

[4] Stanford Woods Institute for the Environment, Stanford University, USA

Bioenergy with Carbon Capture and Storage (BECCS) in the UK: Contrasting Land-use Scenarios and Implications for Natural Capital

Caspar DONNISON[1], Robert A. HOLLAND[1], Astley HASTINGS[2], Lindsay-Marie ARMSTRONG[3], Felix EIGENBROD[4], Gail TAYLOR[1,5]

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The role of biomass for negative emissions in Germany

Nora SZARKA[1], Daniela THRÄN[1,2]

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3A Incentives

Wednesday, May 23, 11:00-12:00

European Union's post-2020 climate policy and the incentives to use forests for climate change mitigation

Aapo RAUTIAINEN[1], Jussi LINTUNEN[1], Johanna POHJOLA[2], Jani LATURI[1], Jussi UUSIVUORI[1]

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Making Negative Emissions Economically Feasible: The View from California VIDEO

Roger D. AINES, Sean T. MCCOY

Lawrence Livermore National Laboratory, Livermore, California, USA

The Financing of Future Negative Emissions – Bringing it All Back Home or Tangled up in Blue? VIDEO

Anders LYNGFELT

Chalmers University of Technology, Gothenburg, Sweden

3B BECCS – CLC pilots

Wednesday, May 23, 11:00-12:00

Biomass Combustion with CO_2 Capture by Chemical Looping: Experimental results in a 50 kWth Pilot plant

Albeŕto ABAD, Raúl PÉREZ-VEGA, Antón PÉREZ-ASTRAY, Teresa MENDIARA, Luis F. DE DIEGO, Francisco GARCÍA-LABIANO, Pilar GAYÁN, María T. IZQUIERDO, Juan ADÁNEZ

Instituto de Carboquímica (ICB-CSIC), Zaragoza, Spain

Operational Experience of CO_2 Capture Using Chemical-Looping Combustion of Biomass-Based Fuels in a 100 kW Unit

Matthias SCHMITZ, Carl LINDERHOLM, Anders LYNGFELT

Chalmers University of Technology, Gothenburg, Sweden

Chemical Looping Combustion of wood pellets in a 150 kWth CLC reactor

Øyvind LANGØRGEN, Inge SAANUM

SINTEF Energy Research, Trondheim, Norway

3C Biospheric storage – Soil/Biochar

Wednesday, May 23, 11:00-12:00

Technologies for maximising biochar's carbon sequestration potential

Ondrej MAŠEK, Wolfram BUSS

UK Biochar Research Centre, School of GeoSciences, University of Edinburgh, UK

The FP7 EuroChar project: Biochar as a Negative Emission Technology

L. GENESIO[1], F. VACCARI[1], S. BARONTI[1], A. MAIENZA[1], I. CRISCUOLI[1,2], G. ALBERTI[3], E. LUGATO[1,4,] M. VENTURA[2], G. TONON[2], B. GLASER[5], G. TAYLOR[6], C. RUMPELL[7], A. POZZI[8], R. MASS[9], J. WOODS[10], F. MIGLIETTA[1]

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[5] Halle University, Germany

[6] Southampton University, UK

[7] UPMC-INRA-CNRS, France

[8] AGT, Italy

[9] Carbon Solutions, Germany

[10] Imperial College, UK

Modelling the biogeochemical potential of biomass pyrolysis systems as a negative emission technology

C WERNER[1], H-P SCHMIDT[2] , D GERTEN[1,3], W LUCHT[1,3,4], C KAMMANN[5]

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[3] Humboldt-Universität zu Berlin, Department of Geography, Berlin, Germany

[4] Integrative Research Institute on Transformations of Human-Environment Systems, Berlin, Germany

[5] Hochschule Geisenheim University, WG Climate Change Research for Special Crops, Department of Soil Science and Plant Nutrition, Geisenheim,Germany

3D Policy

Wednesday, May 23, 11:00-12:00

Immediate deployment opportunities for negative emissions with BECCS: a Swedish case study

Henrik KARLSSON[1], Timur DELAHAYE[1], Filip JOHNSSON[2], Jan KJÄRSTAD[2], Johan ROOTZÉN[2]

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[2] Department of Space, Earth and Environment, Chalmers University of Technology, Gothenburg, Sweden

UK Policy Dynamics and the Development of Negative Emissions Technologies

Peter HEALEY[1], Tim KRUGER[2]

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Challenges and required R&D regarding negative CO_2 emissions

Frans VAN DIJEN

4A Policy

Wednesday, May 23, 14:00-15:00

Investigating Moral Hazard and Other Imagined Threats of Negative Emissions Technologies VIDEO

David M REINER

Energy Policy Research Group, Judge Business School, University of Cambridge, UK

Limits to the Compensation of Greenhouse Gas Emissions through Carbon Dioxide Sequestration in Plants VIDEO

Josef SPITZER[1], David Neil BIRD[2], Annette COWIE[3], Helmut HABERL[4], Kim PINGOUD[5], Hannes SCHWAIGER[2]

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Allocating negative emissions to countries VIDEO

Glen PETERS[1], Robbie ANDREW[1], Oliver GEDEN[2,3], Detlef VAN VUUREN[4,5]

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4B Modelling

Wednesday, May 23, 14:00-15:40

The value and institutional challenges of different carbon dioxide removal technologies for climate change mitigation

Jessica STREFLER, Nico BAUER, Florian HUMPENÖDER, David KLEIN, Elmar KRIEGLER

Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany

Estimating National Carbon Quotas and Modelling the Role of NETs in Compatible Emission Pathways at a Small Nation Scale

Barry McMULLIN1, Paul PRICE1, Michael B. JONES2, Alwynne H. McGEEVER2

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[2] University of Dublin, Trinity College, Dublin, Ireland

Ocean carbon cycle feedbacks under negative emissions

Jörg SCHWINGER, Jerry TJIPUTRA

Uni Research Climate, Bjerknes Centre for Climate Research, Bergen, Norway

Energy transition pathways for the US coal sector under delayed climate policy actions

Piera PATRIZIO[1], Sylvain LEDUC[1], Sabine FUSS[1,2], Florian KRAXNER[1]

[1] Ecosystems Services and Management Program (ESM), International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

[2] Working Group, Sustainable Resource Management and Global Change, Mercator Research Institute on Global Commons and Climate Change, Berlin, Germany

The Effects of Carbon Dioxide Removal on the Carbon Cycle

David P. KELLER[1], Andrew LENTON[2,3], Emma W. LITTLETON[4], Andreas OSCHLIES[1], Vivian SCOTT[5], Naomi E. VAUGHAN[6]

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4C BECCS in Industry

Wednesday, May 23, 14:00-15:40

Impact analysis of CO_2 capture from pulp mills - effects on CO_2 emissions, costs and green electricity production

Ragnhild SKAGESTAD[1], Jens WOLF[2], Marie ANHEDEN[2], Stefania Osk GARDARSDOTTIR[3], Anette MATHISEN[2], Fredrik NORMANN[3]

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[2] RISE Bioeconomy, Stockholm, Sweden

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A Strategy for Early Deployment of BECCS in Basic Industry - A Swedish Case Study

Johan ROOTZÉN[1], Jan KJÄRSTAD[1], Filip JOHNSSON[1], Henrik KARLSSON[2]

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[2] Biorecro AB, Stockholm, Sweden

Evaluation of Steel Mills as Carbon Sinks

Maximilian BIERMANN, Alberto ALAMIA, Fredrik NORMANN, Filip JOHNSSON

Chalmers University of Technology, Sweden

Opportunities for achieving negative emissions from European iron and steel industry

Hana MANDOVA[1], Sylvain LEDUC[2], Piera PATRIZIO[2], Chuan WANG[3], Elisabeth WETTERLUND[4], William GALE[1], Florian KRAXNER[2]

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Pulp Mill as BioCCU

Katja KUPARINEN, Esa VAKKILAINEN, Tero TYNJÄLÄ

Lappeenranta University of Technology, Finland

4D Biospheric storage – Forestry

Wednesday, May 23, 14:00-15:40

The Mitigation Potential of Large-Scale Tropical Forest Restoration: Assessing the Promise of the Bonn Challenge

Charlotte E. WHEELER[1,2] Edward MITCHARD[1] Alexander KOCH[2], Simon L. LEWIS[2,3]

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[2] Department of Geography, University College London, UK

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Climate Change Mitigation Potential of Biomass Based Heat and Power Production

Torun HAMMAR[1], Johan STENDAHL[2], Cecilia SUNDBERG[1,3], Hampus HOLMSTRÖM[4], Per-Anders HANSSON[1]

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[3] Dept. of Sustainable Development, Environmental Science and Engineering, KTH Royal Institute of Technology, Stockholm, Sweden

[4] Department of Forest Resource Management, SLU, Umeå, Sweden

On the trade-offs and synergies between forest carbon sequestration and substitution

Sampo SOIMAKALLIO[1], Tuomo KALLIOKOSKI[2], Aleksi LEHTONEN[3], Olli SALMINEN[3]

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The temporal greenhouse gas impacts of forest-based bioenergy within a cumulative emissions framing

Mirjam RÖDER[1], Evelyne THIFFAULT[2], Celia MARTÍNEZ-ALONSO[3], Patricia THORNLEY[1]

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The risks of large-scale biosequestration in the context of Carbon DioxideRemoval

Coraina DE LA PLAZA[1], Oliver MUNNION[2], Simon FISCHER[1], Simone LOVERA[3]

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[3] Global Forest Coalition, Asunción, Paraguay

4E NETs – Weathering

Wednesday, May 23, 14:00-15:00

An intrusive investigation of the weathering of legacy iron and steel wastes at Consett, County Durham, UK

Huw PULLIN[1], Devin SAPSFORD[2], Will MAYES[3], Phil RENFORTH[1]

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[2] School of Engineering, Cardiff University, UK

[3] School of Environmental Sciences, University of Hull, UK.

Development of in-situ high pressure (20 MPa) high temperature (773 K) infrared spectroscopy for monitoring silicate weathering

Greg MUTCH[1], James ANDERSON[2], David VEGA-MAZA[2]

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Safely & Economic Sequestering CO_2 with Olivine

Pol KNOPS[1], Eddy L. WIJNKER[2]

[1] Green Minerals, Netherlands

[2] greenSand, Netherlands

5A Modelling

Wednesday, May 23, 16:10-17:30

Energy system implications of negative emission technologies VIDEO

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Biomass in the electricity system: complement to variable renewables or carbon sink? VIDEO

Viktor JOHANSSON[1], Mariliis LEHTVEER[1,2], Lisa GÖRANSSON[1]

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Potential Impacts of Land-Based Negative Emissions Technologies on Biodiversity and Ecosystem Services VIDEO

Pete SMITH

Institute of Biological and Environmental Sciences, University of Aberdeen, Scotland, UK

Global energy sector emission reductions and bioenergy use: overview of the bioenergy demand phase of the EMF 33 model comparison VIDEO

Nico BAUER[1], Steven K. ROSE[2], Shinichiro FUJIMORI[3], Detlef P. VAN VUUREN[4,5], John WEYANT[6], Marshall WISE[7], Yiyun CUI[7], Vassilis DAIOGLOU[4], Matthew GIDDEN[8], Etsushi KATO[9], Alban KITOUS[10], Florian LEBLANC[11], Ron SANDS[12], Fuminori SANO[13], Jessica STREFLER[1], Junichi TSUTSUI[14], Ruben BIBAS[11], Oliver FRICKO[8], Tomoko HASEGAWA[3], David KLEIN[1], Atsushi KUROSAWA[9], Silvana MIMA[15], Matteo MURATORI[16]

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[4] Netherlands Environmental Assessment Agency (PBL), The Netherlands

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[6] Stanford University, CA, USA

[7] Pacific Northwest National Laboratory (PNNL), MD, United States

[8] International Institute for Applied Systems Analysis (IIASA), Austria

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[10] Joint Research Center (JRC), Seville, Spain

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5B Policy

Wednesday, May 23, 16:10-17:30

We must learn from climate change to avoid politicisation and polarisation of negative emissions

R.M. COLVIN[1], Luke KEMP[2], Anita TALBERG[3], Clare DE CASTELLA[1], Christian DOWNIE[4], Sharon FRIEL[4], Will GRANT[5], Mark HOWDEN[1], Frank JOTZO[6], Andrew MACINTOSH[7], Francis MARKHAM[8], Michael PLATOW[9]

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Fast-growing dependence on negative emissions

Jan C. MINX[1,2], Gunnar LUDERER[3], Felix CREUTZIG[1,4], Sabine FUSS[1] and Ottmar EDENHOFER[1,3,4]

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Accounting for Negative CO_2 Emissions

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Understanding the need for policy action on Greenhouse Gas Removal in addressing Climate Change: Initial Case for a Robust Decision Making Approach

Mark WORKMAN[1], Jim MALTBY[2], Geoff DARCH[3]

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5C NETs – Direct Air Capture

Wednesday, May 23, 16:10-17:30

The role of direct air capture and bioenergy in net zero CCU fuel loops

Mijndert VAN DER SPEK, Daniel SUTTER, Cristina ANTONINI, Marco MAZZOTTI

Institute of Process Engineering, ETH Zurich, Switzerland

CO_2 Direct Air Capture for effective Climate Change Mitigation: A new Type of Energy System Sector Coupling

Christian BREYER, Mahdi FASIHI, Arman AGHAHOSSEINI

Lappeenranta University of Technology, Finland

Global Thermostat Low Cost Direct Air Capture Technology

Eric PING, Miles SAKWA-NOVAK, Peter EISENBERGER

Global Thermostat LLC, New York, USA

Assessment of the Performance of a Bench Scale Direct Air Capture Device Operated at Outdoor Environment

Cyril BAJAMUND, Jere ELFVING, Juho KAUPPINEN

VTT Technical Research Centre of Finland, Jyväskylä, Finland

5D BECCS – CLC

Wednesday, May 23, 16:10-17:30

Negative CO_2 – Halfway through the Nordic Energy Research flagship project

Magnus RYDÉN[1], Anders LYNGFELT[1], Øyvind LANGØRGEN[2], Yngve LARRING[3], Anders BRINK[4], Maria ZEVENHOVEN[4], Toni PIKKARAINEN[5], Tomi J LINDROOS[5], Keith WHIRISKEY[6], Per KARMHAGEN[7]

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The comparative chemical-looping combustion performance of synthetic ilmenite perovskite with mineral ilmenite

Nima KHAKPOOR, Davood KARAMI, Nader MAHINPEY

Department of Chemical and Petroleum Engineering, University of Calgary, Canada

Behaviour of Devolatilising Biomass Particles in Fluidised Beds

Z. W. M. BOND, J. S. DENNIS

University of Cambridge, Department of Chemical Engineering and Biotechnology, UK

Use of cheap Mn- and Fe-based oxygen carriers in chemical-looping combustion (CLC) and gasification (CLG) with negative emissions of carbon dioxide

Tobias MATTISSON, Ye LI, Fredrik HILDOR,Carl LINDERHOLM

Chalmers University of Technology, Gothenburg, Sweden

5E Biospheric storage – Soil/Biochar

Wednesday, May 23, 16:10-17:30

Pyrogenic Carbon Capture & Storage (PyCCS)

Hans-Peter SCHMIDT[1], Andrés ANCA-COUCE[2], Nikolas HAGEMANN[1,3], Constanze WERNER[4], Dieter GERTEN[4,5], Wolfgang LUCHT[4,5], Claudia KAMMANN[6]

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Carbon-budget effects of biomass-based negative emission approaches – a high-level comparison

Tobias PRÖLL, Florian ZEROBIN

University of Natural Resources and Life Sciences, Vienna, Austria

System analysis of large-scale biochar production and use for negative CO_2 emissions in Sweden

Elias AZZI[1], Erik KARLTUN[2], Cecilia SUNDBERG[1,3]

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CO_2-Negative Cooking and Cultivation in Smallholder Farms in Africa - the Potential Role of Pyrolysis and Biochar

Cecilia SUNDBERG[1,2], Erik KARLTUN[3], James GITAU[4], Thomas KÄTTERER[5], Geoffrey KIMUTAI[6], Yahia MAHMOUD[7], Mary NJENGA[4,8], Gert NYBERG[9], Kristina ROING DE NOWINA[3,10], Dries ROOBROECK[6], Petra SIEBER[2]

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6A Biospheric storage – Forestry

Thursday, May 24, 11:00-12:20

Contribution of harvested wood products to negative emissions: historical trends in Norway, Sweden and Finland and future projections under the shared socioeconomic pathways

Cristina-Maria IORDAN[1], Xiangping HU[1], Anders ARVESEN[1], Pekka KAUPPI[2], Francesco CHERUBINI[1]

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Combining Forest Plot Data and Remotely-Sensed Biomass Maps for Improved Estimates of the Carbon Sink in Tropical Regrowth Forests

Danaë M.A. ROZENDAAL[1], Lourens POORTER[2], Daniela K. REQUENASUAREZ[1], Angélica M. ALMEYDA ZAMBRANO[3], Frans BONGERS[2], Eben N. BROADBENT[4], Robin L. CHAZDON[5], Veronique DE SY[1], Erika ROMIJN[1], Martin HEROLD[1]

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Do biophysical effects thwart mitigation potential of boreal forest management? VIDEO

Eero NIKINMAA[1†], Tuomo KALLIOKOSKI[1,2], Kari MINKKINEN[1], Jaana BÄCK[1], Michael BOY[2], Yao GAO[3], Nina JANASIK-HONKELA[4], Janne I. HUKKINEN[4], Maarit KALLIO[5], Markku KULMALA[2], Nea KUUSINEN[1], Annikki MÄKELÄ[1], Brent D. MATTHIES[1], Mikko PELTONIEMI[5], Risto SIEVÄNEN[5], Ditte TAIPALE[1, 2,7], Lauri VALSTA[1], Anni VANHATALO[1], Martin WELP[6], Luxi ZHOU[2], Putian ZHOU[2], Frank BERNINGER[1]

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[†] Prof. Eero Nikinmaa was the initiator of this study. He regrettably deceased before we finished the paper.

A Method for Locating Sustainable BECCS Potentials
VIDEO

Florian KRAXNER[1], Piera PATRIZIO[1], Dmitry SCHEPASCHENKO[1], Sylvain LEDUC[1], Sabine FUSS[1,2], Linda SEE[1], Ping YOWARGANA[1], Bintang YUWONO[1], Andrey KRASOVSKII[1], Sennai MESFUN[1], Georg KINDERMANN[1], Kasparas SPOKAS[3], Anders LUNNAN[4], Anatoly SHVIDENKO[1]

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6B NETs – Weathering

Thursday, May 24, 11:00-12:20

Expanding Global, Negative-Emissions Energy: Electrogeochemical Conversion of Renewable Electricity to Negative-Emissions H_2

Greg H. RAU

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Negative CO_2 emissions via enhanced silicate weathering in coastal environments

Filip J.R. MEYSMAN[1,2], Francesc MONTSERRAT[1]

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Physiological responses of Corallina spp. to an increase in total alkalinity-an ex-situ study

Sarah GORE, Phil RENFORTH, Rupert PERKINS, Stephen BARKER

School of Earth and Ocean Sciences, Cardiff University, UK

Multi-gigatonne net CO_2 sequestration in cropland soils amended with basalt?

David BEERLING[1], Euripides KANTZAS[1], Peter WADE[1], Mark LOMAS[1], Joe QUIRK[1], Binoy SARKAR[1], Steve BANWART[2], Shaun QUEGAN[3]

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6C Policy

Thursday, May 24, 11:00-12:20

Defining Limits to Terrestrial Carbon Removal for 1.5 Degrees

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Carbon dioxide removal – the need to marry financial incentives with sustainable development

Matthias HONEGGER[1,2,3]

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Assessing the terrestrial capacity for Negative Emission Technologies at a small developed nation scale

Alwynne H. MCGEEVER[1], Paul PRICE[2], Barry MCMULLIN[2], Michael B. JONES[1]

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6D Modelling

Thursday, May 24, 11:00-12:20

Large uncertainty in carbon uptake potential of land-based climate-change mitigation efforts

Andreas KRAUSE[1], Thomas A. M. PUGH[1,2], Anita D. BAYER[1], Wei LI[3], Felix LEUNG[4], Alberte BONDEAU[5], Jonathan C. DOELMAN[6], Florian HUMPENÖDER[7], Peter ANTHONI[1], Benjamin L. BODIRSKY[7], Philippe CIAIS[3], Christoph MÜLLER[7], Guillermo MURRAY-TORTAROLO[4], Stefan OLIN[8], Alexander POPP[7], Stephen SITCH[4], Elke STEHFEST[6], Almut ARNETH[1]

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Evaluating Different Implementations of the UN Climate Target in Integrated Assessment Models and the Effect on the Use of BECCS

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Relative effectiveness of forests and BECCS in stabilizing climate change at 1.5C

Anna B. HARPER[1], Tom POWELL[2], Peter M. COX[1], Joanna HOUSE[3], Chris HUNTINGFORD[4], Timothy M. LENTON[2], Stephen SITCH[2], Eleanor BURKE[5], Sarah E. CHADBURN[1,6], William J. COLLINS[7], Edward COMYN-PLATT, Vassilis DAIOGLOU[8,9], Jonathan C. DOELMAN[8], Garry HAYMAN[4], Eddy ROBERTSON[5], Detlef VAN VUUREN[8,9], Andy WILTSHIRE[5], Christopher P. WEBBER[7], Ana BASTOS[10], Lena BOYSEN[11], Philippe CIAIS[12], Narayanappa DEVARAJU[12], Atul K. JAIN[13], Andreas KRAUSE[14], Ben POULTER[15], Shijie SHU[13]

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Evaluating the use of biomass energy with carbon capture and storage in low emission scenarios

Naomi E VAUGHAN[1], Clair GOUGH[2], Sarah MANDER[2], Emma W LITTLETON[3], Andrew WELFLE[2], David E H J GERNAAT[4,5] Detlef P VAN VUUREN[4,5]

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6E BECCS – Oxy- and Post-combustion

Thursday, May 24, 11:00-12:20

ASPEN simulation of a 100 MW solar powered thermo-chemical air separation system combined with an oxy-fuel power plant for BECCS

Clemens F. PATZSCHKE, Husain BAHZAD, Matthew E. BOOT-HANDFORD, Paul S. FENNELL

Department of Chemical Engineering, Imperial College London, UK

The effect of potassium salts and ash from biomass combustion on the degradation of monoethanolamine for carbon capture

Diarmaid CLERY[1,2], Jenny JONES[1], Douglas BARNES[3], Muhammad AKRAM[4], Christopher RAYNER[2,3]

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The effect of flue gas recirculation on the formation of alkali- chlorides and sulfates in Oxy-BECCS power plants

Thomas ALLGURÉN, Klas ANDERSSON, Fredrik NORMANN

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Bio-Energy CCS (BECCS) via Oxy-FBC

Margarita DE LAS OBRAS LOSCERTALES, Robert T. SYMONDS, Robin W. HUGHES, Ryan BURCHAT, Kelly ATKINSON

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7A BECCS – Power plants

Thursday, May 24, 14:00-15:00

Sustainability Constrains on Biomass Resources Significantly Limit BECCS Negative Emissions Potential VIDEO

Kasparas SPOKAS[1,2], Piera PATRIZIO[2], Sylvain LEDUC[2], Sennai MESFUN[2], Florian, KRAXNER[2]

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Natural gas, biomass and carbon capture and storage for low carbon power plants

Constanza CUMICHEO[1], Niall MAC DOWELL[1,2], Nilay SHAH[1]

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Opportunities for efficiency enhancement of bioenergy with carbon capture and storage (BECCS) VIDEO

Mai BUI[1, 2], Mathilde FAJARDY[1,2], Niall MAC DOWELL[1,2]

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7B Biospheric storage – Forestry

Thursday, May 24, 14:00-15:20

Blue carbon strategies for climate change mitigation are most effective at the national scale

Pierre TAILLARDAT[1,2], Daniel A. FRIESS[1], Massimo LUPASCU[1]

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An integrated assessment of the potential of negative emissions of boreal forests - economic costs and environmental benefits

Anna REPO[1,2], Kyle EYVINDSON[1], Juha VUORIKKO[1], Mikko MÖNKKÖNEN[1]

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Contribution of the land sector to a 1.5°C World

Stephanie ROE[1,2], Deborah LAWRENCE[1], Charlotte STRECK[2], Michael OBERSTEINER[3], Stefan FRANK[3], Petr HAVLÍK[3], María José Sanz SÁNCHEZ[4], Bronson GRISCOM[5], Jo HOUSE[6], Nancy HARRIS[7], Mykola GUSTI[3], Jonathan SANDERMAN[8], Pete SMITH[9]

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Bioenergy from Degraded Land in Africa: Sustainable and Technical Potential under Bonn Challenge Pledges

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7C NETs – Direct Air Capture

Thursday, May 24, 14:00-15:20

Comparative assessment and optimization of direct air capture via absorption and adsorption processes

Francesco SABATINO[1], Matteo GAZZANI[2], Alexa GRIMM[2], Fausto GALLUCCI[1], Martin VAN SINT ANNALAND[1], Gert Jan KRAMER[2]

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Prospects for Direct Air Capture using Amine Adsorbents

Anshuman SINHA, Lalit DARUNTE, David S. SHOLL, Matthew J. REALFF, Christopher W. JONES

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CO_2 Capture from Air via Lime-Based Sorbents

Mohammad SAMARI[1], Firas RIDHA[2], Vasilije MANOVIC[3], Arturo MACCHI[1], E.J. ANTHONY[3]

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Achieving low-cost CO_2 removal and its policy implications

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7D Policy

Thursday, May 24, 14:00-14:40

Regenerate Earth, the practical drawdown of 20 billion tonnes of carbon back into soils annually, to rehydrate bio-systems and safely cool climates

Walter JEHNE

Regenerate Earth, Yarralumla, Australia

Ocean Surface CArbon Relocation (OSCAR™) Technology

Philip KITHIL

Atmocean, Inc., Santa Fe, USA

7E Modelling

Thursday, May 24, 14:00-15:20

Exploring the Trade-Offs in Negative Emissions via Bioenergy

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Techno-Economic and Reactivity Assessments of a Methane- Fuelled Chemical Looping Combustion Process Using Supported Bimetallic Oxygen Carrier (Cu-Ni/Al2O3): A Case Study to Produce 50 MW Power

Mansour Mohammedramadan TIJANI, Nader MAHINPEY

Department of Chemical and Petroleum Engineering, Schulich School of Engineering, University of Calgary, Canada

CO_2-Payback Year in CO_2-Roadmaps with Afforestation and BECCS

Per E. R. BJERAGER

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Assessment of CO_2 removal with the Australian Earth System Model, ACCESS-ESM

Tilo ZIEHN[1], Andrew LENTON[2], Rachel LAW[1]

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8A Modelling

Thursday, May 24, 16:10-17:30

Assessing Carbon Dioxide Removal Through Global and Regional Ocean Alkalinization under High and Low Emission Pathways. VIDEO

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[5] Tyndall Centre for Climate Change Research, School of Environmental Sciences, University of East Anglia, Norwich, UK.

Exploring the role and value of negative emissions technologies to the UK electricity system VIDEO

Habiba DAGGASH[1,2,3], Clara HEUBERGER[2,3], Niall MAC DOWELL[2,3]

[1] Grantham Institute of Climate Change and the Environment, Imperial College London, UK

[2] Centre for Environmental Policy, Imperial College London, UK

[3] Centre for Process Systems Engineering, Imperial College London, UK

Designing optimal BECCS supply chains: a water-energy-carbon-land nexus' problem VIDEO

Mathilde FAJARDY[1,2], Niall MAC DOWELL[1,2]

[1] Centre for Environmental Policy, Imperial College London, UK

[2] Centre for Process Systems Engineering, Imperial College London, UK

Efficient technologies and sustainable feedstock for BECCS deployment in mitigation pathways VIDEO

Etsushi KATO

Institute of Applied Energy, Tokyo, Japan

8B BECCS – CLC

Thursday, May 24, 16:10-17:30

The multipurpose dual fluidized-bed for biomass – providing ultimate flexibility to achieve the desired mix of heat/power, fuels, negative emissions, power grid stabilization, low NOx and benefits with respect to fouling/corrosion

Anders LYNGFELT, Tobias MATTISSON, Magnus RYDÉN, Carl LINDERHOLM

Chalmers University of Technology, Gothenburg, Sweden

Assessment of the Potential for Negative CO_2 Emissions by the Utilization of Alternative Fuels in 2nd Generation CCS Processes

Martin HAAF, Peter OHLEMÜLLER, Jochen STRÖHLE, Bernd EPPLE

Institute for Energy Systems and Technology, Technische Universität Darmstadt, Germany

Bio-CLC, a Breakthrough in CO_2 Capture Cost?

Anders LYNGFELT[1], Matti NIEMINEN[2], Carl LINDERHOLM[1]

[1] Chalmers University of Technology, Gothenburg, Sweden

[2] VTT Technical Research Center of Finland Ltd, Esbo, Finland

Techno-Economic Evaluation of BECCS via Chemical Looping Combustion of Woody Biomass in Japan - Costs, Challenges and Opportunities

Martin KELLER[1], Kenji KAIBE[1], Hiroyuki HATANO[2], Junichiro OTOMO[1]

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8C Biospheric storage – Agriculture

Thursday, May 24, 16:10-17:10

Management strategies for soil carbon sequestration in cropland evaluated in long-term field experiments

Martin A. BOLINDER, Thomas KÄTTERER

Swedish University of Agricultural Sciences, Department of Ecology, Uppsala, Sweden

Modelling the Synergistic Relationship between Soil Organic Carbon and Crop Yields in a Climate Impact Perspective

Kajsa HENRYSON[1], Cecilia SUNDBERG[1,2], Thomas KÄTTERER[3], Per-Anders HANSSON[1]

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Carbon sink potential in Swiss agricultural soils

Sonja G. KEEL, Chloé WÜST-GALLEY, Jens LEIFELD

Agroscope, Agroecology and Environment, Climate and Agriculture, Zurich, Switzerland

8D Other NETs

Thursday, May 24, 16:10-16:50

CO_2 Submarine Storage in Glass Containers: Life Cycle Assessment and Cost Analysis of Four Case Studies in the Cement Sector

Beatriz BARRETO, Stefano CASERINI, Giovanni DOLCI, Mario GROSSO

Politecnico di Milano, Dipartimento di Ingegneria Civile e Ambientale, Italy

Biomass - Petroleum Switching for Negative Emissions

Henrik THUNMAN, Filip JOHNSSON, Martin SEEMANN

Chalmers University of Technology, Gothenburg, Sweden

8E POLICY/BECCS

Thursday, May 24, 16:10-17:30

Who is driving BECCS research? A co-authorship network analysis

Alena HAHN[1], Nora SZARKA[1], Daniela THRÄN[1,2]

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Unlocking negative emissions with BECCS: system-level challenges

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Public perceptions of bioenergy with carbon capture and storage under different policy instrument framings

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