



#### **BECCS in Practice Lessons and Pilot Demonstration**

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Session Chair: Henrik Karlsson, President & CEO Biorecro, Sweden

#### BECCS in Practice Lessons and Pilot Demonstration

- Session Chair: Henrik Karlsson, President & CEO, Biorecro, Sweden
- Overview of global BECCS projects Jessica Morton, Capacity Development Advisor, Global CCS Institute, Australia
- Lessons Learned A perspective from CCS project developers a focus on storage – *Chris Greig*, Director of Energy Initiative , University of Queensland, Australia
- Biomass-Energy R&D and CCS Status in Japan Atsushi Kurosawa, Director, Global Environment Program, Research and Development Division, The Institute of Applied Energy (IAE), Japan



#### **Current BECCS Deployment**

- 550 000 tonnes CO<sub>2</sub>/year BECCS currently operating
- Very thin project pipeline
- No incentives, or negative incentives
- Real world problems = awareness, knowledge, permitting, lead times, etc



#### Scale-up Challenge

#### CO<sub>2</sub> per year

Source: "Technology Roadmap for Carbon Capture and Storage" International Energy Agency, 2009



BECCS, in Million tonnes of

#### **Example: BECCS in Kansas**

- Kansas, US, present several promising early opportunites
- Suitable geology, many ethanol plants, mature industry capacity
- Uncertain, volatile incentives
- Regulatory obstacles



Photo: Jennifer Raney, University of Kansas (Wellington, Kansas, US, 4<sup>th</sup> June 2013)



#### Primum Non Noscere

- Time to recieve permit in Kansas, US:
  - Oil extraction permit: 1 month
  - CO<sub>2</sub> storage permit: **2 years+**
- To recieve US carbon sequestration tax credit (\$20/tonne), the project must store more than 500 000 tonnes/year, just above typical amount of US BECCS opportunities
- US CCS efforts managed by the Office of Fossil Fuels, who have little interest in biomass and BECCS projects



## Appendix



## **Biorecro AB**



#### Biorecro

- Biorecro removes carbon dioxide from the atmosphere
- Utilising the BECCS technology (Bio-Energy with Carbon Capture and Storage)
- Focus on business models and BECCS deployment
- Bring BECCS to the market through carbon credits and offsets
- Biorecro has 40+ paying customers
- Positive cash flow
- Next step is to expand the business



#### **Biorecro AB**

#### **Board of Directors**

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#### **Network and Partners**





























EARTH







#### Awards and Media Attention



- Biorecro has advised the UN, IEA, Swedish Ministry of Finance, Australian government CCS Institute, and others
- Biorecro has held lectures at leading universities: Stanford, Oxford, Orléans, Edinburgh, KTH, SSE, etc
- Awarded "Climate Solver" by World Wide Fund for Nature WWF



#### Finalist in the Virgin Earth Challenge

- Biorecro finalist
- \$25 million prize
- 10 000+ applications,
   2600 considered,
   11 finalists
- The jury includes Al Gore and Richard Branson



#### E A R T H CHALLENGE



## What is BECCS?



#### **BECCS and Negative Emissions**

- BECCS = Bio-Energy with Carbon Capture and Storage
- The "BECCS" term was established in the IPCC 4<sup>th</sup> Assessment Report
- BECCS produces negative emissions, the opposite of fossil fuel emissions



#### Carbon cycle





#### **Renewable Energy**





## Bio Energy with Carbon Capture and Storage (BECCS)





#### Systems Comparison





# Why BECCS and Negative CO<sub>2</sub> Emissions?



#### **BECCS** and Negative Emissions

- BECCS can mitigate emissions from any CO<sub>2</sub> emission source
- BECCS can mitigate emissions which have already occurred
- Since BECCS can mitigate historic emissions, it can act as a climate mitigation risk management tool
- BECCS can be added as a supplement to other measures, on top of bio-energy use



#### Carbon in the Atmosphere





#### 392 ppm Already Today





Gton C

#### Returning Below 350 ppm





Gton C

#### **BECCS Needed Quickly**

Fatih Birol, the IEA's chief economist (2012): "...the door for a 2 degree Celsius target about to be closed and closed forever"

- IEA (2009): 2.4 Billion tonnes of BECCS needed in 2050 to meet 2 degree target.
- OECD (2011): "Achieving lower concentration targets (450 ppm) depends significantly on the use of BECCS."
- AVOID (2010): "BECCS has the most immediate 'negative emissions' potential – at least 10% of current UK CO2 emissions by 2030"
- ■IPCC 5<sup>th</sup> Assessment Report



## Current BECCS Deployment



#### **BECCS Demonstration in Illinois**

- Start up 4<sup>th</sup> November 2011, 300 000 tCO<sub>2</sub>/y
- Full production late 2013 at 1 000 000 tCO<sub>2</sub>/y
- In Partnership with the US Department of Energy, the University of Illinois and 46 other partners



Source: University of Illinois

Injection ends in 2016 (planned)



#### Planned BECCS Pilot in North Dakota

 Biorecro in cooperation with PCOR and EERC (Energy and Environmental Research Center) at the University of North Dakota, 1.500 – 5.000 tons/year





Source: EERC/University of North Dakota



#### Pilot in Kansas under Construction

- Pilot in Wellington, Kansas, US
- US DoE funded, led by Kansas Geological Survey at the University of Kansas
- Start up in 2014
- 40 000 tonnes of CO2 in total





#### **Existing and Proposed Projects**





### **Project List**

- 1. Russel, Kansas, United States COMPLETED
- 2. Liberal, Kansas to Booker area, Texas, United States OPERATING
- 3. Garden City to Stuart Field, Kansas, United States OPERATING
- 4. Decatur, Illinois, United States OPERATING
- 5. Wellington, Kansas, United States CONSTRUCTION
- 6. North Dakota, United States EVALUATED
- 7. Rotterdam, The Netherlands EVALUATED
- 8. Värö, Sweden EVALUATED
- 9. São Paulo, Brazil EVALUATED
- 10. Artenay, France EVALUATED
- 11. Domsjö, Sweden IDENTIFIED
- 12. Norrköping, Sweden IDENTIFIED
- 13. Skåne, Sweden IDENTIFIED
- 14. Greenville, Ohio, United States CANCELLED
- 15. Wallula, Washington, United States CANCELLED
- 16. Rufiji cluster, Tanzania CANCELLED



## BECCS Deployment – Problems



#### Problem 1: Carbon price



Sources: Point Carbon and The Environmentalist



### Problem 2: Institutional Challenges

- Very few technology champions, in spite of climate scientist support
- Weak status of BECCS in international negotiations in relation to its mitigation potential
- Excluded from most demonstration project funding
- No dedicated financial incentives for BECCS found in any country or region (Vergragt et al 2011)
- BECCS stumbling on
  - Bad biomass accounting
  - Complexity biomass ILUC, complex emission life cycle profile
  - Blurred view on baseline because of negative emission potential, yielding tuffer demands on BECCS than other options



#### Problem 4: Sustainability of Biomass

- The sustainability of underlying biomass sourcing
- If biomass is produced unsustainably, negative effects include carbon emissions, water depletion and biodiversity loss
- There is already today widespread sustainable biomass production
- Excellent opportunities to produce biomass sustainably in the future at a considerable scale (e.g. Kraxner 2003)



## BECCS Deployment – Opportunities



## Existing facilities, many applications

- Pulp and paper industry
- Power plants
- Combined heat and power plants
- Ethanol production
- Biogas upgrading
- Gasification of biomass
- Future biomass conversion technologies



### Early Opportunities

- Ethanol industry
  - More than 50 Mtonnes of biogenic CO<sub>2</sub> emitted in 2010
  - Technically favourable purity in CO<sub>2</sub> streams, typically
  - 50 000 300 000 tonnes emitted per source and year
  - Already 3 operational projects, 2 more in construction/ planning stage
- Chemical pulp production industry
  - More than 300 Mtonnes of biogenic CO<sub>2</sub> emitted in 2010
  - Medium sized, 500 000 2 000 000 tonnes emitted per source and year



## Case: BECCS in Sweden



### Sources of biotic CO<sub>2</sub>

61 major emitters of biotic CO2 in Sweden
They emit 31 Mtons per

year







#### Sources & Sinks

Match Swedish CO2
 sources with Norwegian
 storage capacity





#### Potential for BECCS in Sweden 2030: 30,0 Mton



Källor: Zantioti et al, "Opportunities and Societal Costs of Introducing the BECCS Technology in Sweden", CEMS at Stockholm School of Economics, 2009; "Möjligheter och kostnader för att reducera växthusgasutsläpp i Sverige", McKinsey & Company, 2008; m.fl.



#### Total emissions in Sweden





## Thank you!

