The Current Status of BECCS

GCEP Workshop on Energy Supply with Negative Carbon Emissions

Stanford University, June 15th 2012
What is BECCS?
BECCS and Negative Emissions

- BECCS = Bio-Energy with Carbon Capture and Storage
- The “BECCS” term was established in the IPCC 4th 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

+ CO₂

0 CO₂

0 CO₂

- CO₂

Biorecro
Why BECCS and Negative CO$_2$ Emissions?
BECCS and Negative Emissions

- BECCS can mitigate emissions from any CO$_2$ 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

![Graph showing carbon dioxide levels over time with three scenarios: Business as usual, "Kyoto", Fossilfritt. The graph indicates a significant increase in carbon dioxide in the atmosphere by the year 2070. Source: Read and Lermit, "Energy", 2005]
392 ppm Already Today

Source: Read and Lermit, "Energy", 2005
Returning Below 350 ppm

Source: Read and Lermit, "Energy", 2005
BECCS Needed Quickly

- 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.”

- Fatih Birol, the IEA’s chief economist (2012): “…the door for a 2 degree Celsius target about to be closed and closed forever”
Current BECCS Deployment
BECCS Demonstration in Illinois

- Start up 4th November 2011, 300 000 tCO$_2$/y
- Full production in 2013 at 1 000 000 tCO$_2$/y
- In Partnership with the US Department of Energy, the University of Illinois and 46 other partners
- Injection ends in 2016 (planned)

Source: University of Illinois
Planned BECCS Pilot in North Dakota

- Biorecroc 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 2013
- 40 000 tonnes of CO2 in total
Existing and Proposed Projects

Source: Biorecroc, Global CCS Institute, 2011

<table>
<thead>
<tr>
<th>CAPTURE FACILITY</th>
<th>STORAGE TYPE</th>
</tr>
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<tbody>
<tr>
<td>Pulp and Paper</td>
<td>△ Geological</td>
</tr>
<tr>
<td>Ethanol</td>
<td>○ Beneficial reuse</td>
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<tr>
<td>Gasification and others</td>
<td>□ Geological and/or beneficial reuse</td>
</tr>
</tbody>
</table>
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
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 3: Scale-up

BECCS, in Million tonnes of CO\textsubscript{2} per year

Source: “Technology Roadmap for Carbon Capture and Storage”
International Energy Agency, 2009
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$_2$ emitted in 2010
  - Technically favourable purity in CO$_2$ 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$_2$ emitted in 2010
  - Medium sized, 500 000 – 2 000 000 tonnes emitted per source and year
Case:
BECCS in Sweden
Sources of biotic CO₂

- 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

- Energy: 65,5
- Industry: 28,2
- Homes: 1,8
- Transport: 20,5
- Waste: 9,5
- Agriculture: 0,4

BECCS: 30,0

- 2030 reference
- Energy
- Industry CCS
- Industry other
- BECCS
- Homes
- Transport
- Waste
- Agriculture
- 2030 after measures

Millions of tonnes CO$_2$e
Reference scenario and mitigation under 110 €/tonne in 2030

The Swedish government's 2020 ambitions and 2050 vision

Measures including BECCS

Total emissions in Sweden
Thank you!
Appendix