



BECCS – Economic and environmental  
challenges (and opportunities!)

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1. Biorecro in Brief
2. Environmental challenges and opportunities
3. Economic challenges and opportunities
4. Swedish economic case study
5. Demonstration

# 1. Biorecro in Brief

# Carbon Cleanup with BECCS

- Biorecro is a Swedish company founded in 2007
- Biorecro develops a voluntary market for BECCS
- Combining early production and market opportunities
- We offer to clean up the CO<sub>2</sub> emissions from companies and organisations with negative emissions through BECCS
- A possibility to go further and beyond carbon offsetting
- BECCS here and now!

# Partners and Network



# Biorecro's Vision

Biorecro's vision is to use BECCS to reach pre-industrial levels of CO<sub>2</sub> in the atmosphere, below 350 ppm



## 2. Environmental challenges and opportunities

# Environmental challenges

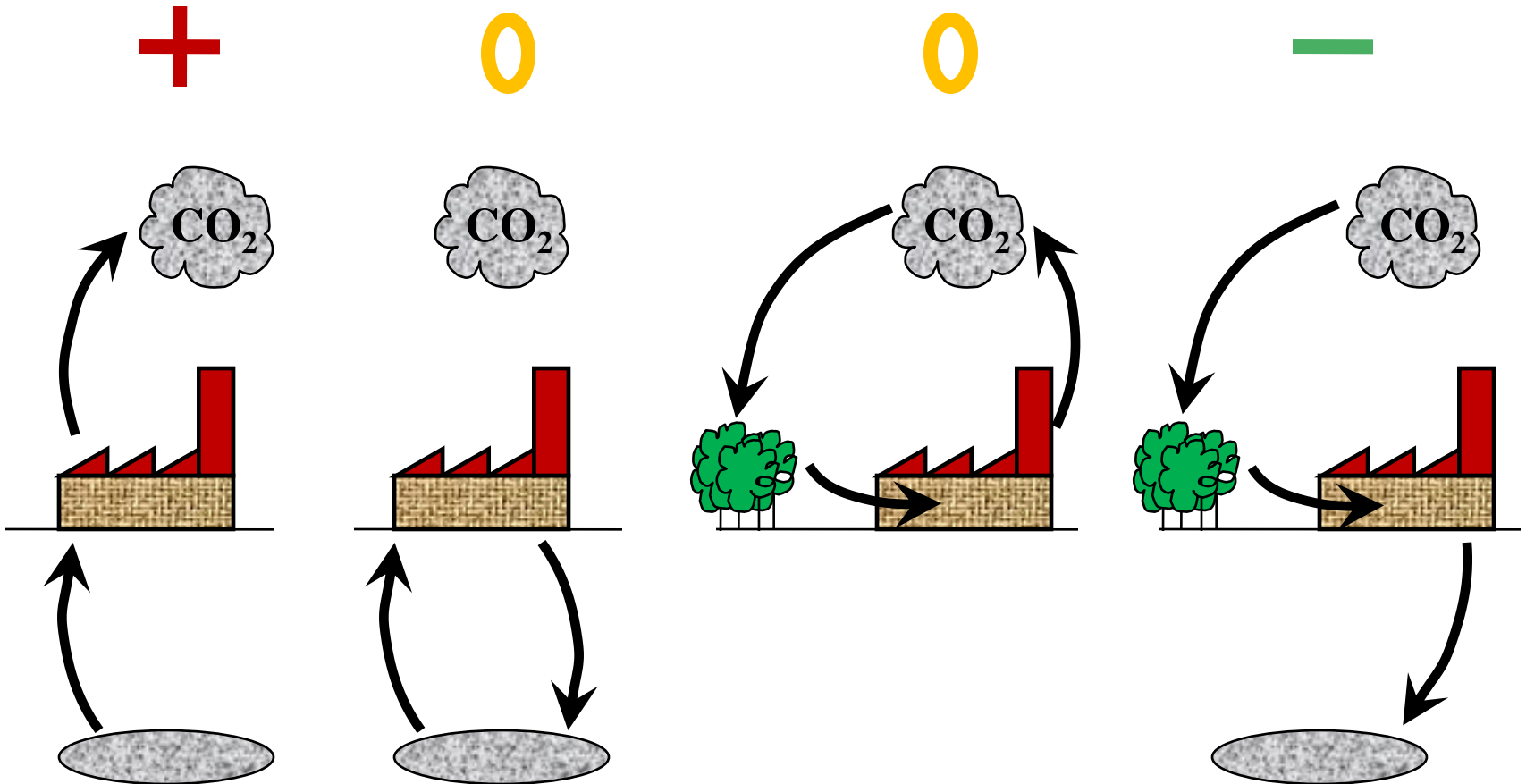
## BECCS

- Energy requirement
- Storage security

## BECCS

- Biomass sourcing
- Transport and processing

# Systems Comparison



# Sustainability Analysis by NGO

## The Natural Step Intl.

- Baseline analysis of BECCS using Sustainable Framework criteria.
- The analysis found a plentiful of considerations:

- Is the potential source of CO<sub>2</sub> from biomass on a level that could have a significant importance in a global context? (SP<sub>3</sub>)

- Are there more effective ways of managing the released CO<sub>2</sub> from biomass? (SP<sub>2</sub>)

- Are there any scarce elements, i.e. heavy metals in the separation process, which need to be safeguarded? (SP<sub>1</sub>)

- If so, could potential scarce elements be remitted back underground with the CO<sub>2</sub> in a safe way? (SP<sub>2</sub>)

- Are there any gas emissions or compounds (e.g. amines) that could increase in concentration in the biosphere during the separation process? (SP<sub>2</sub>)

- How is the sustainability performance of the supplier, from which the CO<sub>2</sub> is emitted, being evaluated? (SP<sub>1-4</sub>)

- Has the harvesting of biomass from forests been done in a way that doesn't degrade its biodiversity and capacity for reforestation? (SP<sub>3</sub>)

- Has the harvesting of biomass from agricultural land been done in a way that doesn't degrade its biodiversity, contents of nutrients, and carbon contents of humus? (SP<sub>3</sub>)

- Has the biomass been genetically modified? (SP<sub>3</sub>)

- Has the harvesting of biomass from the sea been done in a way that doesn't degrade biotopes and/or reduce its biodiversity? (SP<sub>3</sub>)

- Are there any health risks related to the flue gases in the capturing and separation processes? (SP<sub>4</sub>)

- Are there any other resources such as water that are affected by capture process requirements? (SP<sub>3</sub>)

- What energy use and efficiency are there for alternative methods of capturing? (SP<sub>1-SP<sub>4</sub></sub>)

- Has the compression technology a capacity potential at a level that could have a significant importance in a global context? (SP<sub>1</sub>)

- Are there any health risks related to the compression of CO<sub>2</sub>? (SP<sub>4</sub>)

- Which sustainability impacts could be identified in the construction, transportation and assembly of the equipment used for compression and how could they be addressed? (SP<sub>1-4</sub>)

- How is the electricity for the compression being produced? (SP<sub>1-4</sub>)

- What is the efficiency rate after sourcing, capturing and compression? (SP<sub>1</sub>)

- Has the transport capacity potential at a level that could have a significant importance in a global context? (SP<sub>1</sub>)

- What is the environmental impact of the construction, transportation and assembly of the equipment used for transportation? (SP<sub>1-4</sub>)

- How is the fuel for the transportation being produced? (SP<sub>1-4</sub>)

- Are there any health risks related to the transports of CO<sub>2</sub>? (SP<sub>4</sub>)

- Has the storage capacity potential at a level that could have a significant importance in a global context? (SP<sub>1</sub>)

- What are the risks for leakage to the storage site ground water and soils as well as back to the atmosphere and how could it be safeguarded? (SP<sub>1, 3, 4</sub>)

- What are the risks for physical deformation of the cap rock due to changes in pressure when pumping CO<sub>2</sub> into the aquifers? (SP<sub>3</sub>)

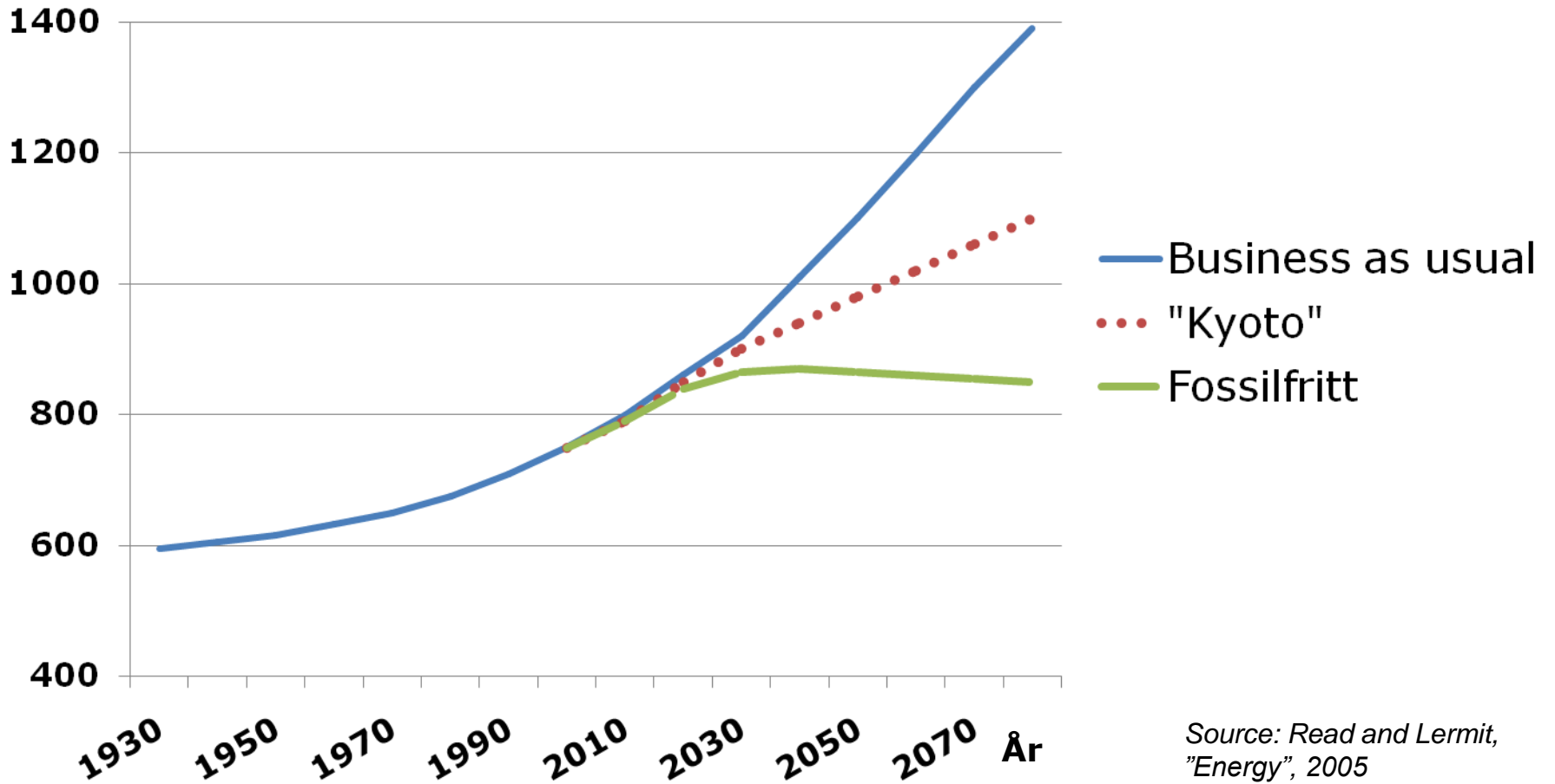
- Are there any health risks related to the storage of CO<sub>2</sub>? (SP<sub>4</sub>)

# Environmental Opportunities

- Negative emissions needed to meet stringent targets
- Negative emission gives a strategic possibility to handle late policymaking and uncertainty in climate modelling
- Negative emission methods
  - Direct air capture is very expensive
  - Forestry/land use and biochar has less permanence and will not suffice
  - BECCS is the only available method for permanent negative CO<sub>2</sub> emissions

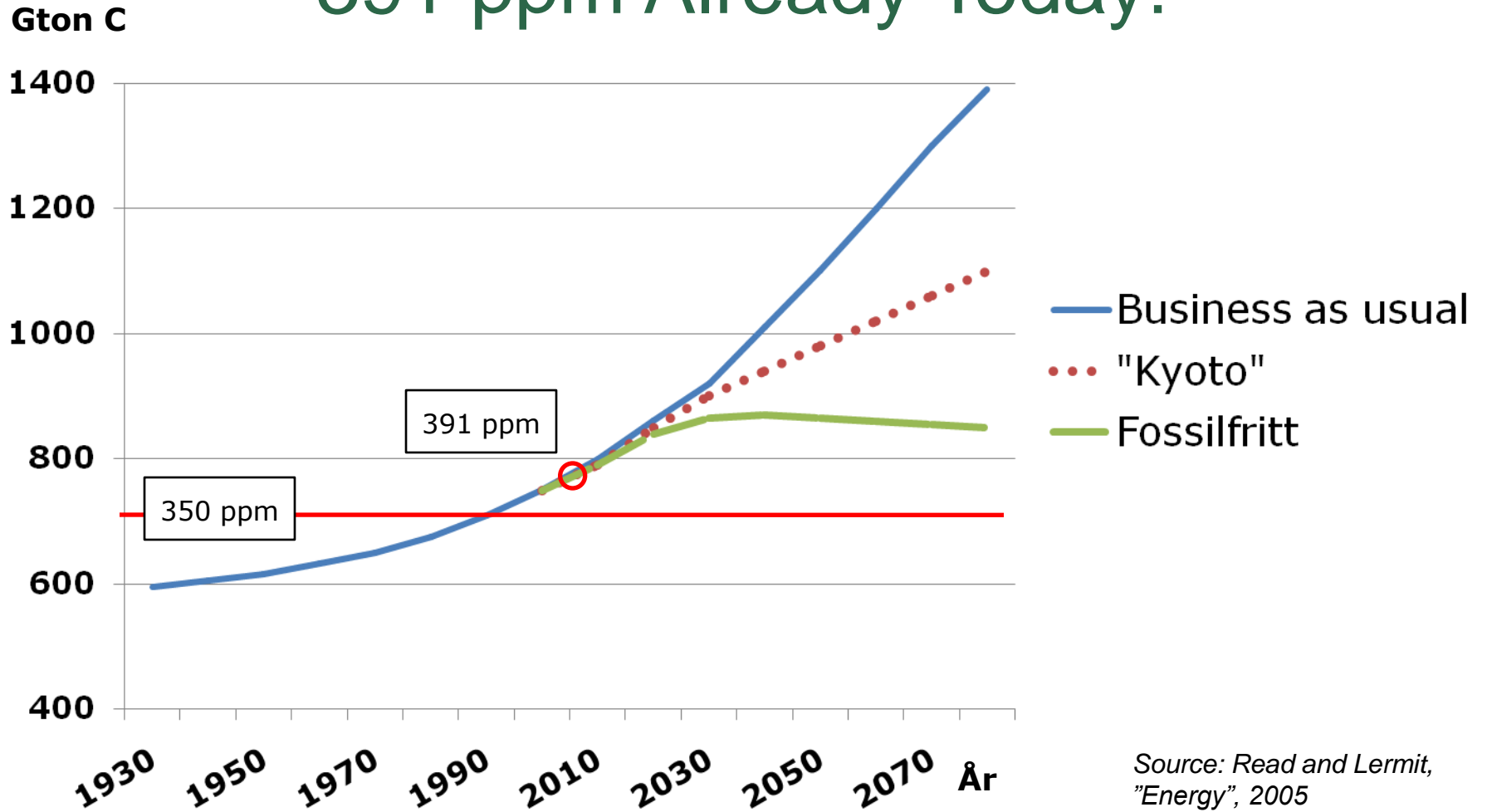
# Carbon in the Atmosphere

Gton C



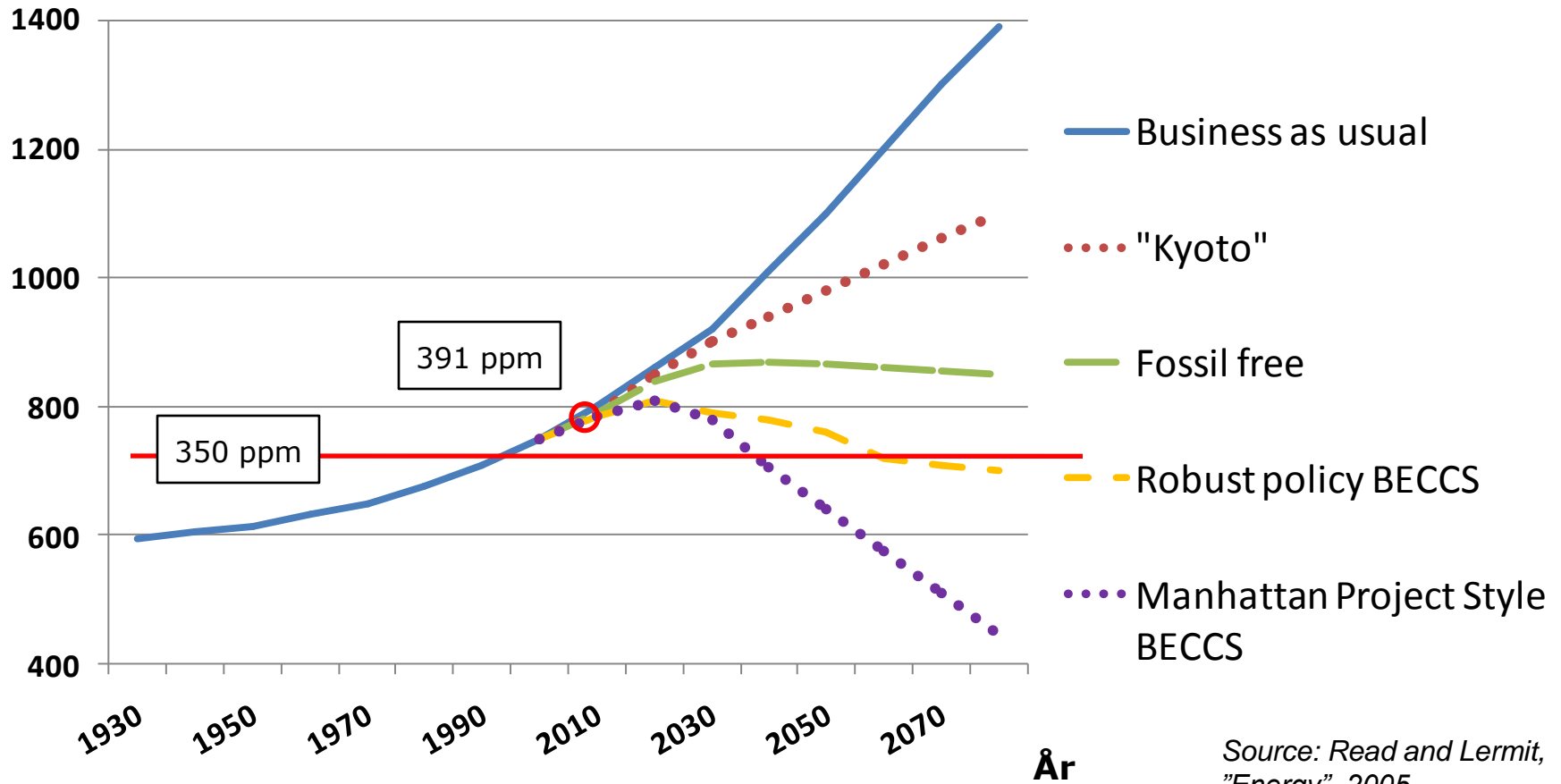
Source: Read and Lermitt, "Energy", 2005

# 391 ppm Already Today!



# Returning Below 350 ppm

Gton C



# 3. Economic challenges and opportunities

# Economic challenges

Short term challenges:

- Awareness & diffusion of knowledge
- Few champions within the biomass and CCS communities
- BECCS RD&D funding

Long term challenges:

- Accounting, market mechanisms, costs
- Smaller scale of BECCS than FECCS -> higher per ton costs
- Multiple technology pathways – everything from CHP to fermentation (>4 types of emissions in a pulp plant)

# Economic opportunities

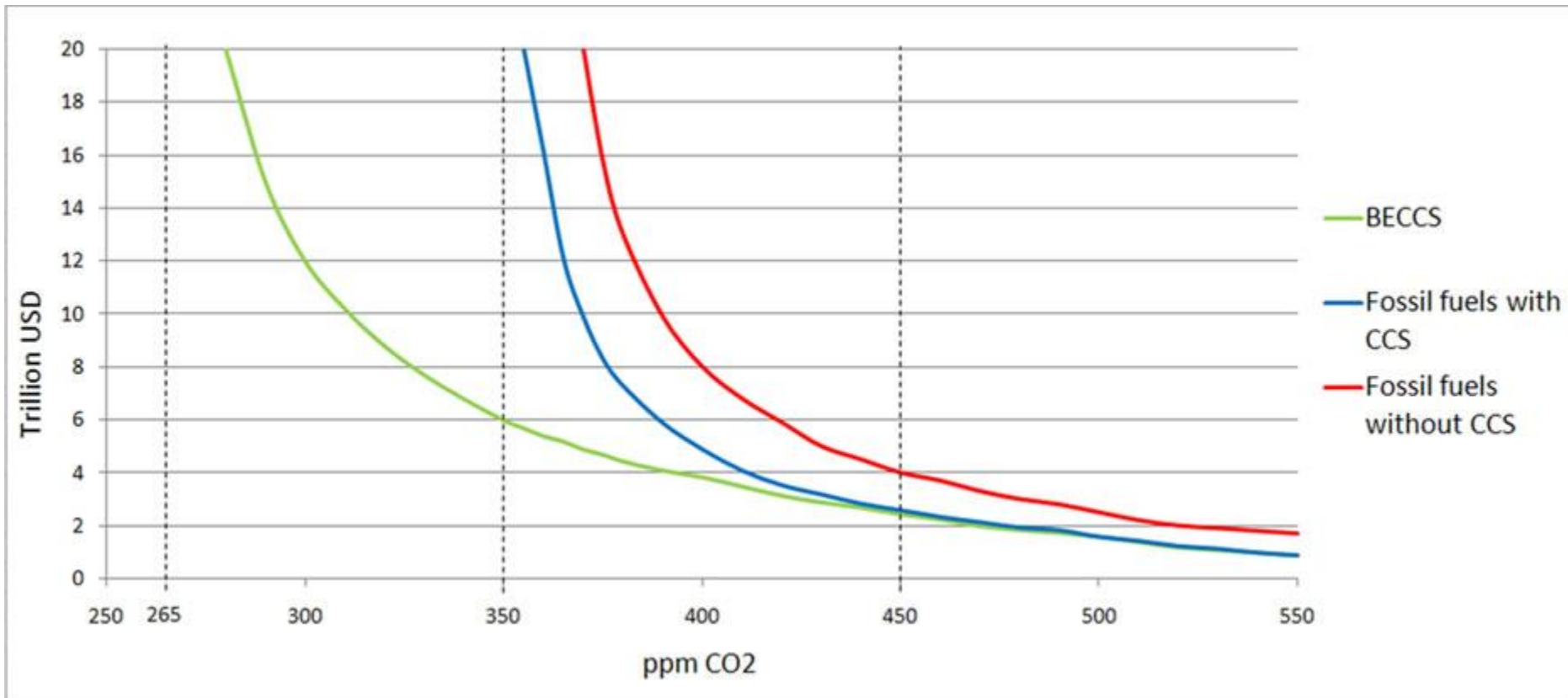
Short term opportunities:

- Early adopters in a diverse market
- Low cost early opportunities, such as ethanol fermentation

Long term opportunities:

- Negative emissions on the Gigaton scale
- Lower overall mitigation costs with BECCS in portfolio, especially for stringent targets and late action

# BECCS: Deeper & Cheaper

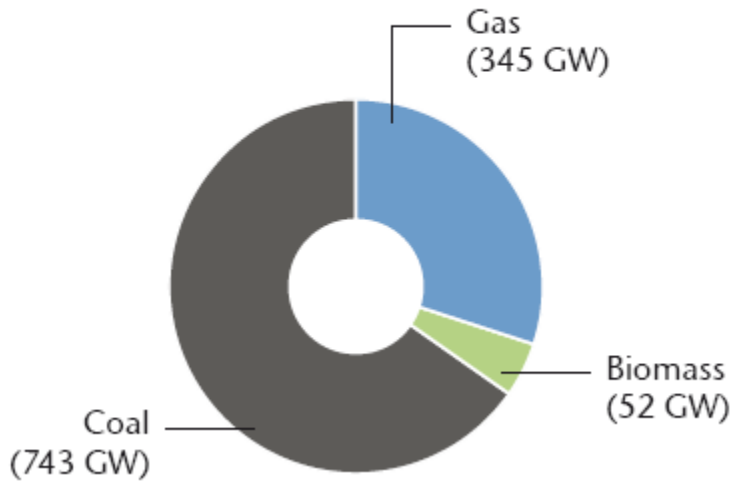


Azar, C., Lindgren, K., Larson, E.D. and Möllersten, K.: (2005) "Carbon capture and storage from fossil fuels and biomass – Costs and potential role in stabilising the atmosphere", *Climatic Change*, 74, 47-79

# IEA: 2,4 Gtons of BECCS in 2050

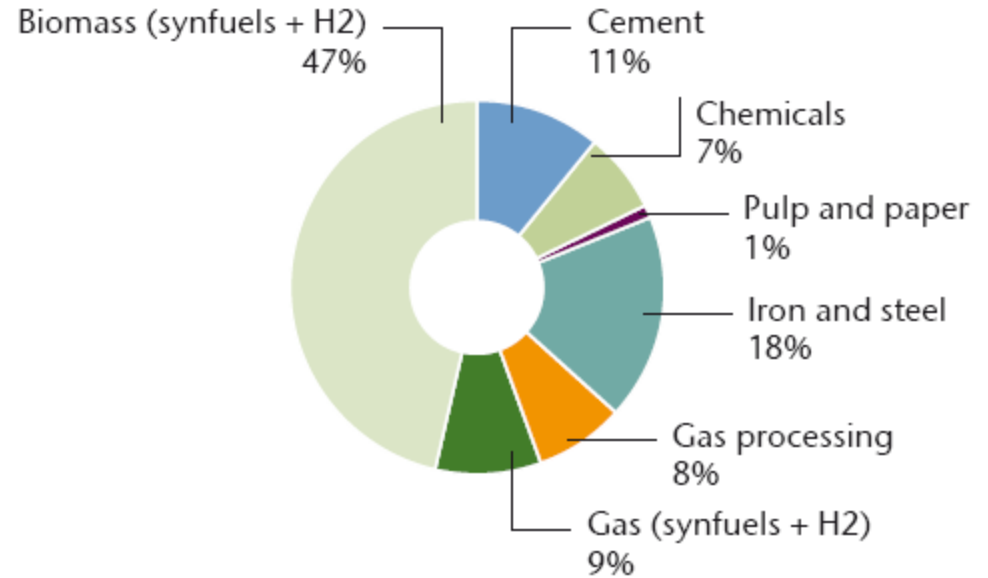
## Power

CCS capacity 2050 (1 140 GW installed)



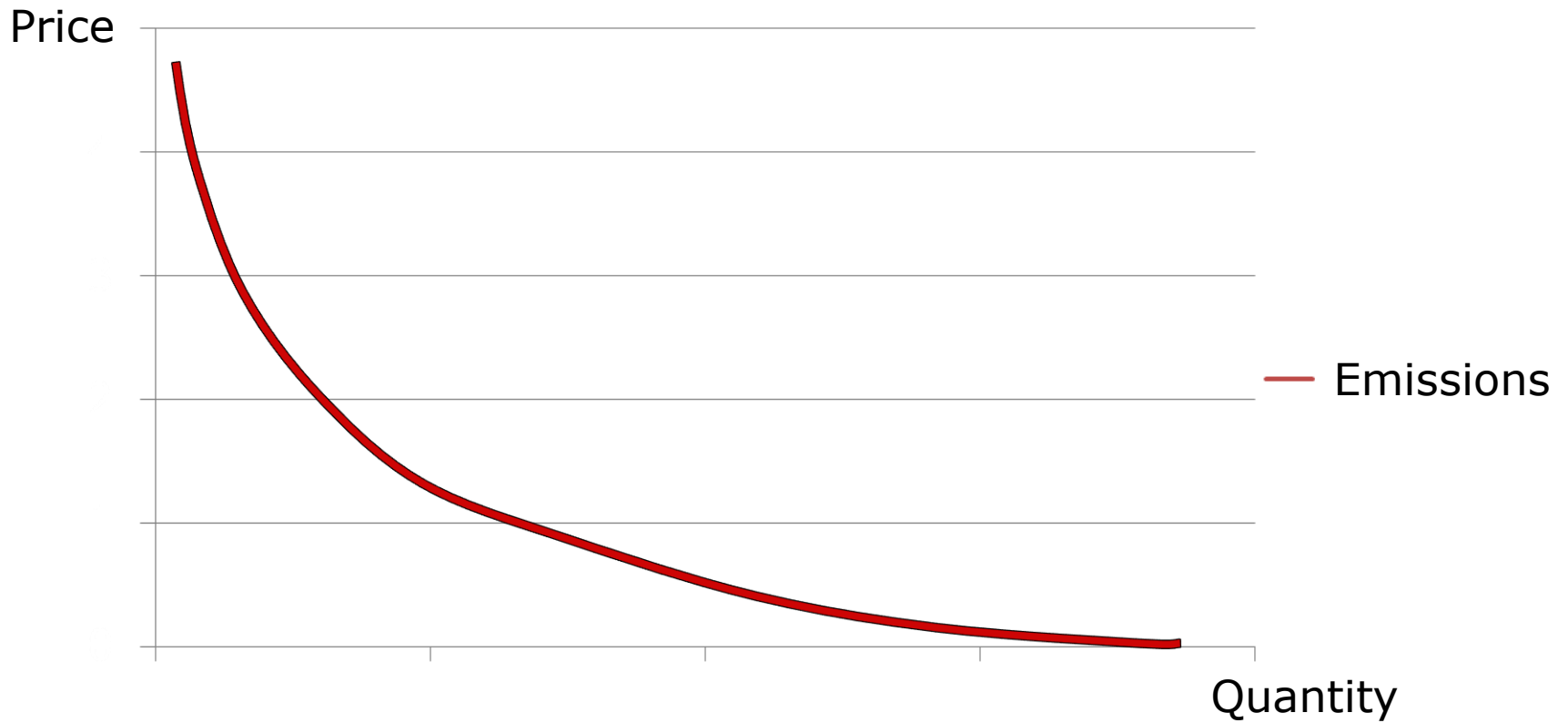
## Industry & upstream

Captured in 2050 (4 570 Mt CO<sub>2</sub>/yr)

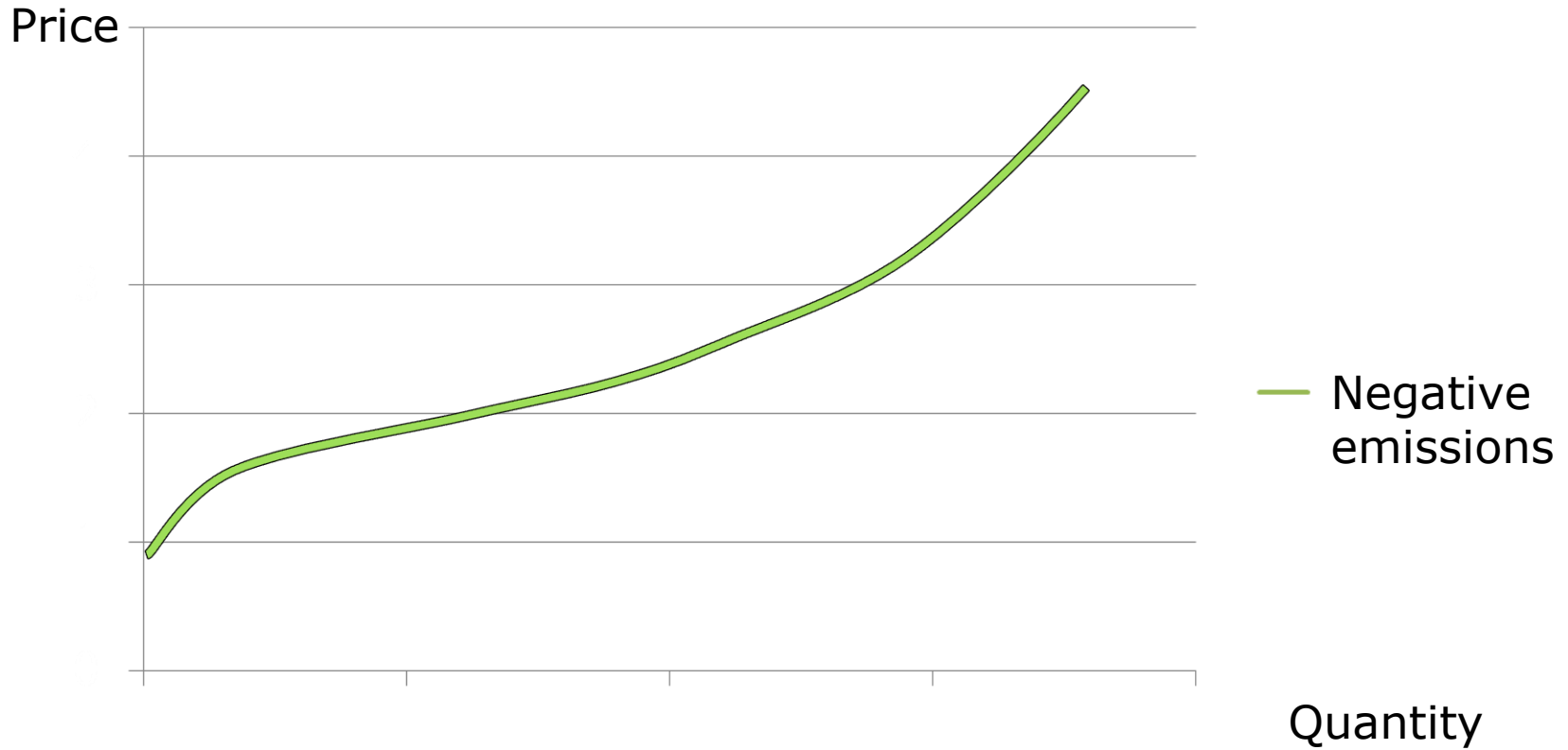


IEA CCS roadmap (2009)

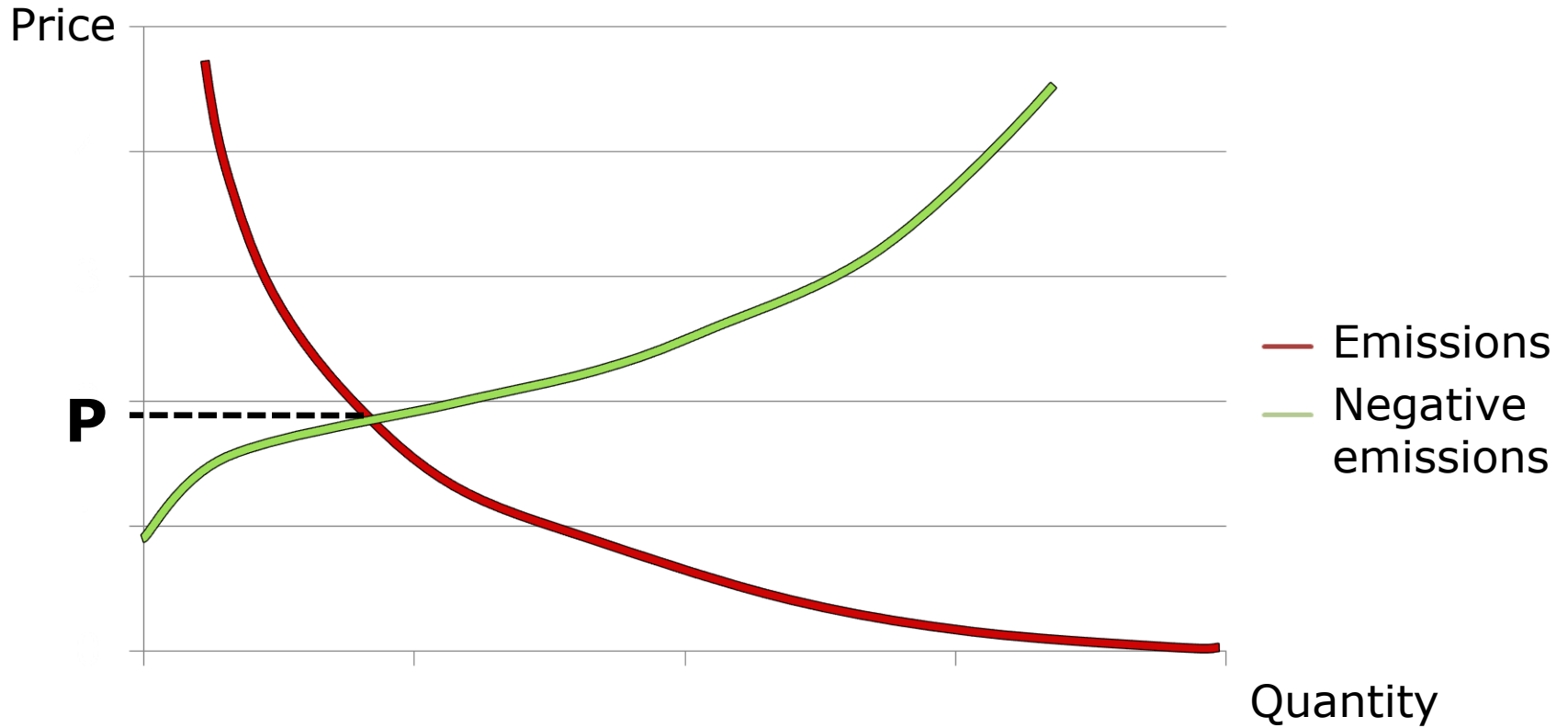
# Demand CO<sub>2</sub> Emissions



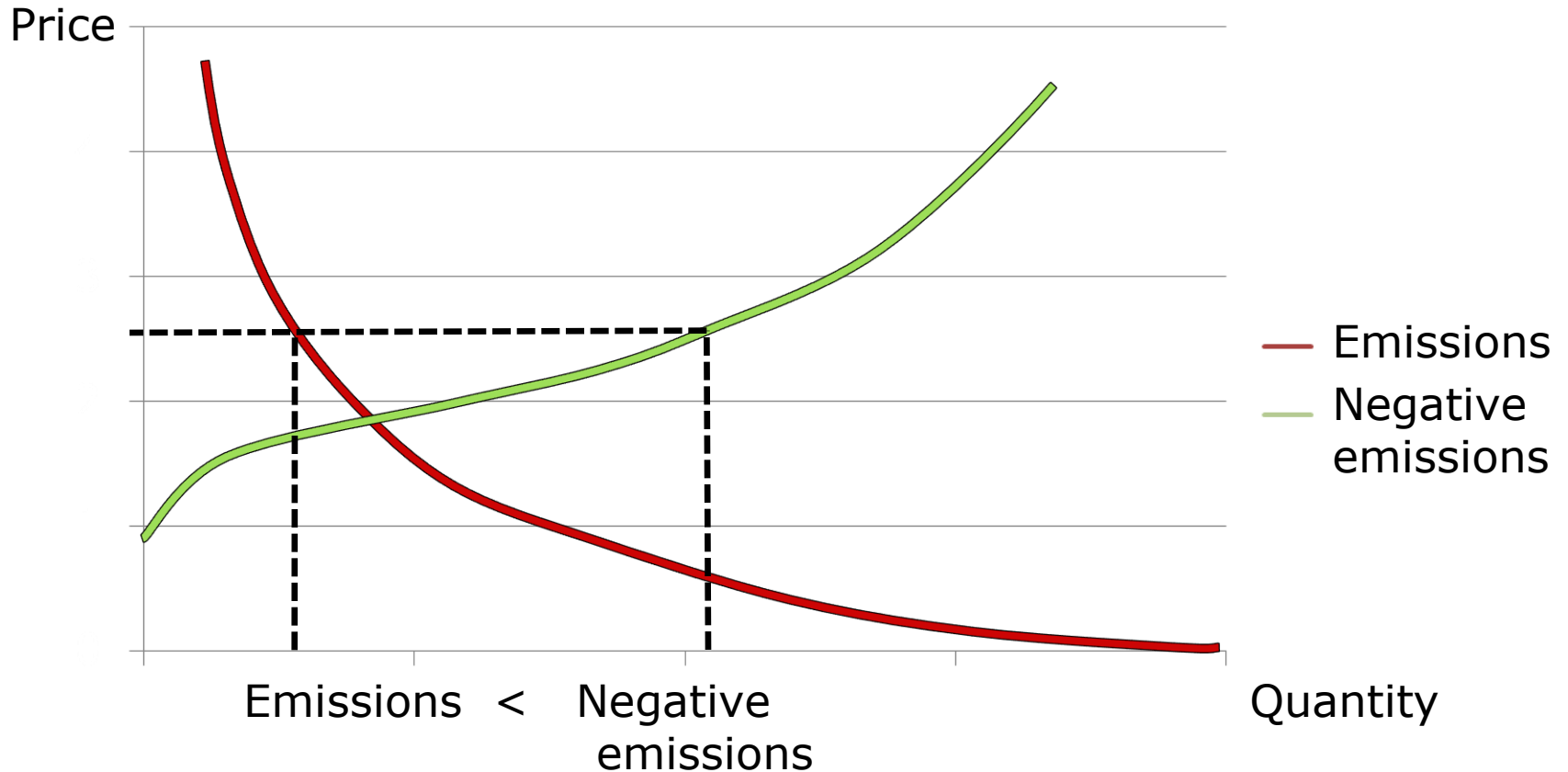
# Supply negative CO<sub>2</sub> emissions



# Zero Emission System



# Carbon Negative System



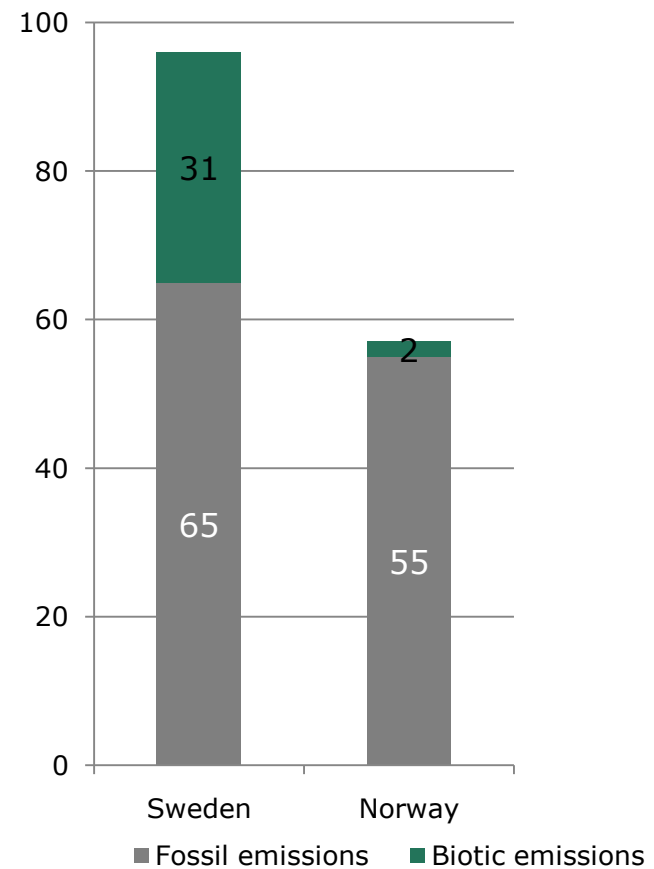
# 4. Swedish economic case study

# Swedish biotic CO<sub>2</sub>

- Swedish point sources:

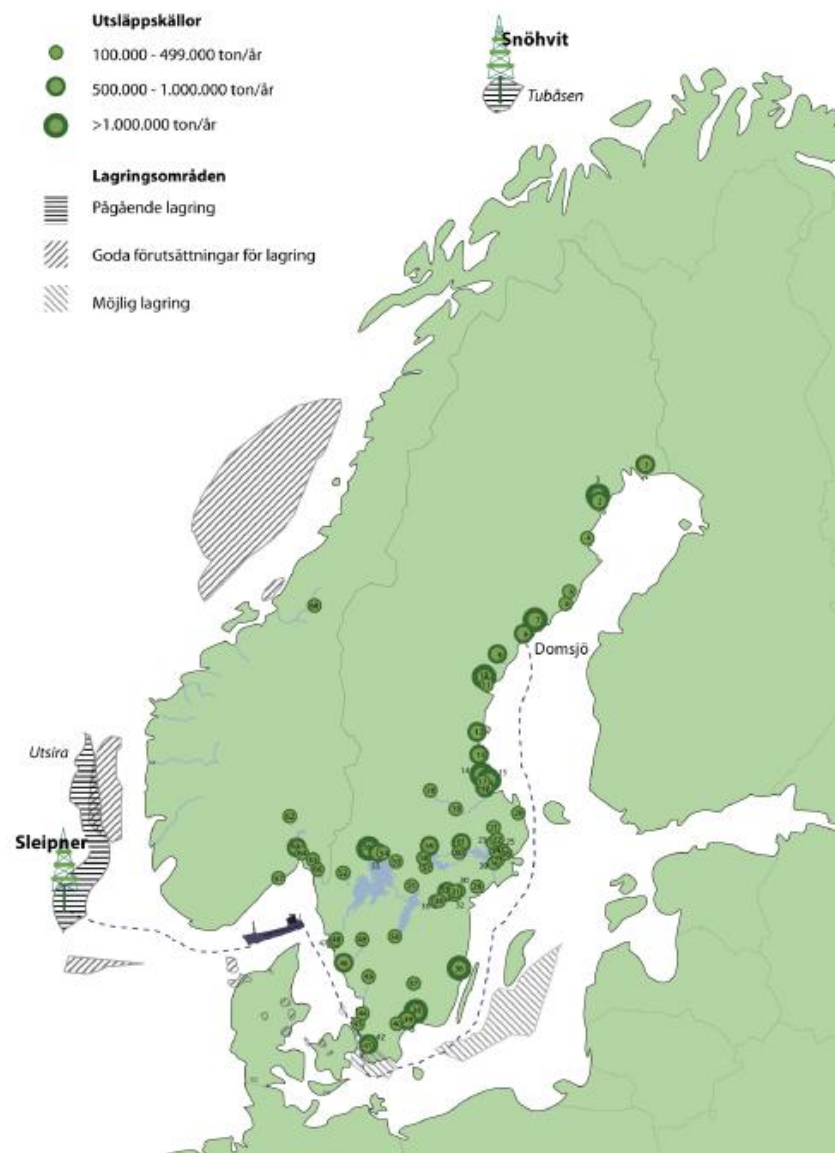
- 31 Mton biogenic
- 16 Mton fossil

Million tons/year



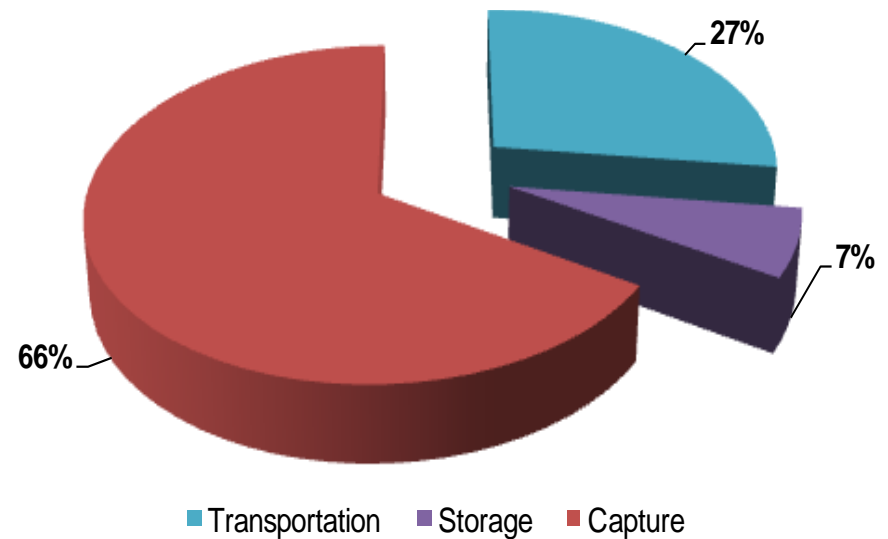
# Swedish sources & Norwegian Sinks

- 61 biotic point sources in Sweden
- Largest source >2 Mton/y
- Multi Gigaton storage capacity in North Sea



# Swedish BECCS-systems 2020

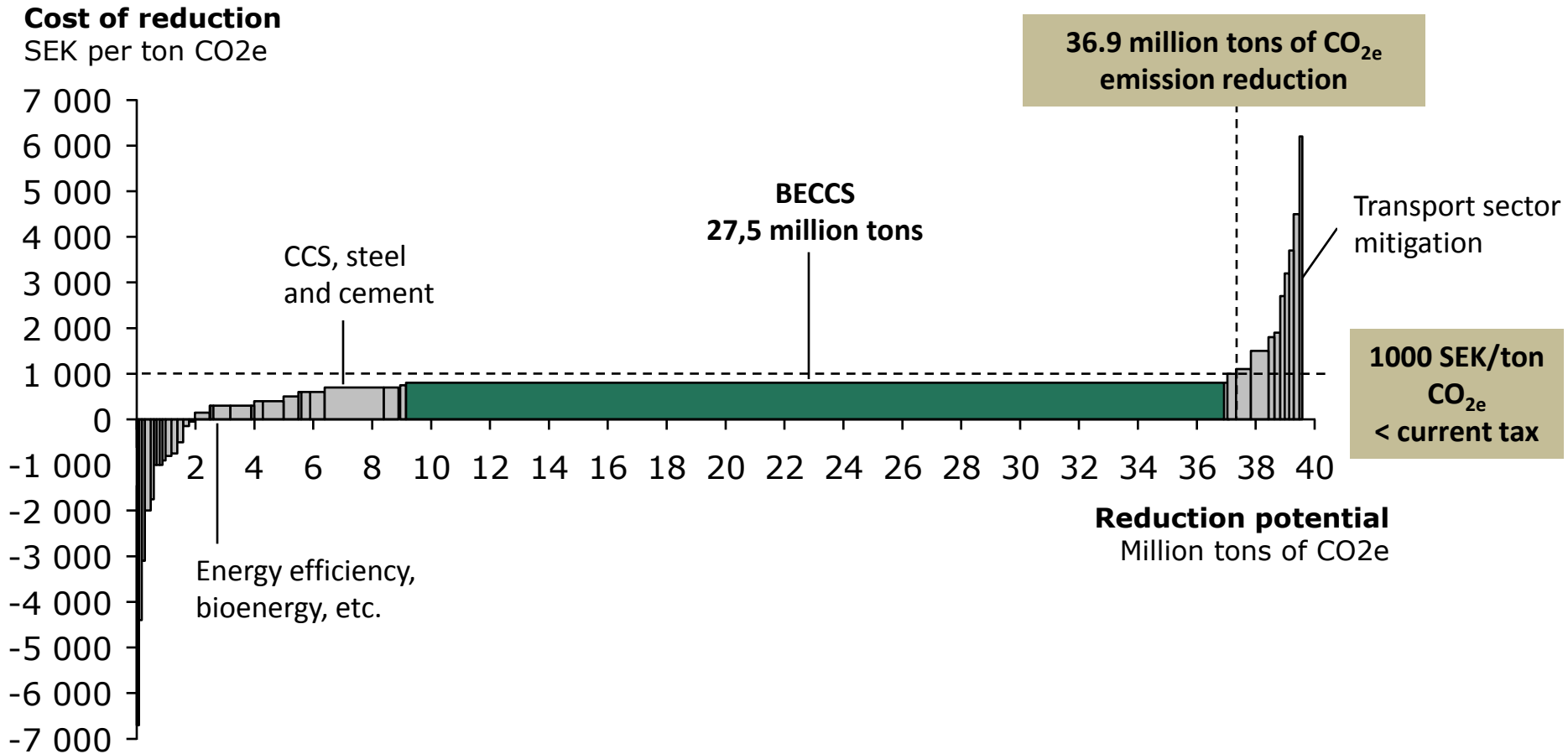
- Average cost: 77 € per ton CO<sub>2</sub> stored in 2020
- Capacity: 27,5 Mtons



Sources: Zantioti et al, "Opportunities and Societal Costs of Introducing the BECCS Technology in Sweden", CEMS at Stockholm School of Economics, 2009; m.fl.



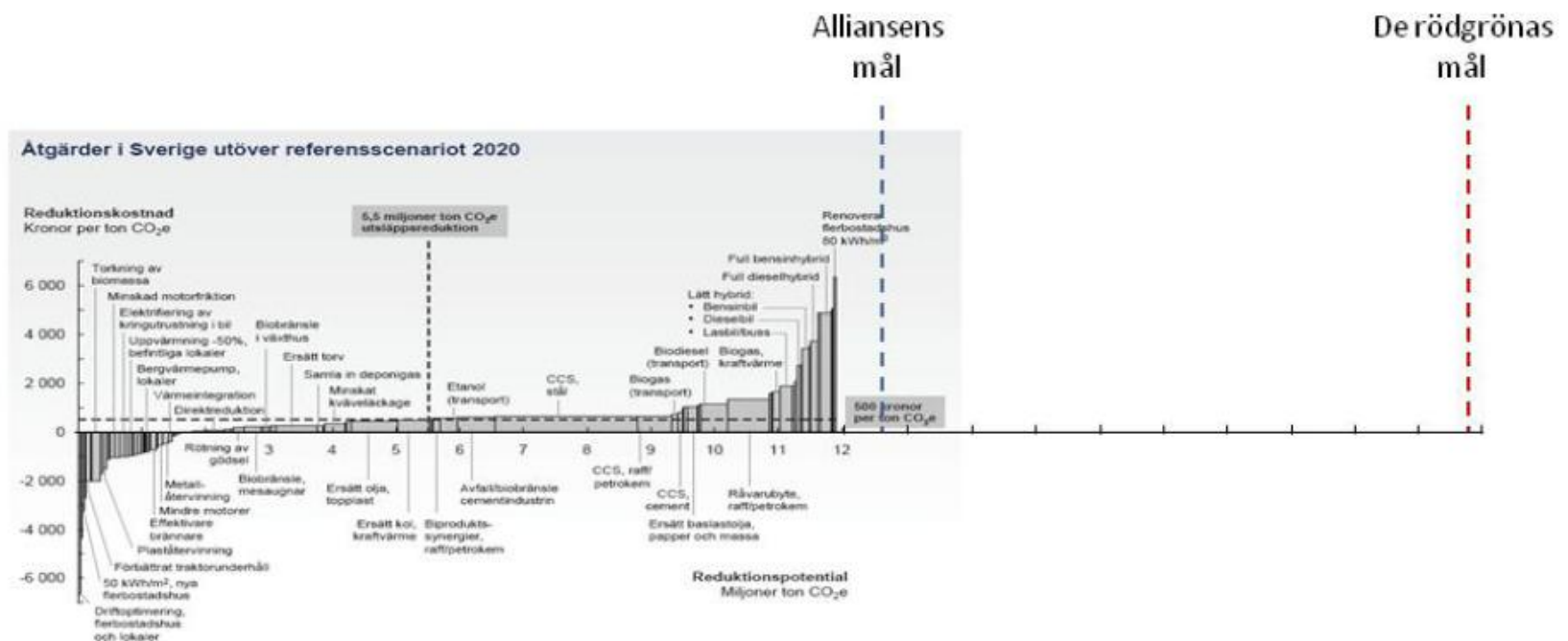
# Mitigation in Sweden 2020, with BECCS



Sources: 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.

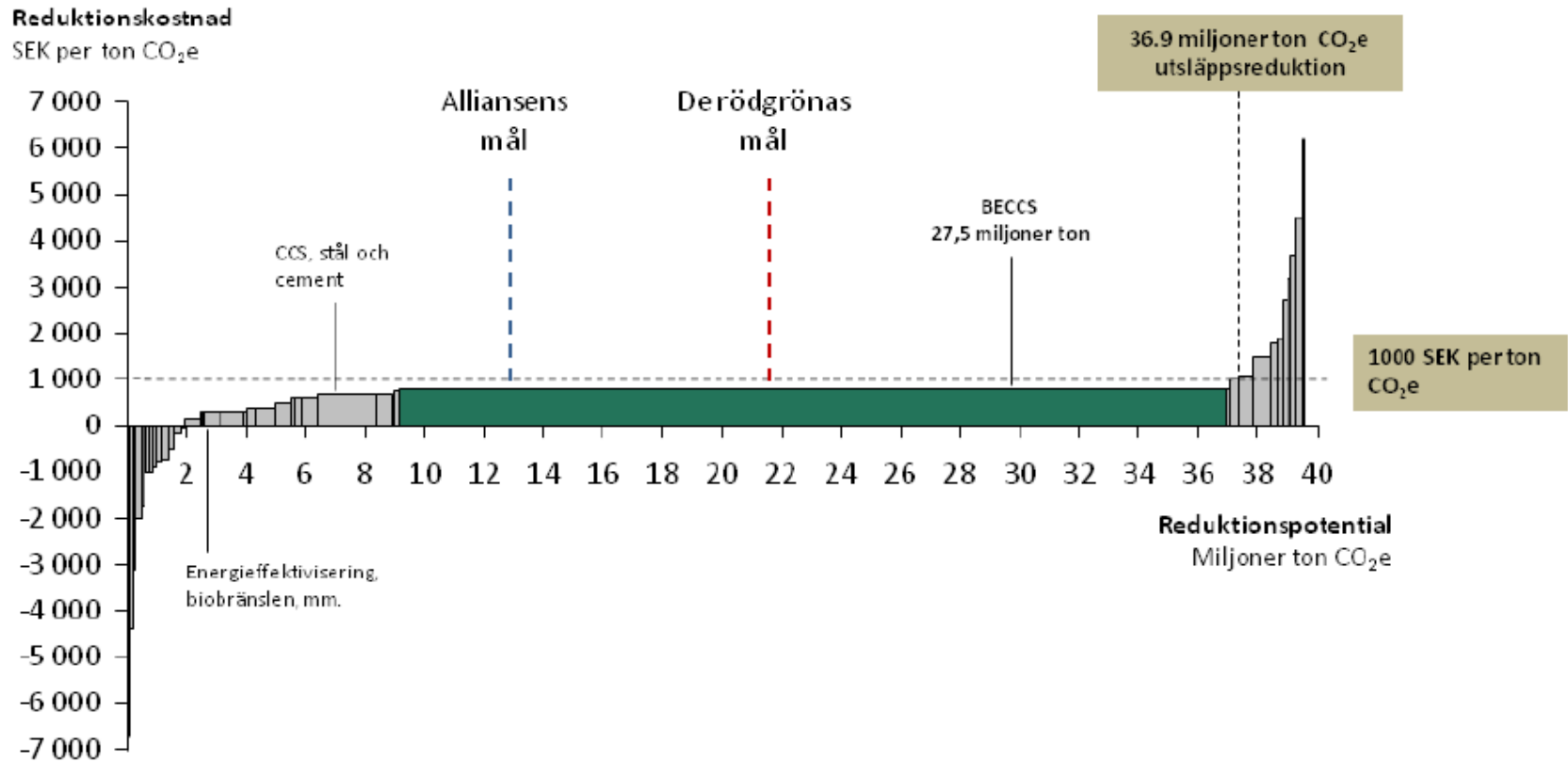
# Ambitious 2020 Climate Targets

- Political targets of 27 – 45 % decrease in non-EU-ETS sectors in 2020



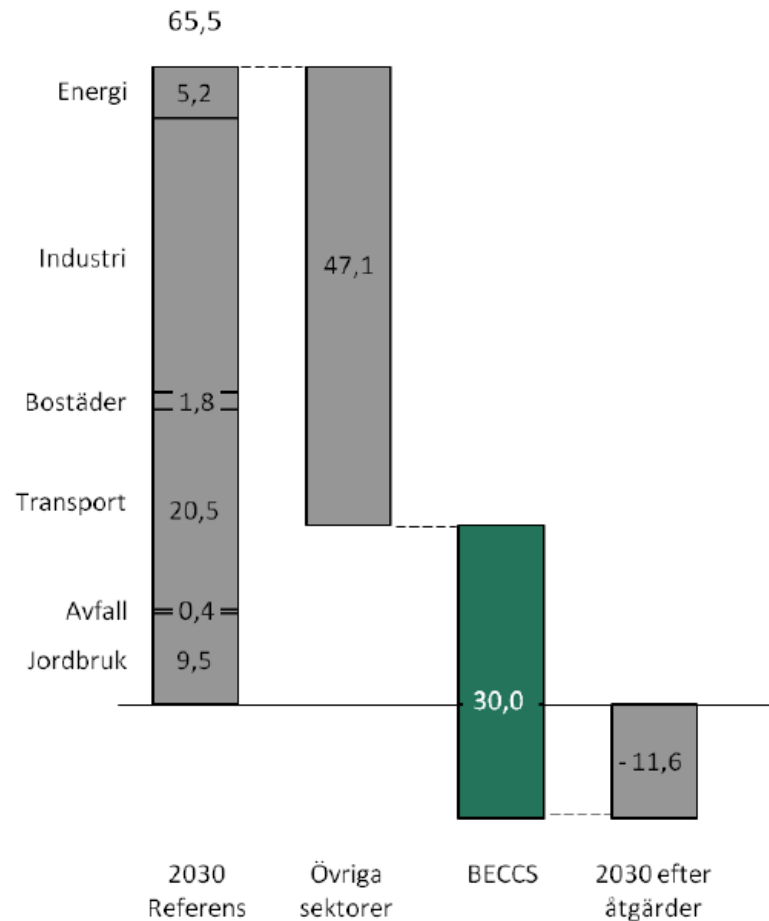
Source: "BECCS som klimatåtgärd", Biorecro, 2010

# Climate Targets with BECCS



Source: "BECCS som klimatåtgärd", Biorecro, 2010

# Sweden a Net Negative Emitter in 2030



Source: "BECCS som klimatåtgärd", Biorecro, 2010

# 5. Demonstration

# BECCS has Already Happened!

- Kansas EOR-project with biogenic CO<sub>2</sub> during the 2000's
- A few more projects planned in the US and elsewhere



Kansas Geological Survey, University of Kansas:  
Dubois, White, Carr, Byrnes

# Biorecro BECCS Pilot in North Dakota

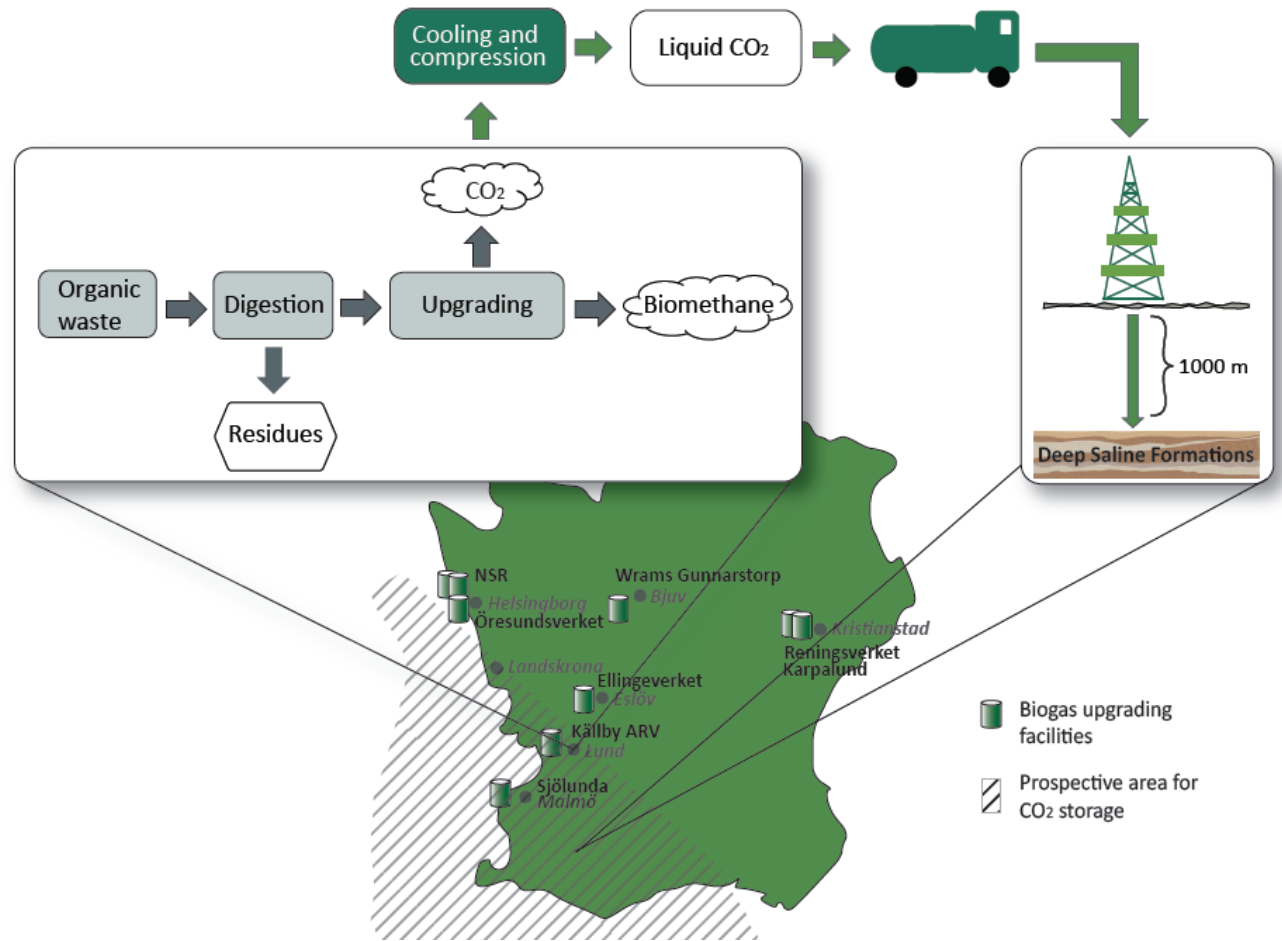
- Biorecro in cooperation with PCOR and EERC (Energy and Environmental Research Center) at the University of North Dakota
- Capacity for 1.500 – 5.000 tons/year
- Costs only 2 MUSD
- 18 months lead time



*Källa: EERC/University of North Dakota*

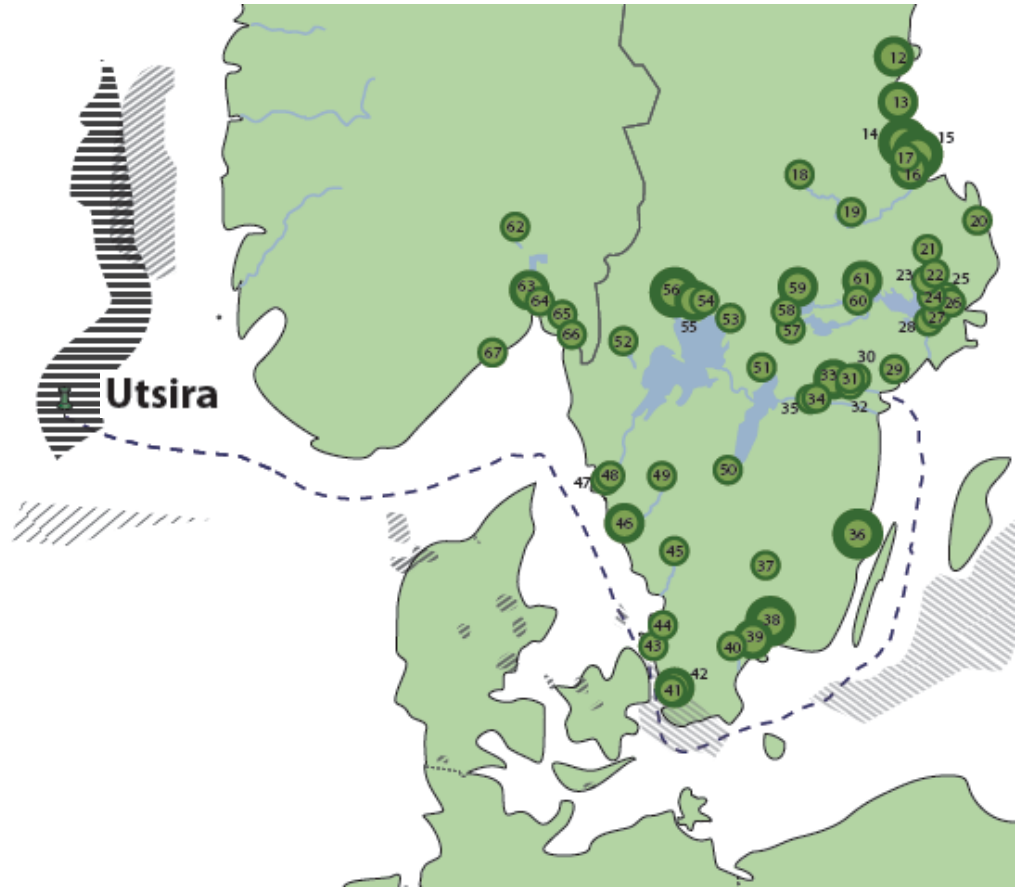
# BECCS Pilot in Skåne, Sweden

- Biogas upgrading yields pure CO<sub>2</sub>
- 500-5000 tons/year
- Total project cost 120 MSEK



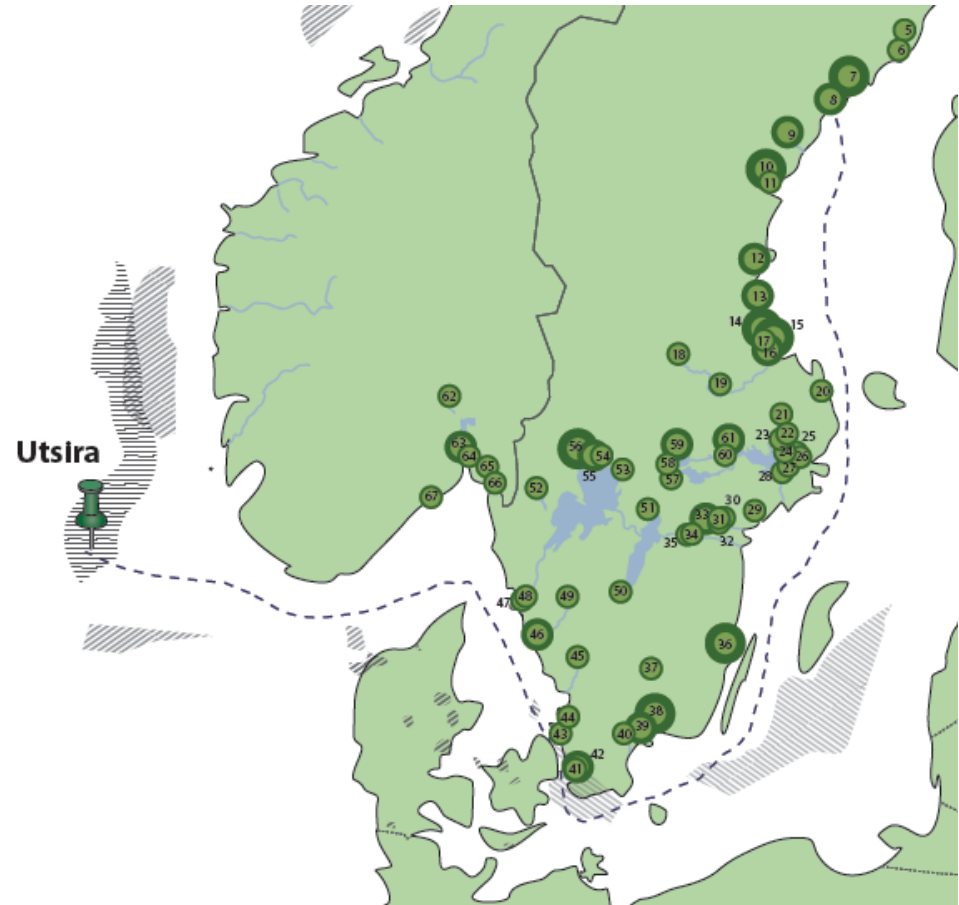
# BECCS Demonstration in Norrköping

- Ethanol fermentation is also very suitable for BECCS
- Pure stream of 170.000 tons of CO<sub>2</sub>/year
- Cost approx 50 €/ton CO<sub>2</sub> stored in first project, below 40 €/ton in n:th project



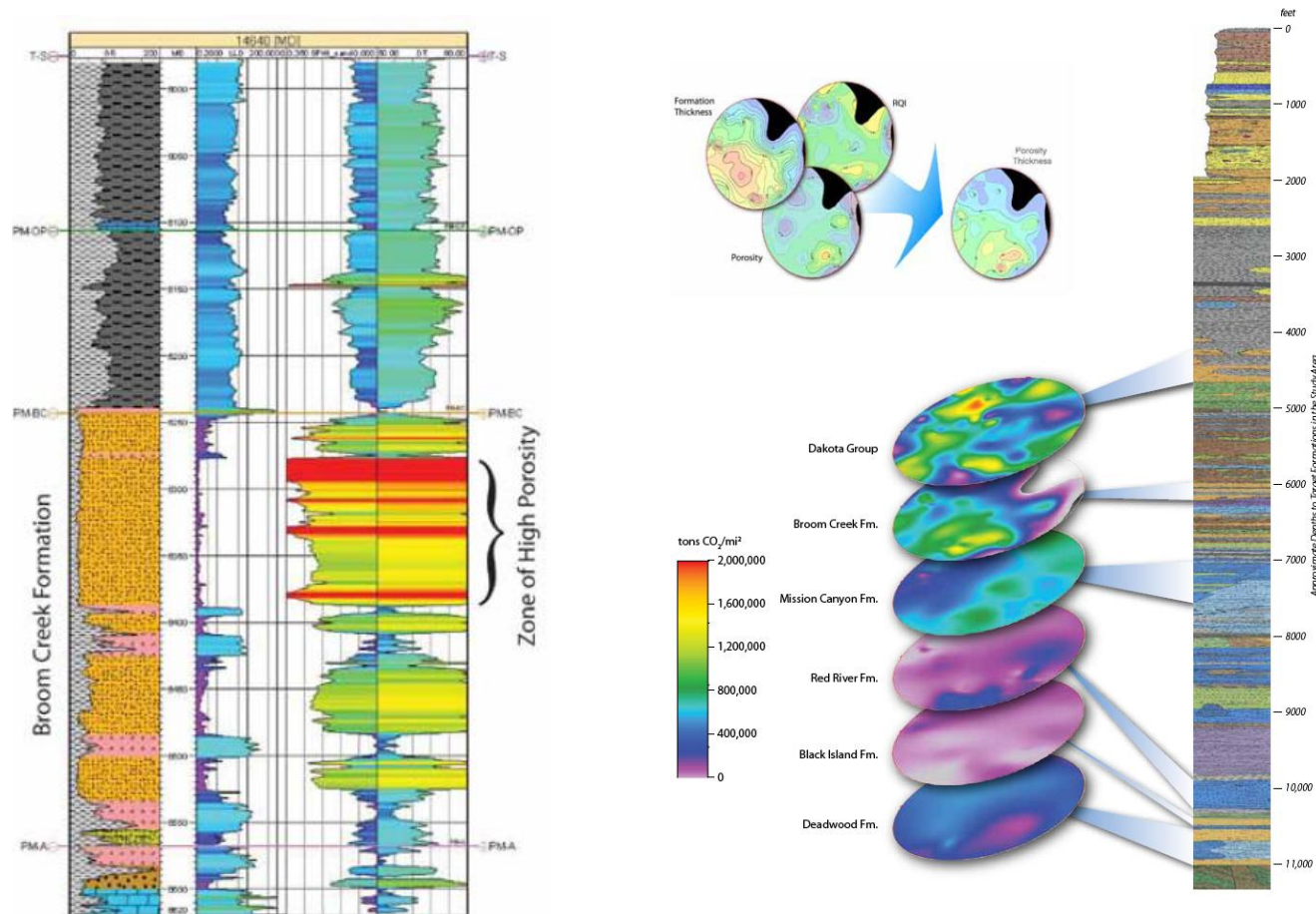
# BECCS Demonstration in Domsjö

- Black Liquor Gasification in Pulp mills is very suitable for BECCS
- Pure stream of 260.000 tons of CO<sub>2</sub>/year
- Cost approx 50 €/ton CO<sub>2</sub> stored in first project, below 40 €/ton in n:th project



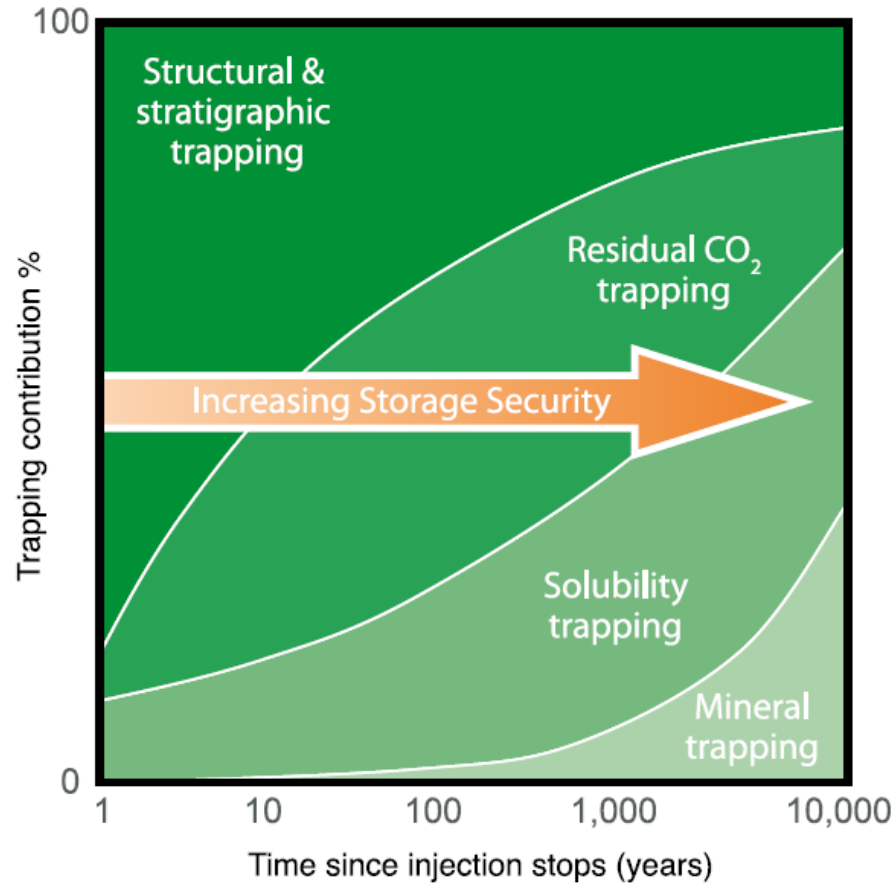
Thank you!

# Geological surveying



Source: EERC/University of North Dakota

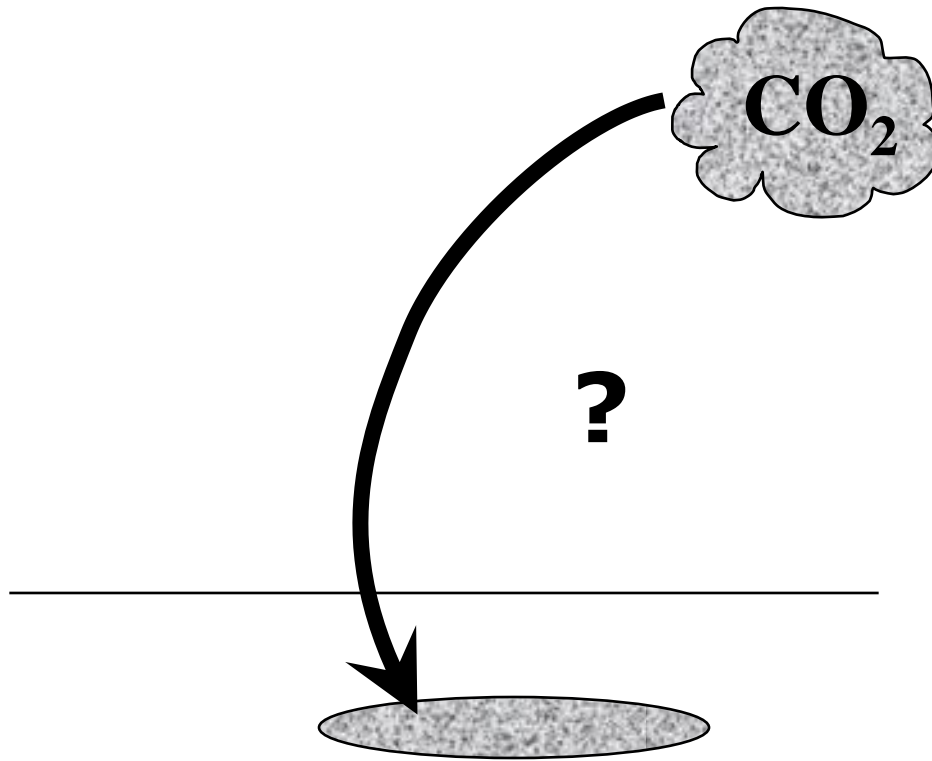
# Storage security



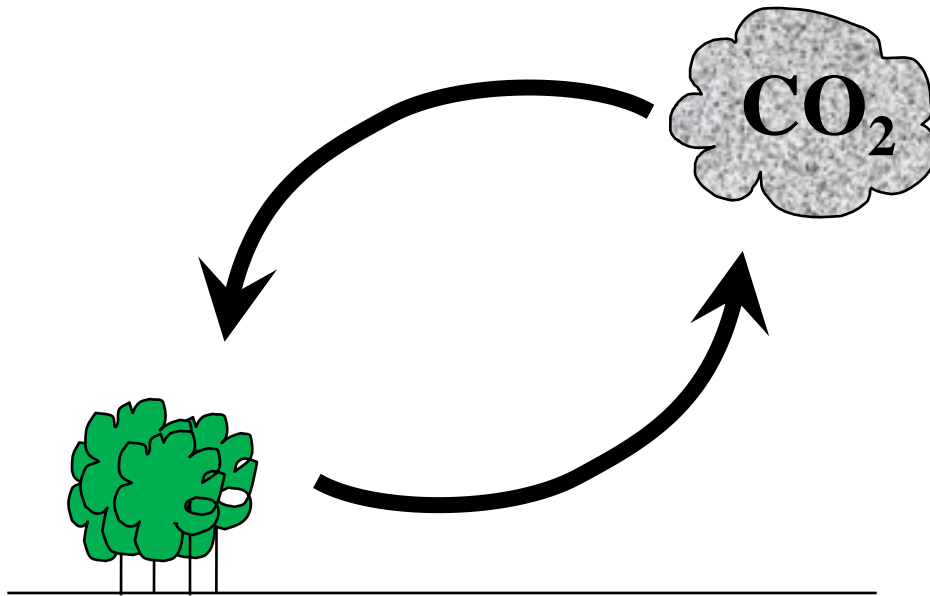
Källa: IPCC Special Report on Carbon Capture and Storage

## 2. Overview of BECCS

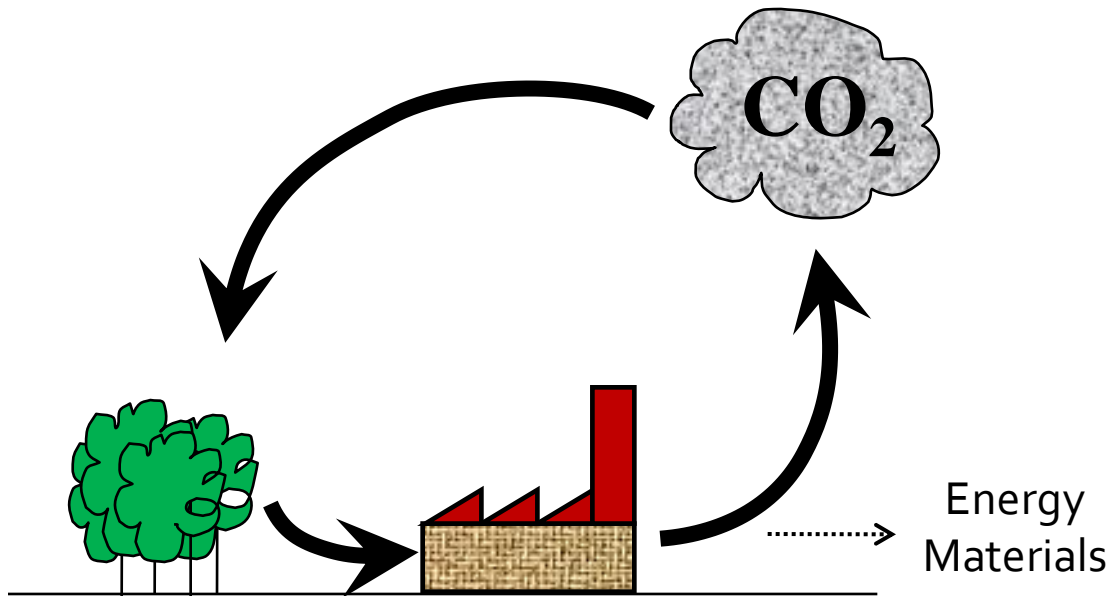
# We have to Restore the Atmosphere



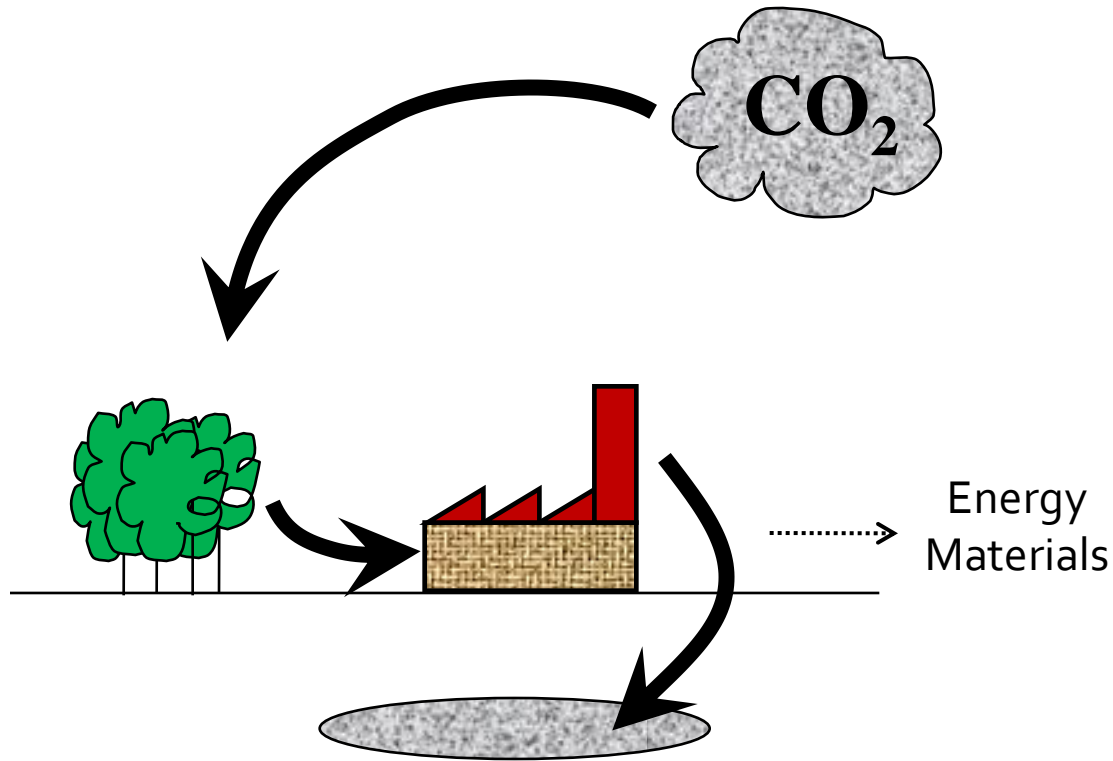
# Carbon cycle



# Renewable Energy



# Bio Energy with Carbon Capture and Storage (BECCS)



# Questions?

Please don't hesitate to contact us:

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