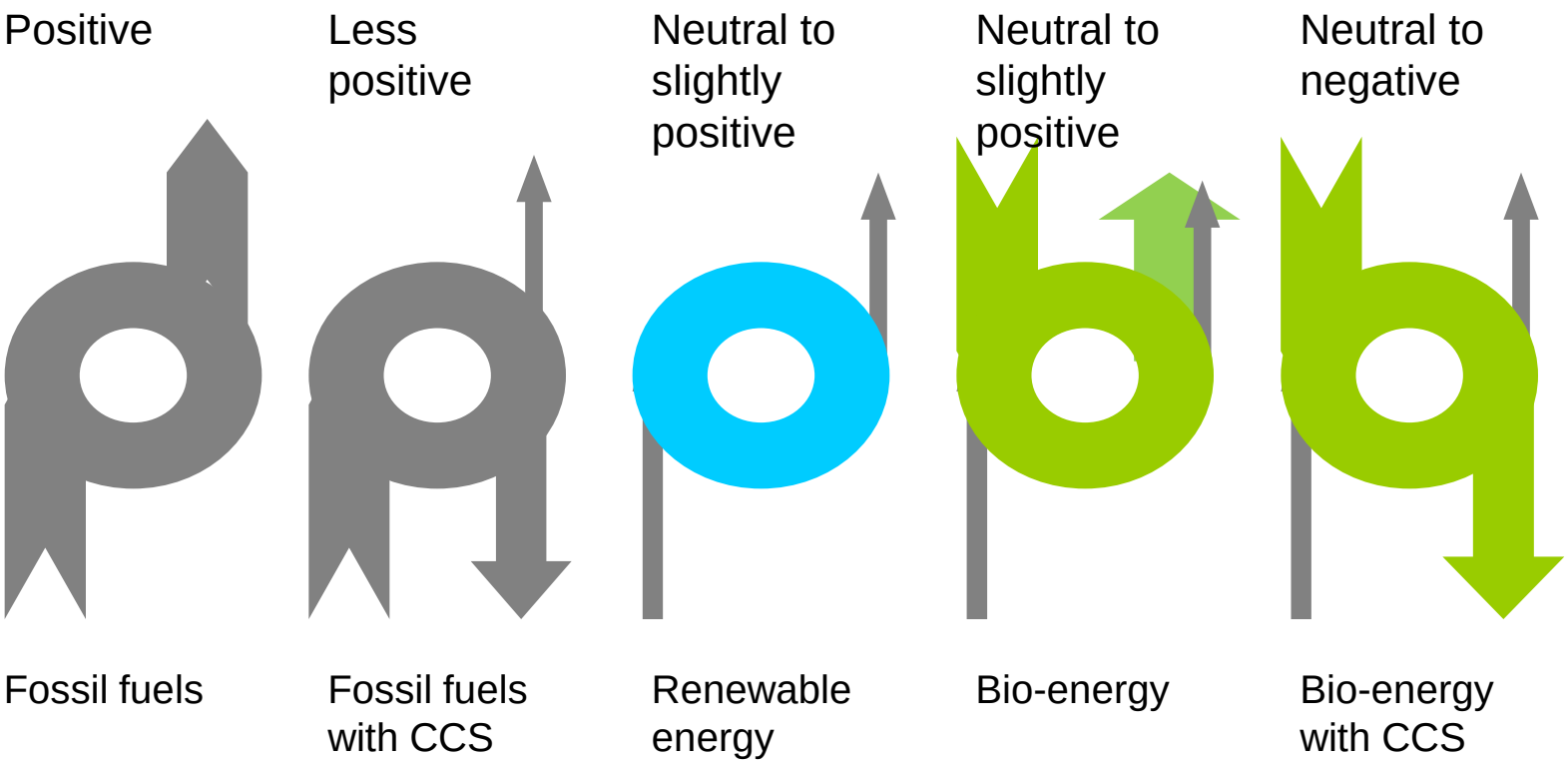
# The Global Potential of CCS with Biomass

Tim Dixon (IEAGHG), Joris Koornneef, Pieter van Breevoort, Carlo Hamelinck, Chris Hendriks, Monique Hoogwijk, Klaas Koop and Michèle Koper, Heleen Groenenberg (ECOFYS), Ameena Camps (IEAGHG)

*Bellona 25th Anniversary Conference*
*16th June 2011*
*Olso, Norway*

# Why Biomass and CCS - the net carbon balance




Koornneef, ECOFYS 2010

# Potential for Biomass and Carbon Dioxide Capture and Storage

- ECOFYS - Joris Koornneef et al

- Identify the main potential types of biomass and technologies applicable for energy conversion/process

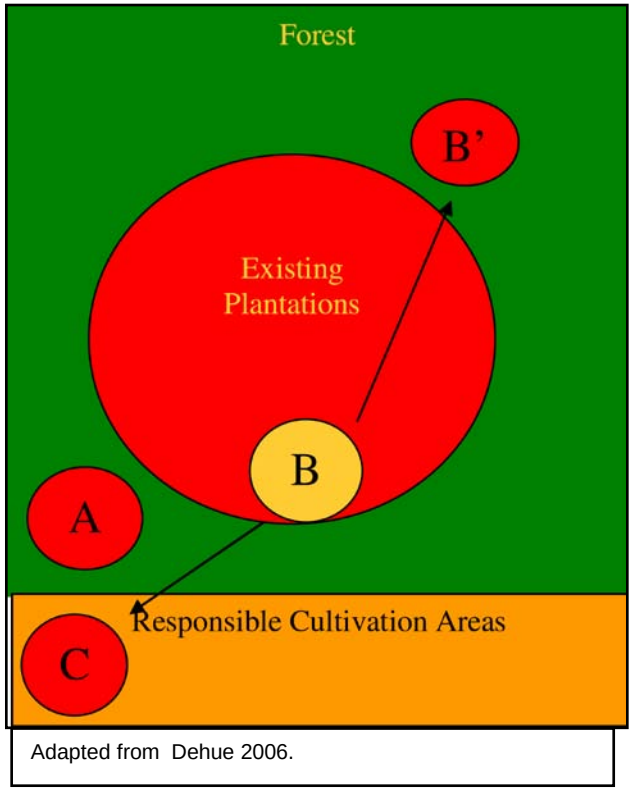
- To provide global and regional techno-economic assessment of potential for BE-CCS

# Methodology

- First order assessment of potential for BE-CCS at 2030 and 2050
- Considering various levels of potential:
  - Technical Potential: Potential that is technically feasible and not restricted by economic limitations
  - Realisable Potential: Technically feasible and takes future energy demand and scenarios for capital stock turnover into account.
  - Economic Potential: Potential at competitive cost compared to alternatives.
- **Combining existing studies on biomass potentials and $CO_2$ storage potentials**
- Six technology options selected for detailed analysis from two major sectors: **large-scale electricity generation and biofuel production**:
  - PC-CCS co-firing; CFB-CCS dedicated; IGCC-CCS co-firing; BIGCC-CCS dedicated; Bio-ethanol advanced generation; FT biodiesel.

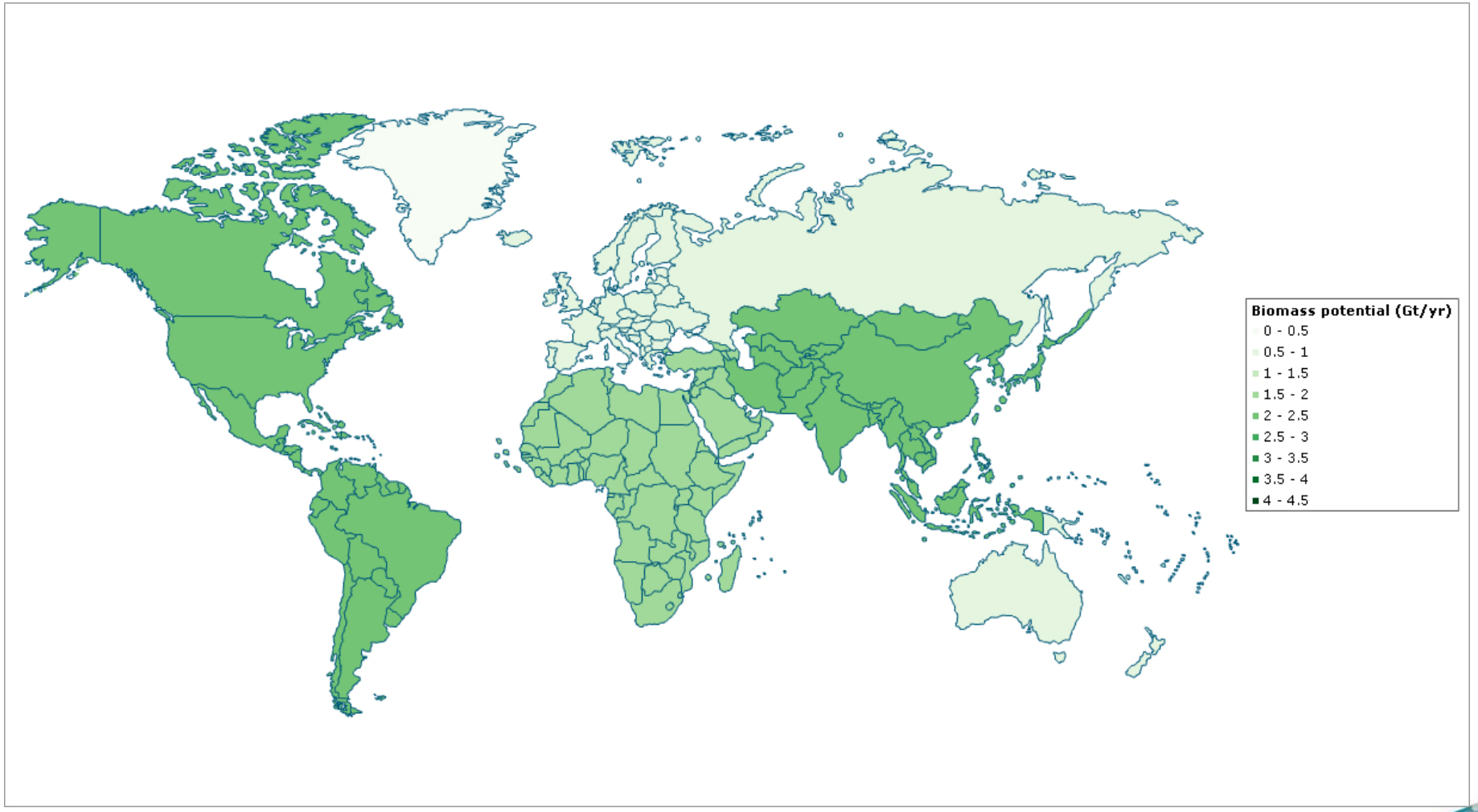
# Sustainability Criteria

- Sustainability criteria of ‘strict’ is used
- Factors classifying sustainable supply include:
  - Labour conditions
  - Protection of areas with high ecological, historical or cultural value
  - Food prices and security
  - Avoidance of indirect land use change (ILUC), and LUC.
  - Water supply and quality
  - Land rights of local communities
- Competition for land (and food prices) as well as ILUC and LUC are key areas of debate.




Adapted from Dehue 2006.

# Regional Biomass Potential



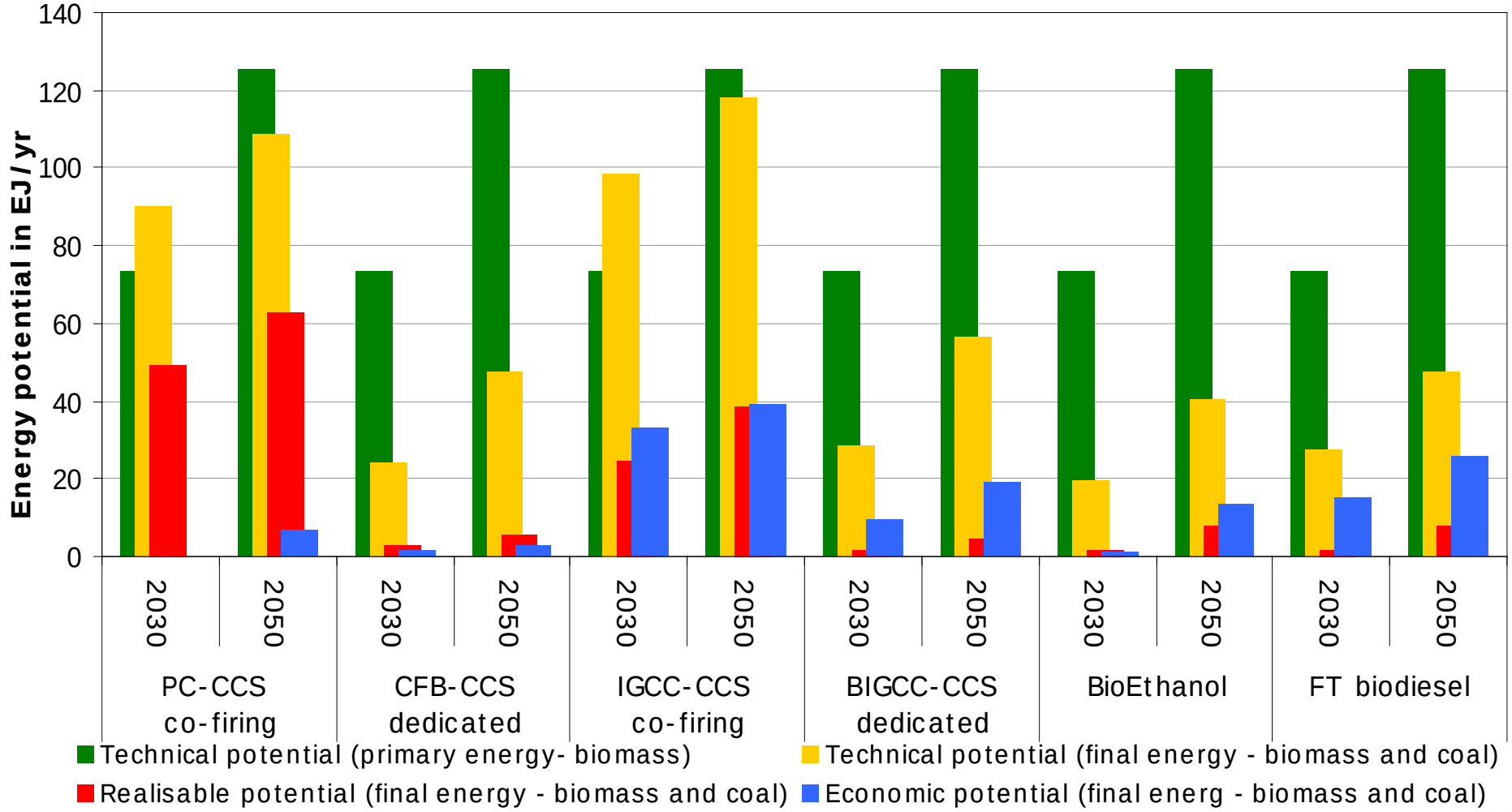
# Methodology

- **Determining Technical Potential**
  - Regional and global technical potential - in terms of primary energy converted, final energy and net greenhouse gas emissions determined by the net energy conversion efficiency (including the energy penalty) and the carbon removal efficiency of the BE-CCS route, **combining existing studies on biomass potentials, and $CO_2$ storage potentials.**
  - Seven regions: Africa and Middle East (AFME), Asia (ASIA), Oceania (OCEA), Latin America (LAAM), Non-OECD Europe and the Former Soviet Union (NOEU), North America (NOAM) and, OECD Europe (OEU).
  - Three categories of biomass analysed:
    - **energy crops; forestry residues; agricultural residues**;
    - sustainable biomass potential is estimated based on data from previous studies

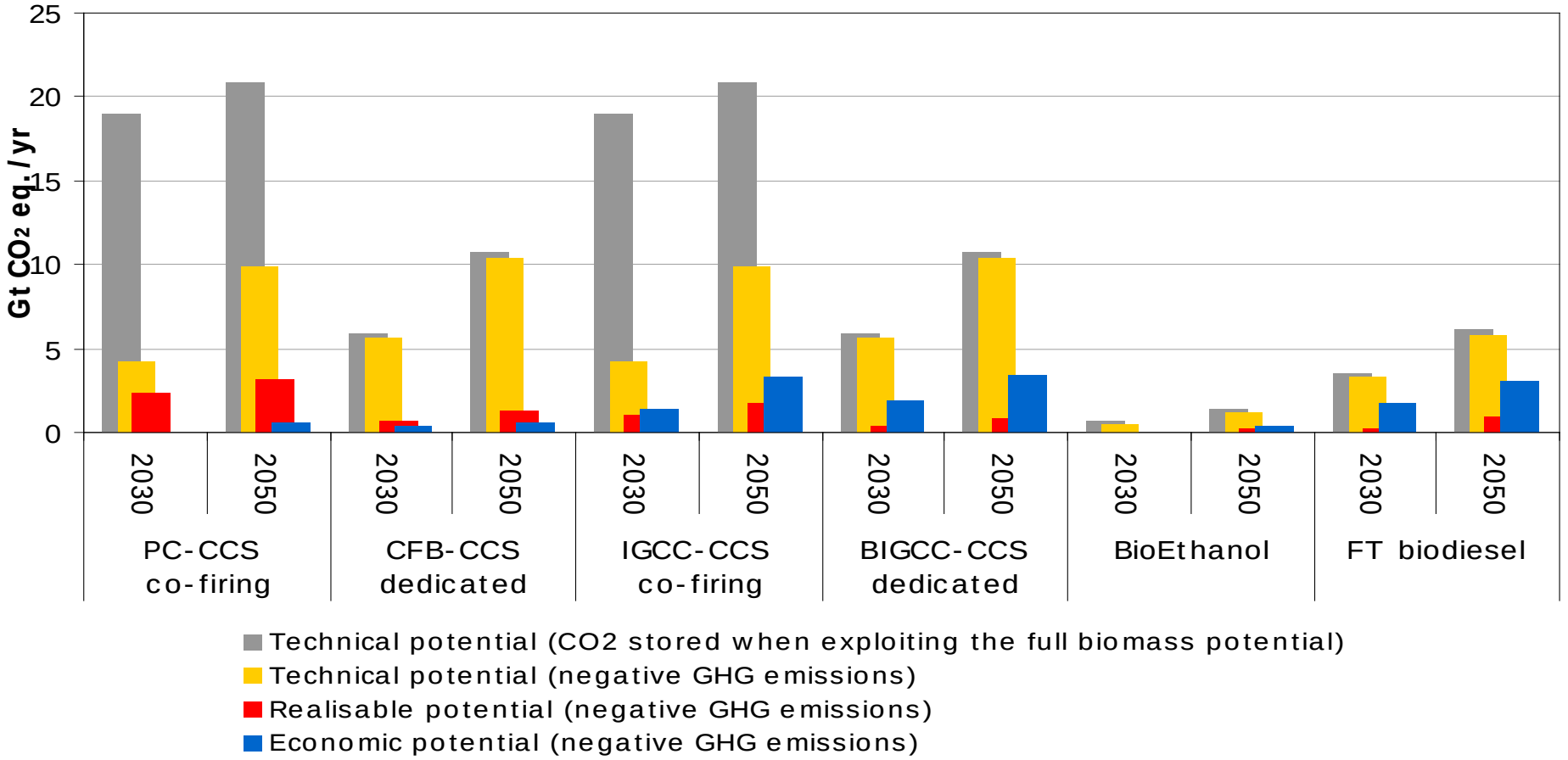
# Methodology

- **Determining Realisable Potential**
  - Adds limitations by including energy demand, capital stock turnover and possible deployment rate. Estimates for electricity supply and transport fuels BE-CCS routes based on the reference scenario in the IEA World Energy Outlook (IEA, 2009), adapted to include the view year of 2050.
- **Determining Economic Potential**
  - Combining the price of biomass resources with costs for biomass conversion and CCS for selected BE-CCS routes. The cost of producing electricity and biofuels (with and without CCS) are assessed, considering the $CO_2$ price, yielding supply curves for the BE-CCS routes and reference technologies.
  - Biomass pre-treatment and transport is a significant part of the biomass supply chain cost, and is assumed to be an average cost adding approximately 1.3 €/$GJ_{primary}$

# Results: Energy Potential

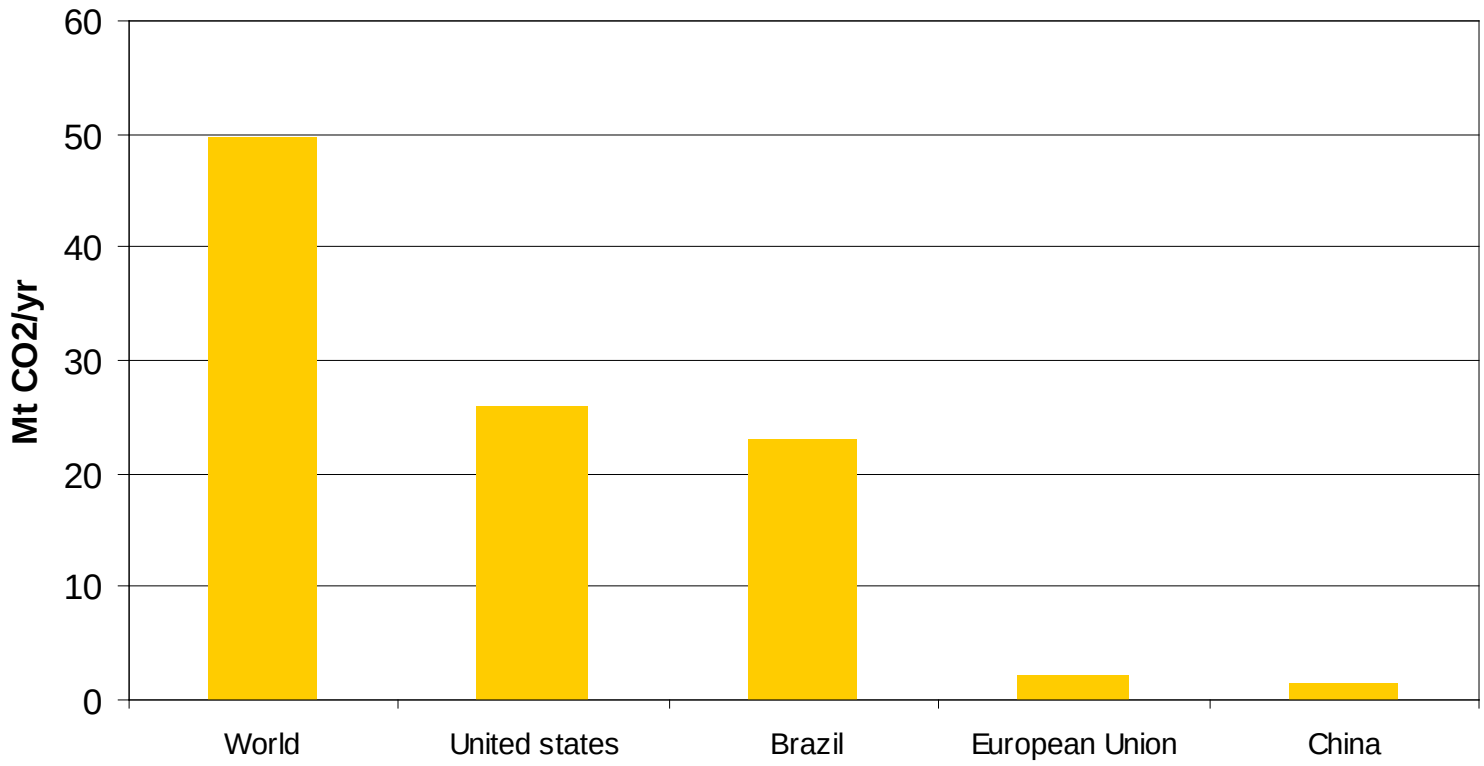


# Results: GHG Balance




- Technical Potential electricity: up to 10 Gt $CO_2$ eq/yr (Realisable less)
- Technical Potential biofuels: up to 6 GT $CO_2$ eq/yr (Realisable less)
  - wrt 48 GT/yr 2050 IEA Blue Map

# Conventional bio-ethanol Early opportunities !




$CO_2$ from fermentation in bio-ethanol 2008

# Market Barriers

- **$CO_2$ value**: Under the EU ETS, storing $CO_2$ from biomass will not 'create' sellable allowances, so no economic value to 'negative emissions'.
  - Stricter climate policy needed to increase the $CO_2$ policy, and inclusion of BE-CCS in the Clean Development Mechanism (CDM) would be another key driver for all BE-CCS routes.

- **Secure supply of low cost sustainable biomass** is a key driver for BE-CCS, and factors such as land use scenarios and biomass price fluctuations will influence this cost.

# Recommendations

- *$CO_2$ stored from biomass should have an economic value*
- *Further research on assessing BE-CCS potential per region through regional specific cost supply curves*
- *Further research on biomass supply options not included in this study, such as aquatic biomass from algae and seaweed, and on other utilisation options*
- *The effect of (co-)firing biomass on the performance of $CO_2$ capture options in pilot/demonstration plants*
- *Investigate biodiesel early opportunities of co-utilisation of biomass and coal in existing and new Fischer Tropsch facilities*
- *Early opportunities for bio-ethanol BE-CCS exist in Brazil and the U.S.A.*

# Incentives using Carbon Markets

IEAGHG and Heleen Groenenberg (Ecofys)

ECOFYS

- EU ETS – EUAs
- JI – ERUs
- CDM – CERs
- IPCC GHG Guidelines - AAUs

# Thank you