IEAGHG Activities on Biomass and CCS: Techno-economic Evaluation; Global Potential; Carbon Market Issues

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IEA GHG R&D Programme

2nd Workshop Cofiring Biomass with Coal, 27-28 March 2012
IEA Clean Coal Centre

IEA Greenhouse Gas R&D Programme

- A collaborative international research programme founded in 1991
- Aim: To provide information on the role that technology can play in reducing greenhouse gas emissions from use of fossil fuels.
- Producing information that is:
  - Objective, trustworthy, independent
  - Policy relevant but NOT policy prescriptive
  - Reviewed by external Expert Reviewers
- IEAGHG is an IEA Implementing Agreement in which the Participants contribute to a common fund to finance the activities.
- Activities: Studies and reports (>250); International Research Networks : Wells, Risk, Monitoring, Modelling, Oxy, Capture, Social Research, Solid Looping; Communications (GHGT conferences, IJGGC, etc); facilitating and focussing R&D and demonstration activities eg Weyburn, Summer Schools, Peer Reviews.


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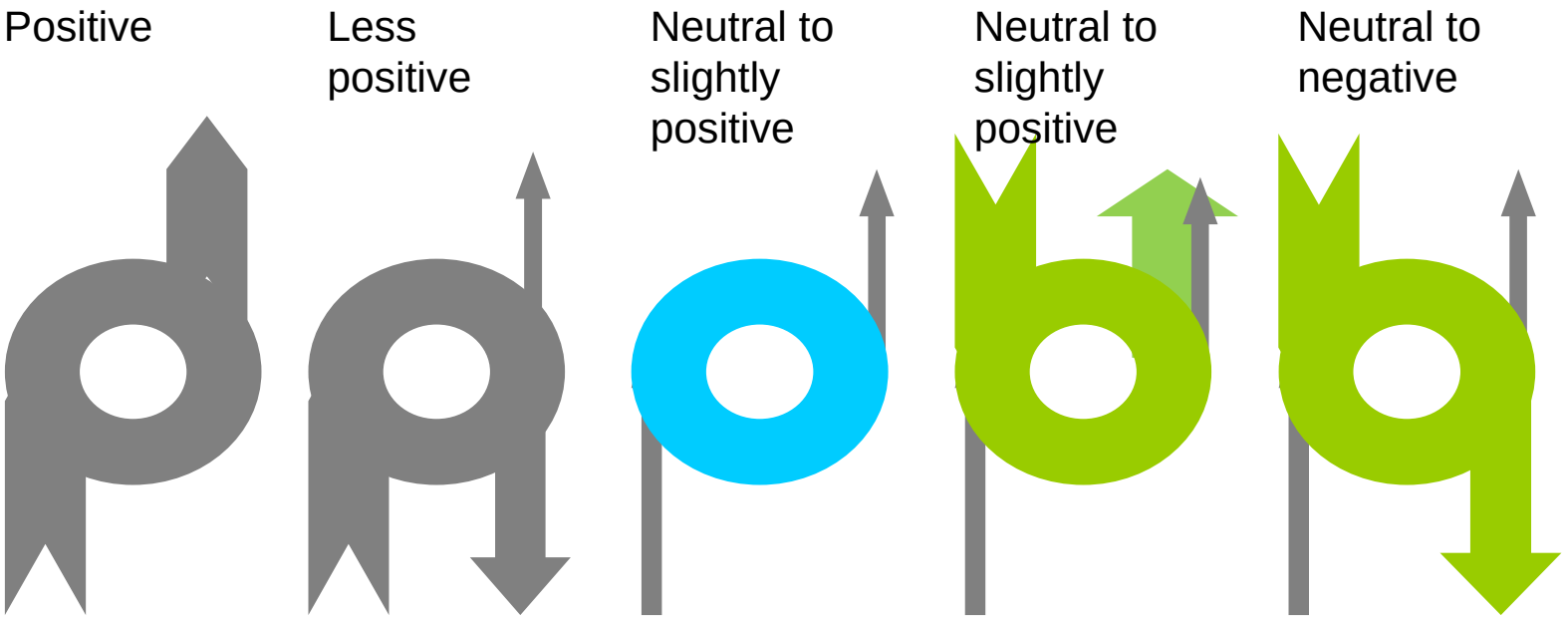
Why Biomass and CCS - the net carbon balance



Need for Biomass CCS

- Deployment of current emissions reduction technologies may not be enough for climate stabilisation - future emission scenarios (IPCC 4th AR) may require negative emissions
- Only one technology option large-scale and near-market – biomass and CCS
- Highlighted in GHGT9 conclusions, and starting to be recognised, but no assessment of realistic potential, issues, limitations etc.
- Implications uncertain, possibly large, not reflected in climate policy (Rhodes & Keith 2008) – due to lack of information
- IEA CCS Roadmap

TECHNO-ECONOMIC EVALUATION OF POST COMBUSTION CAPTURE ON BIOMASS POWER PLANT

Techno-Economic Evaluation of Biomass Fired or Co-Fired Power Plant with Post-Combustion CO_2 capture

- Study undertaken by Foster Wheeler Italiana SpA, from December 2008 to July 2009.

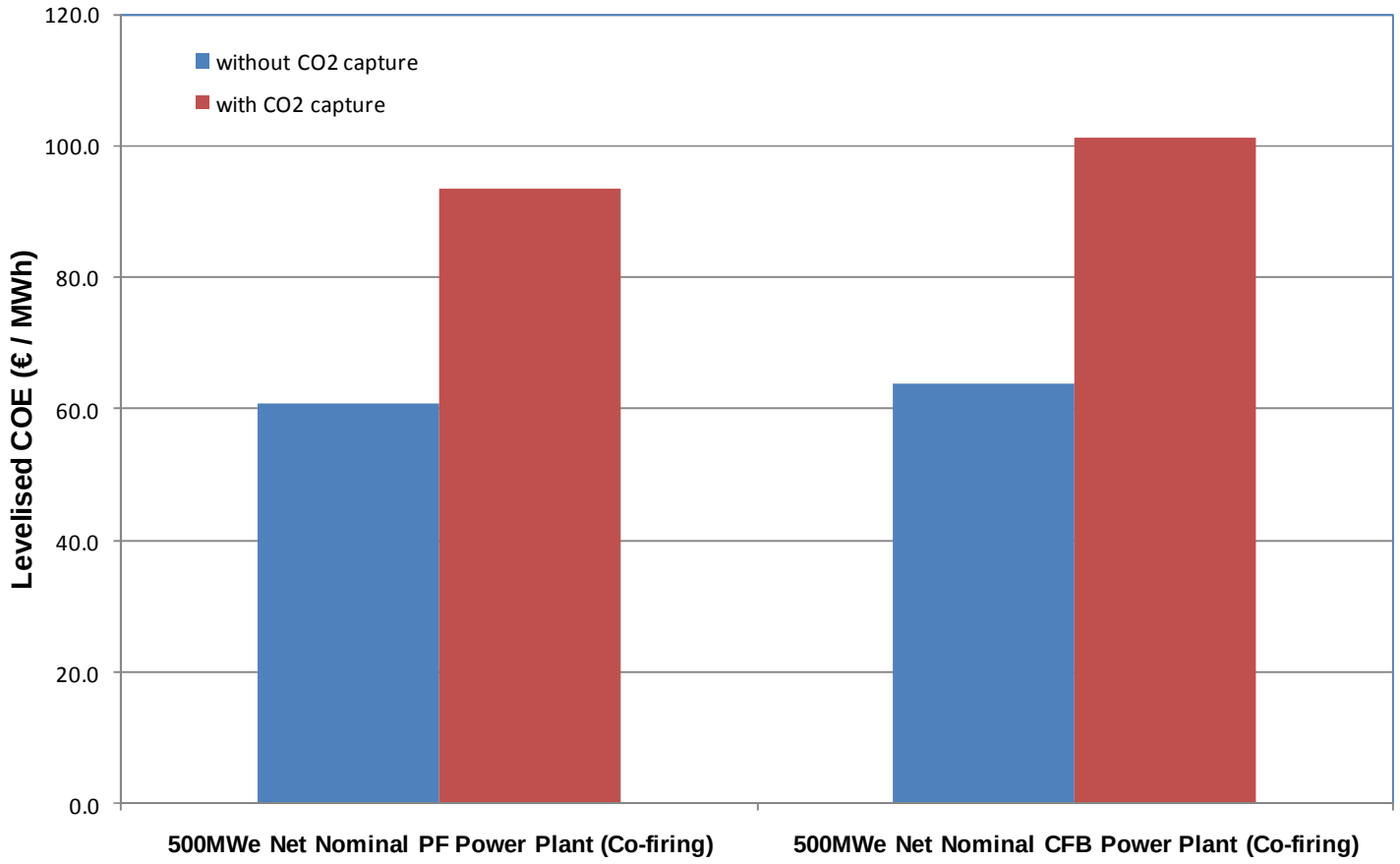
- Main aims of the study :
  - To evaluate the techno-economic feasibility of installing CO_2 capture plant in a biomass fired or co-fired power plants.

  - To examine the possible impact on the economics of the power plant based on the benefits to be gained from the “Green” and “ETS” certificates mechanism

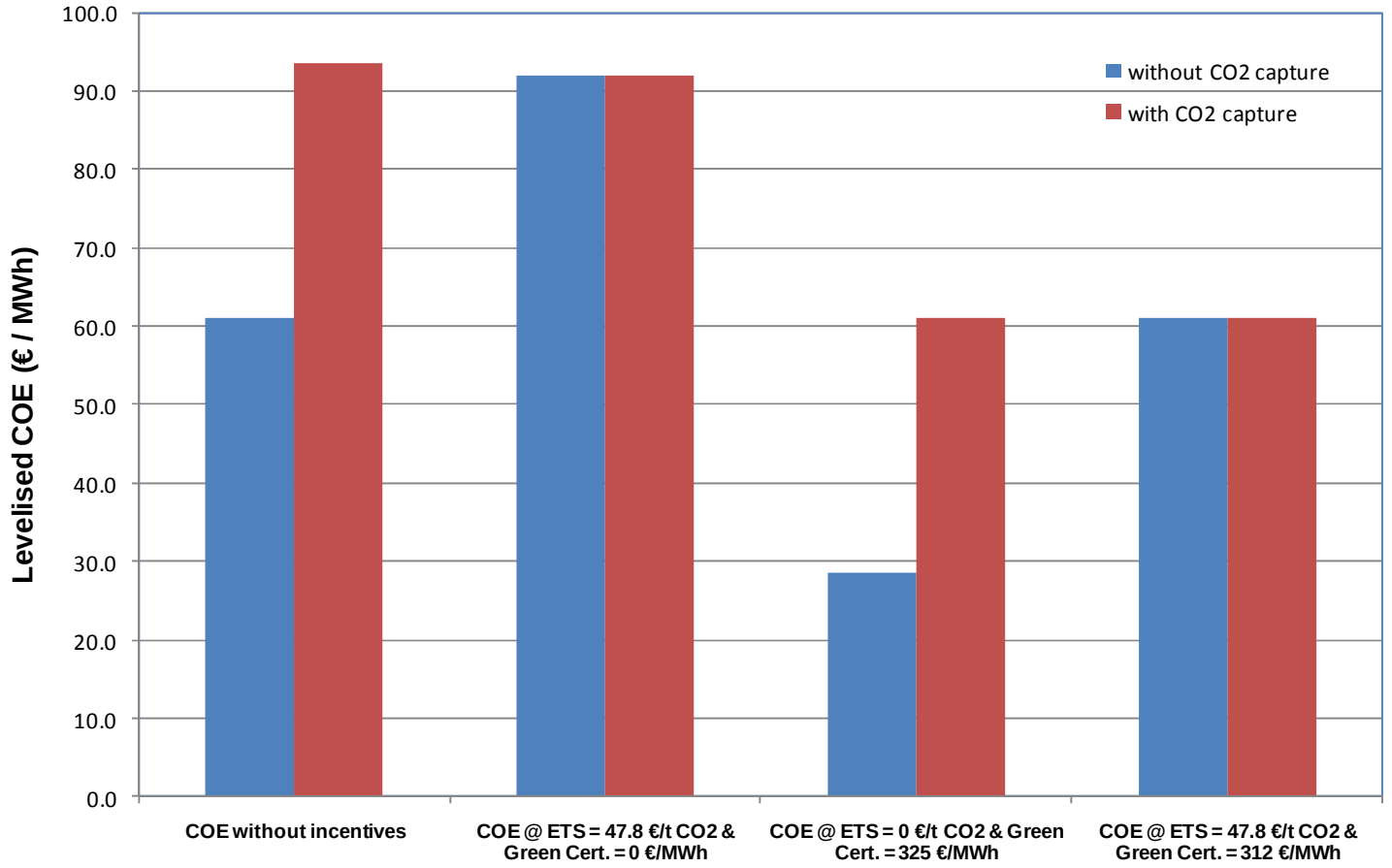
Scope of the Study

- Covers 4 different Cases
  - Case 01 – Nominal 500MWe SCPC with Biomass Co-Fired Power Plant.
  - Case 02 – Nominal 500MWe SC-CFB with Biomass Co-Fired Power Plant.
  - Case 03 – Nominal 250MWe biomass fired subcritical CFB.
  - Case 04 – Nominal 75MWe biomass fired subcritical CFB.
- Only Post-Combustion Capture process using standard MEA are examined.
- Economic evaluation covers 4 different scenarios:
  - Scenario 01 – No incentives to be gained from Green or ETS certificate.
  - Scenario 02 – Only the Green Certificate are considered.
  - Scenario 03 – Only the ETS Certificate are considered.
  - Scenario 04 – Both ETS and Green Certificate are considered.

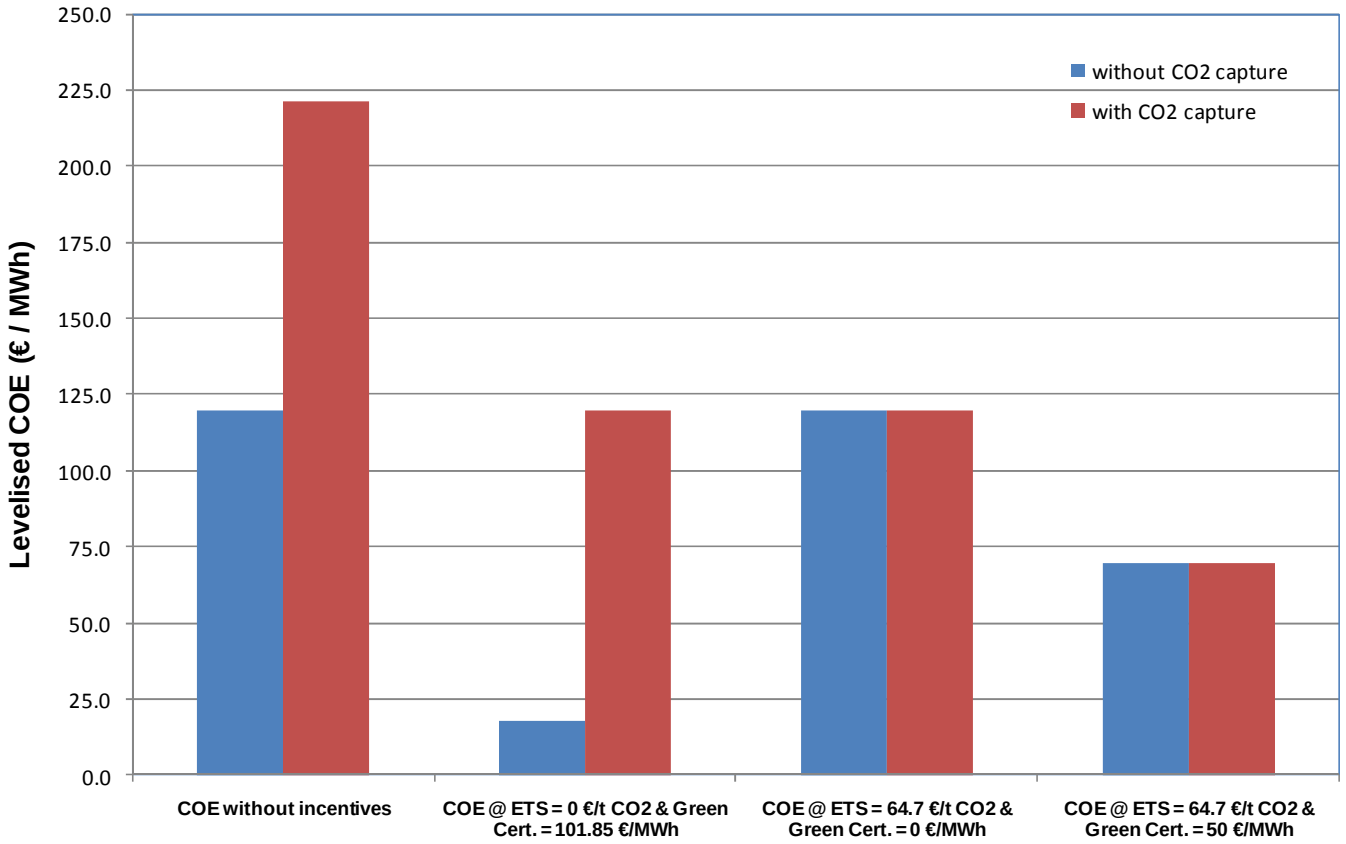
Results – Cost of Electricity (Co-Firing Cases)
No Incentives from ETS or Green Certificate



Results – Implication of ETS and Green Certificate (For Nominal 500MWe Co-Fired SCPC Case)



Results – Implication of ETS and Green Certificate (For Nominal 250MWe Biomass Fired CFB Cases)



Conclusions – Performance

- Performance of the biomass fired or co-fired power plant with post-combustion CO_2 capture could be affected by:
  - Flue gas cleaning processes.
  - Expected increase of the volume of flue gas and lower CO_2 concentration since biomass has lower energy density.
- Still no experience in operating ultra-supercritical PC co-fired with biomass.
- Still need to do the techno-economic evaluation of using more difficult biomass fuel.

Conclusions – Cost of Electricity

- The increase in capital cost of a biomass power plant with CCS is primarily due to:
  - Cost of the CO_2 capture and compression unit
  - Cost of the flue gas processing unit.
- The viability of the biomass with CCS could significantly affected by:
  - Cost of the ETS certificate
  - Fuel Cost
- Considering Green certificate alone would not make biomass with CCS economically attractive.

Potential for Biomass and Carbon Dioxide Capture and Storage

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

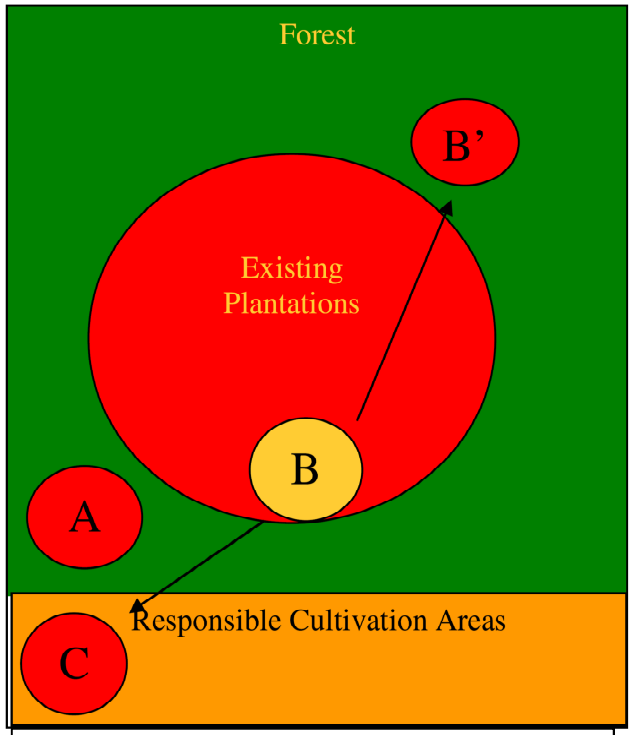
- To provide global and regional techno-economic assessment of potential for BE-CCS

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.
- Three categories of biomass analysed:
  - **energy crops; forestry residues; agricultural residues**

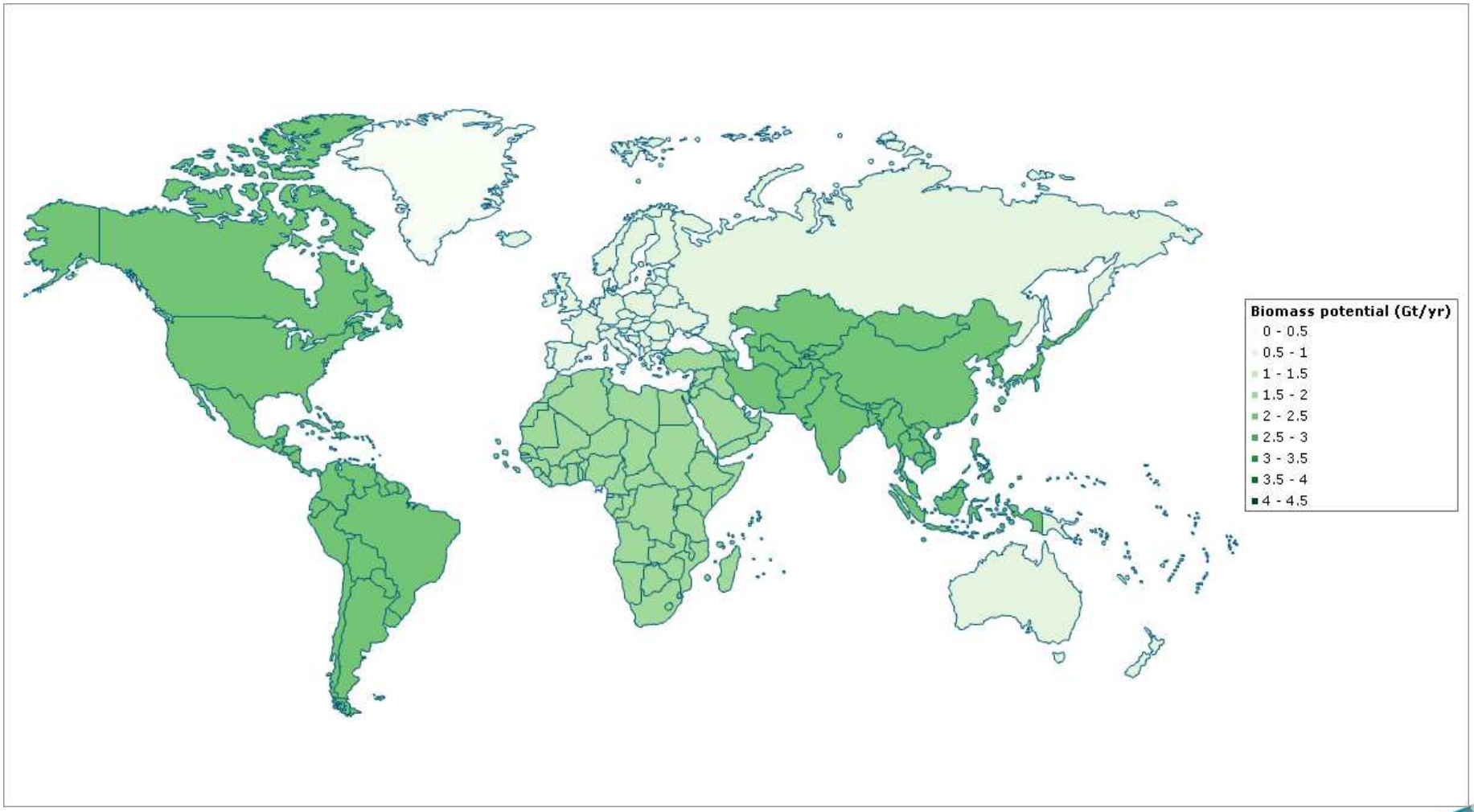
Sustainability Criteria

- 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.

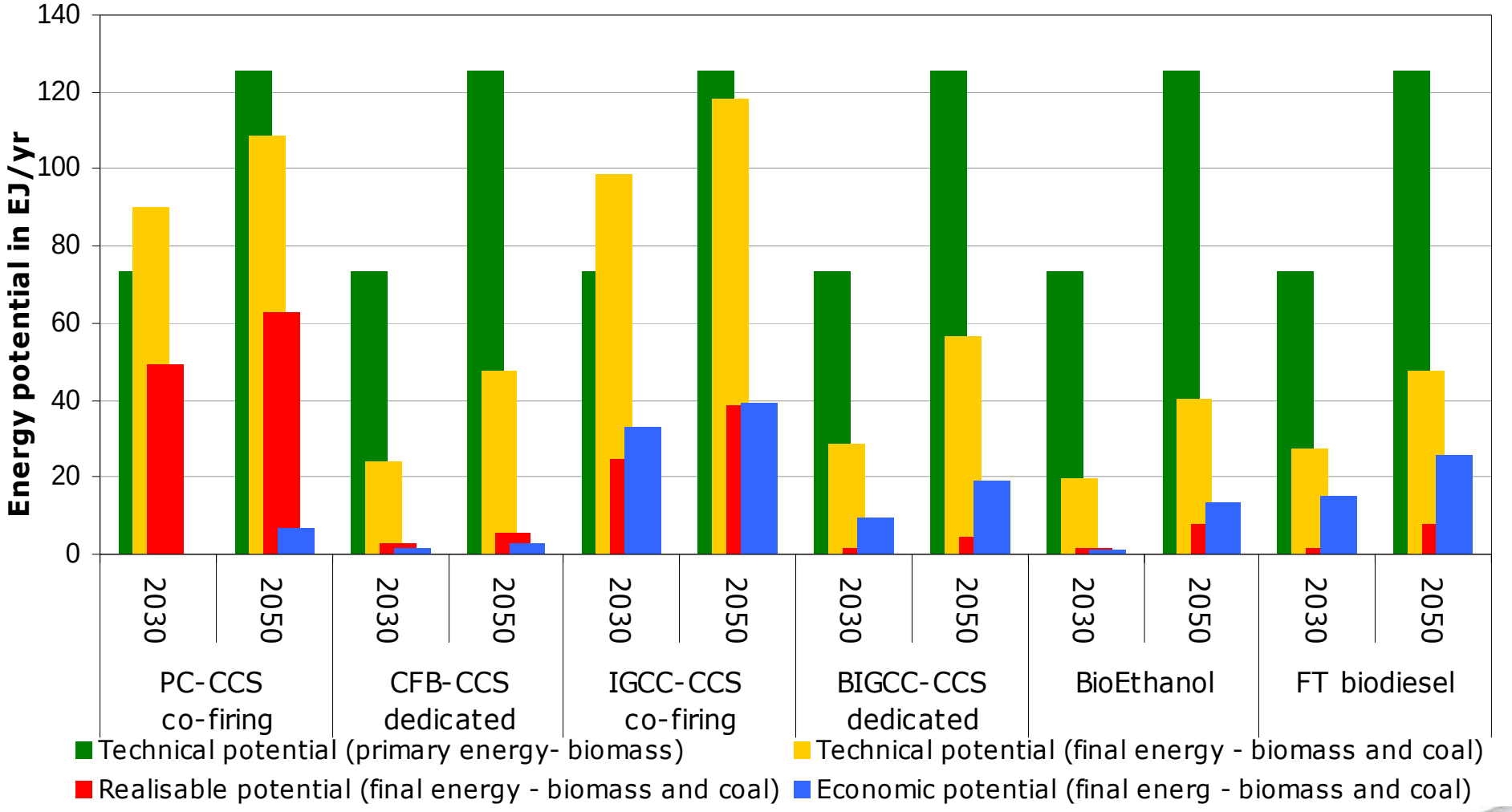


Adapted from Dehue 2006.

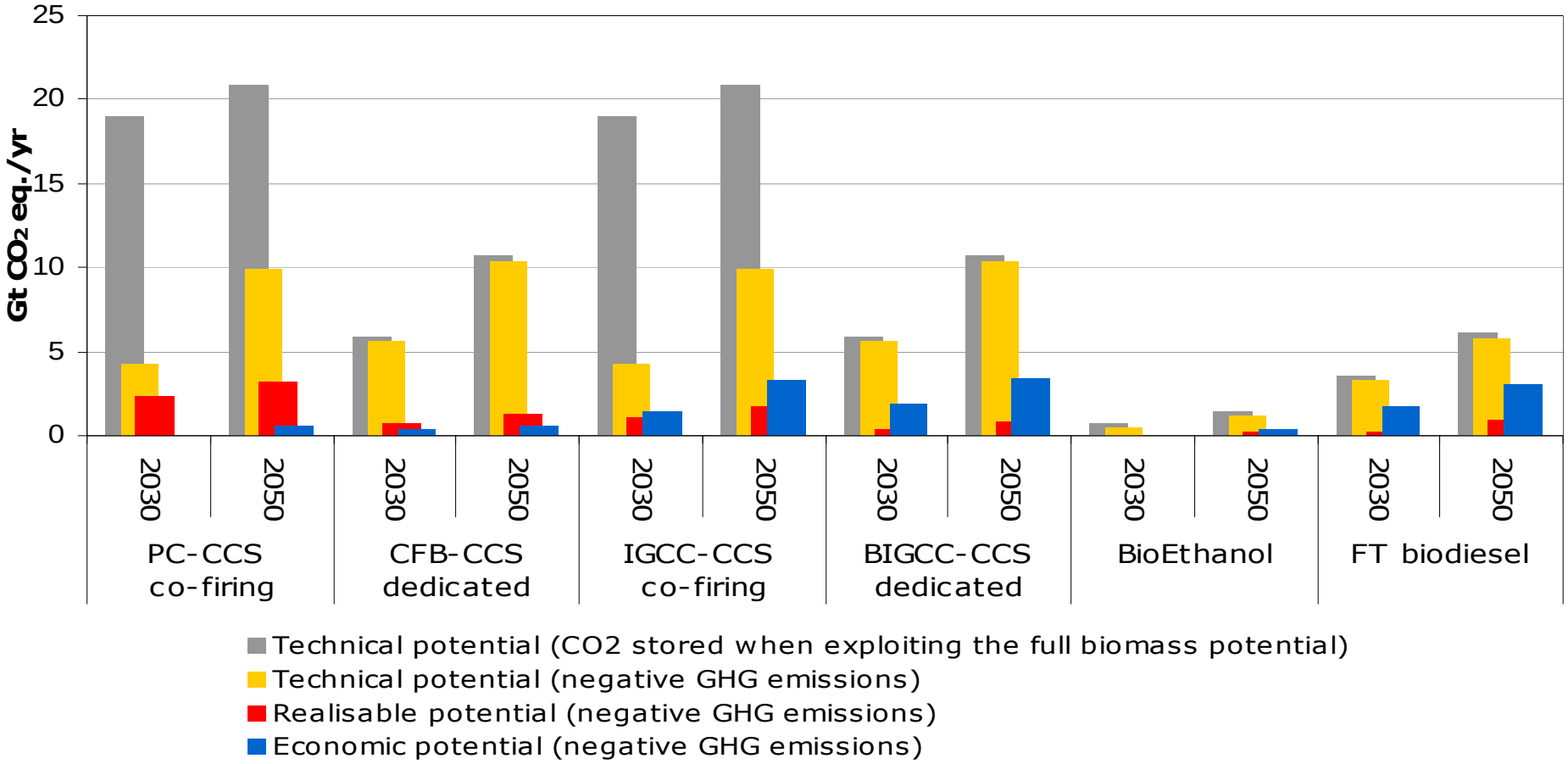
Regional Biomass Potential



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

Biomass CCS
Economic Incentives using Carbon Markets

Biomass CCS – Accounting for Negative Emissions

- ‘Negative’ emissions not generally recognised by low-carbon incentives, such as cap-and-trade emissions trading schemes

- ***We know the ‘need’***

- ***But do we know the solutions??***

National GHG Inventories

- IPCC GHG Guidelines (2006) for countries to report their GHG inventories, Vol 2 Energy
- Combustion Chapter 2 – "*If the plant is supplied with biofuels, the corresponding CO2 emissions will be zero, so the subtraction of the amount of gas [captured and] transferred to long-term storage may give negative emissions. This is correct since if the biomass carbon is permanently stored it is being removed from the atmosphere*".
- CCS Chapter 5 – "*Negative emissions may arise……if CO2 generated by biomass combustion is captured. This is a correct procedure and negative emissions should be reported as such*."

EU Emissions Trading Scheme

- EU ETS Directive 2009 – EUAs

- Cap and Trade scheme requires surrendering of EUAs for any emissions from installation, maximum benefit when emissions equal zero. What about negative emissions?
- Art 10a – free allocation can be given to biomass CCS, but not to any electricity production
- So industrial use of biomass CCS OK? use of benchmarks
- Annex 1.1 – 100% biomass use not covered by Directive
- Article 24a – EUAs can be given to activities reducing GHGs outside ETS, given not in respect of emissions. Needs host govn to apply.
- Creates uncertainty, needs clarification

Joint Implementation (UNFCCC)

- JI-ERUs

- Bilateral project-based mechanism between developed countries
- Co-operation with host govn – allocates from AAUs and converts AAUs to ERUs for project – could work for biomass CCS
- Domestic (unilateral) projects? Not currently enabled

Clean Development Mechanism

- CDM – CERs

- Project-based mechanism in developing countries
- CERs allocated for emissions reductions below baseline – could work for biomass CCS. Durban - CCS now yet recognised for CDM

- Copenhagen CMP5 – invited new methodologies for net reduction technologies

- Sustainable development

Conclusions – the need

- Carbon accounting and Biomass CCS could work at country level
- Needs to take into account biomass fuel cycle emissions and sustainability
- But at project level there are: limitations; uncertainty; lack of being tested; complexities due to different industry sectors
- Needs clarification or changes in accounting frameworks
- Other incentive options include feed-in-tariffs, green certificates – dependant upon national policy situation

What next.....

- IEA CCS Unit - some work underway by on accounting guidelines (under IPCC) to include ‘incomplete’ accounting from biomass fuel cycle emissions and sustainability, and incentives for Bio-CCS
- IEAGHG study - will look at carbon accounting options, and draw upon IEA CCS Unit accounting guidelines and incentives work on Bio-CCS
- EBTP/ZEP Joint Taskforce Bio-CCS – Concept document (Strategic Research Agenda) for a policy audience – will have chapter on Deployment Issues – incentives!

Thank You