Biomass and CCS

Global potential and GHG accounting

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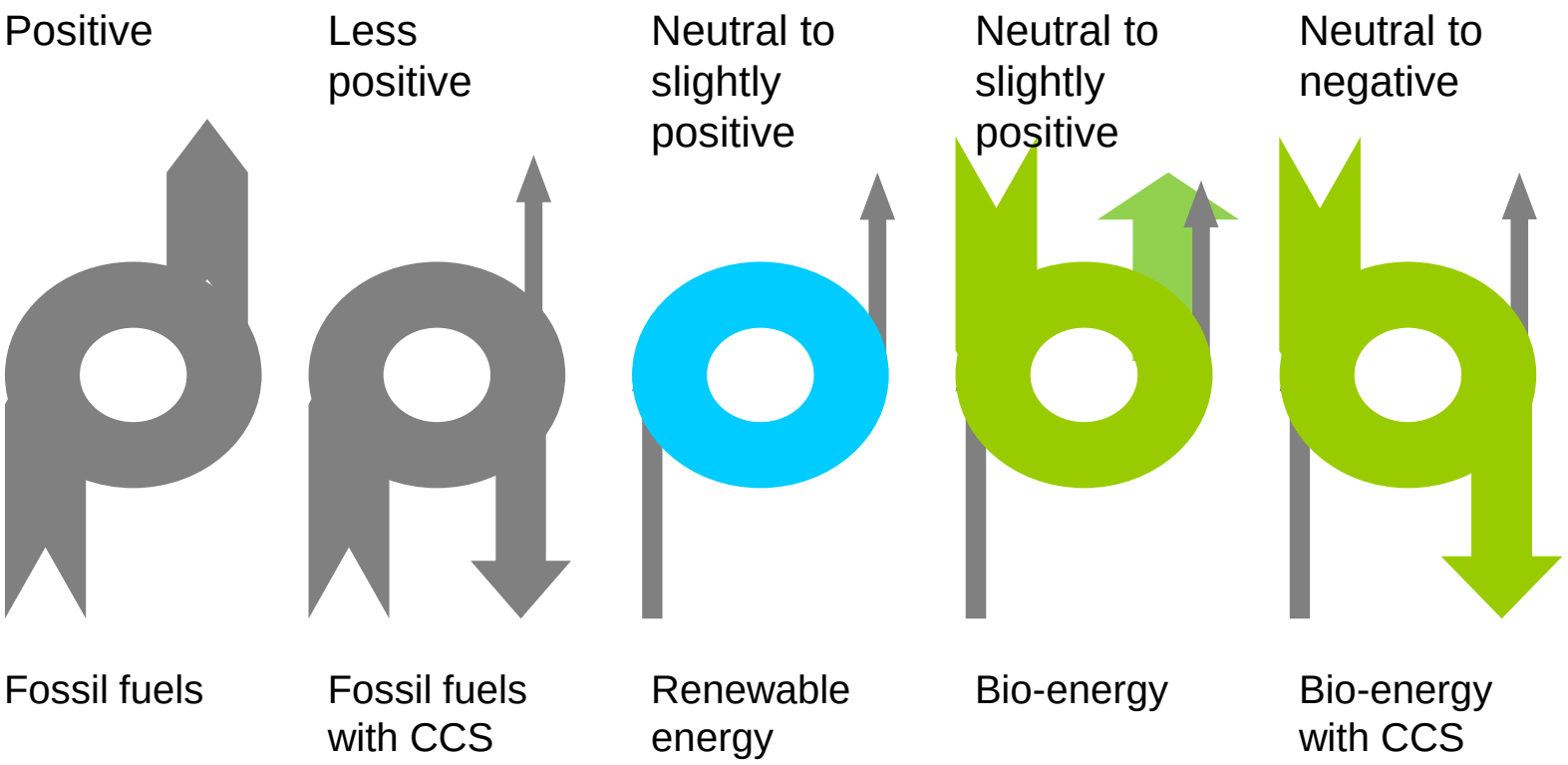
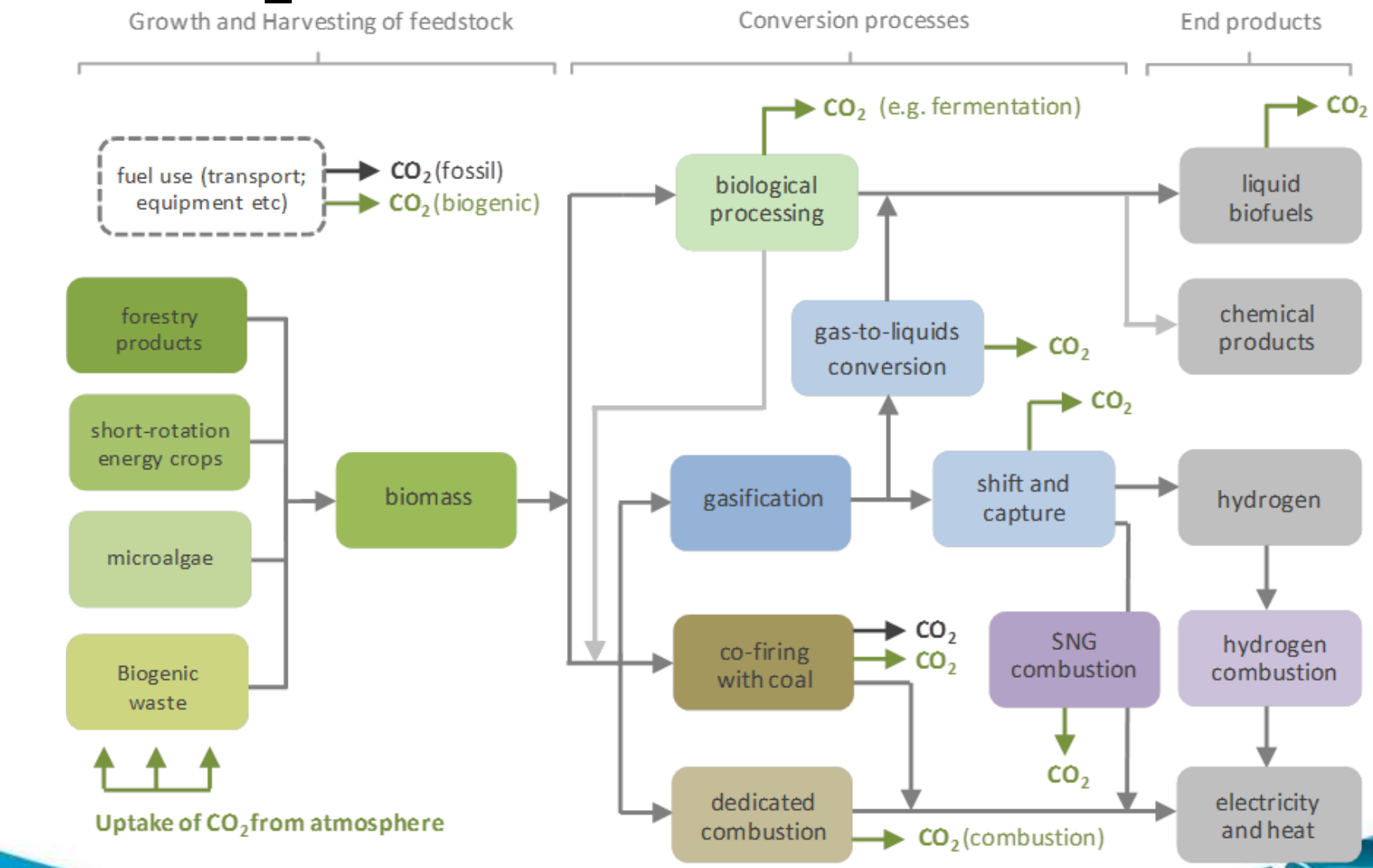
Carbon balance of different energy systems



Koornneef, ECOFYS 2010

Bioenergy pathways & sources of CO_2



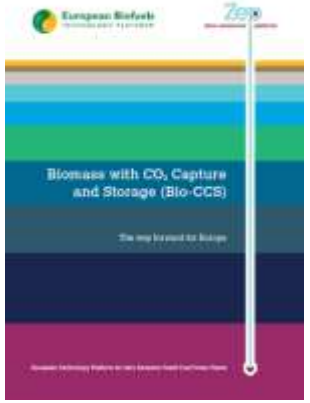
Carbon Counts 2014 (adapted from Rhodes and Keith, 2005)

Recent work

- IEAGHG studies:
  - „Potential for biomass and carbon dioxide capture and storage“ (Ecofys, July 2011)
  - „Potential for biomethane production with carbon dioxide capture and storage“ (Ecofys, September 2013)
  - „Biomass and CCS – guidance for accounting for negative emissions“ (Carbon Counts, publication in progress)

http://www.ieaghg.org/publications/technical-reports

- Joint Taskforce on Bio-CCS
  - „Biomass and CO_2 Capture and Storage“ (EBTP & ZEP, 2012)



http://www.zeroemissionsplatform.eu/news/news/1407-biomass-with-co2-capture-and-storage-bio-ccs-the-way-forward-for-europe.html

European Biofuels TECHNOLOGY PLATFORM

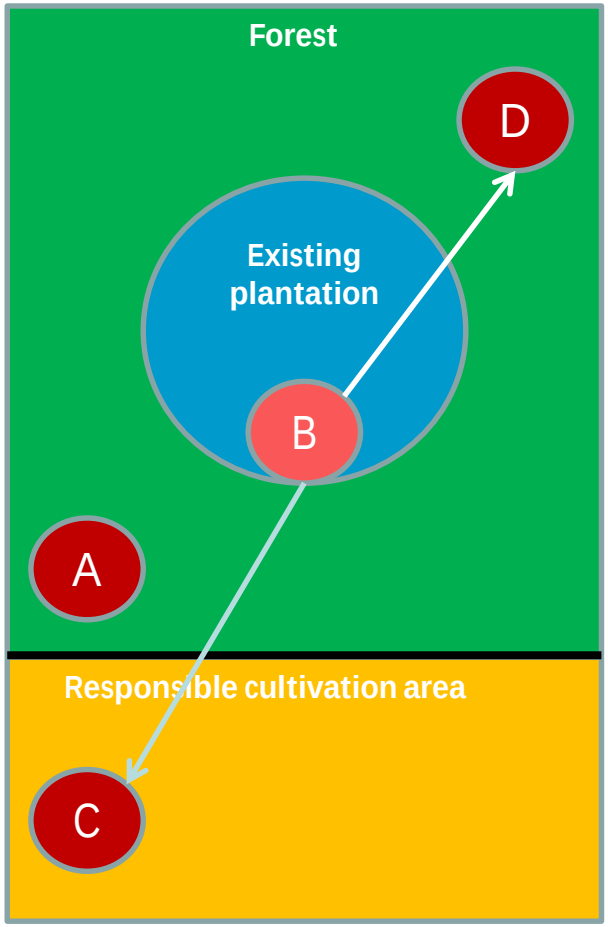
Zep Zero emissions platform

Potential for Bio-CCS: Study methodology

- First order assessment of potential for Bio-CCS in 2030 & 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.
- Six technology options selected for detailed analysis:
  1) PC-CCS co-firing
  2) CFB-CCS dedicated
  3) IGCC-CCS co-firing
  4) BIGCC-CCS dedicated
  5) Bio-ethanol advanced generation
  6) FT biodiesel

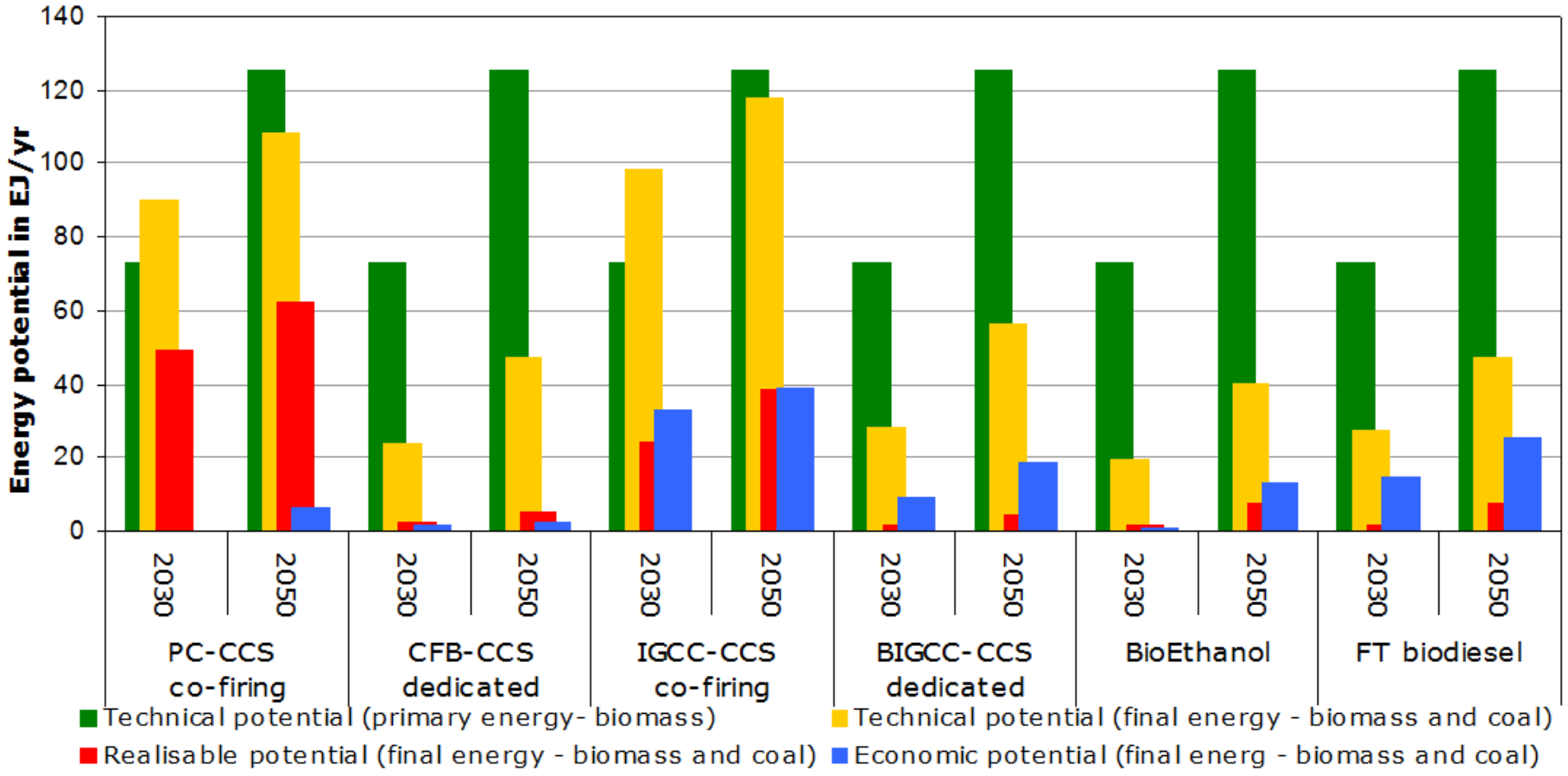
Sustainability criteria

- Sustainability criteria 'strict'
- Factors include:
  - Labour conditions
  - Protection of areas with high ecological, historical or cultural value
  - Food prices and security
  - Avoidance of direct and indirect land use change (dLUC & iLUC)
  - Water supply and quality
  - Land rights of local communities
- Competition for land (and food prices) as well as dLUC/iLUC are key areas of debate.

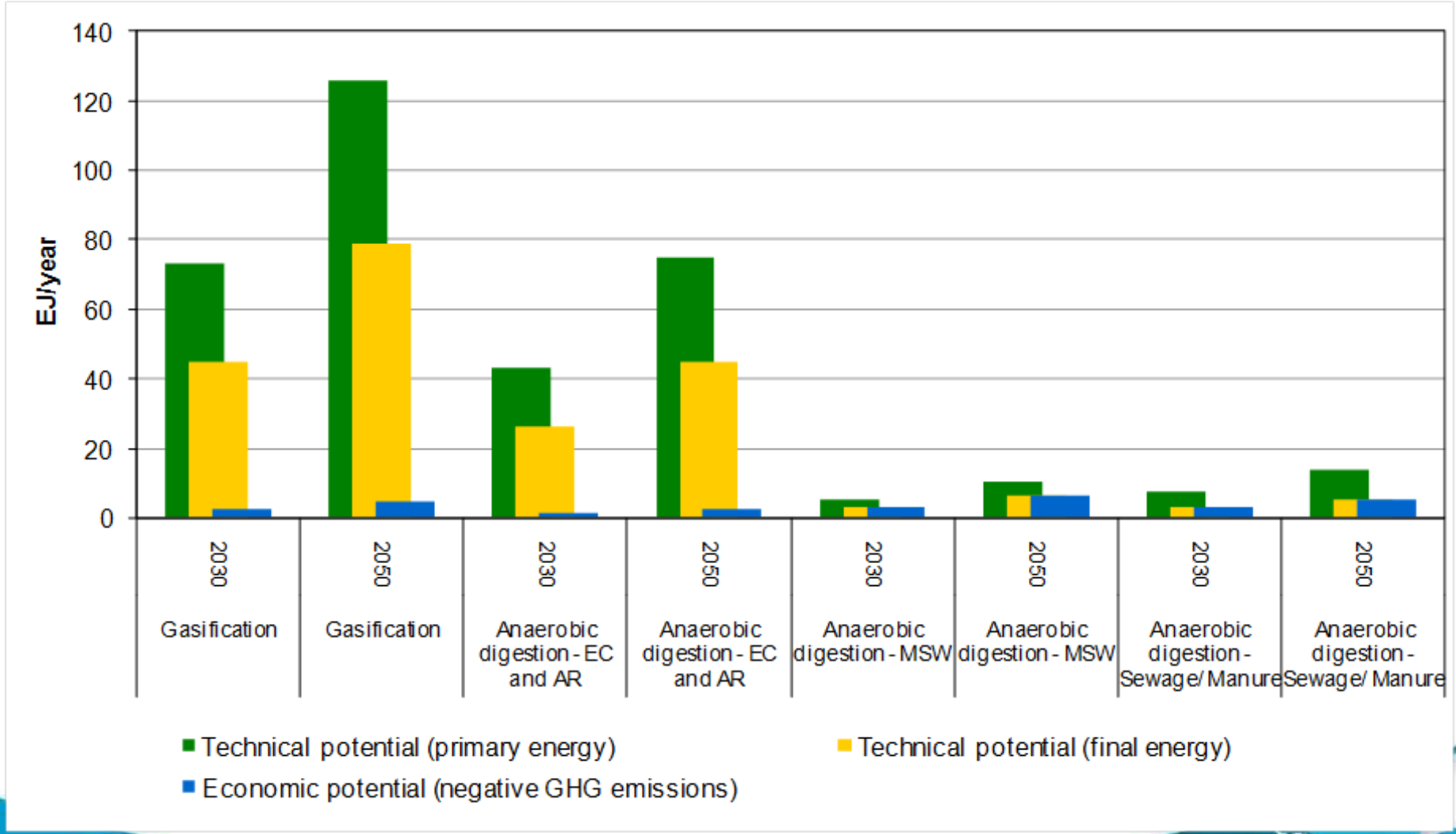


Adapted from Dehue 2006

Energy potential for Bio-CCS

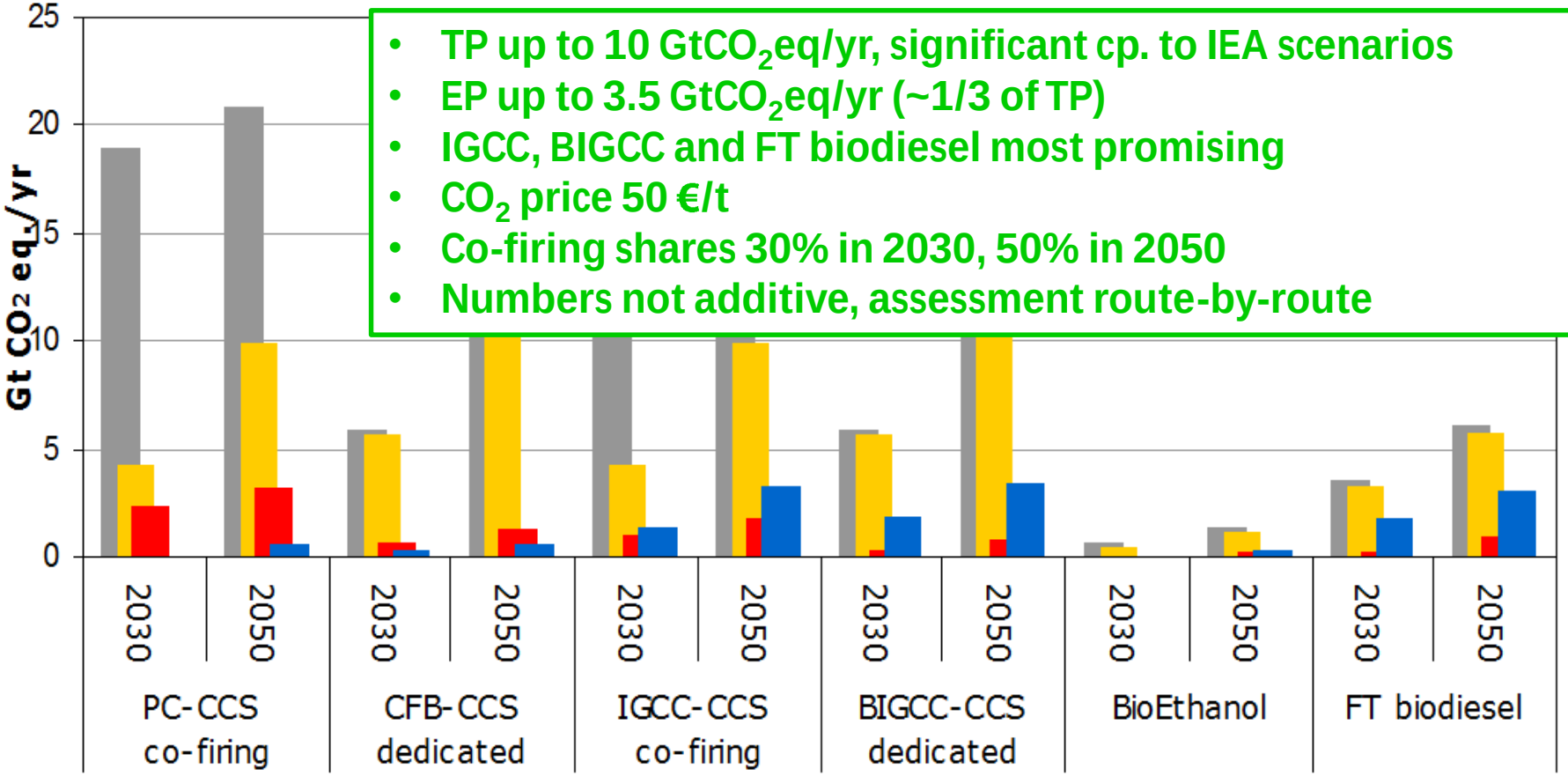


Energy potential for biomethane routes



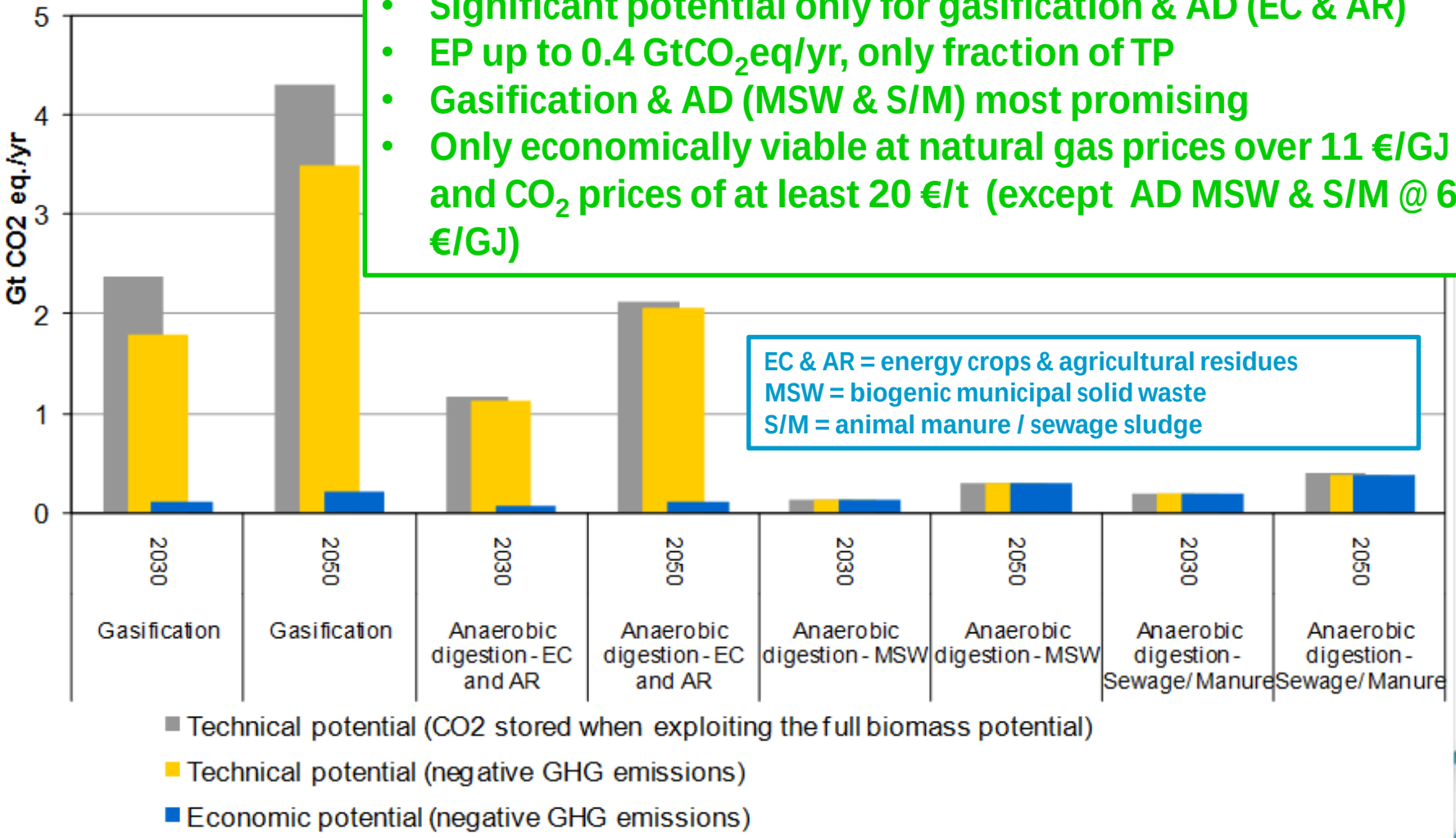
Negative emissions potential for Bio-CCS

- TP up to 10 $GtCO_2eq/yr$, significant cp. to IEA scenarios
- EP up to 3.5 $GtCO_2eq/yr$ (~1/3 of TP)
- IGCC, BIGCC and FT biodiesel most promising
- CO_2 price 50 €/t
- Co-firing shares 30% in 2030, 50% in 2050
- Numbers not additive, assessment route-by-route



Negative emissions potential for biomethane routes

- TP up to 3.5 $GtCO_2eq/yr$, smaller than previous routes
- Significant potential only for gasification & AD (EC & AR)
- EP up to 0.4 $GtCO_2eq/yr$, only fraction of TP
- Gasification & AD (MSW & S/M) most promising
- Only economically viable at natural gas prices over 11 €/GJ and CO_2 prices of at least 20 €/t (except AD MSW & S/M @ 6.7 €/GJ)



Drivers & barriers for Bio-CCS

- CO_2 price
- Level of maturity of some Bio-CCS technologies
- Reliable supply of low-cost, sustainable biomass
- More positive publilc perception than Fossil-CCS
- Existence of suitable infrastructure
- Presence of CCUS options

webdesigningz.com, wipomo.com, www.dreamstime.com

Accounting for negative emissions from Bio-CCS

GHG schemes & accounting rules reviewed:

- 2006 IPCC Guidelines
- Kyoto Protocol CDM
- Kyoto Protocol JI
- EU ETS
- EU RED
- EU FQD
- US GHGRP
- California ETS
- California LCFS
- Australia CPM

Recognising & attributing negative emissions

Scheme	CCS	Biomass growth/ harvesting/ combustion/ processing	dLUC/iLUC	Life cycle emissions	Negative emissions
2006 IPCC Guidelines	✓	✓	✓	✓	✓
EU ETS	✓	✓	✗	✗	✗
EU RED/FQD	✓	✓	✓	✓	✓
GHGRP	✓	✓	✗	✗	✓
California ETS	✗	✓	✗	✗	✓
California LCFS	✓	✓	✓	✓	✓
Australia CPM	✓	✗	✗	✗	✗
CDM/JI	✓	✓	✓	✓	✓

Recognising & attributing negative emissions

Almost all reviewed schemes allow for negative emissions, except the EU ETS and the Australia CPM.

- EU ETS
  - Only „fossil carbon“ emissions can be deducted from GHG inventory
  - Installations exclusively using biomass are excempted
  - Options to address these shortfalls:
    - Amending the EU ETS MMR to include biogenic CO_2
    - Proposing new monitoring & reporting guidelines for Bio-CCS
- California ETS
  - Does not allow for negative emissions as an appropriate quantification methodology for CCS does not exist yet within the scheme

Rewarding negative emissions

Benefits of negative emission technologies:

- Offsetting the more difficult to abate emission sources
- Reducing the overall cost of mitigation
- Offsetting legacy or historical emissions
- Putting a price ceiling on CO_2 emissions reductions

Considerations for rewarding appropriately:

- Level of reward for negative emission technologies
  - Potential dLUC/iLUC and sustainability impacts of bioenergy
  - Potential for carbon leakage

The term „negative emission“ elicits the idea of a „double dividend“:

1) Zero emission from the biomass part
2) Negative emission from the CCS part

Rewarding negative emissions

Challenges for incentivising Bio-CCS:

- Debate wether negative emissions should be given additional subsidies or a double credit per tCO_2 captured and stored
- Benefit from biomass is typically forgone under certain schemes, as it is inherently included in the baseline
- ➢ Bio-CCS competes on a per tCO_2 reduction basis with other options

Approaches for rewarding appropriately:

- Pooling
- Crediting system
  - ➢ Domestic or community offset projects (DOP/COP) under EU ETS
  - ➢ Scope for the use of JI under EU Effort Sharing Decision

Land use change effects

Concerns related to C stock changes caused by LUC:

- EU ETS, California ETS & EU RED/FQD are believed to accelerate the clearing of forests in developing countries
- Assymmetry between GHG and AFOLU accounting rules

Two core challenges for measuring dLUC/iLUC:

- Lack of data
- Reporting requirements

Two approaches exist to address these issues:

- Quantitative approaches
- Qualitative approaches

Land use change effects

Significant controversy has arisen regarding the promotion of biofuels in jurisdictions such as the US and EU.

→ Bioenergy can be imported into regulated jurisdictions and GHG benefits accrued without consideration of upstream emissions and dLUC/iLUC effects (e.g. under EU ETS)

- Effect of energy crop cultivation on:
  - Land degradation
  - Loss of C stocks as a result of related LUCs

→ Robust monitoring system for LULUCF and REDD needed

→ At present these are patchy and poorly implemented

→ LCFSs and California ETS are exceptions

Conclusions & recommendations

- Bio-CCS has significant potential for negative emissions
- Challenges for Bio-CCS accounting & rewarding:
  - Sustainability of biomass
  - Emissions along the value chain
  - Direct and indirect land use change
- Discussions regarding support measures for Bio-CCS should address dLUC/iLUC and other sustainability issues
  - Creditability of negative emissions and GHG accounting schemes
  - Be mindful of the parity of treatment: biomass vs. fossil fuels
- Assessment and amendment of GHG accounting rules with regards to Bio-CCS is needed
  - Might result in complex political process
- Competitive environment for Bio-CCS
- Further research & development of policy recommendations

Thank you, any questions?

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