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# The Greenhouse gas balance of biofuels

Basic principles, main results and  
recommendations

Bettina Kampman, June 7, 2006



# Overview of the presentation

- Greenhouse gas emissions of biofuels
  - Some background information
- Results and conclusions
  - Greenhouse gas balances of biofuels
- Recommendations
  - How to achieve the full GHG reduction potential of biofuels?



# CE Delft

- Independent research and consultancy organisation
- Specialised in developing innovative solutions to environmental problems
- ± 40 staff, based in Delft (NL)
- Key themes:
  - Transportation
  - Energy
  - Government policy
  - Industry policy
  - Strategic consultancy



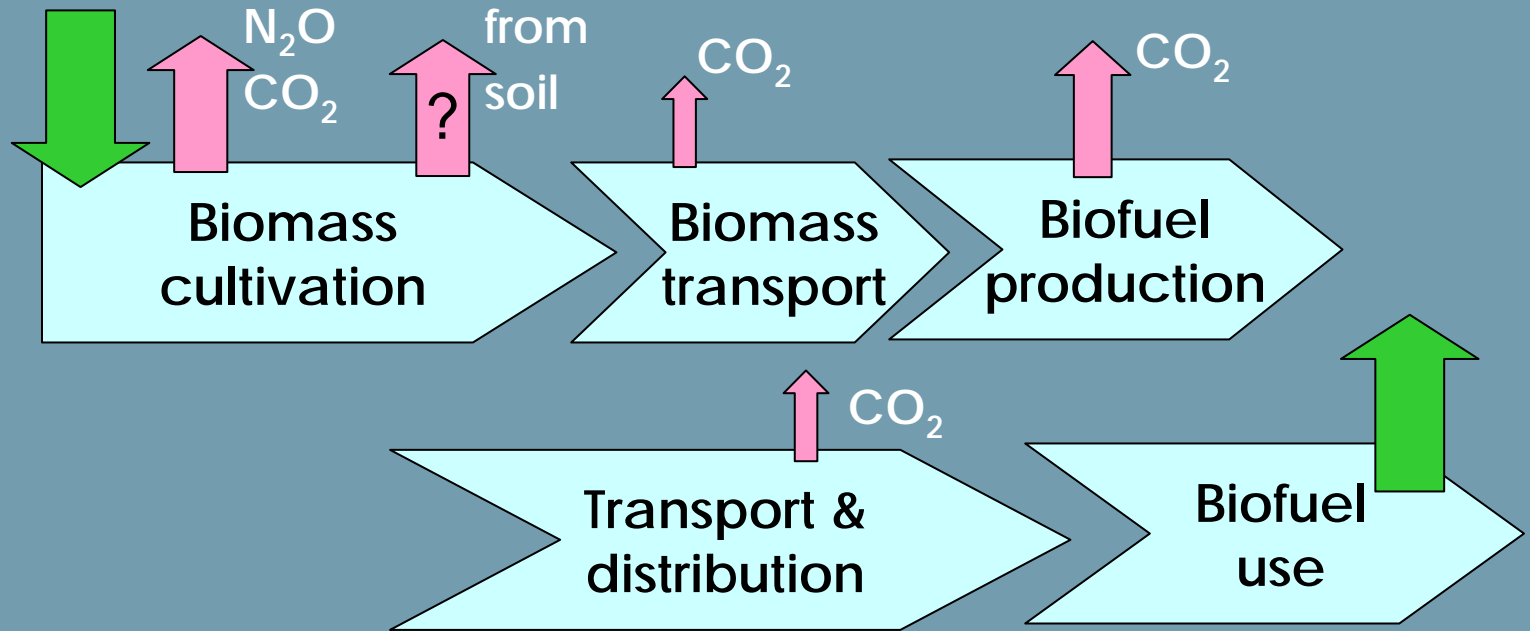


# Greenhouse gas emissions of biofuels

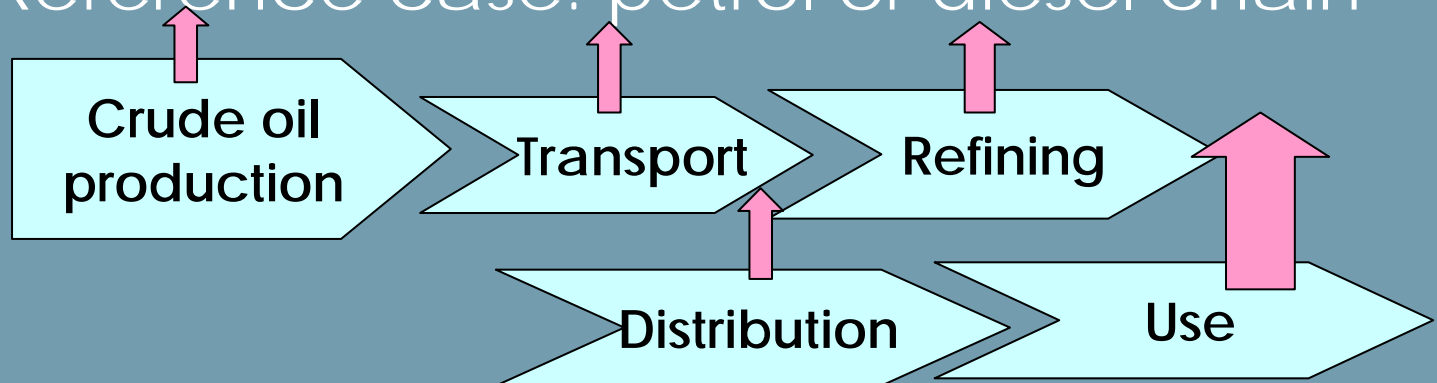
Some background information



# GHG emissions in the biofuels chain



## Reference case: petrol or diesel chain

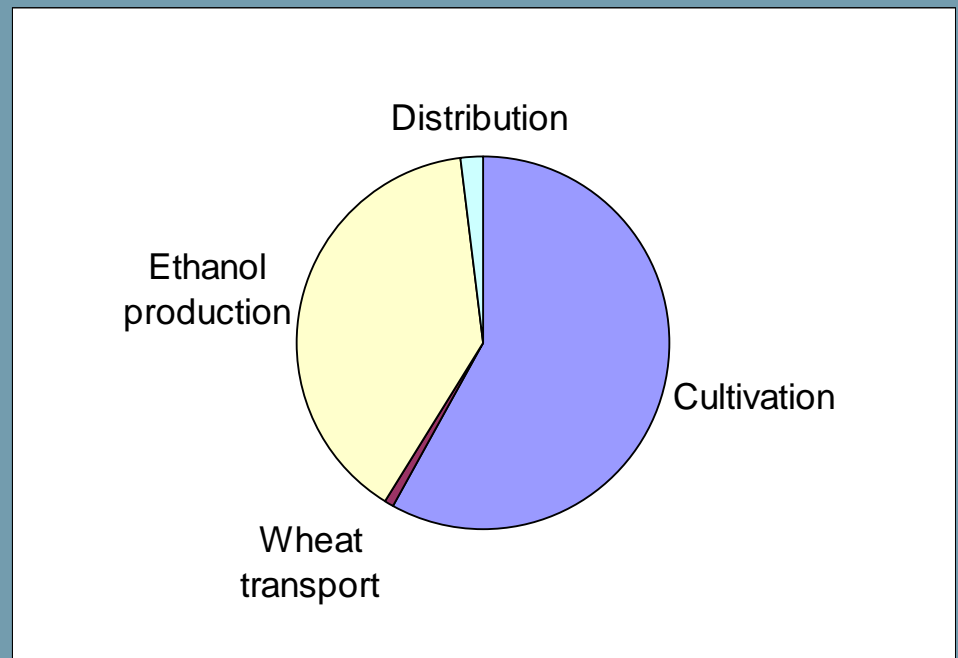




# Main factors that determine the GHG balance of a biofuel

- Biomass cultivation/fertilizer use
- Energy efficiency biofuel production
- Carbon emissions from the land
  - in case of deforestation

Example:  
ethanol from  
grains, no  
deforestation





## GHG balances – often result in significant ranges (and debate)

- Ranges in emissions from cultivation
  - variations in fertilizer use, yield, land type, climate, weather, etc.,
  - uncertainties
- Ranges in production emissions
  - differences in energy efficiency of production facilities
- Results from different studies may vary
  - differences in assumptions, byproduct treatment, reference cases, ...



## However ...

- Many life cycle analyses of biofuels have been performed
- General consensus about main issues and methodology



# How to compare the GHG balance of biofuels?

- GHG balance of the fuel:  
*GHG emission reduction per GJ fuel*
- Land use efficiency:  
*GHG emission reduction per hectare*
- Cost effectiveness:  
*Euro per tonne CO<sub>2</sub> reduced*



# What biofuels are we talking about?

- Currently available biofuels:
  - Biodiesel
    - from rapeseed, palm oil, etc.
  - Bio-ethanol
    - from grain, sugar beet, sugar cane
  - ETBE from bio-ethanol
- Biofuels under development:
  - Bio-ethanol (and ETBE)
    - from cellulosic biomass
  - Fischer-Tropsch diesel
    - from cellulosic biomass
  - HTU diesel (Hydrothermal Upgrading)
    - from wet biomass

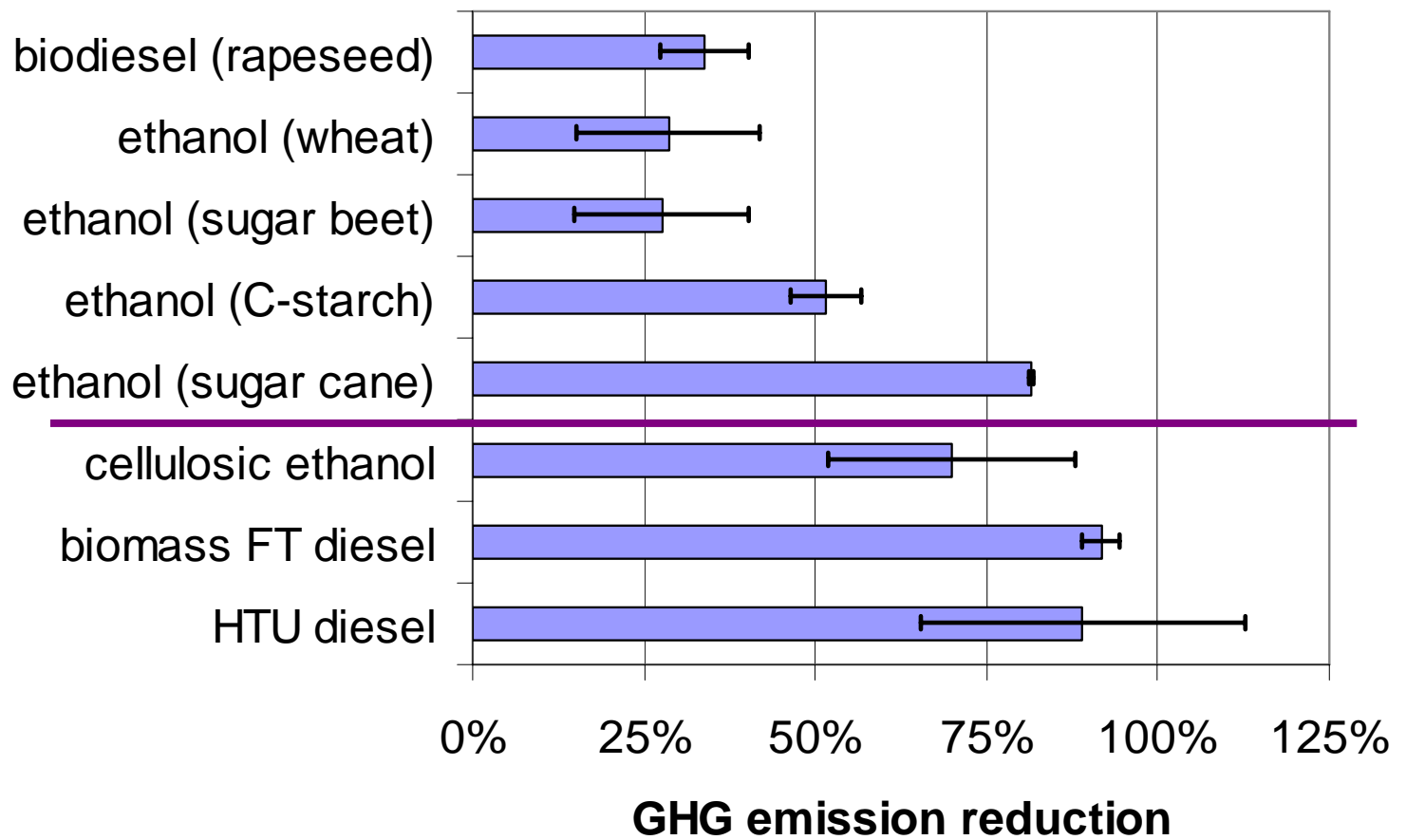


# Results

Greenhouse gas balances of  
biofuels

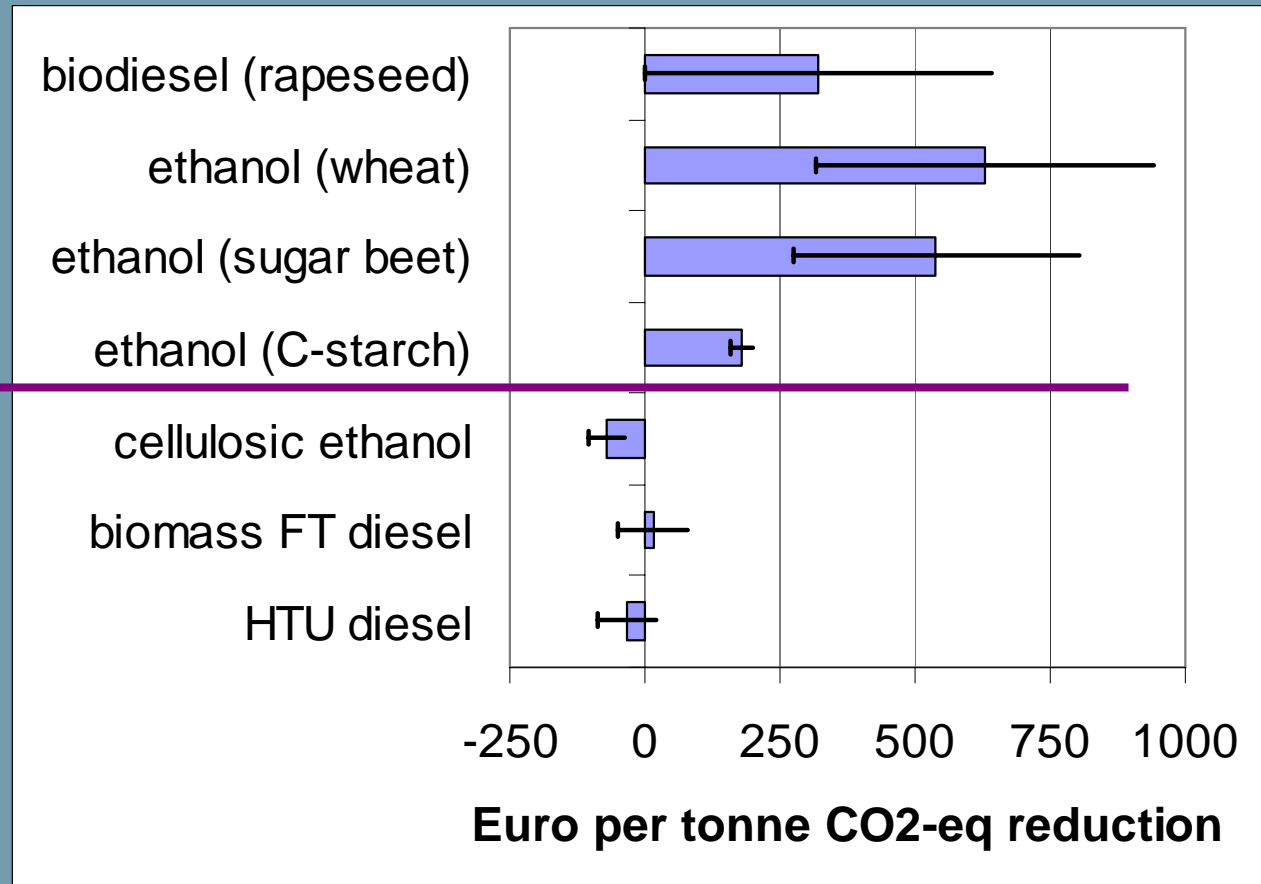


# GHG emission reduction, per unit of petrol/diesel





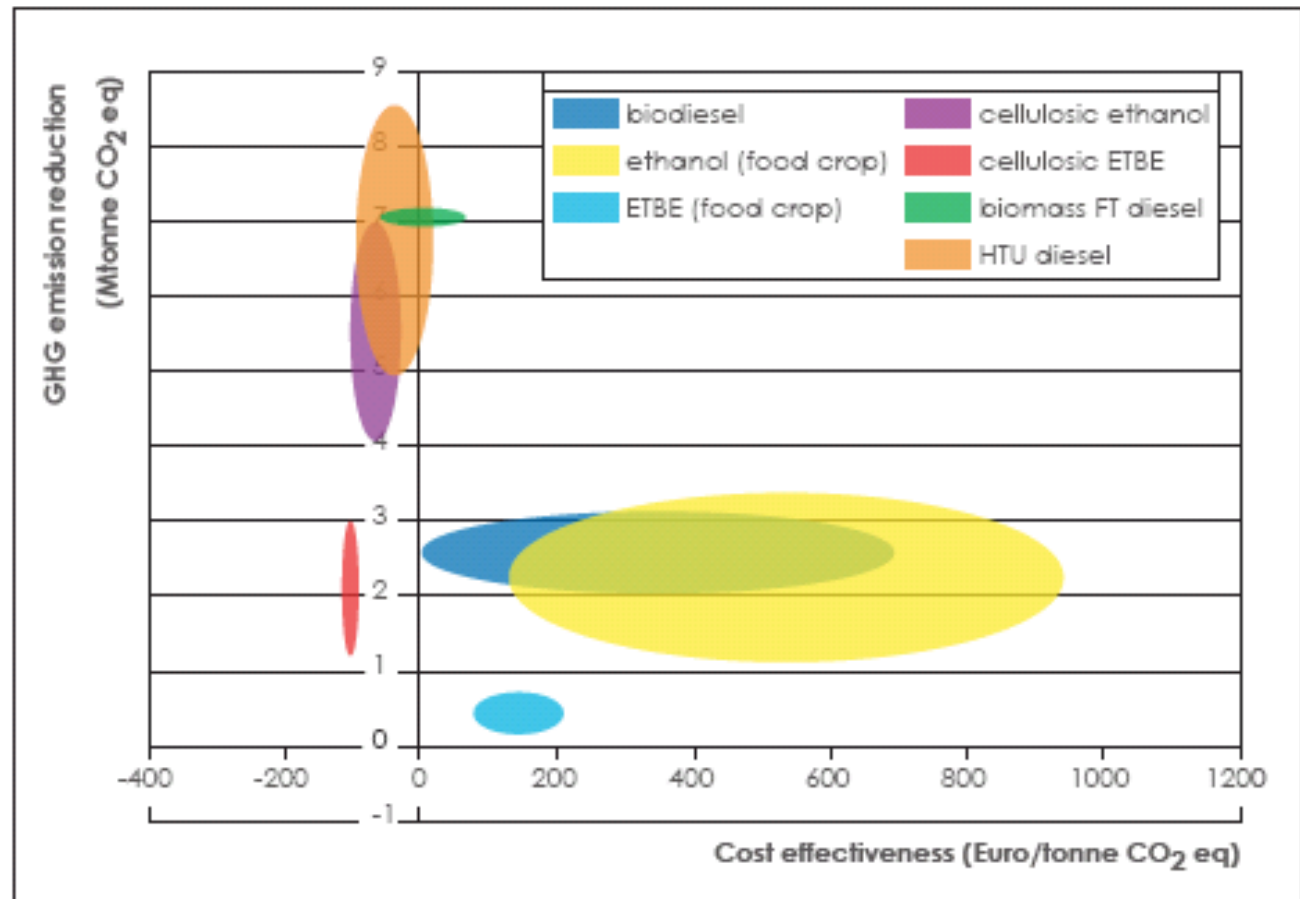
# Costs per tonne CO<sub>2</sub> reduction (cost effectiveness)



At appr. \$60/barrel



# Scenario: Biofuel 20% of all transport fuels in NL, 2020



At appr. \$60/barrel



# Biofuels from cellulosic biomass: when?

- Commercial-scale installations within 5-10 years
  - if technological bottlenecks are resolved
  - if efforts and funding are sufficient
  - >> depends on government policies
- R&D efforts are significant and increasing
  - Iogen, Choren, Nedalco, ...



# Conclusions

- GHG reduction differs significantly between biofuels
- Many of the current biofuels only achieve 30-40% GHG reduction on average
- Some perform better
- Biofuels from cellulosic biomass look very promising
  - not yet commercially available, but research is ongoing



# Recommendations

How to achieve the full GHG reduction potential of biofuels?



## Achieving the GHG reduction potential of biofuels requires:

- Improving the GHG balance of the fuels  
*(GHG reduction per GJ fuel)*
  - Improving the land use efficiency  
*(GHG reduction per hectare)*
  - Optimisation of cost effectiveness  
*(Euro per tonne CO<sub>2</sub> reduced)*
- >> Achieving the full potential requires government incentives!



## Recommendation: Active role of governments

- Implement policies that
  - a) provide market incentives for fuels with higher GHG reduction
  - b) encourage sustainability improvements/demand meeting minimum criteria
  - c) provide long term certainty for investors
- >> Industry will invest in sustainable GHG reduction of current biofuels, and in R&D of new technologies



# Examples of policy incentives

- Financial incentives
  - differentiated according to GHG reduction
- Biofuels obligation, with weighing factor
  - USA, Canada: 1 l cellulosic ethanol = 2.5 l conventional ethanol
- Biofuels obligation, with average GHG emission reduction requirement
  - e.g., average GHG reduction 2010: 50%; 2015: 60%.



# Further recommendations

- Develop GHG reduction monitoring
  - Incentives require knowledge of the GHG balance of the biofuels
- Give clear signal that the goal is *climate neutral & sustainable* biofuels
  - not just any biofuel
  - this goal is achievable, but may take time
- Provide EU-wide incentives
  - to reduce cost
  - to develop a large market

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**Thank you!**

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