

Environmental impacts of various options of biofuels for transportation

Dr Guido Reinhardt

Seminar on Bioenergy: Food, Fuel or Forest ?

Wageningen NL, March 2nd 2007

Who we are - What we do



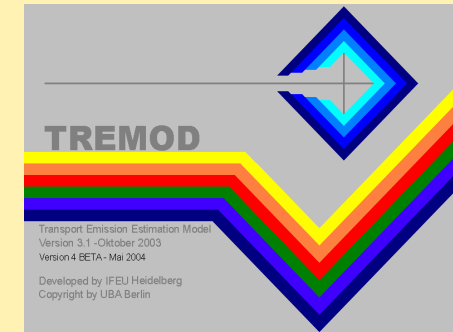
IFEU - Institute for Energy and Environmental Research Heidelberg, since 1978

- **Independent scientific research institute**
- **organised as a private non profit company with currently about 40 employees**
- **Research / consulting on environmental aspects of**
 - **Energy (including Renewable Energy)**
 - **Transport**
 - **Waste Management**
 - **Life Cycle Analyses**
 - **Environmental Impact Assessment**
 - **Renewable Resources**
 - **Environmental Education**

Who we are - What we do



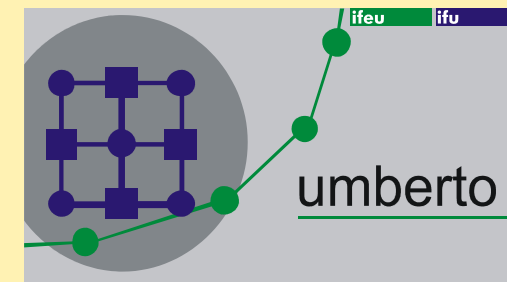
TREMOD: Transport Emission Model



- Modelling emissions of road vehicles, trains, ships and airplanes
- Official database of the German Ministries for emission reporting

Life cycle analyses (LCA) and technology impact assessments since 1990:

- Biofuels (all biofuels, all applications)
- Alternative transportation modes
- Renewable Energy



Who we are - What we do



IFEU - Institute for Energy and Environmental Research Heidelberg, since 1978

- **Our clients (on biofuel studies)**

- World Bank
- UNEP, GTZ etc.
- European Commission
- National and regional Ministries
- Associations (national and international)
- Local authorities
- WWF, Greenpeace etc.
- Companies (DaimlerChrysler, German Telekom, etc.)
- Foundations (German Foundation on Environment, British Foundation on Transport etc.)

Overview



- **Literature review about transport fuels**
- **Energy and greenhouse gas balances**
- **Further environmental impacts**
- **Summary and conclusions**

Biofuels for transportation



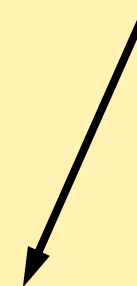
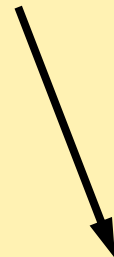
Environmental advantages and disadvantages:

+

- CO₂ neutral
- Save energetic resources
- Organic waste reduction
- Less transport
- etc.

-

- Land use
- Eutrophication of surface water
- Water pollution by pesticides
- Energy intensive production
- etc.



**Total:
positive or negative**

?

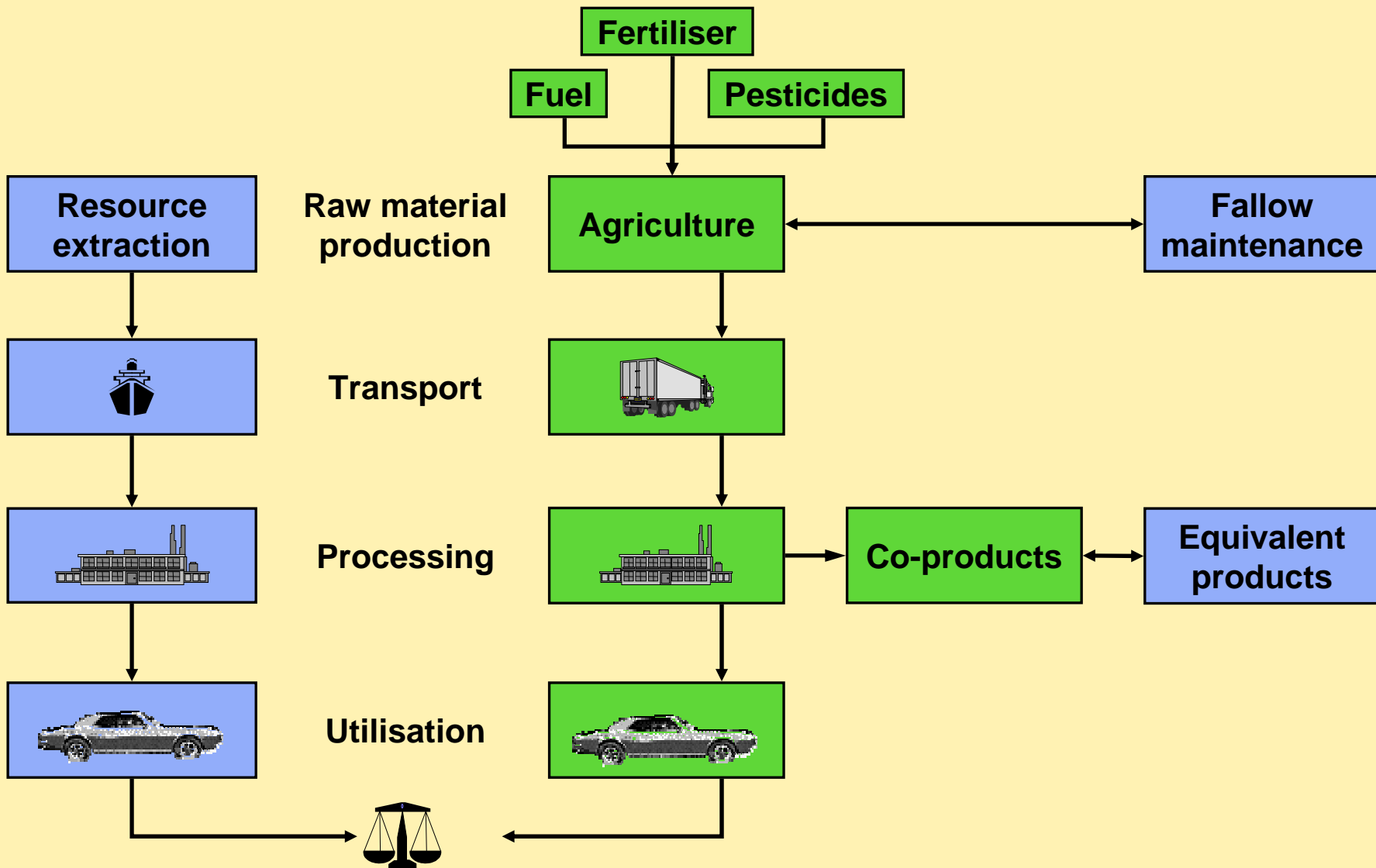
Life cycle comparison



Fossil fuel

Biofuel

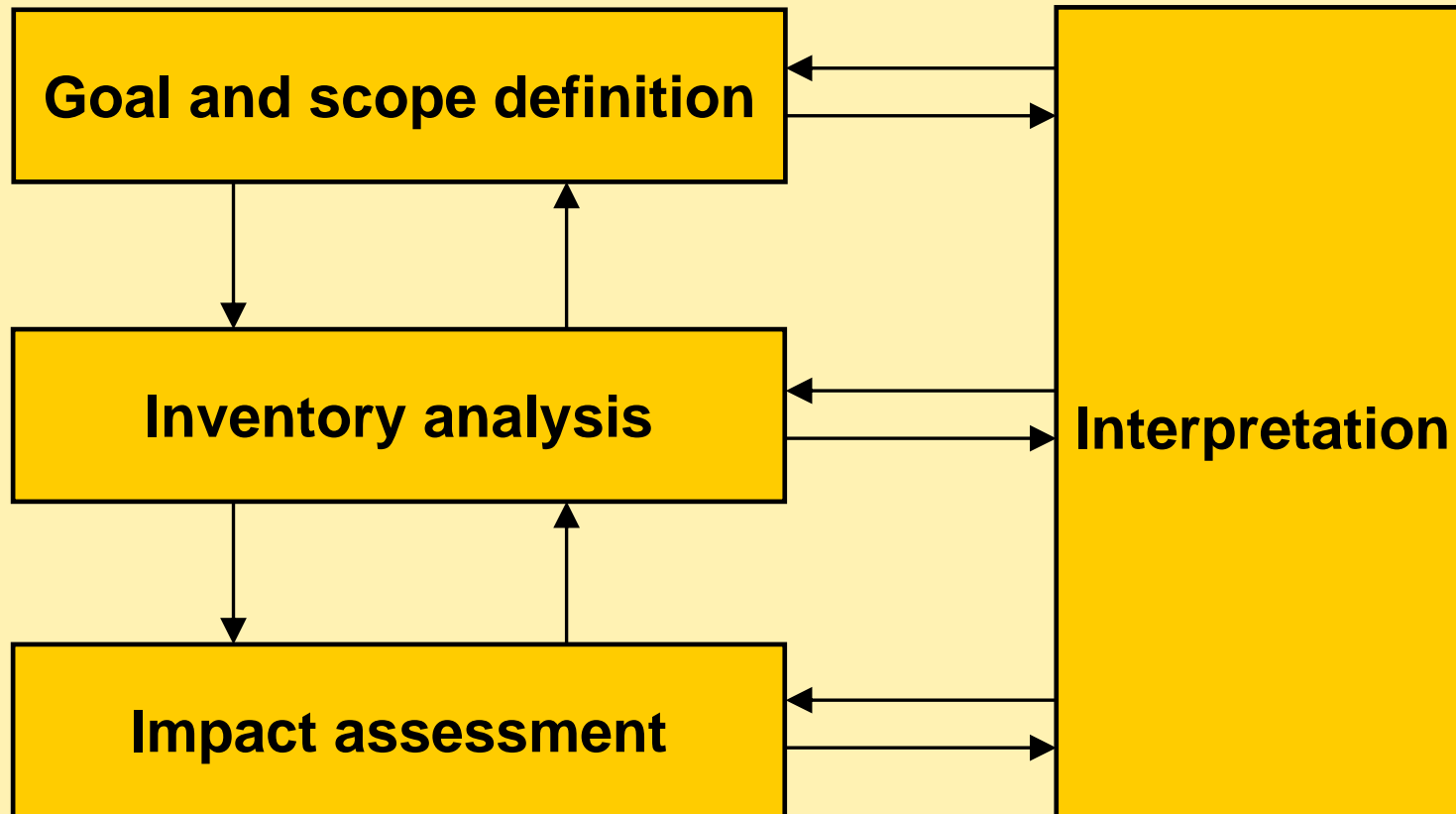
Credits

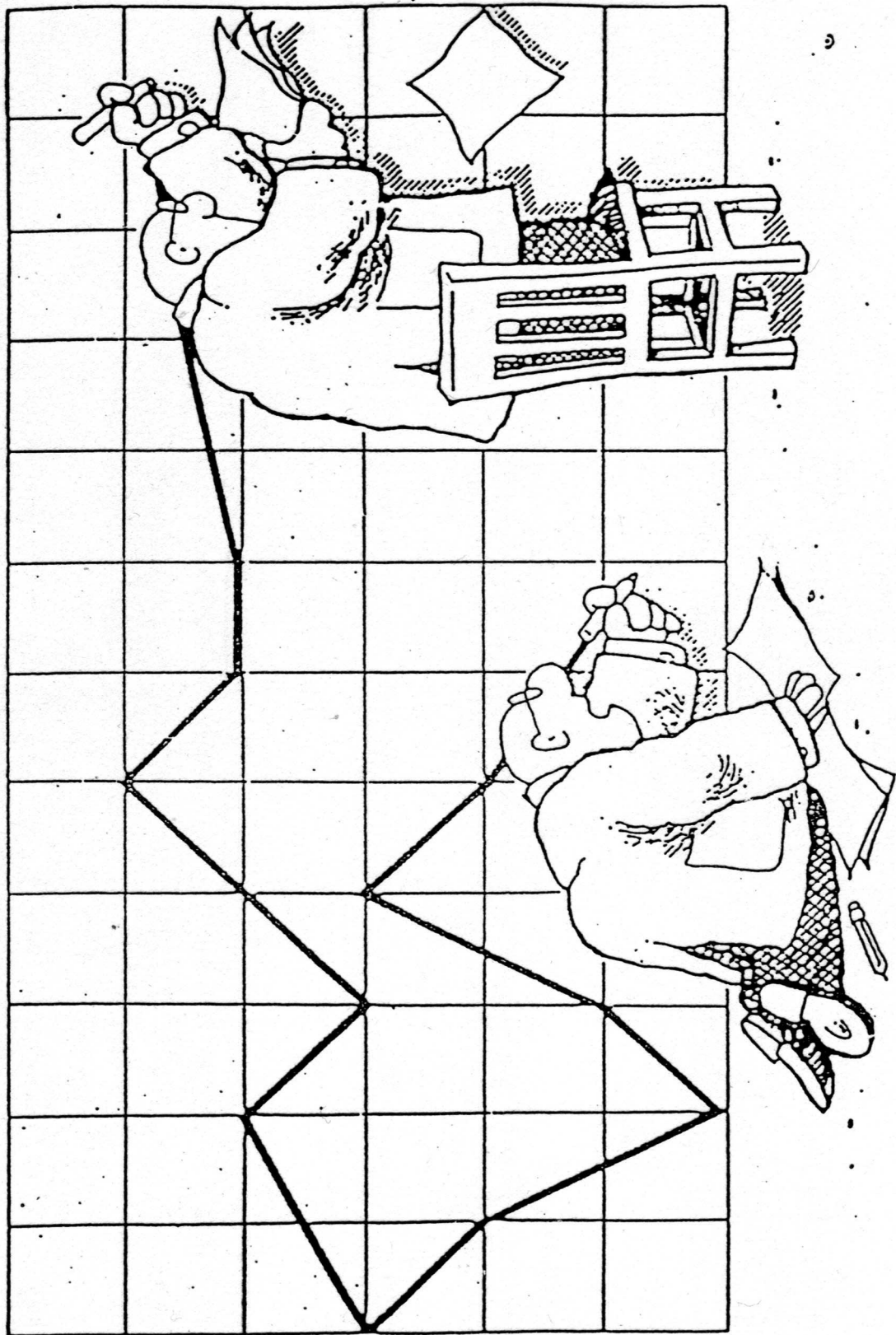


Life cycle analysis (LCA)



ISO 14040-43





"HEY, I THOUGHT WE WERE WORKING WITH THE SAME DATA..."

CO₂ Mitigation through Biofuels in the Transport Sector

– Status and Perspectives –

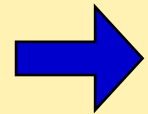
- **Analysis of all LCAs world wide published on current and innovative biofuels for transportation.**
- **Analysis of literature regarding costs and potentials.**
- **Conclusions including necessities for research.**

Download available from: www.ifeu.de

Further reports since then (selection):

- **VIEWLS-Project**, by SenterNovem et al., final report (2006)
- **WTW analysis of biofuels**, by JRC et al., final report (2006)
- **Life cycle assessments of BtL**, by IFEU, final report (2006)
- **Palm oil for bioenergy: Status quo and perspectives**, by IFEU & WI, in print (2007)

Overview

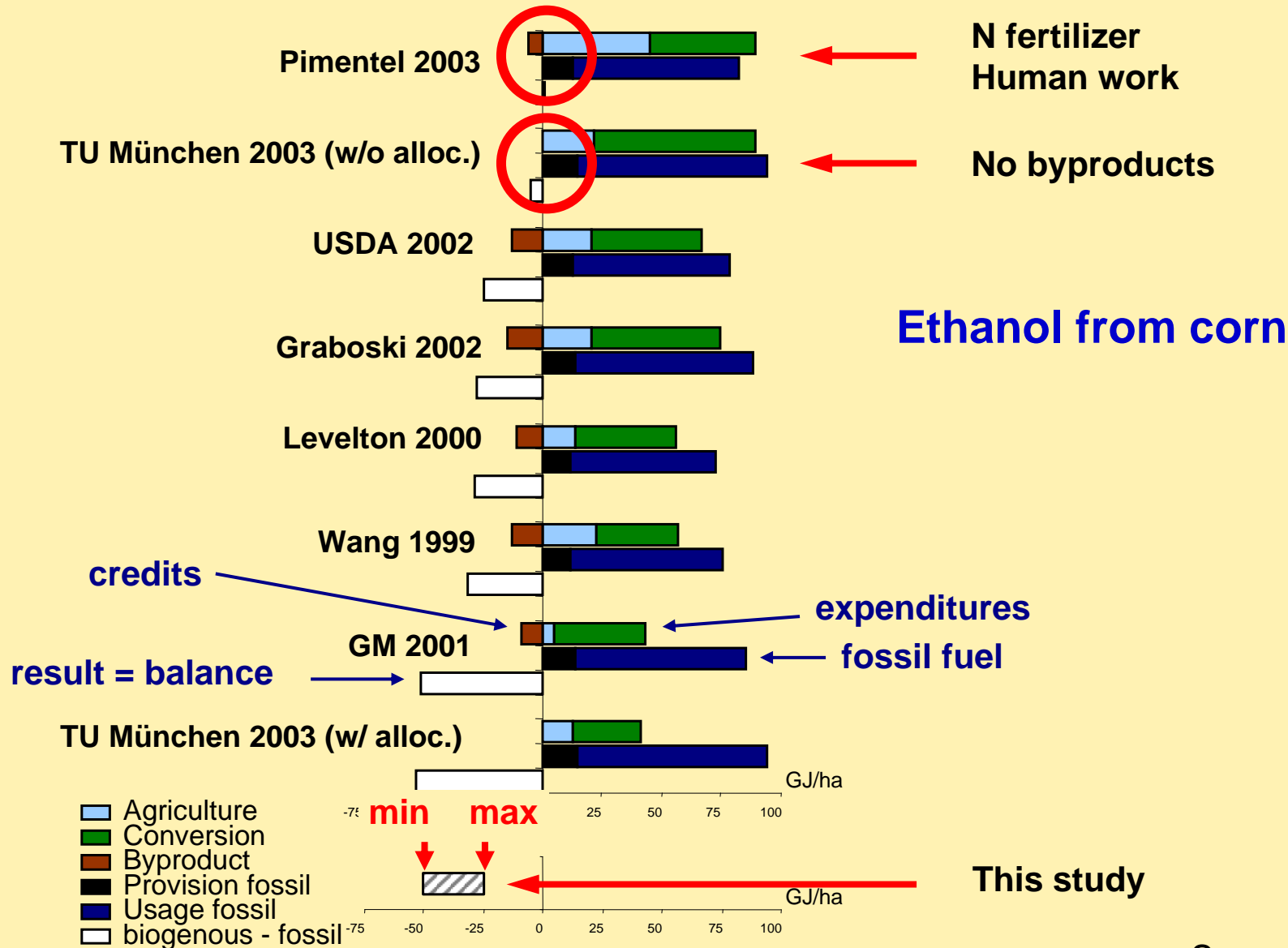


- Literature review about transport fuels
- **Energy and greenhouse gas balances**
- Further environmental impacts
- Summary and conclusions

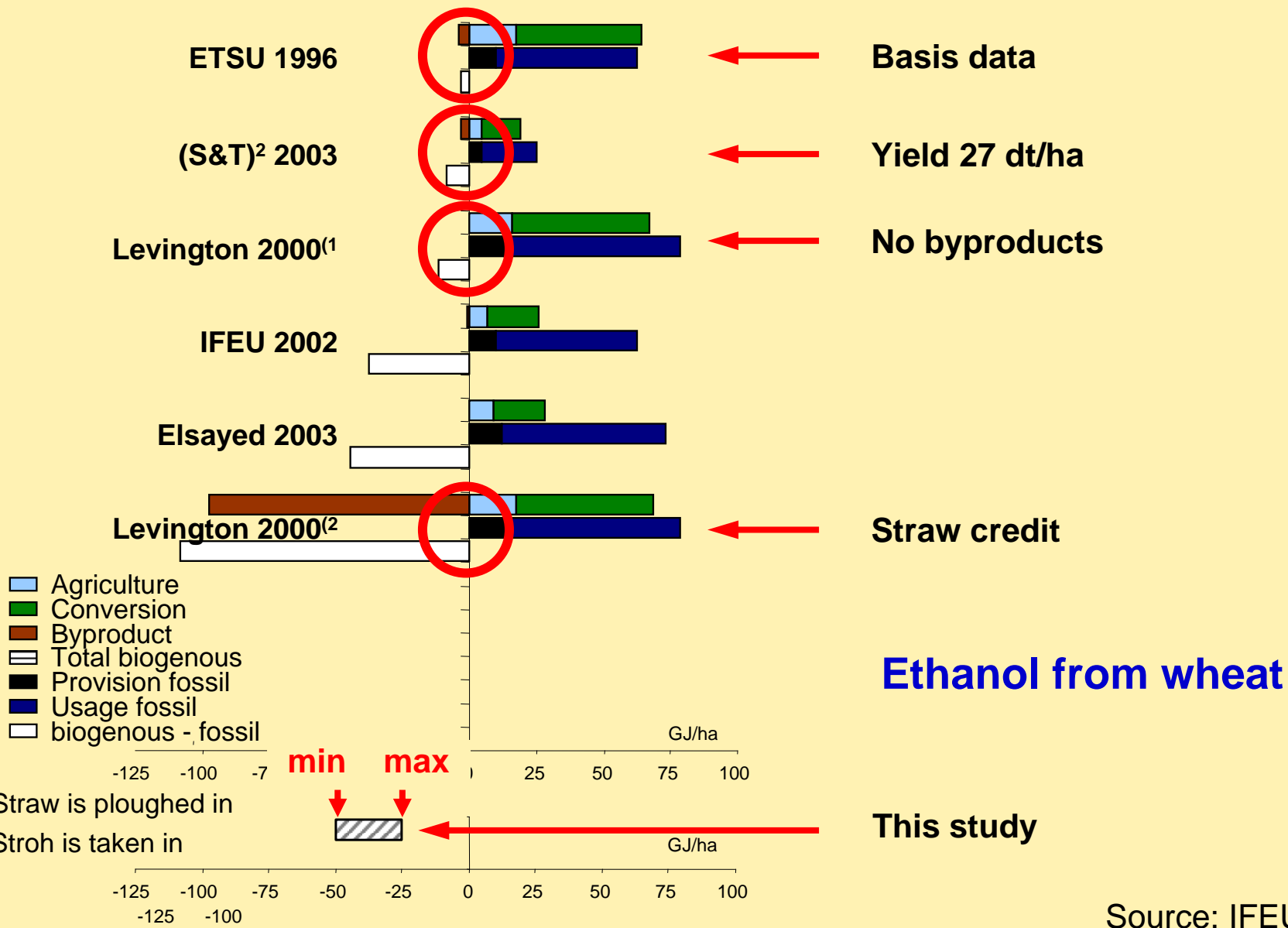
Result:

Not all LCA studies can be regarded to be representative: for this reason, deduction of bandwidths necessary

Deduction of bandwidths



Deduction of bandwidths

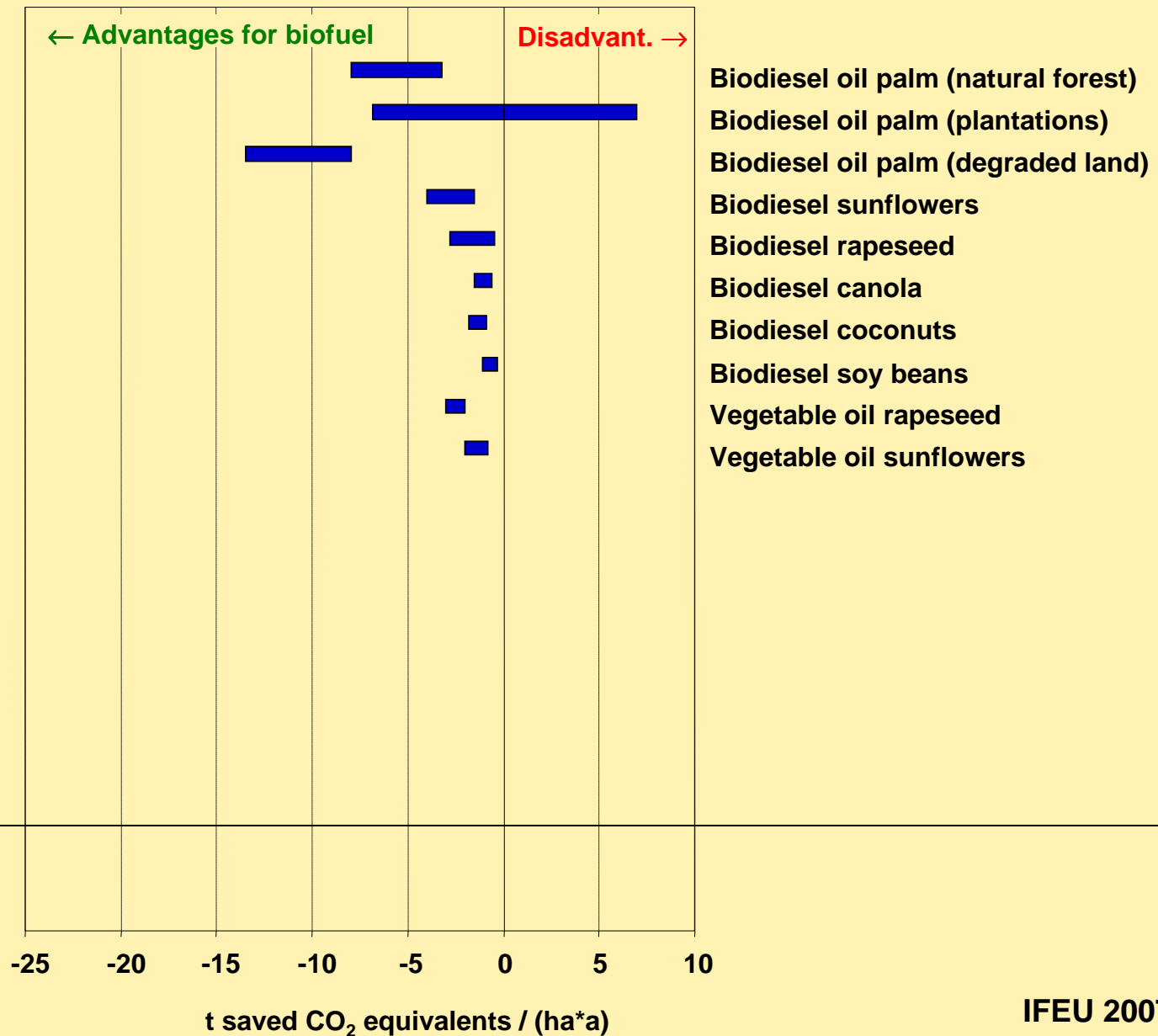


Source: IFEU 2006

CO₂ balance of biofuels



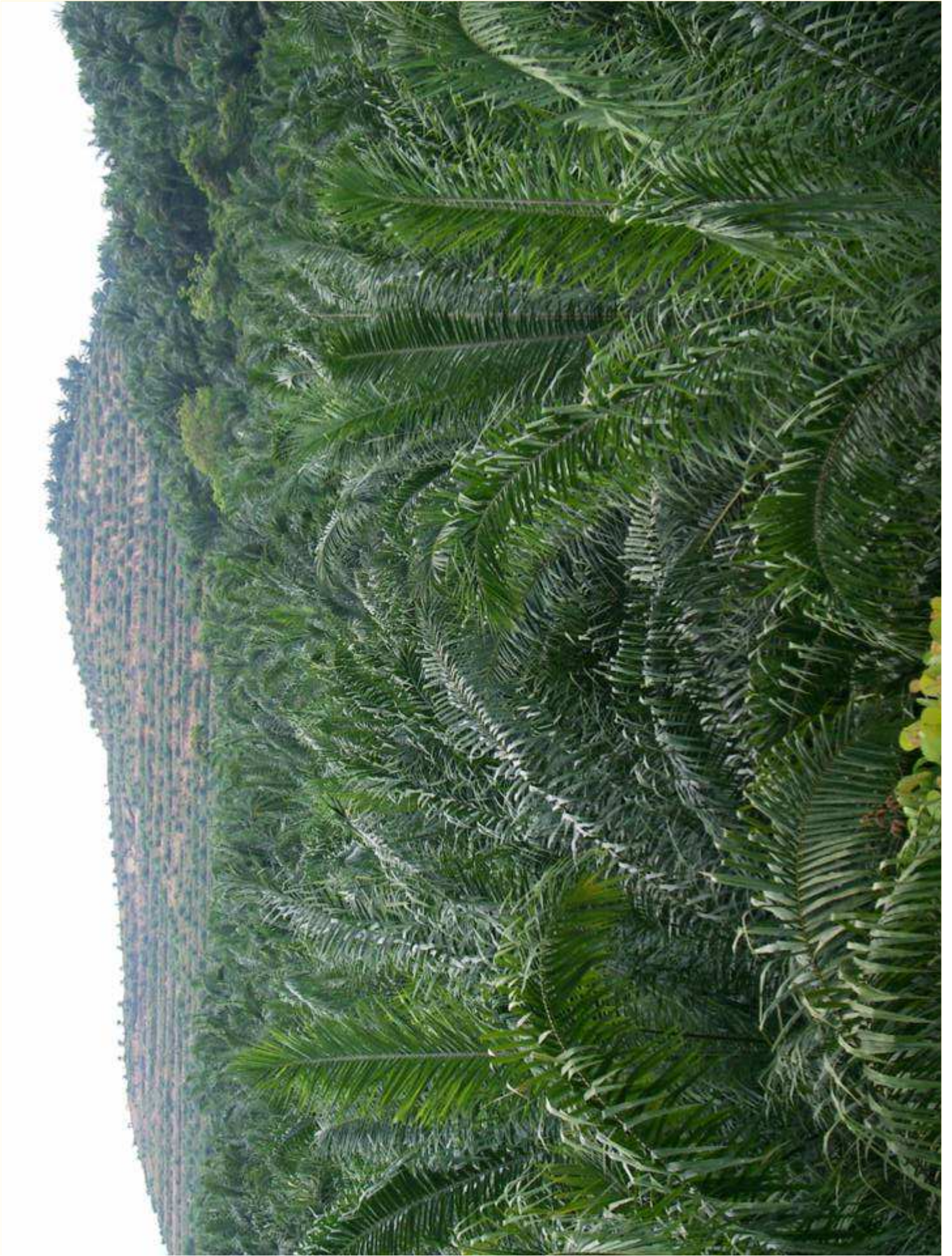
1st generation biofuels







Oil palm plantation through cutting of tropical forests





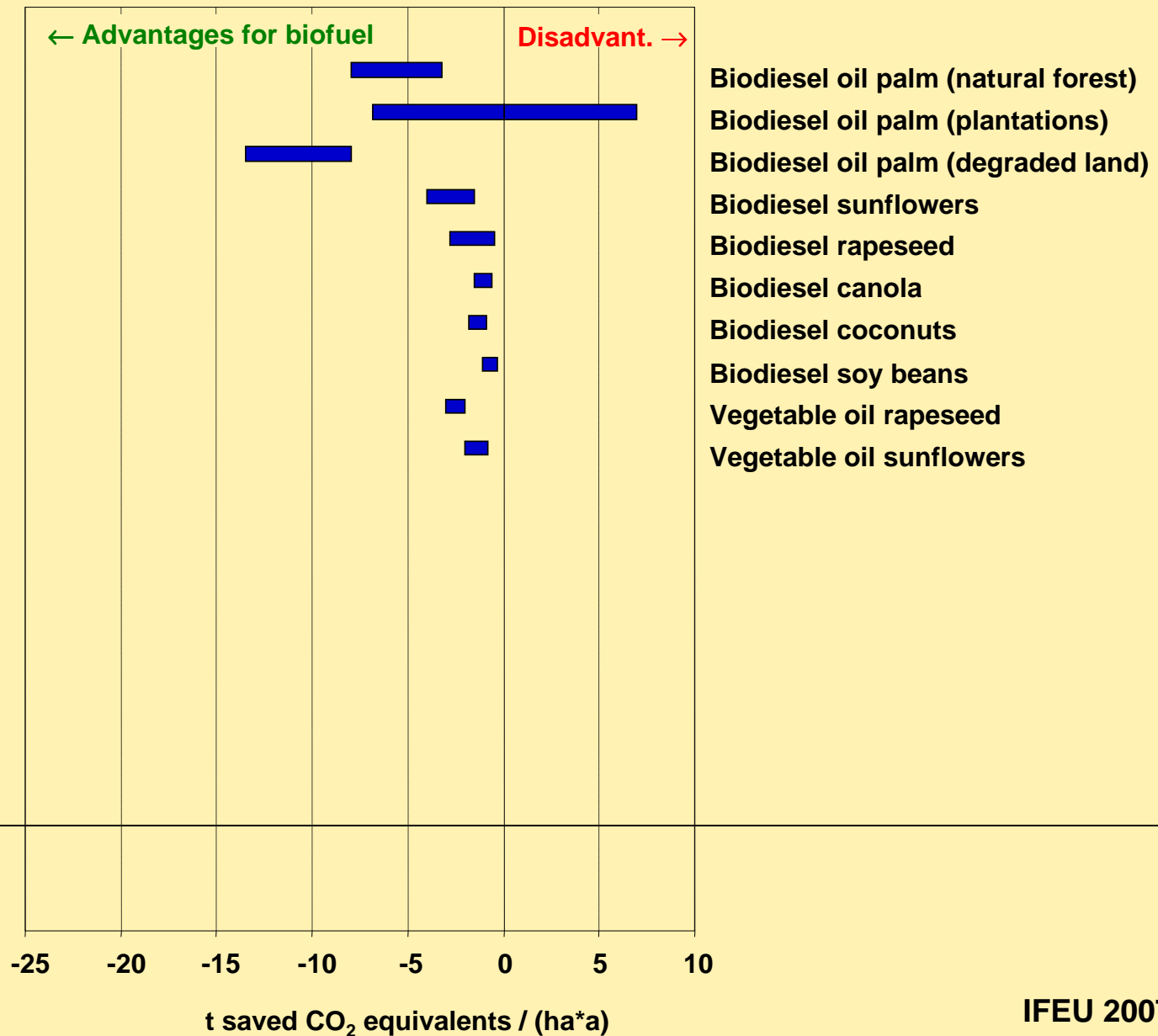
**Oil palm plantation instead of
existing plantations (coconut)**



CO₂ balance of biofuels



1st generation biofuels



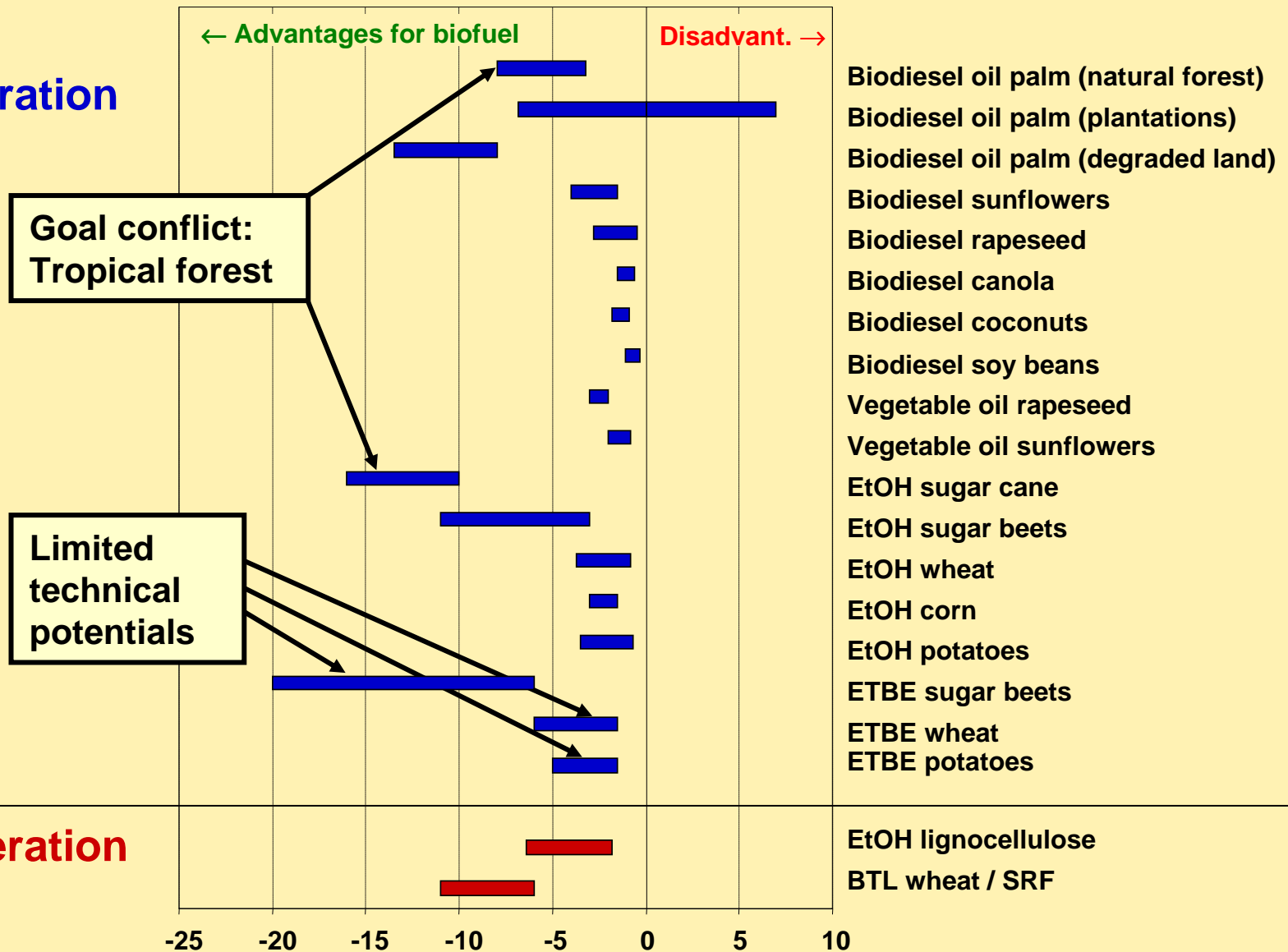


**Oil palm plantation on
marginal degraded land**

CO₂ balance of biofuels



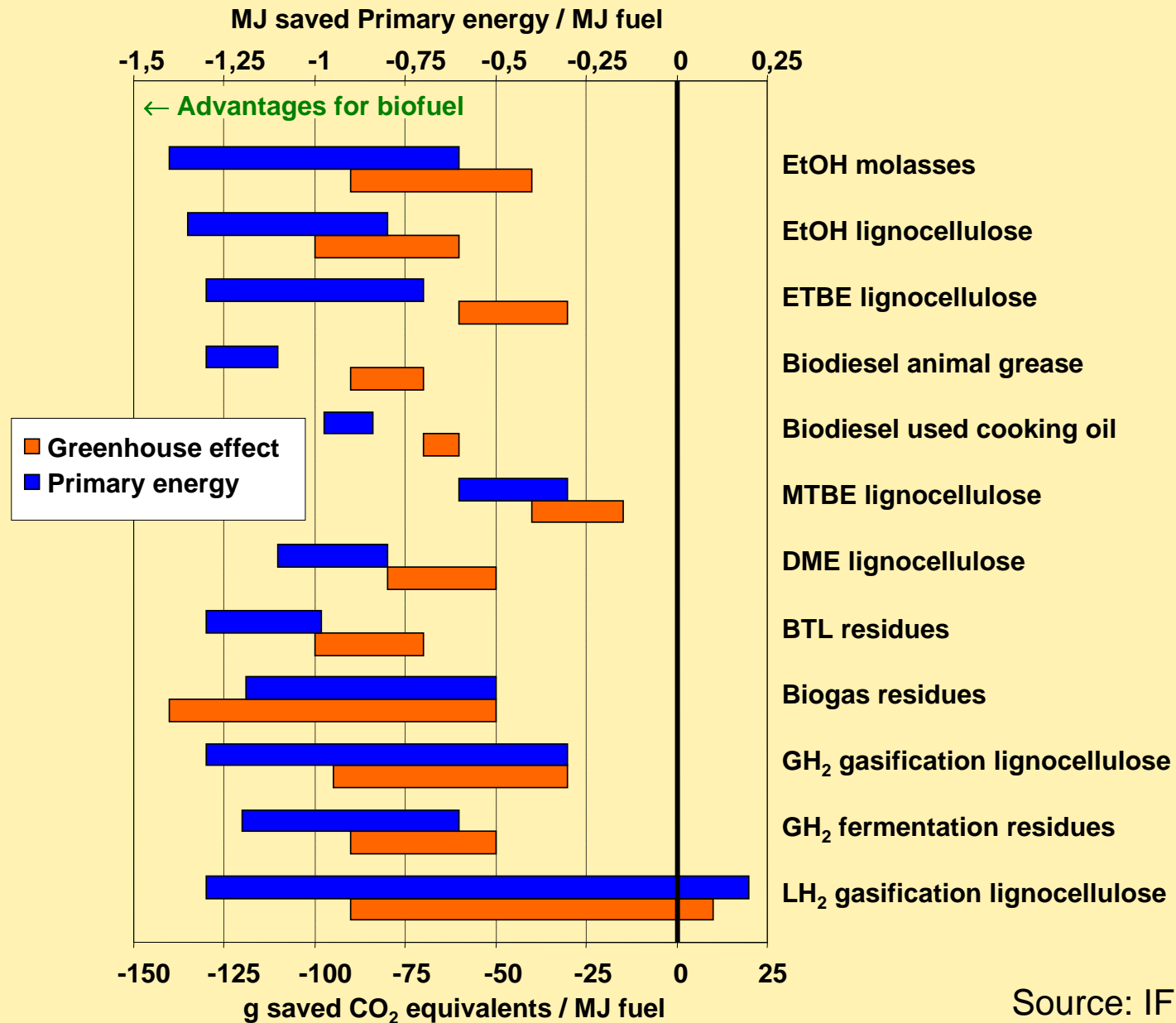
1st generation biofuels



2nd generation biofuels

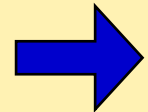
t saved CO₂ equivalents / (ha*a)

Biofuels from residues



Source: IFEU 2006

Overview



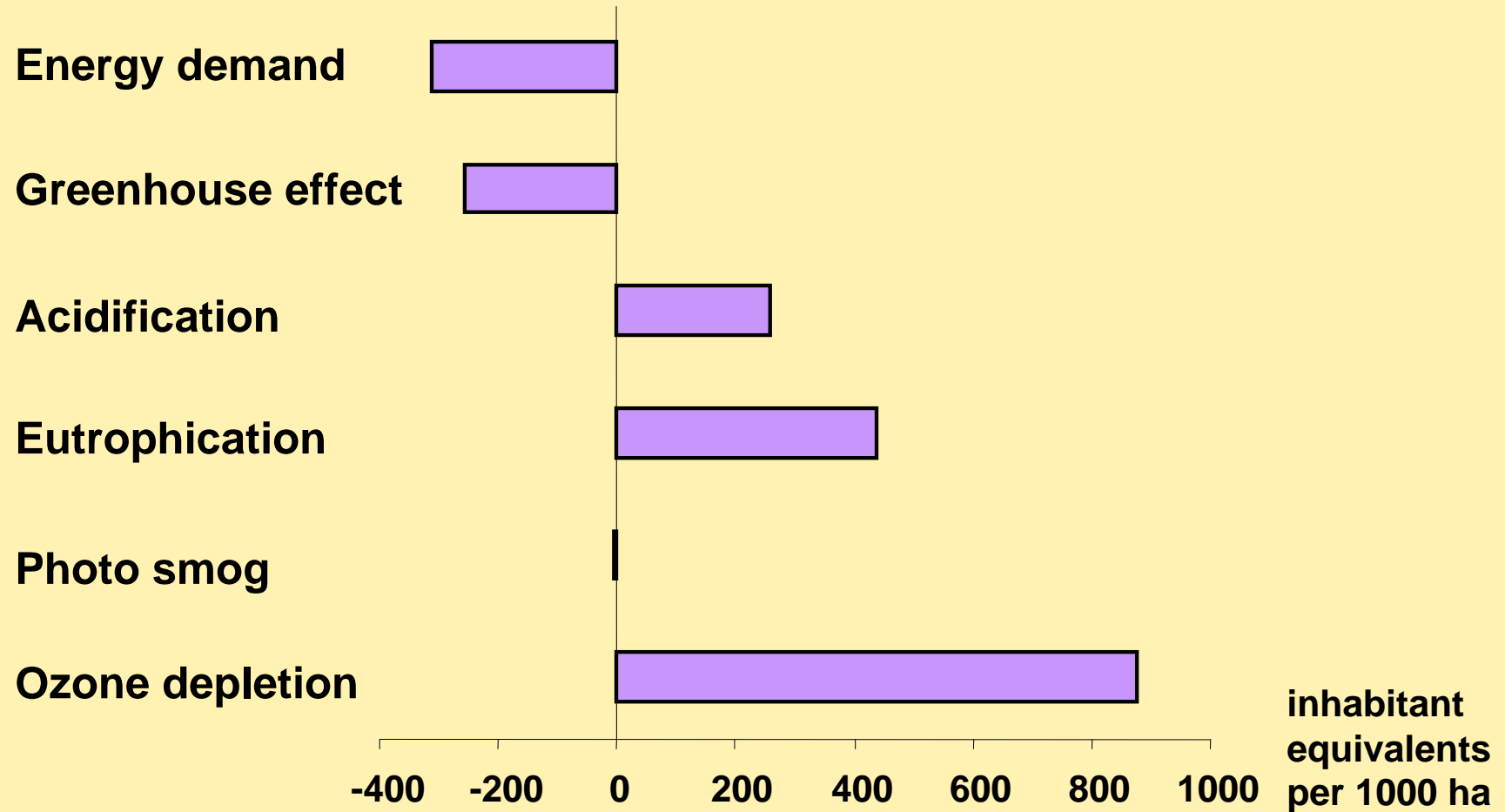
- Literature review about transport fuels
- Energy and greenhouse gas balances
- **Further environmental impacts**
- Summary and conclusions

Biodiesel versus diesel oil



Advantages for biodiesel

Advantages for diesel fuel



Source: IFEU 2006

Results: Biofuels vs. fossil fuels



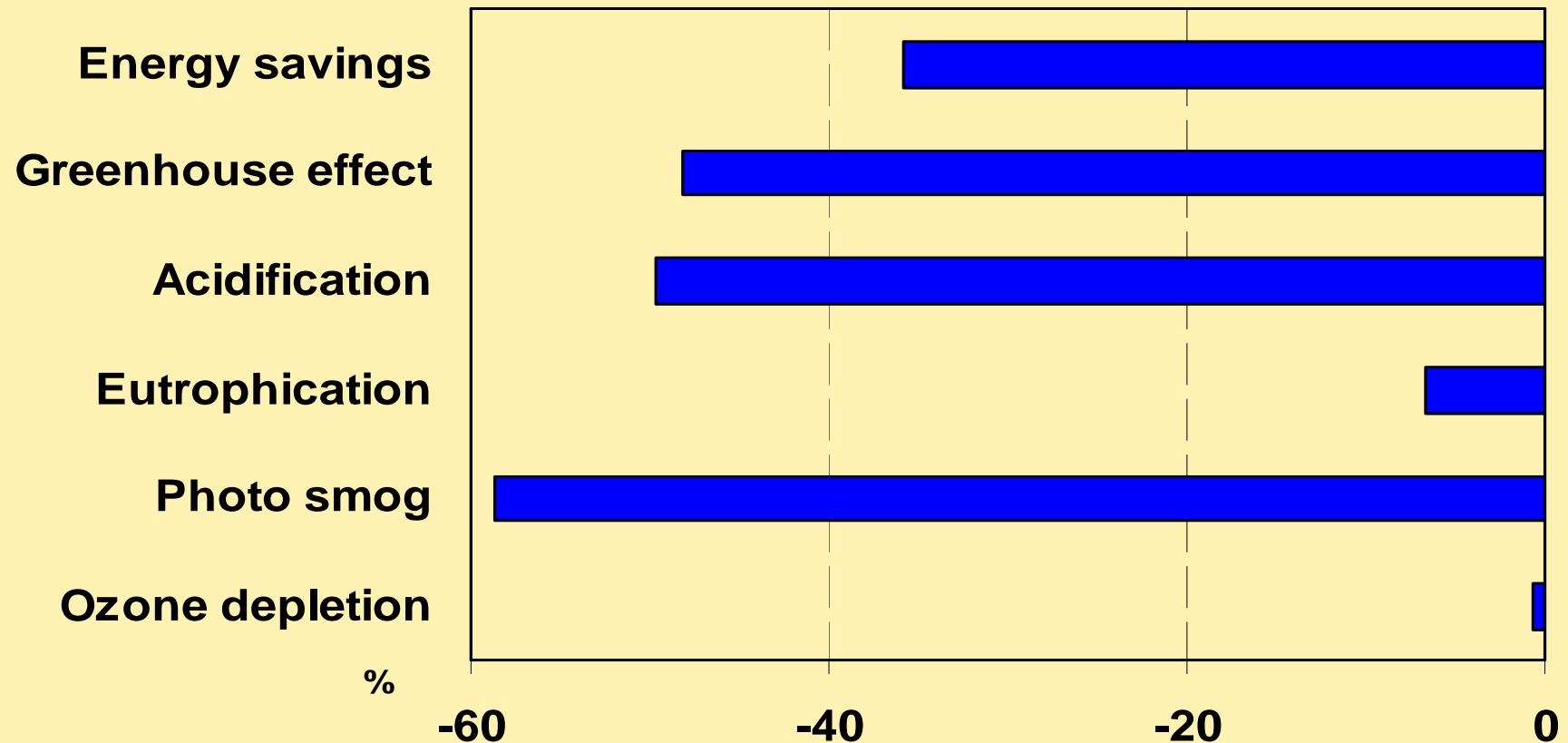
1. All biofuels listed hold ecological advantages as well as disadvantages in comparison with fossil fuels: **Advantages** with respect to both saving of non-renewable energy carriers and greenhouse effect, **disadvantages** e. g. with respect of acidification and eutrophication.
2. An objective decision for or against a particular fuel cannot be made. However, based on a subjective value system a decision is possible.

If, for example, energy saving and greenhouse effect is given the highest priority, all of the biofuels studied perform better than the alternative fossil fuels.

Biodiesel versus pure rapeseed oil



← Advantages for biodiesel

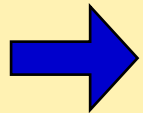


Source: IFEU 2006

Overview



- Literature review about transport fuels
- Energy and greenhouse gas balances
- Further environmental impacts
- **Summary and conclusions**



Key findings & conclusions



- **Environmental assessment**

- ➔ **Biofuels have environmental advantages and disadvantages compared to fossil fuels, but at least: in general, biofuels save fossil energy and greenhouse gases.**

Key findings & conclusions



- **Environmental assessment**

- Biofuels have environmental advantages and disadvantages compared to fossil fuels, but at least: in general, biofuels save fossil energy and greenhouse gases.
- 2nd generation biofuels have great potentials to save greenhouse gases as well as palm oil on marginal degraded land.
- Ethanol from sugar cane and biodiesel from palm oil must be discussed in the context of tropical rain forest cuttings.
- Palm oil: if grown instead of existing plantations: fair to negative CO₂ balance.

Key findings & conclusions



- **Sustainable potentials**

- Because of competition for land and competition in the usage of biomass the potentials for energy crops are limited.
- If energy crops are used for biofuels, biggest greenhouse gas savings are associated with high yield crops like SRF or sugar beet.
- Lignocellulose has by far the biggest sustainable mass potential (energy crops and residues) and therefore the second generation biofuels, too. This comes along additionally with very effective greenhouse gas savings.

Key findings & conclusions



- **Environmental assessment**

- ➔ **Biofuels from residues: no big differences in the environmental implications associated with these biofuels. Therefore, all of them should be realized, if technical and economic viable.**

Key findings & conclusions



- **Sustainable development**

- ➔ **There is a great potential for biofuels for transportation which should be developed in accordance with other goals towards a sustainable development including alternative use of biomass for electricity and heat generation, as well as for industry and chemistry.**

The IFEU Biofuel Team



Sven Gärtner

Dr. Guido Reinhardt



Contact details:

guido.reinhardt@ifeu.de
+ 49 – 6221 – 4767 – 0 / - 31
www.ifeu.de

Hinrich Helms



Nils Rettenmaier