Are biofuels better than fossil fuels for the reduction of climate changes?

Plantekongres 2009

13-14 January, Herning

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Background

- Biofuels in the media debate:

  - from an *opportunity* to a *threat*!

- What is true?

- Well, both views could be true; there are both good and bad systems!

A new and constructive focus is needed

- With our current knowledge we can point out the most important factors for whether or not biofuels lead to significant greenhouse gas benefits, thus:
- *How can we promote current "good" systems?*
- *How can we improve current "fairly good" system?*
- *How can we avoid inherent "bad" systems?*

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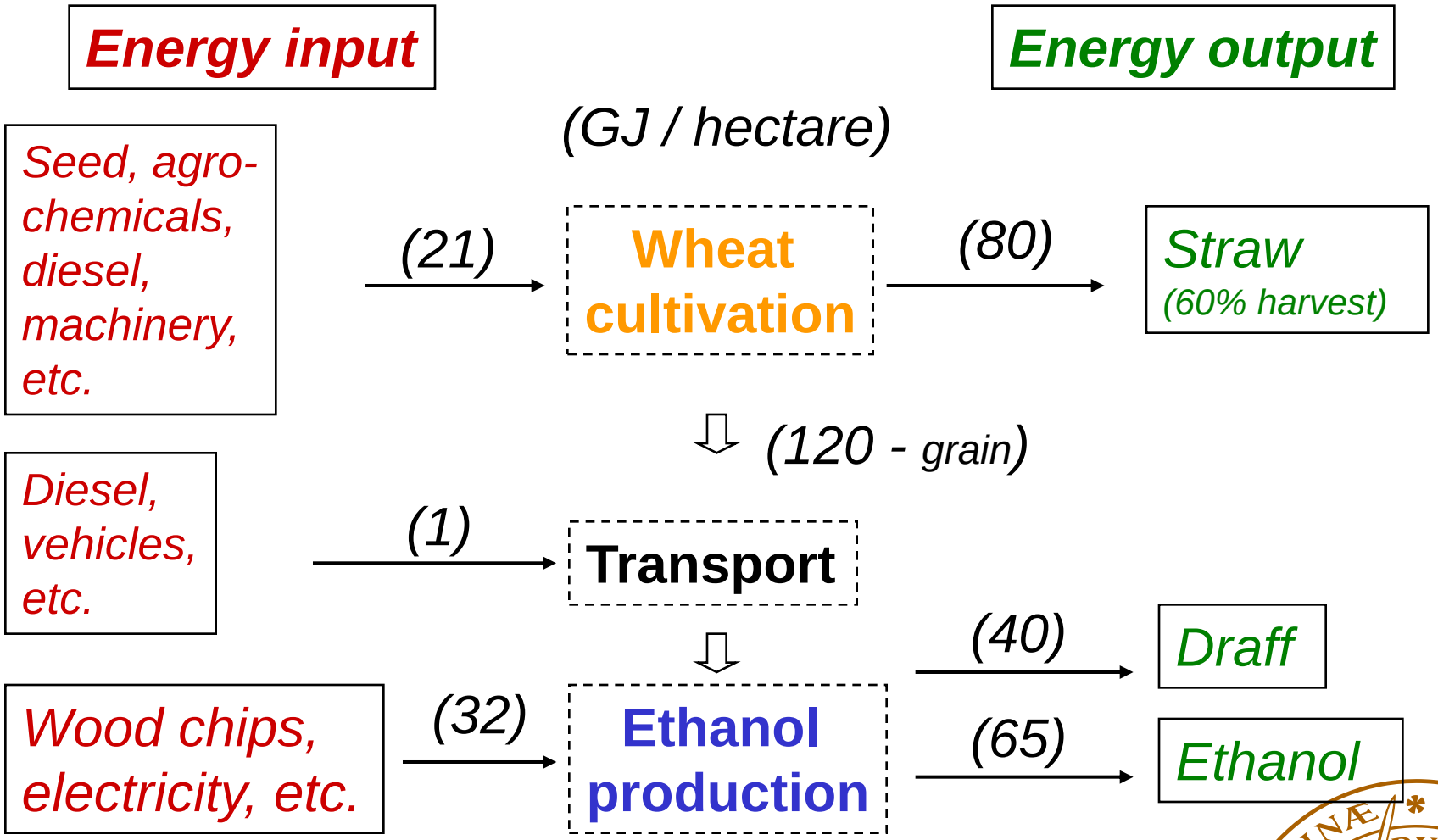
Energy flow in ethanol production systems



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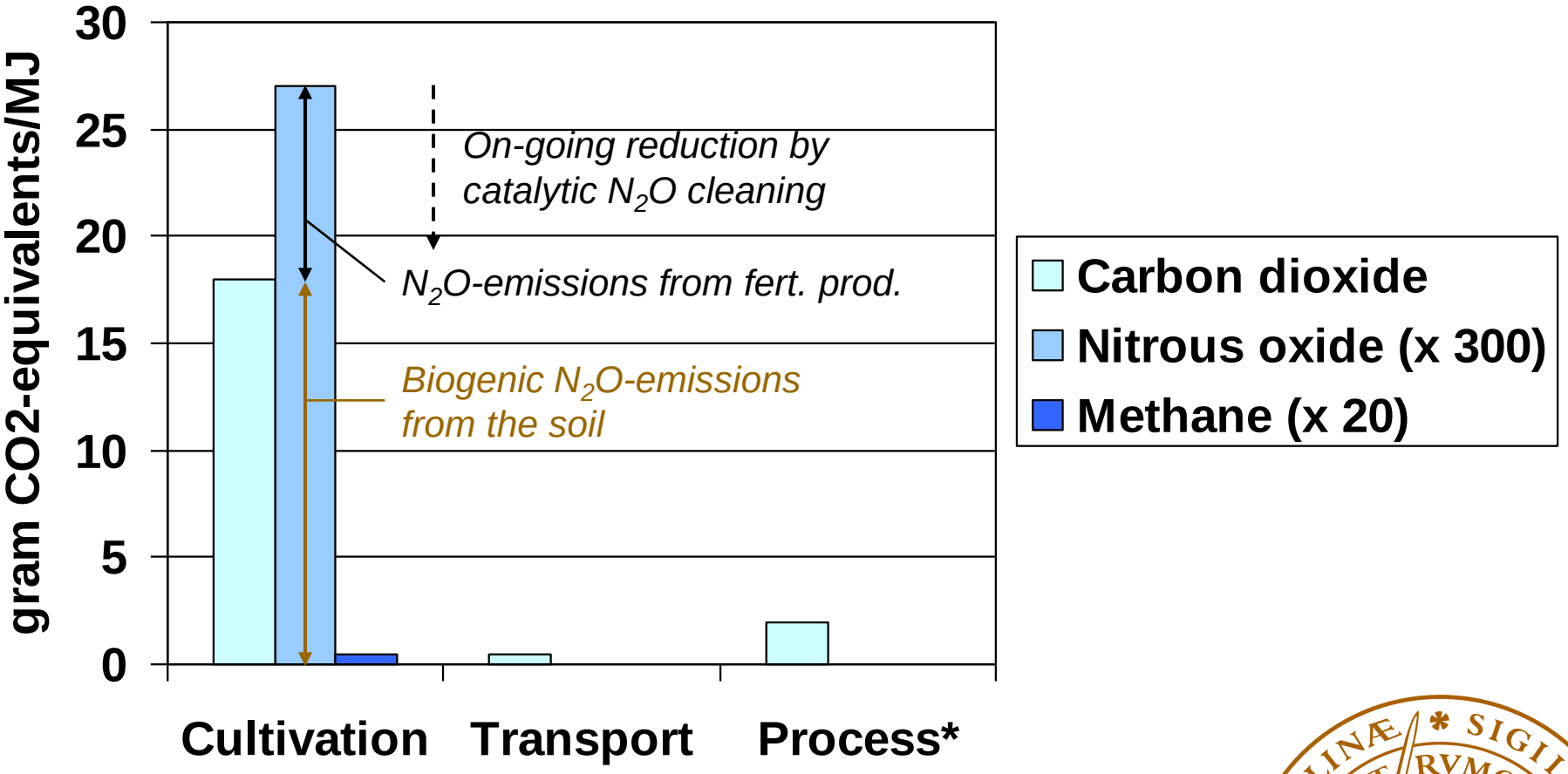
Emissions of greenhouse gases
- per MJ ethanol



** Biomass energy in the ethanol plant*

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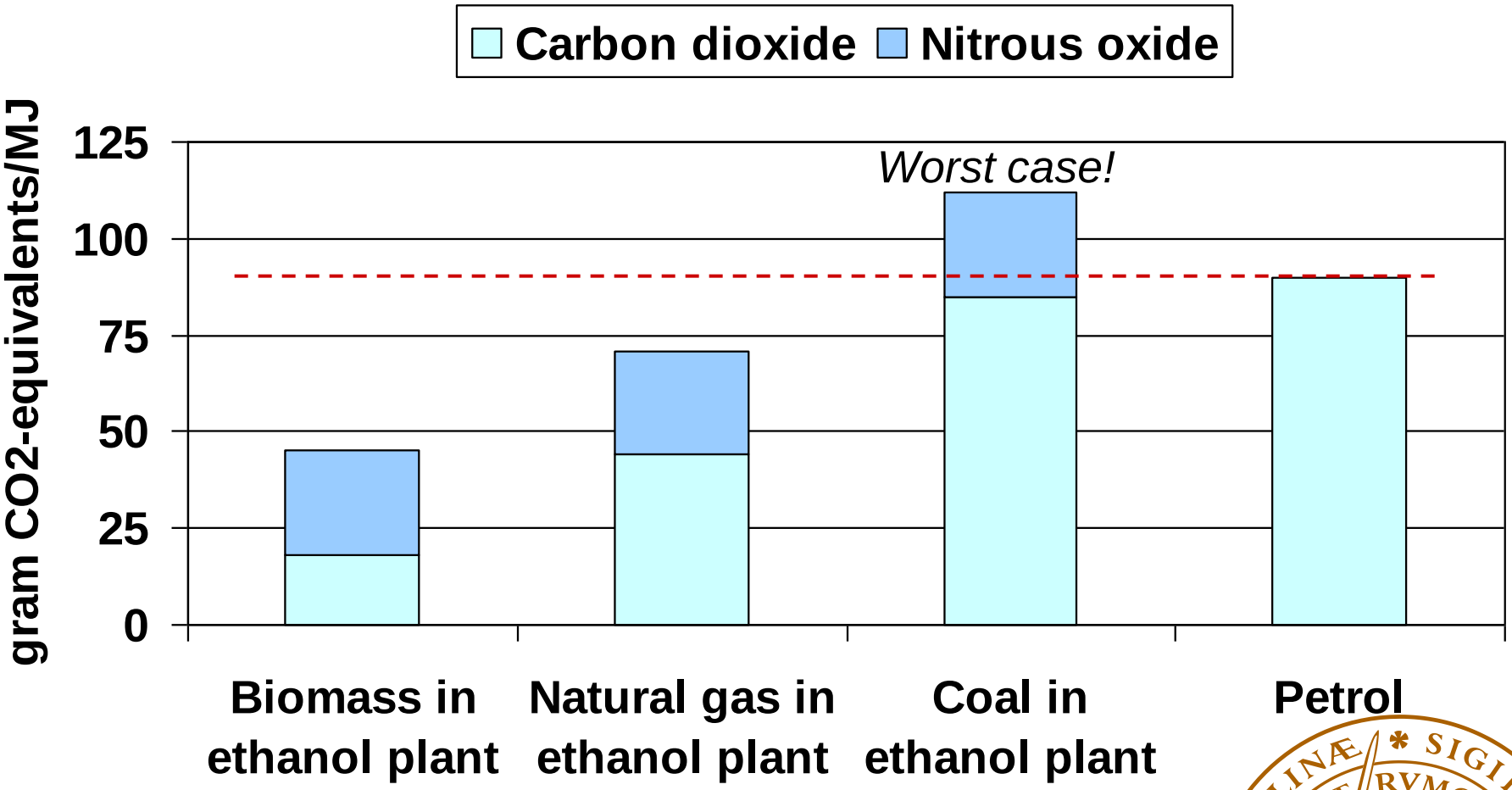
Total emissions of greenhouse gases

- per MJ ethanol



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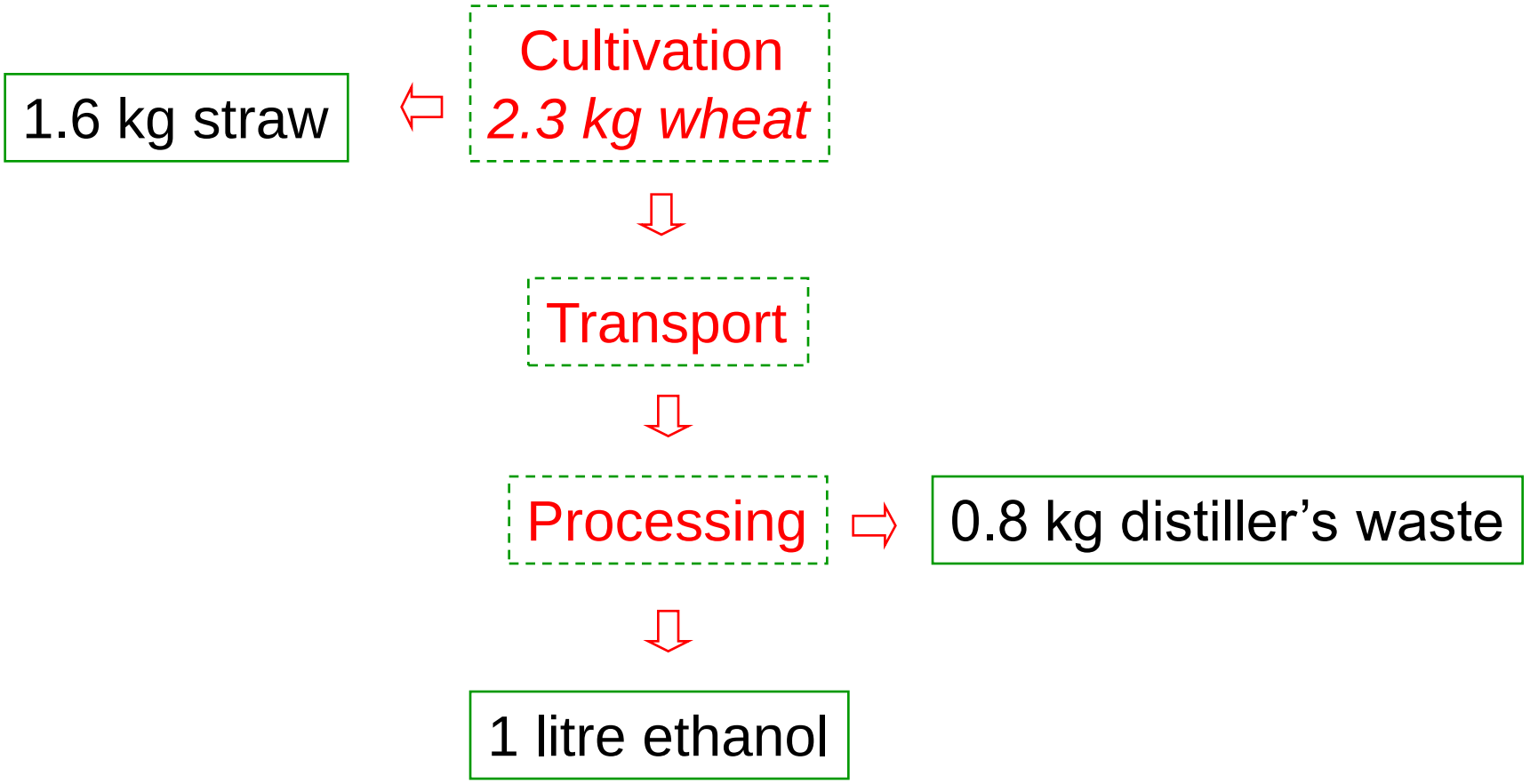
Including by-products (allocation)



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Including by-products
- different allocation methods

	Energy content	Economic value
Ethanol	***36 %***	***70 %***
Distiller's waste (draff)	*22 %*	*18 %*
Straw	*42 %*	*12 %*

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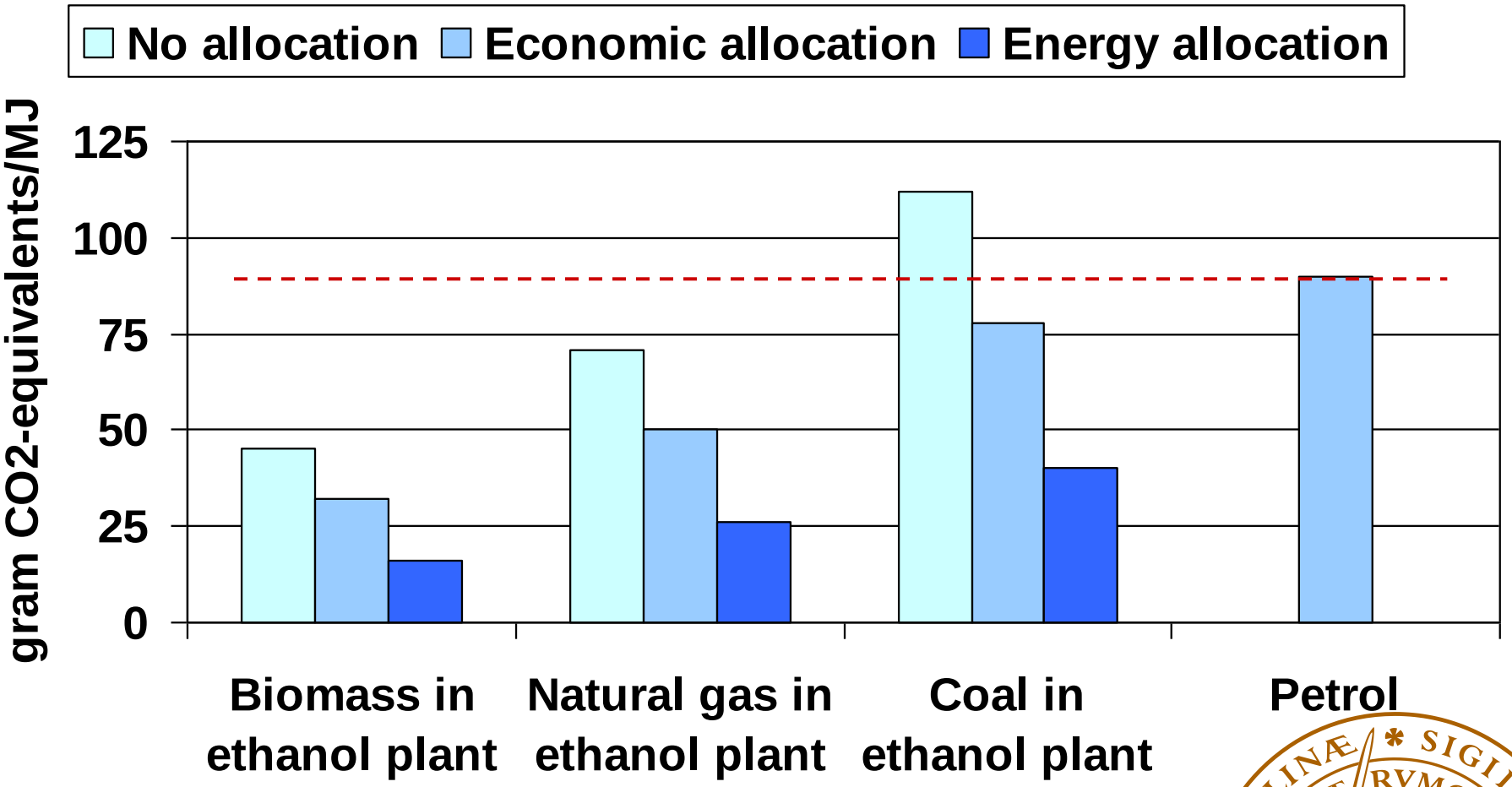
Emissions of greenhouse gases

- per MJ ethanol



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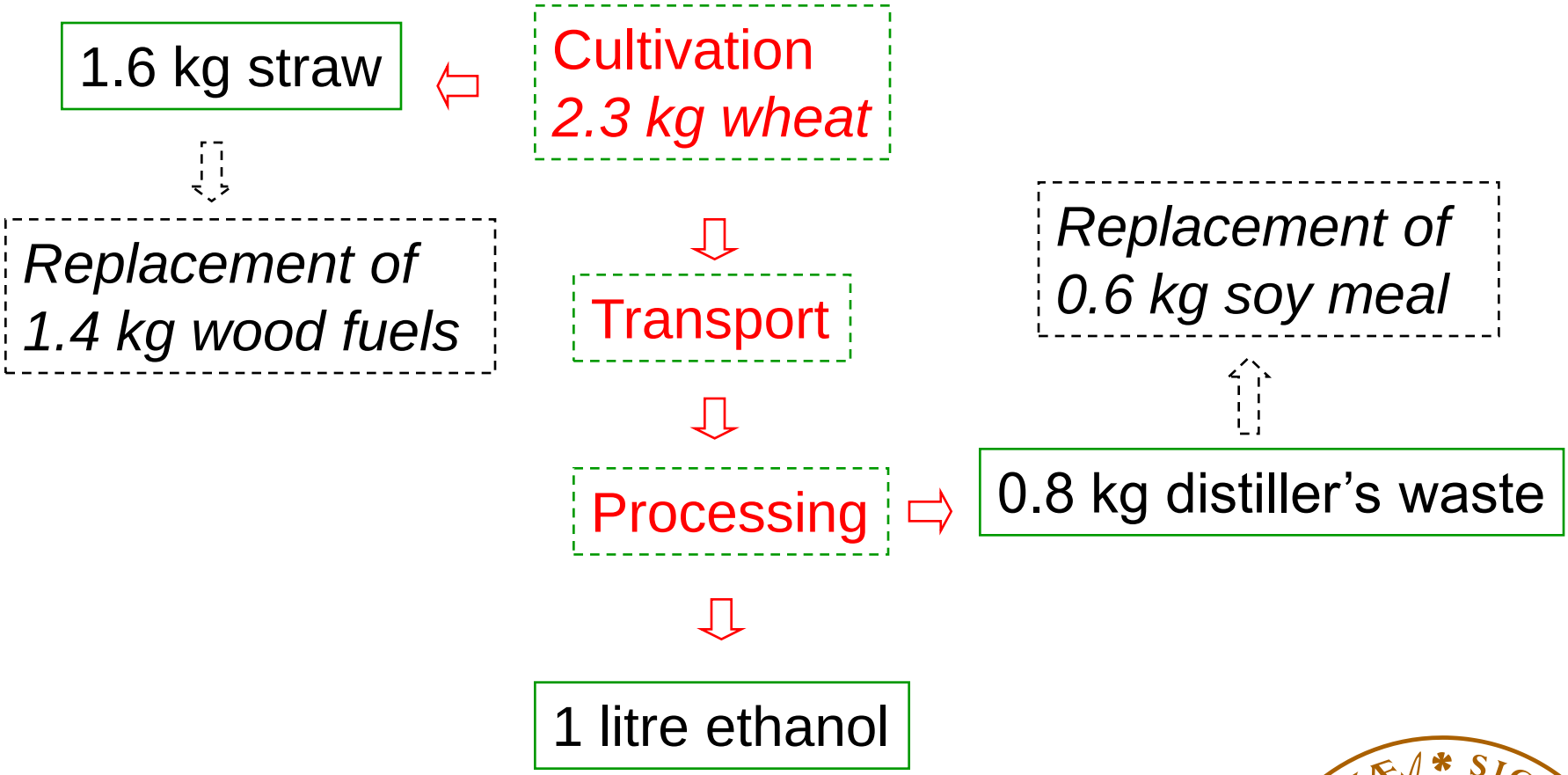
Including by-products
- systems expansion



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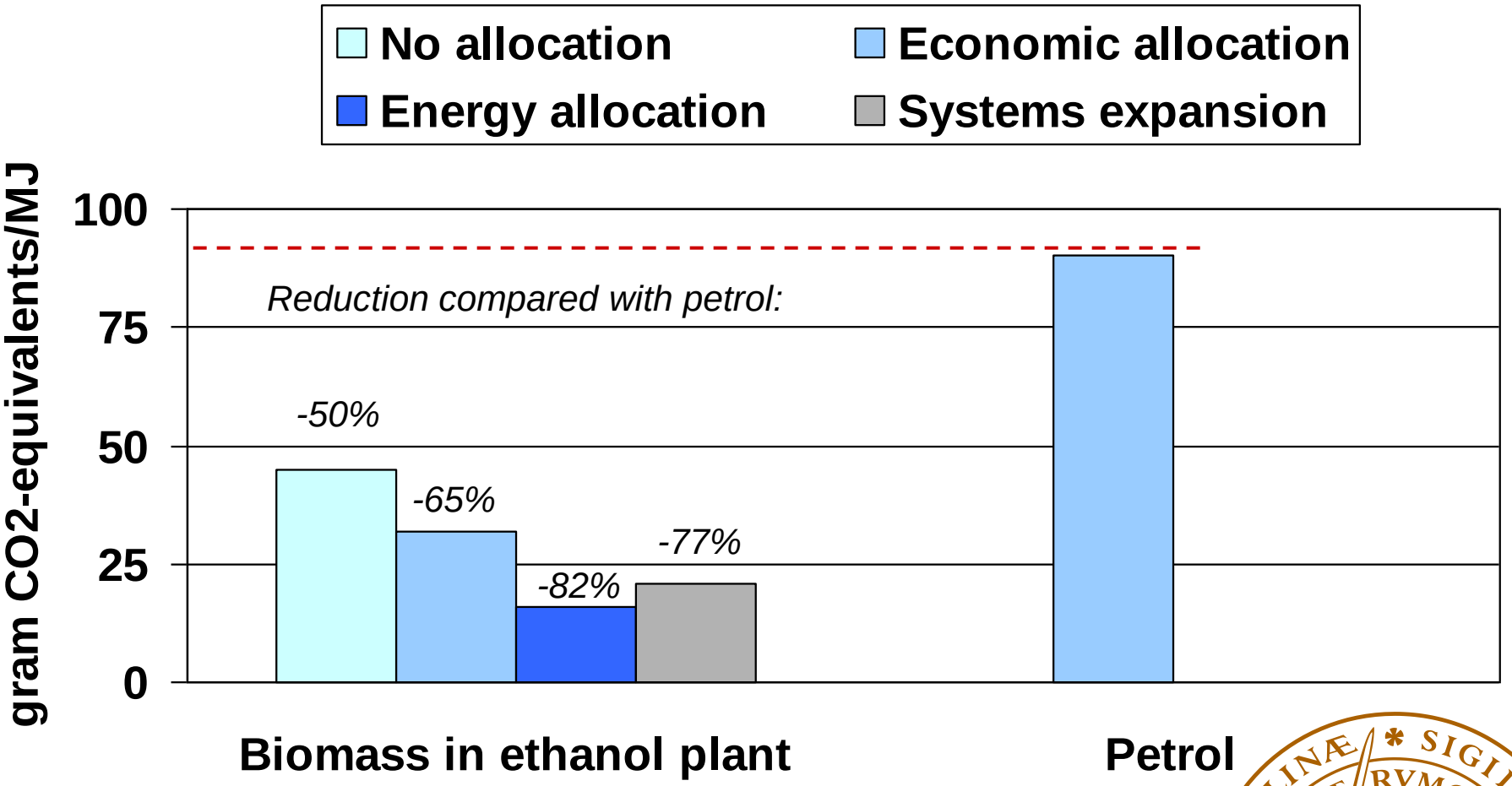
Emissions of greenhouse gases
- per MJ ethanol



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Allocation procedure according to ISO 14044
(Life cycle assessment)

1. Systems expansion

   (The ”protein feed” market in Europe correspond to an ethanol production equivalent to ≈5 % of current use of petrol)

2. Physical allocation (e.g. based on energy content)

   (OK, when more or less equivalent products are produced)

3. Economic allocation

   (More rational when large quantities of by-products with low economic value is produced, e.g. straw)

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Systems expansion
- alternative land-use

Cultivation of wheat

⇩

On “excess” farm land

⇩

No changes in the “natural” carbon stock (soil, veget)

Cultivation of wheat

⇩

On “new” farm land

⇩

Potential losses in the “natural” carbon stock (permanent pasture, etc)

Cultivation of perennial non-food crops

⇩

On “marginal land” not available for food production

⇩

Potential increase in the “natural” carbon stock

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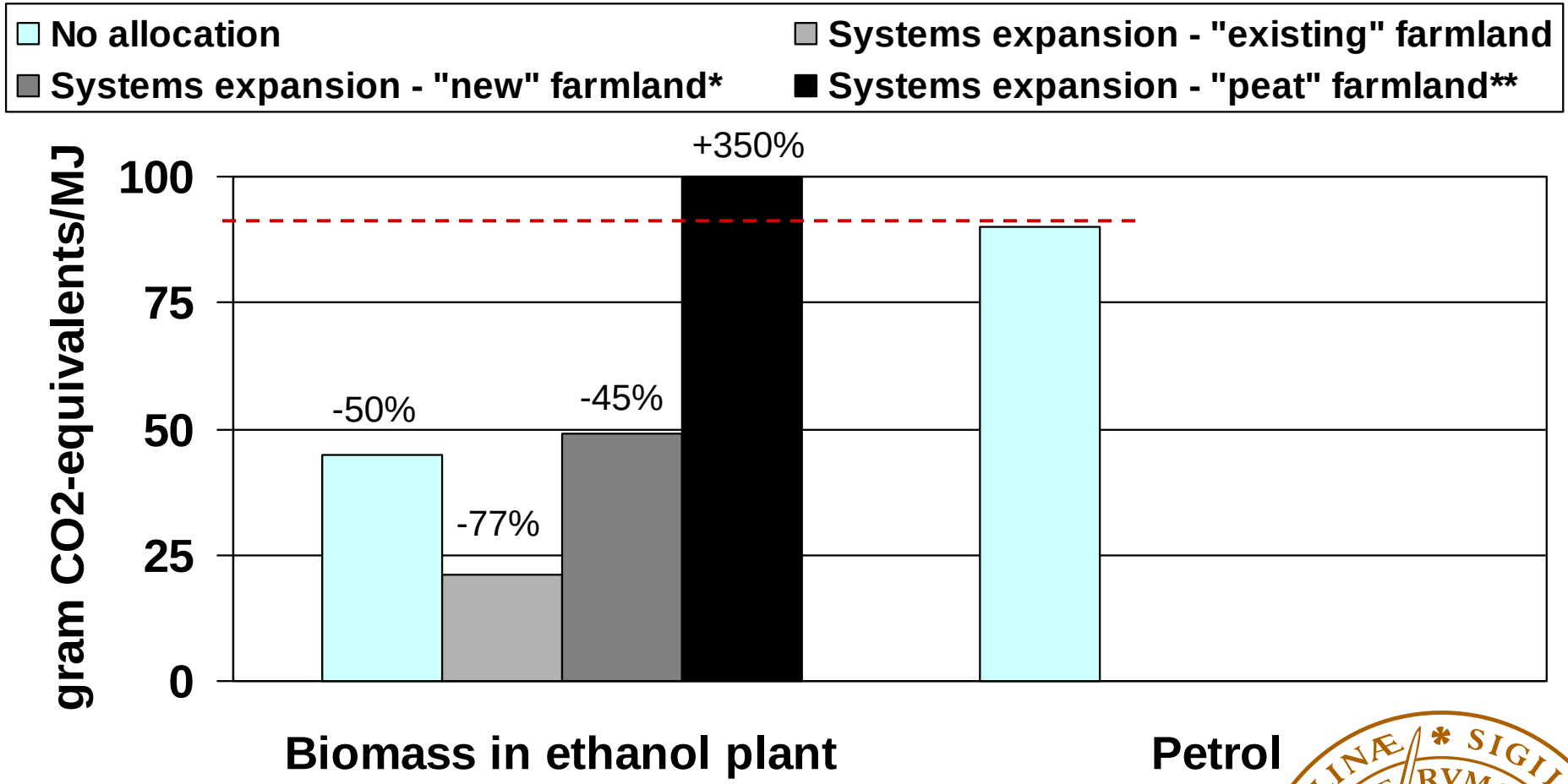
Emissions of greenhouse gases
- per MJ ethanol



**Permanent pasture – northern Europe, **Permanent pasture on peat land*

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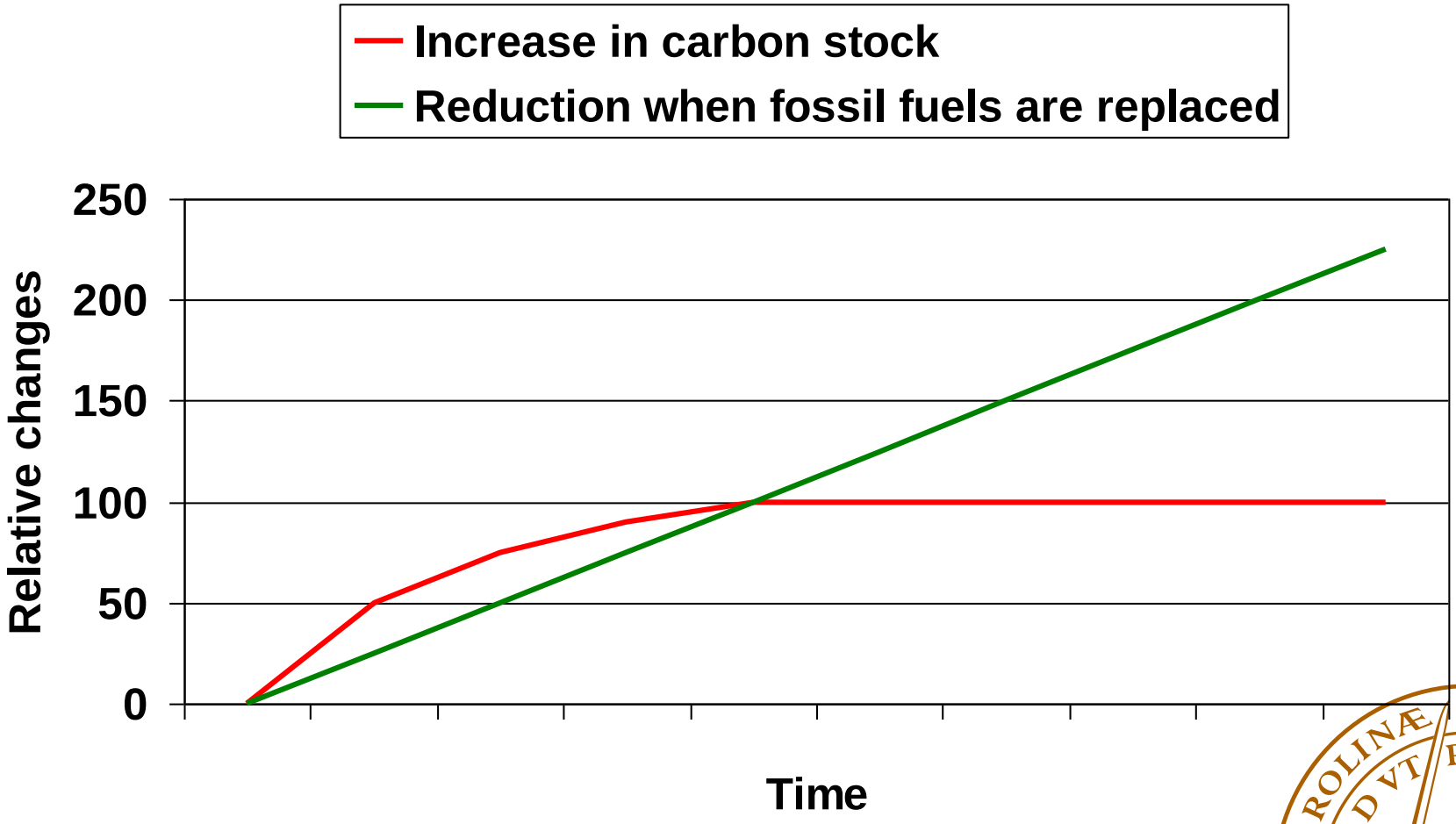
Changes in the carbon stock vs reduction in GHG when fossil fuels are replaced



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Good or bad biofuels – critical factors

- Biofuel plants should use biomass and not fossil fuels
- Cultivation of annual feedstock crops should be avoided on land rich in carbon (e.g. peat soils used as permanent grassland)
- By-products should be utilised efficiently in order to maximise their energy and GHG benefits (and these benefits should be credited by system expansion, followed by economic allocation and physical allocation)
- Nitrous oxide emissions should be kept to a minimum by means of efficient fertilisation strategies, and commercial nitrogen fertilisers should be produced in plants which have N_20 cleaning

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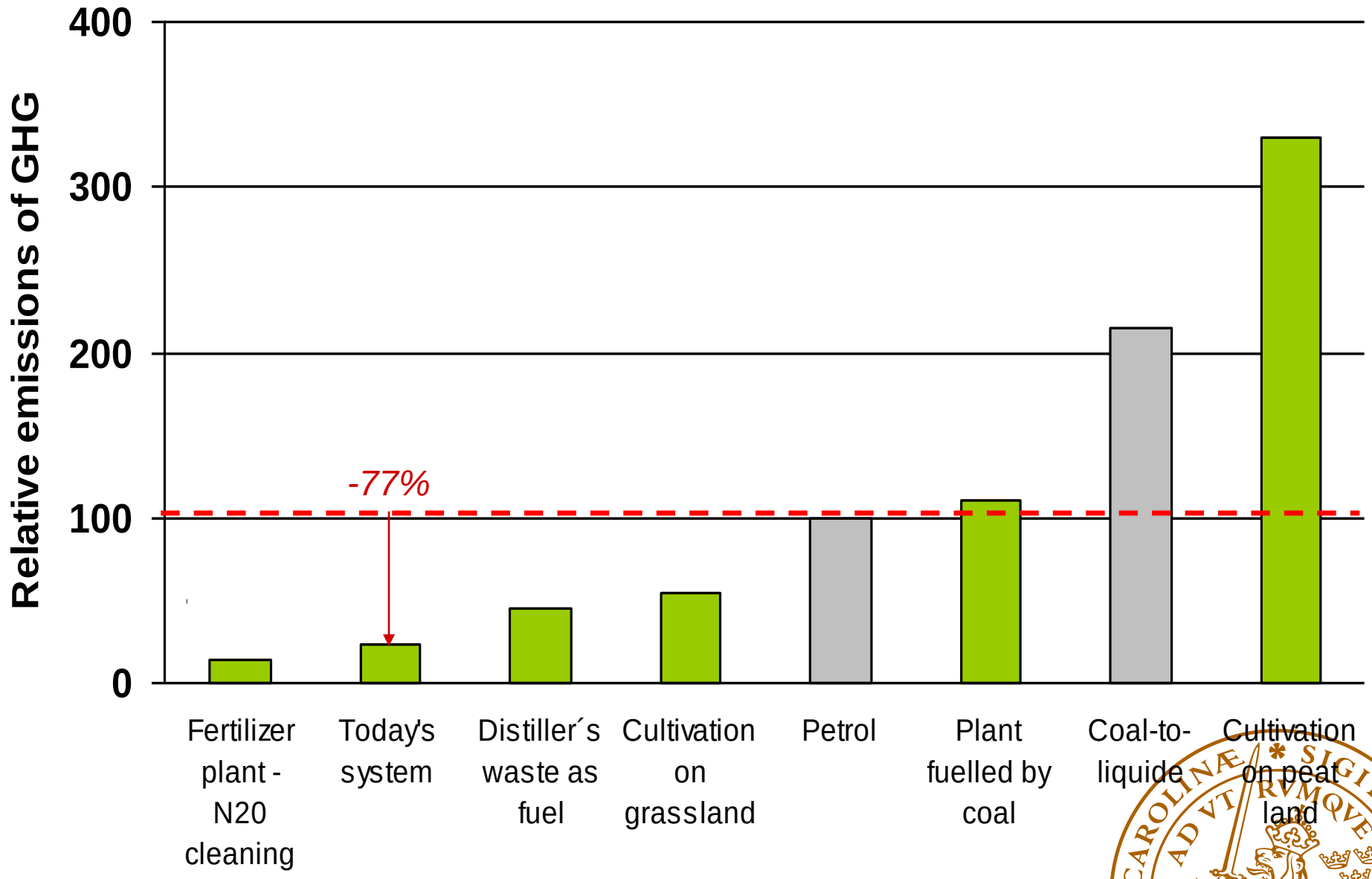
Good or bad ethanol? (wheat-based)



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GHG emissions from land-use changes

- Direct land-use changes are relevant to include in LCA's of specific biofuel production systems when such changes clearly occur
- Indirect land-use changes by displacement of food and feed production, however, should not be included. The reasons for this is:
  - *There are large, inherent uncertainties concerning such potential effects*
  - *It is almost impossible to present clear evidence that an expansion of a specific biofuel production system leads to a specific displacement of food or feed production*
  - *If displacement effects occur, these effects should be allocated between all production systems that are expanded, also food and feed production and not only biofuel production*

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GHG emissions and displacement effects

- There exist a substantial amount of “excess” by-products in forestry and agriculture available for energy purposes not leading to land competition
- In a short-term perspective, biofuel production could be expanded, to some extent, on excess arable land not currently used for food or feed production, both within EU and globally
- In a long-term perspective, increased food prices will lead to a development of the agriculture sector world wide leading to increased crop yields on existing farmland and thereby reduced risk of land competition
- Thus, two crucial factors regarding a potential future risk of displacement effects will be:
  1) The expansion rate of the various biofuel systems
  2) Their total production volume

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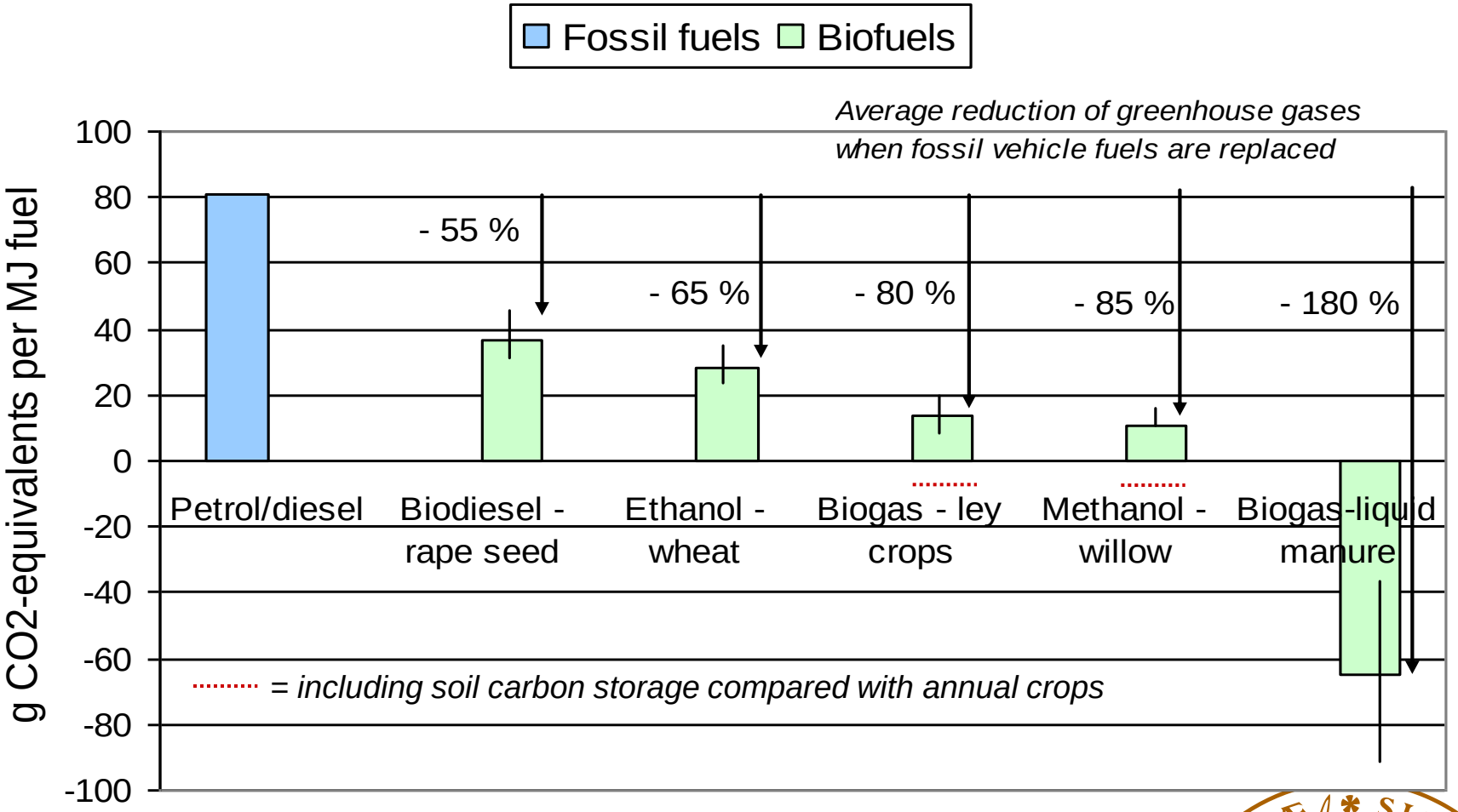
Emissions of greenhouse gases *(well-to-wheel)*



(Based on economic allocation of by-products, current conditions in northern Europe, and biomass-based energy input in biofuel plants)

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Conclusions

- It is not possible to state generally whether biofuels are good or bad as regards to the climate – this depends on the structures of the individual systems
- Furthermore, there are various calculation methods which affect the results; i.e. we have to have a critical attitude towards LCA's which sometimes receive a lot of media attention
- However, with our current knowledge we can point out the most important factors regarding the GHG performance of biofuels
- This knowledge is crucial when structuring, for example, certification schemes which will help us to promote the development of "good" biofuels and counteract the production of "bad" biofuels

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