

Comparing Biorefinery Systems to Conventional Processes

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Towards a Methodological Approach of IEA Bioenergy Task 42 “Biorefinery”

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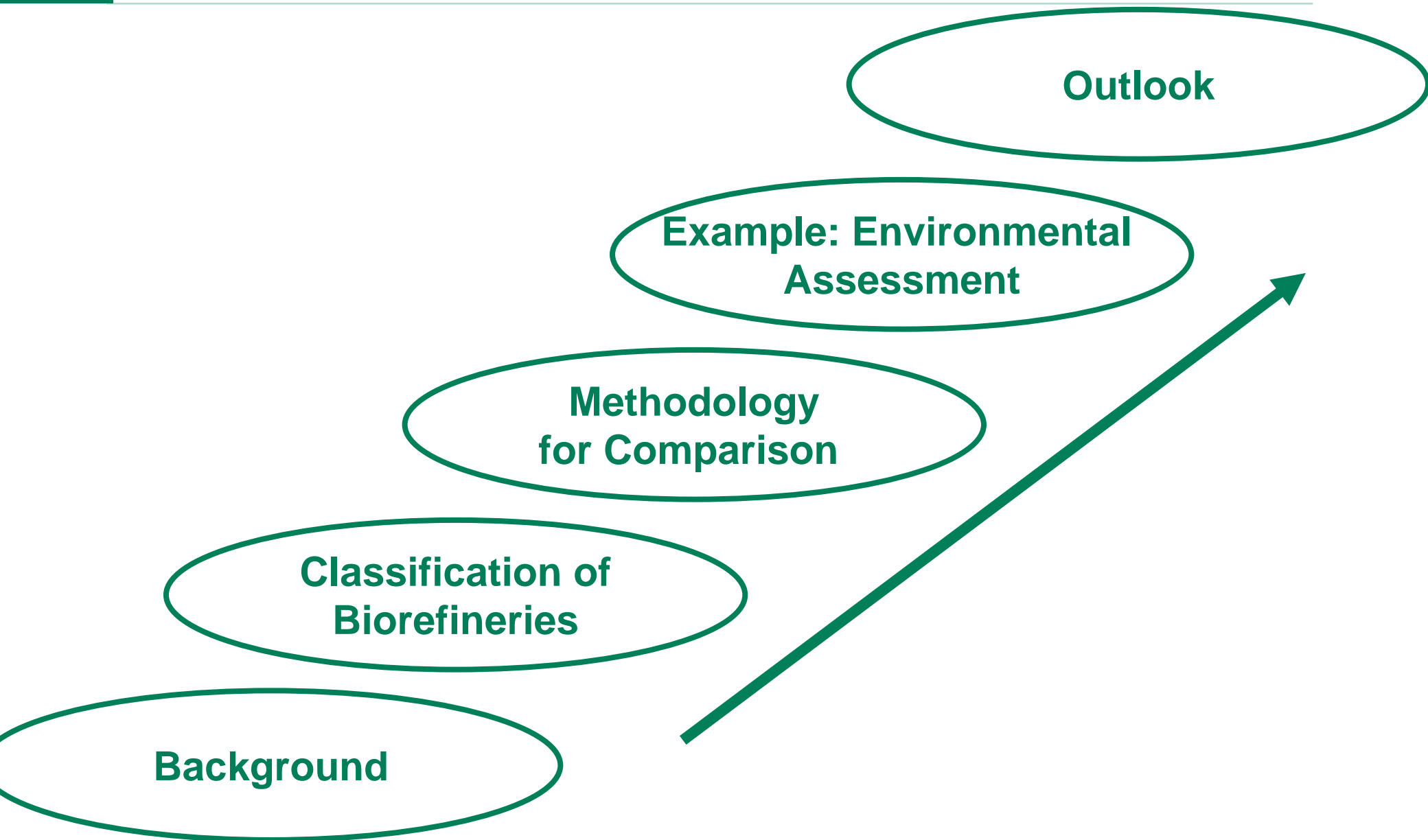
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Biofuels & Bioenergy - A Changing Climate,

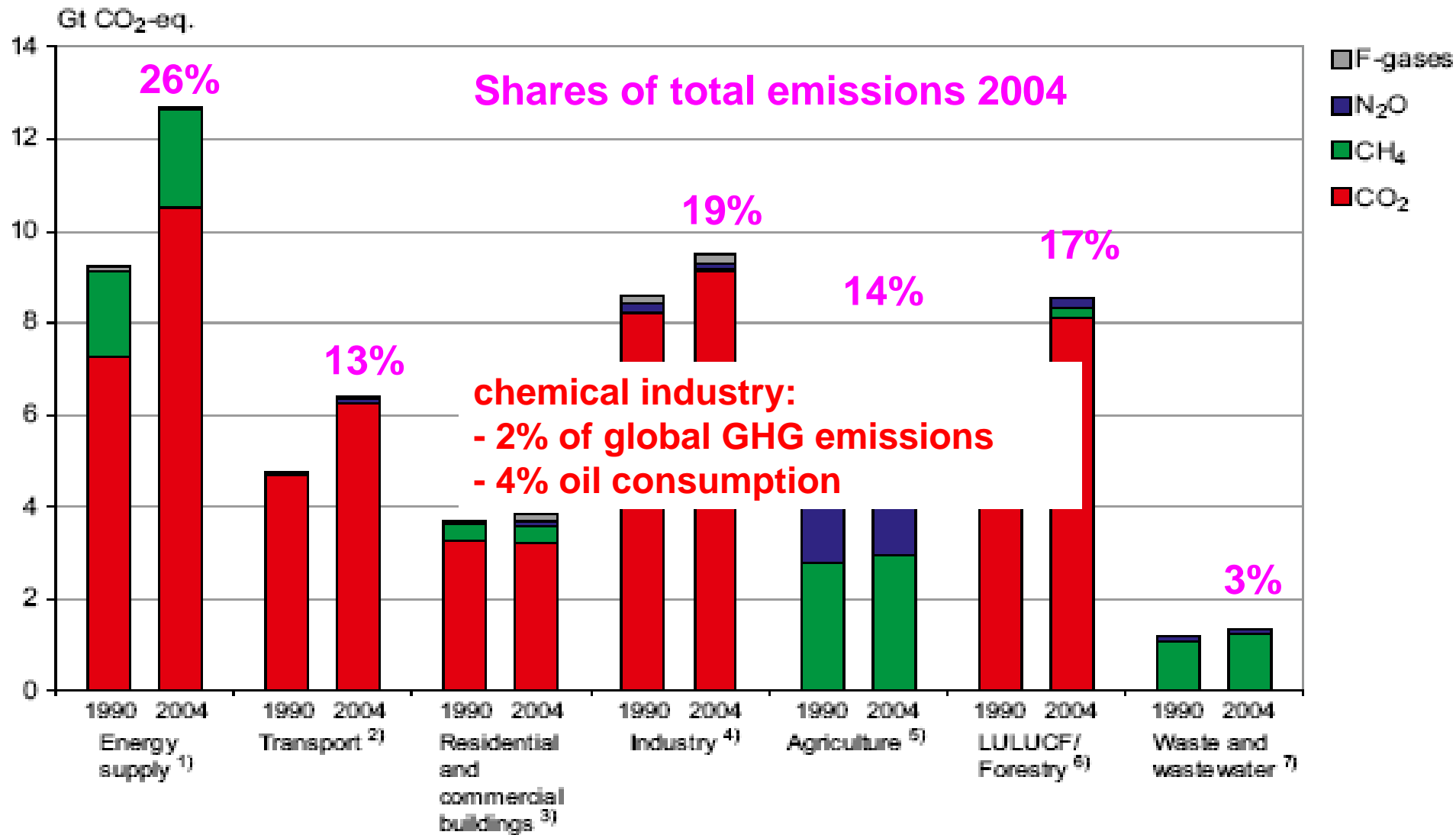
August 23 – 26, 2009, Vancouver, Canada

Outline



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Development Greenhouse Gas Emissions per Sector 2004



European Roadmap for Biofuels

Vision 2030: 25% Biofuels

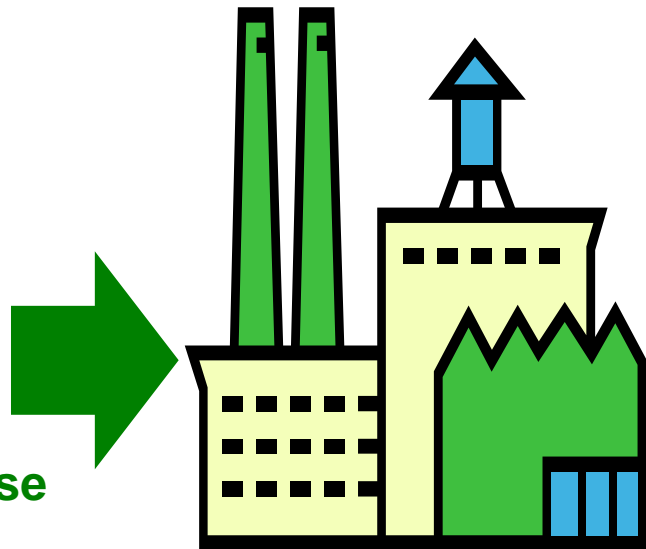


Source: *Biofuels in the European Union – A vision for 2030 and beyond*,
Final report of the Biofuels Research Advisory Council, June 2006

Biorefinery With Transportation Biofuel Orientation

Biomass Resources

- oil
- starch
- sugar
- lignocellulose
-



Biorefinery

Bioenergy

- liquid/gaseous transportation fuels
- electricity
- heat
- solid fuels

Biomaterials

- bulk chemicals
- fine chemicals
- animal feed
- food
- materials
- fertilizer
-

Based on different conversion processes

- Bio-chemical
- Thermo-chemical
- Physical-chemical
- Others

What is a Biorefinery”?

IEA Bioenergy

Task 42 on Biorefineries

“**Biorefinery** is the **sustainable processing of biomass** into a **spectrum of marketable products**”

- **Biorefinery:** concepts, facilities, processes, clusters of industries
- **Sustainable:** maximising economics, - social aspects, minimising environmental impacts, fossil fuel replacement, closed cycles
- **Processing:** upstream processing, transformation, fractionation, thermo-chemical and biochemical conversion, extraction, separation, downstream processing
- **Biomass:** wood & agricultural crops, organic residues, forest residues, aquatic biomass
- **Spectrum:** multiple energetic and non-energetic products
- **Marketable:** Present and forecasted (volume and prices)
- **Products:** both intermediates and final products (i.e. food, feed, materials, chemicals, fuels, power, heat)

The 4 Features to Characterise A Biorefinery Systems

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Task 42 on Biorefineries

1. Platforms

2. Products

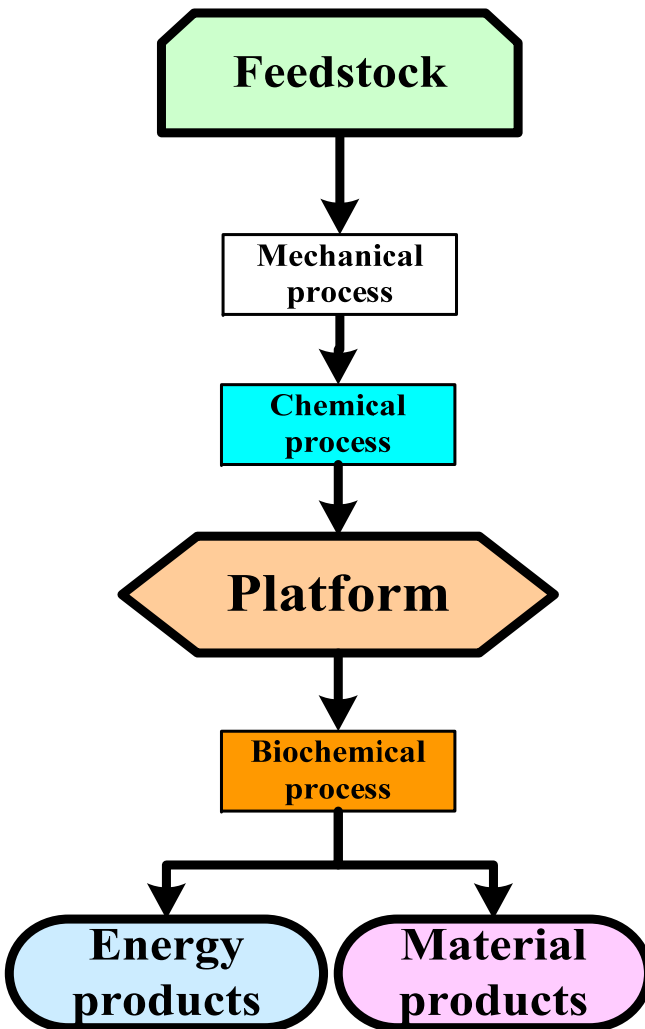
Biorefinery

3. Feedstocks

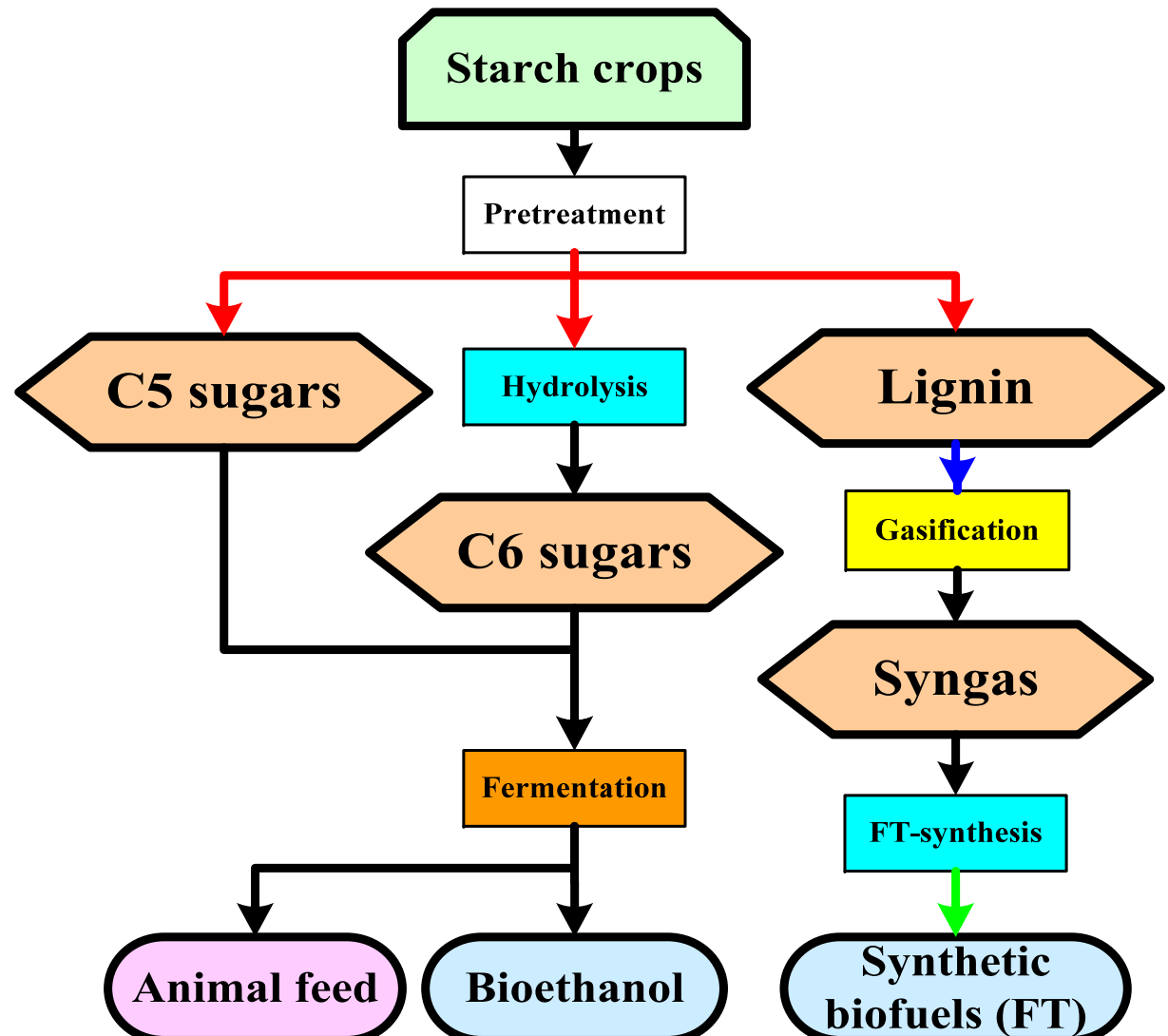
4. Processes

Example: Description of a Biorefinery System

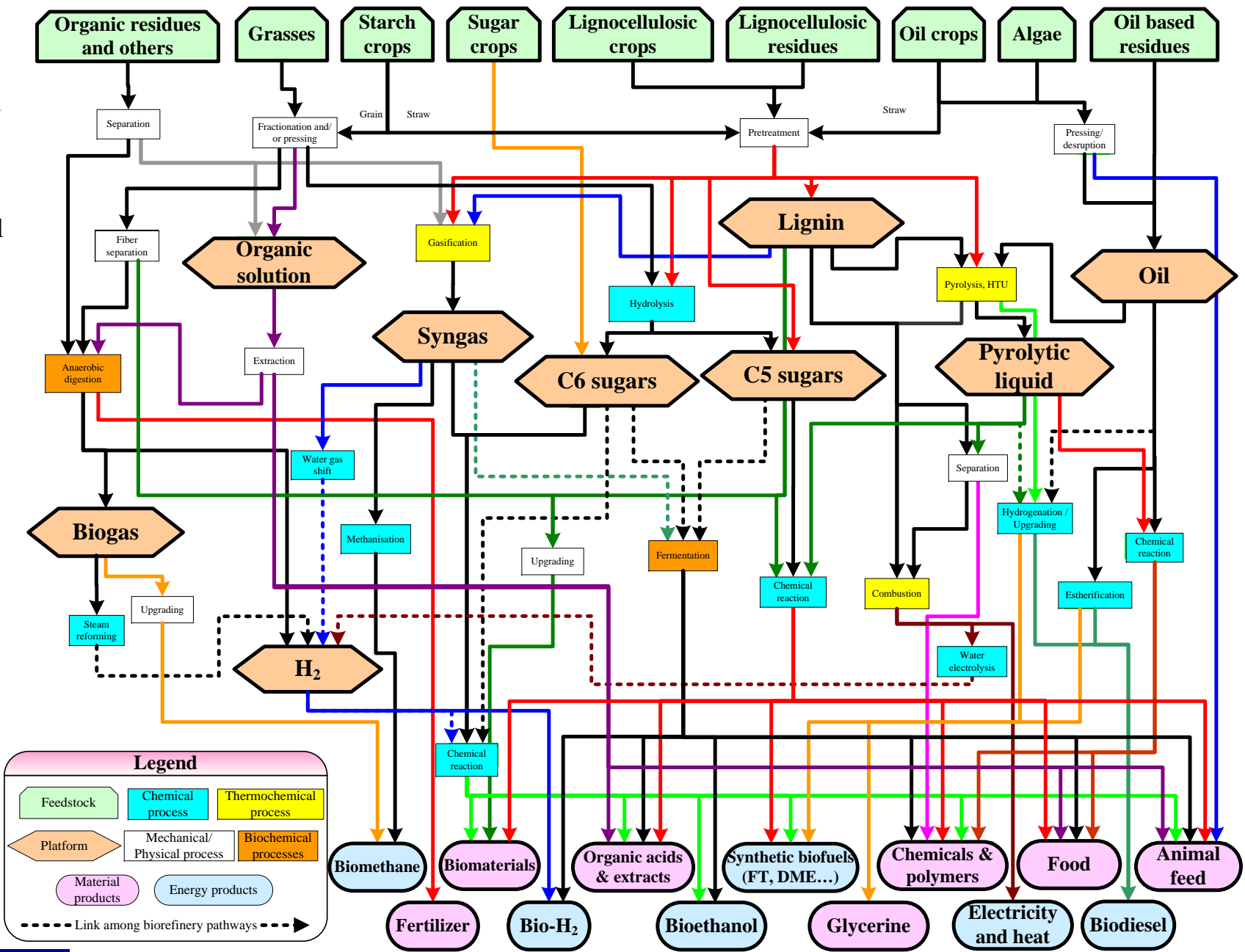
Generic System



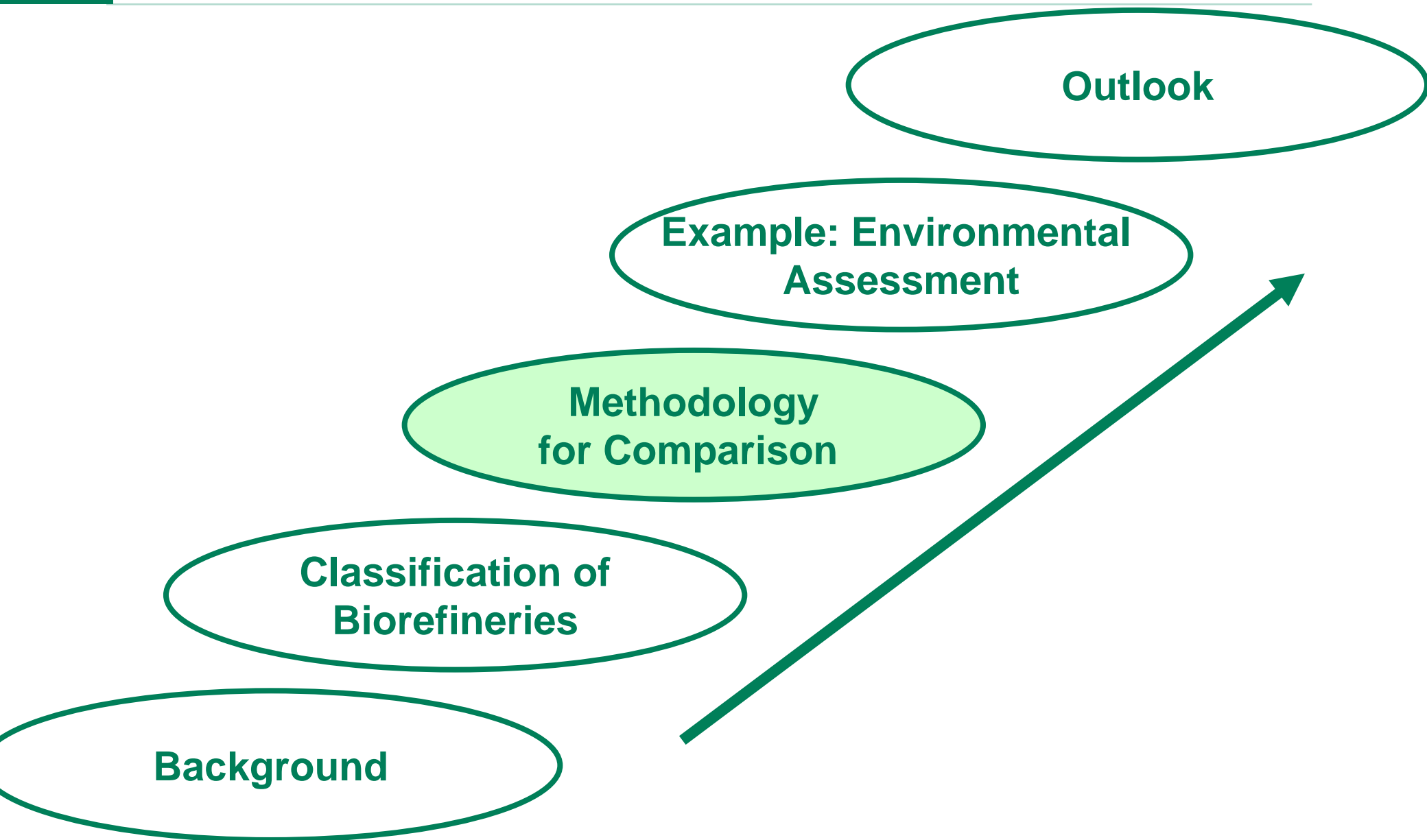
Example



- 1. Bioethanol from starch
- 2. Biodiesel from oil crop
- 3. Biomethane from organic residues
- 4. FT-Fuels from lignocellulosic residues
- ...

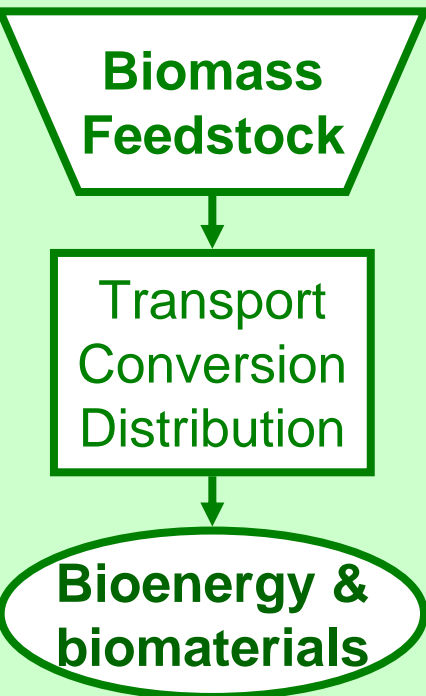


Outline



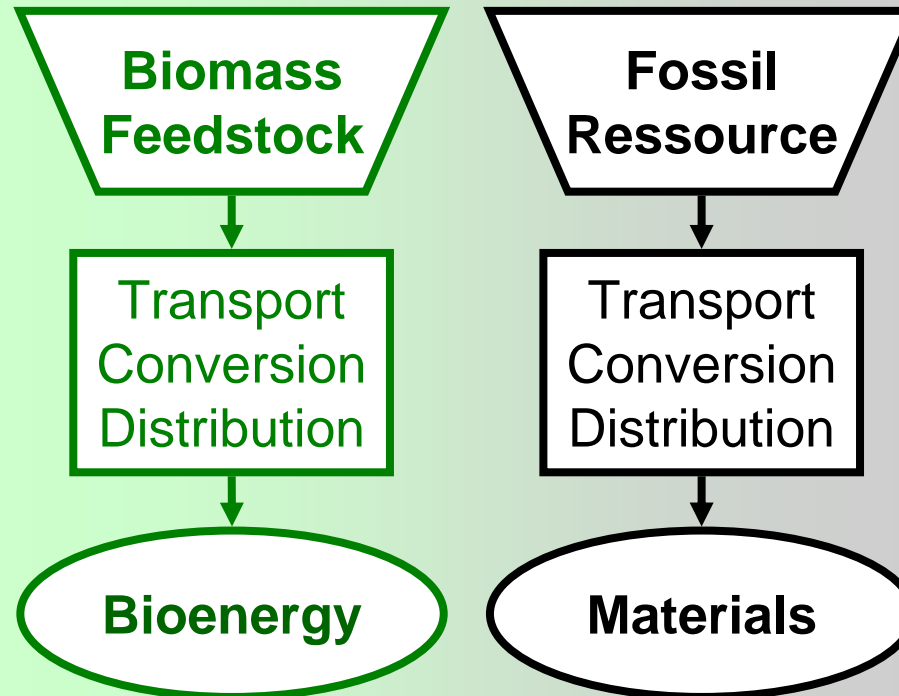
What are the „Conventional Systems?“

Biorefinery System

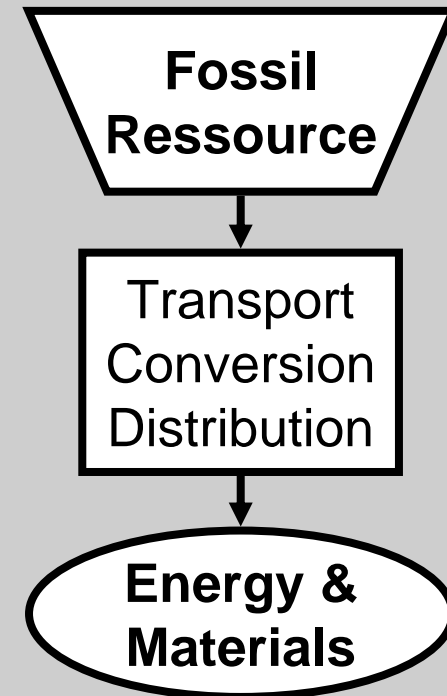


Conventional Systems

Bioenergy and Fossil System



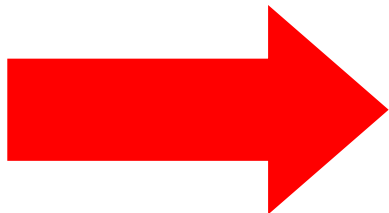
Fossil System



Product services

Basics of Comparing Biorefineries to “Conventional Systems”

- ✓ Same amount of products with same services
- ✓ Same amount and type of biomass input
- ✓ Same amount of agricultural/forestry area used
- ✓ Whole chain approach e.g. life cycle, value chain



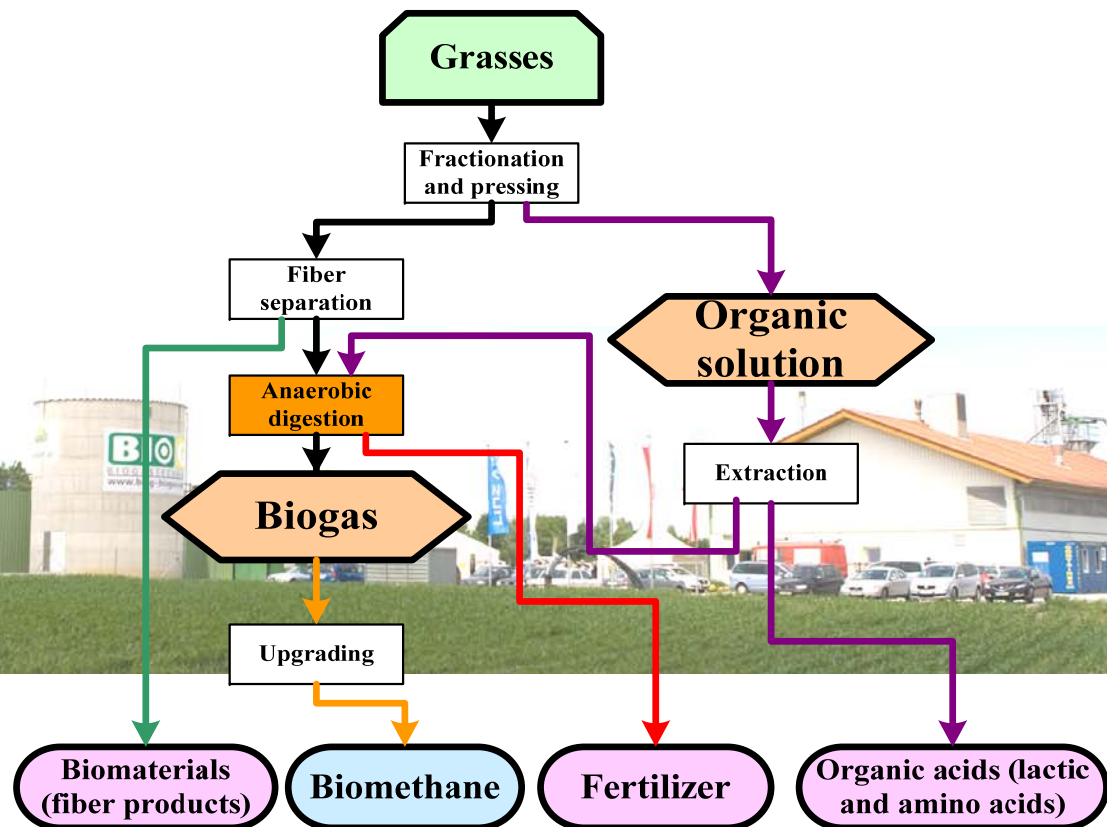
These basics are applied to two cases

Case 1: Demonstration Plant „Green Biorefinery“, Austria

Upgrading of grass silage to

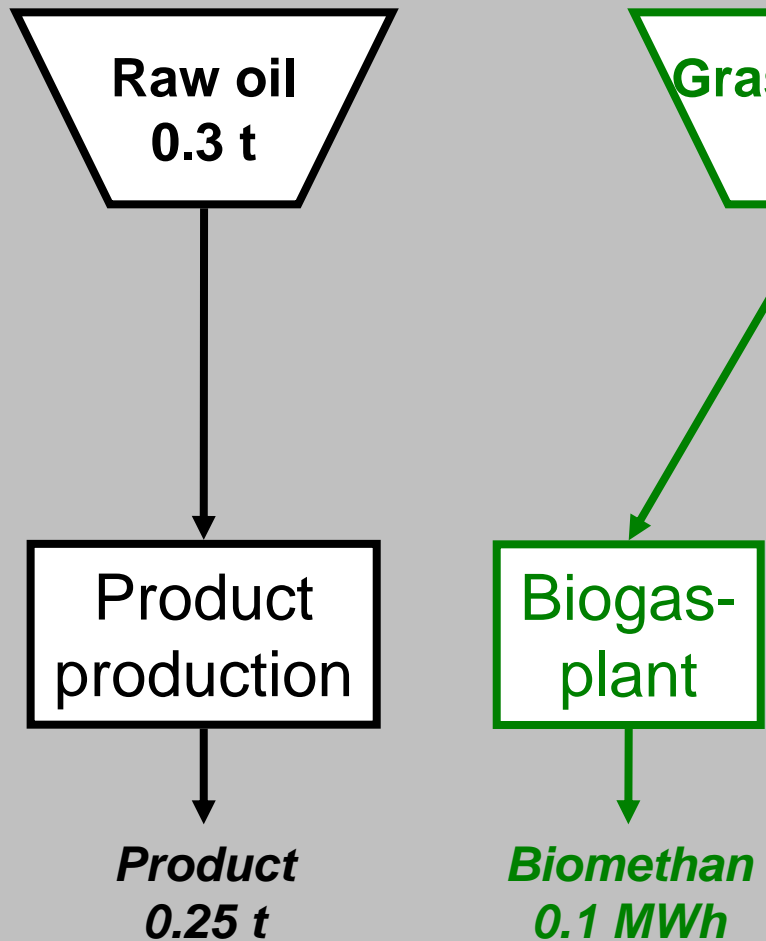
- lactic acid,
- amino acids and
- biogas (biomethan)

*“A Two Platform Biorefinery with
Grasses for Biomethan - Biogas,
organic solution”*



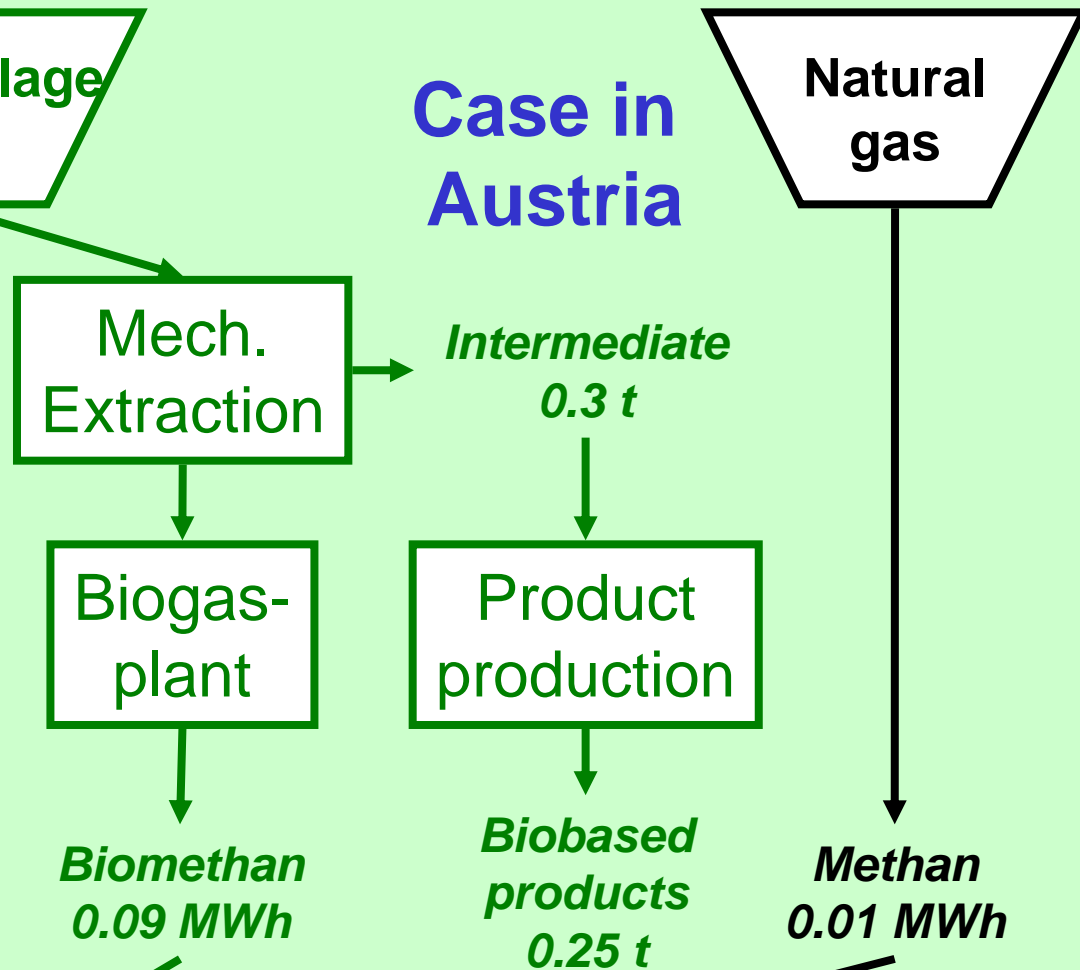
Conventional System

Biogas and raw oil



Biorefinery System

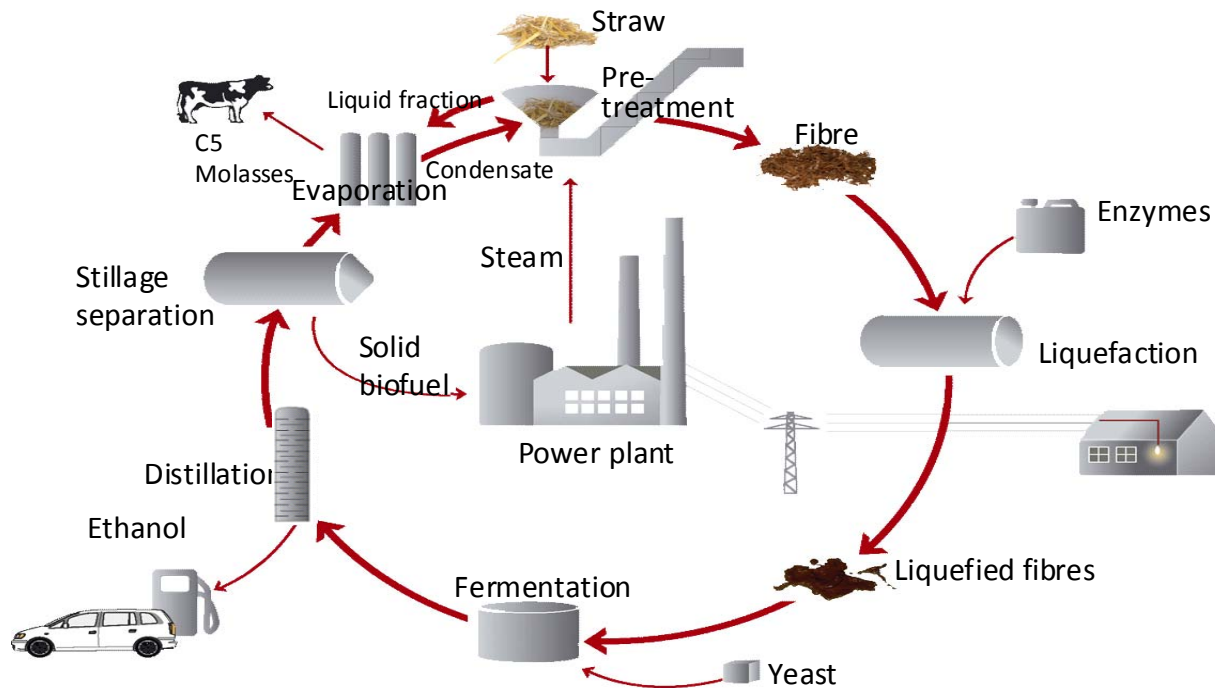
Biorefinery and natural gas



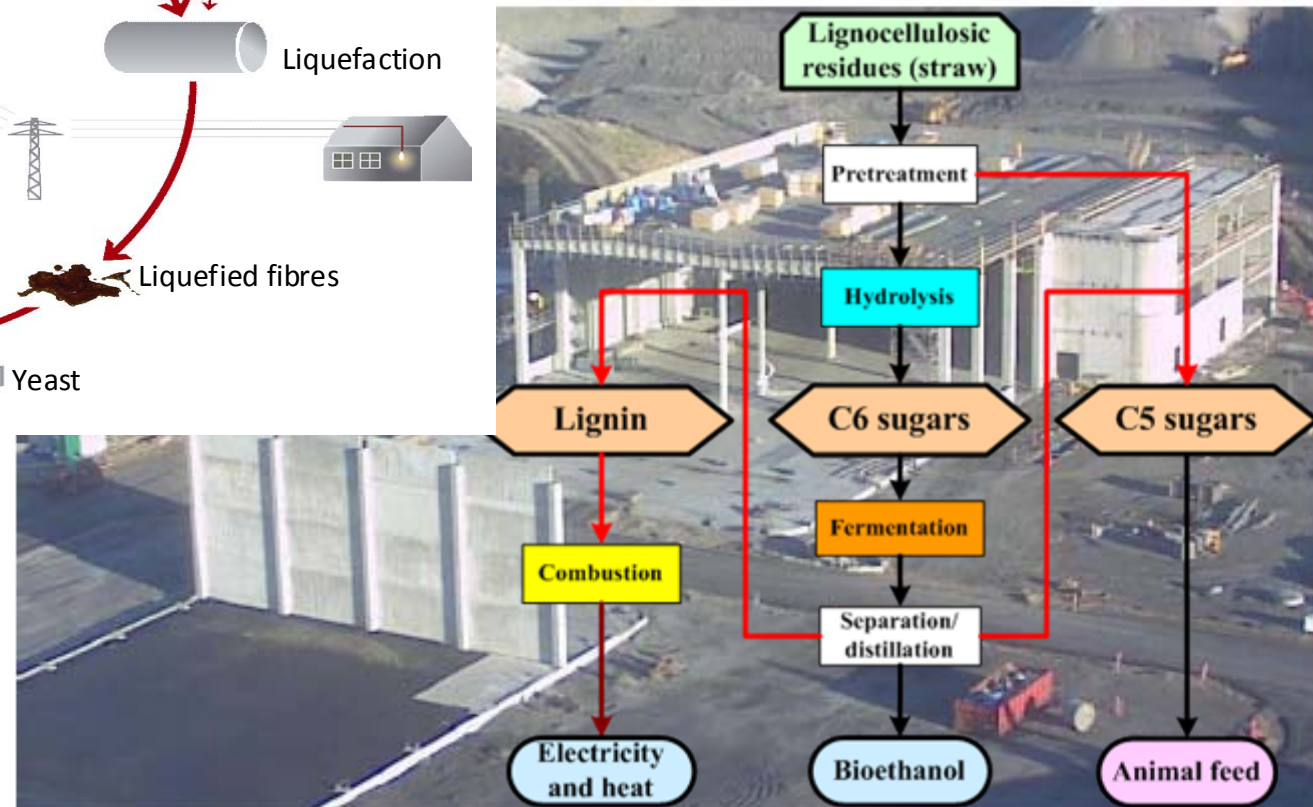
**Case in
Austria**

0.1 MWh Methan and 0.25 t Products

Case 2: Demonstration Plant IBUS Biorefinery Denmark



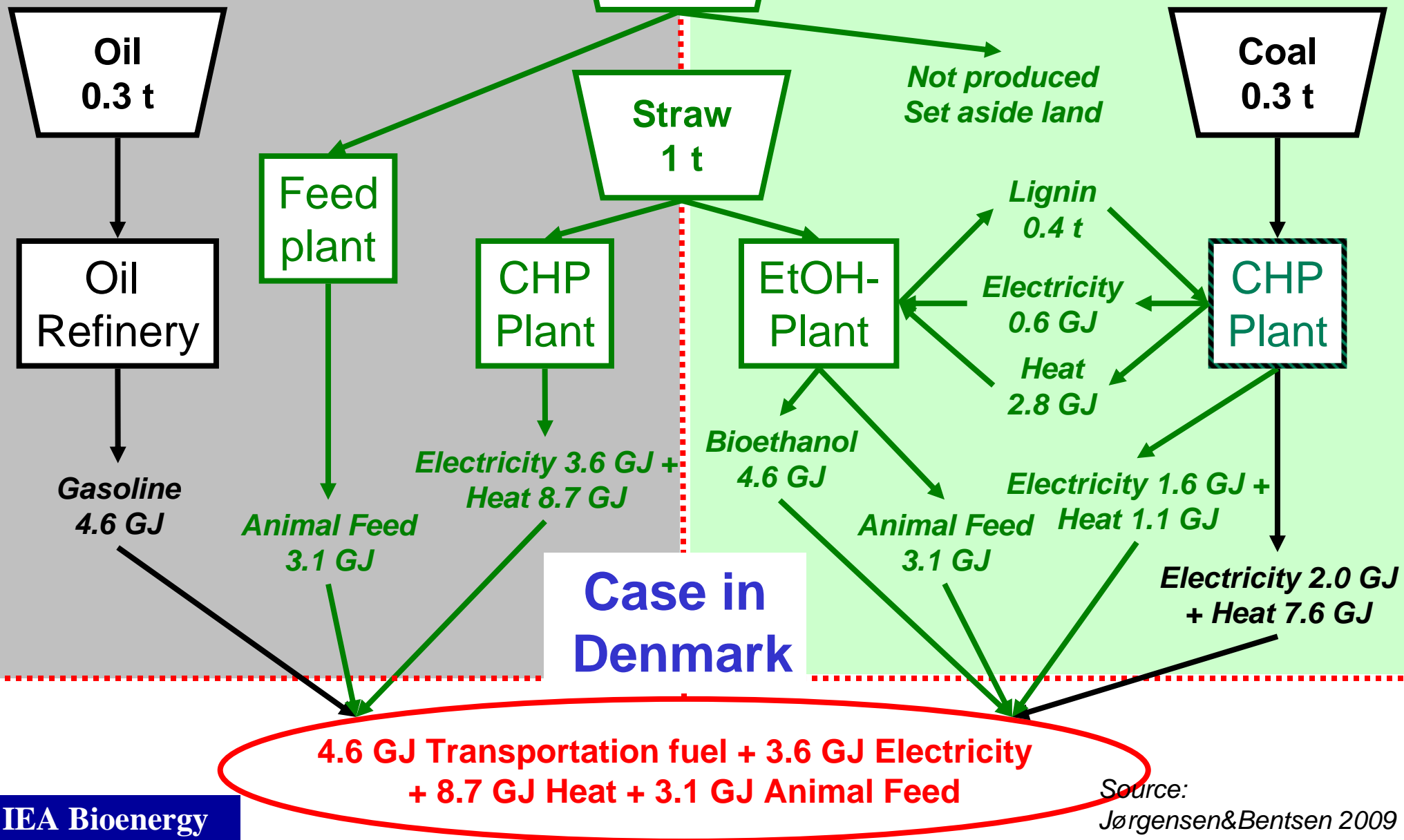
*„A Three Platform Biorefinery
with Straw for Bioethanol –
C6&C5 Sugars and Lignin“*



Kalundborg, Denmark – 7. January 2009

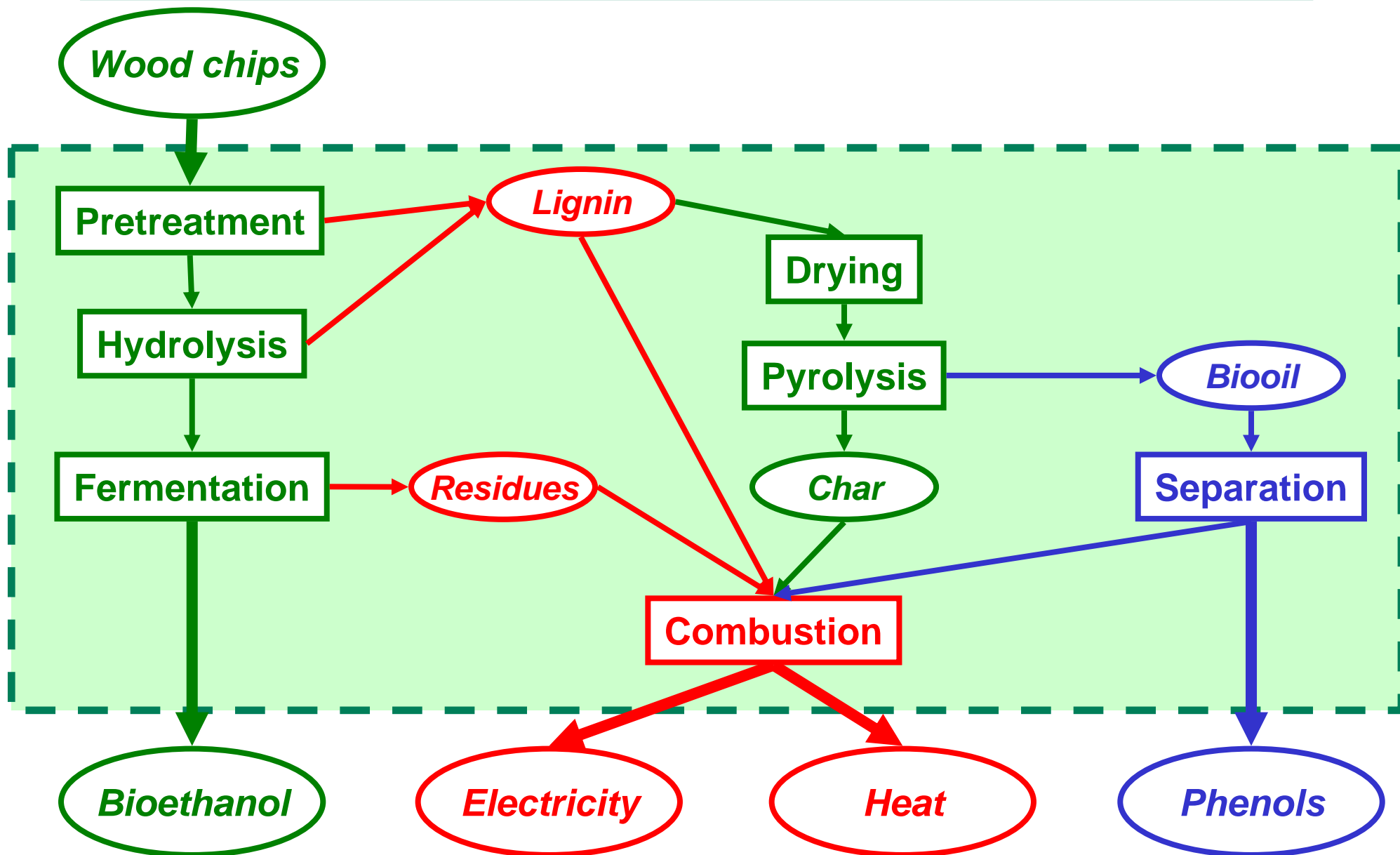
Conventional System

Biorefinery System



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Process System: Wood Bioethanol Biorefinery



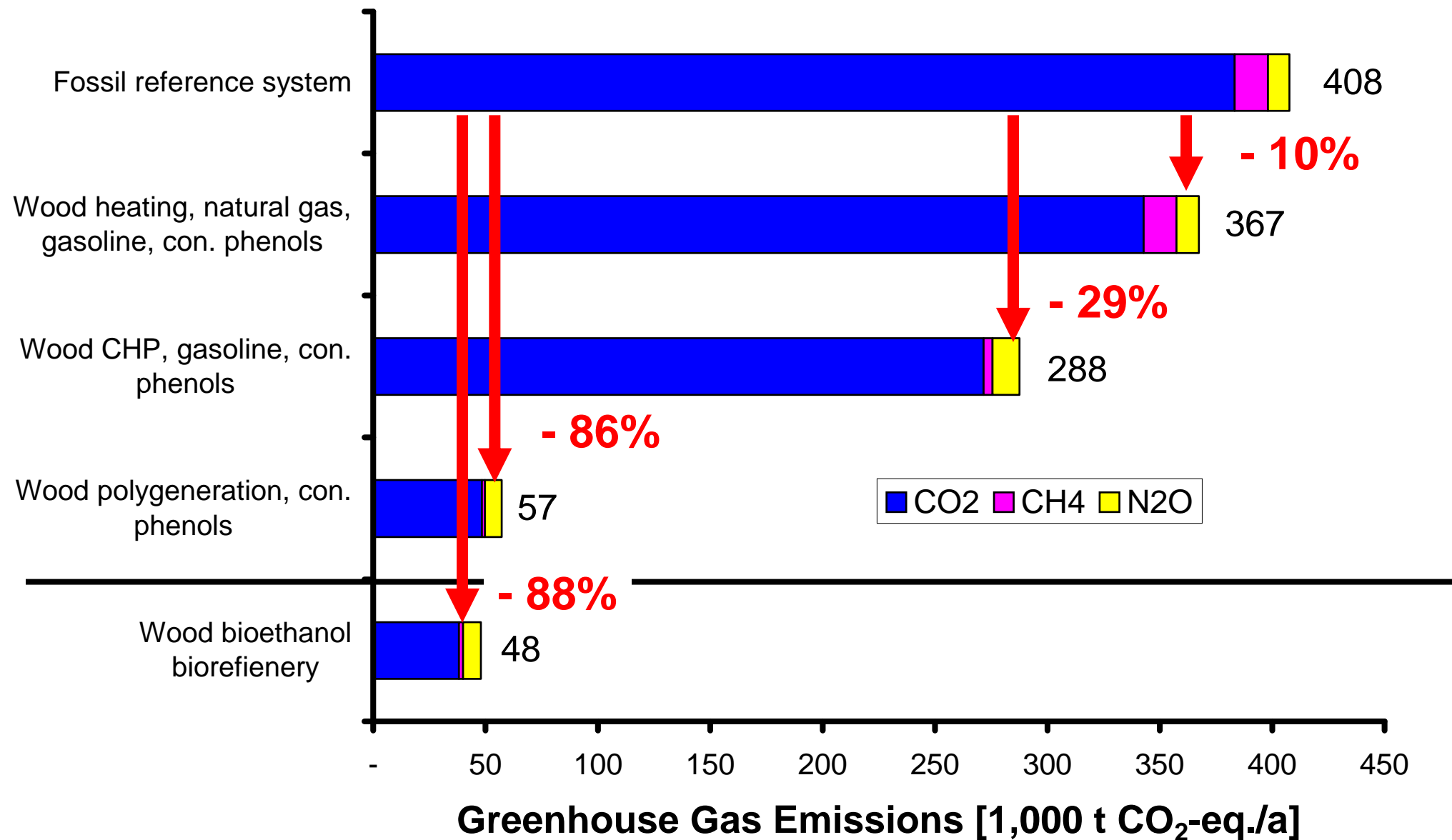
System Description for Example Environmental Evaluation

| Systems | Product services | | | |
|---|-------------------|--------------------------|---|----------------------|
| | Heat 110 GWh/a | Electricity 175 GWh/a | Transportation service *) 1,000 Mio. km/a | Phenols 5,600 t/a |
| Wood bioethanol biorefinery | wood | | | |
| Wood polygeneration, con. phenols | wood | | | oil |
| Wood CHP **), gasoline, con. phenols | wood | | gasoline | oil |
| Wood heating, natural gas, gasoline, con. phenols | wood | natural gas | gasoline | oil |
| Fossil reference system | oil | natural gas | gasoline | oil |

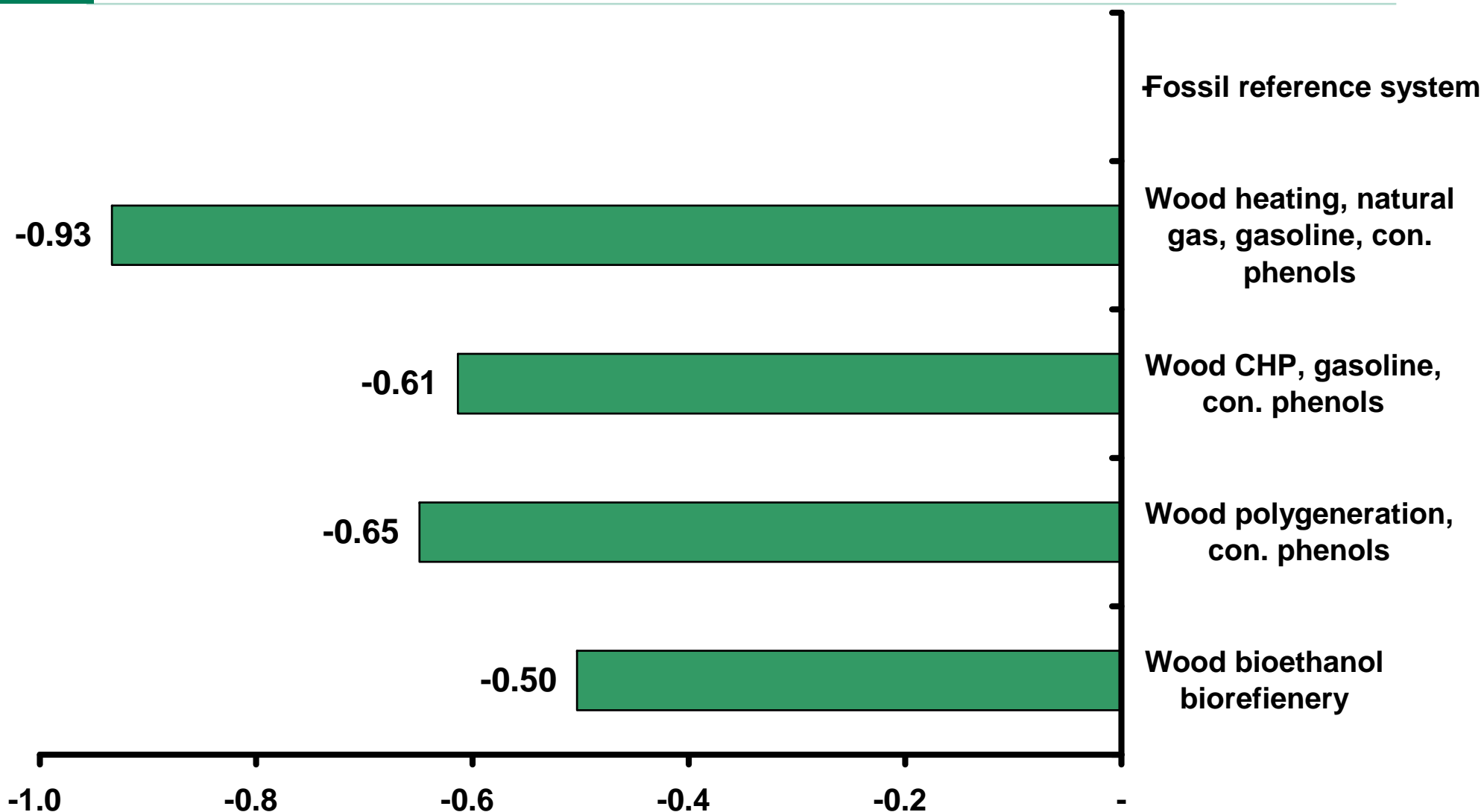
*) Bioethanol: 100.000 t/a
**) Combined heat and power

Conventional systems

Annual Greenhouse Gas Emissions

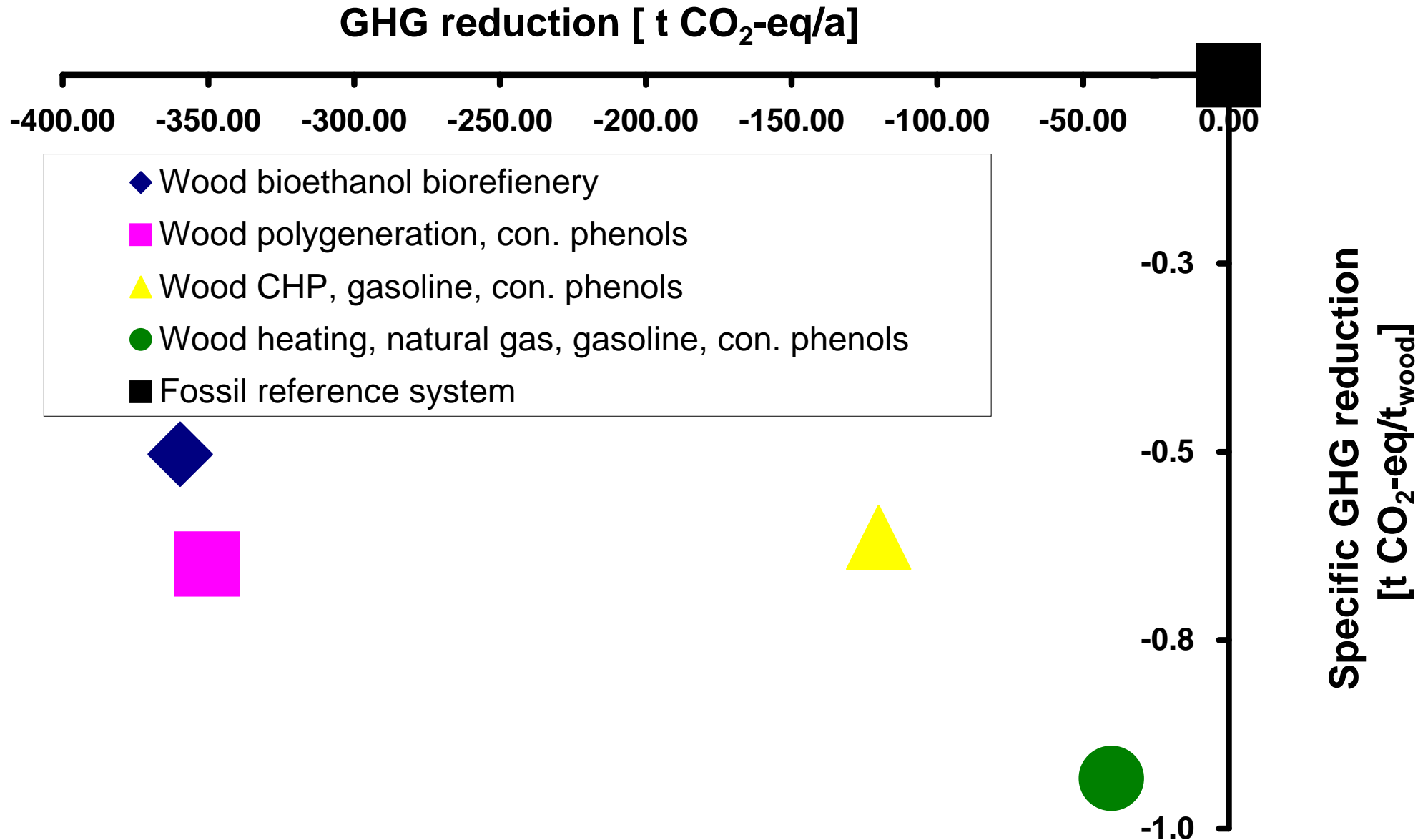


Specific Greenhouse Gas Reduction

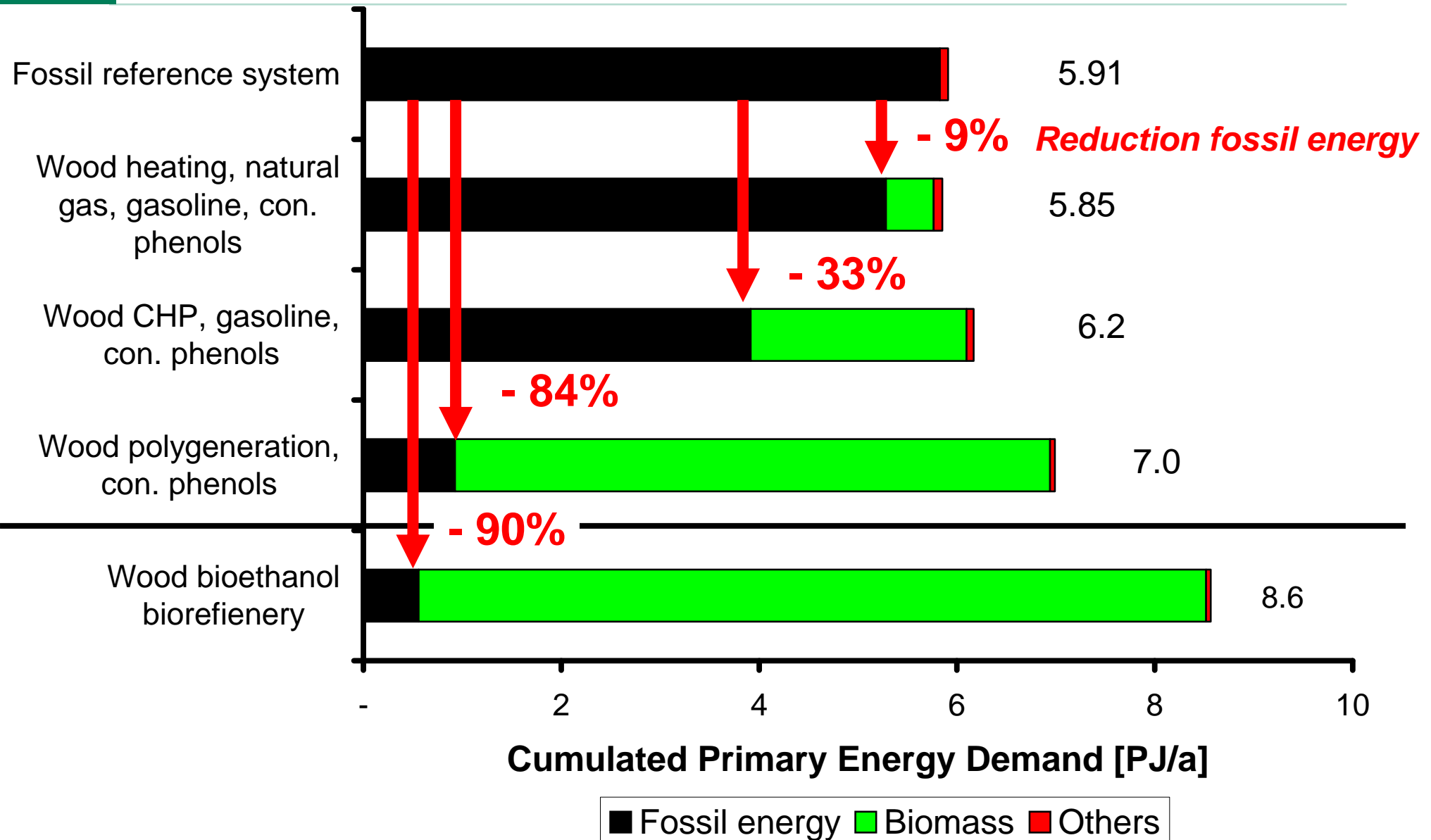


Specific Greenhouse Gas Emissions Reduction [t CO₂-eq./t_{wood}]

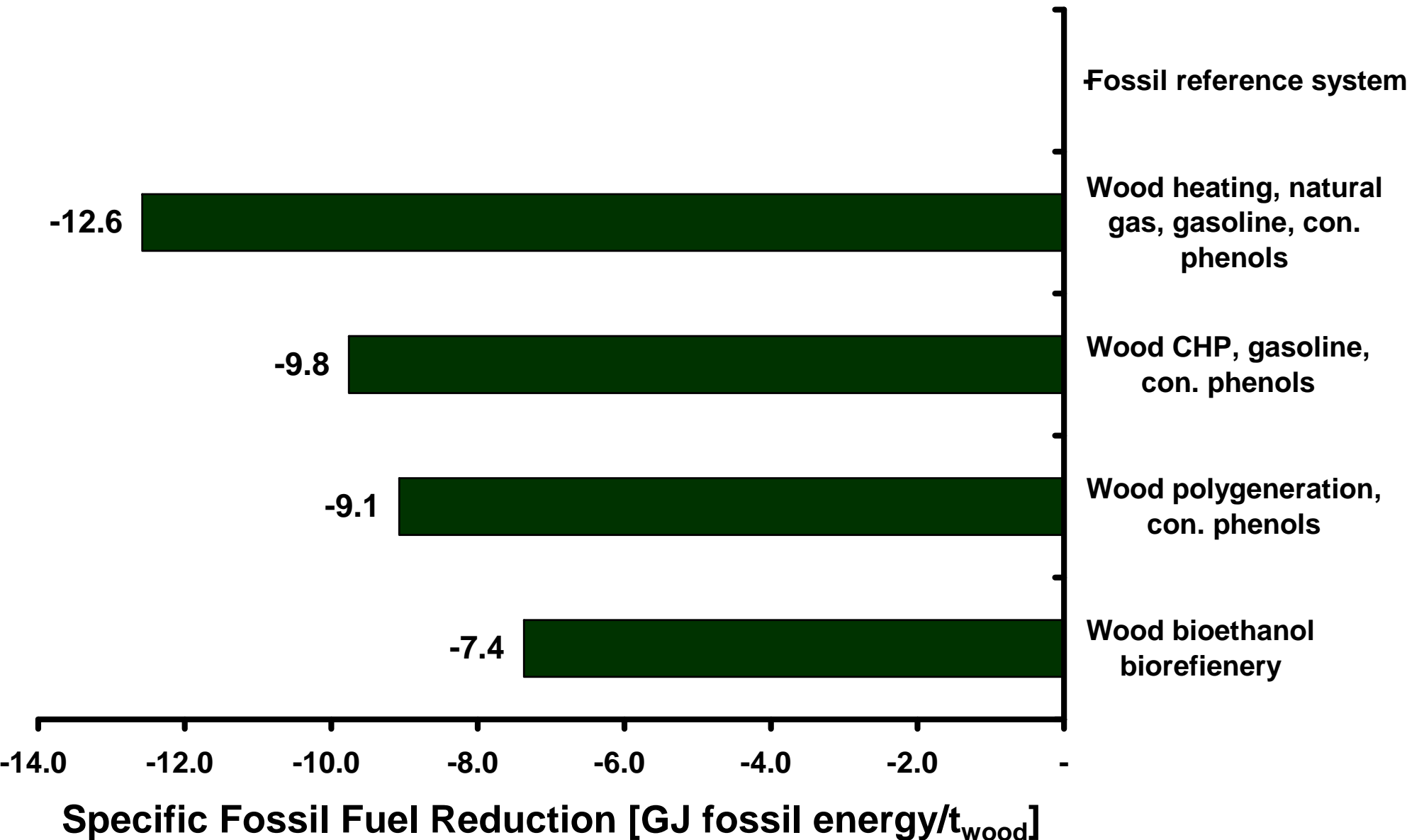
Annual and Specific Greenhouse Gas Reduction



Annual Primary Energy Demand

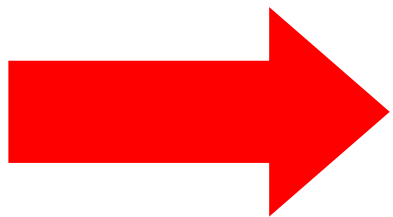


Specific Fossil Fuel Reduction



Basics of Comparing Biorefineries to “Conventional Systems”

- ✓ Same amount of products with same services
- ✓ Same amount and type of biomass input
- ✓ Same amount of agricultural/forestry area used
- ✓ Whole chain approach e.g. life cycle, value chain



Applicable to all aspect: environment, economy, Socio-economics etc.

Conclusions

Task 42 „Biorefinery“ will work out examples for sustainability assessment

Conventional system includes fossil and biomass based systems (for heat&electricity)

Comparison of systems must be done on whole chain approach by using same biomass and/or land

Unique classification possible via platforms, products, feedstock and processes

Biorefinery systems coproduce bioenergy and biomaterials (key driver transportation biofuels)