“Life Cycle Assessment (LCA) of Biofuels"

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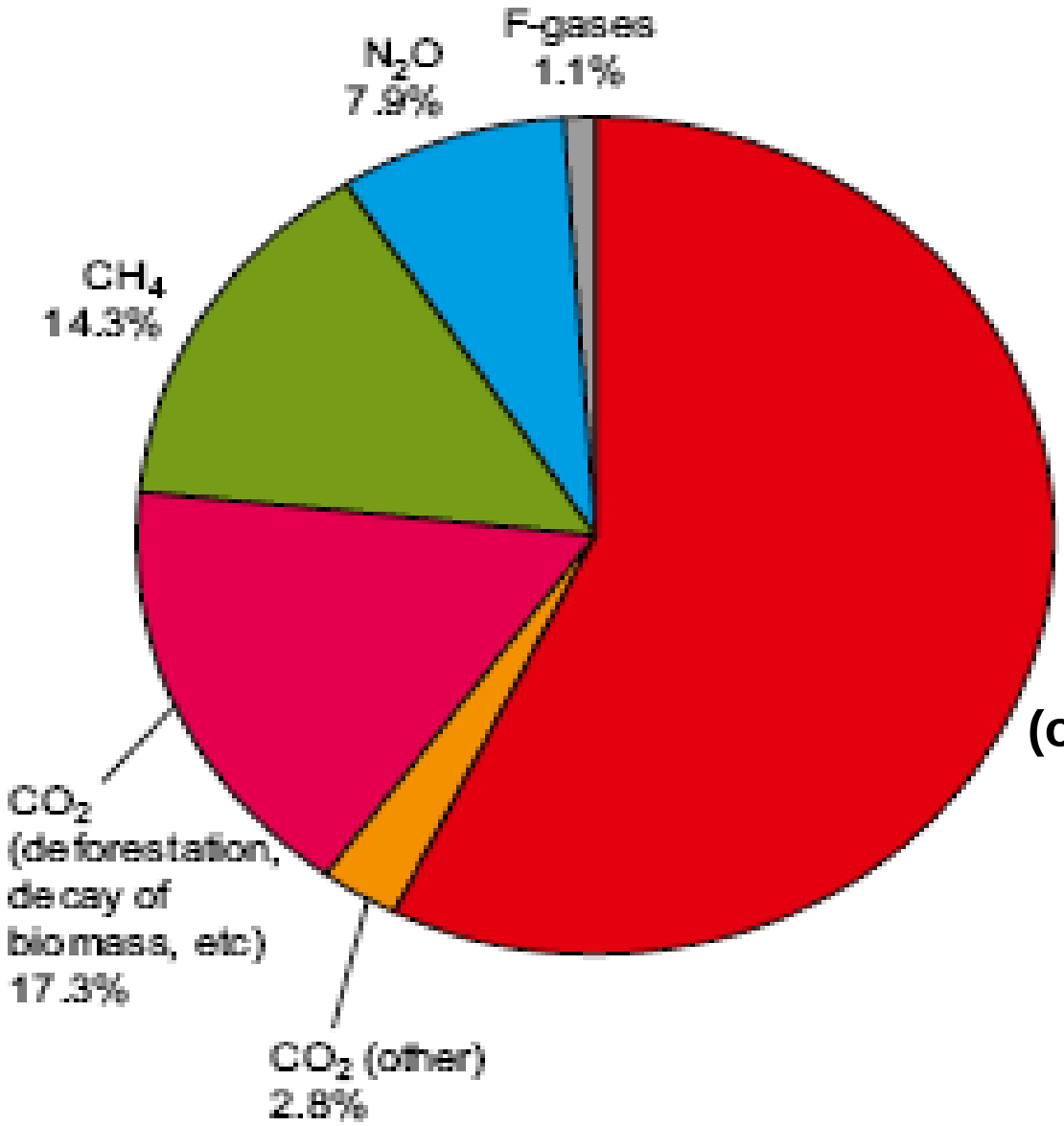
2. National IEA Bioenergy Task 39 “Liquid Biofuels” Workshop

“Transportation Biofuels Research in Austria”!

9th September 2008, Vienna

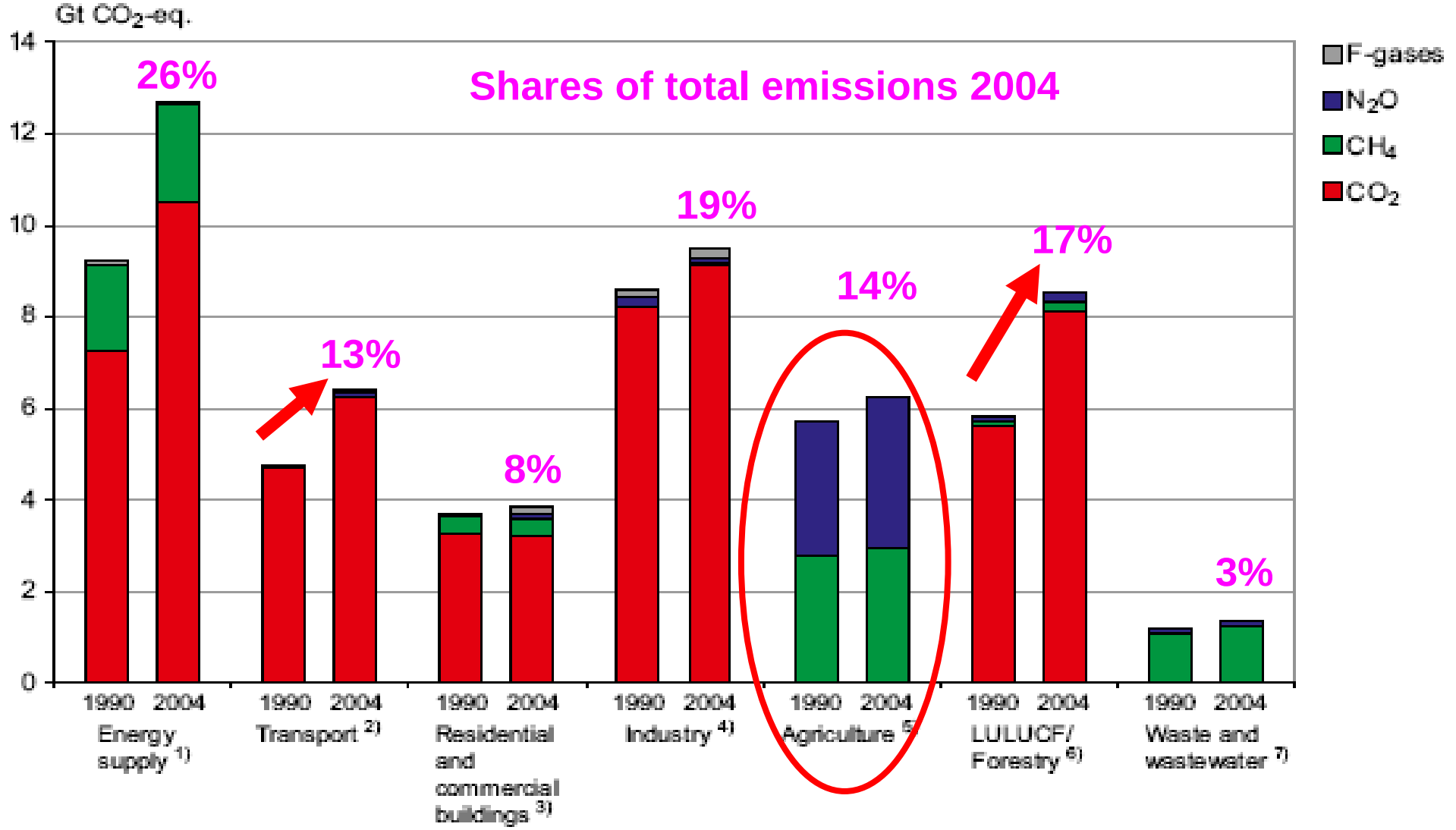
Global Anthropogenic Greenhouse Gas Emissions 2004



(oil, gas and coal)

Source: www.ipcc.ch

Development Greenhouse Gas Emissions per Sector 2004



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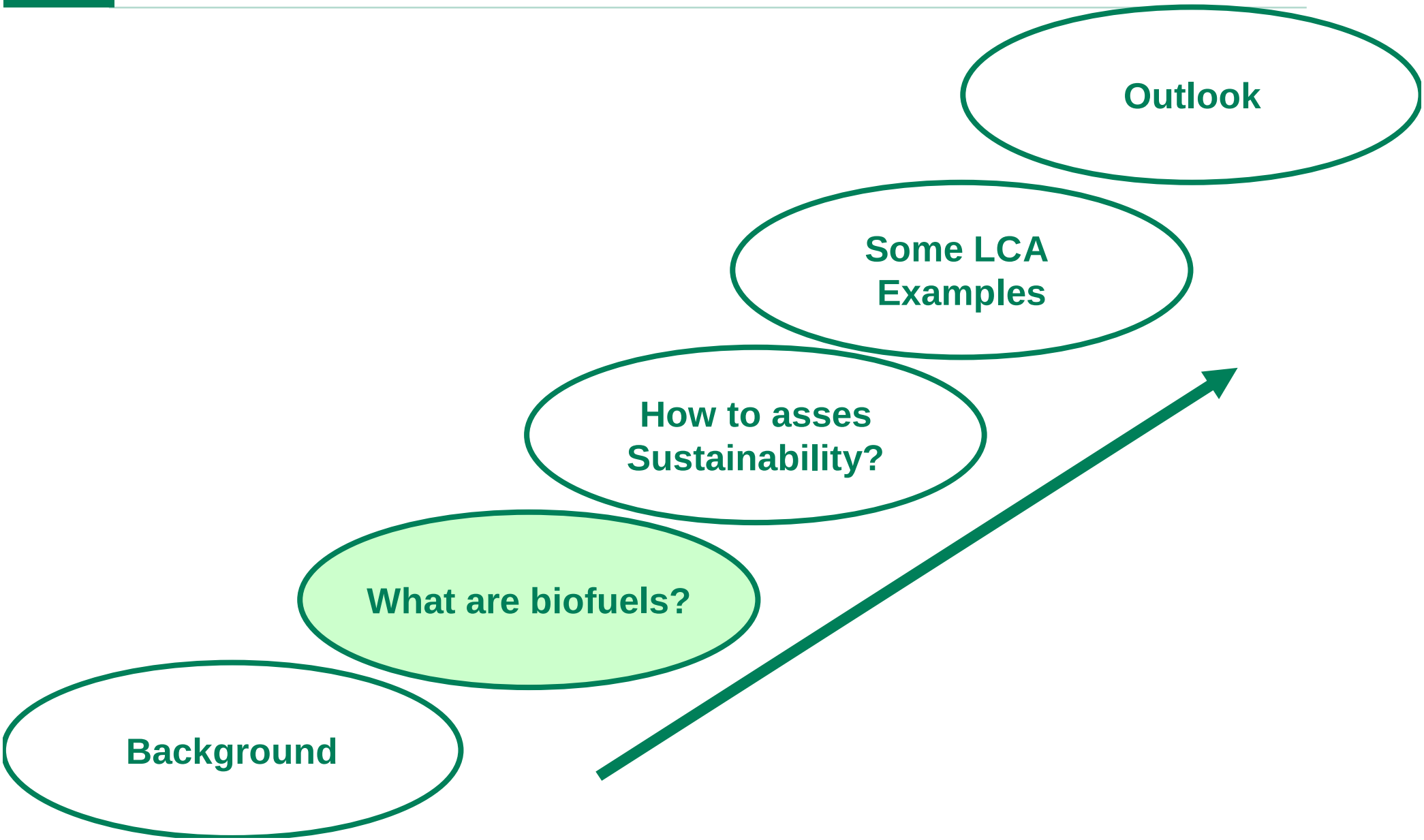
Outline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Some LCA Examples
How to asses Sustainability?
What are biofuels?
Background

Overview Transportation Biofuels 1st and 2nd Generation

1) **(pure) Vegetable oil**
2) **Biodiesel**
   a) conventional biodiesel via esterification
   b) hydro-treated biodiesel via hydration
3) **Bioethanol**
   a) conventional bioethanol from sugar and starch
   b) lignocellulosic bioethanol
4) **Biobutanol**
5) **Biogas**
6) **Synthetische Biotreibstoffe**
   a) Fischer-Tropsch biofuels (e.g. FT-Diesel)
   b) Synthetic natural gas (SNG)
   c) Dimethylester (DME)
   d) Methanol
   e) Synthetic hydrogen
7) **Biological hydrogen**
8) **(upgraded) Pyrolyses oil**
9) **Biofuels from direct liquifaction**
   a) HTU-Biofuels from hydro-thermal upgrading
   b) CLC-Biofuels from catalytic low temperature conversion

Overview Transportation Biofuels
1st Generation

1) **(pure) Vegetable oil**
2) **Biodiesel**
   a) conventional biodiesel via esterification
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3) **Bioethanol**
   a) conventional bioethanol from sugar and starch

Today commercially produced

5) **Biogas**

Overview Transportation Biofuels
2nd Generation

3) **Bioethanol**
   b) lignocellulosic bioethanol
4) **Biobutanol**

6) **Synthetische Biotreibstoffe**
   a) Fischer-Tropsch biofuels (e.g. FT-Diesel)
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Most interessting in near term future (> 2010)

From Raw Material to Transportation Biofuels

Raw Materials

- Agriculture
  - ✓ oil crops
  - ✓ starch crops
  - ✓ .....
- ➢ Forestry
  - ✓ forest residues
  - ✓ thinnings
- ➢ Trade and Industry
  - ✓ bark
  - ✓ cooking oil
  - ✓ .....

Conversion Processes

- ➢ Bio-chemical
- ➢ Thermo-chemical
- ➢ Physical-chemical
- ➢ others e.g. hydration

Transportation Biofuels

1) (pure) vegetable oil
2) Biodiesel
3) Bioethanol
4) Biobutanol
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6) Synthetic biofuels
7) Biological hydrogen
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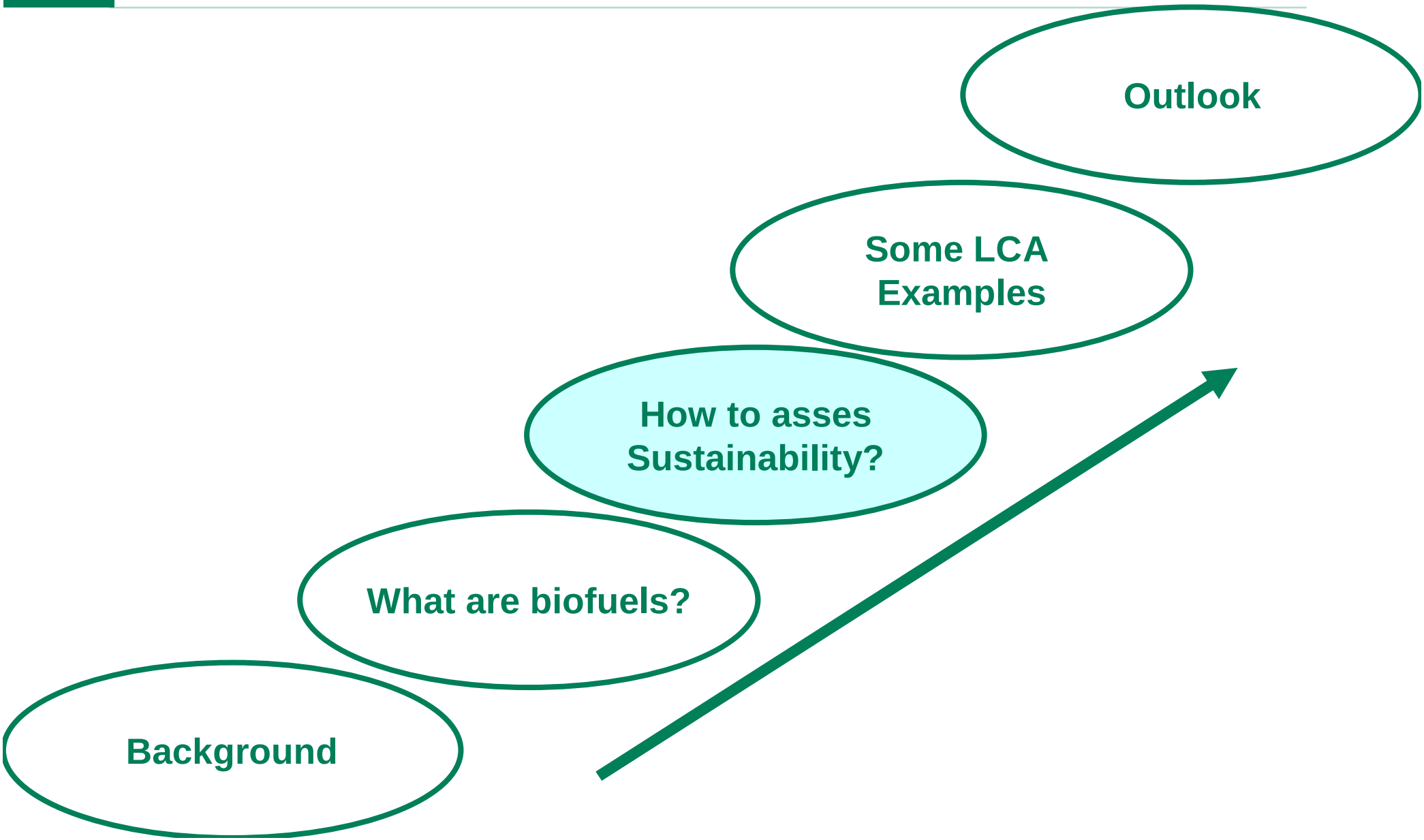
Currently about 40 combinations
Raw material/Conversion/Biofuel under discussion

Outline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Steps Towards
A Sustainable Energy System

Increasing of Energy Security

e.g. domestic renewable energy

Reduction of local pollutants

e.g. PM10, NO_x

Reduction of Greenhouse Gas Emissions,

e.g. Kyoto-Target: minus 13% (2008-2012 ref. 1990)

(further) Increase of using Renewable Energy

e.g. biofuels, solar energy

Increasing of Energy Efficiency in energy conversion,

e.g. hybrid vehicles, new conversion systems

"Energy Saving" – Reduction of useful energy consumption with same energy service, e.g. public transport, insulation of buildings

Steps Towards A Sustainable Energy System

Possible Contributions of biofuels

Increasing of **Energy Security**

e.g. domestic renewable energy

Reduction of local pollutants

e.g. **PM10**, NO_x

Reduction of **Greenhouse Gas Emissions**,

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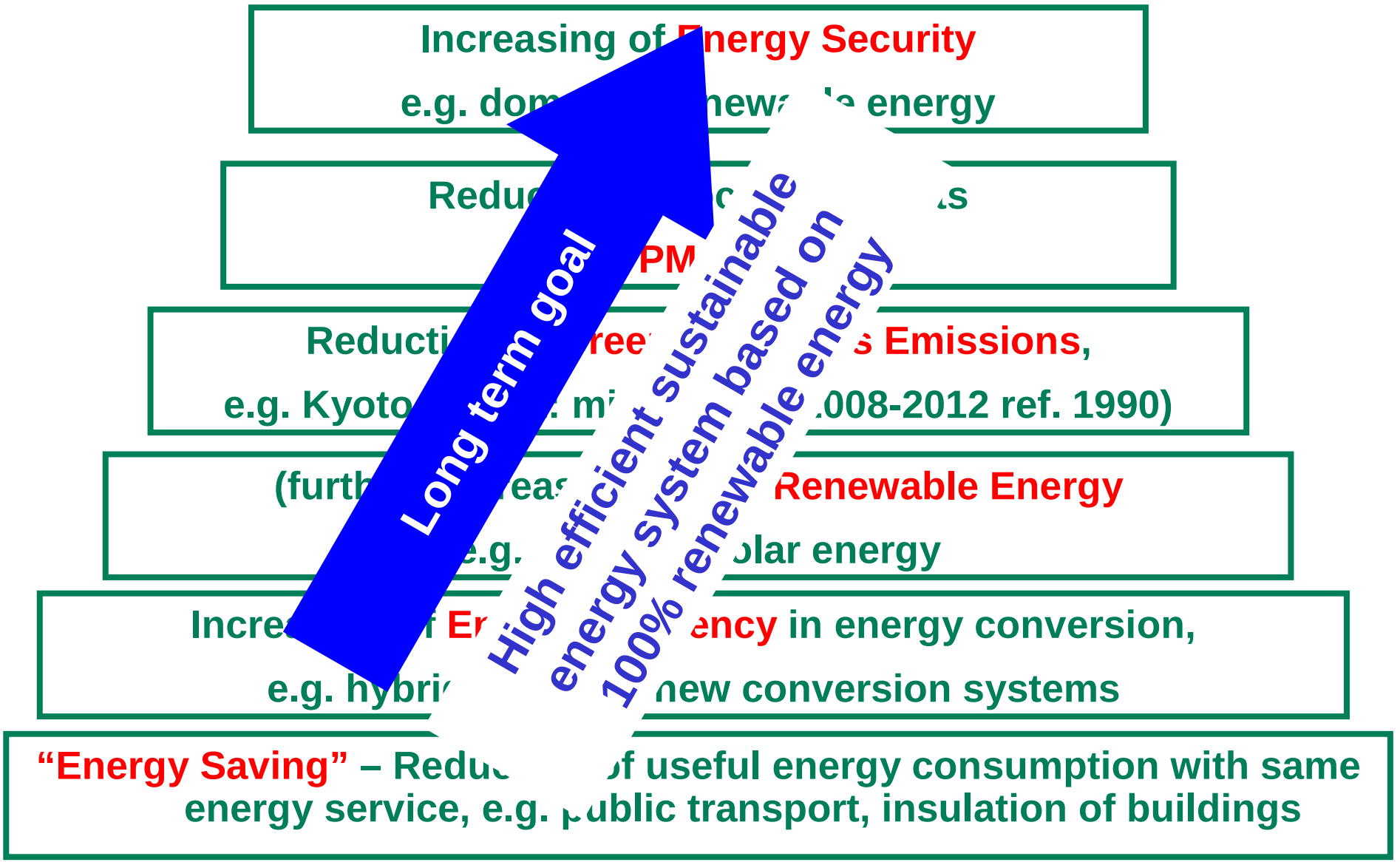
Steps Towards A Sustainable Energy System



Indicators for „Sustainable Biofuels“

- Greenhouse gas balance (> 35% reduction)
- Land use change
  - Change of carbon storage pools
  - Loss of biodiversity
  - Competition
    - agriculture for food and feed
    - forestry: construction materials, wooden products, local energy use
  - Others: soil erosion, water resource, plant protection agents, GMOs...

Environment

Economic prosperity, e.g. labour creation, land ownership

Social welfare, e.g. working conditions, healthiness

Sustainability

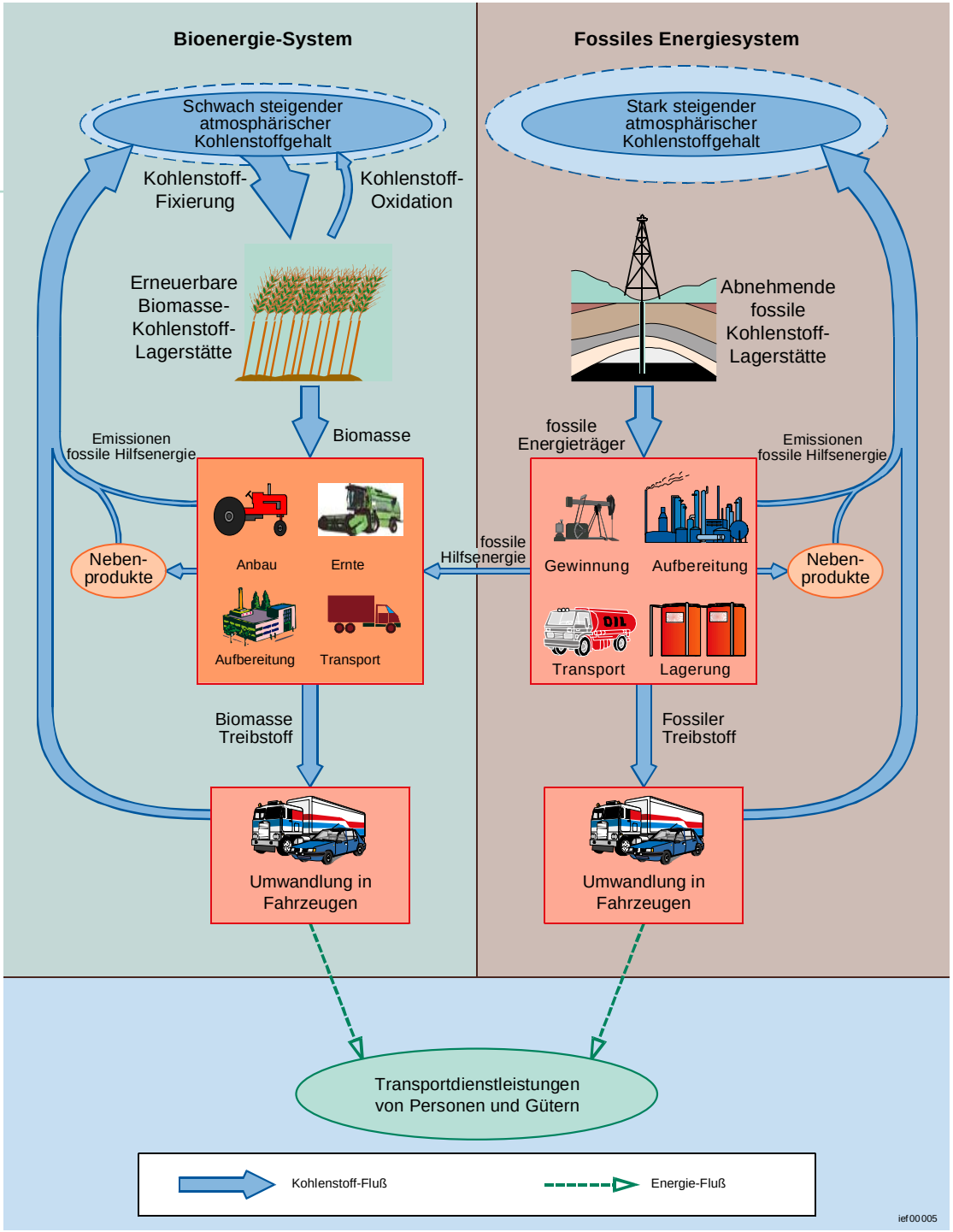
Perspective

Certification of biomasse raw materials and biofuels

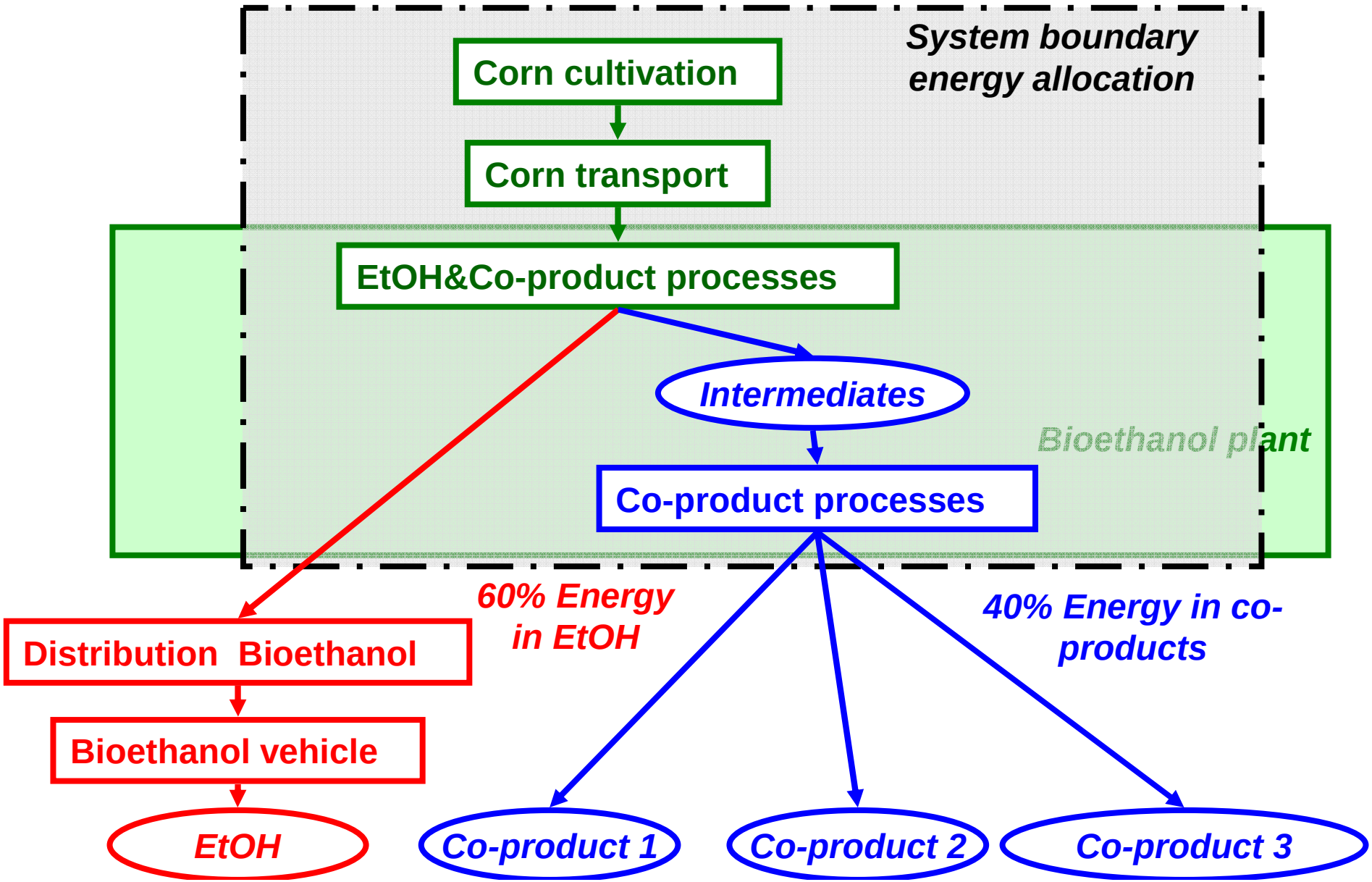
Methodology of LCA

- ✓ ISO 14,040 „Life Cycle Assessment“
- ✓ Standard Methodology of IEA Bioenergy Task 38 „Greenhouse Gas Balances of Bioenergy Systems“
- ✓ JRC/CONCAWE/EUCAR: Well-to-Wheels analysis of future automotive fuels and powertrains in the European context
- ✓ Proposal for on the promotion of the use of energy from renewable sources **ALLOCATION !!!**

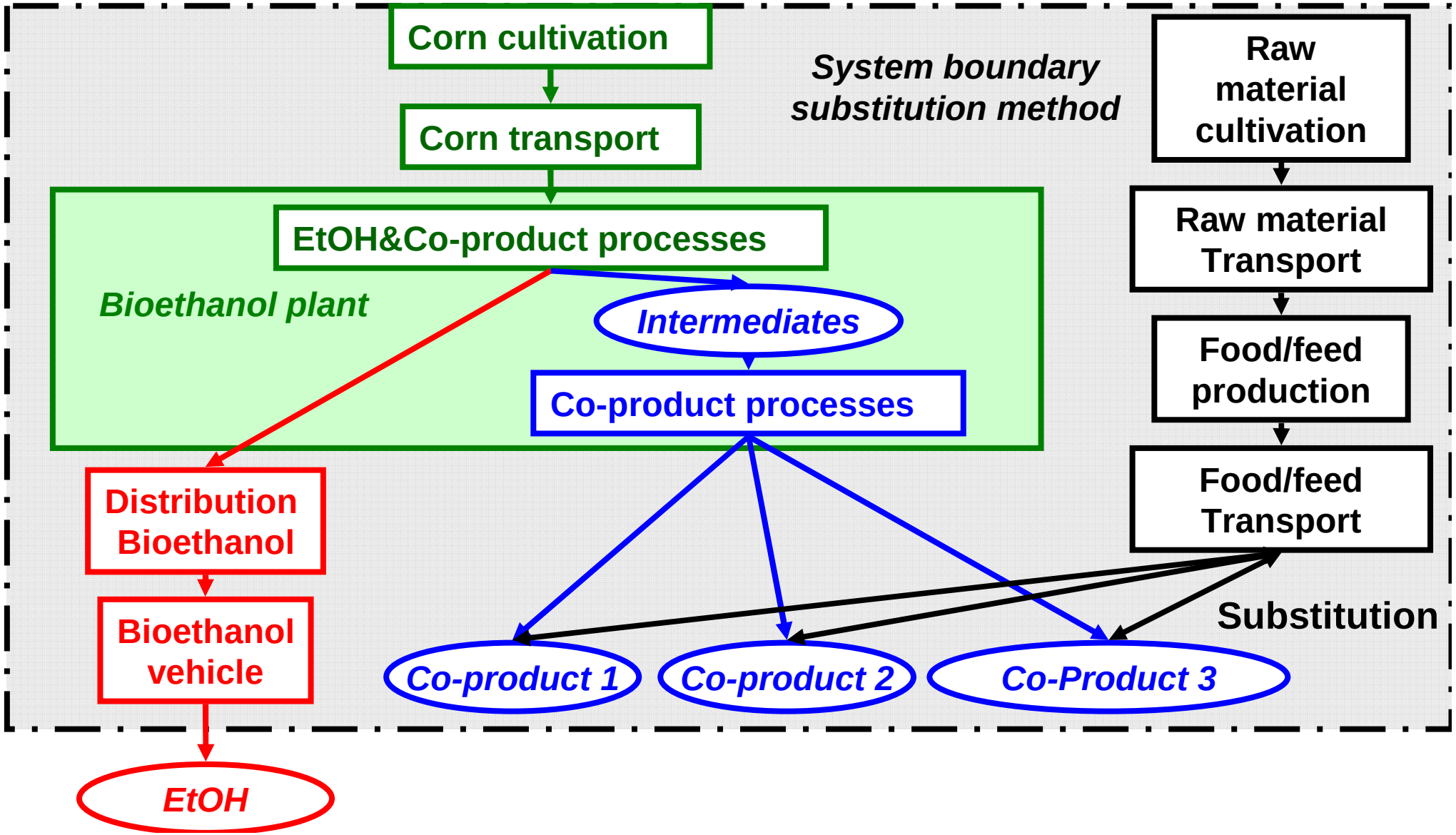
Common international Method exists



Energyallocation for Individual Operators – Bioethanol and Co-products



Substitution Methode for Policy Analyses – Bioethanol and Co-products



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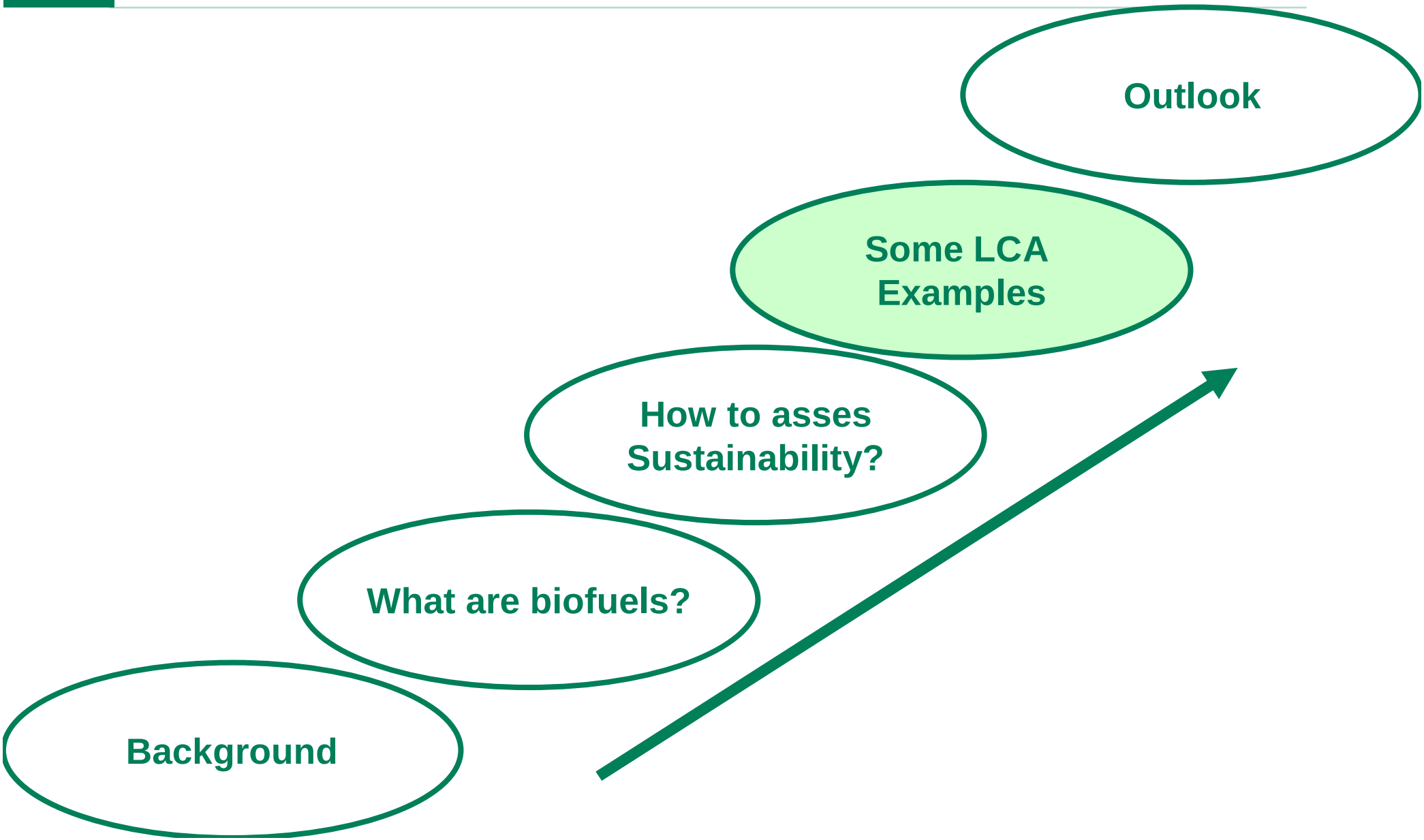
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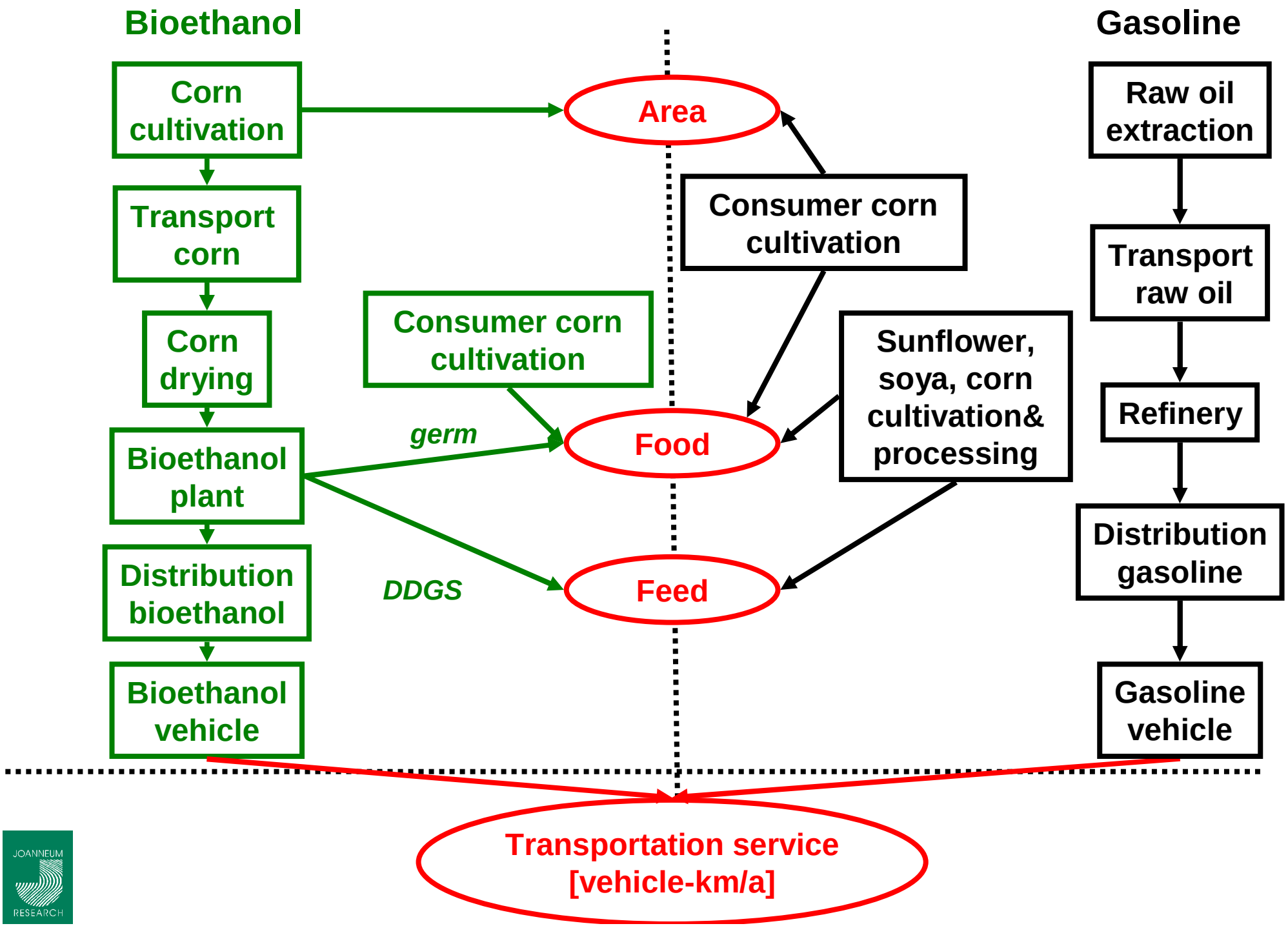
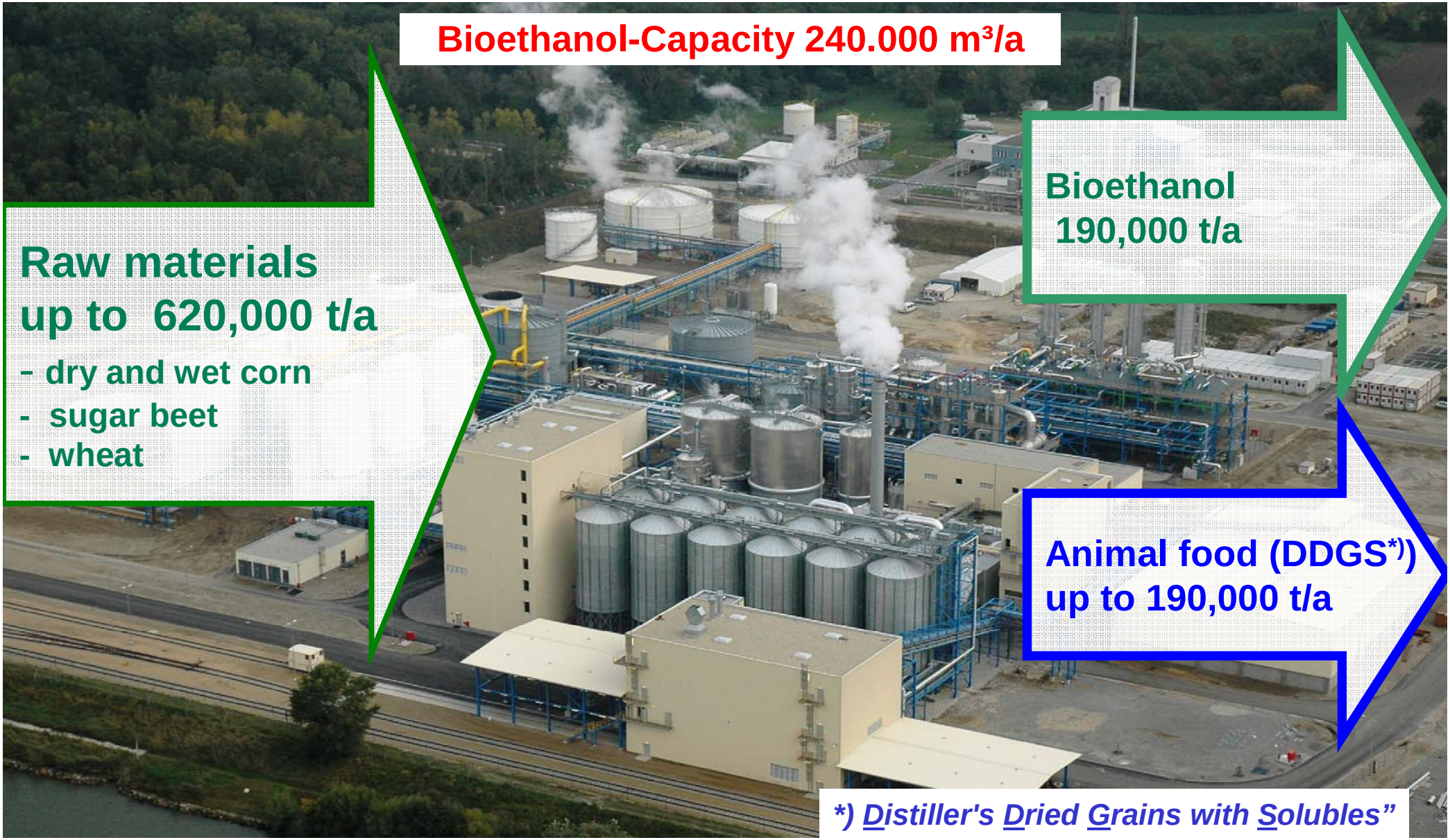

Bioethanol
Gasoline
Corn cultivation
Transport corn
Corn drying
Bioethanol plant
Distribution bioethanol
Bioethanol vehicle
Raw oil extraction
Transport raw oil
Refinery
Distribution gasoline
Gasoline vehicle
Area
Consumer corn cultivation
Consumer corn cultivation
Sunflower, soya, corn cultivation& processing
germ
Food
DDGS
Feed
Transportation service [vehicle-km/a]

The AGRANA Bioethanol-Plant



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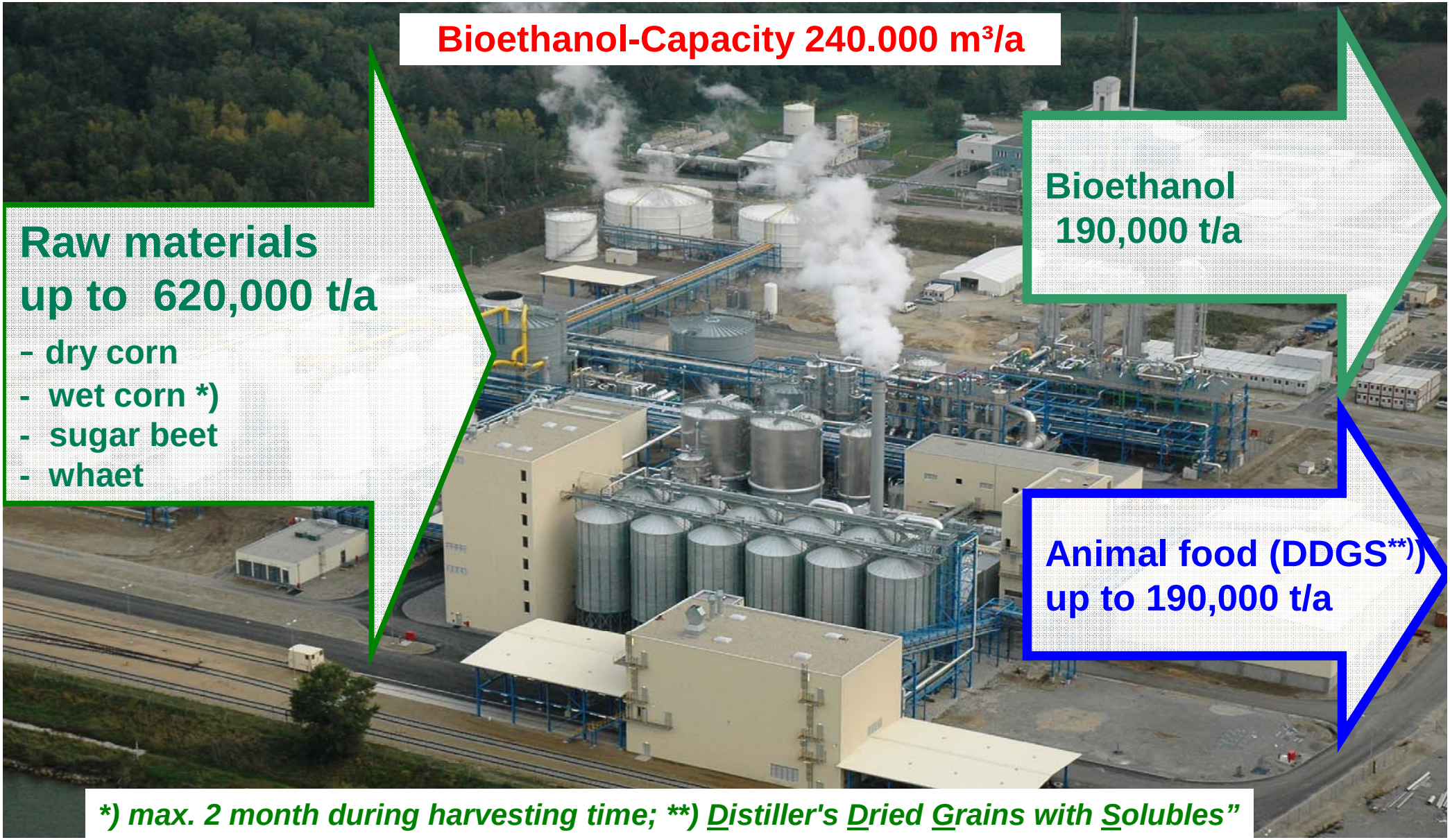


Bioethanol-Capacity 240.000 m³/a

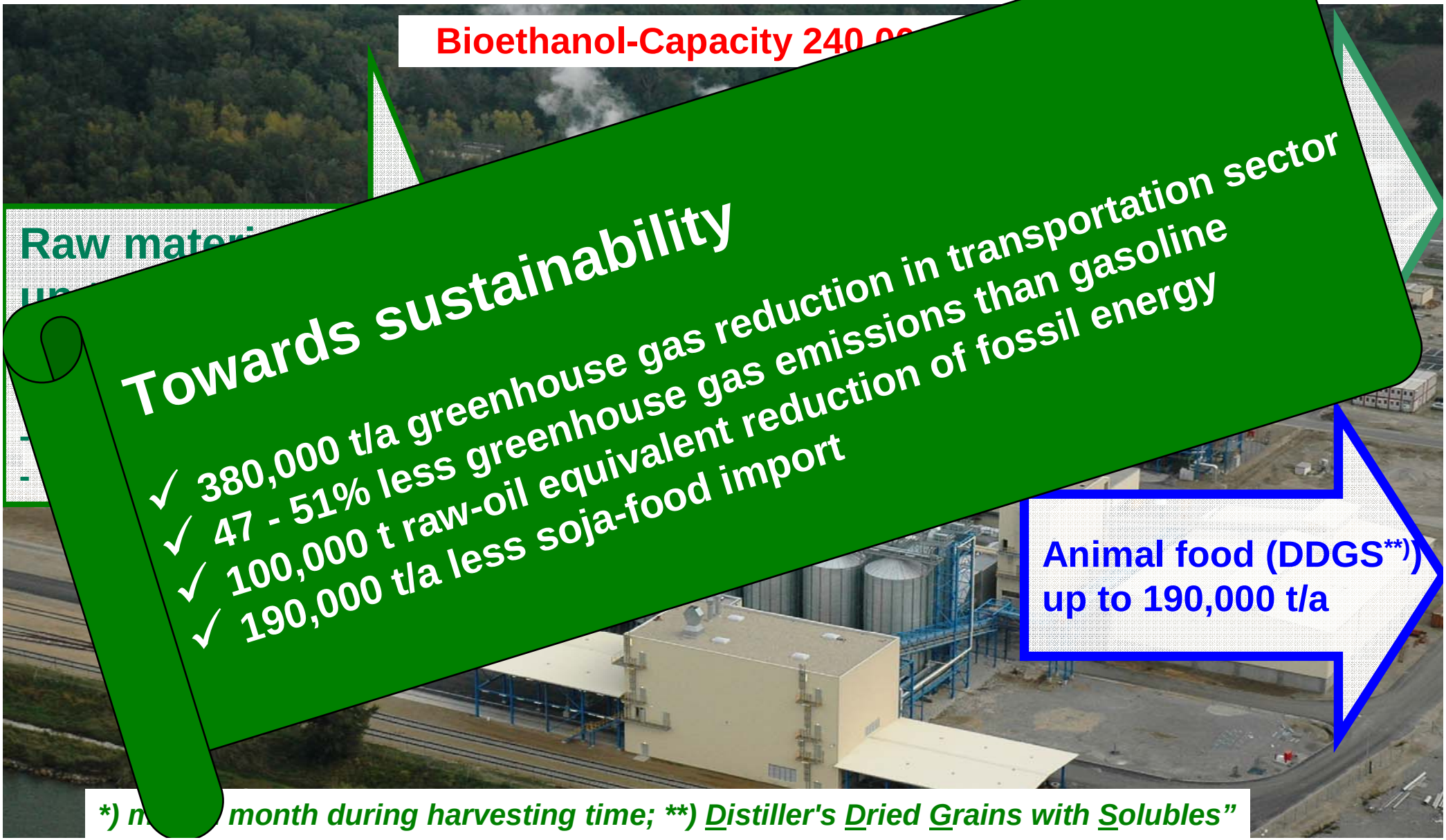
Raw materials
up to 620,000 t/a
- dry corn
- wet corn *)
- sugar beet
- whaet

Bioethanol
190,000 t/a

Animal food (DDGS)**
up to 190,000 t/a

**) max. 2 month during harvesting time; **) Distiller's Dried Grains with Solubles"*

The AGRANA Bioethanol-Plant



Bioethanol-Capacity 240.0

Raw materi
up
-
-

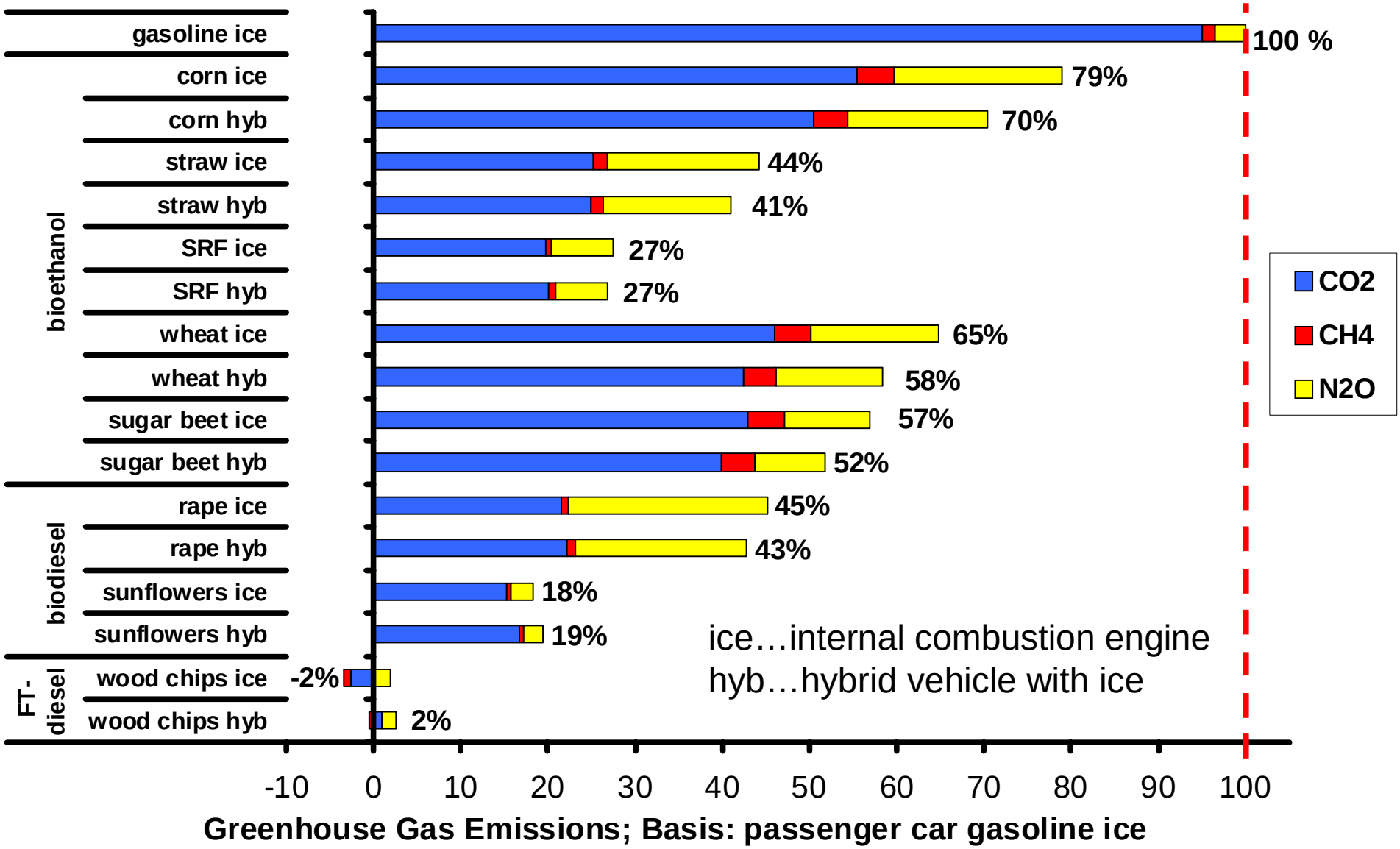
Towards sustainability

- ✓ 380,000 t/a greenhouse gas reduction in transportation sector
- ✓ 47 - 51% less greenhouse gas emissions than gasoline
- ✓ 100,000 t raw-oil equivalent reduction of fossil energy
- ✓ 190,000 t/a less soja-food import

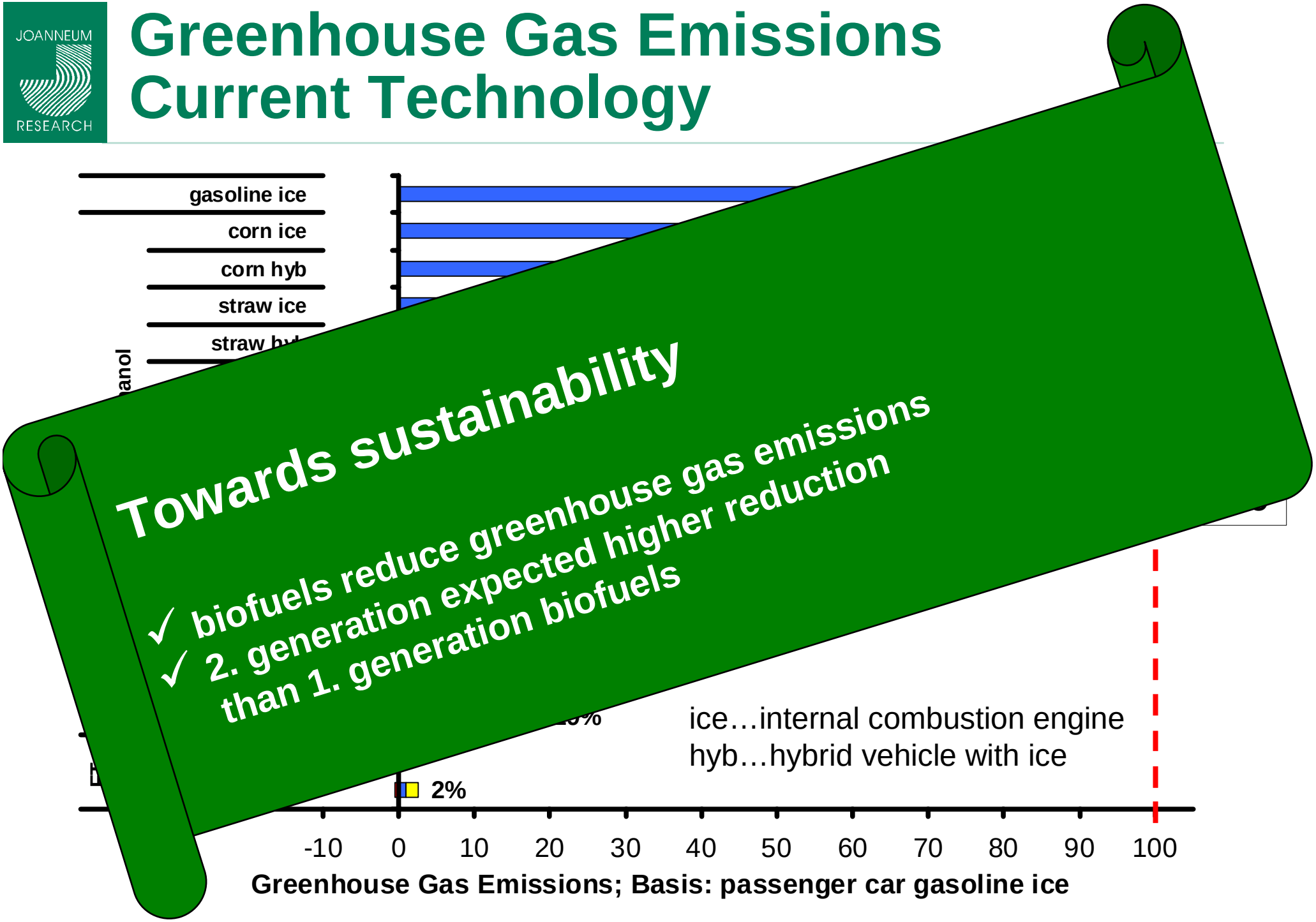
Animal food (DDGS)**
up to 190,000 t/a

*) m month during harvesting time; **) Distiller's Dried Grains with Solubles"

Greenhouse Gas Emissions Current Technology



Greenhouse Gas Emissions
Current Technology

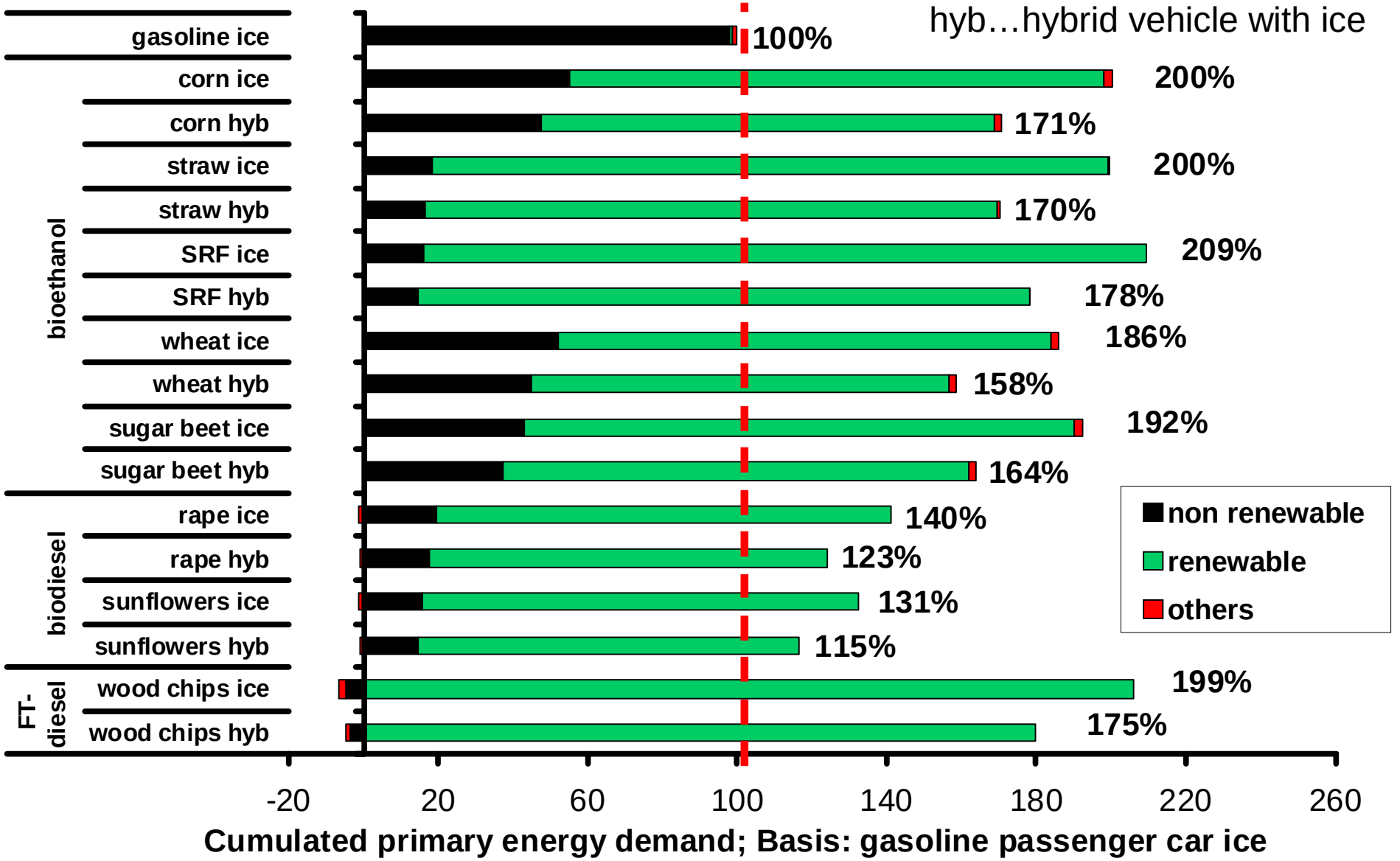


Towards sustainability

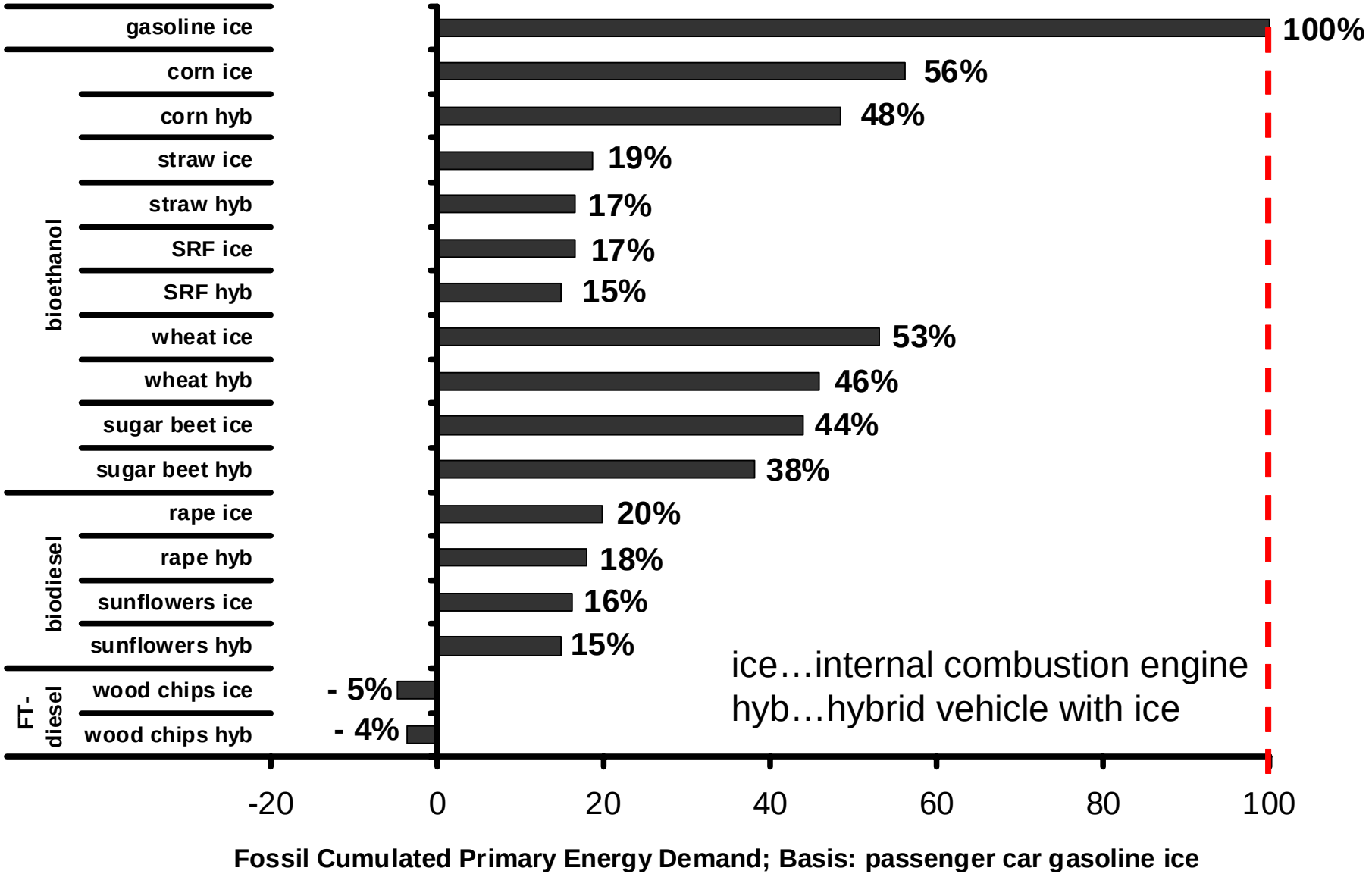
- ✓ biofuels reduce greenhouse gas emissions
- ✓ 2. generation expected higher reduction than 1. generation biofuels

Cumulated Primary Energy Demand Current Technology

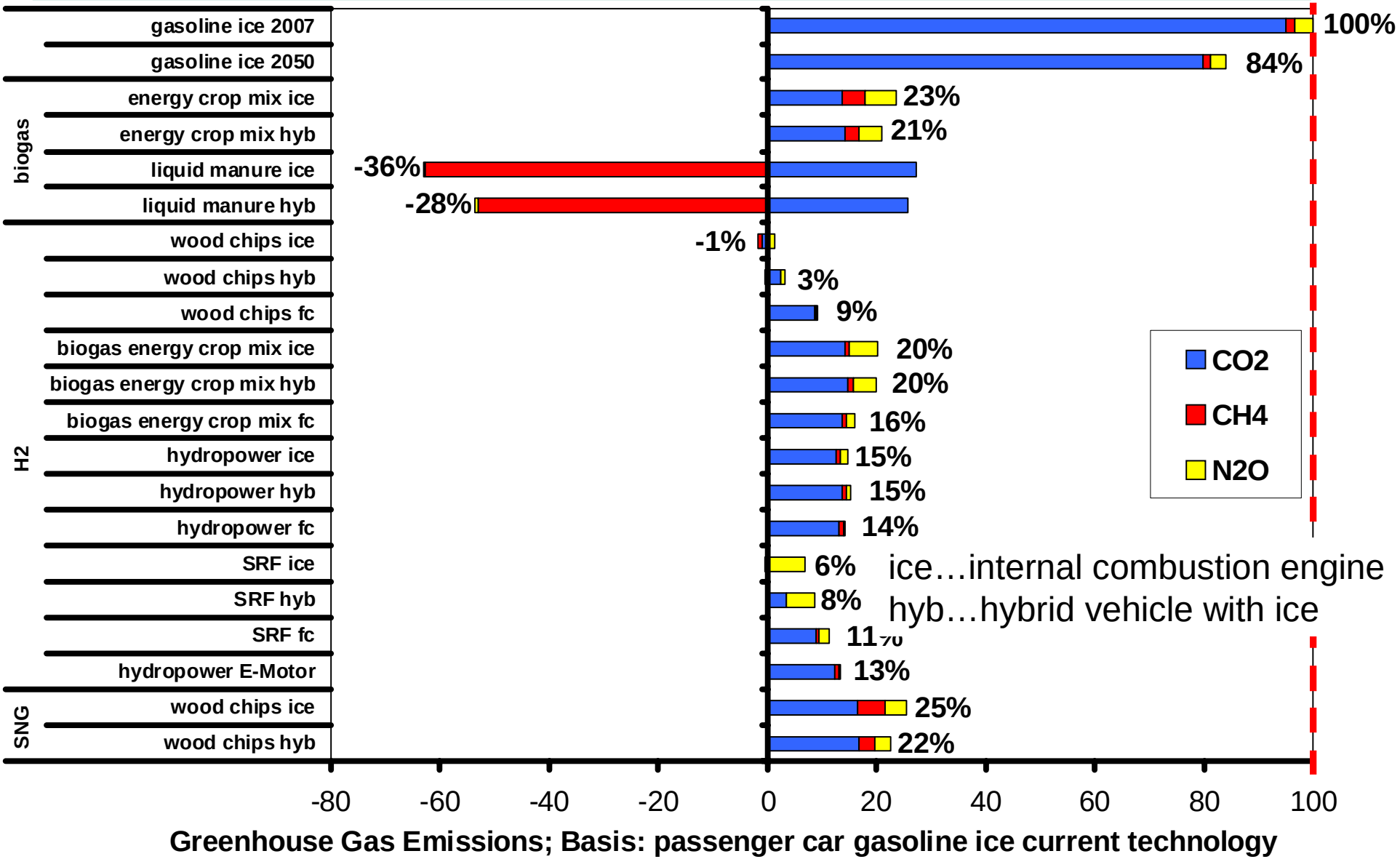
ice…internal combustion engine
hyb…hybrid vehicle with ice



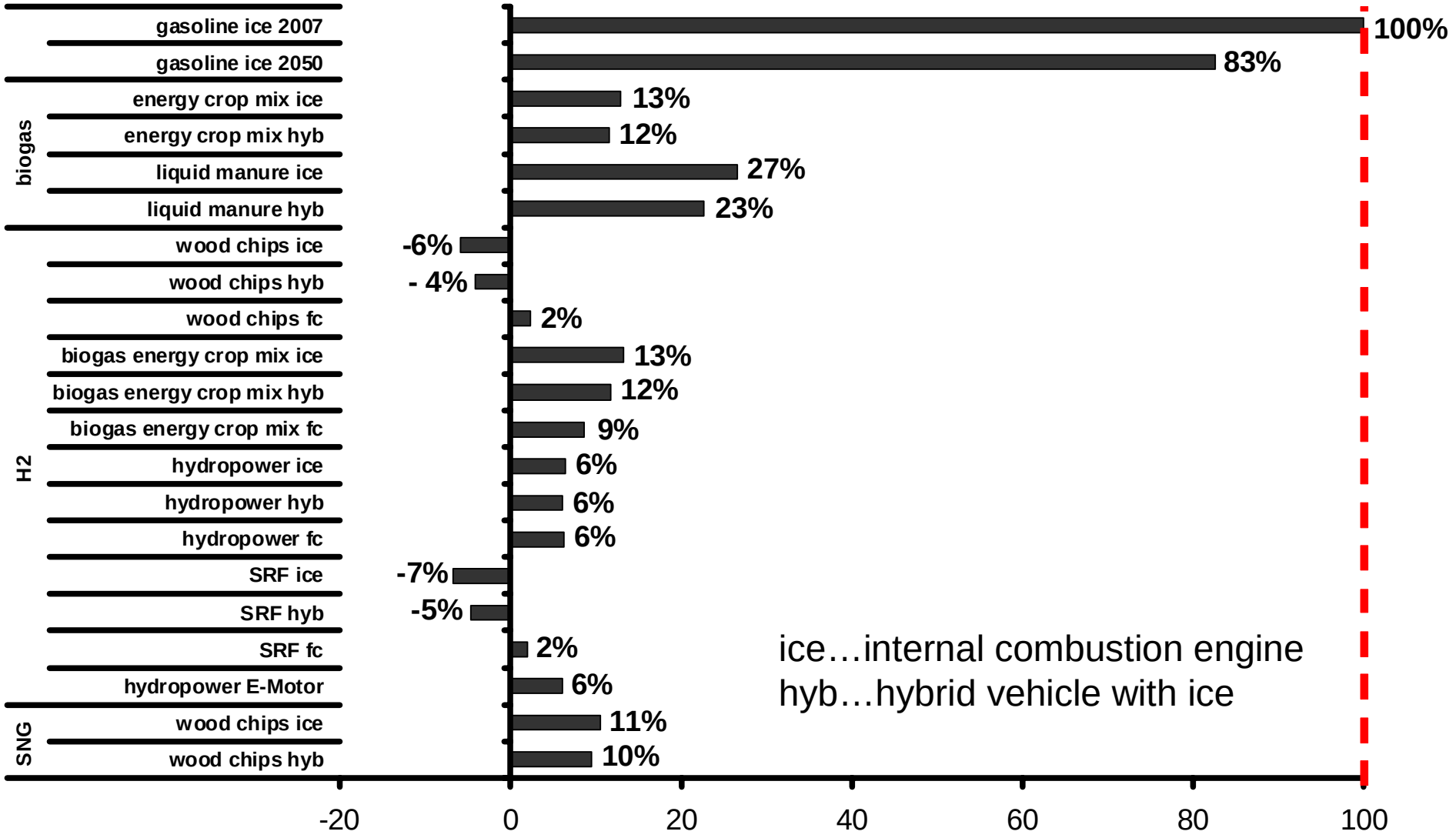
Fossil Cumulated Primary Energy Demand Current Technology



Greenhouse Gas Emissions
Future Technology

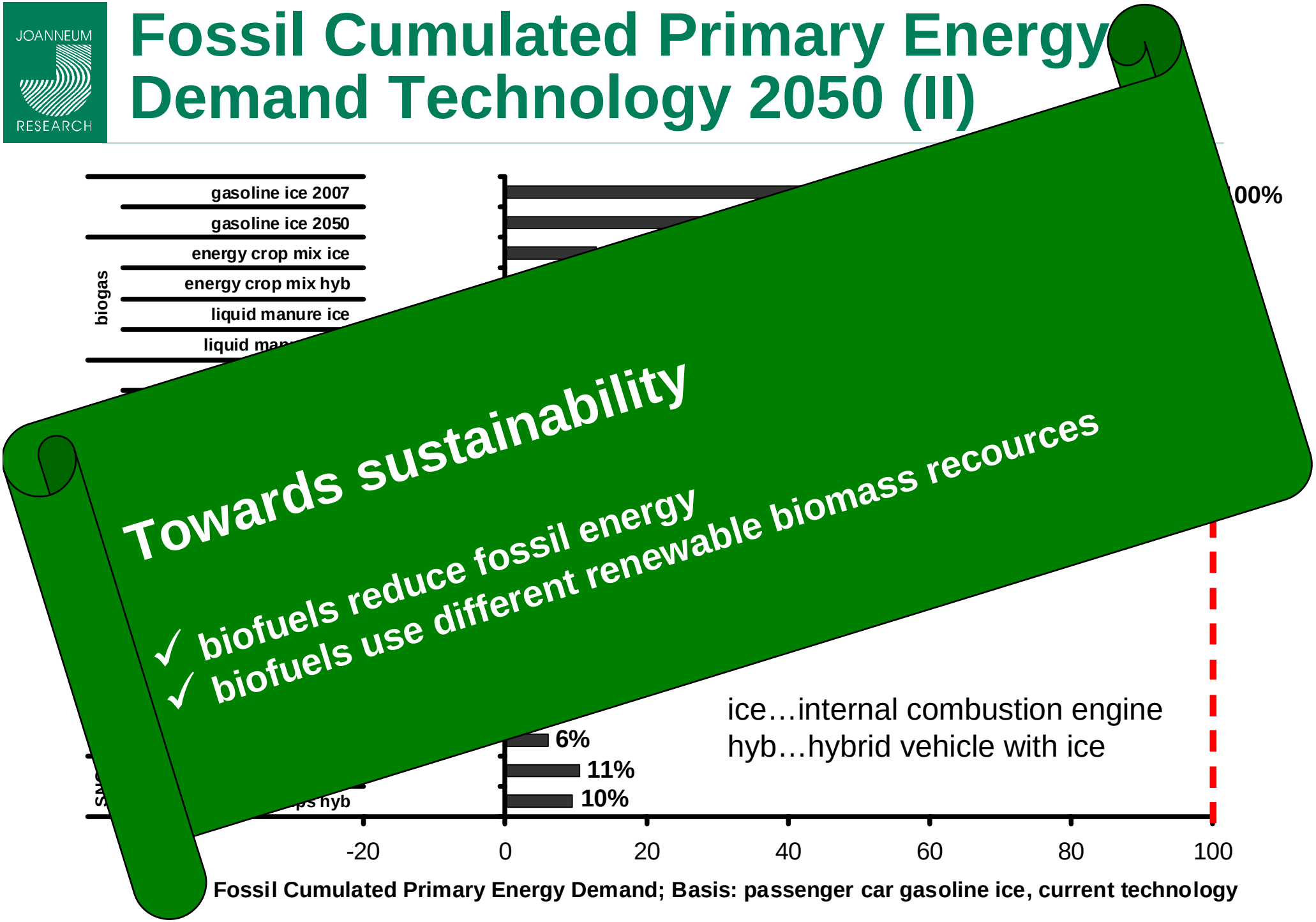


Fossil Cumulated Primary Energy Demand Technology 2050 (II)



Fossil Cumulated Primary Energy Demand; Basis: passenger car gasoline ice, current technology

Fossil Cumulated Primary Energy Demand Technology 2050 (II)



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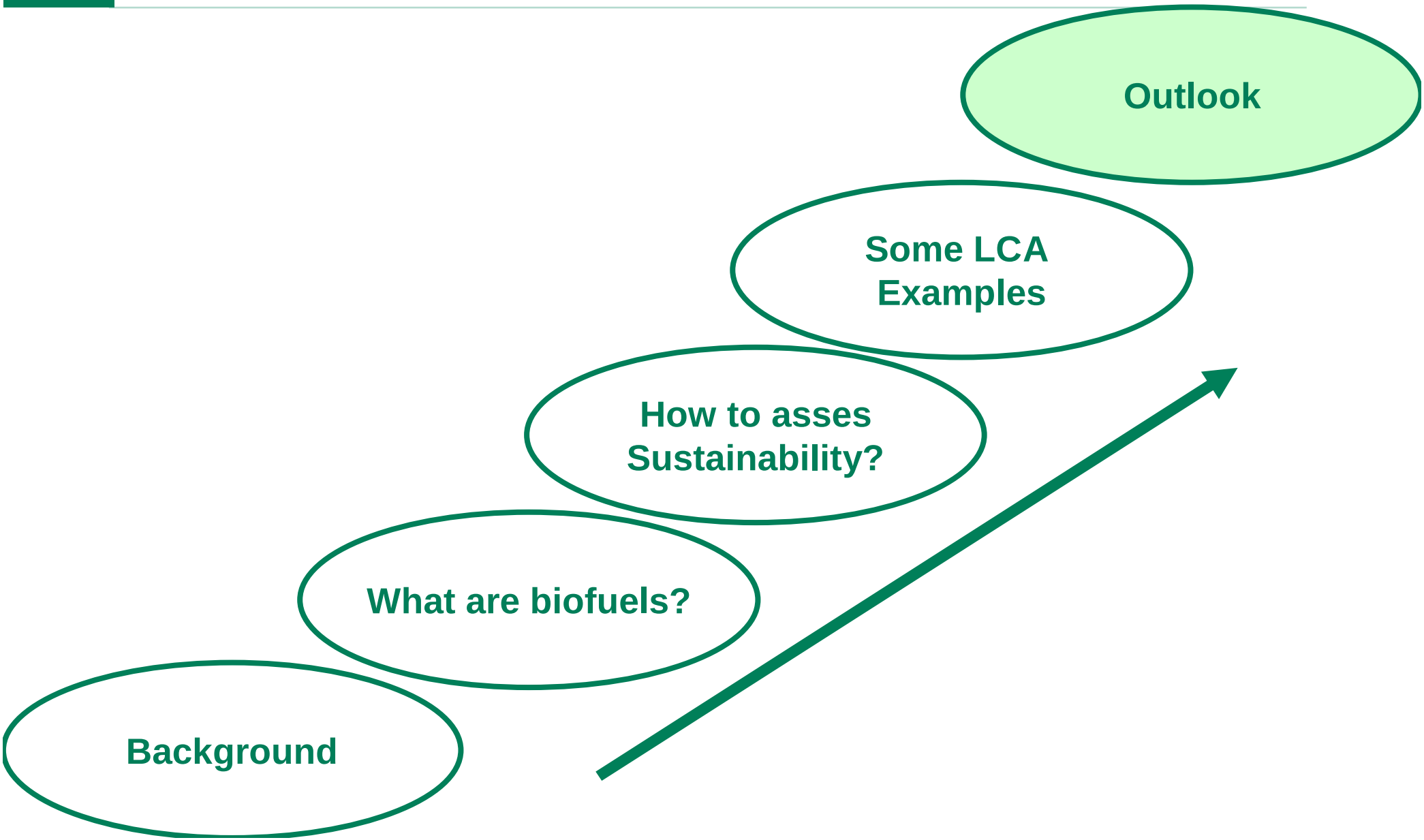
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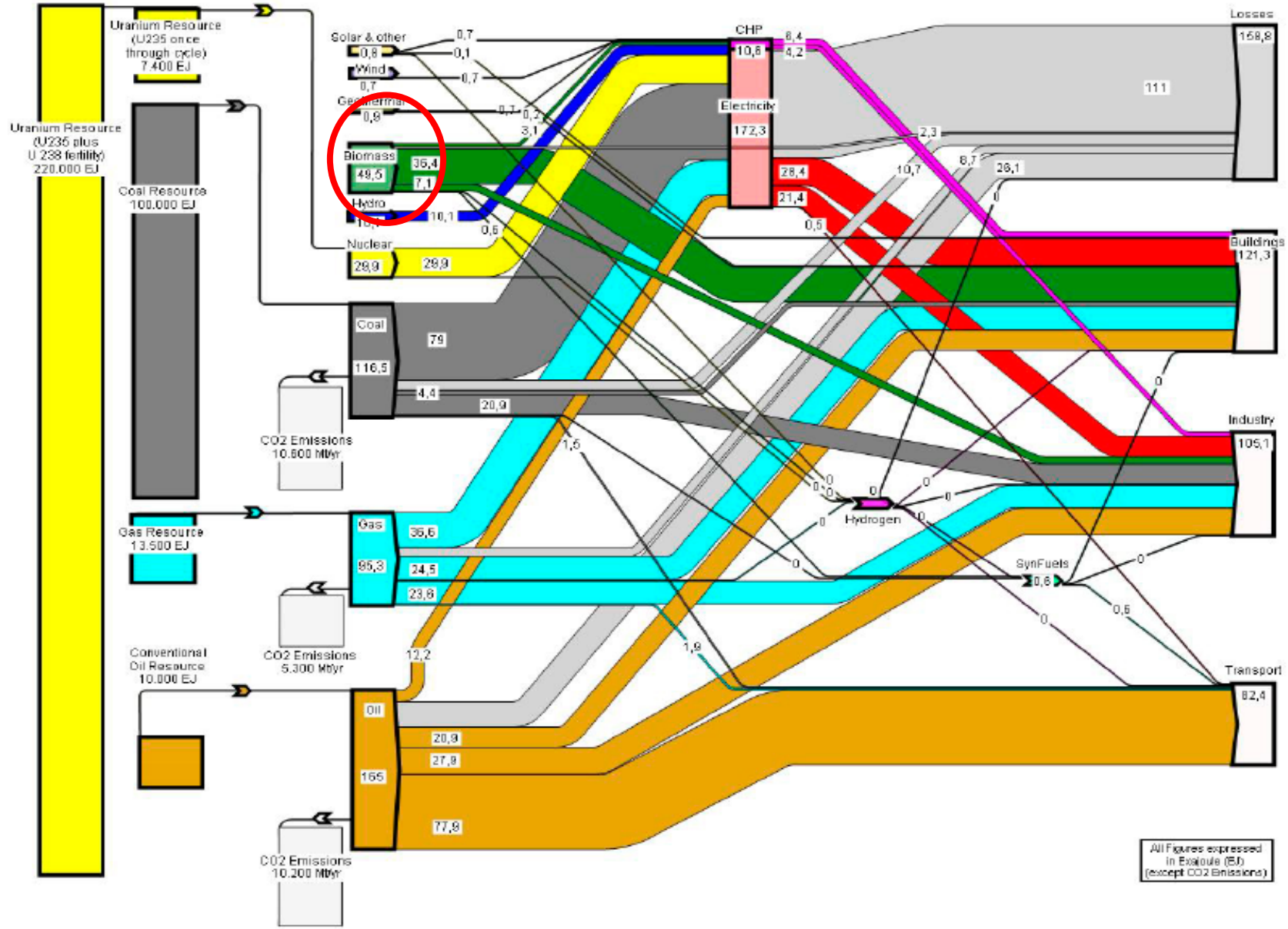
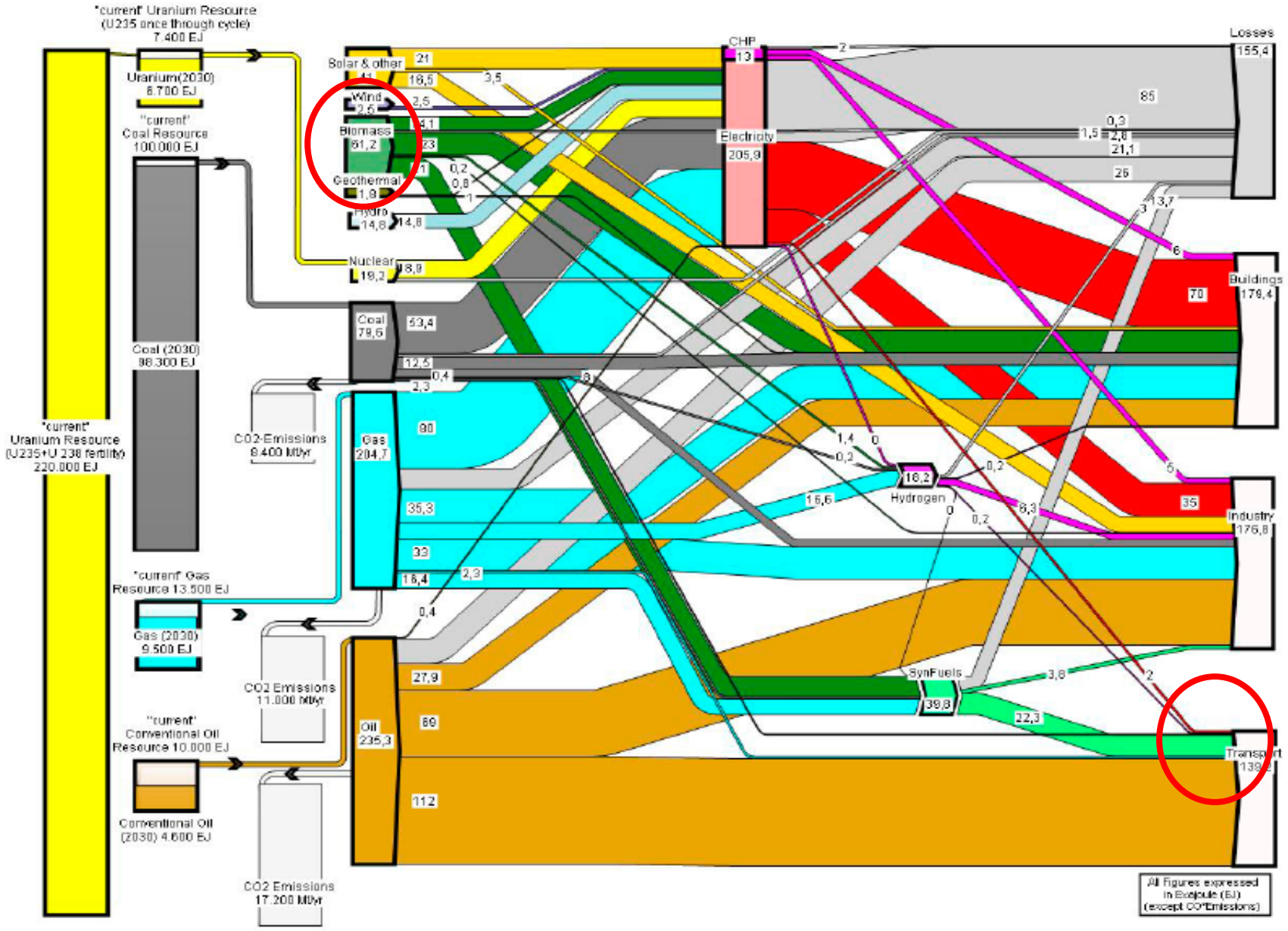
Global Energy Flow 2005



Source: www.ipcc.ch

Global Energy Flow Outlook 2030



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