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Experiences and Lessions Learned of Applying the GHG-Methodology of the European Directive to Austrian Biofuel Plants

Gerfried Jungmeier, Lorenza Canella

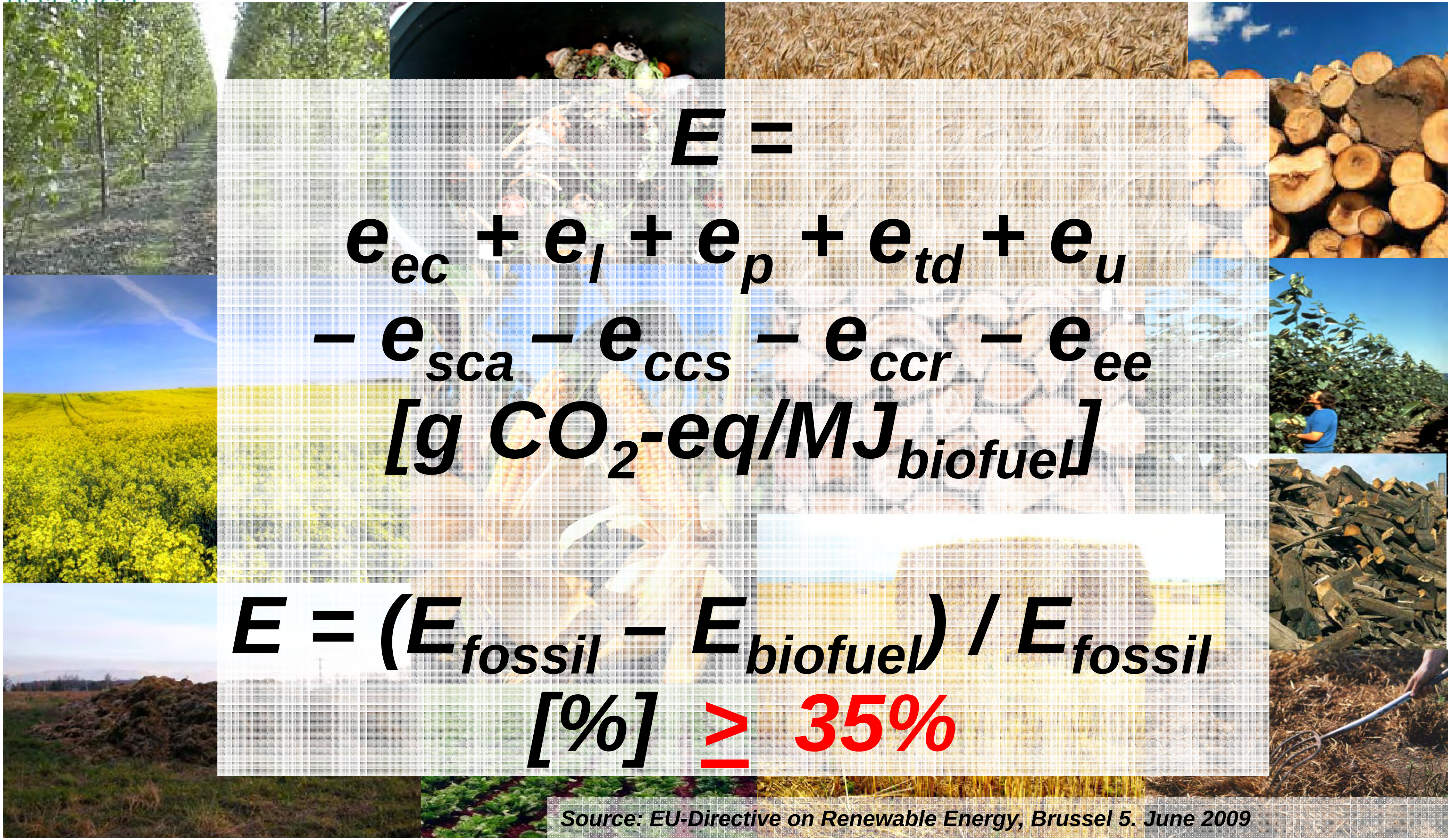
Highlights der Bioenergieforschung,

Biofuels and Sustainability

30 .- 31. März 2011, Wieselburg

This is Biomass for Transportation Biofuels

…and this is the Formula for Greenhouse Gas Calculation of Transportation Biofuels



$$E =$$

$$e_{ec} + e_{l} + e_{p} + e_{td} + e_{u}$$

$$- e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

$$[g\ CO_2\text{-}eq/MJ_{biofuel}]$$

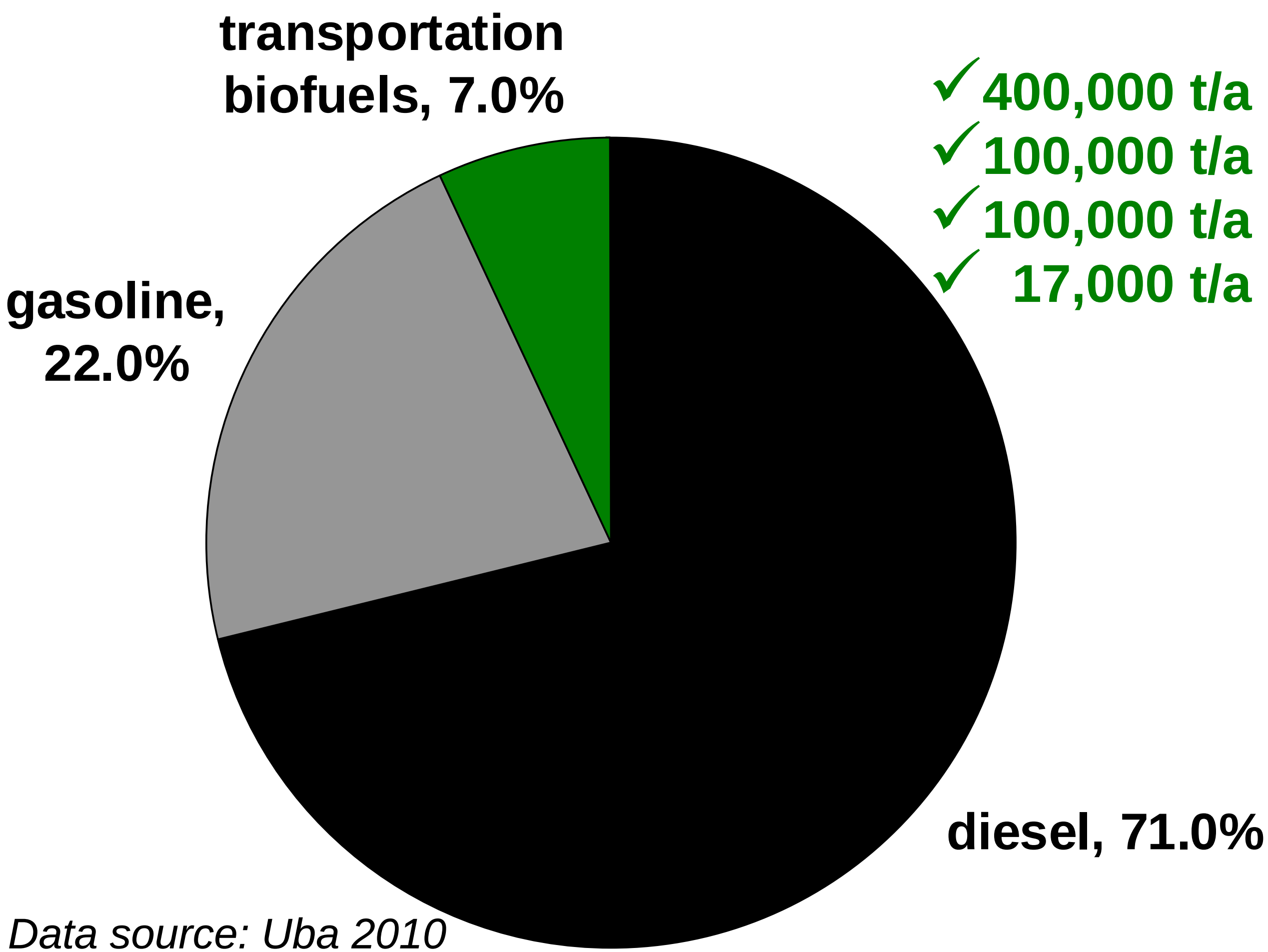
$$E = (E_{fossil} - E_{biofuel}) / E_{fossil}$$

$$[\%] \geq 35\%$$

Source: EU-Directive on Renewable Energy, Brussel 5. June 2009

The Austrain Transportation Sector in 2009

Transportation fuel demand: 331 PJ/a (domestic passenger cars 128 PJ/a)



Data source: Uba 2010

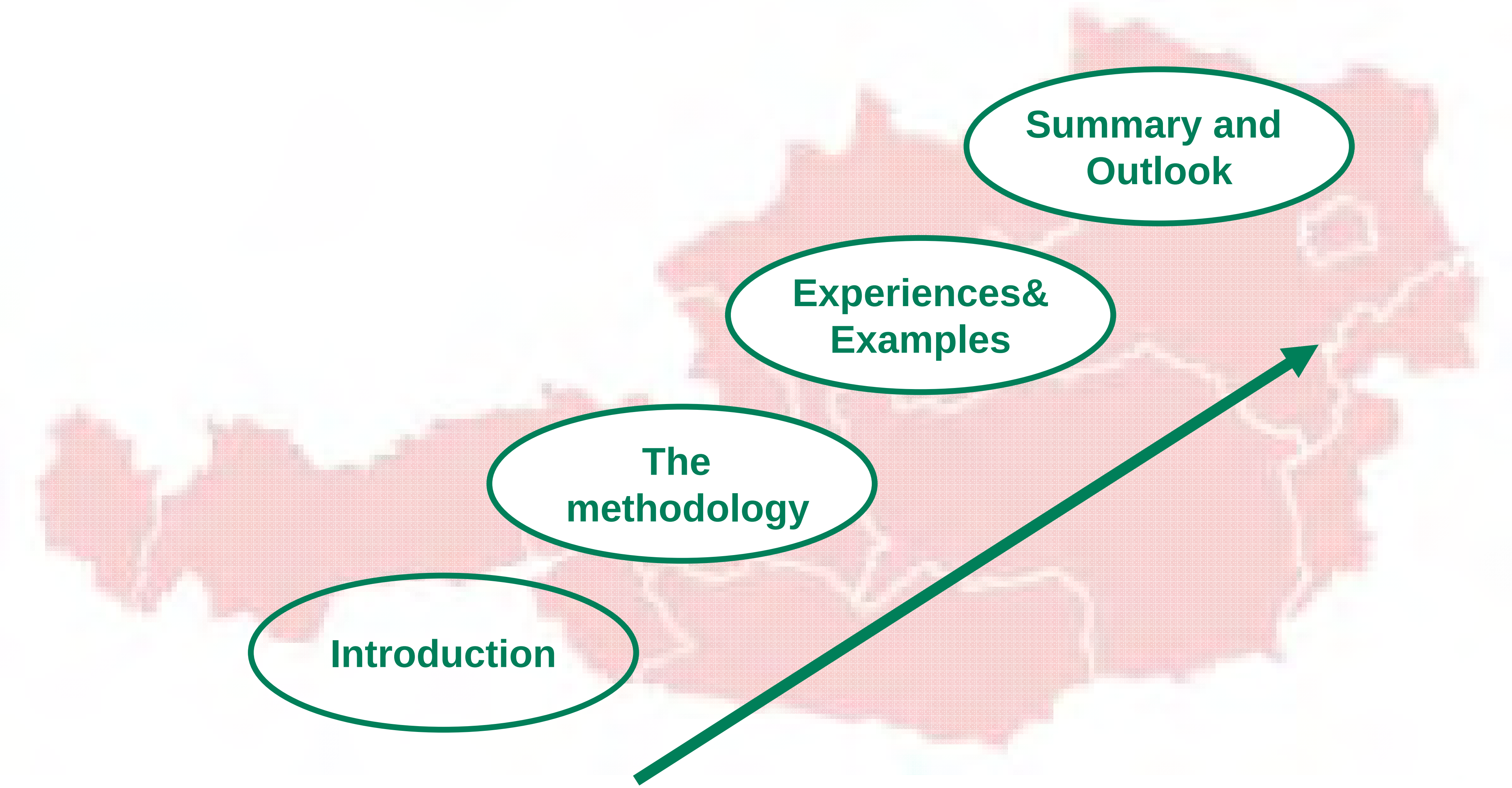
Transportation biofuels:

- ✓ 400,000 t/a biodiesel blending to diesel
- ✓ 100,000 t/a bioethanol blending to gasoline
- ✓ 100,000 t/a pure biodiesel
- ✓ 17,000 t/a pure vegetable oil

We did the Greenhouse Gas Calculation for

- Existing bioethanol and biodiesel production plants
- In Austria, Hungary, Germany and Belgium, e.g.
  - Pischelsdorf/NÖ: AGRANA Bioethanol GmbH
  - Arnoldstein/K: Biodiesel Kärnten GmbH
  - Wien: Münzer Bioenergie GmbH
  - ……

Outline


Introduction
The methodology
Experiences& Examples
Summary and Outlook

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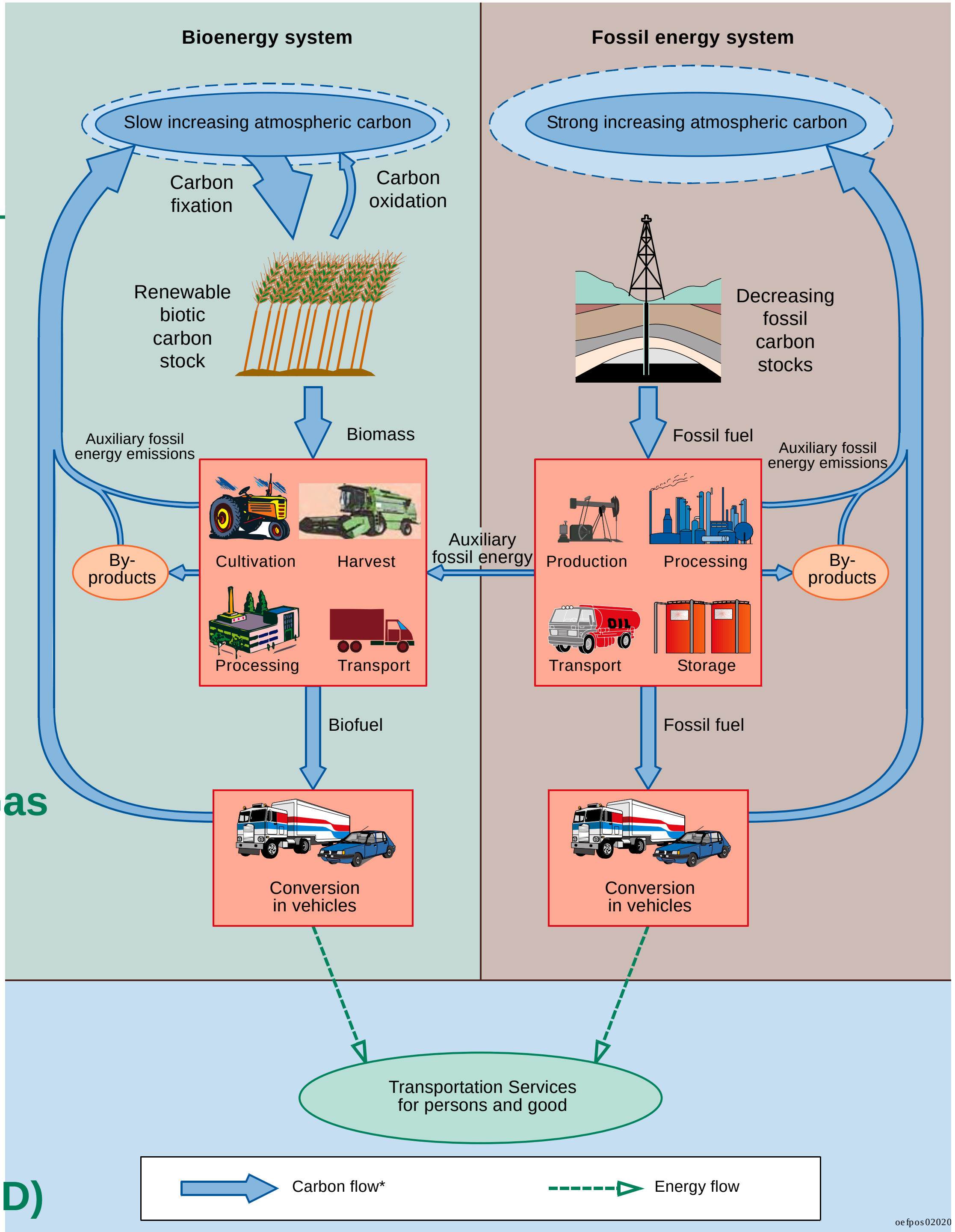
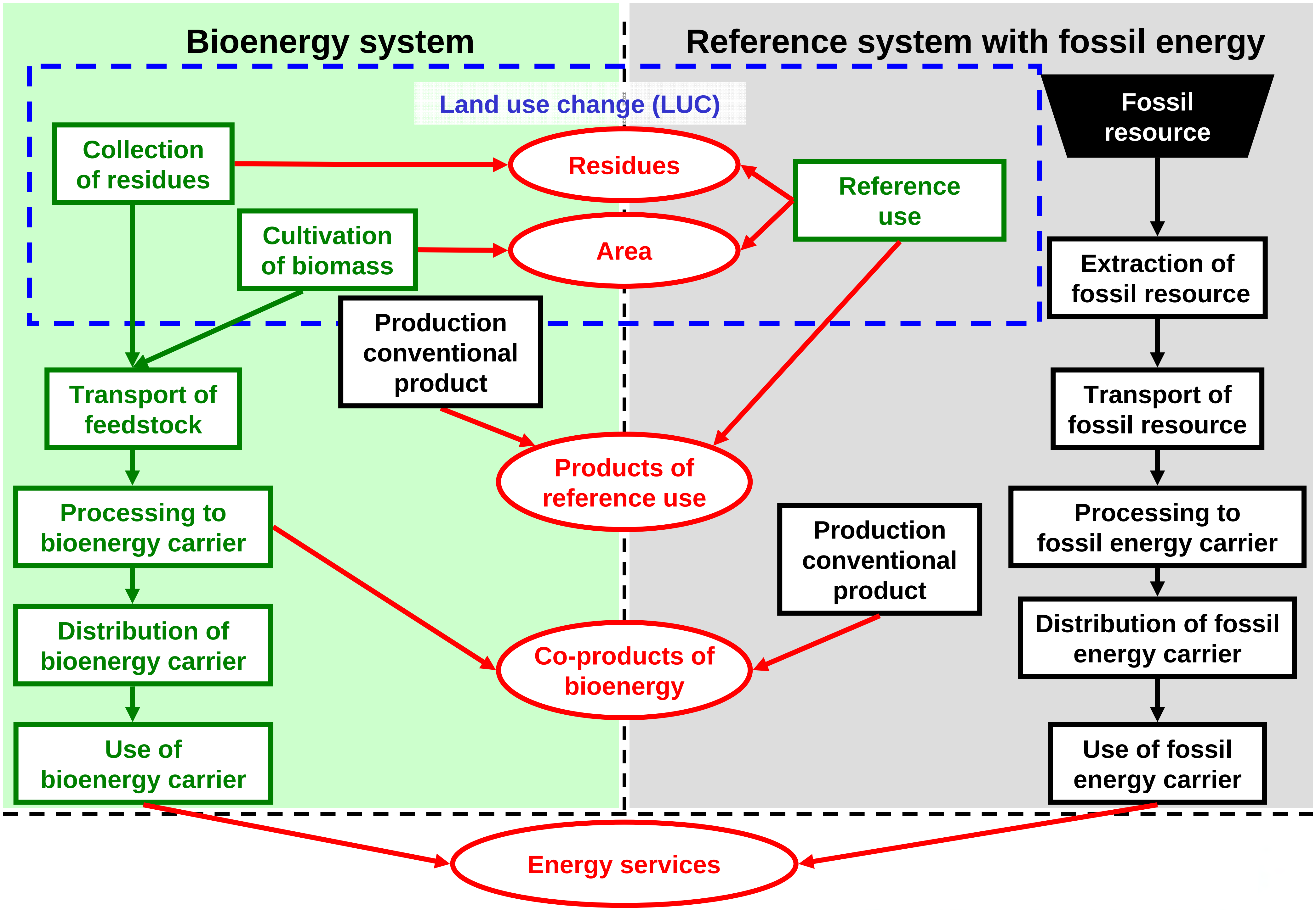
***Life Cycle Assessment** (LCA) is a method to estimate the material and energy flows of a product (e.g. transportation) to calculate the environmental effects in the total lifetime of the product „from cradle to grave“*



Methodology according to

- ✓ **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**
- ✓ **EU-Directive on Renewable Energy (RED)**



Bioenergy system
Reference system with fossil energy
Land use change (LUC)
Collection of residues
Residues
Cultivation of biomass
Area
Reference use
Fossil resource
Extraction of fossil resource
Production conventional product
Transport of feedstock
Transport of fossil resource
Products of reference use
Processing to bioenergy carrier
Processing to fossil energy carrier
Production conventional product
Distribution of bioenergy carrier
Distribution of fossil energy carrier
Co-products of bioenergy
Use of bioenergy carrier
Use of fossil energy carrier
Energy services

GHG Calculation according to EU-Directive

$E = e_{ec} + e_l + e_p + e_{td} + e_u – e_{sca} – e_{ccs} – e_{ccr} – e_{e}$… [g C… /$MJ_{biofuel}$]

$E = (E_{fossil} – E_{biofuel}) / E_{fossil}$ [%…

E = total emissi…
e_{ec} = em…
e_l = … ange;
e_p = …
e_{td} = …
e_u = …
e_{sca} = e… on via improved agricult. management;
e_{ccs} = e… re and geological storage;
e_{ccr} = e… bon capture and replacement; and
e_{ee} = em… from excess electricity from cogeneration.

Emissions …m the manufacture of machinery and equipment shall not be taken into account

Source: EU-Directive on Renewable Energy, Brussel 5. June 2009

Allocation based on energy content of biofuel and its co-products

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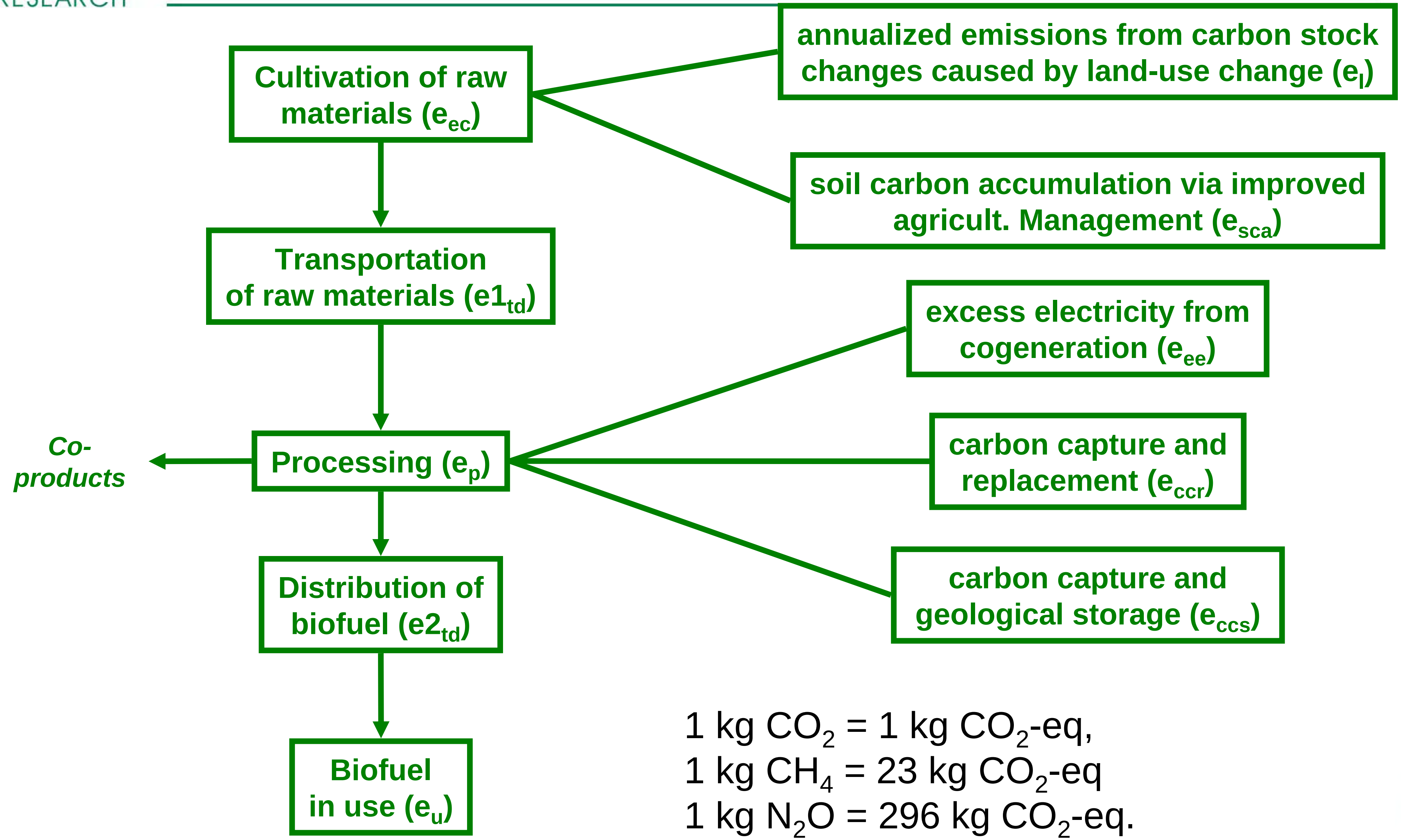
Process Steps in EU-Directive



1 kg CO_2 = 1 kg CO_2-eq,
1 kg CH_4 = 23 kg CO_2-eq
1 kg N_2O = 296 kg CO_2-eq.

Lessons Learnt

- **Energy allocation between biofuel and its co-products**
- **System boundaries for energy allocation and data availability**
- **Emissions from the manufacture of machinery and equipment shall not be taken into account**
- **Emissions from vehicles are zero**
- **Use of aggregated or disaggregated default or actual calculated values possible “Cherry picking”**
- **Emissions from Cultivation data on country level only available as allocated values to biofuel**
- **e_{ccr} = emission saving from carbon capture and replacement allocation only to biofuel?**
- **Greenhouse gas emissions of gasoline and diesel might be higher than in RED**

Lessons Learnt

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EU-Directive on Allocation Method

„..... Co-products from the production and use of fuels should be taken into account in the calculation of greenhouse gas emissions. The ***energy allocation method is appropriate for the regulation of individual economic operators and individual consignments of transport fuels****. The energy allocation method is the most appropriate method, as it is easy to apply, is predictable over time, minimizes counter-productive incentives and produces results that are generally comparable with those produced by the substitution method.* ***For the purposes of policy analysis the Commission should also, in its reporting, present results using the substitution method.***

Source: DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the promotion of the use of energy from renewable sources, Brussels, June 5, 2009

Typical and Standard Greenhouse Gas Emissions&Savings of Directive RED

- **‘actual value’:** **greenhouse gas emission saving for some or all of the steps of a specific biofuel production process calculated in accordance with the methodology laid down in RED;**

- **‘typical value’:** **an estimate of the representative greenhouse gas emission saving for a particular biofuel production pathway;**

- **‘default value’** **means a value derived from a typical value by the application of pre-determined factors and that may, in circumstances specified in the Directive, be used in place of an actual value.**

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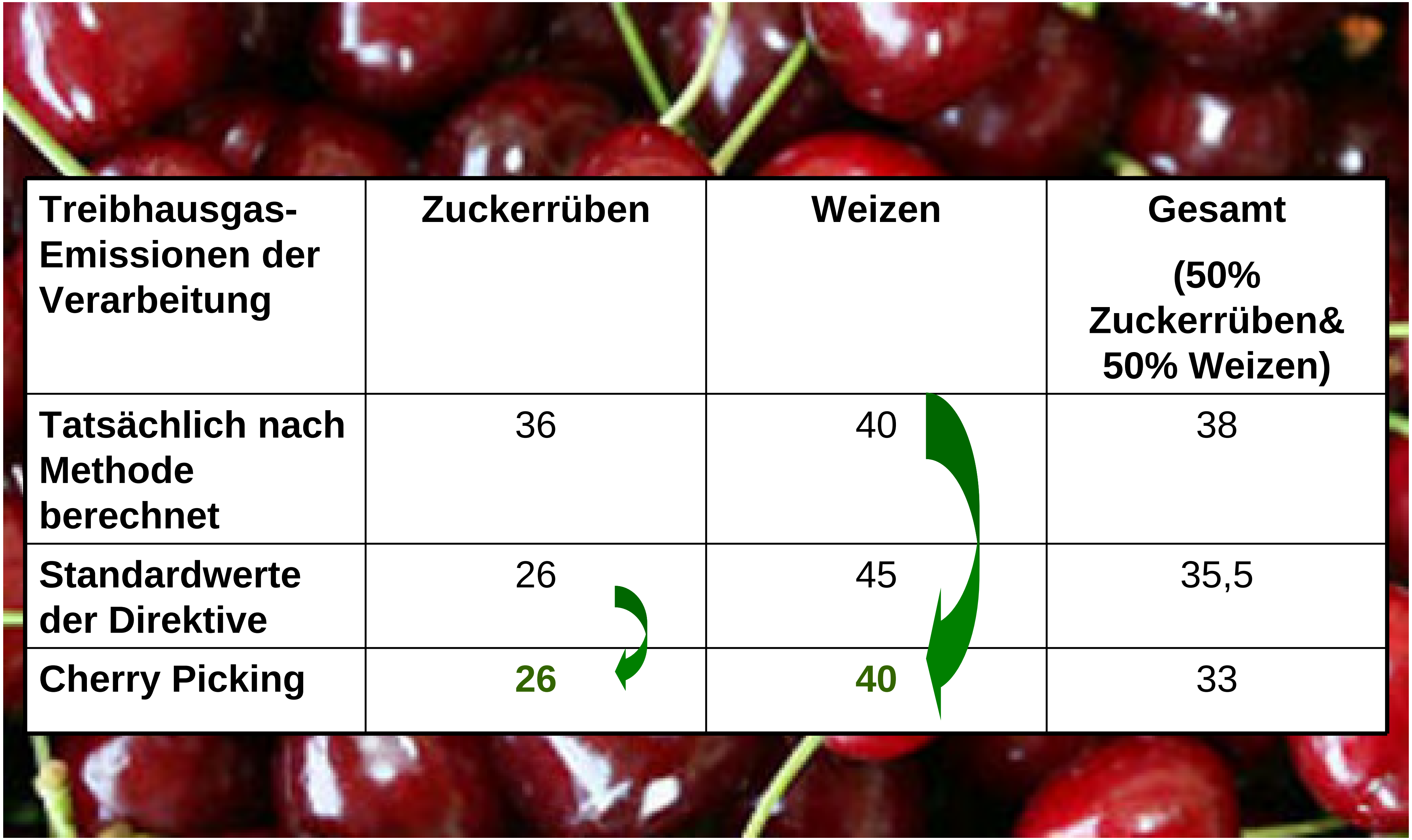
Typical and Standard Greenhouse Gas Emissions&Savings of Directive RED

- **'actu** ... **ps of a spe ... method**
- **'typic** ... **n saving f**
- **'defa** ... **on of pre-d ... Directiv**

sugar beet eth
wheat ethano
wheat ethano
wheat ethan boiler)
wheat ethano
wheat ethano
corn (maize) process fuel i
sugar cane et
the part fro (ETBE)
the part fro (TAEE)
rape seed bio
sunflower bio

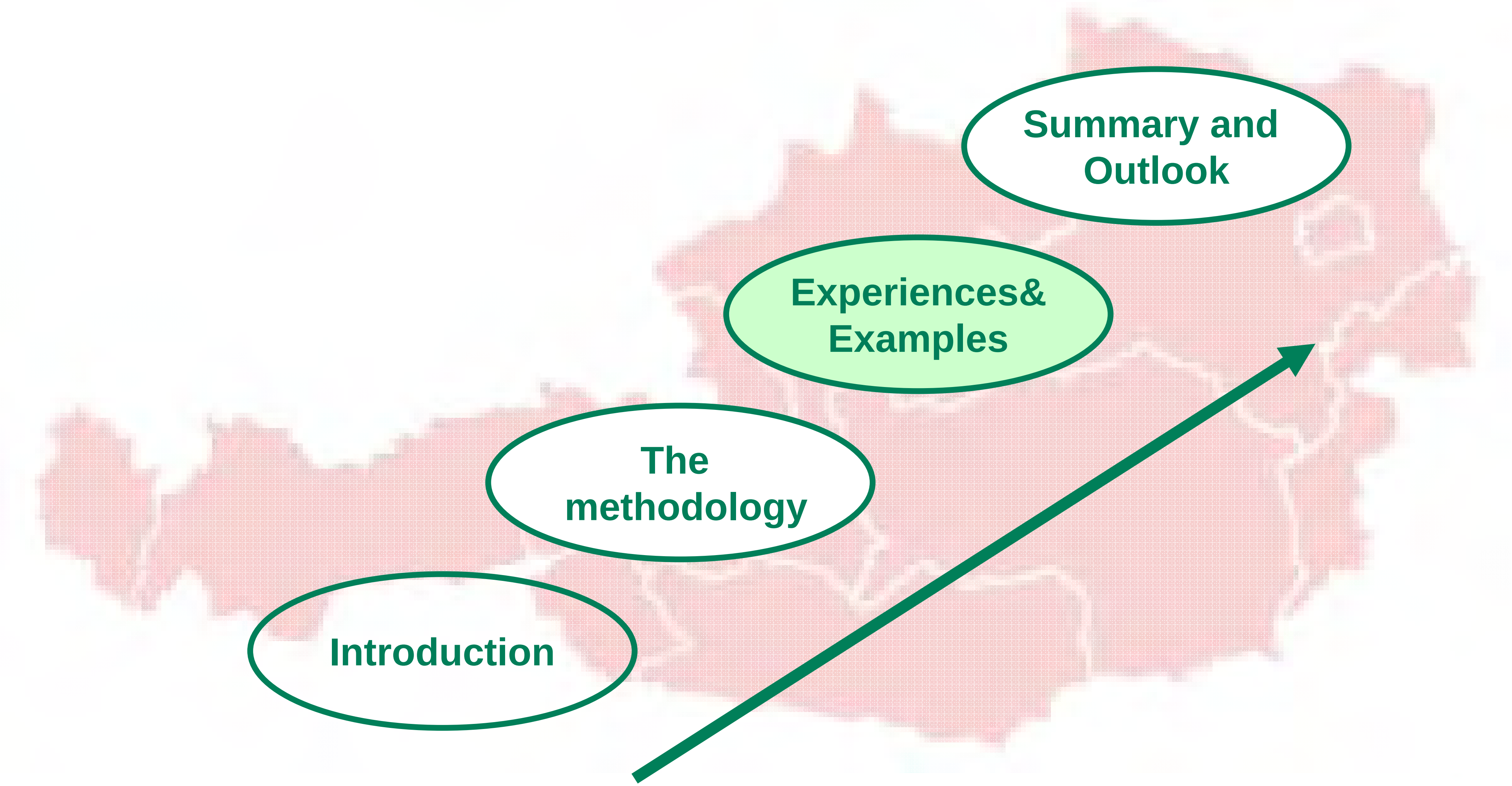
Biofuel production pathway	Typical greenhouse gas emission saving	Default greenhouse gas emission saving
sugar beet ethanol	61 %	52 %
wheat ethanol (process fuel not specified)	32 %	16 %
wheat ethanol (lignite as process fuel in CHP plant)	32 %	16 %
wheat ethanol (natural gas as process fuel in conventional boiler)	45 %	34 %
wheat ethanol (natural gas as process fuel in CHP plant)	53 %	47 %
wheat ethanol (straw as process fuel in CHP plant)	69 %	69 %
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	56 %	49 %
sugar cane ethanol	71 %	71 %
the part from renewable sources of ethyl-tertio-butyl-ether (ETBE)	Equal to that of the ethanol production pathway used	
the part from renewable sources of tertiary-amyl-ethyl-ether (TAEE)	Equal to that of the ethanol production pathway used	
rape seed biodiesel	45 %	38 %
sunflower biodiesel	58 %	51 %
soybean biodiesel	40 %	31 %

Example „Cherry Picking“



Treibhausgas-Emissionen der Verarbeitung	Zuckerrüben	Weizen	Gesamt (50% Zuckerrüben& 50% Weizen)
Tatsächlich nach Methode berechnet	36	40	38
Standardwerte der Direktive	26	45	35,5
Cherry Picking	**26**	**40**	33

Outline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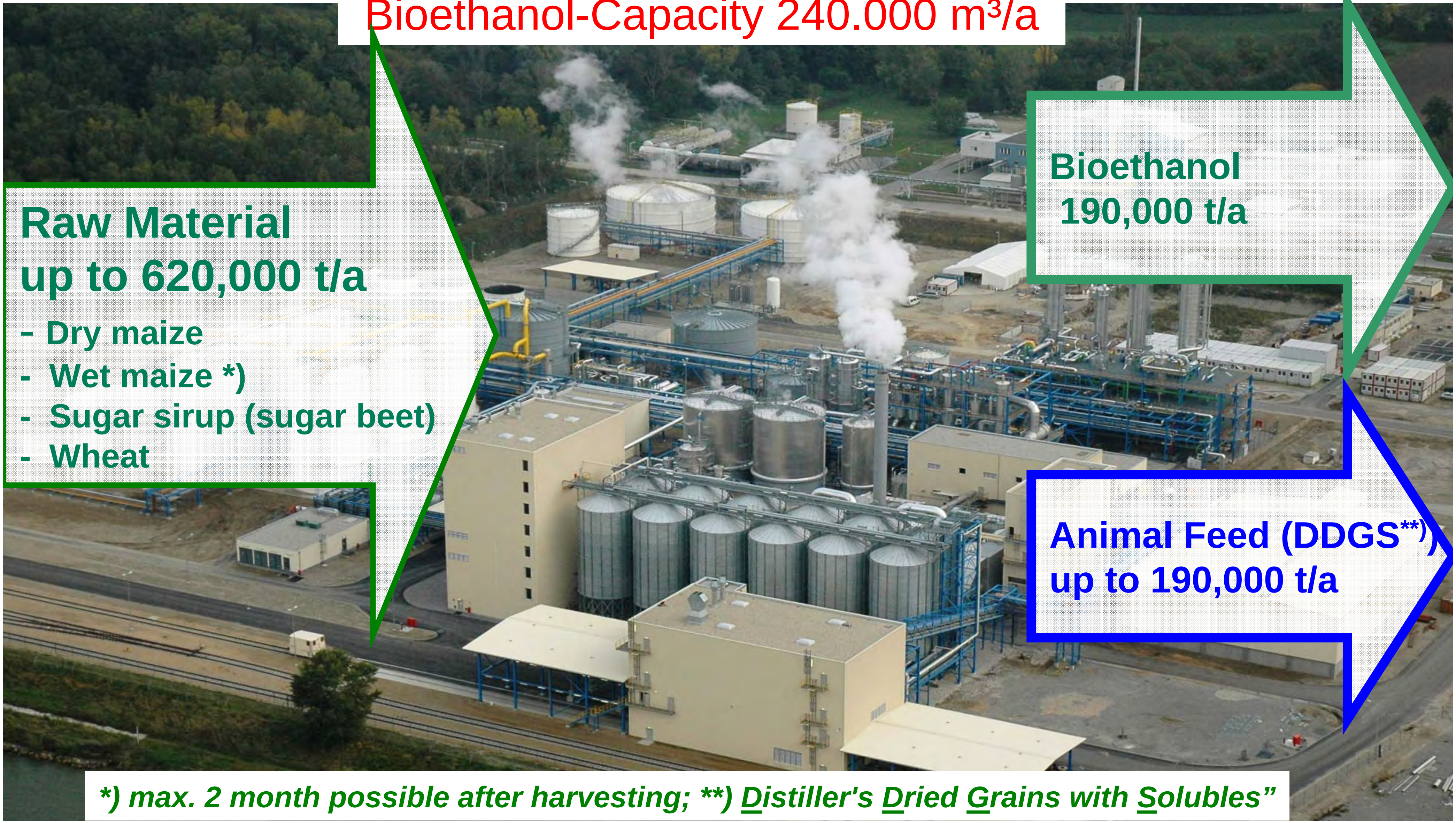
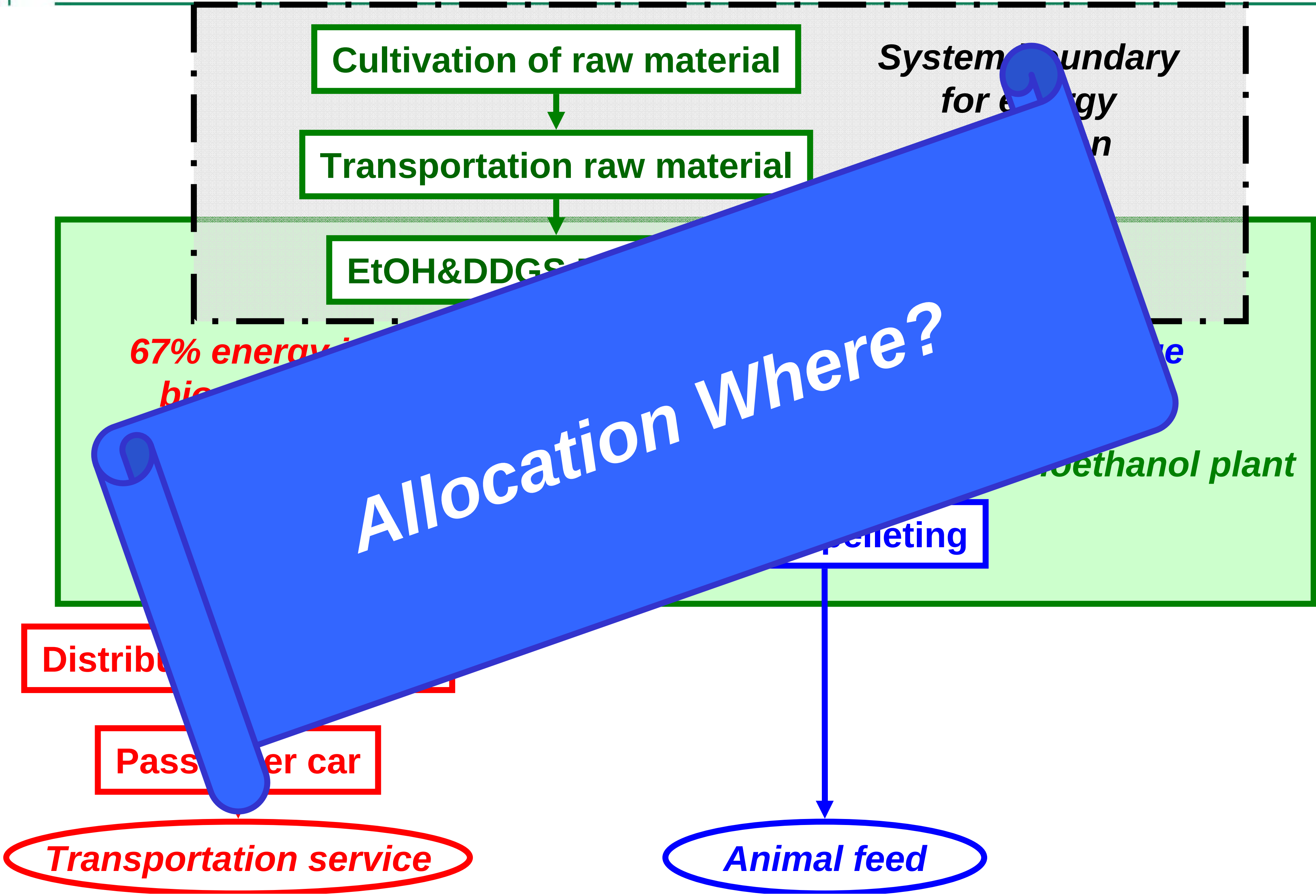
The AGRANA Bioethanol-Plant in Pischelsdorf/Austria

AGRANA BIOETHANOL GMBH

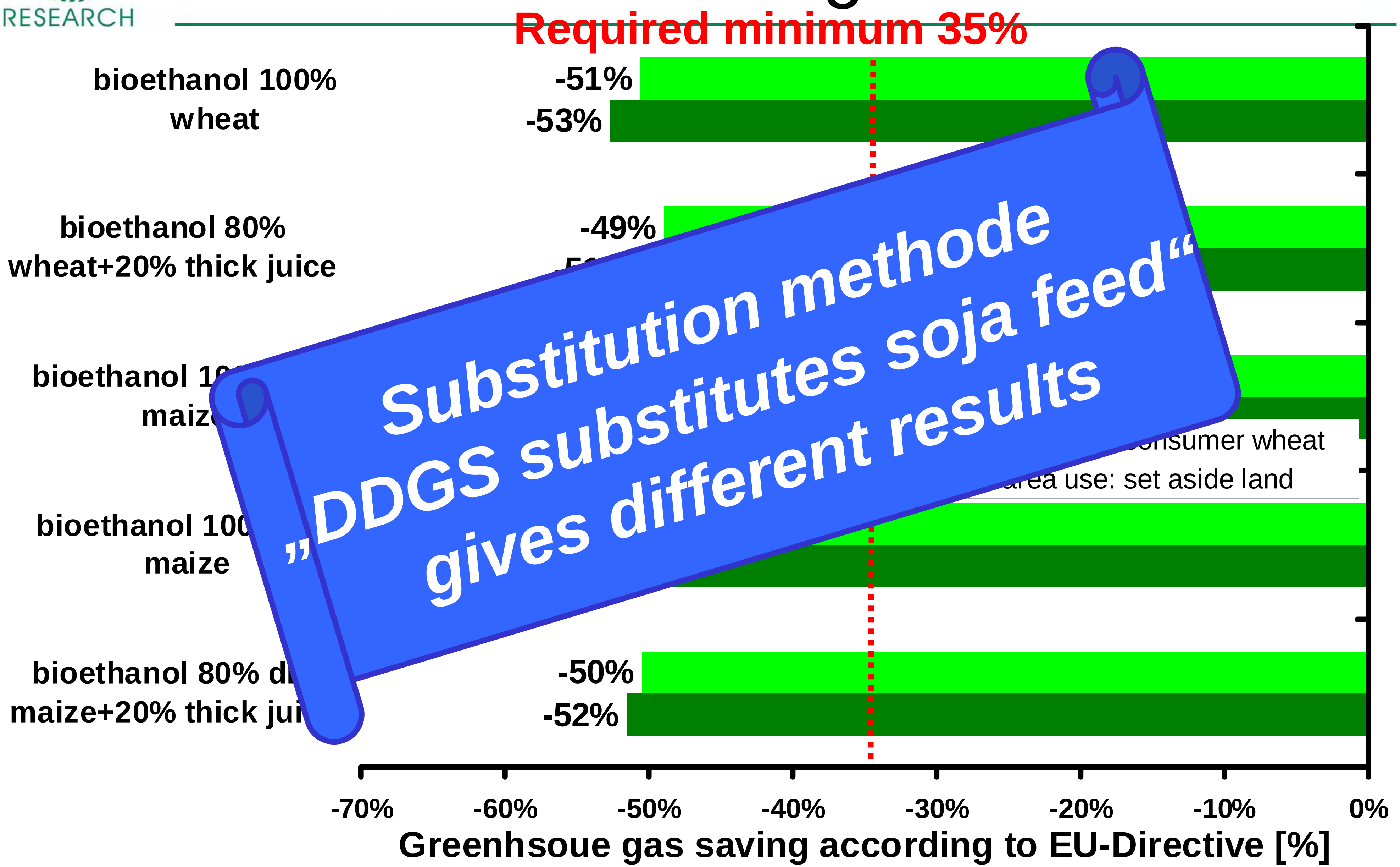


*) max. 2 month possible after harvesting; **) Distiller's Dried Grains with Solubles”

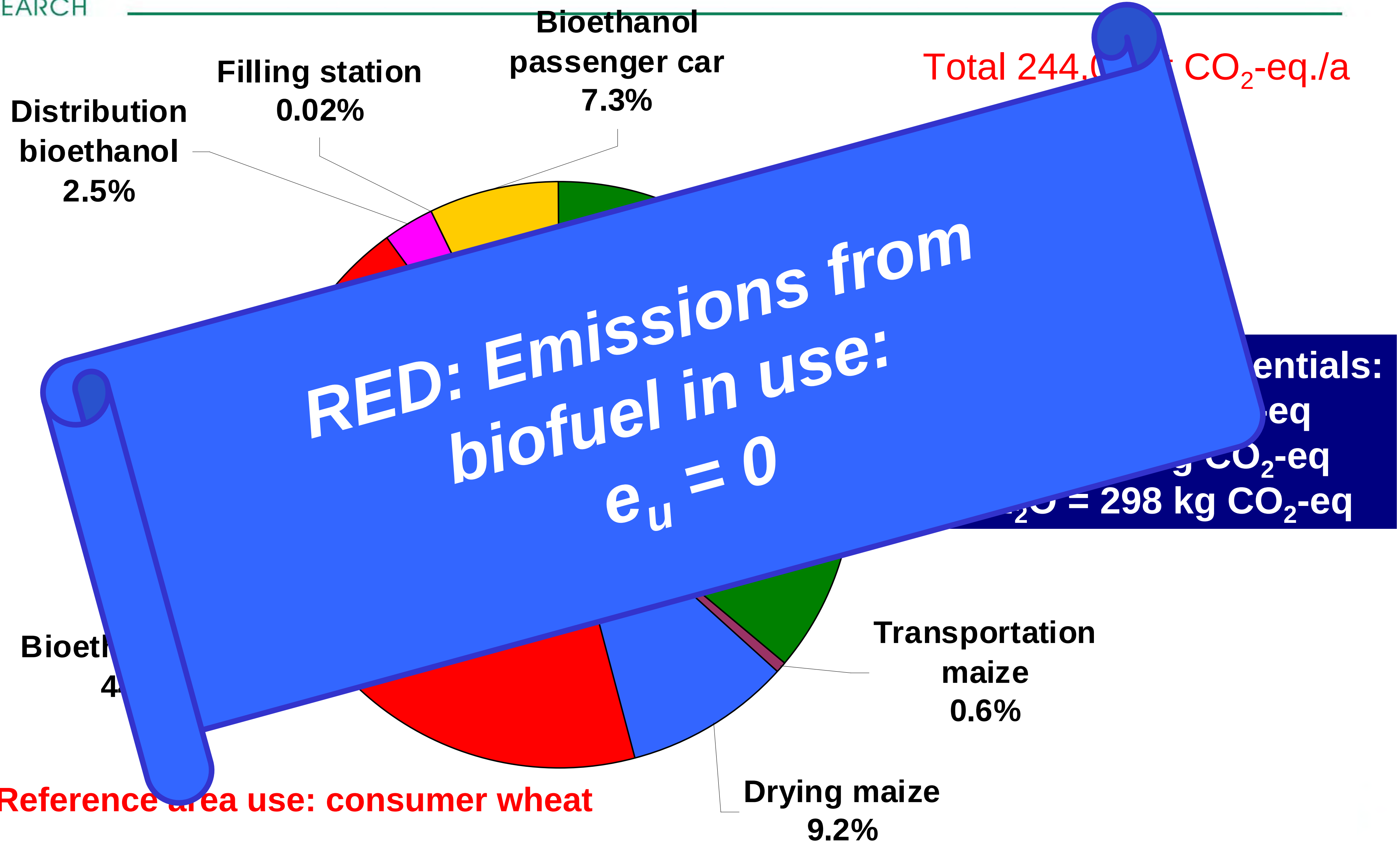
Energy Allocation Method – Bioethanol & DDGS



Greenhouse Gas Saving According to EU-Directive



Greenhouse Gas Emissions of Process Steps 100% Dry Maize



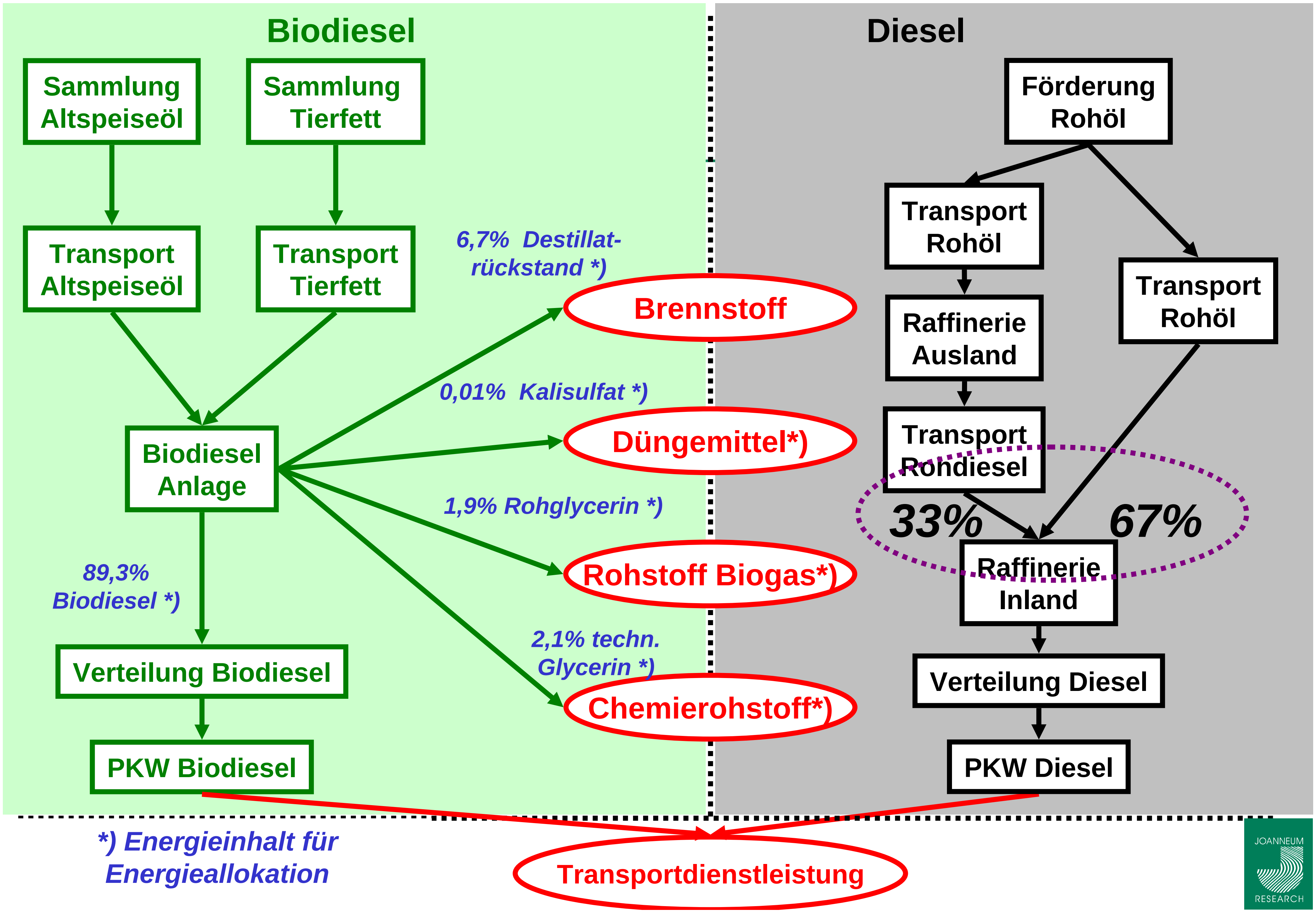
Reference area use: consumer wheat

Biodiesel-Plant in Arnoldstein

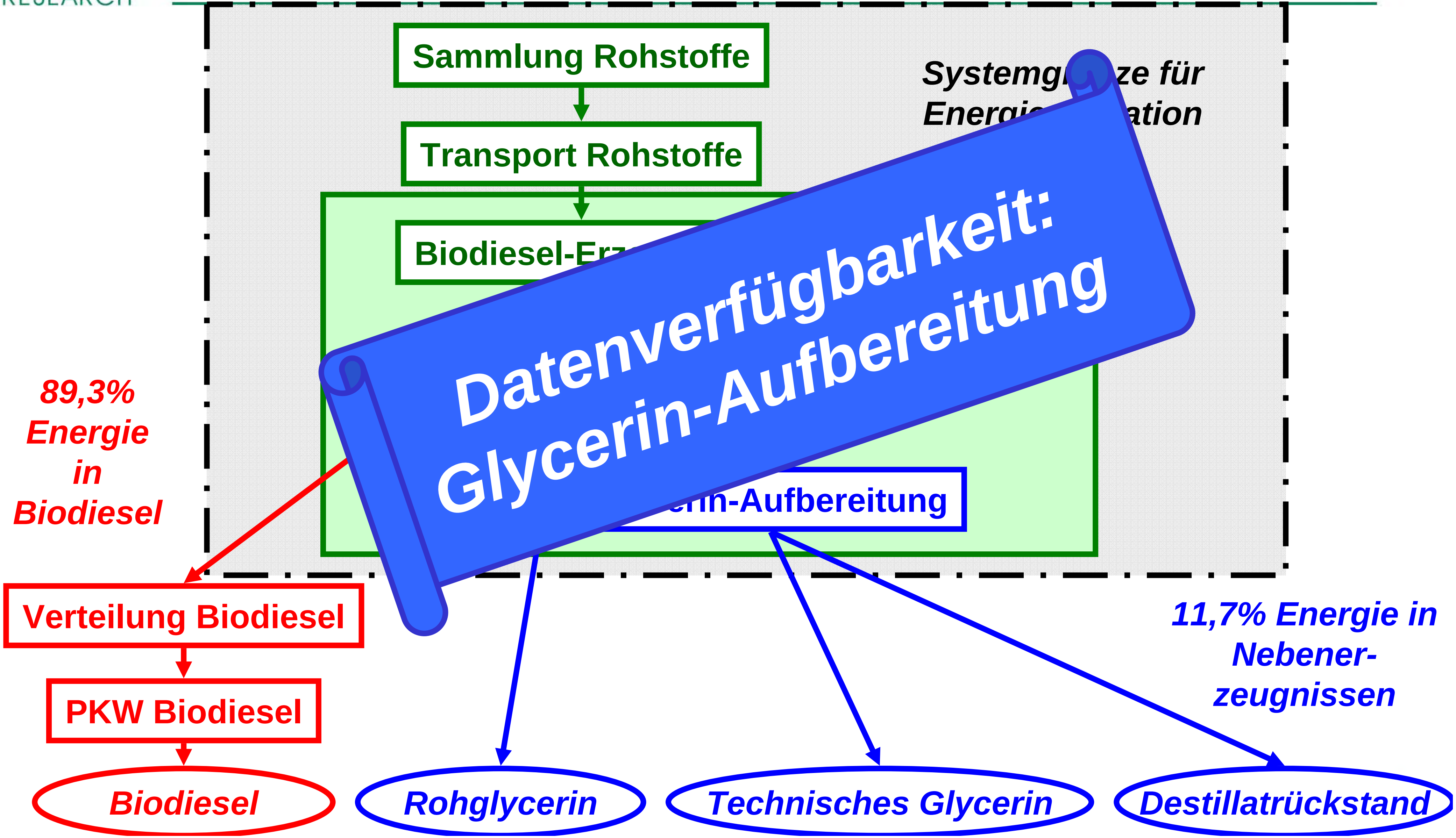
Raw Material from Austria and Neighbour countries
- **waste cooking oil**
- **animal fat**

Biodiesel 50,000 t/a

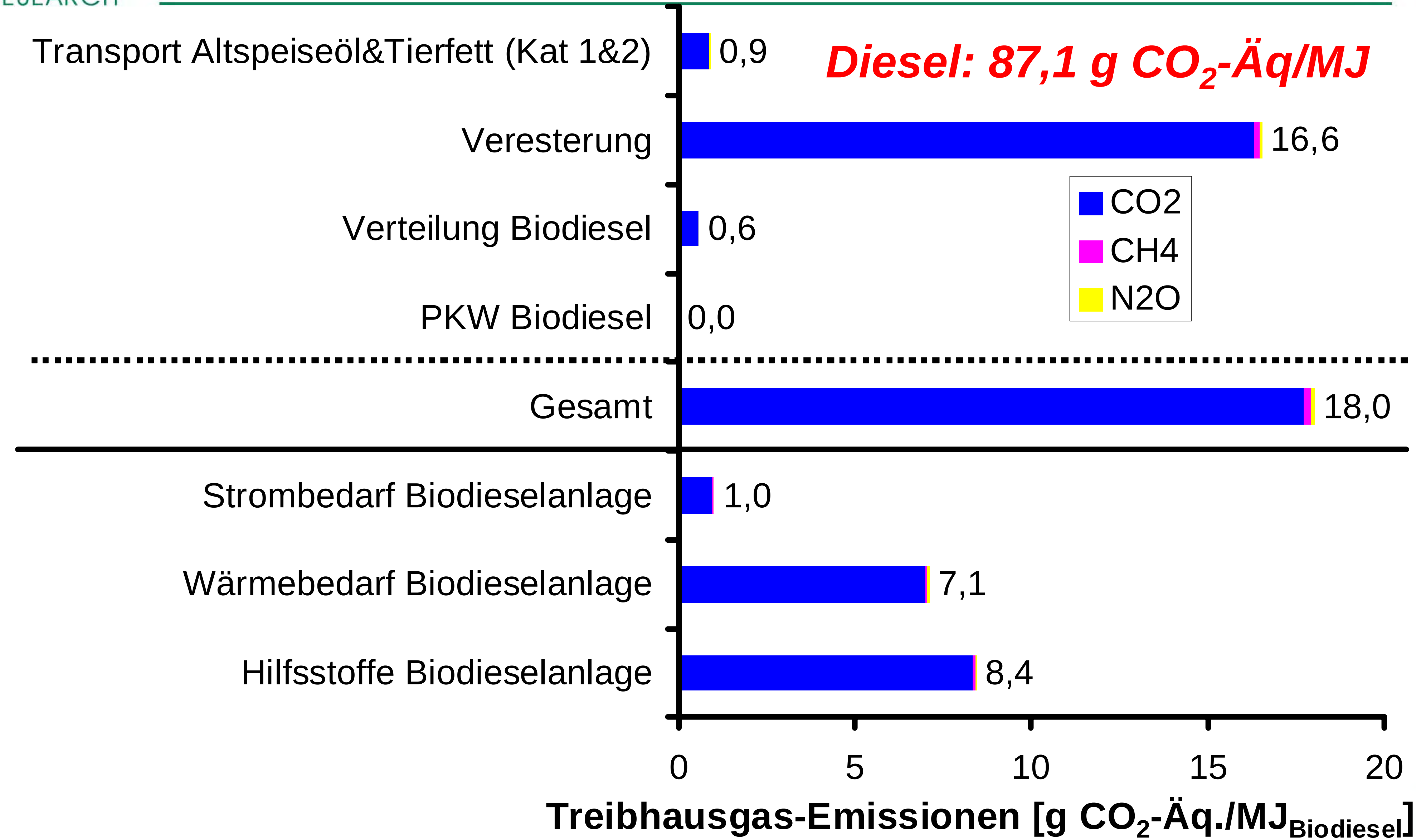
Co-products:
- **Pharmaglycerin**
- **Raw glycerin Potassium-Sulphate fertilizer**
- **Destillation residues**


Biodiesel
Diesel
Sammlung Altspeiseöl
Sammlung Tierfett
Transport Altspeiseöl
Transport Tierfett
Biodiesel Anlage
6,7% Destillat-rückstand *)
Brennstoff
0,01% Kalisulfat *)
Düngemittel*)
1,9% Rohglycerin *)
Rohstoff Biogas*)
2,1% techn. Glycerin *)
Chemierohstoff*)
89,3% Biodiesel *)
Verteilung Biodiesel
PKW Biodiesel
Förderung Rohöl
Transport Rohöl
Raffinerie Ausland
Transport Rohdiesel
Transport Rohöl
33%
67%
Raffinerie Inland
Verteilung Diesel
PKW Diesel
*) Energieinhalt für Energieallokation
Transportdienstleistung

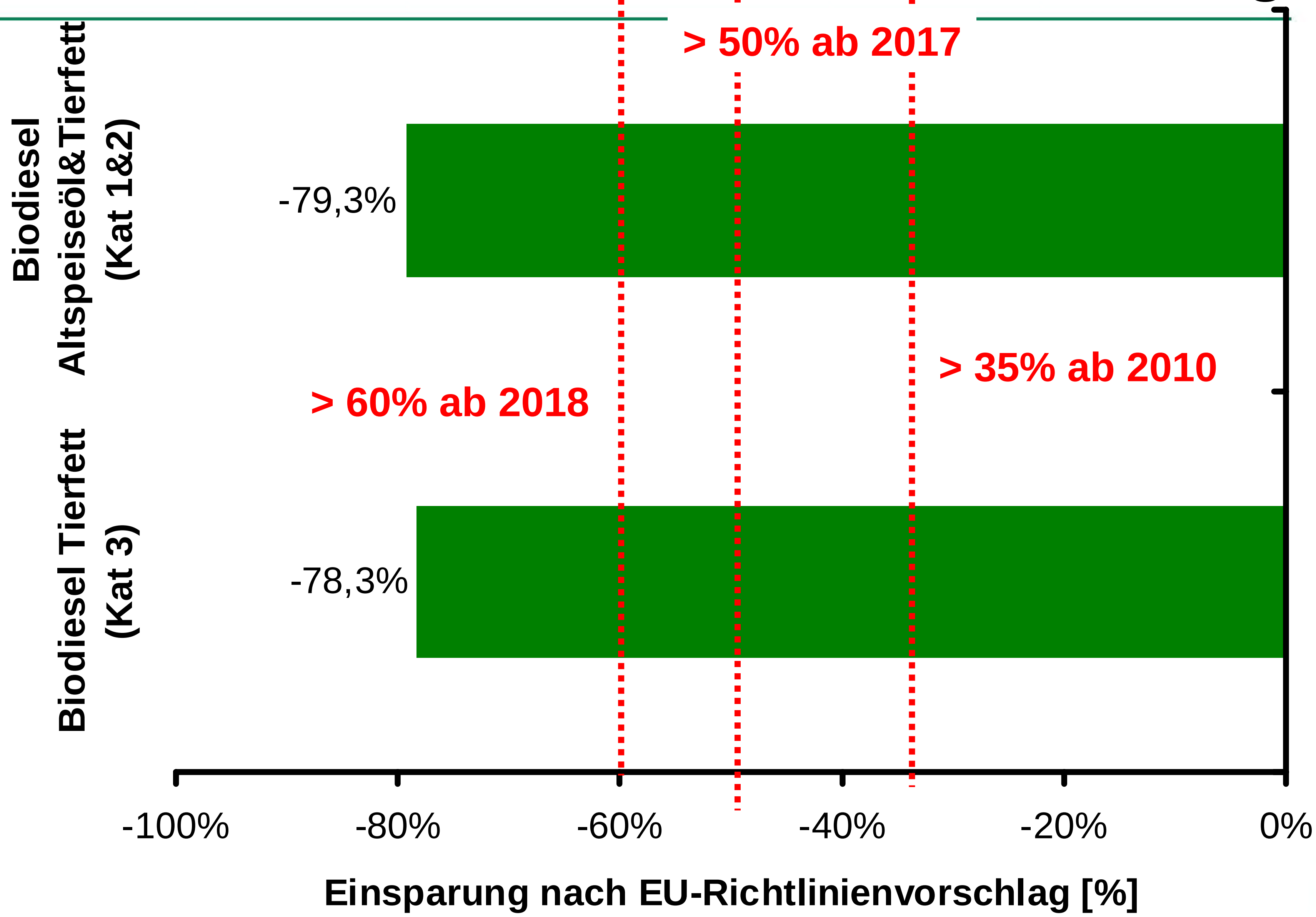
Energieallokation für Biodiesel, Glycerin, und Destillatrückstand



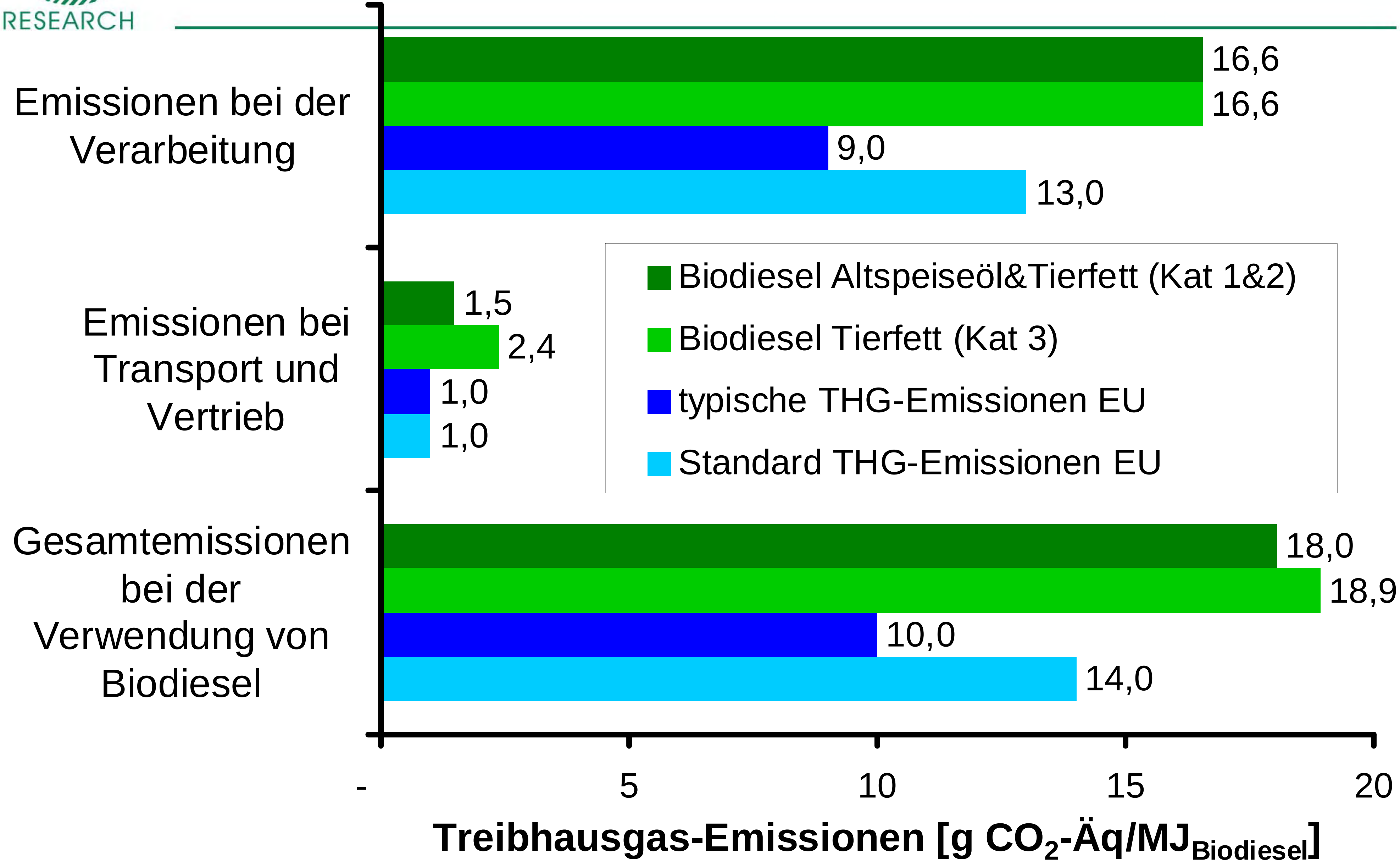
Gesamtemissionen für Biodiesel aus Altspeiseöl&Tierfett (Kat 1&2)



Einsparung nach EU-Richtlinienvorschlag



Gesamtemissionen im Vergleich zur EU-Direktive



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Greenhouse Gas Emissions from Cultivation I

Umweltbundesamt
Austrian Environment Agency

TYPICAL GREENHOUSE GAS EMISSIONS FROM CULTIVATION OF AGRICULTURAL RAW MATERIALS FOR USE AS BIOFUEL AND BIOLIQUID

Data from the Republic of Austria
in accordance with Article 19(2) of Directive 2009/28/EC

Ralf Winter
Werner Pölz
Elisabeth Süssenbacher
Andrea Spanischberger
Heinz Bach

Vienna, 2010

Greenhouse Gas Emissions from Cultivation II

Since the Directive contains no data on the energy density of the products (main products and co-products) and therefore no fixed allocation code is defined in it – this depends very much on the specific installations involved in each case – the values corresponding to the Austrian installation structure were used for the analysis. The data come from the GEMIS-Austria database. The respective allocation codes are given with the results.

					Cultivation in the f			
Crop types	Biofuel and bioliquid	Standard GHG emission [gCO2eq/M]	Min. GHG emission [gCO2eq/M]	Max. GHG emission [gCO2eq/M]	B AT11	K AT21	NÖ AT12	OÖ AT3
Sugar beet	*Sugar beet ethanol*	*12*	*7.46*	*7.70*	X	X	X	X
Wheat	*(Common) wheat ethanol*	*23*	*18.78*	*20.82*	X	X	X	X
Grain maize	*Grain maize ethanol*	*20*	*9.86*	*12.54*	X	X	X	X
Rape	*Rape seed biodiesel*	*29*	*19.36*	*2338*	X	X	X	X
	Pure vegetable oil from rapeseed	*30*	*20.62*	*24.06*	X	X	X	X
Sunflower	*Sunflower biodiesel*	*18*	*10.76*	*13.83*	X	X	X	X
Soya bean	*Soybean biodiesel*	*19*	*9.71*	*12.05*	X	X	X	X

Source: Umweltbundesamt 2010

Greenhouse Gas Emissions from Cultivation II

Biodiesel
55%

In accordance with the energy allocation method, taking in[...]unt the Austrian data basis 54.69%[5] of the emissions are allocated to biodiese[...]) and 45.31% to the coproducts (the separation is made in the i[...]t where the fuel is produced). This value is inde[...]nto the production process (rapese[...]

V

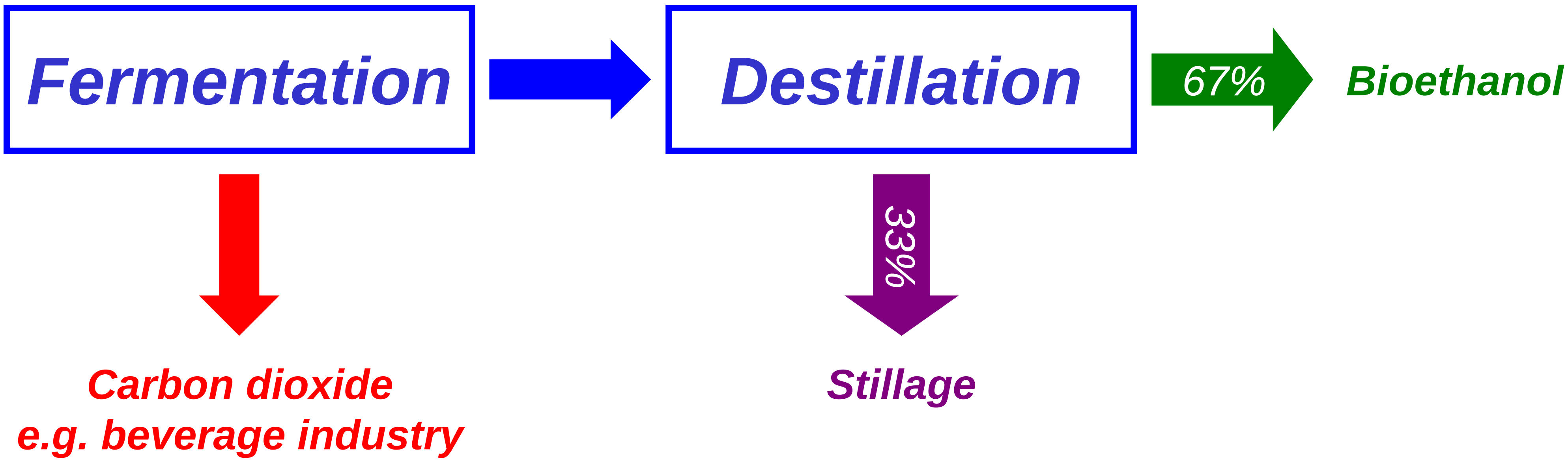
[...] Austrian data [...]3.71% to the [...]roduced).

Emissions from cultivation should be given in CO_2-eq./(ha*a) independent from allocation

[...]allocation method, taking into account the Austrian data [...] the emissions are allocated to bioethanol (or ETBE) and 33.00% to the [...]products (divided up in the installation at the point where the fuel is produced). This value is independent of the raw materials going into the production process (sugar beet, wheat, etc.). In the emissions from cultivation no distinction is made with regard to the limit values according to Directive 2009/28/EC between bioethanol and the bio-ETBE made from it (see fig. 7).

Bioe
67

e_{ccr} = emission saving from carbon capture and replacement



- **RED: The CO2-benefit shall only be allocated to the biofuel, not to co-products**
- **Mistake in Directive or intension to stimulate improvements?**

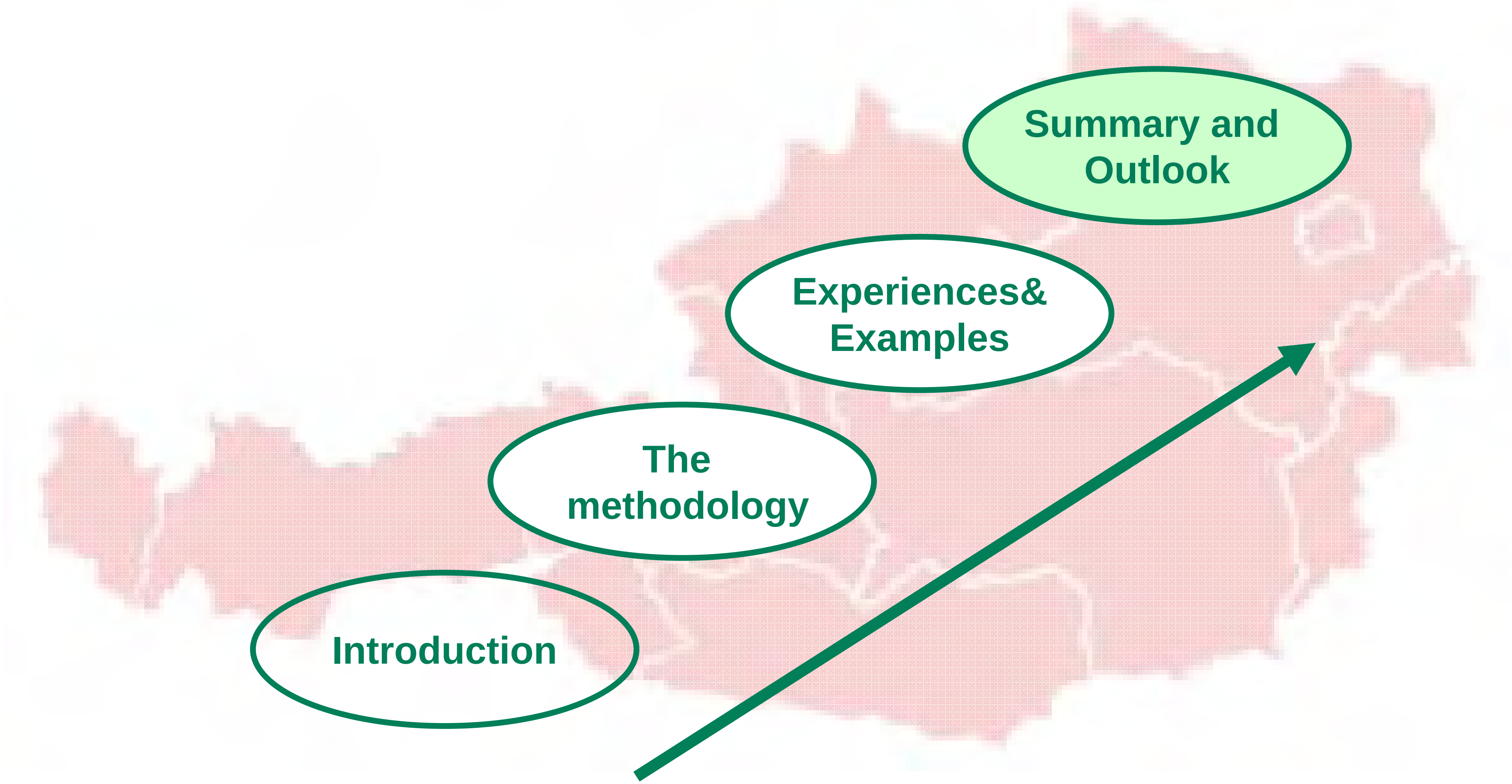
Greenhouse Gas Emissions from Construction and Dismantling

- ***RED: Emissions from the manufacture of machinery and equipment shall not be taken into account***

Greenhouse gas saving:

$$E = (E_{fossil} - E_{biofuel}) / E_{fossil} >$$

Outline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Conclusions

Future application of the RED-methodology will become quicker, more reliable & more effective

The analysed biofuel plants are very specific in terms of their processes, co-products and energy supply, so each plant must be analysed in detail to get a reliable GHG balance.

The influences of allocation procedure, system boundary setting, type of co-products and data source are relevant for the results.

All considered biofuel plants reach the minimum GHG saving of 35%, most of them have a GHG saving between 45% and 55%, one plant up to 80%.

The experiences show that the RED-methodology can be applied to existing different industrial biofuel production plants.