LCA of biogas from different purchased substrates and energy crops

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Introduction

- Most Biogas in CH from sewage sludge, slurry, or biowaste.
- In order to improve the yield of biogas plants, operators often purchase or cultivate substrates with high energy content.
- Environmental impacts of biogas from these substrates?

Requirements for tax reduction of biofuels

641.611.21

Verordnung des UVEK
über den Nachweis der positiven ökologischen Gesamtbilanz von Treibstoffen aus erneuerbaren Rohstoffen

(Treibstoffökobilanz-Verordnung, TrÖbiV)

vom 3. April 2009 (Stand am 15. April 2009)

a. Minimum -40 % greenhouse gases compared to petrol

b. Max. +25 % total environmental impacts compared to petrol

Substrates considered in this study

Sugar beet

Fodder beet

Beet residues

Substrates considered in this study

Maize silage

Molasses

Glycerine

a) From vegetable oil

b) From waste oil

Life cycle inventory modelling

- New LCI of biogas from different substrates
  - Literature data
  - Results from survey (ENERS company)
- New LCI of methane purification technologies
- Updated LCI of biogas combustion in cogeneration unit
- Modelling of biogas based car driving with ecoinvent data

Life cycle inventory modelling

	This study	ecoinvent v2.2
Heat consumption	100% from biogas	Sewage: from natural gas Others: from biogas
Electricity consumption	62% from biogas 38% from grid	Agricultural: 50-60% from biogas, 40-50% from grid Biowaste/whey: 100% from biogas
Substrates	Production of substrates (energy crops) included	Production of substrates not included because of cut-off approach for wastes
Digested matter	Application on agricultural land not included (only in a scenario)	Application on agricultural land not included
Biogas purification	56 % pressure swing adsorption technology, 26 % glycol washing technology, and 18 % amino washing technology	100% Pressure swing adsorption technology

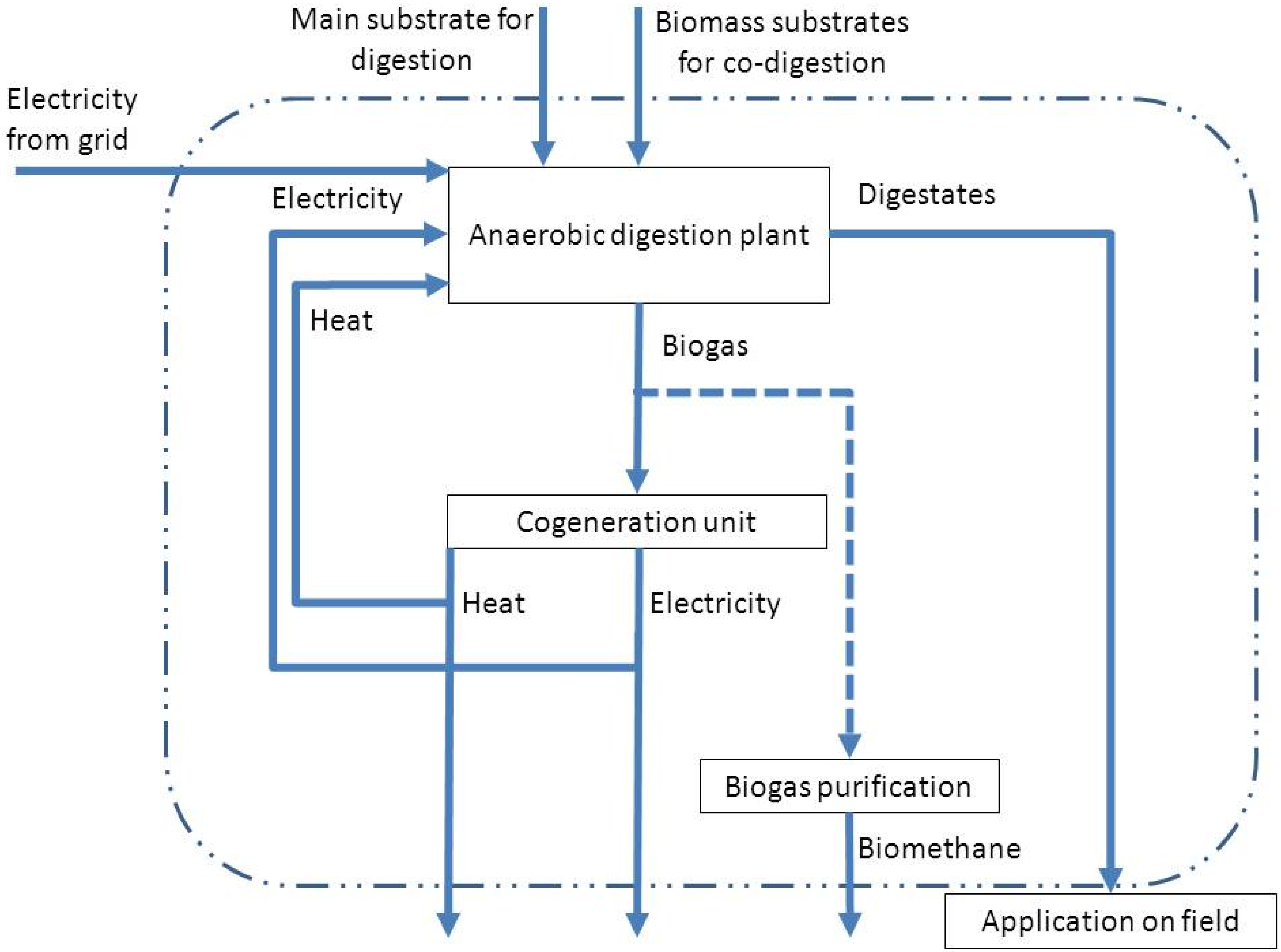
Biogas purification

3 Technologies in CH

- pressure swing adsorption (PSA)
- glycol washing
- amino washing

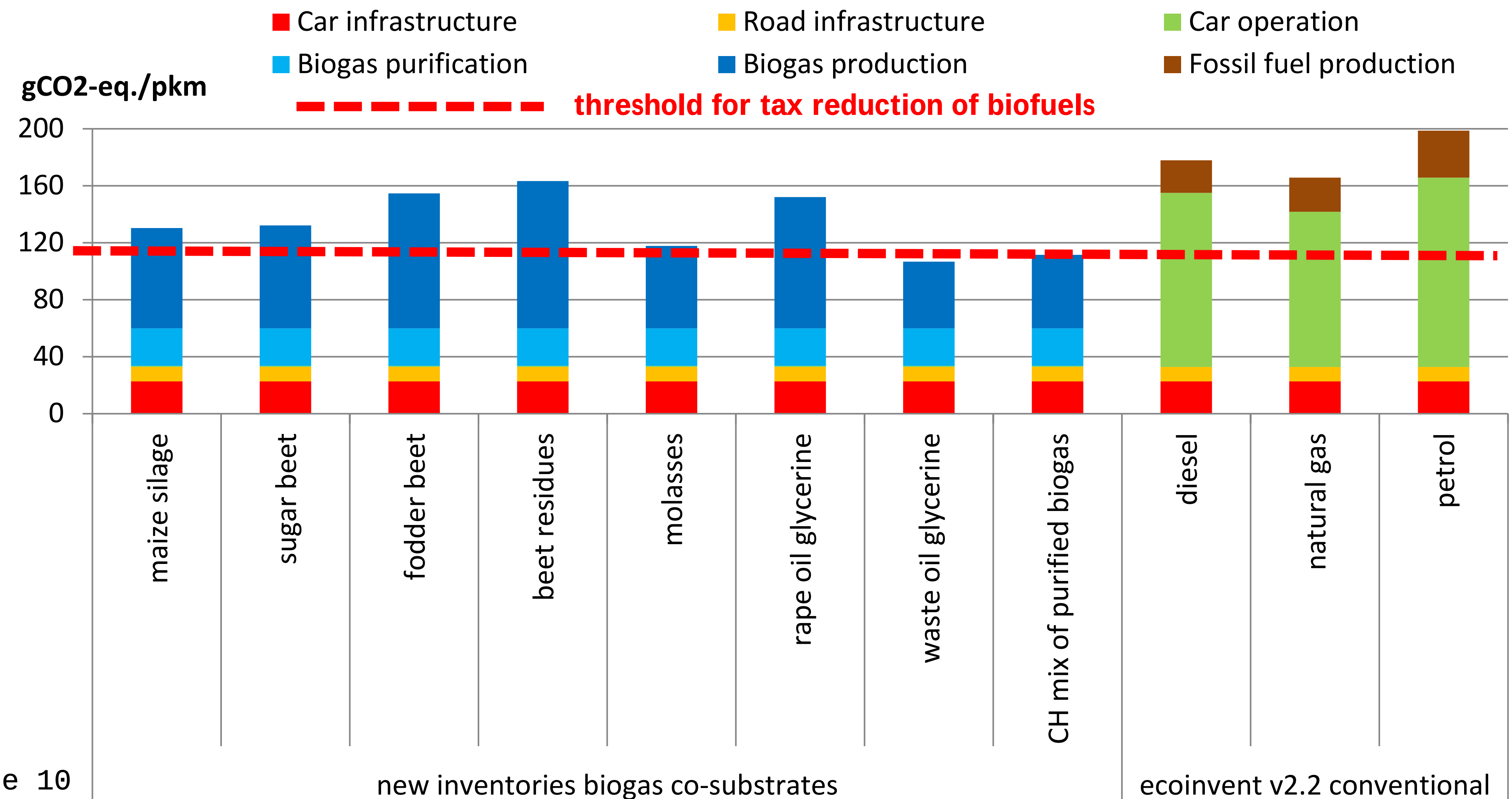
Glycol washing in Pratteln

Biogas system overview



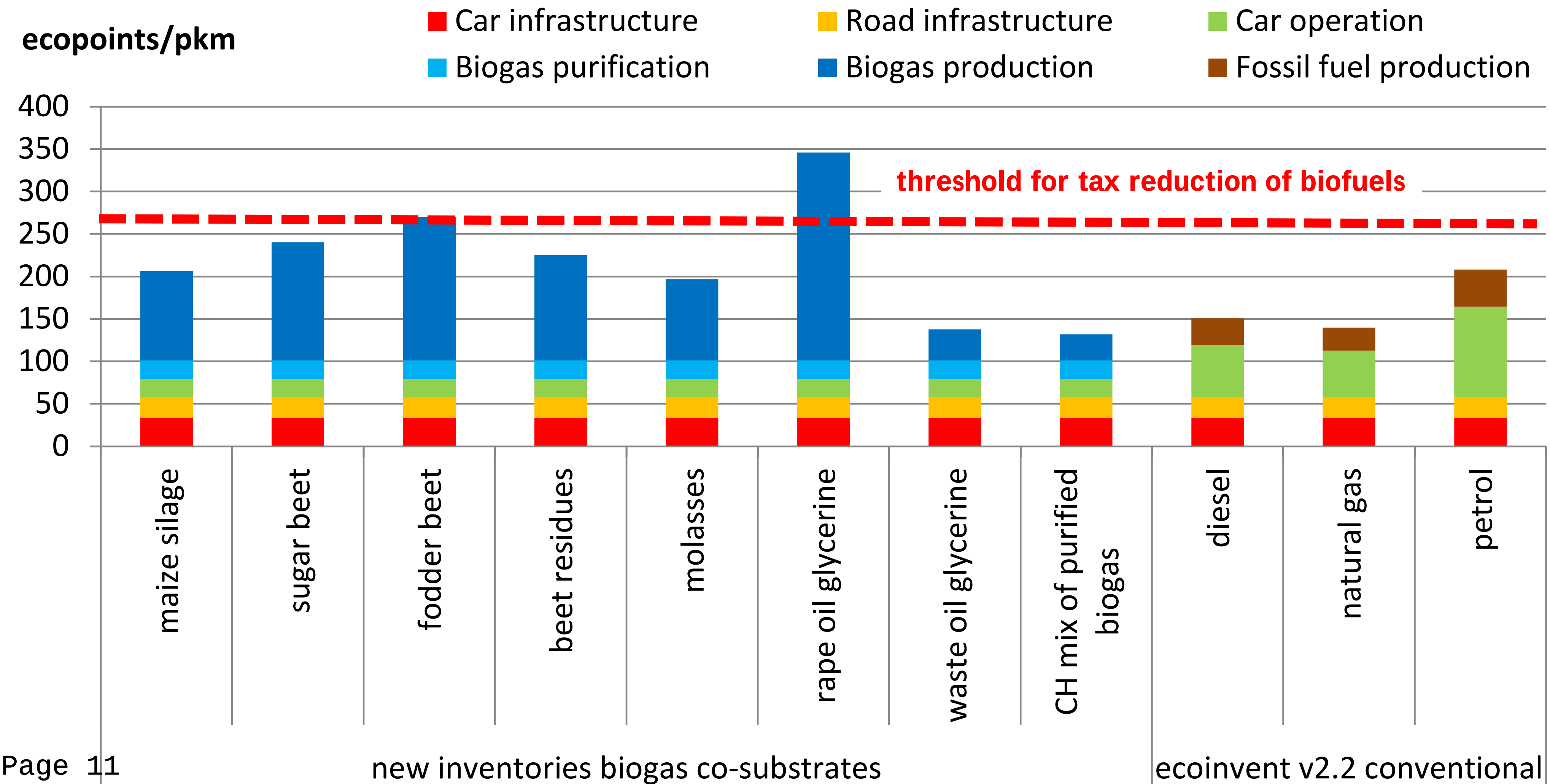
Results: car transportation with biogas

Greenhouse gases



Results: car transportation with biogas

Ecological Scarcity

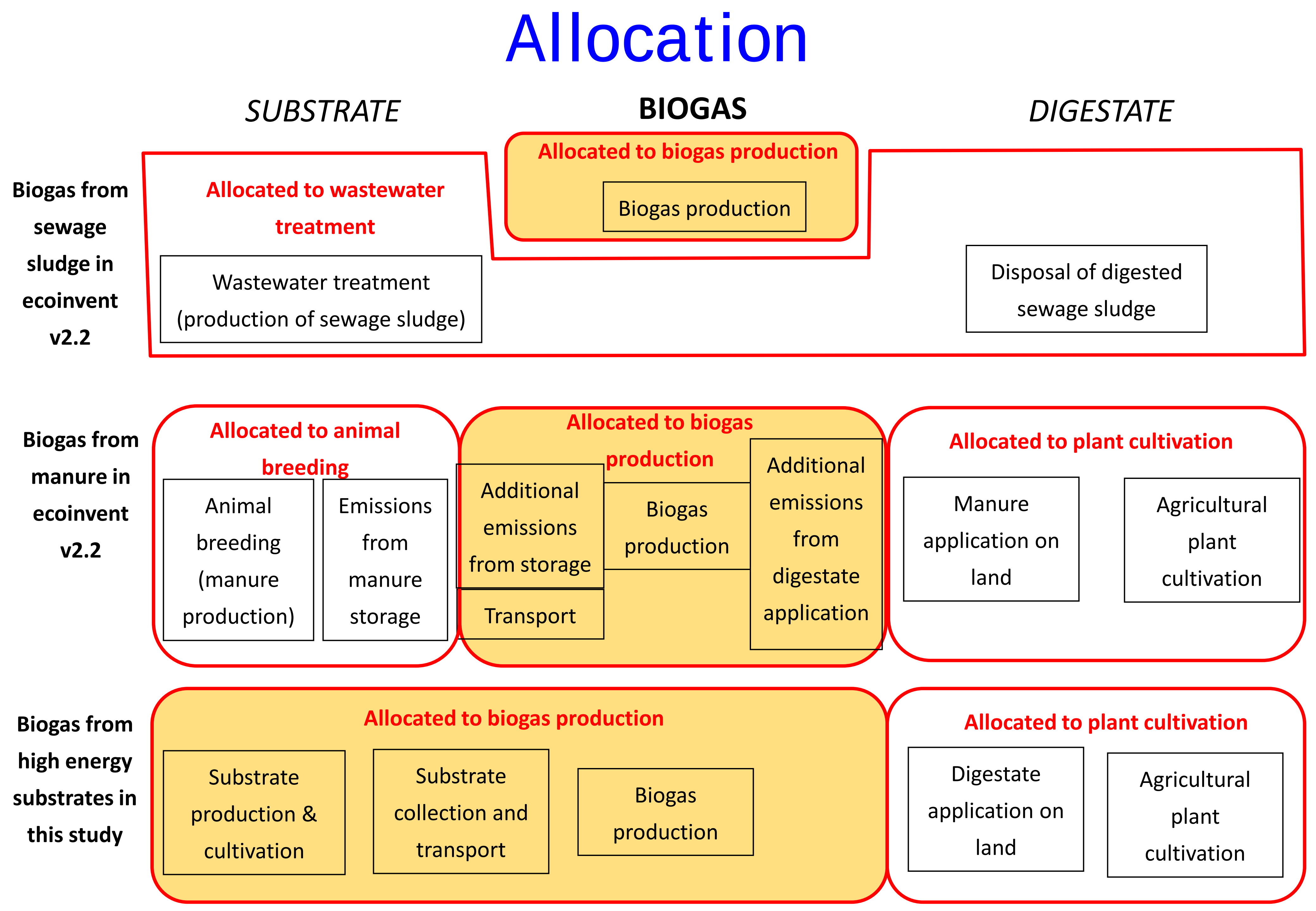


Results: compliance for tax reduction

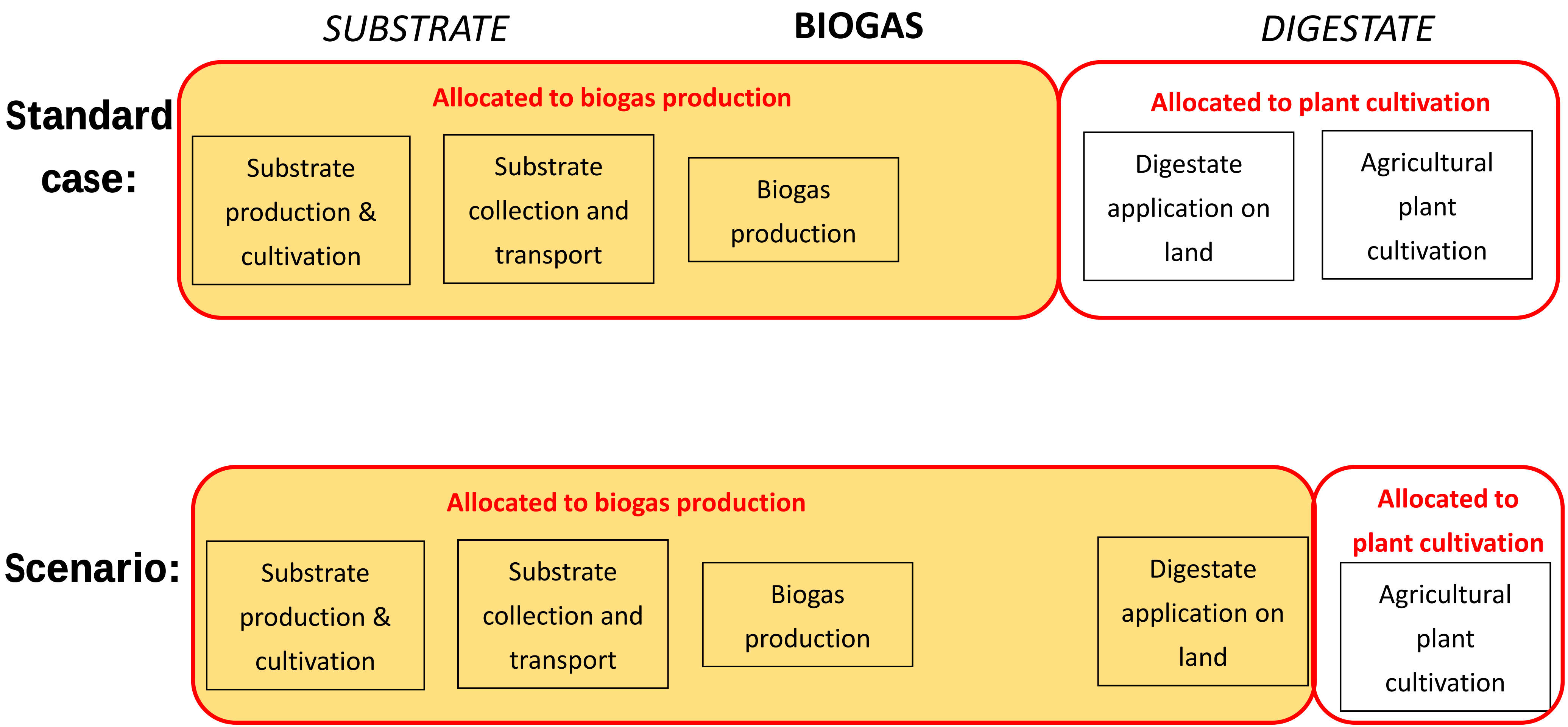
	GHG requirement	UBP requirement
Sugar beet	x	√
Fodder beet	x	x
Beet residues	x	√
Maize silage	x	√
Molasses	x	√
Rape oil glycerine	x	X
Waste oil glycerine	√	√
Current biogas mix	√	√

Allocation of digestate application?

- Trail hoses reduce ammonia emissions
- Heavy metal emissions into soil
- Digestates are a fertilizer

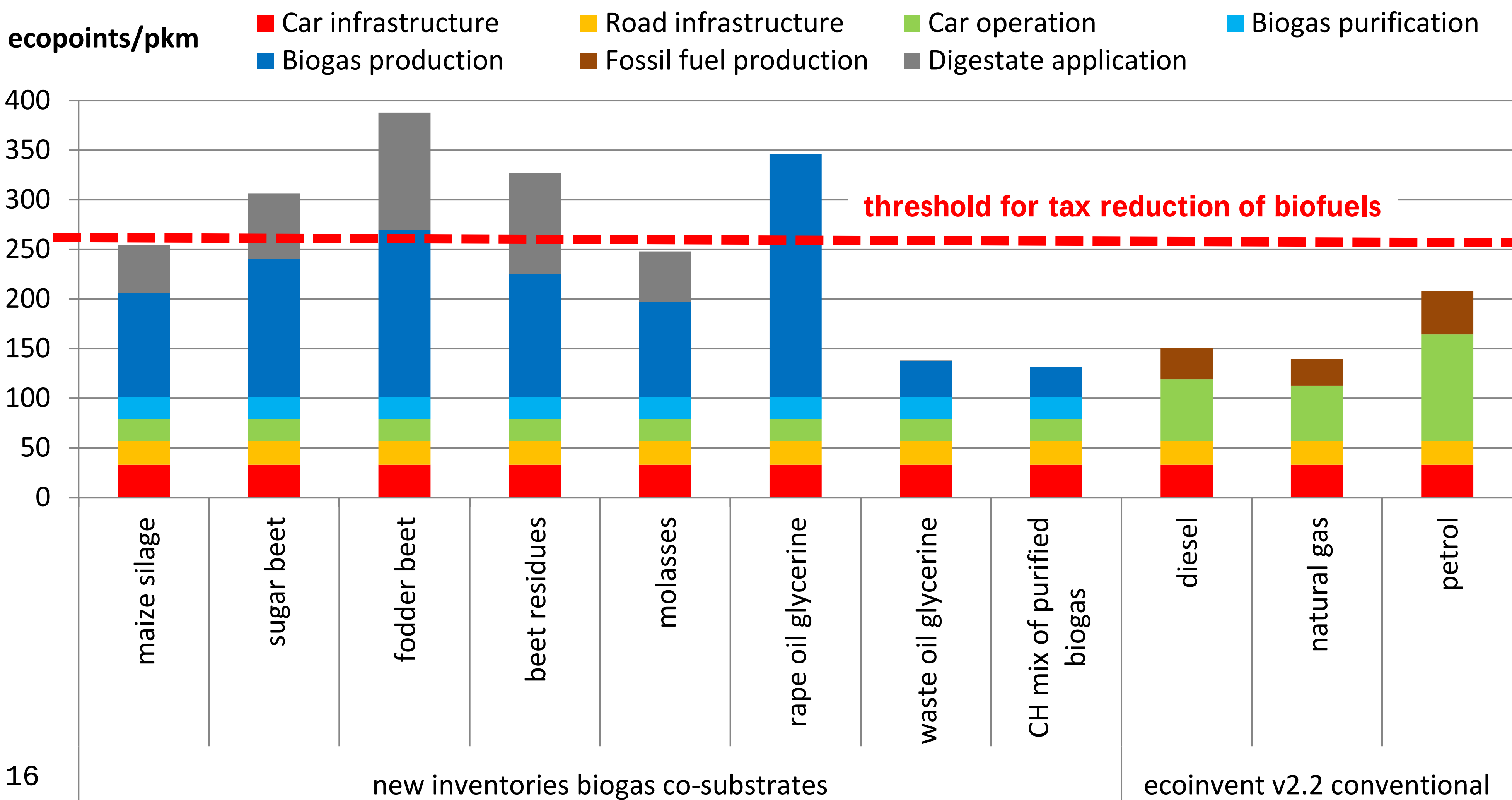

Allocation
SUBSTRATE
BIOGAS
DIGESTATE
Biogas from sewage sludge in ecoinvent v2.2
Allocated to wastewater treatment
Wastewater treatment (production of sewage sludge)
Allocated to biogas production
Biogas production
Disposal of digested sewage sludge
Biogas from manure in ecoinvent v2.2
Allocated to animal breeding
Animal breeding (manure production)
Emissions from manure storage
Allocated to biogas production
Additional emissions from storage
Transport
Biogas production
Additional emissions from digestate application
Allocated to plant cultivation
Manure application on land
Agricultural plant cultivation
Biogas from high energy substrates in this study
Allocated to biogas production
Substrate production & cultivation
Substrate collection and transport
Biogas production
Allocated to plant cultivation
Digestate application on land
Agricultural plant cultivation

Allocation: scenario

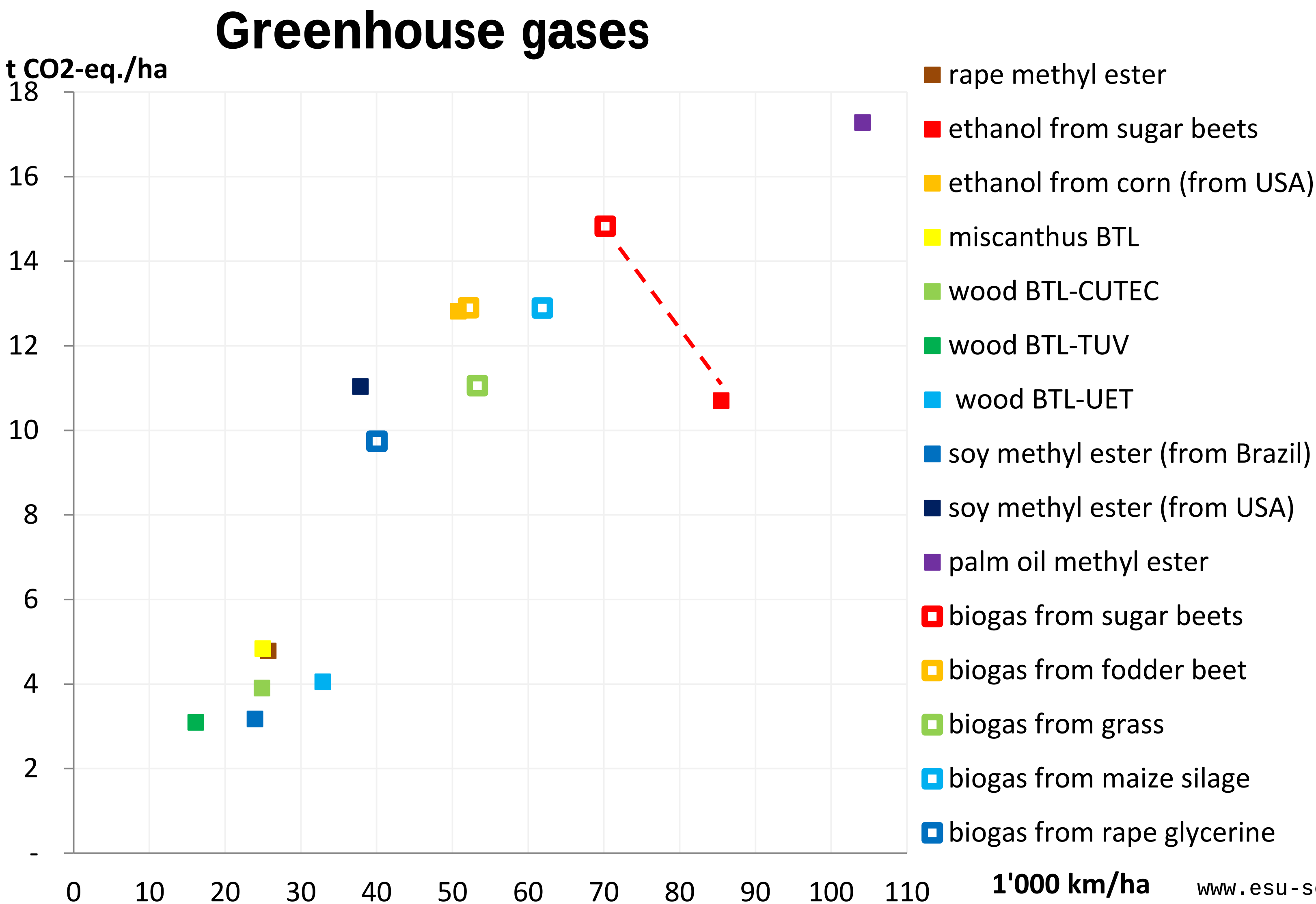


Scenario: Including application of digestates

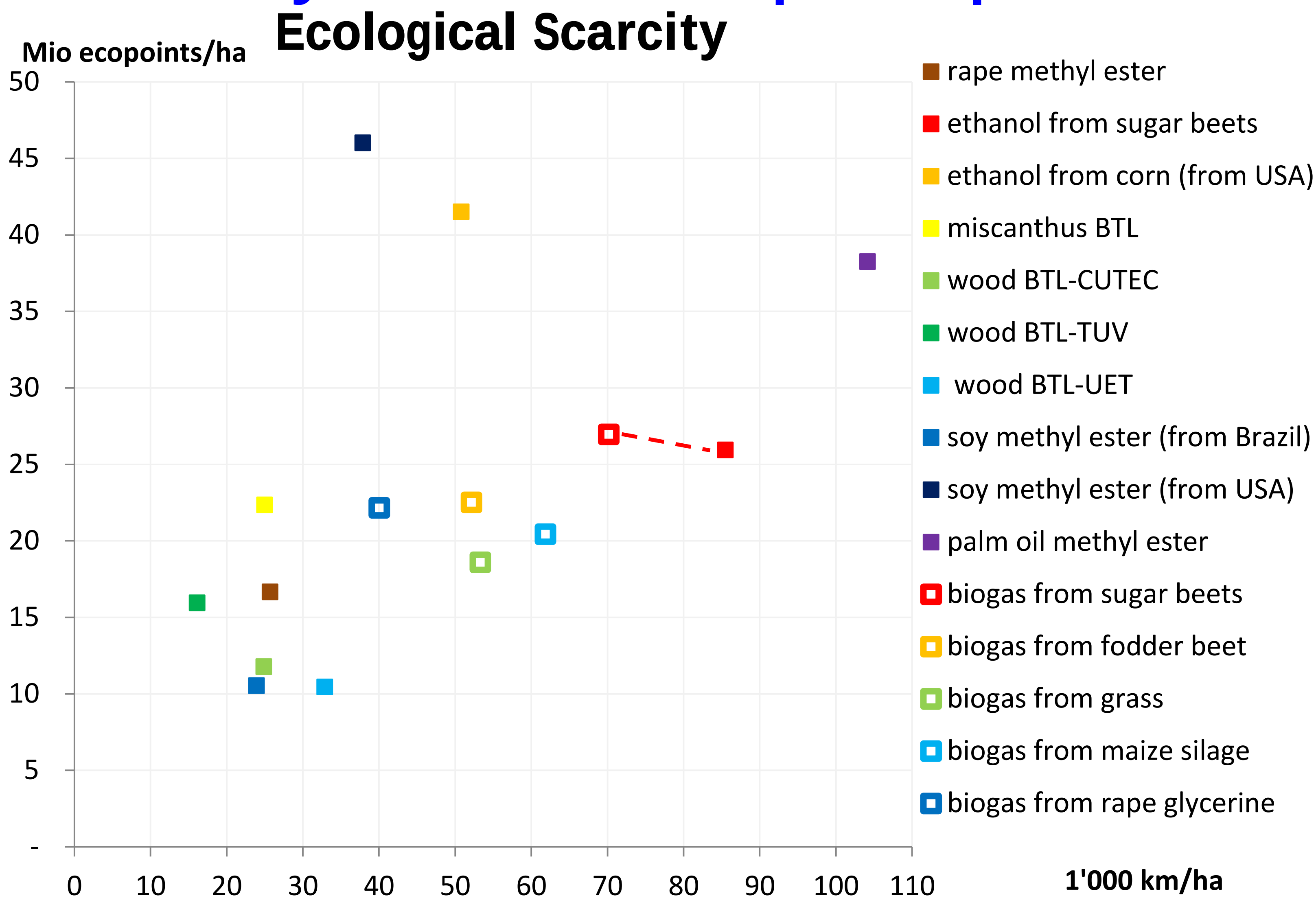
Ecological Scarcity



Results: yield and impact per hectare



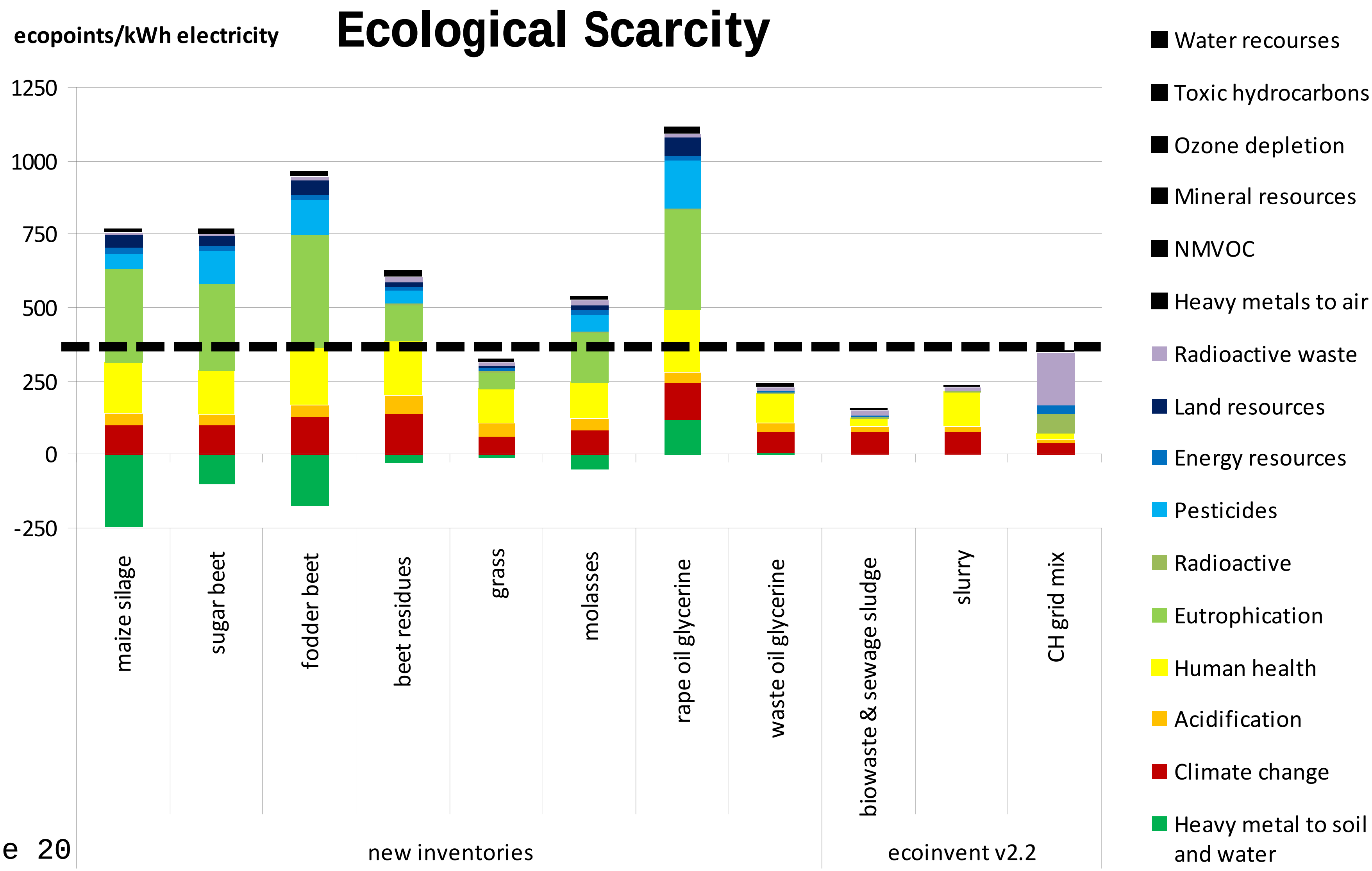
Results: yield and impact per hectare



Results: yield and impact per hectare

- Yield and environmental impacts of producing biogas from cultivated energy crops are in the same range as compared to liquid biofuels.
- The case of sugar beets indicates that the bioethanol route is more efficient than the biogas conversion route for producing biofuels.

Results: electricity generation from biogas



Conclusions 1

- Some environmental benefits of using biogas from purchased substrates compared to fossil fuels
- Higher environmental impacts of biogas from purchased substrates compared to waste substrates
- Allocation of digestate application has a high impact on results

Conclusions 2

- Pure biogas production from purchased substrates does mostly not comply with thresholds for tax reductions
- In contrast to electricity from biogas produced with wastes, electricity from biogas produced with cultivated crops is not favourable from an environmental view: emissions from crop cultivation and biogas combustion

Conclusions

The current trend towards using high energy substrates made from agricultural crops leads to higher environmental impacts and a worse environmental performance of biogas.

Thank you very much for your attention!

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Download the study and electronic data: **http://www.lc-inventories.ch/**

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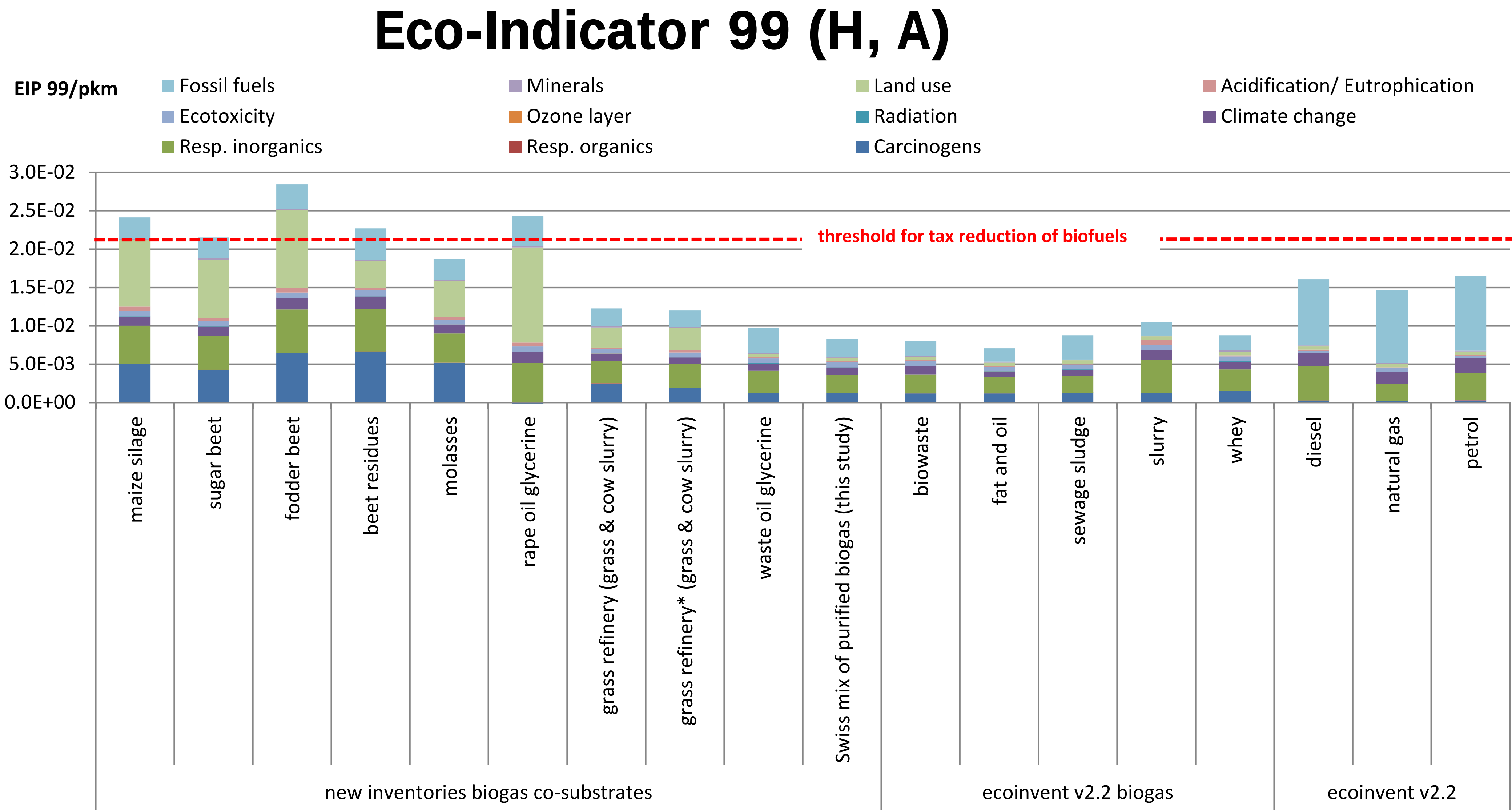
Additional Slides

Results: car transportation with biogas



Allocation of biowaste digestion in ecoinvent v2.2

Agricultural digestion plant (Biowaste)			
	Substrate treatment	Biogas production	Digestate application
Biogas plant		100%	-
Energy consumption	55%	45%	-
NH3 & N2O emissions	47%	39%	14%
CH4 & HS emissions	55%	45%	-
Emissions into soil	50%	-	50%

Anaerobic digestion plant (Biowaste)			
	Substrate treatment	Biogas production	Digestate application
Biogas plant	69%	31%	-
Energy consumption	69%	31%	-
Ammonia emissions	64%	22%	14%
CH4 & HS emissions	69%	31%	-
Emissions into soil	50%	-	50%

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