JOANNEUM RESEARCH Forschungsgesellschaft mbH

Environmental Assessment of Biomethane Injected into the Gas Grid

Johanna Pucker, Gerfried Jungmeier, Christian Leonhartsberger, Daniel Schinnerl, Jan Bleyl

Transportation Biofuels Research in Austria 2011

Wieselburg, 2011-03-31

The work for this presentation was conducted in the Austrian project "Biogas Gesamtbewertung" which is financed by the Austrian "Klima- und Energiefonds" and is carried out within the framework of the programme "Energiesysteme der Zukunft".

Content

- Background information
- Project „Biogas Gesamtbewertung“
- Modeling
- Results
- Conclusions

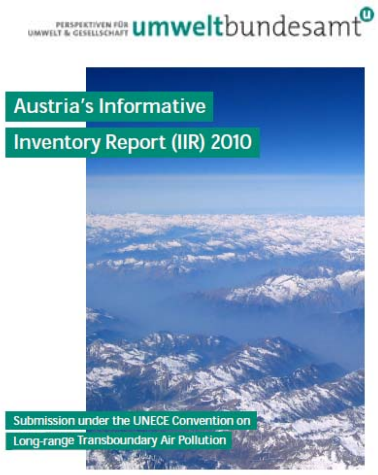
Content

- Background information
- Project „Biogas Gesamtbewertung“
- Modeling
- Results
- Conclusions

Emissions in Agriculture in Austria

- Greenhouse gas emissions (2008):
  - 8.8% of total GHG emissions
  - 72% of total N_2O emissions
    - ➢ Use of fertilizers on agricultural soils
  - 62% of total CH_4 emissions
    - ➢ Enteric fermentation
    - ➢ Manure management

- Air pollutants (2008):
  - 92% of total NH_3 emissions
    - ➢ Livestock breeding and manure management
    - ➢ Use of fertilizers on agricultural soils



Content

- Background information
- Project „Biogas Gesamtbewertung“
- Modeling
- Results
- Conclusions

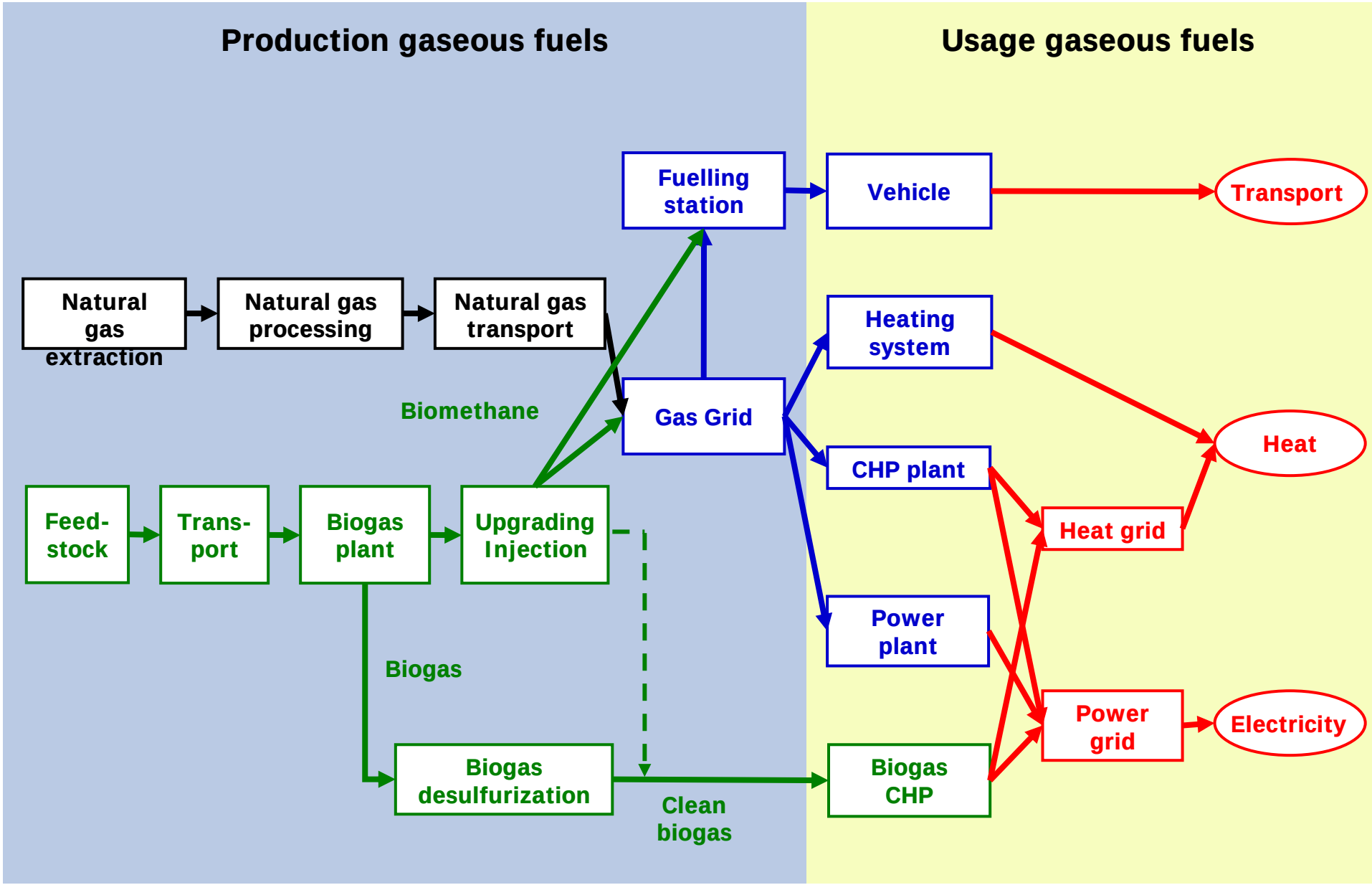
„Biogas Gesamtbewertung“

- Environmental, economic and socio-scientific assessment of biogas from the gas grid used as transport fuel and in stationary applications
- Work packages

1	Cost and potential analysis of biomass production and fermentation
2	Environmental assessment of biomethane energy services
3	Economic analysis and assessment of biomethane energy services
4	Social science analysis of framework conditions for implementation
5	Analysis of agricultural and energy policy
6	Energy market perspectives of biomethane
7	Macro economic analysis: employment, fiscal and foreign trade balance

The project is financed by the Austrian “Klima- und Energiefond” and is carried out within the framework of the program “Energiesysteme der Zukunft”.

Overview biomethane pathways



Investigated production pathways

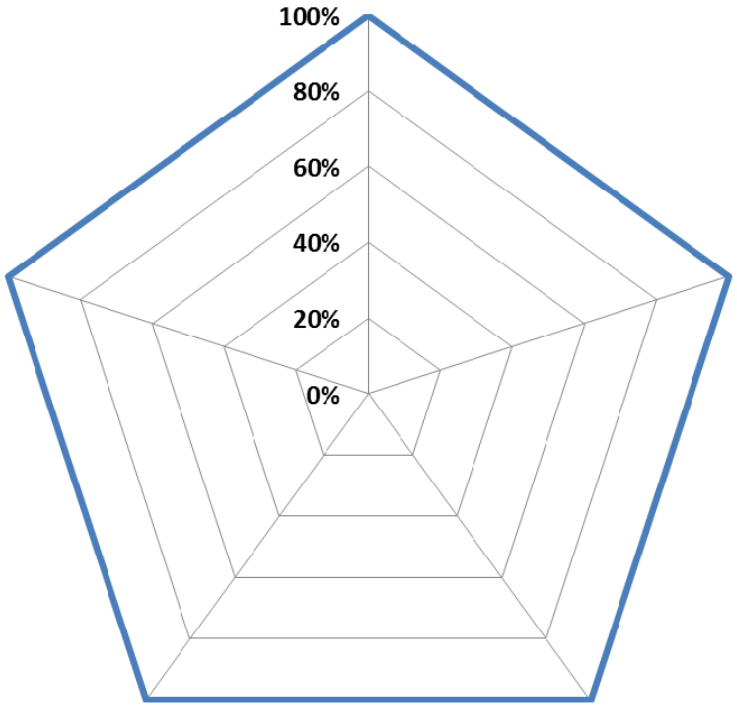
- 15 different production pathways investigated
- Results for 5 selected production pathways

Name [Capacity injection, share feedstock]	Feedstock	Biogas production [Nm³/h]	Upgrading technology
600 Nm³/h_85% energy crop rotation+15% manure	corn, triticale, green rye, sunnflower, cattle manure	1,500	pressurized water washer
400 Nm³/h_100% residues	foul food, lecithin, grease seperator, sugar beet residues, vegetable residues, kitchen residues	800	gas permeation
130 Nm³/h_52% Int. crop rotation+6% straw + 43% manure*	corn straw, sunflower straw, clover gras silage , corn silage, green rye silage, pig manure	450	amine gas treating
22 Nm³/h_50% gras+50% manure	gras, cattle manure	45	pressure swing adsorption (PSA)
20 Nm³/h_25% pig manure+75% cattle manure	cattle and pig manure	45	pressure swing adsorption (PSA)

* future technology

Investigated environmental impacts

Greenhouse gas emissions



Acidification potential

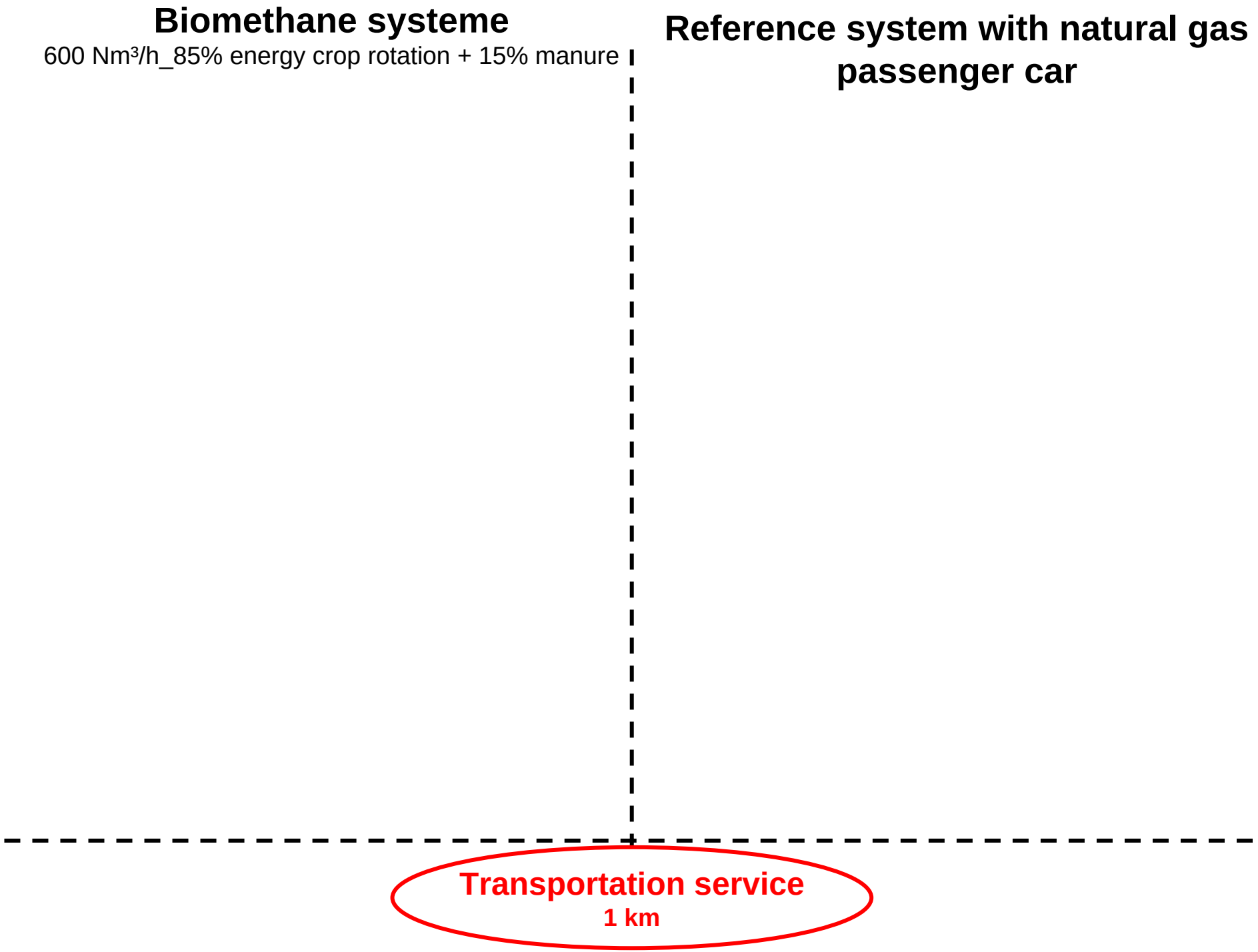
Ozone creation potential

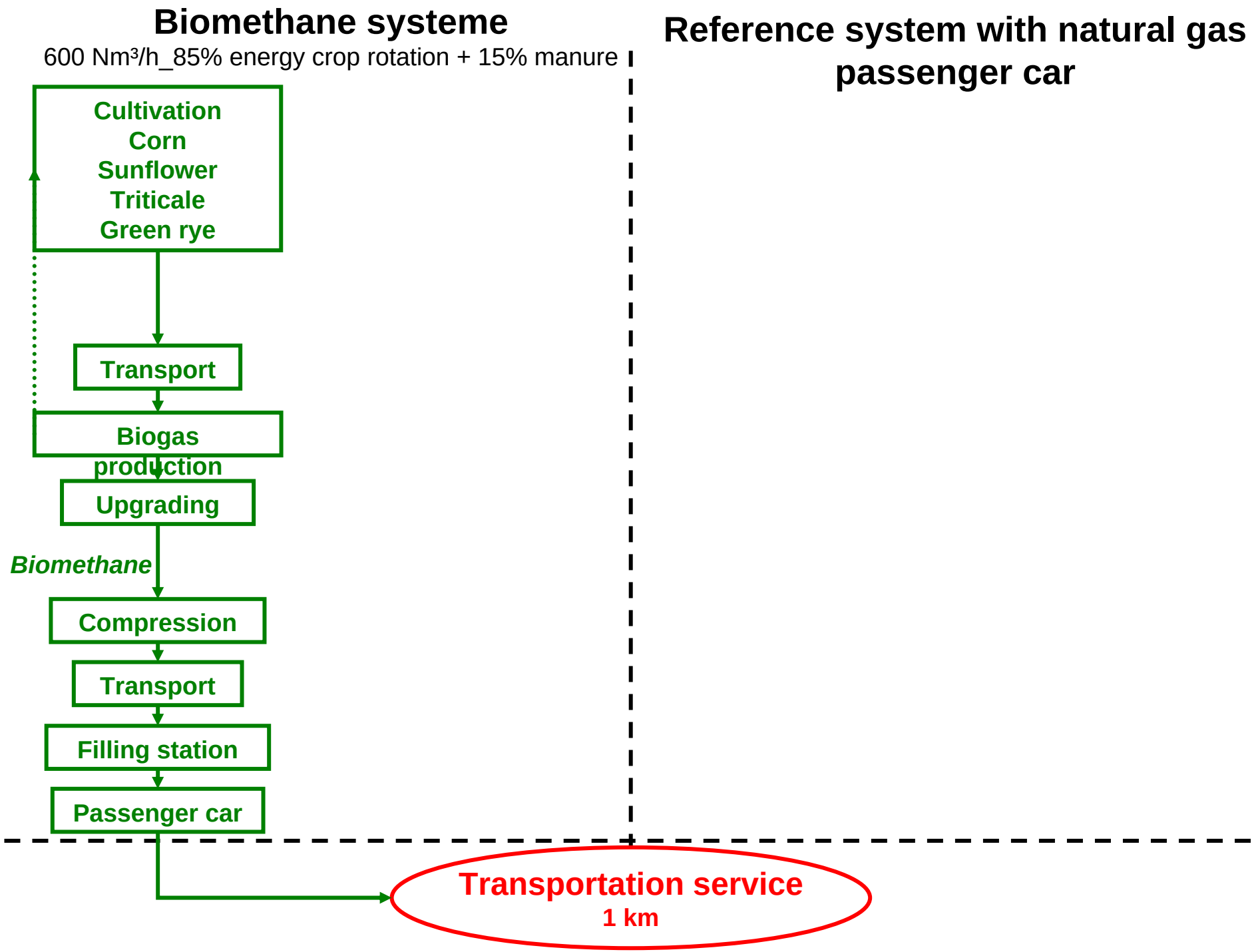
Particulate Emissions

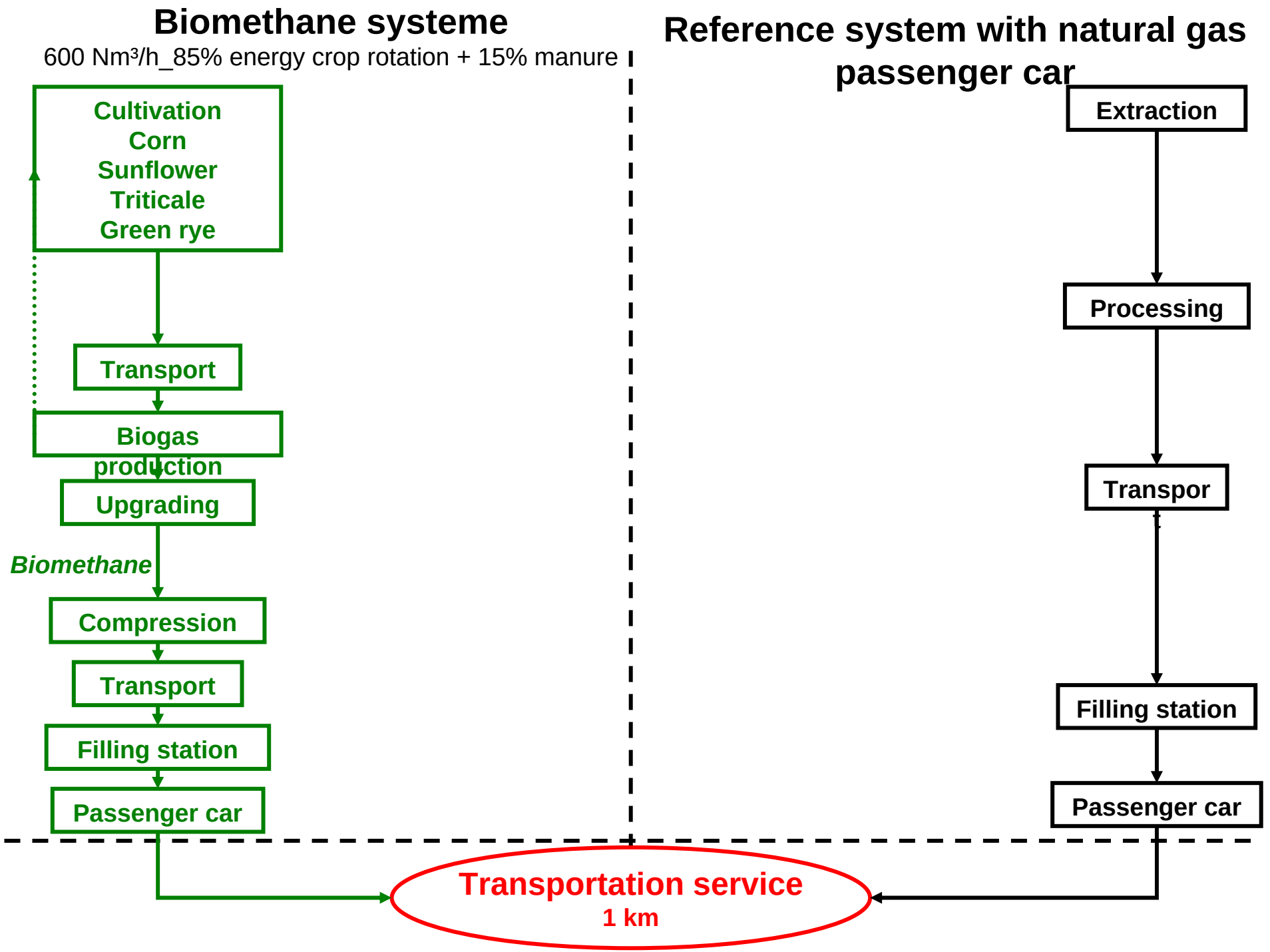
Fossil primary energy use

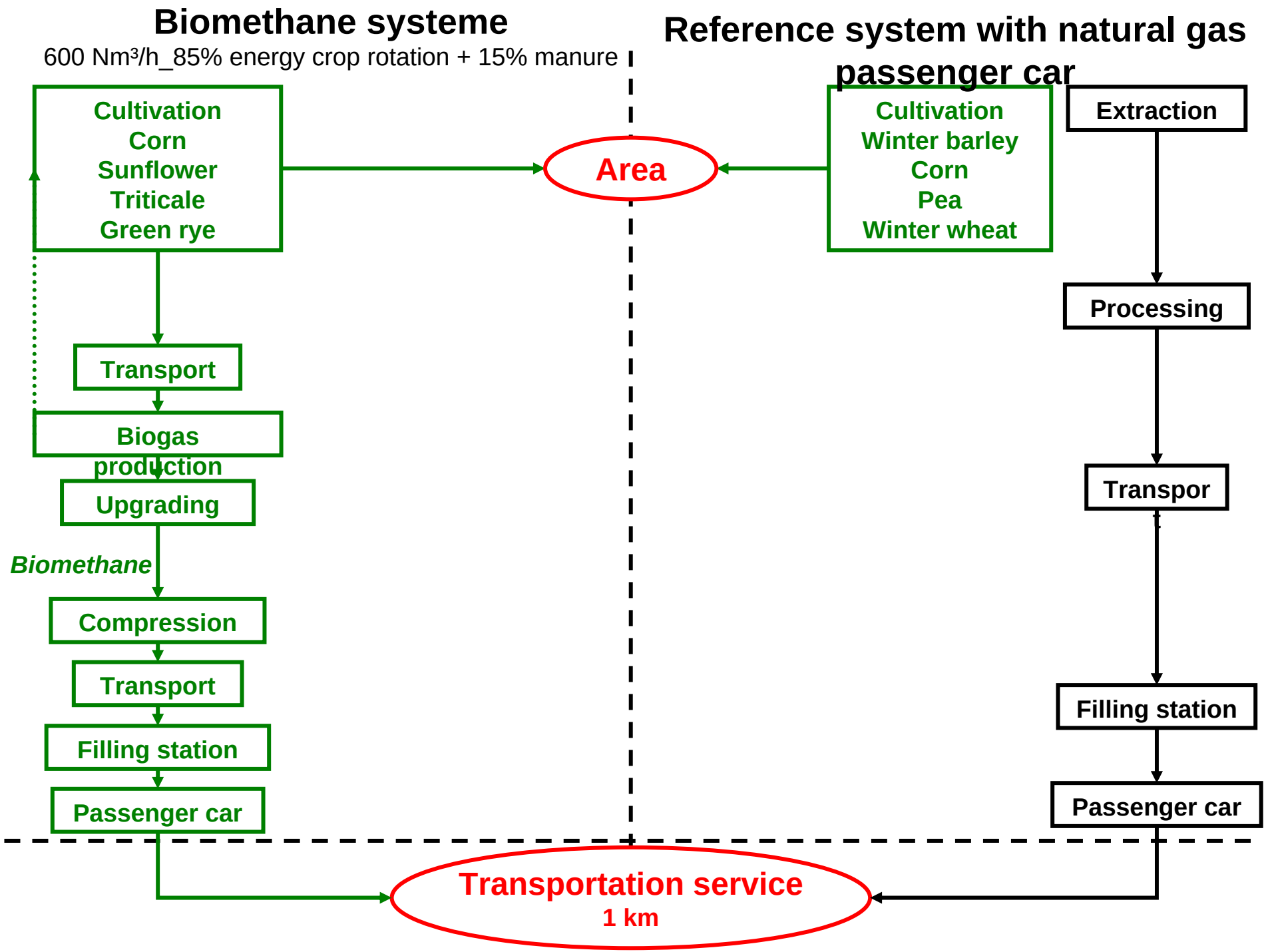
Content

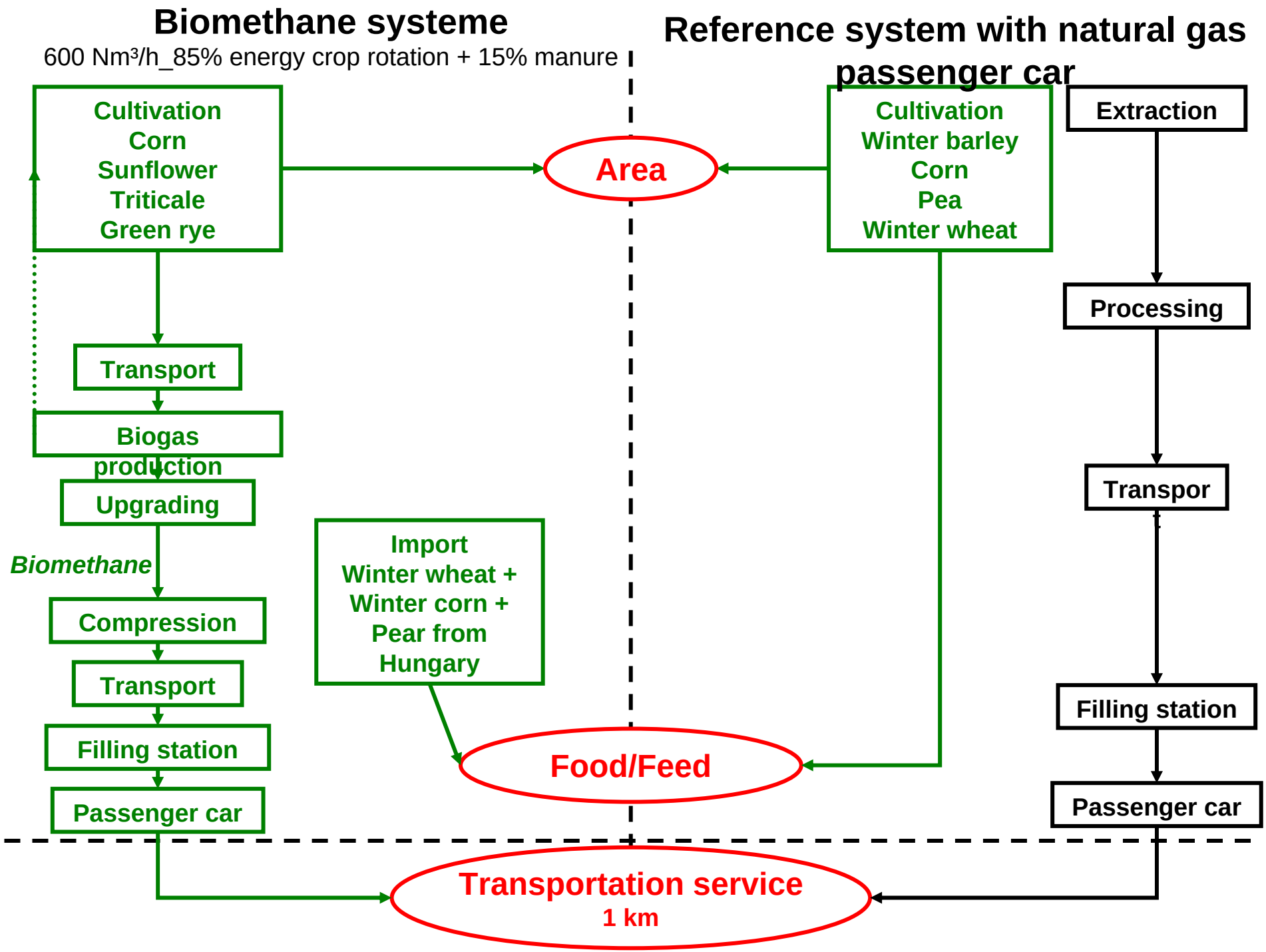
- Background information
- Project „Biogas Gesamtbewertung“
- Modeling
- Results
- Conclusions

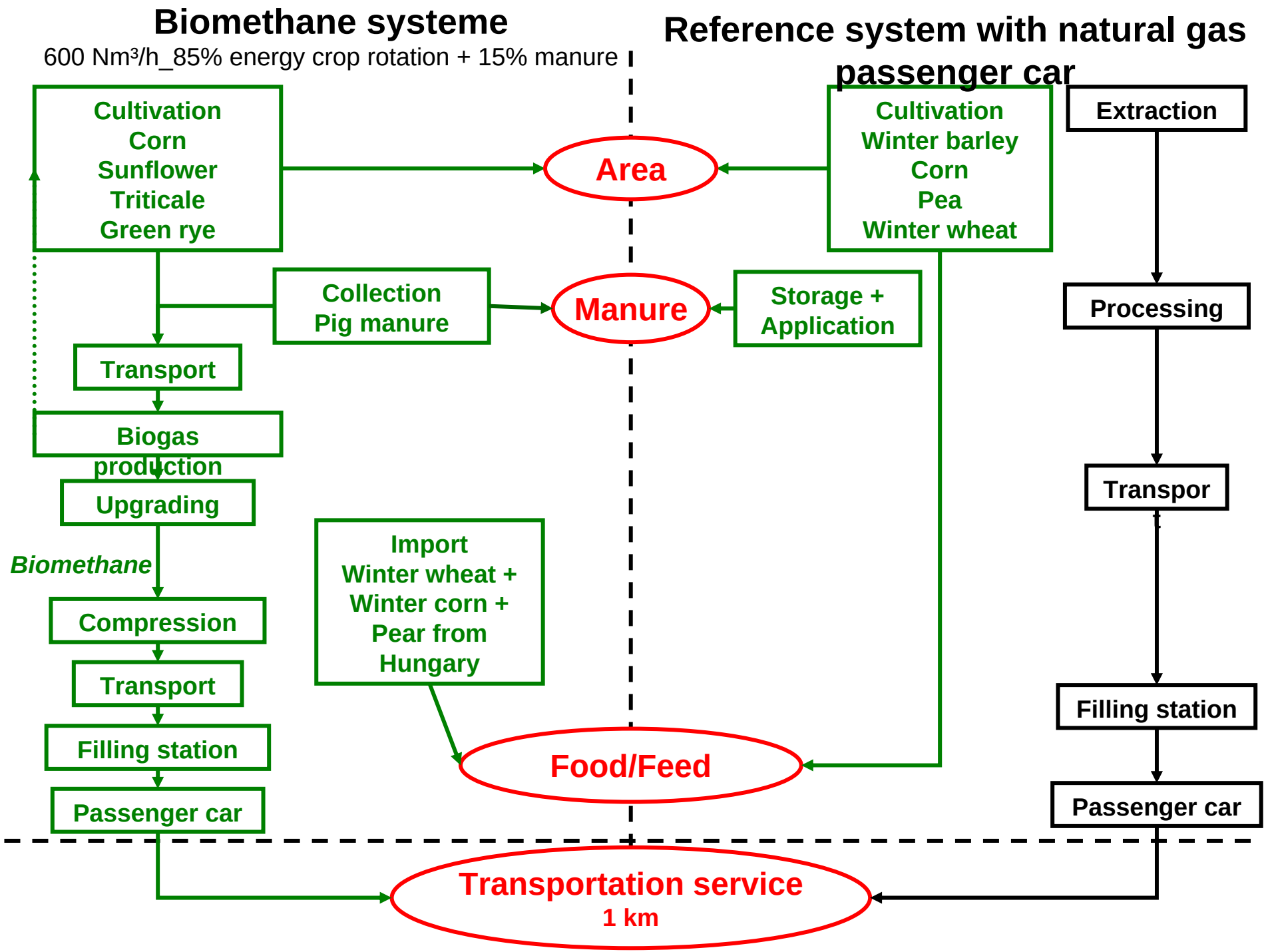

Biomethane systeme
600 Nm³/h_85% energy crop rotation + 15% manure
Reference system with natural gas passenger car
Transportation service
1 km

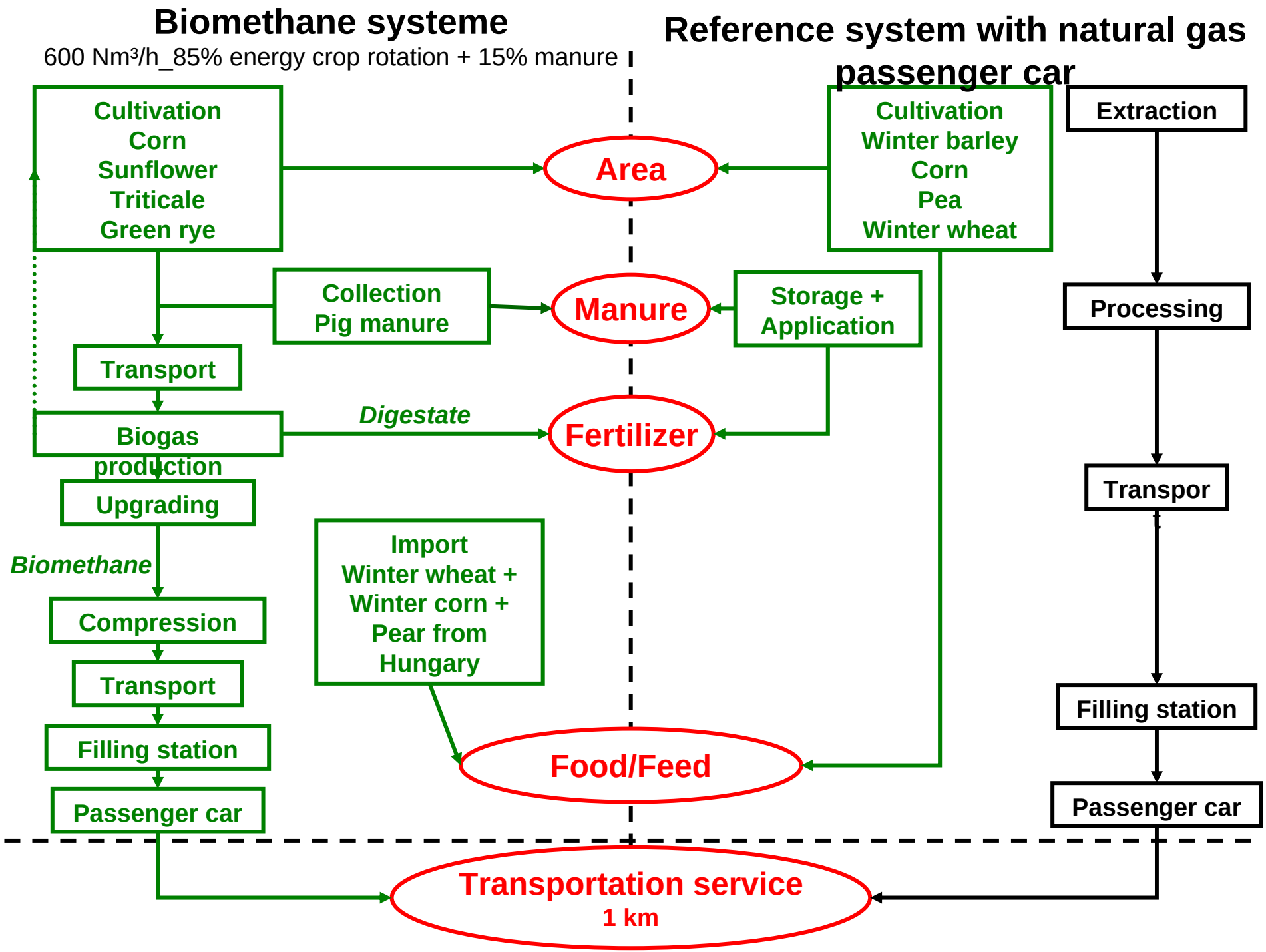

Biomethane systeme
600 Nm³/h_85% energy crop rotation + 15% manure
Reference system with natural gas passenger car
Cultivation
Corn
Sunflower
Triticale
Green rye
Transport
Biogas production
Upgrading
Biomethane
Compression
Transport
Filling station
Passenger car
Transportation service
1 km


Biomethane systeme
600 Nm³/h_85% energy crop rotation + 15% manure
Cultivation
Corn
Sunflower
Triticale
Green rye
Transport
Biogas production
Upgrading
Biomethane
Compression
Transport
Filling station
Passenger car
Reference system with natural gas passenger car
Extraction
Processing
Transpor
Filling station
Passenger car
Transportation service
1 km


Biomethane systeme
600 Nm³/h_85% energy crop rotation + 15% manure
Cultivation
Corn
Sunflower
Triticale
Green rye
Transport
Biogas production
Upgrading
Biomethane
Compression
Transport
Filling station
Passenger car
Area
Reference system with natural gas passenger car
Cultivation
Winter barley
Corn
Pea
Winter wheat
Extraction
Processing
Transpor
Filling station
Passenger car
Transportation service
1 km


Biomethane systeme
600 Nm³/h_85% energy crop rotation + 15% manure
Reference system with natural gas passenger car
Cultivation
Corn
Sunflower
Triticale
Green rye
Area
Cultivation
Winter barley
Corn
Pea
Winter wheat
Extraction
Processing
Transport
Biogas production
Upgrading
Transpor
Biomethane
Import
Winter wheat +
Winter corn +
Pear from
Hungary
Compression
Transport
Filling station
Filling station
Food/Feed
Passenger car
Passenger car
Transportation service
1 km

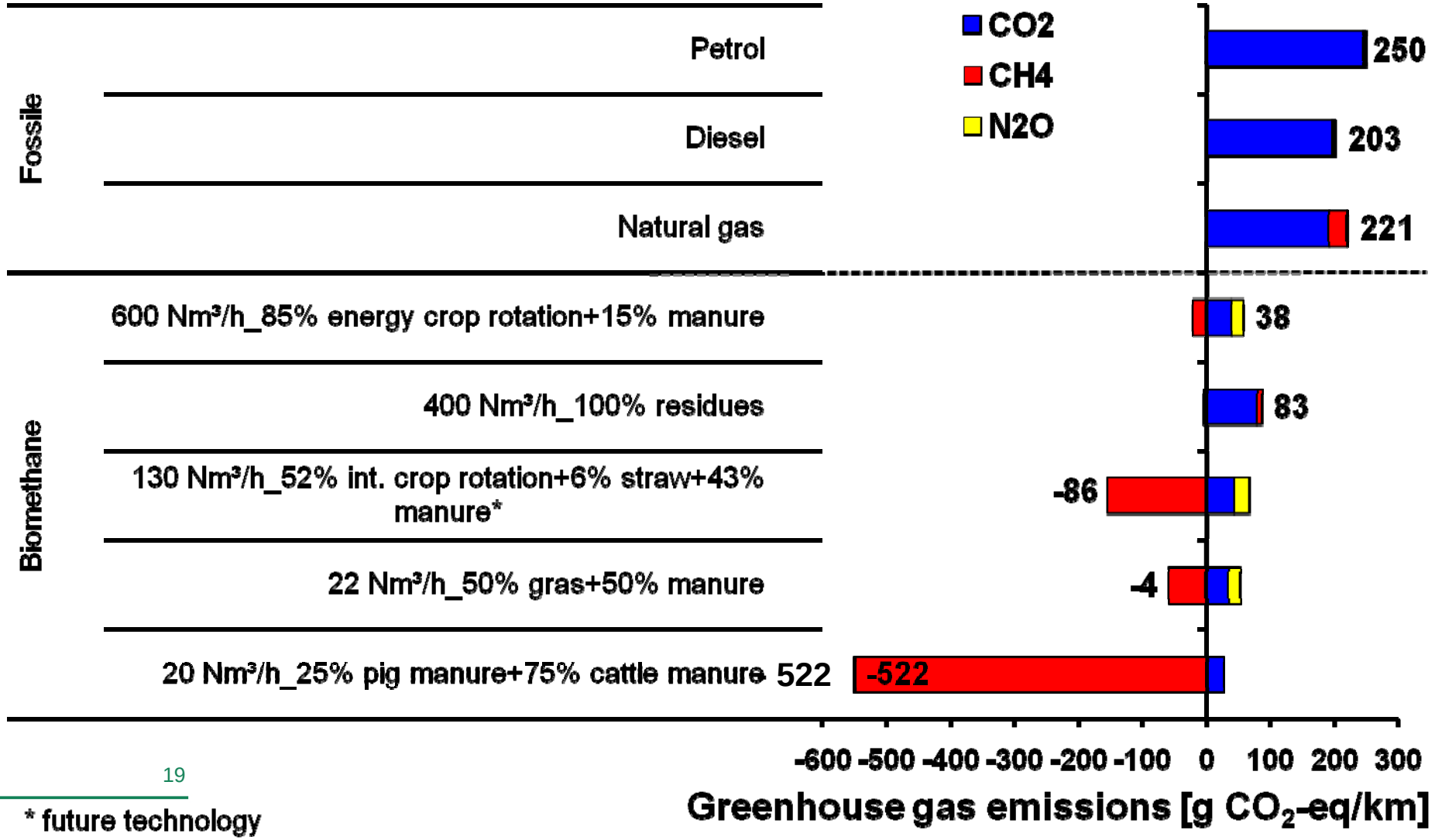

Biomethane systeme
600 Nm³/h_85% energy crop rotation + 15% manure
Reference system with natural gas passenger car
Cultivation
Corn
Sunflower
Triticale
Green rye
Area
Cultivation
Winter barley
Corn
Pea
Winter wheat
Extraction
Collection
Pig manure
Manure
Storage +
Application
Processing
Transport
Biogas production
Upgrading
Transpor
Biomethane
Import
Winter wheat +
Winter corn +
Pear from
Hungary
Compression
Transport
Filling station
Filling station
Food/Feed
Passenger car
Passenger car
Transportation service
1 km


Biomethane systeme
600 Nm³/h_85% energy crop rotation + 15% manure
Reference system with natural gas passenger car
Cultivation
Corn
Sunflower
Triticale
Green rye
Area
Cultivation
Winter barley
Corn
Pea
Winter wheat
Extraction
Collection
Pig manure
Manure
Storage +
Application
Processing
Transport
Digestate
Biogas
production
Fertilizer
Transpor
Upgrading
Import
Winter wheat +
Winter corn +
Pear from
Hungary
Biomethane
Compression
Transport
Filling station
Food/Feed
Filling station
Passenger car
Passenger car
Transportation service
1 km

Content

- Background information
- Project „Biogas Gesamtbewertung“
- Modeling
- Results
- Conclusions

Greenhouse gas emissions
biomethane as transportation fuel



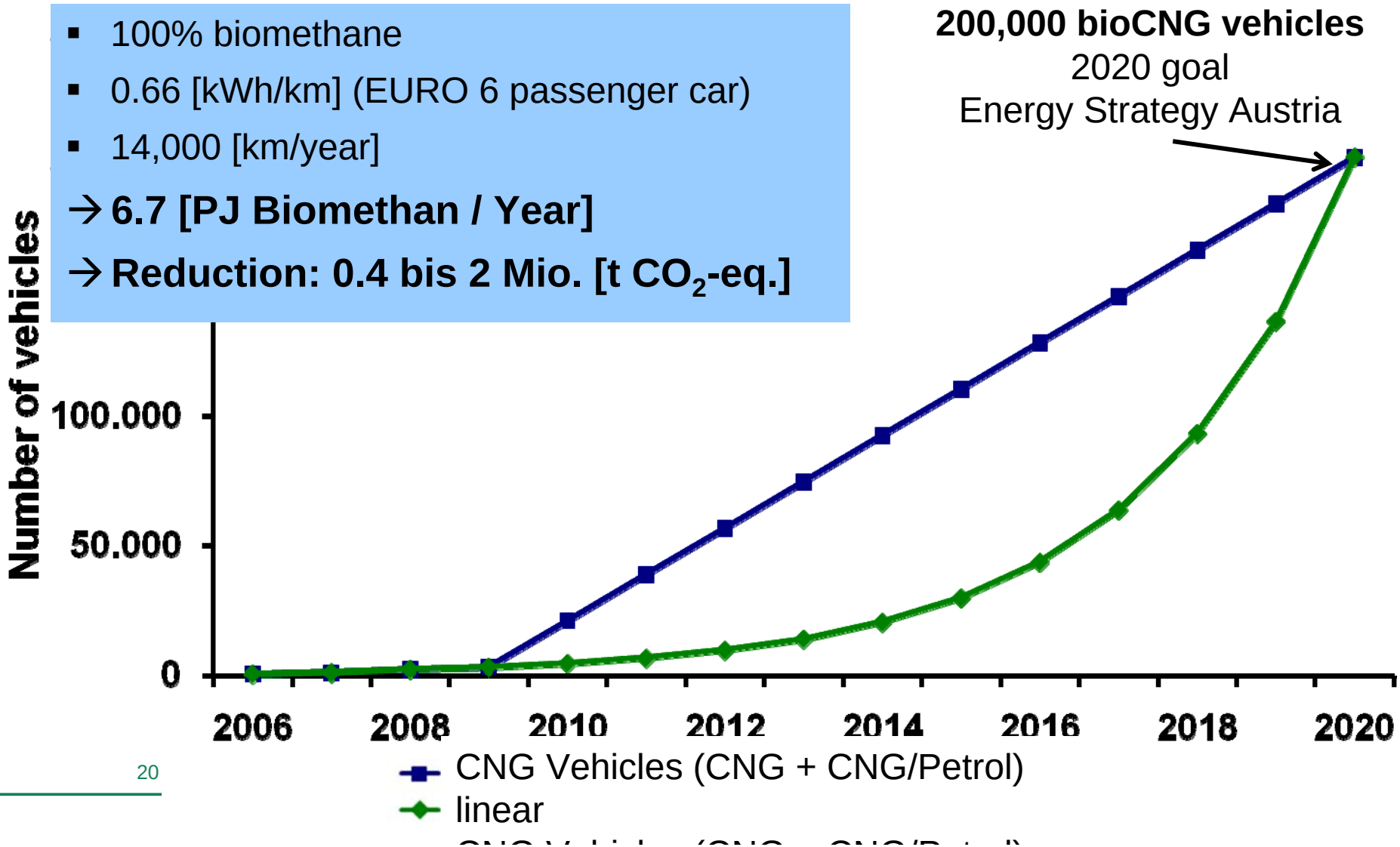
* future technology

GHG reduction potential with 200,000 bioCNG vehicles

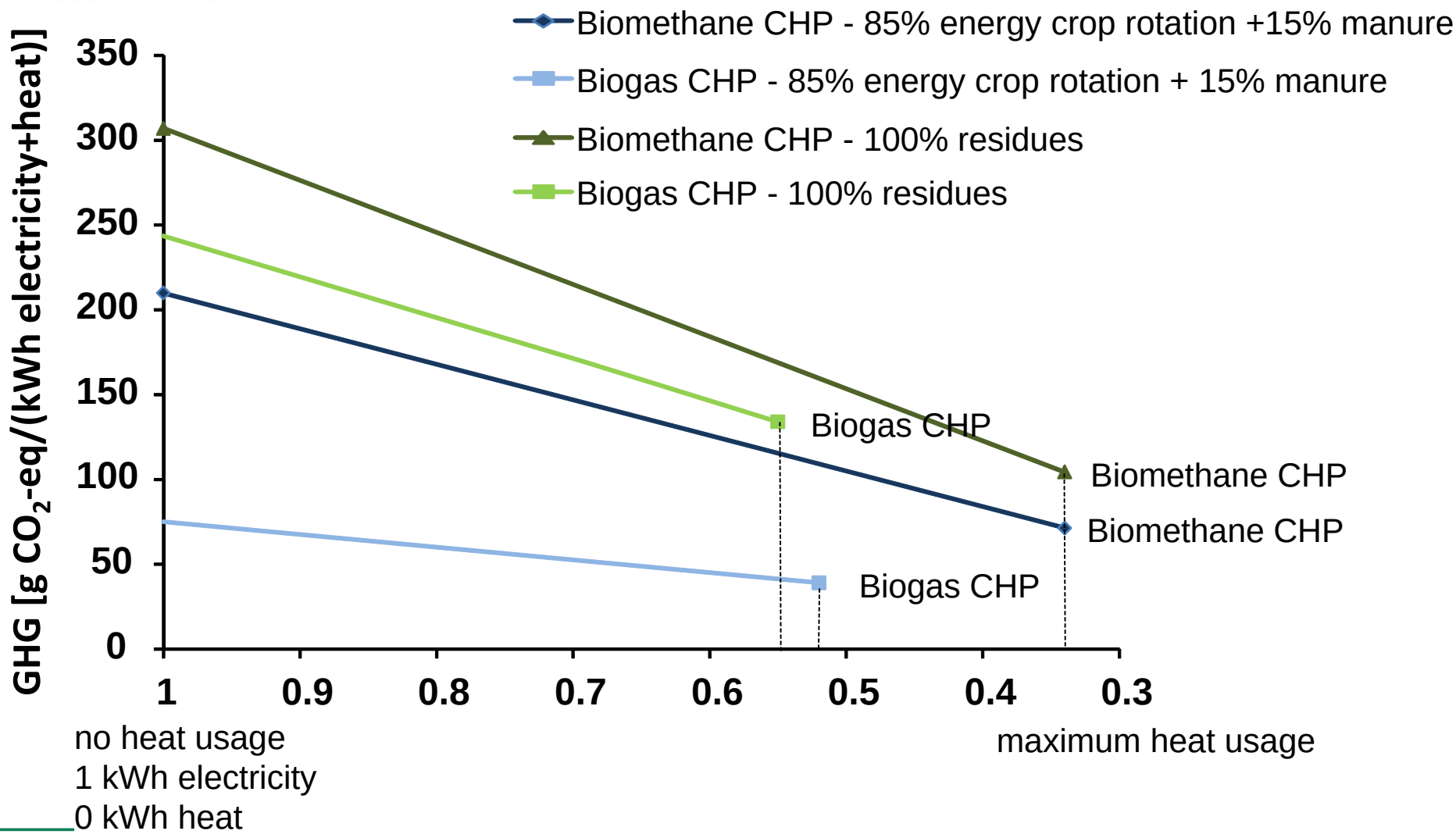
- 100% biomethane
- 0.66 [kWh/km] (EURO 6 passenger car)
- 14,000 [km/year]

→ **6.7 [PJ Biomethan / Year]**

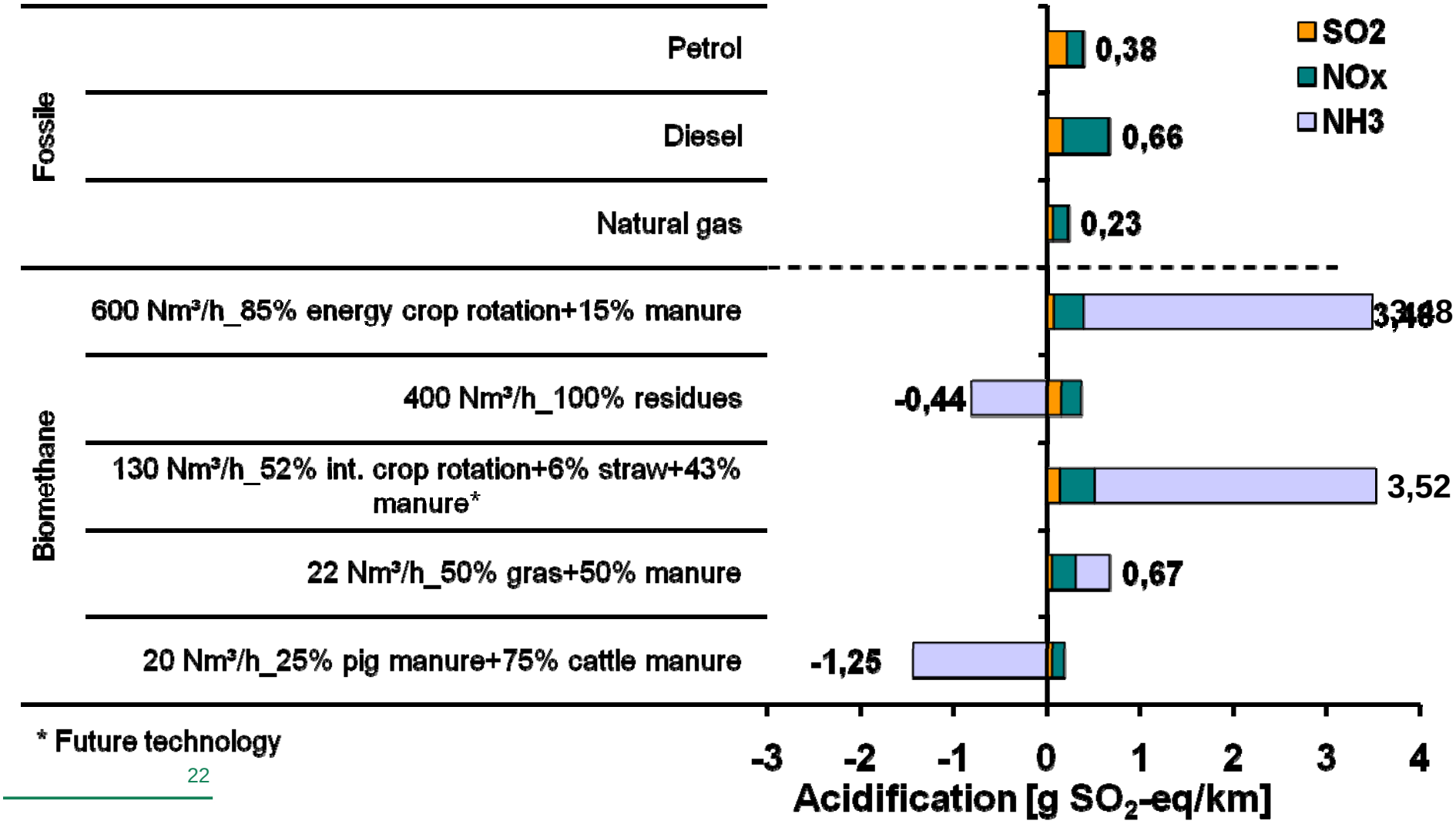
→ **Reduction: 0.4 bis 2 Mio. [t CO_2-eq.]**



Biogas CHP versus biomethane CHP

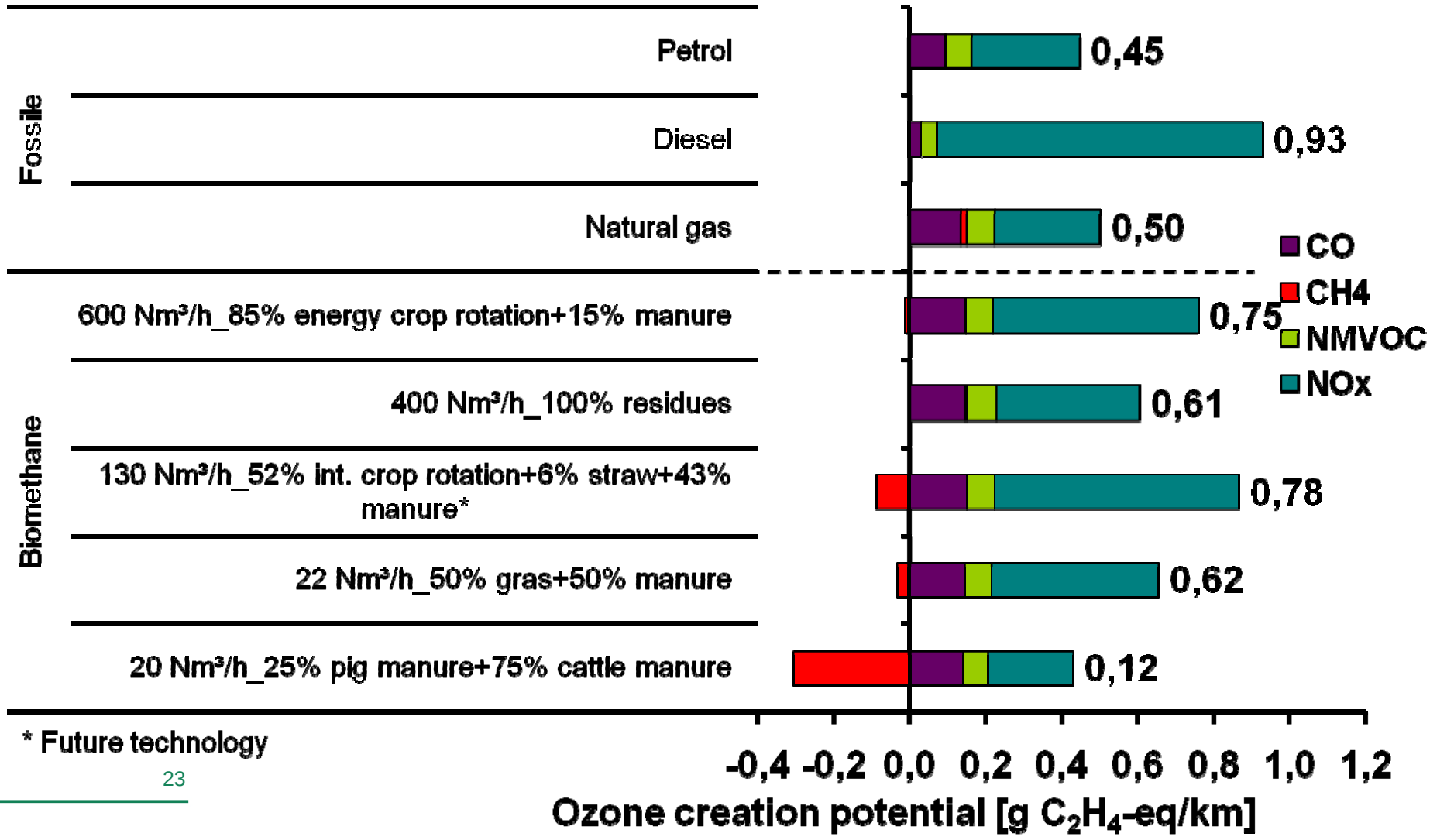


Acidification potential
biomethane as transportation fuel



* Future technology

Ozone creation potential
biomethane as transportation fuel



* Future technology

Content

- Background information
- Project „Biogas Gesamtbewertung“
- Modeling
- Results
- Conclusions

Conclusions

Comparison of biomethane to natural gas:

- Environmental effects are almost independent from type of energy service
- Greenhouse gas emissions
  - Reduction in all cases (-56% to -400%)
  - Higher reduction with liquid manure than with energy crops (-90% to -400%)
  - When residues are used reduction depends on reference use of residues with its products
  - Acidification potential
  - Increasing or decreasing – depending on the feedstock
  - Highest impact: NH_3 emissions from digestate and manure management

JOANNEUM RESEARCH

Conclusions

- Ozone creation potential
  - Increase or decrease possible (+ 280% to -145%)

- Particulate emissions
- Higher compared to fossil systems for most cases (+5% to +650%); one case shows a reduction
- Lower compared to renewable system if solid biomass is used for heat generation (-55% to -95%)

- Fossil primary energy demand
- Reduced in all cases (-60% to -100%)

JOANNEUM RESEARCH

Thank you for your attention!

Questions… ?

Johanna.pucker@joanneum.at