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Assessment of Lingo-cellulosic Bioethanol Concepts in Austria – Technical, Economic and Environmental Aspects

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Outline

1. Project Overview
2. Bioethanol Plant Concepts
3. Technical Data
4. Greenhouse Gas Assessment
5. Economic Analysis
6. Conclusions

Project Overview

- Title: Assessment of Lingo-cellulosic Bioethanol Concepts in Austria – Technical, Economic and Environmental Aspects
- JOANNEUM RESEARCH – RESOURCES, Research Group Energy Research
- Vienna University of Technology, Institute of Chemical Engineering, Thermal Process Engineering - Process Simulation
- Financed by Austrian Climate and Energy Fund
- Project time: 1.3.2009 - 30.4.2011

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Bioethanol Plant Concepts

Key concept characteristics

- Use of C6 + C5 sugar
- Pretreatment: Steam Explosion
- Enzymatic Hydrolysis
- On-site enzyme production
- Process heat and electricity demand produced from residues (e.g. Lignin)
- Plant size (t Bioethanol per year)
  - Softwood: 50,000 / 100,000 t/y
  - Straw: 50,000 / 100,000 t/y

Concepts

Feed Stock	Fermentation of sugars	By-products	
Straw	C6	Electricity	
Straw	C6+C5	Electricity	
Straw	C6	Electricity	Heat
Straw	C6	Ligninpellets	
Straw	C6+C5	Ligninpellets	
Straw	C6	Ligninpellets	Heat
Straw	C6	C5 Molasses	Ligninpellets
Straw	C6	C5 Molasses	Heat
Straw	C6	Biomethane	Electricity
Softwood	C6	Electricity	
Softwood	C6	Ligninpellets	
Softwood	C6	Biomethane	Electricity

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Technical Data

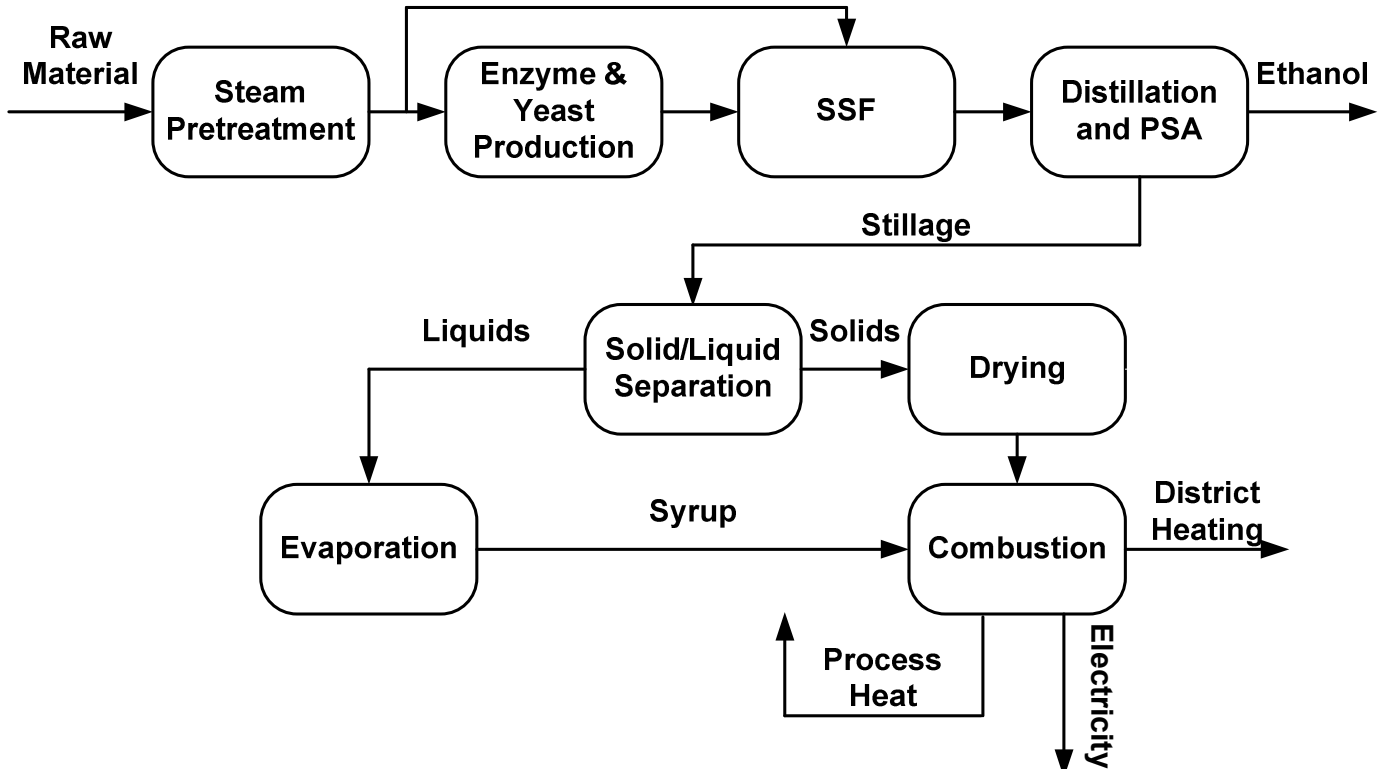
100,000 t/y Bioethanol Concepts Overview

Feedstock		Conversion	By-products					
Type	Total Mass	Sugars in Fermentation	Bioethanol	Heat	Electricity	C5 Molasses (dry)	Lignin-pellets (dry)	Bio-methane
	kt/a		kt/a	GWh/a	GWh/a	kt/a	kt/a	GWh/a
Straw	648	C6	100		379			
	447	C5+C6	100		160			
	648	C6	100	1.003	305			
	648	C6	100				246	
	447	C5+C6	100				117	
	648	C6	100	580			191	
	648	C6	100			202	56	
	648	C6	100	551		202		
	648	C6	100		78			822
Soft-wood	867	C6	100		176			
	867	C6	100				114	
	867	C6	100		114			219

100,000 t/y Bioethanol from straw; electricity and heat (EtOH-Straw-C6/Electricity+Heat)

Straw (90%DM)	648.063	[t/y]
SO2	5.832	[t/y]
NH3 (28w/w% in H2O)	12.970	[t/y]
Molasses (80% DM)	6.621	[t/y]
Corn Steep Liquor (50%DM)	19.874	[t/y]
Diammoniumphosphate	2.499	[t/y]

Straw (LHV, dry)	365,1	[MW]
Ethanol (LHV)	93,4	[MW]
Electricity	38,1	[MW]
District Heat	125,3	[MW]



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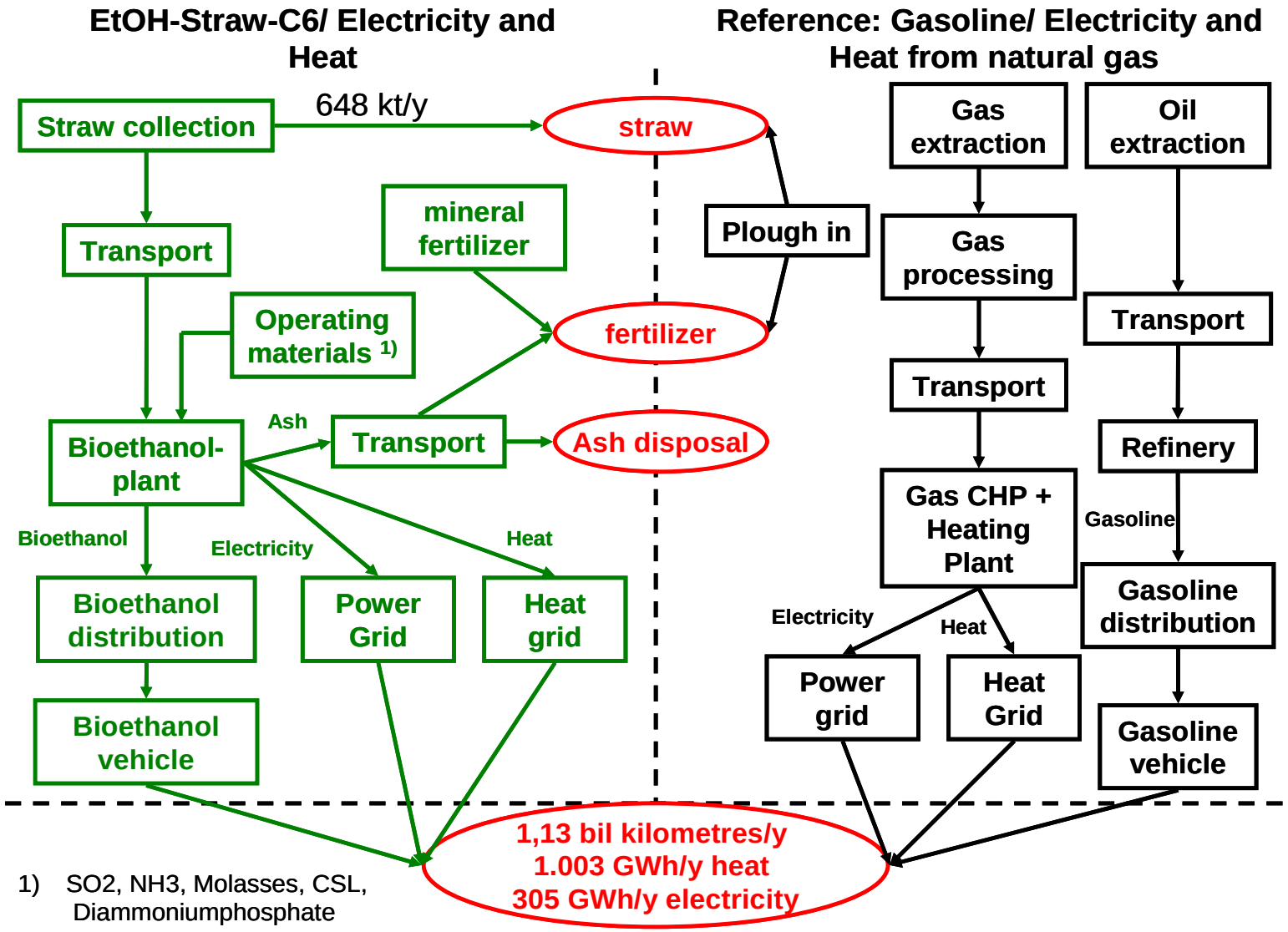
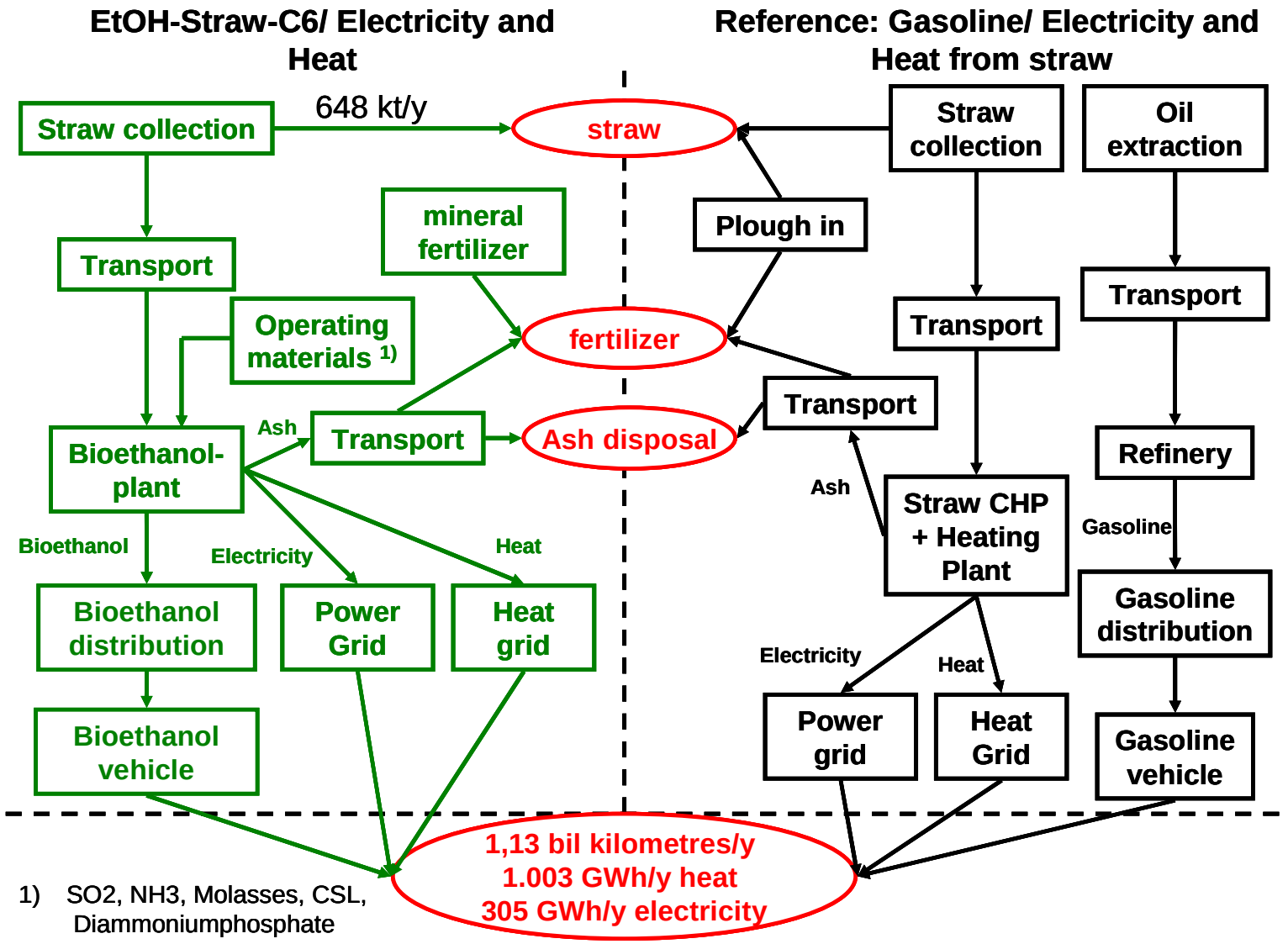
Greenhouse Gas (GHG) Assessment

GHG flow chart: reference fossil EtOH-Straw-C6/Electricity+Heat



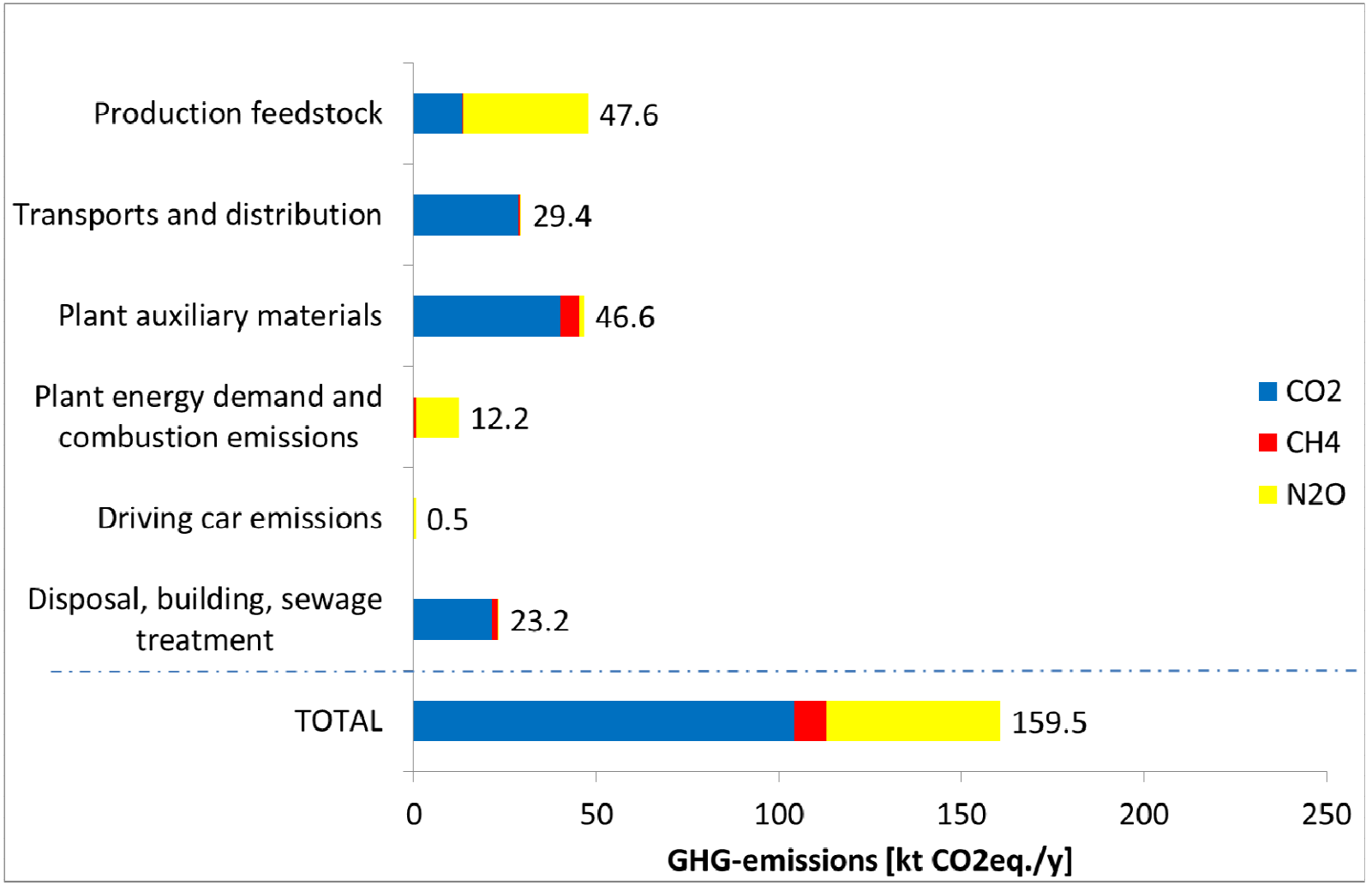
1) SO2, NH3, Molasses, CSL, Diammoniumphosphate

GHG flow chart: reference renewable EtOH-Straw-C6/Electricity+Heat

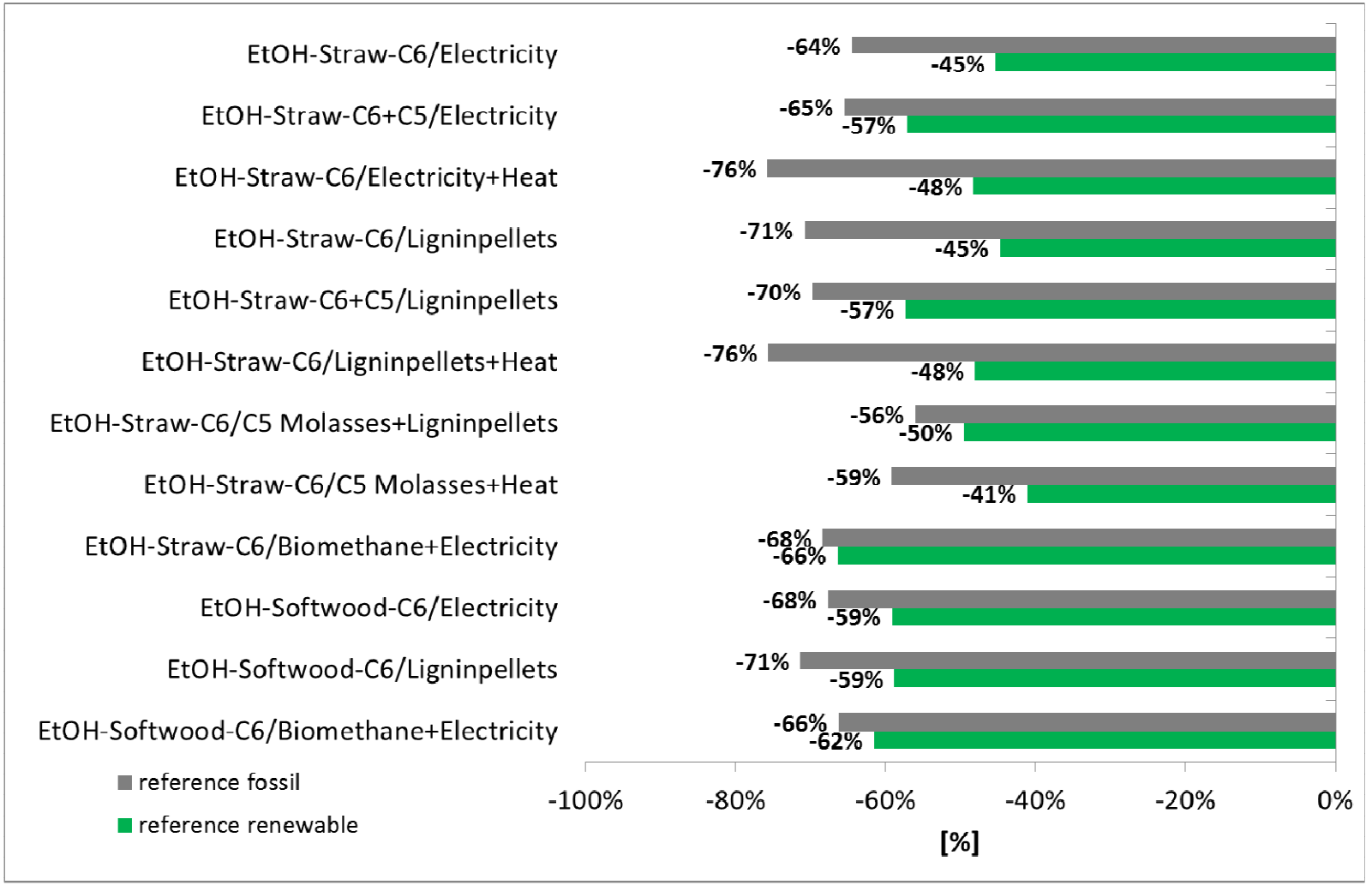


1) SO2, NH3, Molasses, CSL, Diammoniumphosphate

GHG Assessment 100,000 t/y EtOH-Straw-C6/Electricity+Heat



Greenhouse Gas Reduction Concepts overview



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Economic Analysis

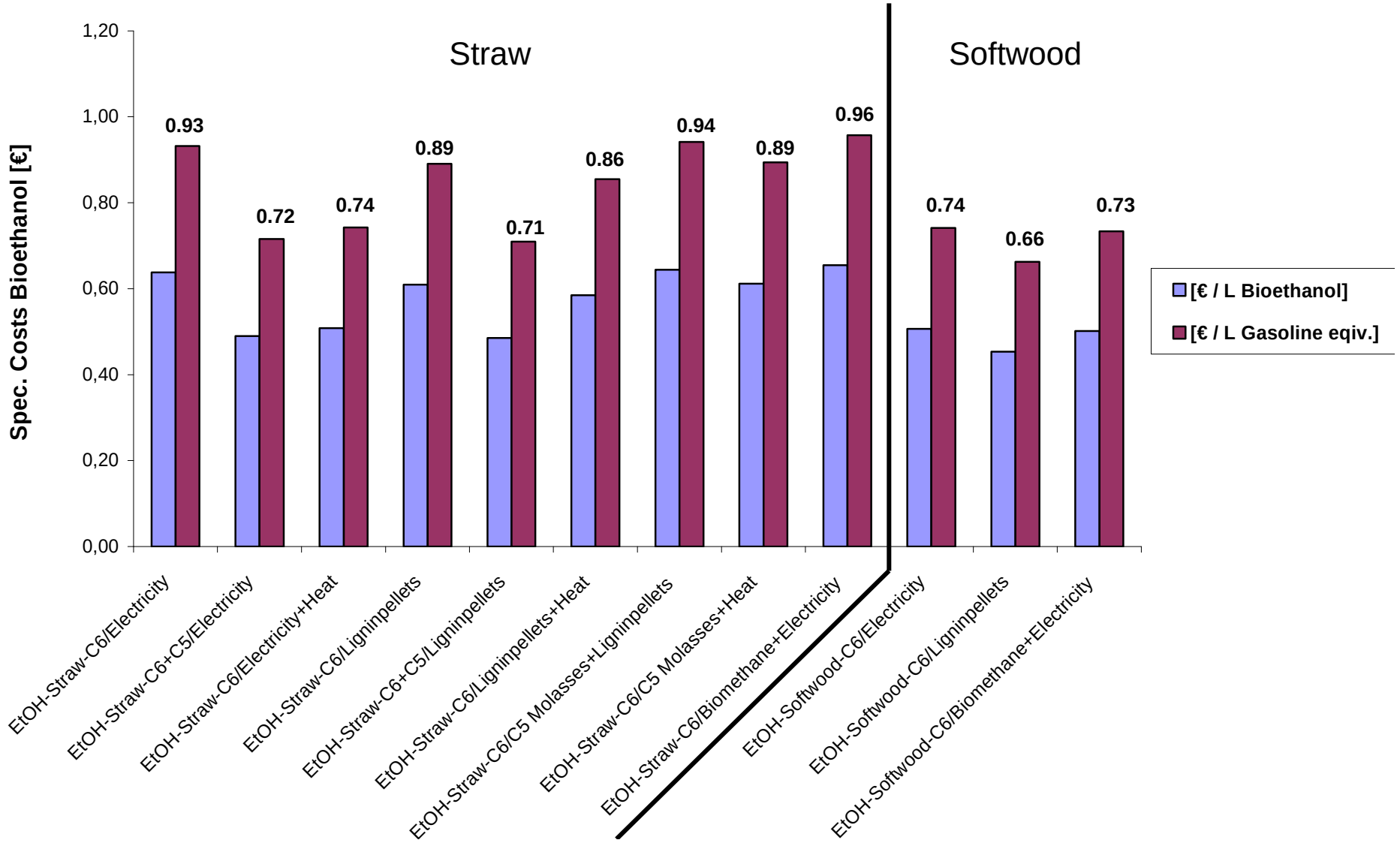
Economic Analysis Methodology

- Costs
  - Investment costs
  - Insurance, maintenance
  - Operating costs
    - Raw material (straw, woodchips)
    - Personal
    - Operating materials
    - Water demand
    - Waste water
- Revenues
  - Heat
  - Electricity
  - Ligninpellets
  - C5 molasses

Economic Analysis 100,000 t/y EtOH-Straw-C6/electricity+heat

Cost Analysis		
Capital costs	**[mil € / y]**	**26.3**
Fix operating costs	**[mil € / y]**	**11.5**
Variable operating costs	**[mil € / y]**	**61.5**
of it Personal	[mil € / y]	1.8
of it Raw material	[mil € / y]	51.9
of it Operating material	[mil € / y]	6.6
Total costs	**[mil € / y]**	**99.3**
Spec. total costs	*[€ / GJ $_{Bioethanol}$]*	*36.9*
Revenues		
Electricity	**[mil € / y]**	**15.2**
Heat	**[mil € / y]**	**20.1**
Total revenues	**[mil € / y]**	**35.3**
Spec. total revenues	*[€ / GJ $_{Bioethanol}$]*	*13.1*
Total costs Bioethanol	**[mil € / y]**	**64.0**
Spec.costs Bioethanol	*[€ / GJ $_{Bioethanol}$]*	*23.8*
Spec.costs Bioethanol	*[€ / L $_{gasoline\ equiv.}$]*	*0.74*

Economic Analysis Concepts overview



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Conclusions

Conclusions 1

- Straw and wood are interesting raw materials for lingnocellulosic bioethanol in Austria
- Lingnocellulosic bioethanol always in coproduction with by-products from lignin, e.g. power, heat,
- Type and amount of by-products influences technical, economic and environmental performance
- Commercial technology not available, technology under development, e.g. pilot plant for wood in Sweden, demo plant for straw in Denmark
- Priority to integration of lingnocellulosic bioethanol plant in existing infrastructure, e.g. from wood in P&P-industry, from straw in EtOH from wheat plant

Conclusions 2

- GHG-reduction between 41% and 76% possible
- Costs of lingnocellulosic bioethanol possible between 0,6 - 1 €/L gasoline equivalent
- Lingnocellulosic bioethanol in comparison to FT-fuels: similar range of costs and environmental effects
- Further R&D necessary, e.g. in Austrian demo plant

Thank you for your attention!

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