Implementing Strategies of Biorefineries in the BioEconomy

The Approach of Life Cycle Sustainability Assessment of Biorefineries

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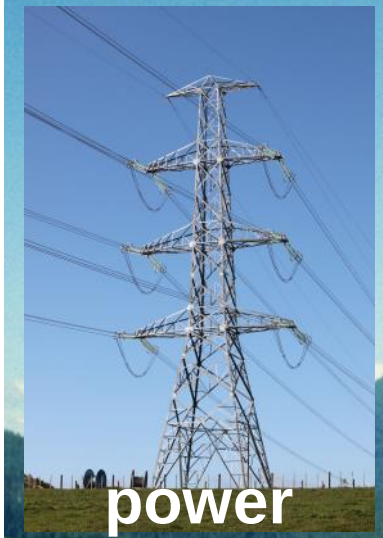
European Biomass Conference
Amsterdam, June 6 – 9, 2016

Most Sustainable Use of Wood?



power

chemicals

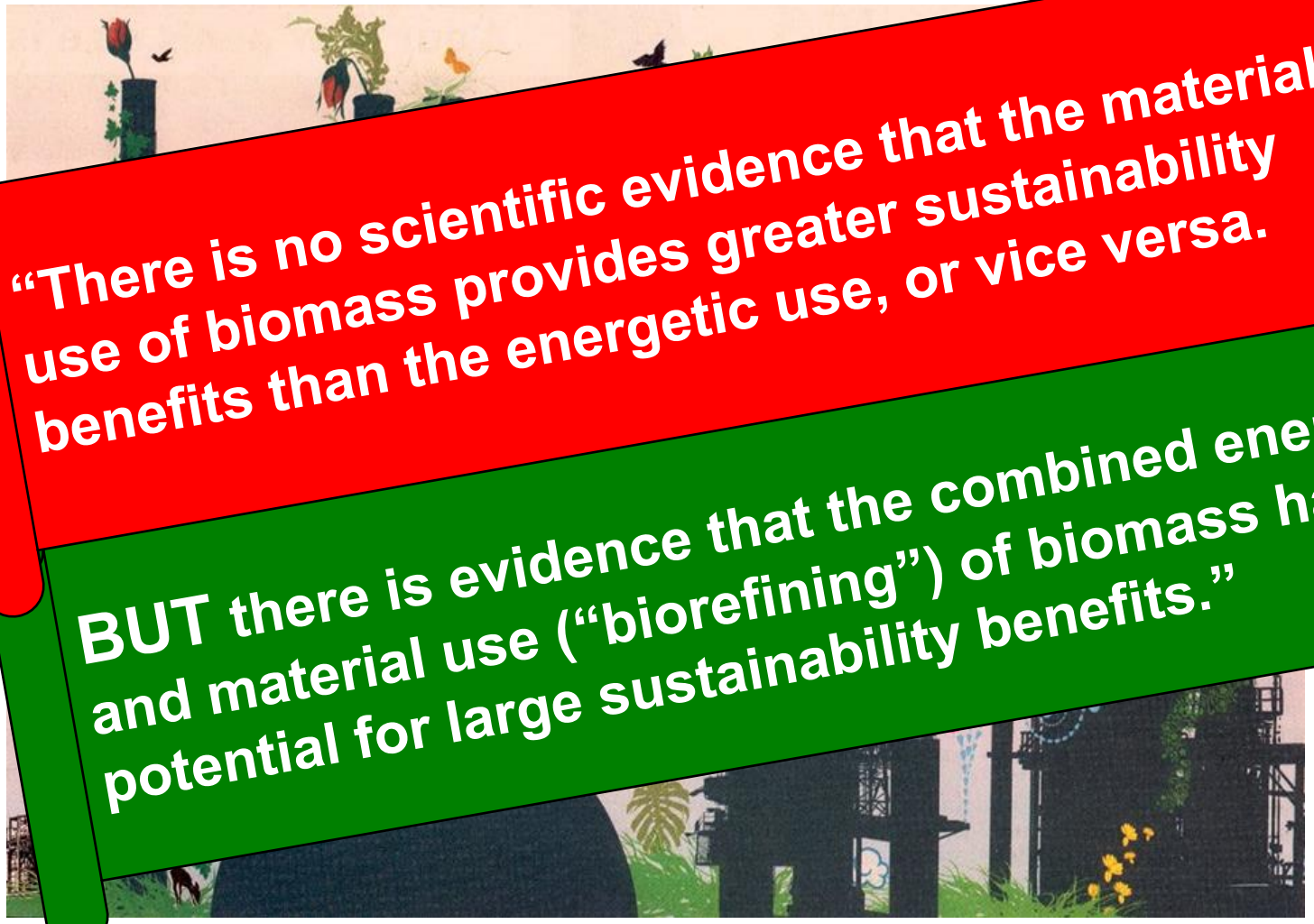
Most sustainable option?

heat

paper

products

A Statement



"There is no scientific evidence that the material use of biomass provides greater sustainability benefits than the energetic use, or vice versa.

BUT there is evidence that the combined energetic and material use ("biorefining") of biomass has the potential for large sustainability benefits."

IEA Bioenergy

Task42 Biorefining

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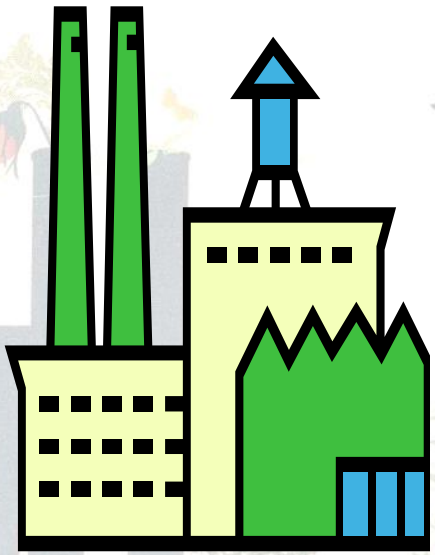
This is a Biorefinery

Biomass Resources

- *oil*
- *starch*
- *sugar*
- *lignocellulose*
- *....*



Biorefinery

Bioenergy

- ***liquid/gaseous transport biofuels***
- ***electricity***
- ***heat***
- ***solid fuels***

Bioproducts

- ***bulk chemicals***
- ***fine chemicals***
- *animal feed*
- *food*
- ***pulp&paper***
- ***materials***
- ***fertilizer***
- ***gases***
- ***.....***

Based on different conversion processes

- ***Bio-chemical***
- ***Thermo-chemical***
- ***Physical-chemical***
- ***Others***

"Biorefinery is the sustainable processing of biomass into a spectrum of marketable products"

Sustainability in the Life Cycle based on Whole Value Chain

The Methods of Sustainability Assessment

Life Cycle Sustainability Assessment (LCSA)

- **Environment**

LCA – Life Cycle Assessment

- **Economy**

LCC – Life Cycle Costing

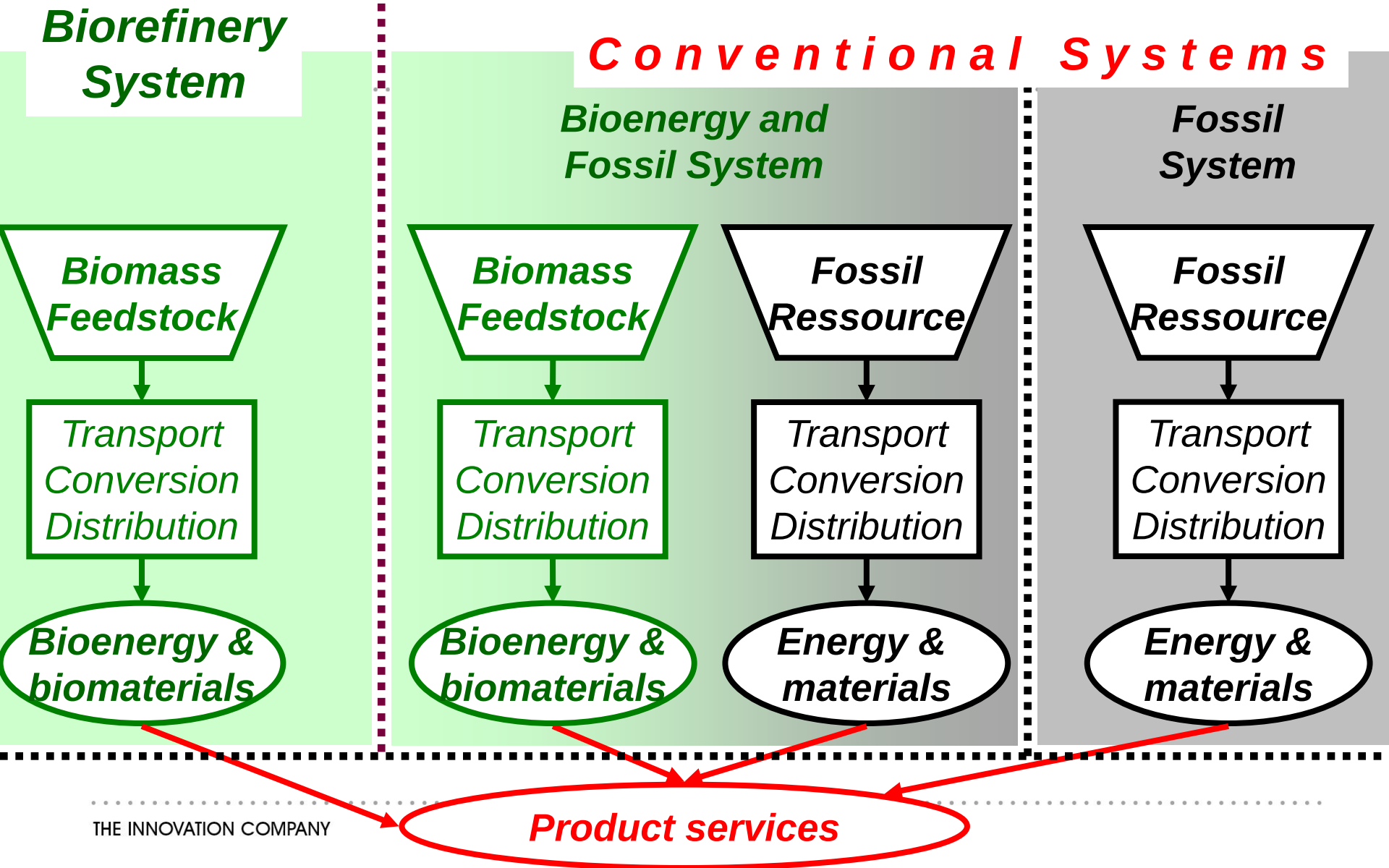
- **Society**

sLCA – Social Life Cycle Assessment

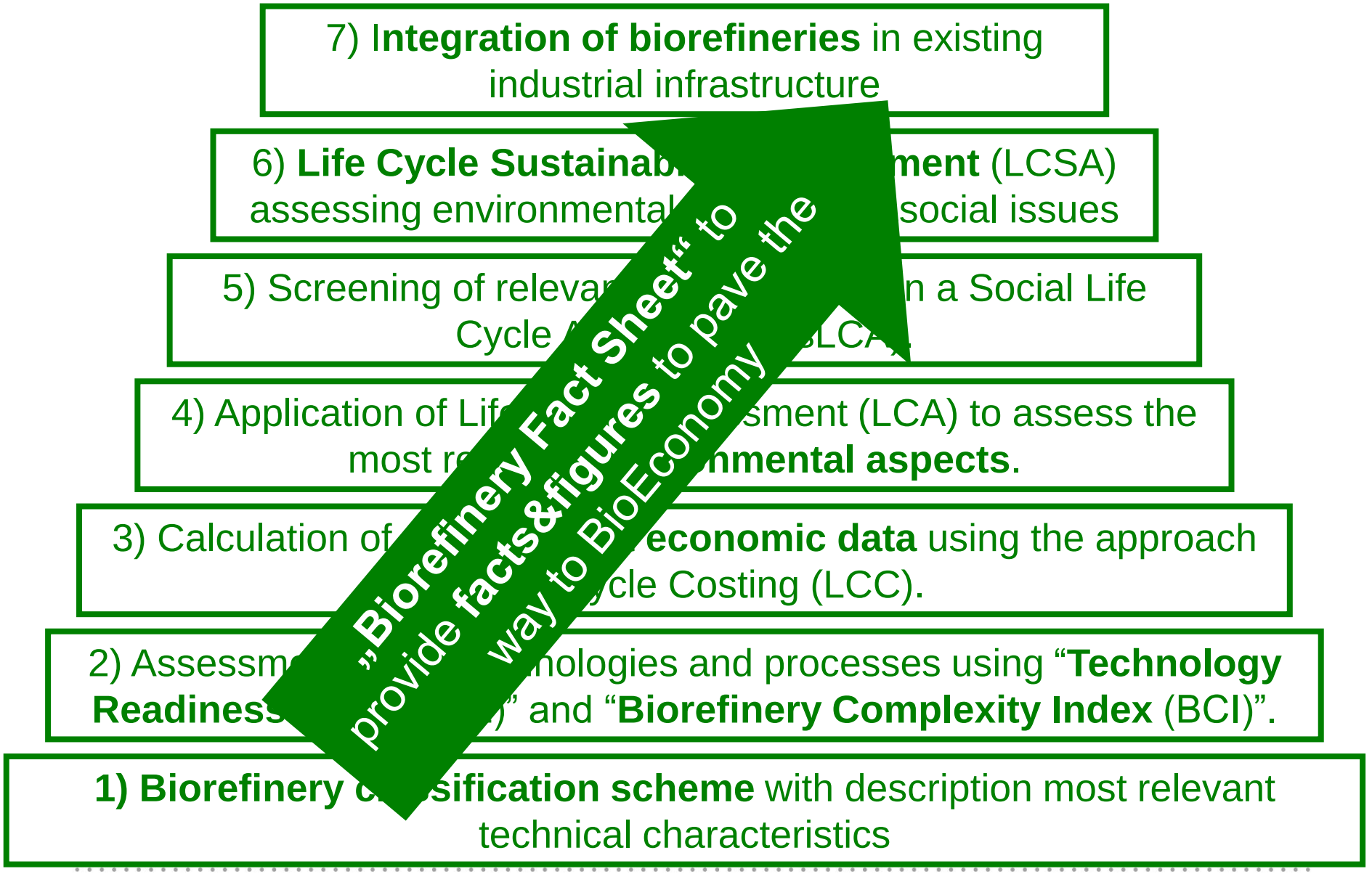
SIA – Social Impact Assessment

Environmental, economic and social assessment of sustainability based on scientific indicators

What are the „Conventional Systems“ for Comparison?



Common Assessment Framework for Biorefineries



Initial Selection of Sustainability Indicators in LCSA

Environment

- ✓ **GHG** emissions (t CO_2-eq/a)
- ✓ **Primary energy** demand (GJ/a) (biomass, renewable, fossil, others)
- ✓ **Area** demand (ha/a)

Economy

- ✓ Production **costs** (€/a)
- ✓ **Revenues** from products (€/a)
- ✓ **Value** added (€/a)
- ✓ **Employment** (persons/a)
- ✓ **Trade** balance (€/a)

Society

- ✓ Workers
- ✓ Consumers
- ✓ **Local community**
- ✓ Society
- ✓ **Value chain actors** (excl. consumers)

Biorefineries for the Biobased Industry

IEA Bioenergy Task42 Biorefining

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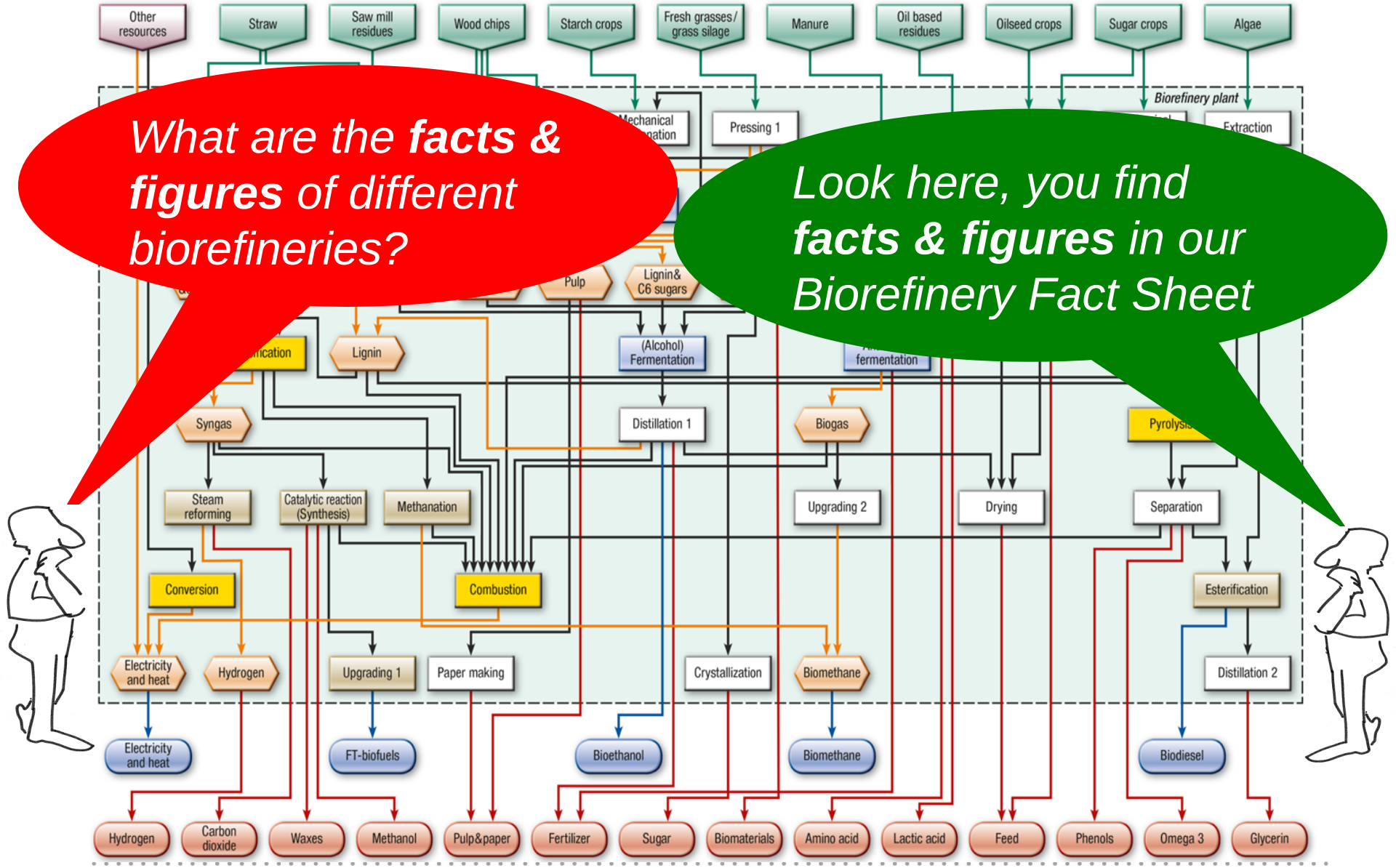
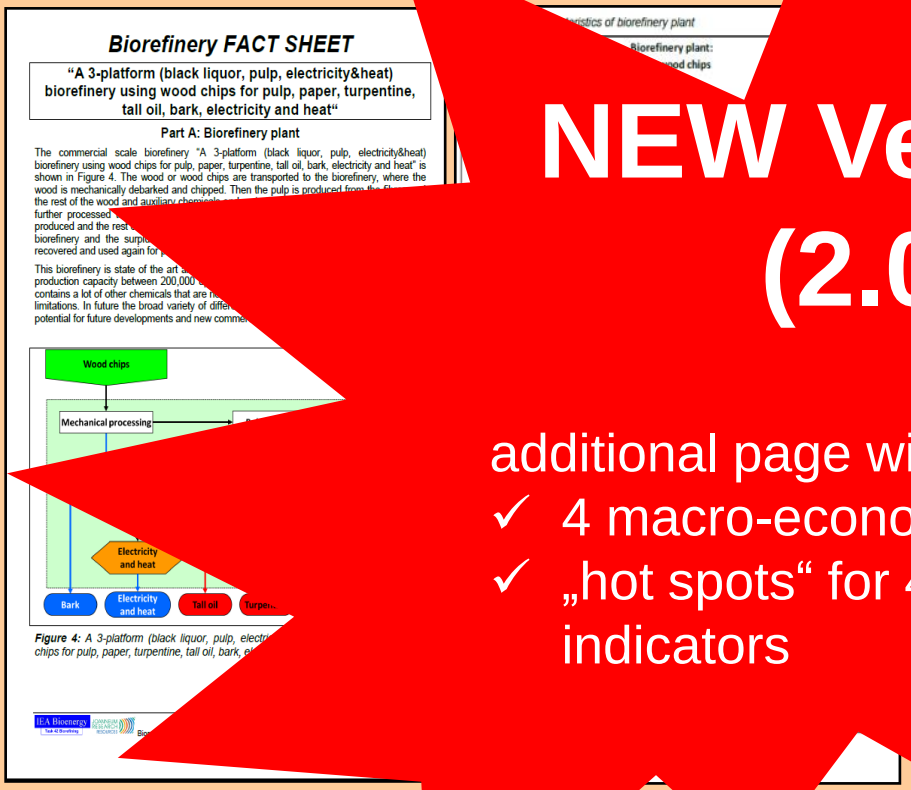
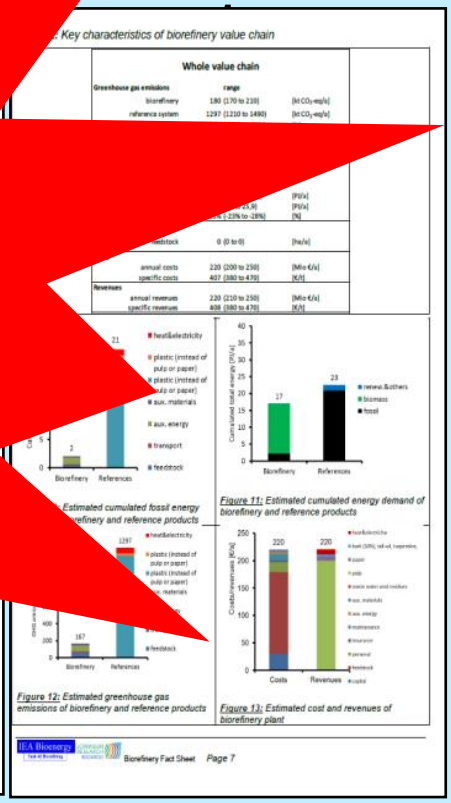


Overview - Biorefinery Fact Sheet (1.0)

Part A: Biorefinery Plant

B: Value Chain





NEW Version (2.0)

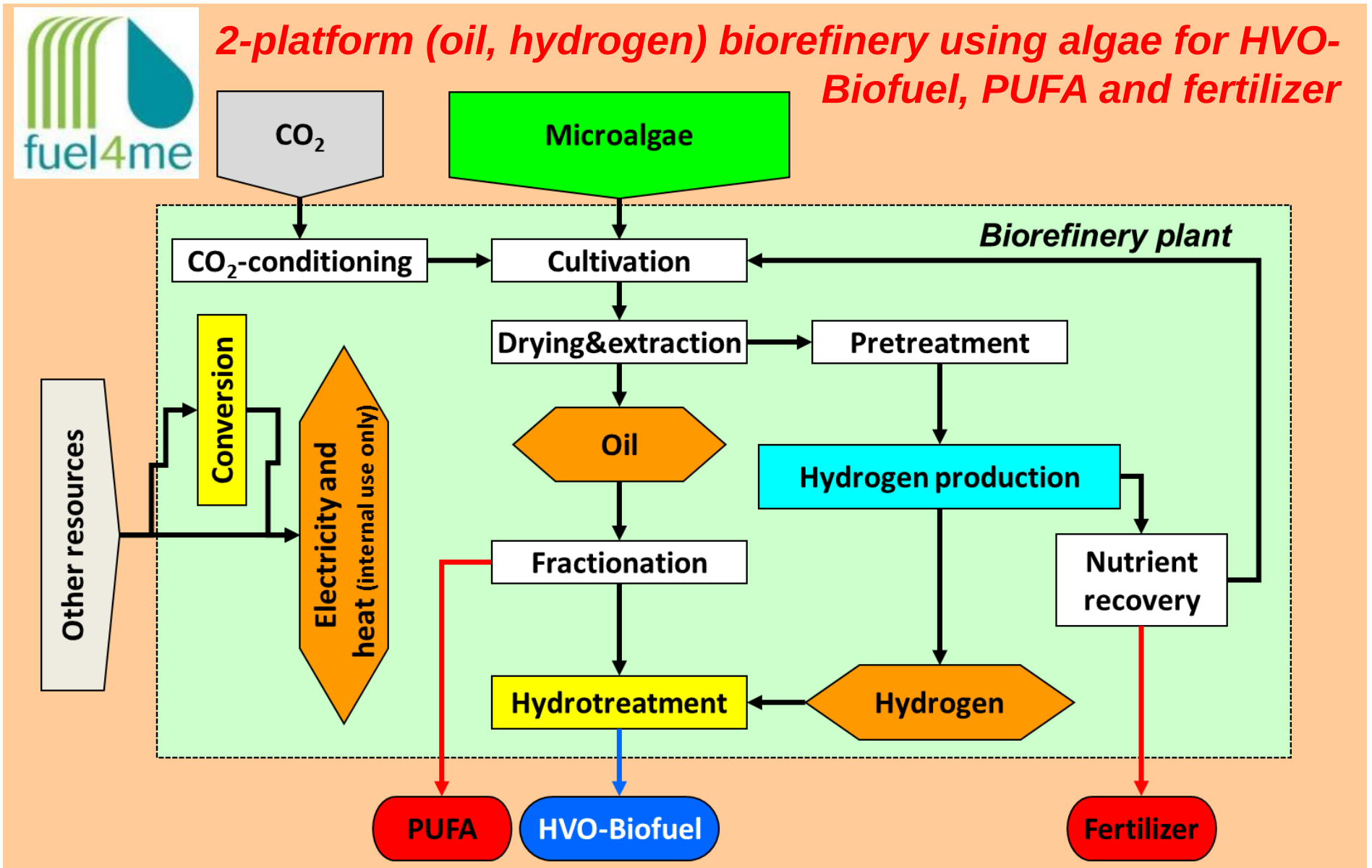
additional page with
- ✓ 4 macro-economic indicators
- ✓ „hot spots" for 4 social indicators

Annex:

Methodology of sustainability assessment and data with references

made by **„Biorefinery Fact Sheet Calculator"** of JOANNEUM RESEARCH

Part A: Biorefinery Plant - Classification Scheme

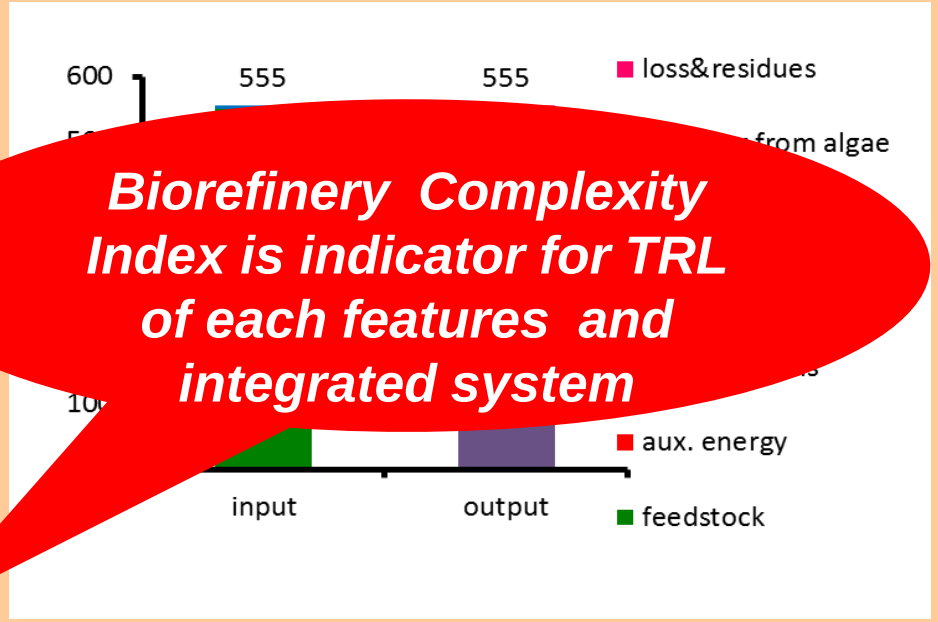


Part A: Biorefinery Plant - Mass &Energy Balance

fuel4me

2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer

Biorefinery Complexity Index is indicator for TRL of each features and integrated system



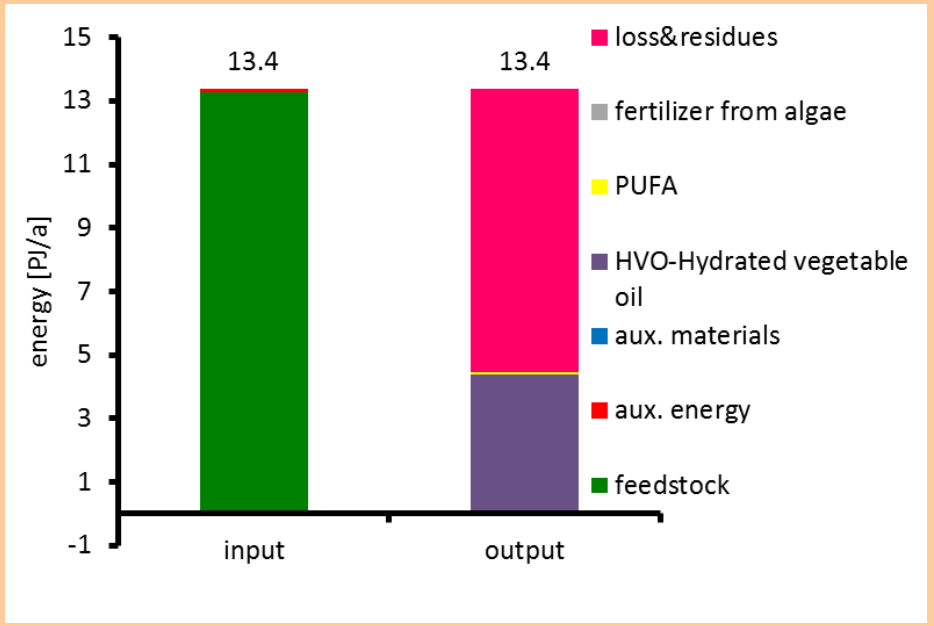
A 2-platform (oil, hydrogen) biorefinery using algae for HVO-biofuel, PUFA and fertilizer

State of technology:	conceptual	Biorefinery Complexity Index	35
Country:	EU 27	(Products/Platform/Feedstock/Processes)	(2/6/6/21)
Main data sources:	FUEL4ME, JOANNEUM RESEARCH		

Products		**Auxiliaries (external)**	
HVO-Hydrated vegetable oil	100 [kt/a]	electricity	0.04 [PJ/a]
PUFA	2 [kt/a]	heat	0.05 [PJ/a]
fertilizer from algae	50 [kt/a]		
		nutrient N	4.3 [kt/a]
		nutrient P	0.6 [kt/a]
		nutrient K	0.3 [kt/a]

Feedstock	**[kt/a]**	**water [%]**	**Costs**	
algae	550	0%	investment costs	1,000 [Mio €]
			feedstock costs	[€/t]
			number of employees	60 [#]

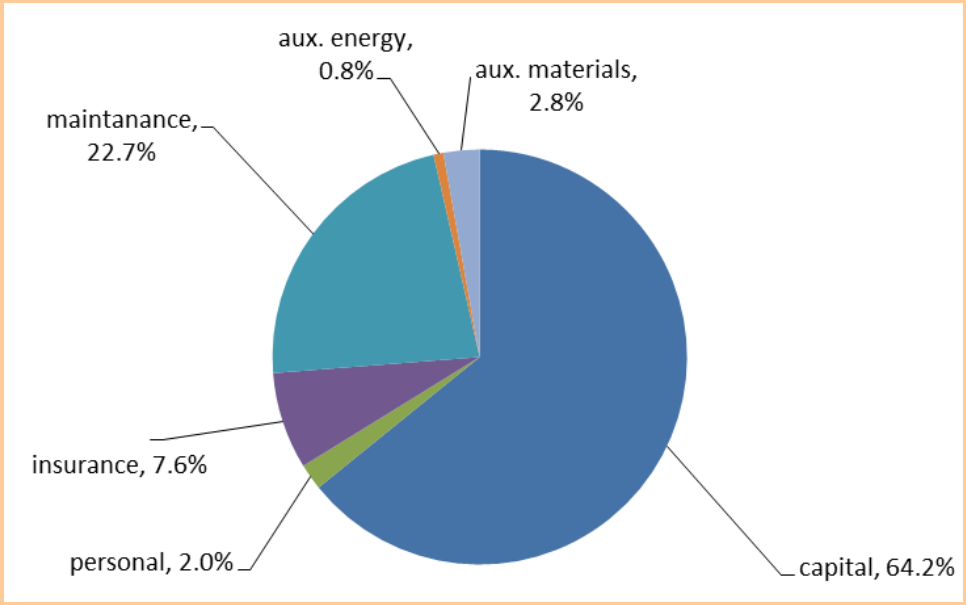
Efficiencies	**mass**	**energy**
input to products	27%	33%
input to transportation biofuel	18%	33%



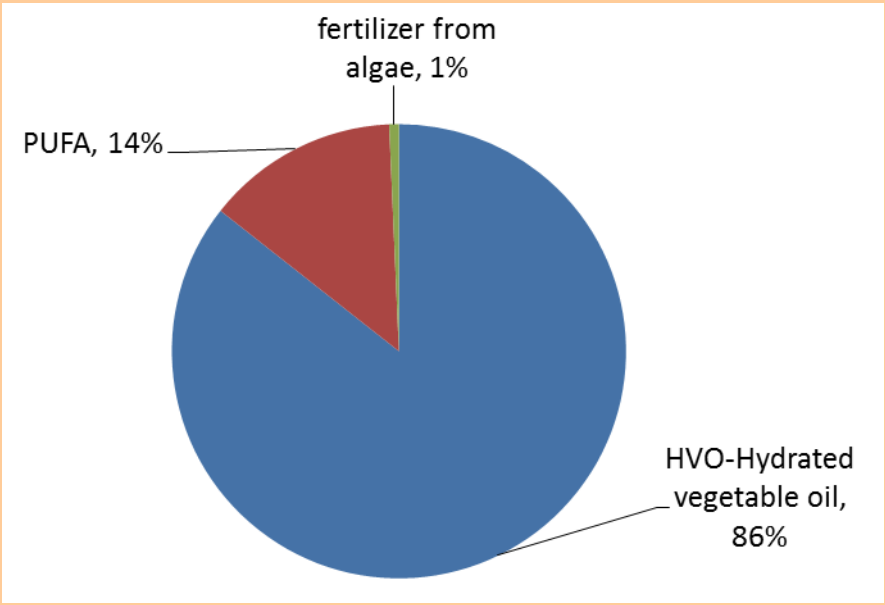
Part A: Biorefinery Plant - Share of Costs & Revenues

2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer

Costs



Revenues

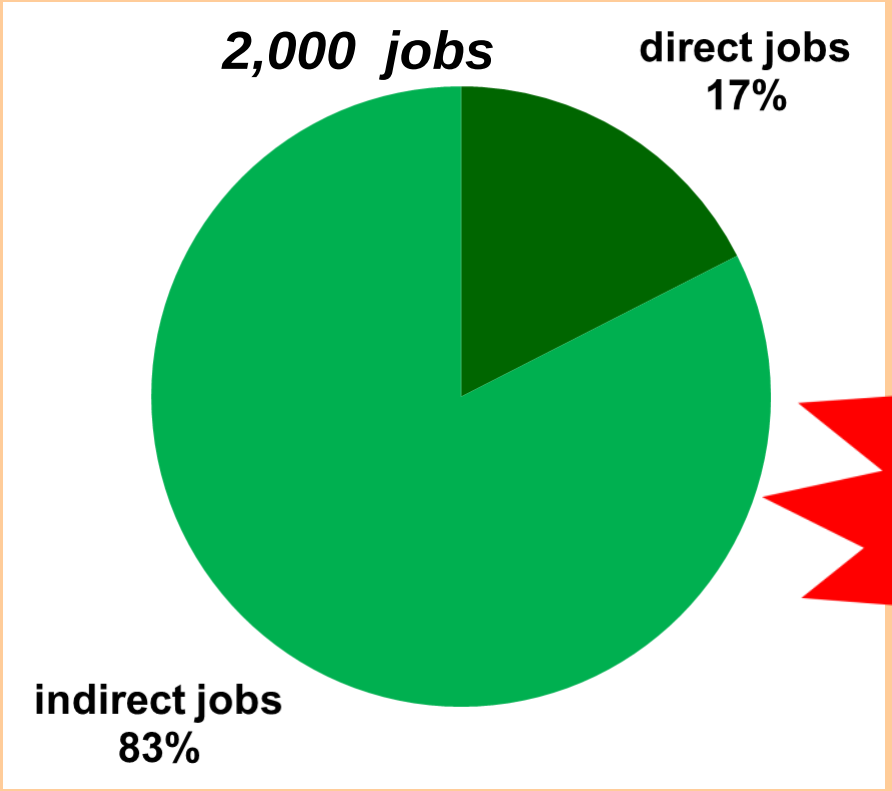


Framework:

Investment	1,000 Mio €		
Revenue:			
Algae yield	70 t/(ha*a)	PUFA	10,000 €/t
HVO:	100 kt/a	HVO	1,250 €/t

Part A: Biorefinery Plant – Job Creation (v2.0)

2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer



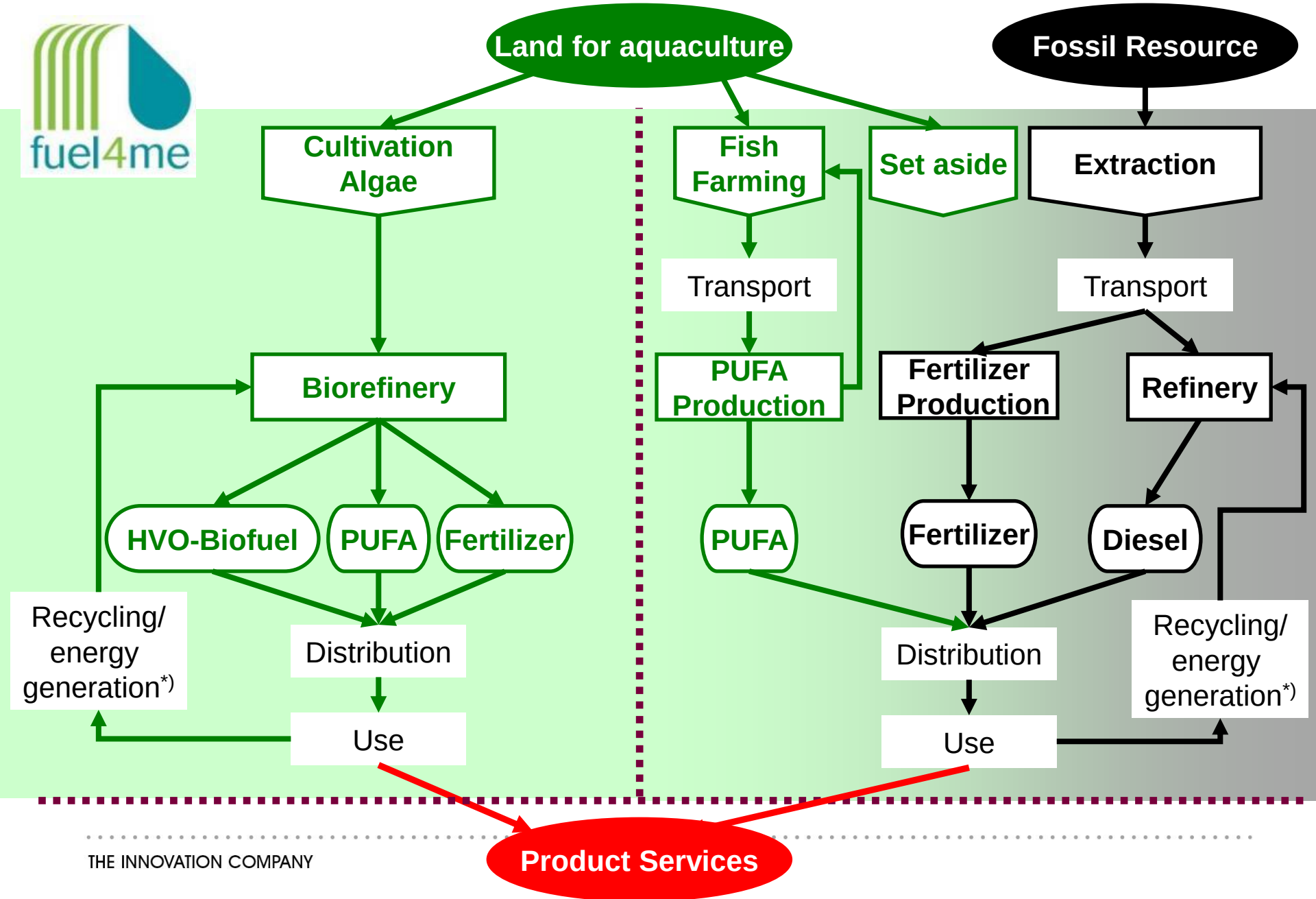
NEW Version (2.0)

additional page with
- ✓ 4 macro-economic indicators
- ✓ „hot spots" for 4 social indicators

Based on socio-economci input/output model

A 2-platform (oil, hydrogen) biorefinery using algae for HVO-biofuel, PUFA and fertilizer

Conventional Reference System



Part B: Value Chain Assessment - Overview

2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer

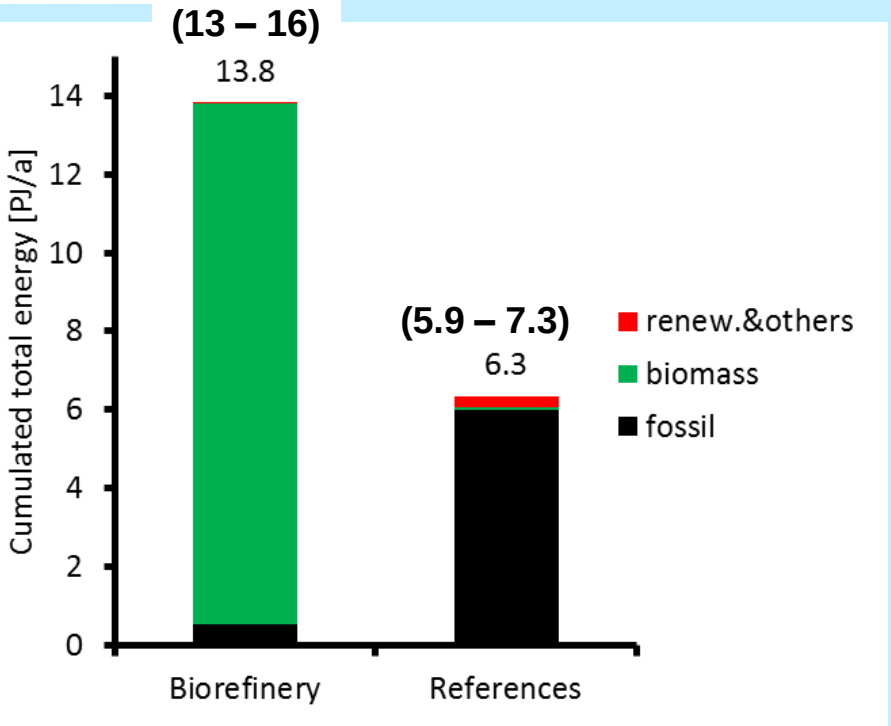
Whole value chain

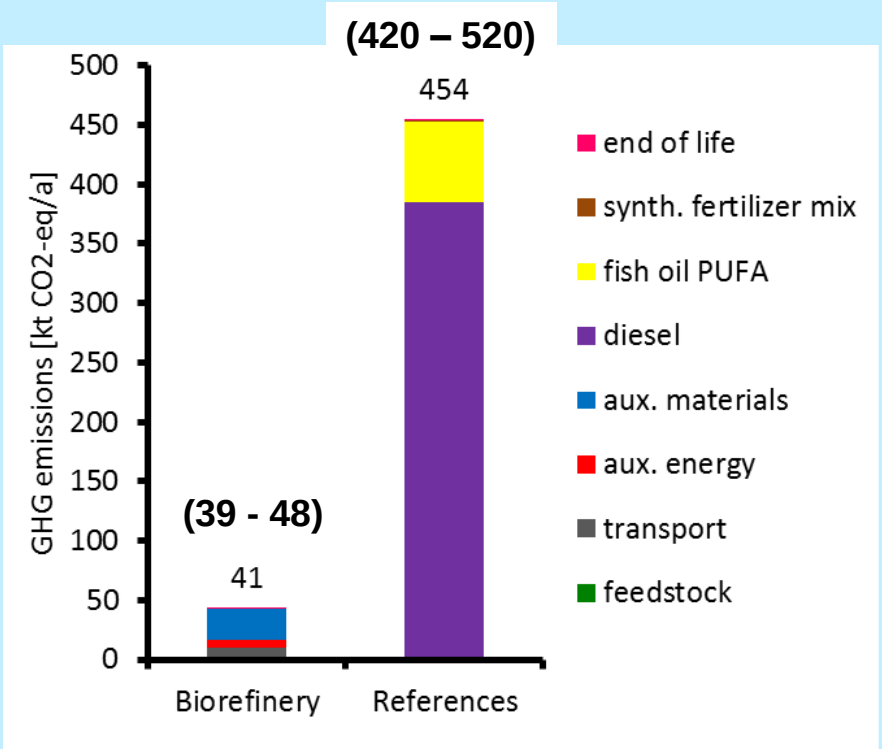
Greenhouse gas emissions		**range**	
biorefinery	41	(39 to 48)	[kt CO_2-eq/a]
reference system	454	(420 to 520)	[kt CO_2-eq/a]
saving	-91%	(-85% to -95%)	[%]
Cumulated energy demand			
fossil			
biorefinery	0.5	(0.47 to 0.59)	
reference system	6.0	(5.6 to 6.9)	
saving	-91%	(-85% to -9	
total			
biorefinery	13.8	(13	
reference system	6.3	(5.9	
change	119%	(110% t	
Area demand for aquaculture			
feedstock	7,900	(7300 to 9000)	[ha/a]
Costs			
annual costs	132	(120 to 150)	[Mio €/a]
specific costs	871	(810 to 1000)	[€/t]
Revenues			
annual revenues	146	(140 to 170)	[Mio €/a]
specific revenues	961	(890 to 1100)	[€/t]

Communication in typical ranges & orders of magnitude!

Part B: Value Chain Assessment – Energy & Emissions

2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer





GHG reduction: **85 – 95%**

Primary energy

total increase: **110 – 136%**

Fossil reduction: **85 – 95%**

Part B: Value Chain Assessment - Cost & Revenues

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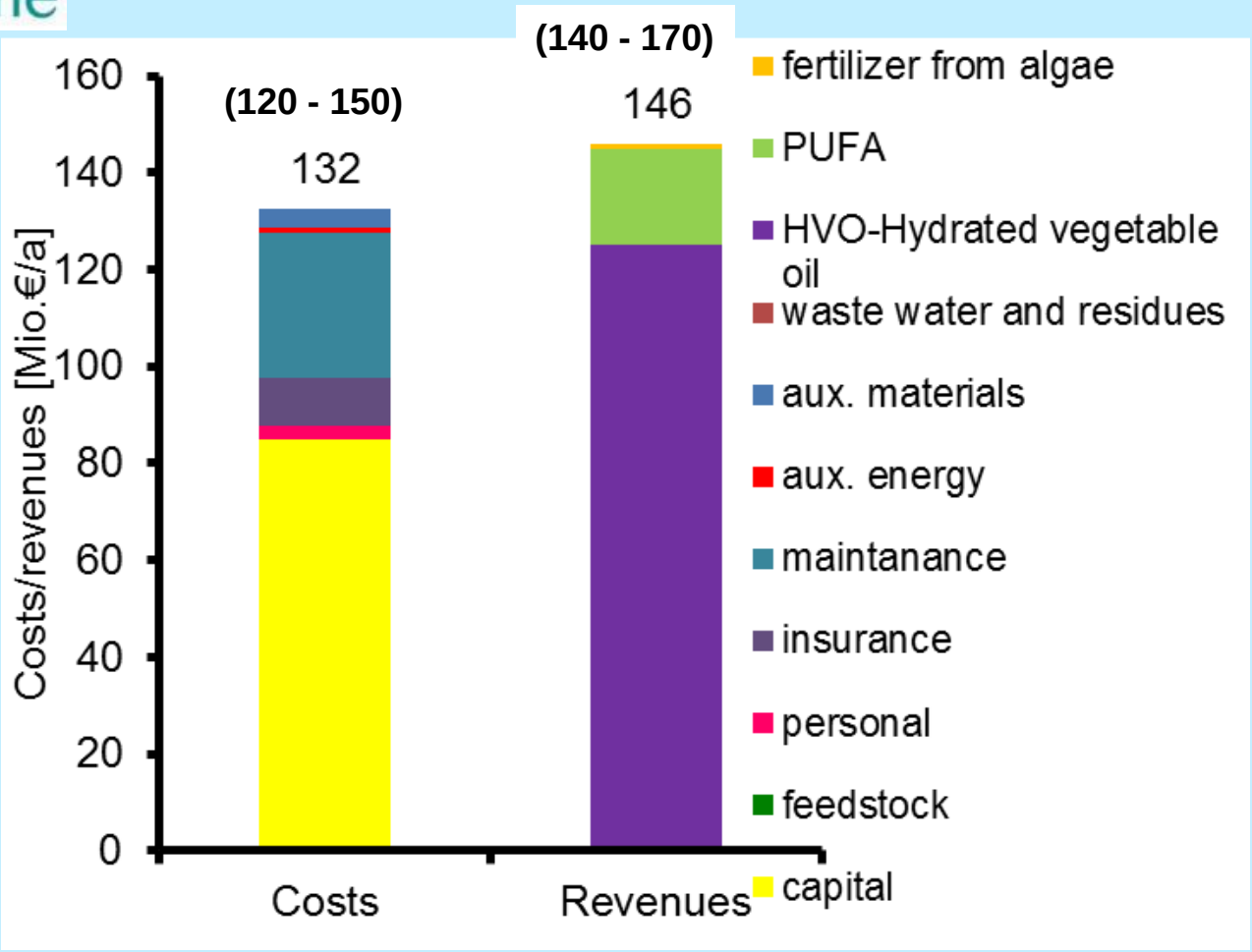
2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer



Part B: Value Chain Assessment – Macro-economic Indicators (2.0)

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2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer

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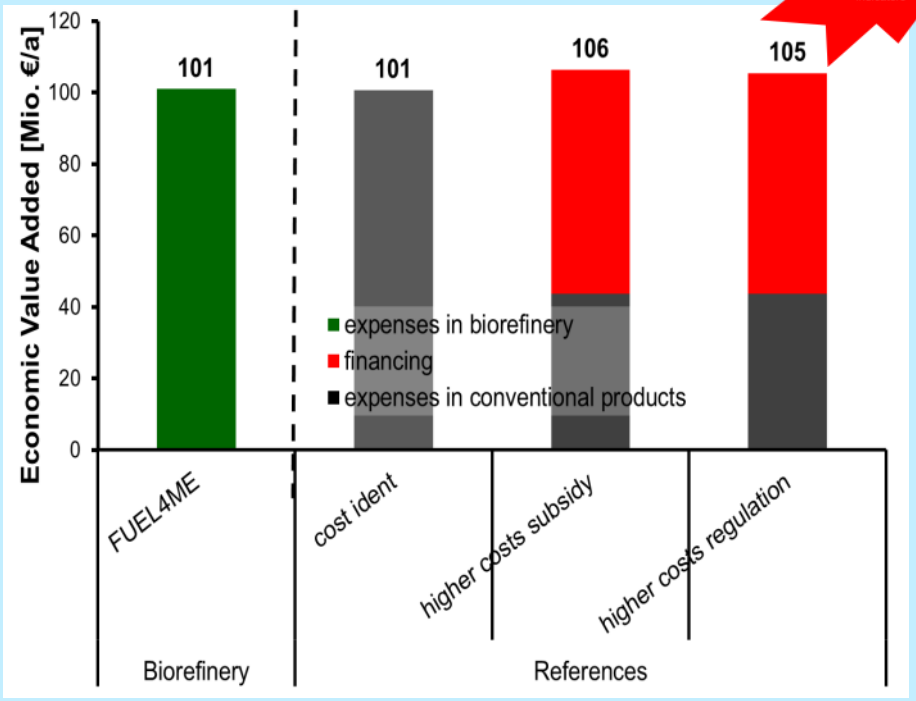
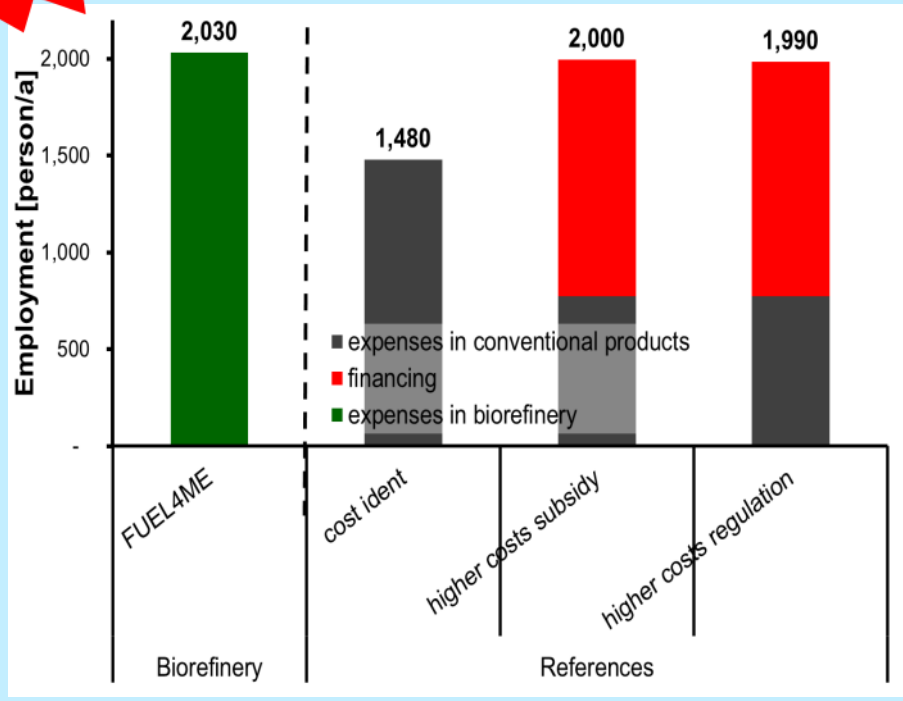
Value added



employment



Based on socio-economci input/output model

Part B: Value Chain Assessment – Social indicators (2.0)

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2-platform (oil, hydrogen) biorefinery using algae for HVO-Biofuel, PUFA and fertilizer

NEW Version (2.0)

additional page with
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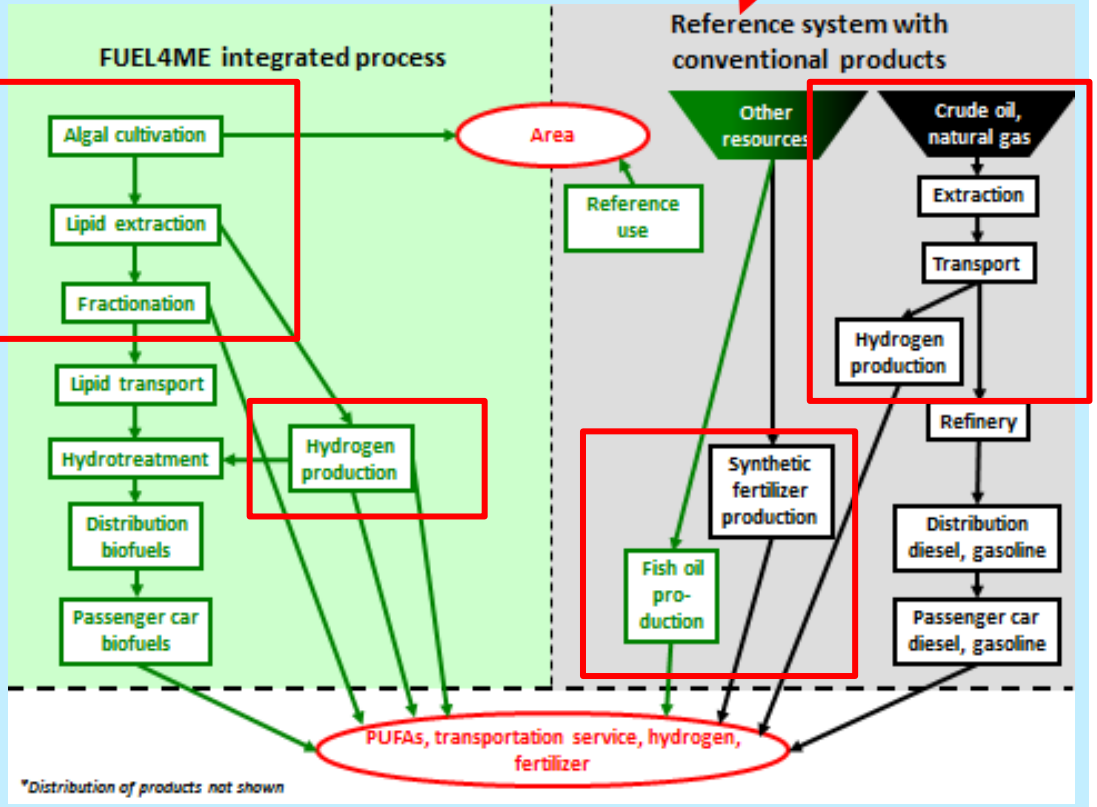
- ✓ „hot spots" for 4 social indicators

Process steps with relevant social issues:

- Cultivation algae
- Lipid extraction
- Hydrogen production

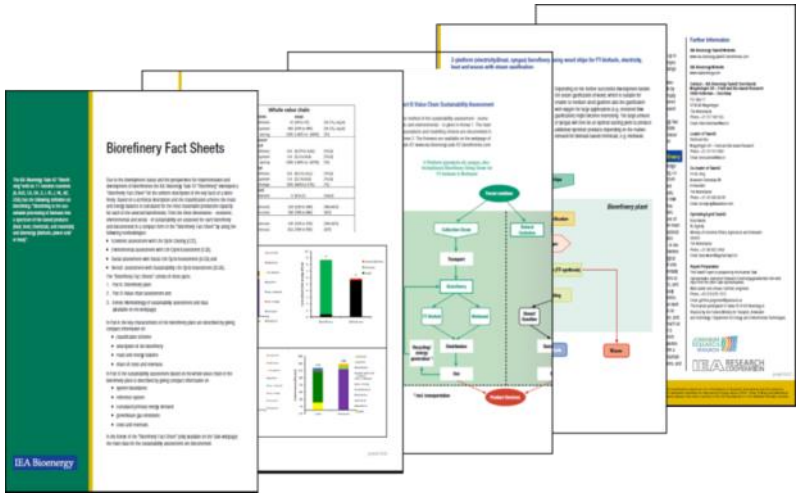
"Hot spots":

- Differences Europe – Outside Europe
- Area demand is a big issue/criteria



27 Biorefinery Fact Sheets are available

- **15 public online on webpage**
  - 2 Austrian Cases
    - Biorefinery Pöls AG (Steiermark)
    - Biorefinery BioCRACK (Schwechat)
  - 5 Glossy Biorefinery Fact Sheets
- **5 non public**



- **7 in progress (e.g. biogas, pyrolysis, protein, rubber dandelion, algae)**
- **New case studies: data collection**

IEA Bioenergy Task42 Biorefining — Data Collection for Biorefinery Fact Sheet — JOANNEUM RESEARCH RESOURCES

INPUT		Biorefinery 1	Biorefinery 2	Biorefinery 3	Biorefinery 4	Biorefinery 5
Biomass						
Feedstock 1	[name]					
amount	[t/a]					
water content	[%]					
price	[€/t]					
Feedstock 2	[name]					
amount	[t/a]					
water content	[%]					
price	[€/t]					
Feedstock 3	[name]					
amount	[t/a]					
water content	[%]					
price	[€/t]					
Auxiliary energy						
grid electricity	[GWh/a]					
natural gas	[Nm³/a]					
oil	[t/a]					
coal	[t/a]					
other (name)	[t/a]					
Auxiliary material						
auxiliary material 1	[name]					
amount	[t/a]					
water content	[%]					
auxiliary material 2	[name]					
amount	[t/a]					
water content	[%]					
auxiliary material 3	[name]					
amount	[t/a]					
water content	[%]					
auxiliary material 4	[name]					
amount	[t/a]					
water content	[%]					
auxiliary material 5	[name]					
amount	[t/a]					
water content	[%]					

Conclusions: The Assessment Framework

Assisting **stakeholders** in finding a position on biorefining in a biobased economy

Biorefinery Fact Sheet gives facts&figures on biorefinery plant in whole value chain assessment

10 sustainability indicators (broadly agreed) for comparison to reference system

Life Cycle based **Sustainability Assessment** with LCSA - environment (LCA), economy (LCC), society (sLCA/SIA)

Biorefinery Complexity Index (BCI) as indicator for the overall complexity and development status of a biorefinery

Technology: Description and assessment of **Technology Readiness Level (TRL)** for involved process technologies&features

Classification of biorefineries via 4 features: platforms, products, feedstocks, processes

IEA Bioenergy
Task42 Biorefining

www.iea-bioenergy.task42-biorefineries.com

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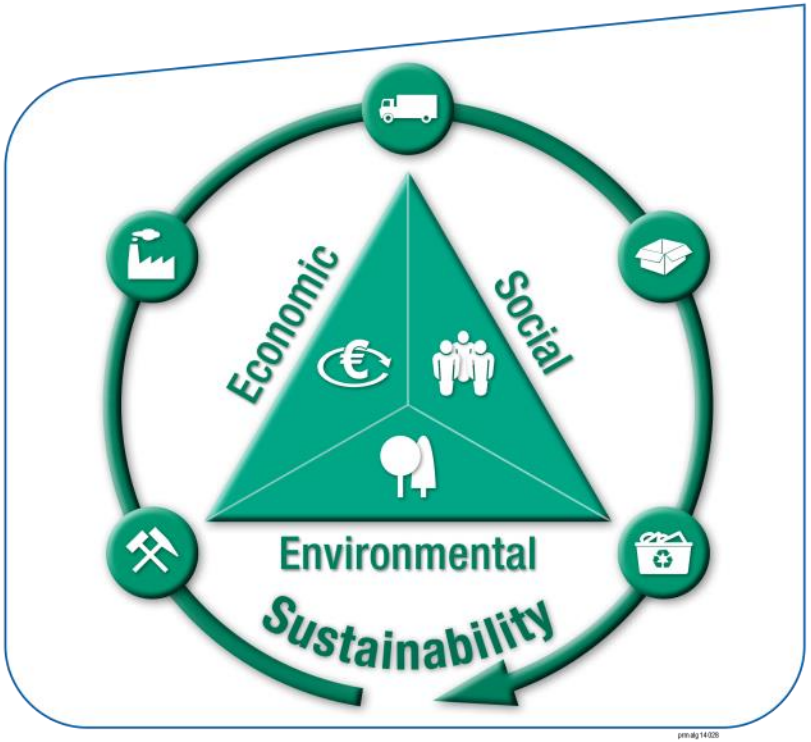
Your Contacts



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Future Energy Systems and Lifestyle

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