



Det Natur- og Biovidenskabelige Fakultet

SeSE Platform: Socioeconomics, Sustainability and Ethics

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SeSE - Research Questions

1. What are the economic costs and environmental burdens, benefits and trade-offs for Denmark of alternative strategies for biomass production and processing in Denmark?
2. In which sectors of the Danish society and in what types of farming systems do these benefits and cost accrue?
3. What are the potential economic costs and benefits for Denmark of alternative international scenarios for biomass production and processing, based on Danish technology?
4. What are the main societal incentives and barriers, including ethical aspects, for the realization of the economic and environmental potentials in the conversion of biomass into high-value materials?

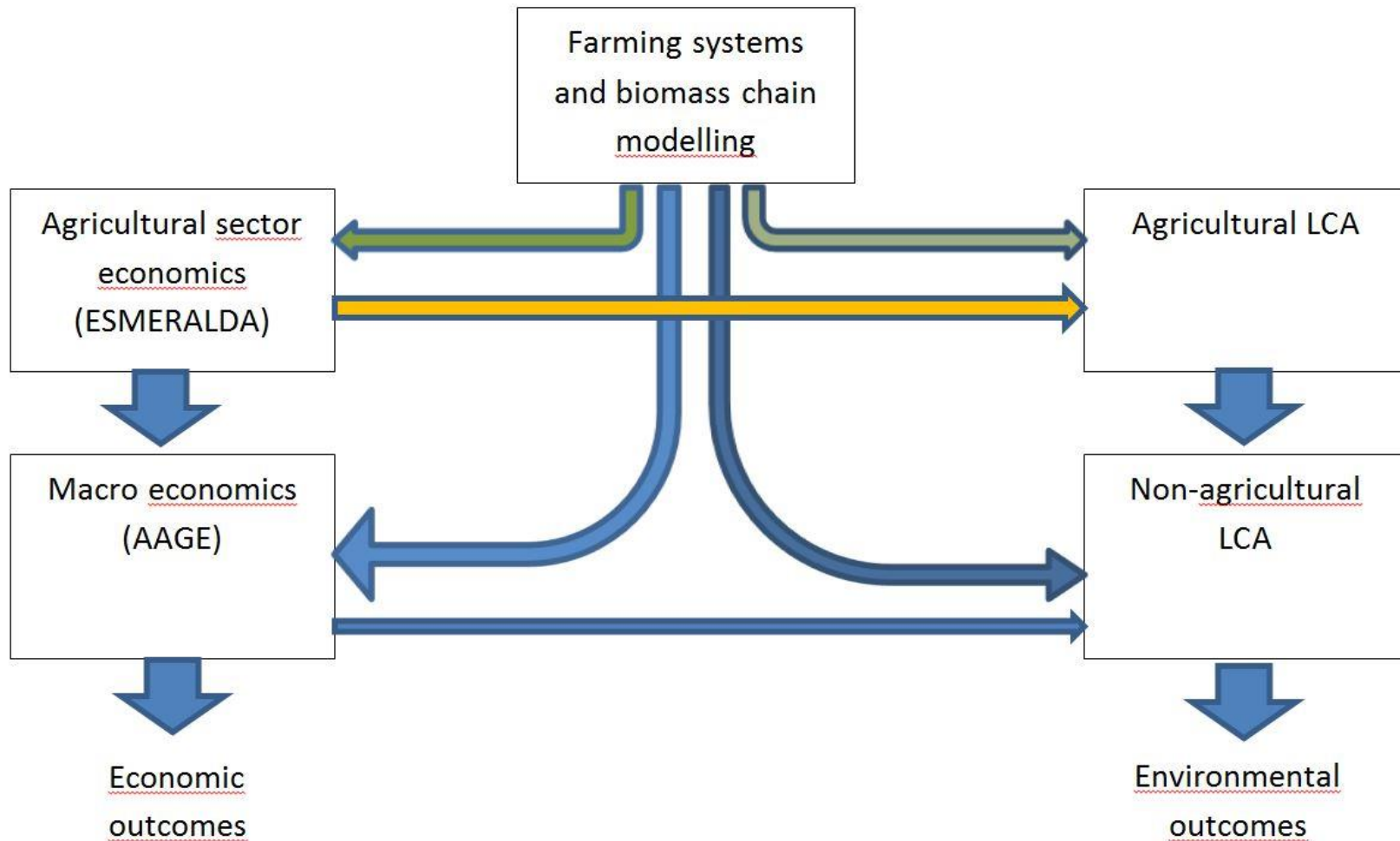
SeSE partners

AU Department of Agroecology

DTU Management Engineering

KU Institute of Food and Resource Economics

SeSE - Quantitative modeling framework



Generic quantitative microeconomic simulation model

Input:

- Crops:
 - Straw
 - Grass
 - Corn silage
- Growing costs (2 soil types)
- Harvest/collection costs.
- Storage costs (deterioration in the storage period)
- Transport to facility (2 transport distances)
- (*Functional unit: 1t dm*)

Output:

- Costs of yearly supply to a facility.
- Supply curves from a predetermined area.

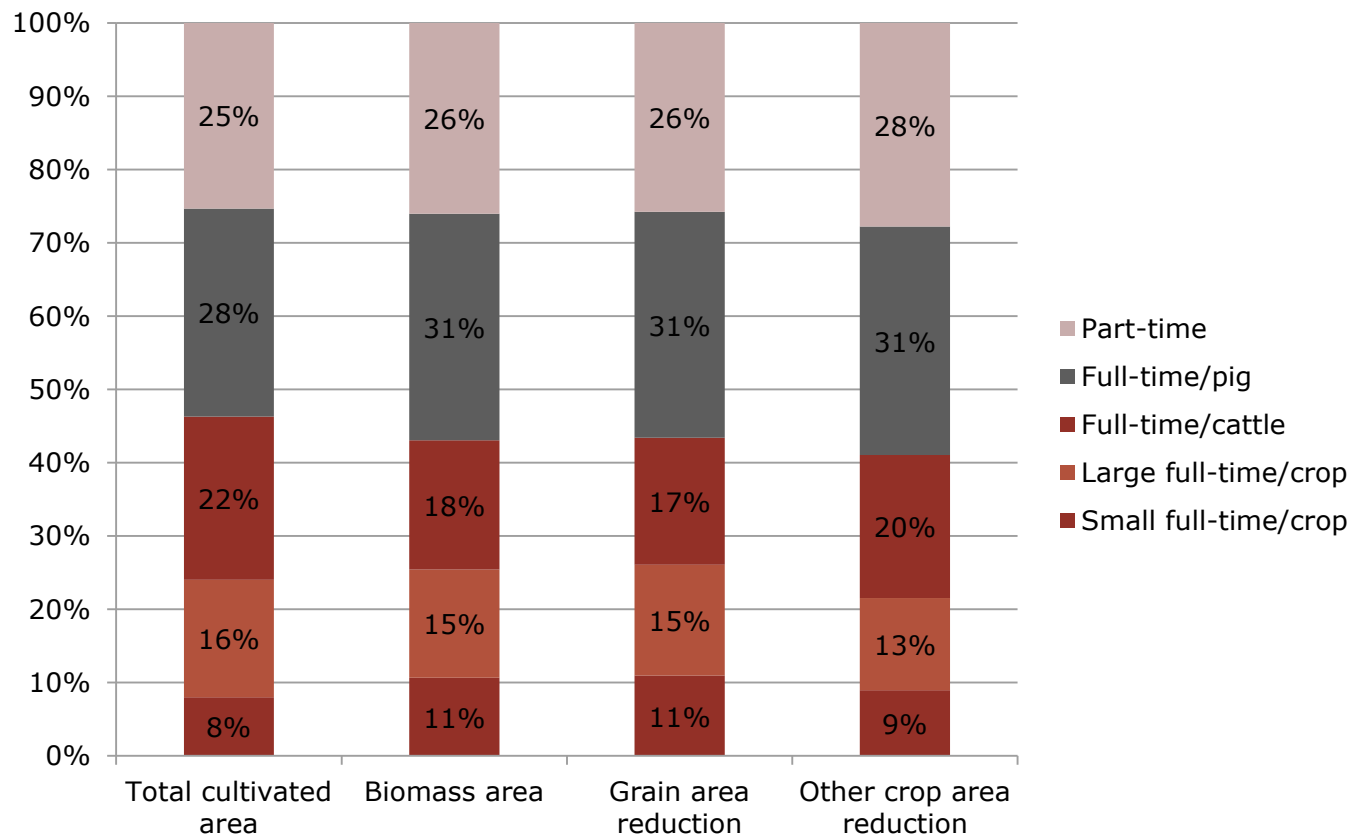


Generic quantitative microeconomic simulation model - output

	A	B	C	D	E	F	G
1	Straw to facility				Decentral briquetting		
2							
3	End produkt:	Extruded straw			End product	Briquetted straw	
4							
5							
16							
17							
18							
19	Expected costs				Expected costs		
20							
21	Pressing		-145 kr./ton		Pressing		-145 kr./ton
22	Storage at farm		-274 kr./ton		Storage at decentral		-269 kr./ton
23	Storage at facility		-392 kr./ton		Storage as briquettes		-90 kr./ton
24	Transport		-117 kr./ton		Transport		-254 kr./ton
25	Pretreatment		-189 kr./ton		Pretreatment		-166 kr./ton
26	Cost in total, per tonne		-1.116 kr./ton		Cost in total, per tonne		-923 kr./ton
27	Total cost		-754.717 kr.		Total cost		-624.161 kr.
28							
29	Expected yield (if biogas is produced)				Expected yield (if biogas is being produced)		
30							
31	Energy yield		2.668 kWh/ton		Energy yield		2.668 kWh/ton
32	- Electricity		1.067 kWh/ton		- electricity		1.067 kWh/ton
33	- Heat		1.334 kWh/ton		- Heat		1.334 kWh/ton
34	Income from electricity		1.185 kr./ton		Income from electricity		1.185 kr./ton
35	Income from heat		334 kr./ton		Income from heat		334 kr./ton
36	Income per tonne		1.518 kr./ton		Income per tonne		1.518 kr./ton
37	Income from energy		1.026.255 kr.		Total income		1.026.255 kr.
38							
39							
40	Difference, kr		271.538 kr.		Difference, kr		402.094 kr.
41							



Sector economic implications from "Esmeralda" Compulsory 10 per cent. blending target for gasoline Distribution of land use effects on farm types.



Macroeconomic implications from AAGE

Compulsory 10 per cent. blending target for gasoline

	Base 2013, mill. DKK	Pct. change	Mill. DKK
Real GDP	1950927	-0,002	-41,75
Real import	468222	-0,042	-196,93
Real export	726726	-0,032	-231,68
Real GNE	1692423	0,000	-6,94
Real private consumption	833794	0,003	20,93
Real public consumption	523515	0,000	0,00
Real Investment	327798	-0,009	-27,86
CPI		-0,011	
wages		-0,008	
Capital rent		-0,003	
Land rent		1,118	
Export prices		0,002	



Selected commodity implications from AAGE, percentage changes Compulsory 10 per cent. blending target for gasoline

	Production	Price	Import	Export
1 Cereal	0,30	0,25	6,63	-4,83
2 Oil Seed	-0,39	0,03	-0,06	-0,52
3 Seed for Sowing	-0,47	0,03	0,12	-0,68
4 Potatoes	-0,22	0,02	0,00	-0,35
5 Sugar beet	-0,30	0,03	0,06	-0,64
6 Roughage	-0,14	0,18	1,42	-3,57
7 Milk	-0,07	0,05	0,00	-0,46
8 Cattle	-0,07	0,06	0,03	-0,56
9 Pigs	-0,14	0,04	-0,01	-0,38
10 Eggs	-0,10	0,04	0,00	-0,33
11 Poultry	-0,08	0,03	0,00	-0,29
12 Fur	0,00	0,00	-0,03	0,00
13 Horticulture	-0,04	0,01	-0,02	-0,06
20 Cattle meat	-0,07	0,02	-0,02	-0,09
21 Pig meat	-0,09	0,02	-0,02	-0,09
22 Poultry meat	-0,04	0,01	-0,01	-0,04
23 Fish industry	0,00	0,00	-0,03	0,00
24 Dairy	-0,08	0,02	0,00	-0,09
25 Bread	-0,05	0,01	-0,03	-0,04
26 Other food	-0,22	0,01	-0,20	-0,05
27 Beverages	-0,01	0,00	0,00	-0,02
28 Ethanol	1296,68	1,04	1893,05	-3,84
29 DDGS	1296,68	-3,61	0,00	0,00
17 Extraction Oil	-0,40	0,00	-1,14	0,06
19 Extraction service	-0,16	0,00	-0,34	0,02
37 Oil Refinery	-1,31	0,24	0,22	-2,10
38 Gasoline	-1,82	-0,81	-11,45	7,38

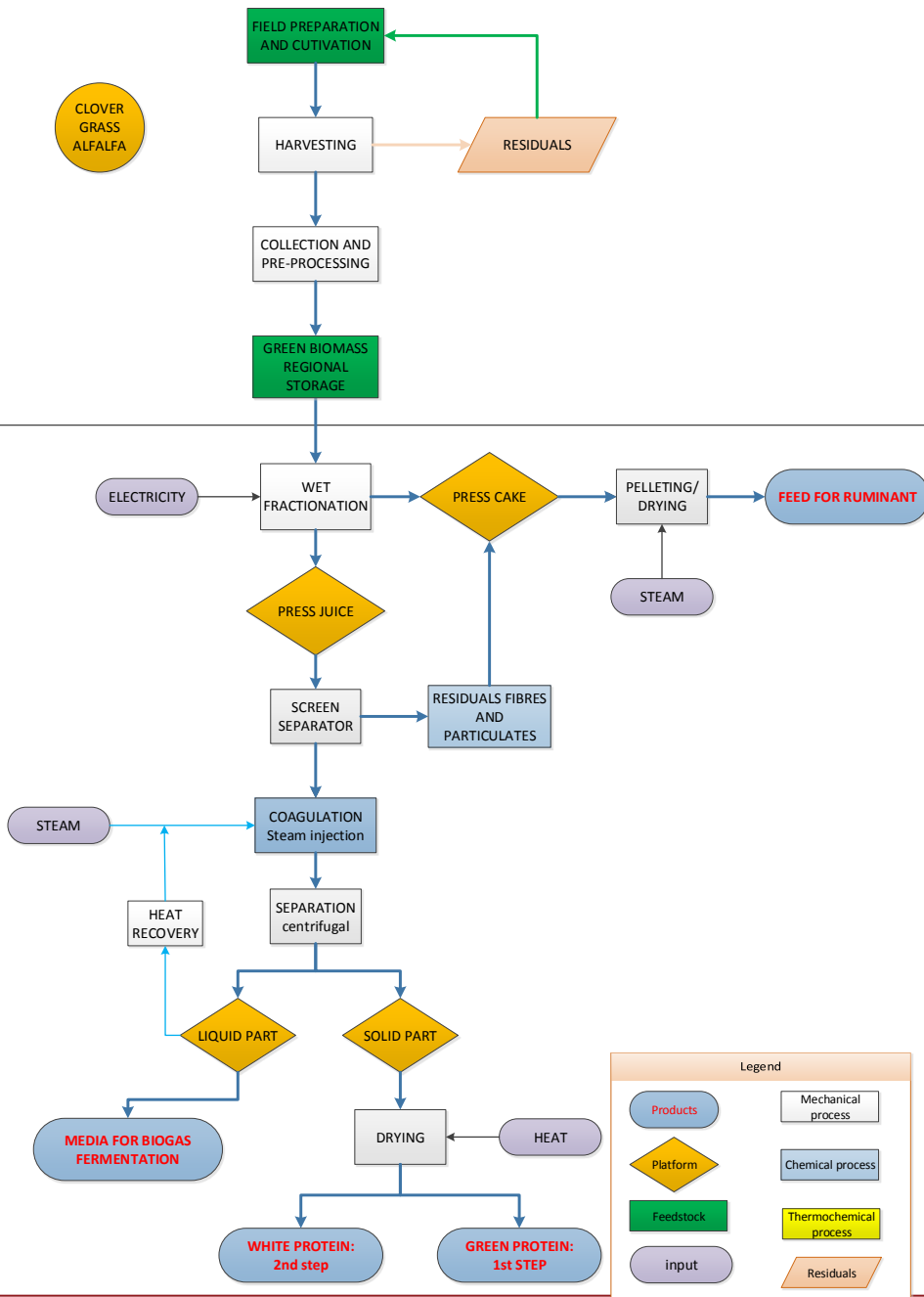


Types of biorefineries for landbased and industrial LCA

LCA of 3 types of biorefinery

1. Green biorefinery
2. Sugar-based biorefinery
3. Lignin-based biorefinery

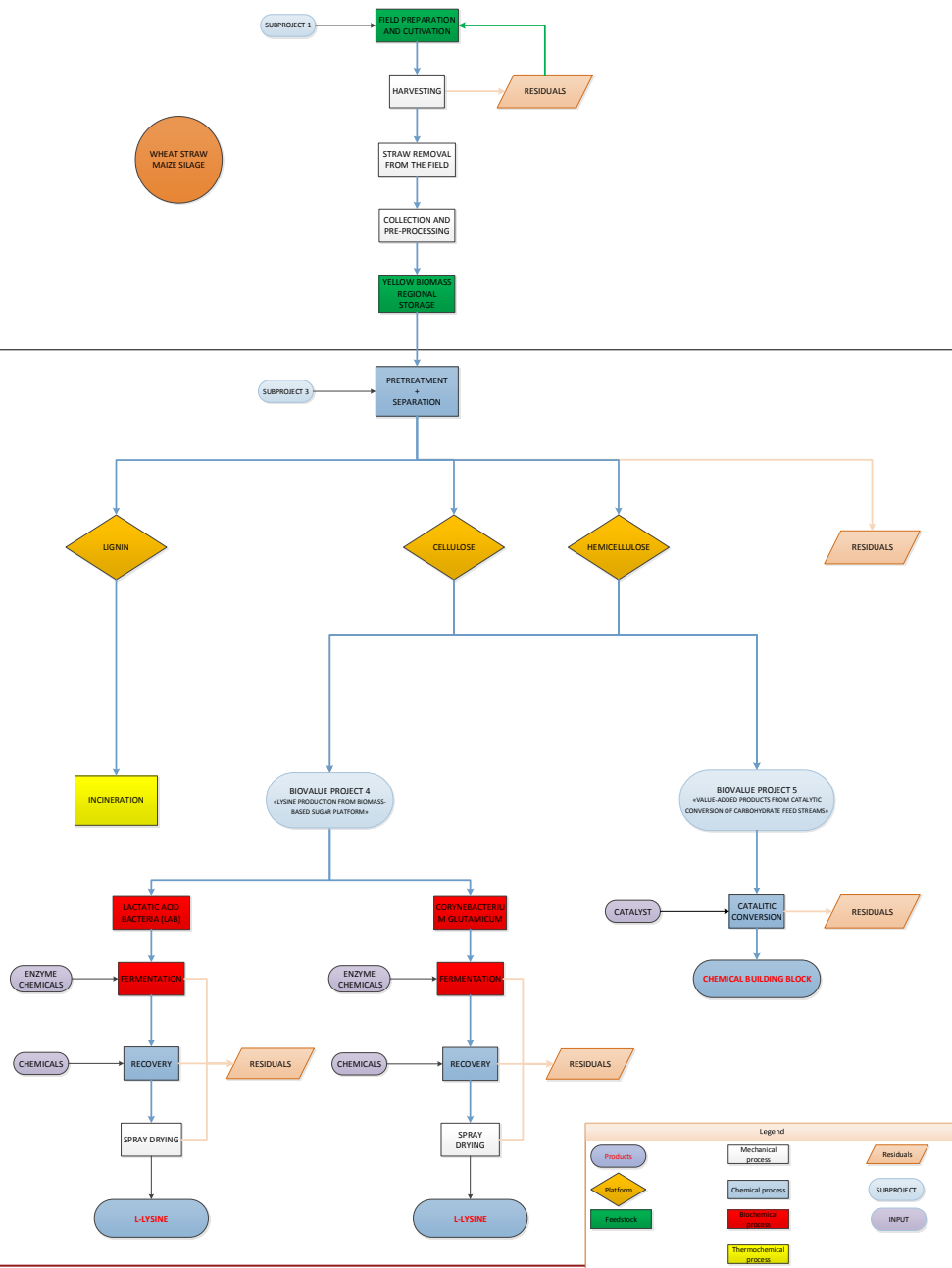
LCA of integrated biorefinery system = 1+2+3



GREEN BIOREFINERY:

- **Feedstock input:**
 - Clover Grass
 - Alfalfa
- **Conversion pathway:**
 - Wet fractionation-
>protein coagulation
- **Output products:**
 - Protein (Main product)
 - Fodder (co-product)
 - Feedstock for biogas (by-product)





SUGAR BIOREFINERY:

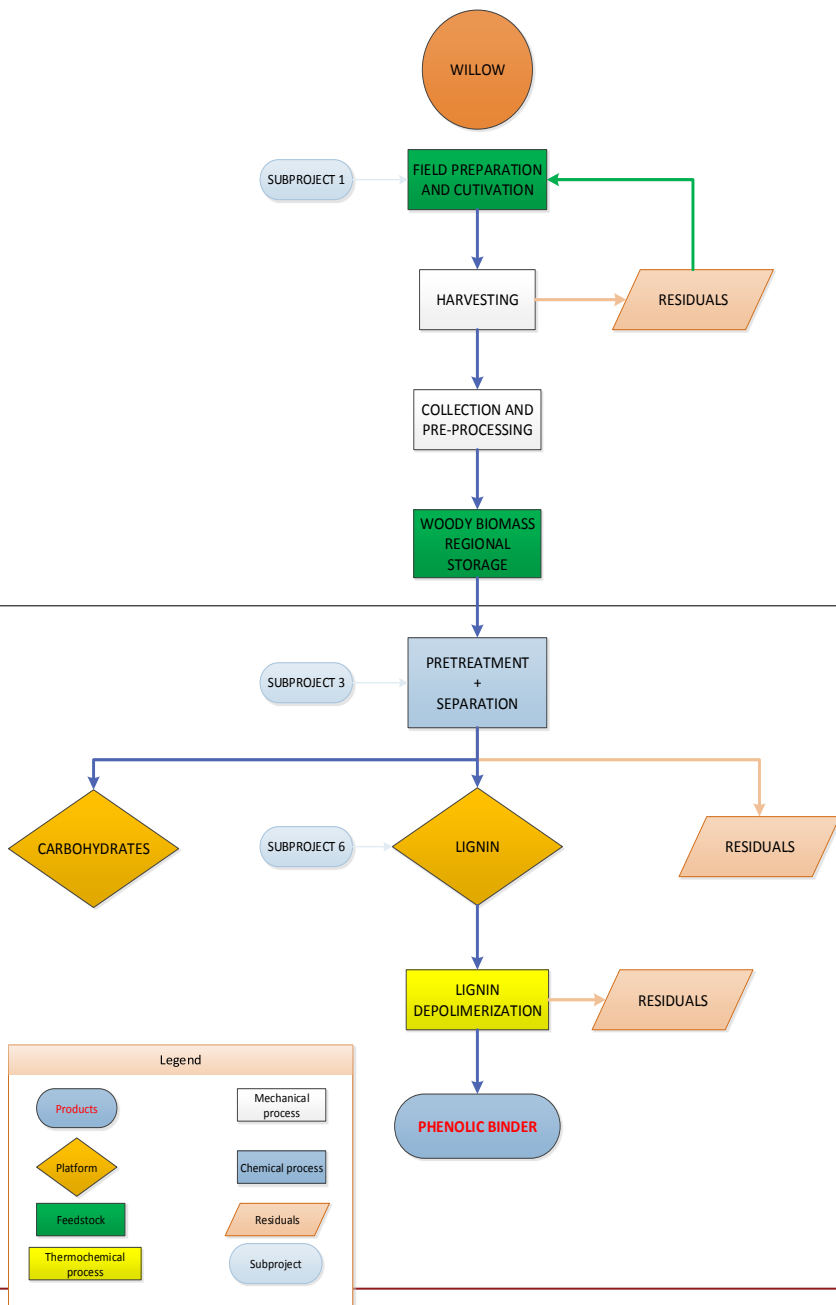
- **Feedstock input:**
 - Wheat Straw
 - Maize Silage
- **Conversion pathway:**
 - Fermentative
 - Catalytic
- **Output products:**
 - Lysine (Fermentative)
 - Chemical building blocks (Catalytic)
 - Lignin stream (by-product)



LIGNIN CONVERSION

AGRICULTURAL LCA

INDUSTRIAL LCA



LIGNIN BIOREFINERY:

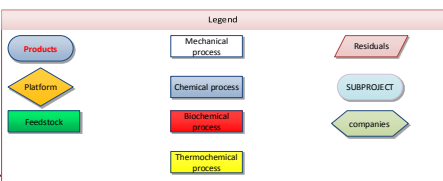
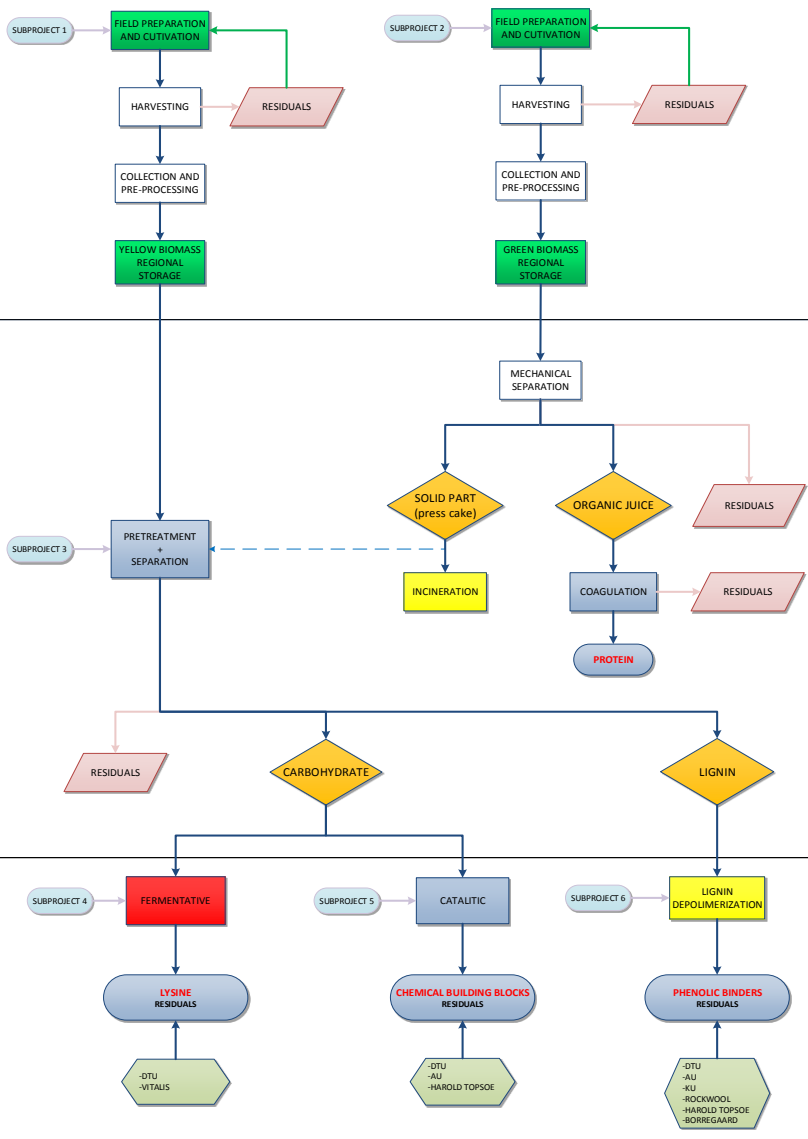
- **Feedstock input:**
 - Willow
- **Conversion pathway:**
 - Lignin depolymerization
- **Output products:**
 - Phenolic Binder (Main product)
 - Carbohydrates stream (By-product)



Biomass

Separation

Conversion



INTEGRATED BIOREFINERY

“Ultimate goal = Best biomass utilization”

All the biomass components are utilized:

- Carbohydrates (C6 and C5)
- Lignin
- Protein



Environmental impacts and Assessment

Environmental impact categories:

- Global Warming Potential (GWP),
- Carbon storage in biobased product
- Acidification Potential (AP),
- Eutrophication Potential (EP),
- Potential Human Ecotoxicity (PHTox)
- Potential Freshwater Ecotoxicity (PFWTox)
- Land use (LU) and Land use change (LUC)
- Non-Renewable Energy (NRE) use and
- Potential Biodiversity Damage (PBD)

Functional unit: 1 t of dry matter (DM)



Status(1) - SeSE

- Progress according to plan
- Economic models adjusted and tested at all 3 levels
- Biorefinery types to be assessed in Landbased and Industrial LCA agreed on
- Data need and data exchange between LCA and economy discussed and agreed on

Status(2) - SeSE

Cooperation with P1 is ongoing

Cooperation with P2 is starting together with P1

Cooperation with P3 – P6 will be planned this spring and a common data collection will be initiated (economics and LCA). The challenge is to get sufficient data technical as well as economic.

Relations to climate KIC - Bioeconomy

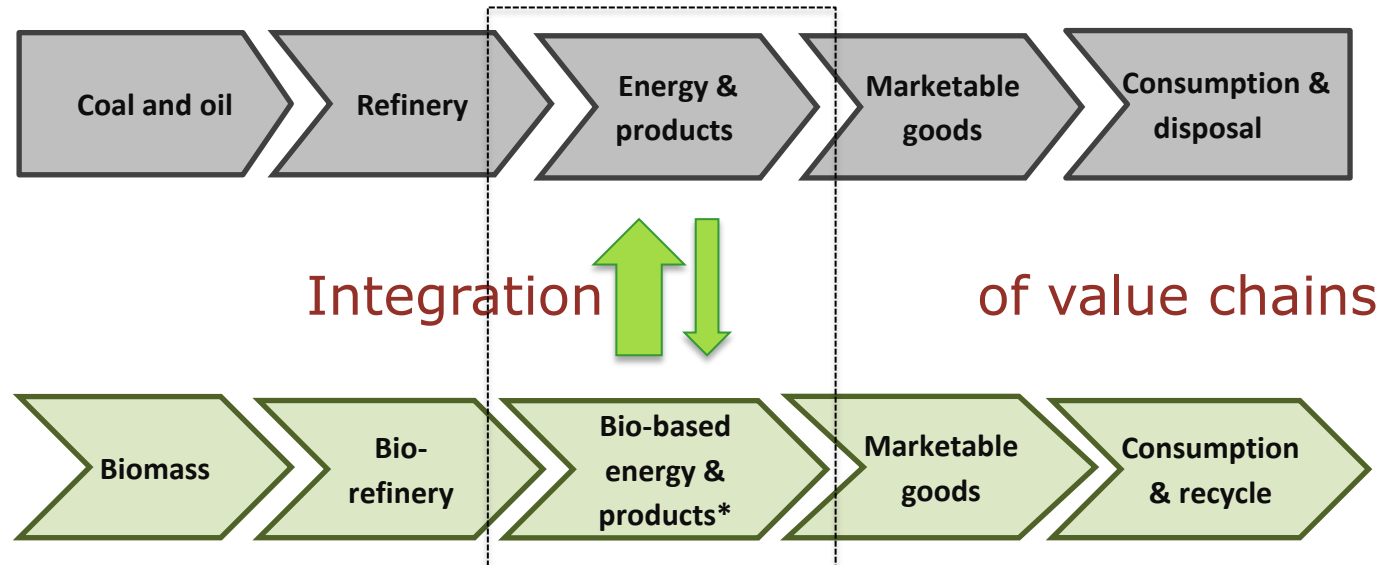
Most of the 8 Climate KIC platforms are “on hold” - including the Bioeconomy platform.

A strategy refresh is currently conducted (BCG)

Flagship proposal – “A climate smart Bioeconomy” was rejected in the second phase, but financing for a renewed proposal was in place.

Climate KIC activities at low key for the time being, but contacts and relations within the KIC community are and will be utilised in other Bioeconomy relevant activities.

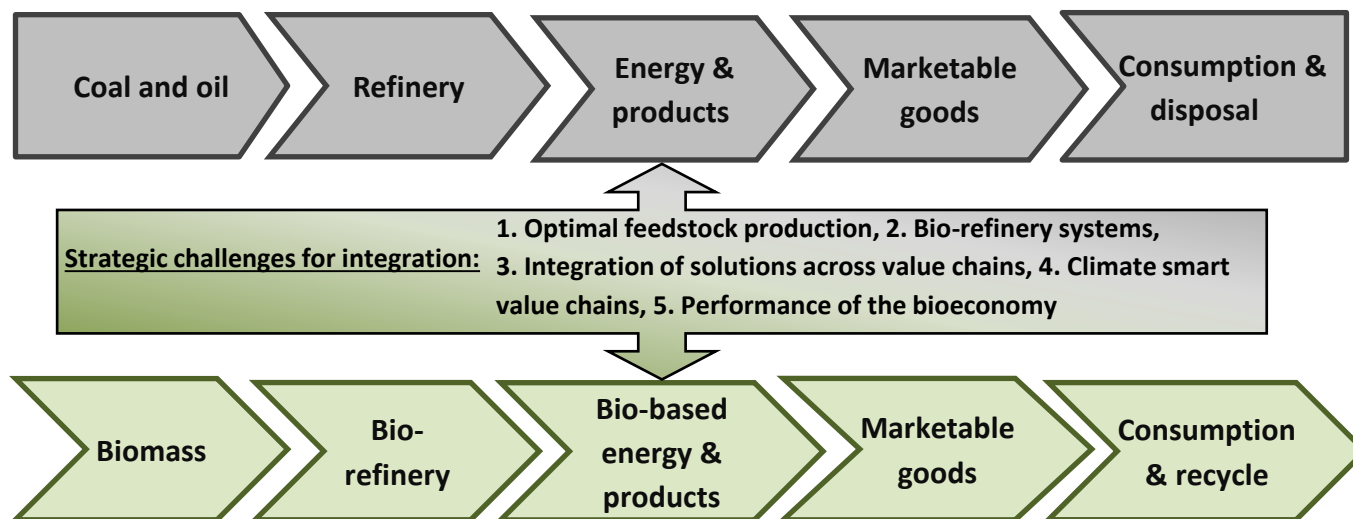
Greening the black economy: A conceptual View



*Integration includes food and feed value chains



CSB: Strategic challenges



Thank you !