

Biorefinery Euroview

SPECIFIC SUPPORT ACTION
An EEC project supported by the FP6



Scenarios for biorefinery development in Europe

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www.biorefinery.euroview.eu

Scenarios for biorefinery development

Propose a number of different strategies for the development of biorefineries in Europe, based on:

1. Status of the technology (current and future)
2. Availability of renewable resources
3. Funding possibilities (pilot plants and demonstration projects)
4. Industrial implementation of biorefineries
5. Synopsis -> Future concepts



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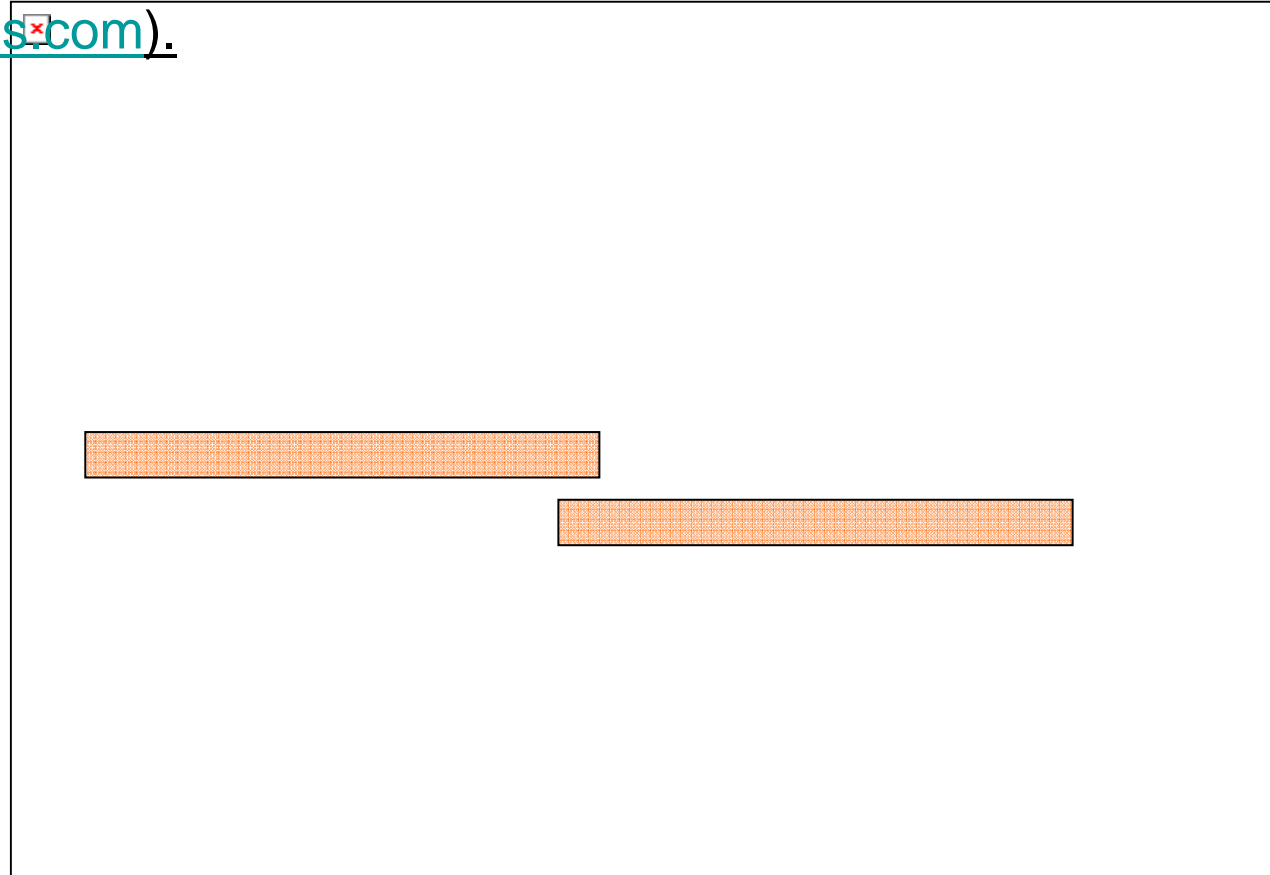
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Status of the technology

Overview of the various routes available for biomass conversion to fuels, chemicals or heat (The Biomass Energy Foundation, <http://www.woodgas.com>).



Status of the technology

⇒ 4 concepts have been defined:

- Green biorefinery
- Cereal biorefinery
- Oilseed biorefinery
- Forest based and lignocellulosic biorefinery

⇒ Within each concept several conversion technologies are used



Overview conversion technologies

1. Thermochemical conversion

- 1.1 Pyrolysis
- 1.2 Gasification
 - 1.2.1 Biomass gasification
 - 1.2.2 Black Liquor gasification
- 1.3 Thermochemical Liquefaction
- 1.4 Combustion

2. (Bio)chemical conversion

- 2.1 Fermentation
- 2.2 Catalysis
- 2.3 Biocatalysis
- 2.4 Anaerobic Digestion
- 2.5 Hydrolysis
 - 2.6.1 Concentrated acid hydrolysis
 - 2.6.2 Dilute acid hydrolysis
 - 2.6.3 Enzymatic hydrolysis
 - 2.6.4 Comparison of pretreatment processes
- 2.6 Esterification/Transesterification

3. Incineration

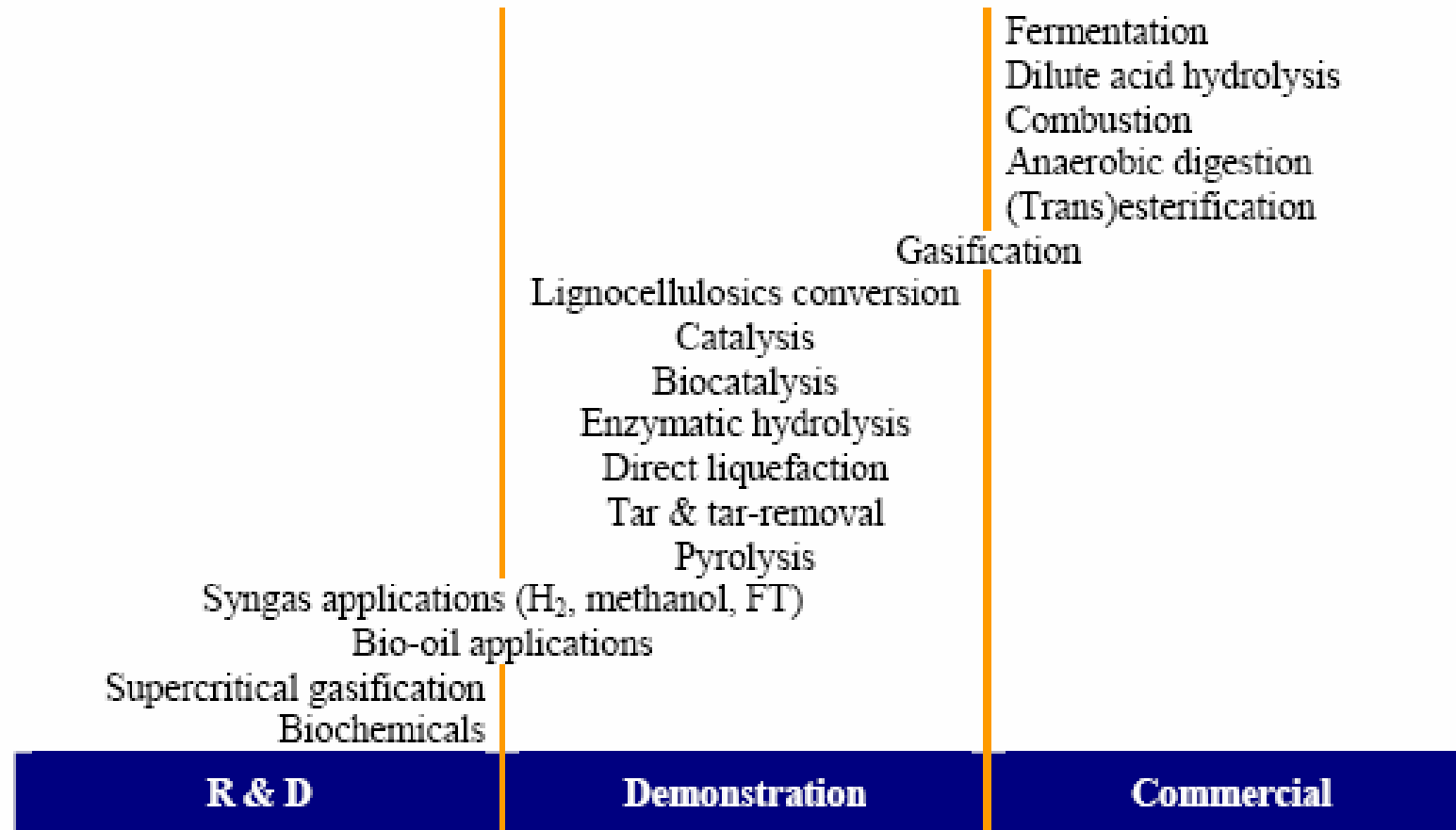
- 3.1 Electrical power generation
- 3.2 Industrial Process Heat and Steam

4. Biomass fractionation

- 4.1 Size reduction/separation
- 4.2 Extraction
- 4.3 Product recovery (distillation)

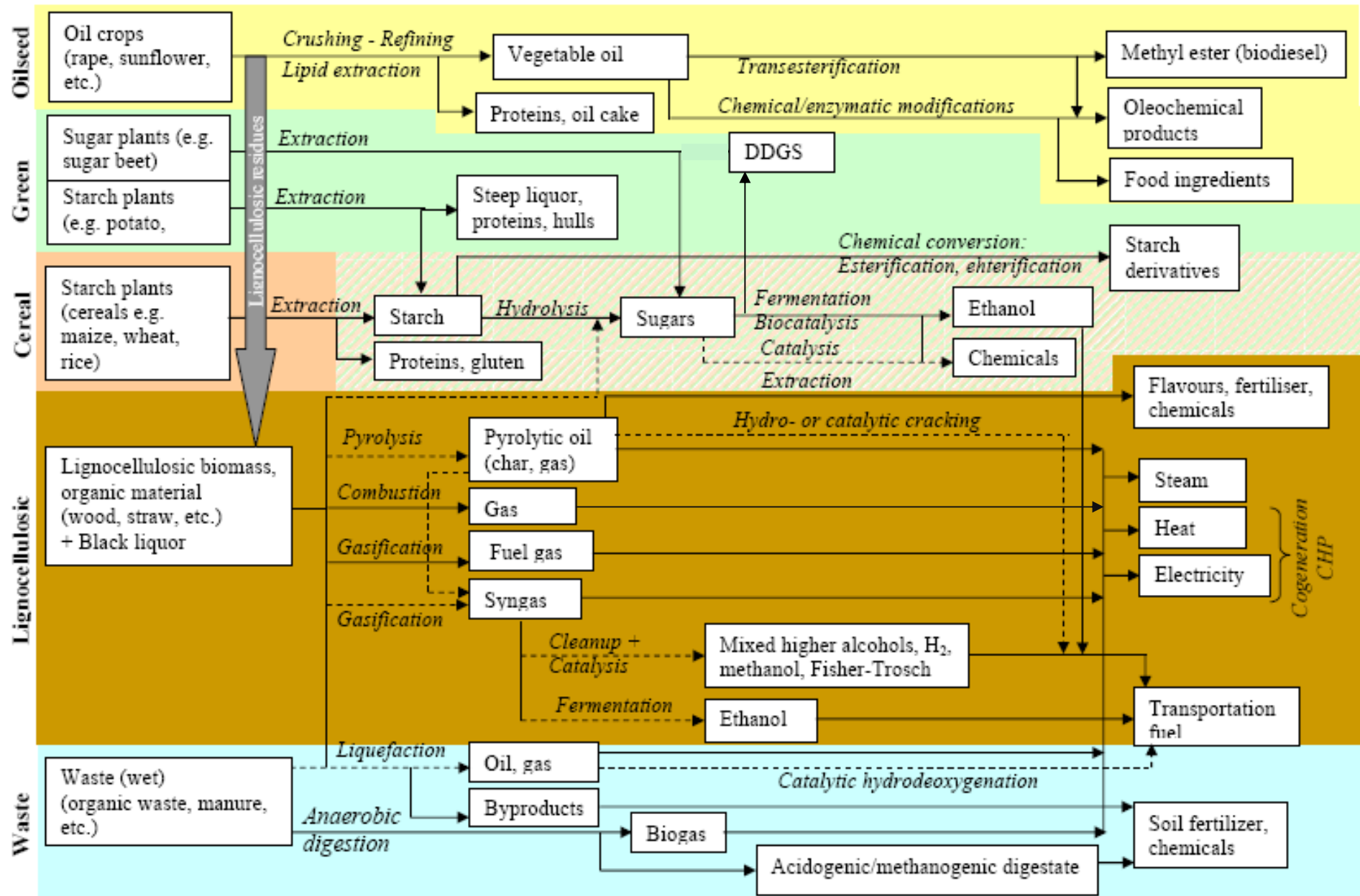


Development status of conversion technologies



*Adapted from BTG Biomass Technology Group b.v., www.btgworld.com

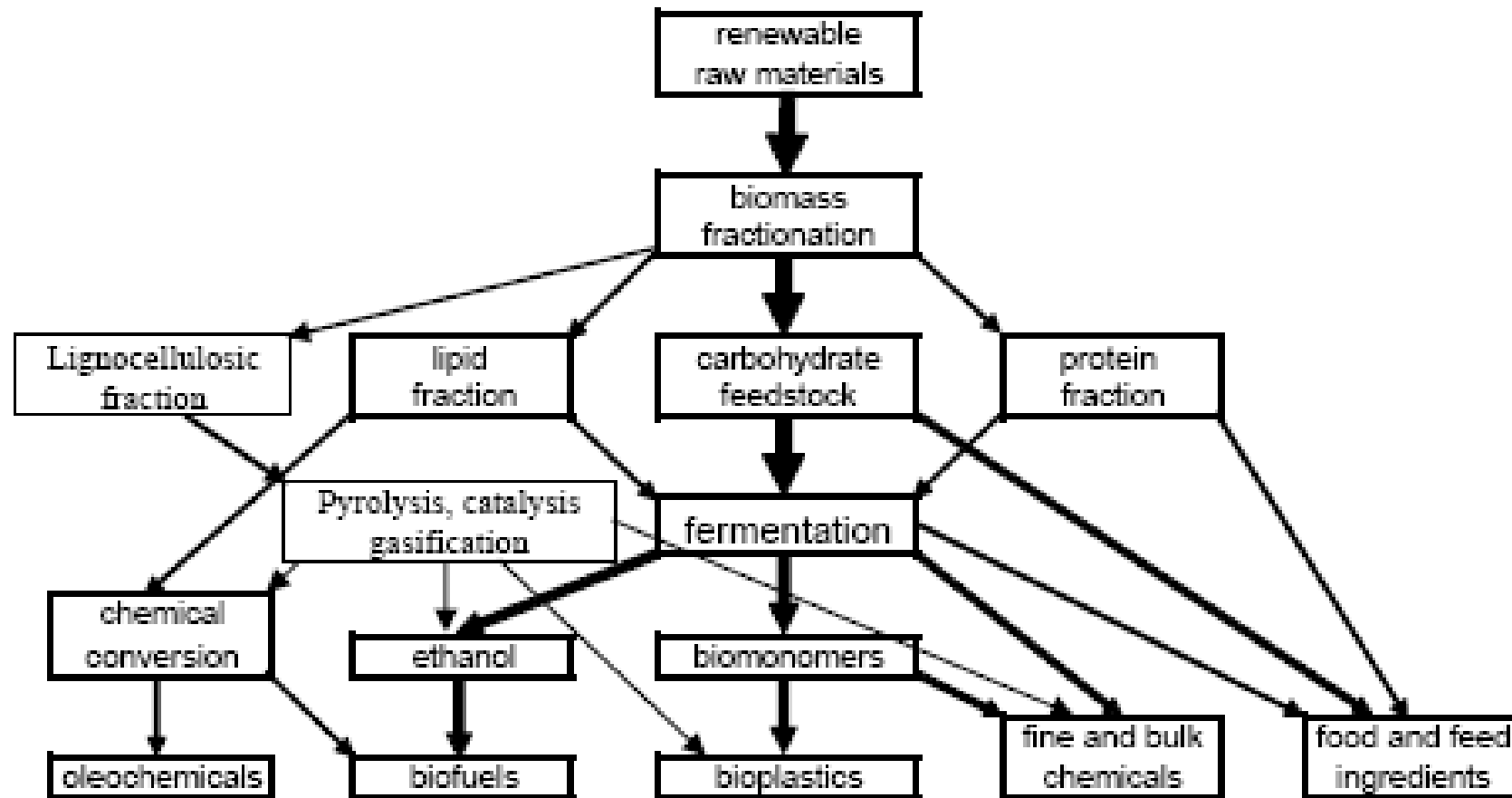




----- Not commercial yet



General concept of a Biorefinery



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Resource availability

⇒ Main feedstock groups (cfr. Scheme)

- Oilseed crops
- Sugar plants
- Starch plants
- Lignocellulosic biomass
- Waste (wet)

⇒ Overview current availability for main feedstock groups

⇒ Availability prognoses for 2010 and 2020

⇒ Impact of European legislation on resource availability

⇒ Resources and sustainability

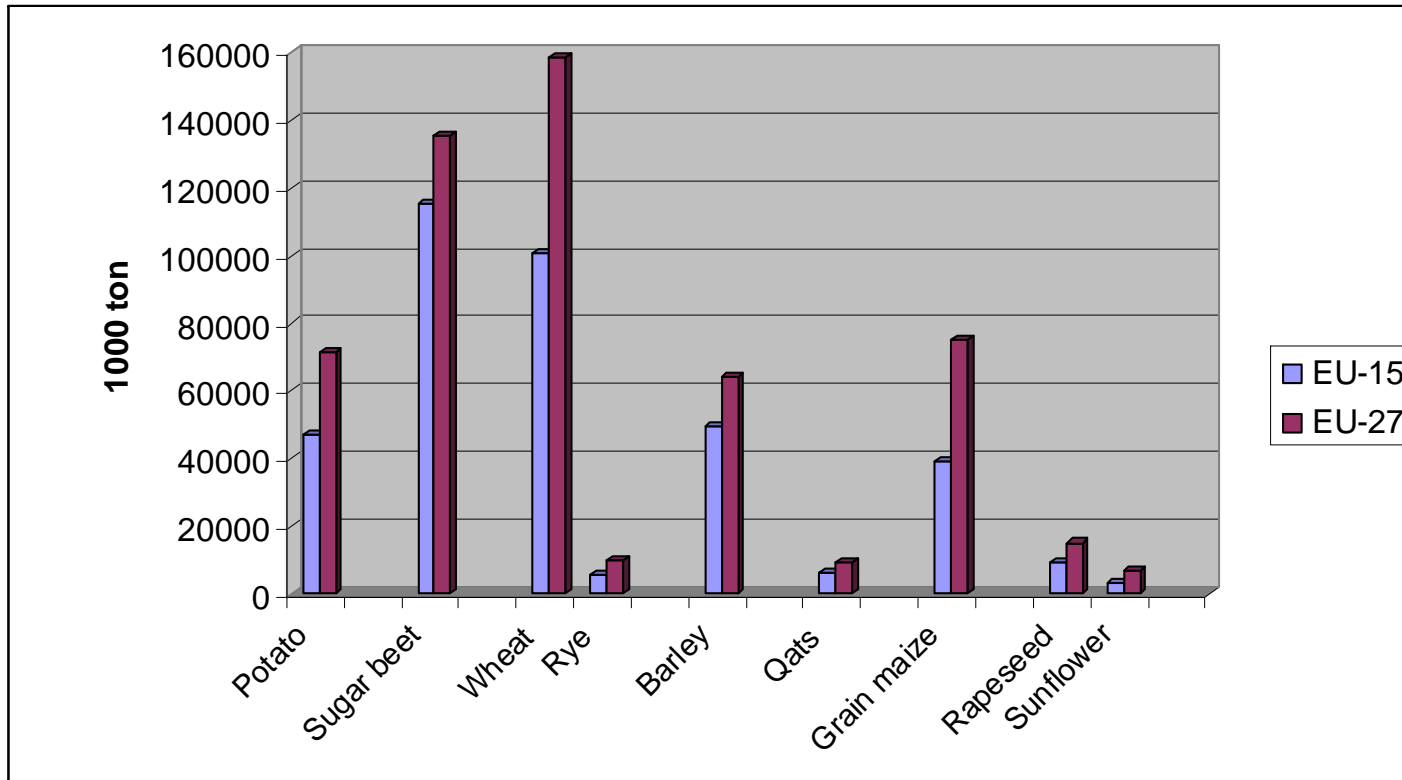


Resource availability

Supply sector	Type	Example
Forestry	Dedicated forestry	Short rotation plantations (e.g. willow, poplar, eucalyptus)
	Forestry by-products	Wood blocks, wood chips from thinnings
Agriculture	Dry lignocellulosic energy crops	Herbaceous crops (e.g. miscanthus, reed canarygrass, giant reed)
	Oil, sugar and starch energy crops	Oil seeds for methylesters (e.g. rape seed, sunflower)
		Sugar crops for ethanol (e.g. sugar cane, sweet sorghum)
		Starch crops for ethanol (e.g. maize, wheat)
	Dry lignocellulosic agricultural residues	Straw, prunings from vineyards and fruit trees
Livestock waste	Wet and dry manure	
Industry	Industrial residues	Industrial waste wood, sawdust from sawmills
		Fibrous vegetable waste from paper industries
	Industrial products	Pellets, bio-oil (pyrolysis oil), ethanol, biodiesel
Waste	Dry lignocellulosic	Residues from parks and gardens (e.g. prunings, grass)
	Contaminated waste	Demolition wood
		Organic fraction of municipal solid waste
		Biodegradable landfilled waste, landfill gas
	Sewage sludge	



Resource availability



Production volumes of agricultural crops in the EU-15 and EU-27.
Compulsory set-aside 10%.



Resource availability

Sector	Resource	Fuel category	2010 Increase or decrease of available biomass energy potential compared to 2000 (%)	2020 Increase or decrease of available biomass energy potential compared to 2000 (%)	Comment
Agriculture	Dry crop residues	Dry lignocellulosic	10%	20%	+1% a year
	Livestock waste	Wet and dry cellulosic	5%	10%	+0,5% a year
	Energy crops	Set aside or idle agricultural	10%	20%	+1% a year
Forestry	Woodfuel	Dry lignocellulosic	10%	20%	+1% a year
	Forestry	Dry lignocellulosic	10%	20%	+1% a year
Industry	Industrial residues	Dry lignocellulosic	10%	20%	+1% a year
		Wet cellulosic	20%	40%	+2% a year
		Black liquor	10%	20%	+1% a year
Waste	Regulated waste	Municipal waste	10%	20%	+1% a year
		Demolition wood	10%	20%	+1% a year
	Non-regulated waste	Landfilled waste	-30%	-60%	-3% a year
		Sewage sludge	20%	40%	+2% a year

Future trends in biomass availability in Europe (Nikolaou, 2003).



Resource availability

<i>Mtoe</i>	Biomass consumption, 2003	Potential, 2010	Potential, 2020	Potential, 2030
Wood direct from forest (increment and residues)	67 ⁴³	43	39-45	39-72
Organic wastes, wood industry residues, agricultural and food processing residues, manure		100	100	102
Energy crops from agriculture	2	43-46	76-94	102-142
TOTAL	69	186-189	215-239	243-316

EU biomass production potential (EEA, 2006).



Resource availability

⇒ Tradeability of different biomass sources:

		High specific heating value	High transport density	Long shelf life	Availability of quantity and quality	Trade options		
						Untreatable	United treatability	Treatable
Woody biomass	Forest wood	X	X	X	X			X
	Logging residues / Small-dimensioned wood	X		X	X		X	
	Wood processing industry by-products and residues	X	X	X	X			X
	Wood pellets	X	X	X	X			X
	Waste wood	X	X	X			X	
	Short rotation wood	X	X	X	X			X
Herbaceous biomass	Straw	X		X	X		X	
	Energy plants (cereals)	X		X	X			X
Fruits and seeds	Cereal grains	X	X	X	X		X	X
	Rape seeds (sunflower seeds)	X	X	X	X		X	X
	Sugar beet				X	X		
Other biomass	Industrial substrates				X	X		
	Organic waste				X	X		
	Sewage sludge				X	X		
	Maize silage			X	X	X		
Bioenergy	Heat from biomass				X	X		
	Electricity from biomass	X	X				X	
	Biodiesel	X	X	X	X			X
	FT diesel (in the future)	X	X	X	X*			X*
	Bioethanol	X	X	X	X			X



Resource availability

Conclusions:

scenarios on resource availability will highly depend on

- European legislation and incentives;
 - new targets for 2020:
 - 20% less energy consumption by better efficiency
 - 20% less CO₂ emissions as compared to 1990
 - 20% renewables in the energy supply of the EU as binding target
 - 10% biofuels for transportation as binding target.
- the kind of products produced (bio-energy or biomaterials);
- the status of the technology, with first generation technologies mainly based on agricultural crops and second generation technologies based on lignocellulosic biomass and waste.



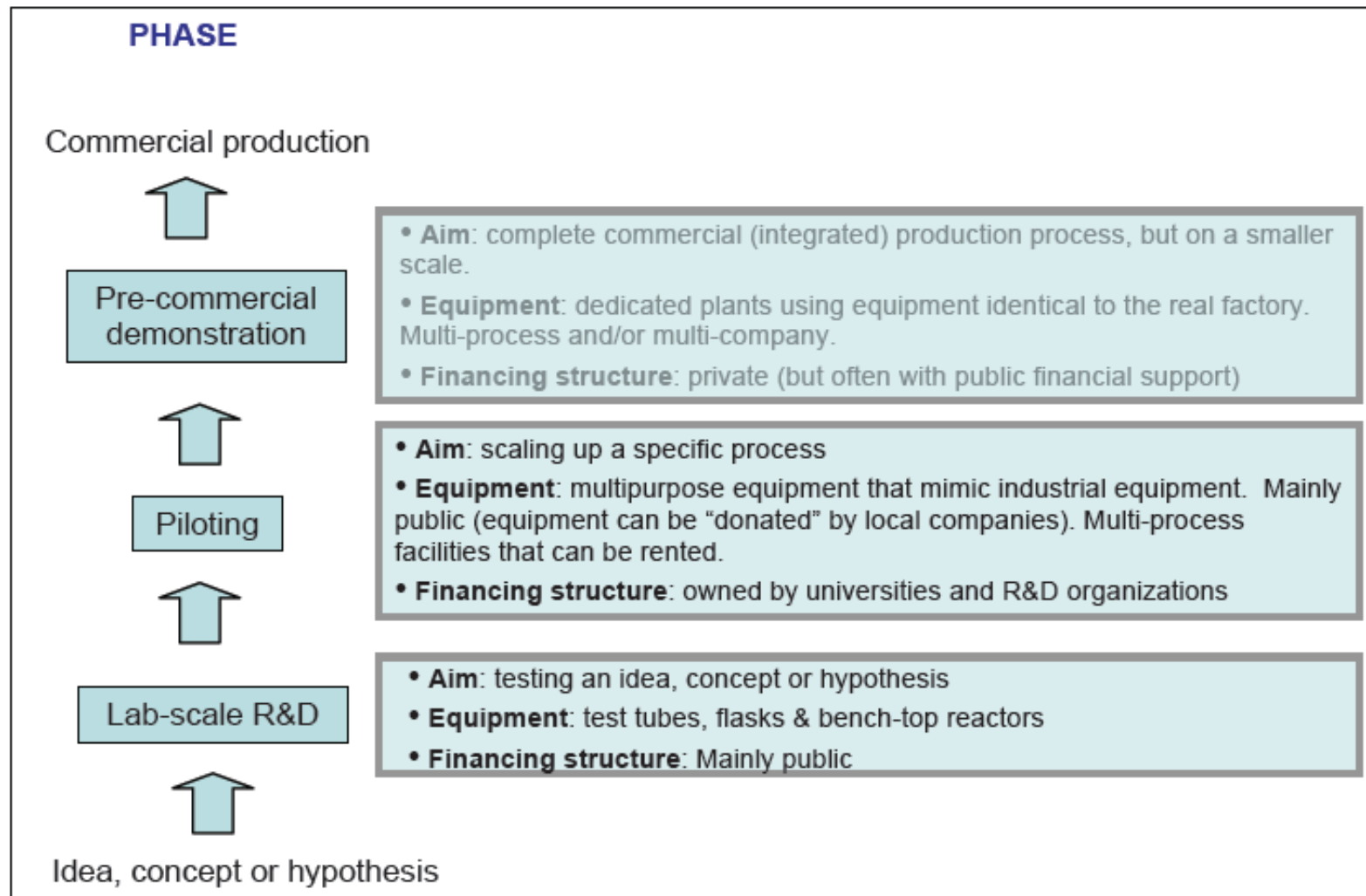
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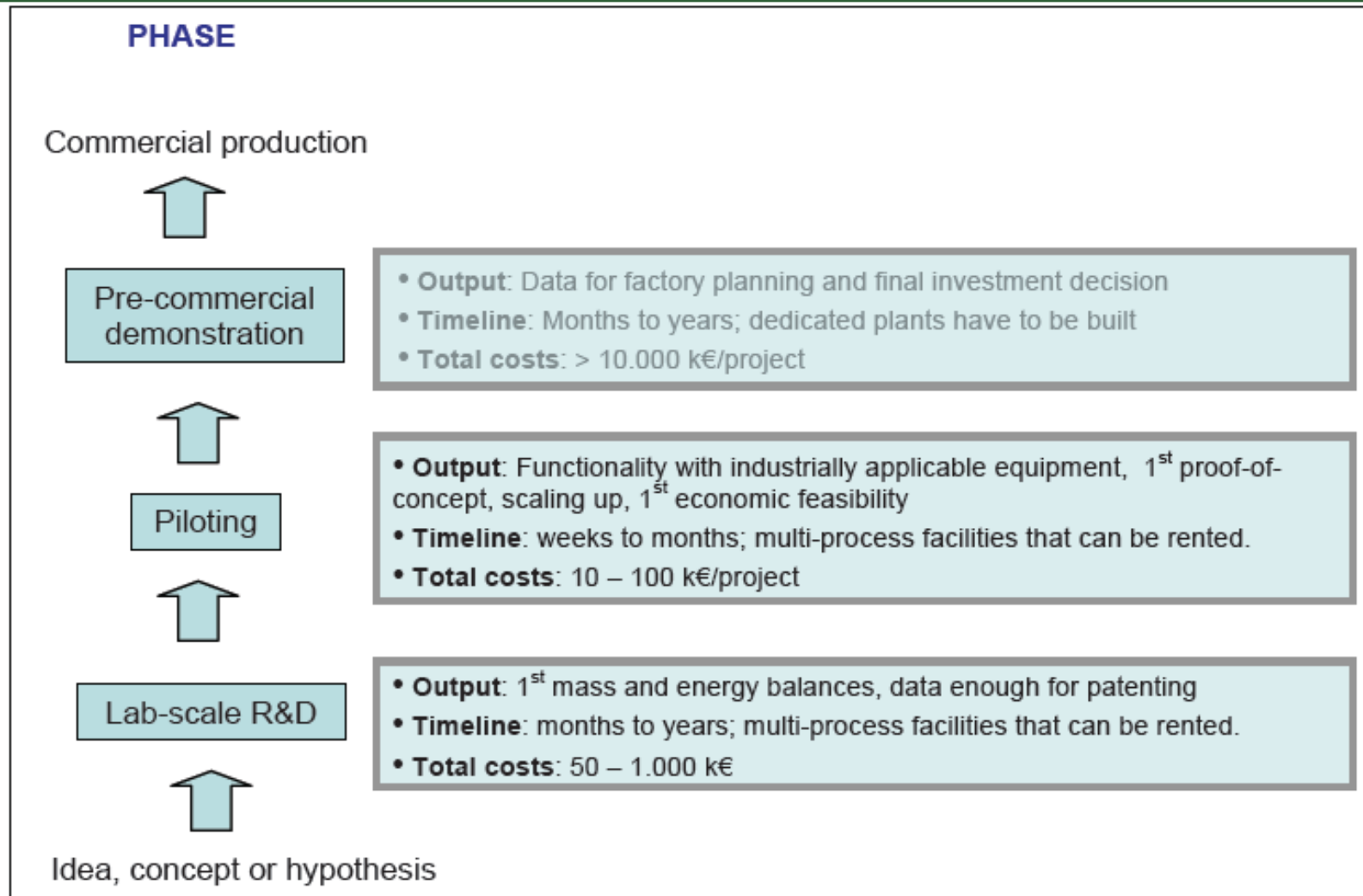
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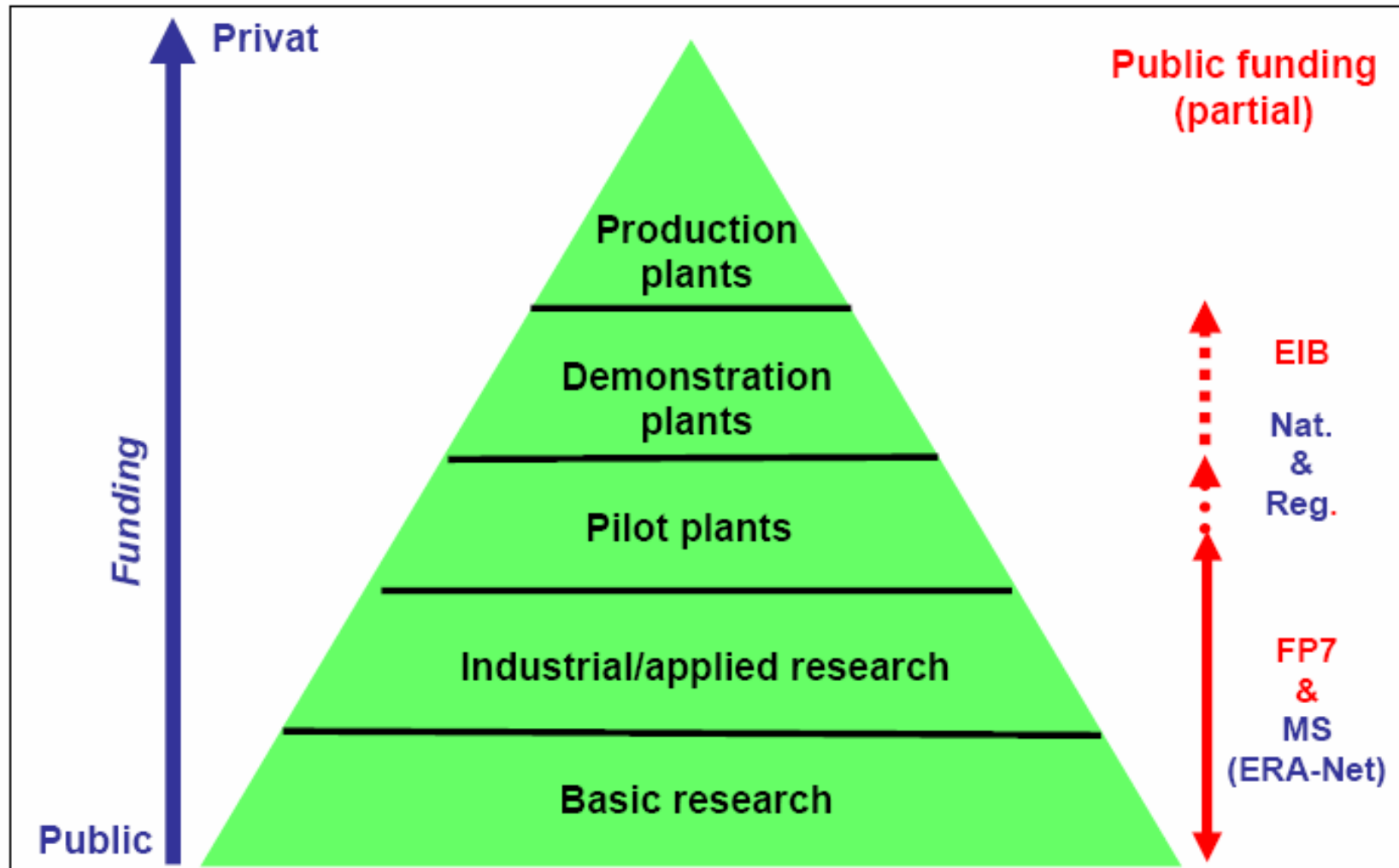
Funding (Pilot & Demonstration)



Funding (Pilot & Demonstration)



Funding (Pilot & Demonstration)



Funding (Pilot & Demonstration)

Funding possibilities:

- 1.1 Private funding
- 1.2 Government funding EU
 - 1.2.1 The European Investment Bank (EIB)
 - 1.2.2 The Risk Sharing Finance Facility (RSFF)
 - 1.2.3 The European Strategy Forum on Research Infrastructures (ESFRI)
 - 1.2.4 The European Regional Development Fund (ERDF)
 - 1.2.5 The 7th Framework Programme (FP7)
- 1.3 Industrial participation EU
- 1.4 Government funding US
- 1.5 Funding by EU member states
 - 1.5.1 The Netherlands
 - 1.5.2 Finland



Funding (Pilot & Demonstration)

Possible scenarios to mobilise additional financial resources for pilot plants and demonstration projects should include the following steps:

- a mapping of different pilot/demonstration plants already existing in the EU, including a description of available infrastructure;
- an inventory of future (technological) needs & gaps;
- better coordination, improving the access (sharing) and use of pilot plants;
- access to funding for pilot and demonstration plants should be coordinated and facilitated at EU level;
- put financing of pilot or demonstration plants for biorefineries on the next ESFRI roadmap, containing the needs for infrastructures of pan-European interest for the next 10 to 20 years.



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Industrial implementation

Possible scenarios:

- Conversion of existing biorefineries into integrated biorefineries
- Local integrated/decentralised biorefineries
- Industrial clusters
- Public-Private Partnership
- Joint Venture
- Co-location



Scenarios for biorefinery development

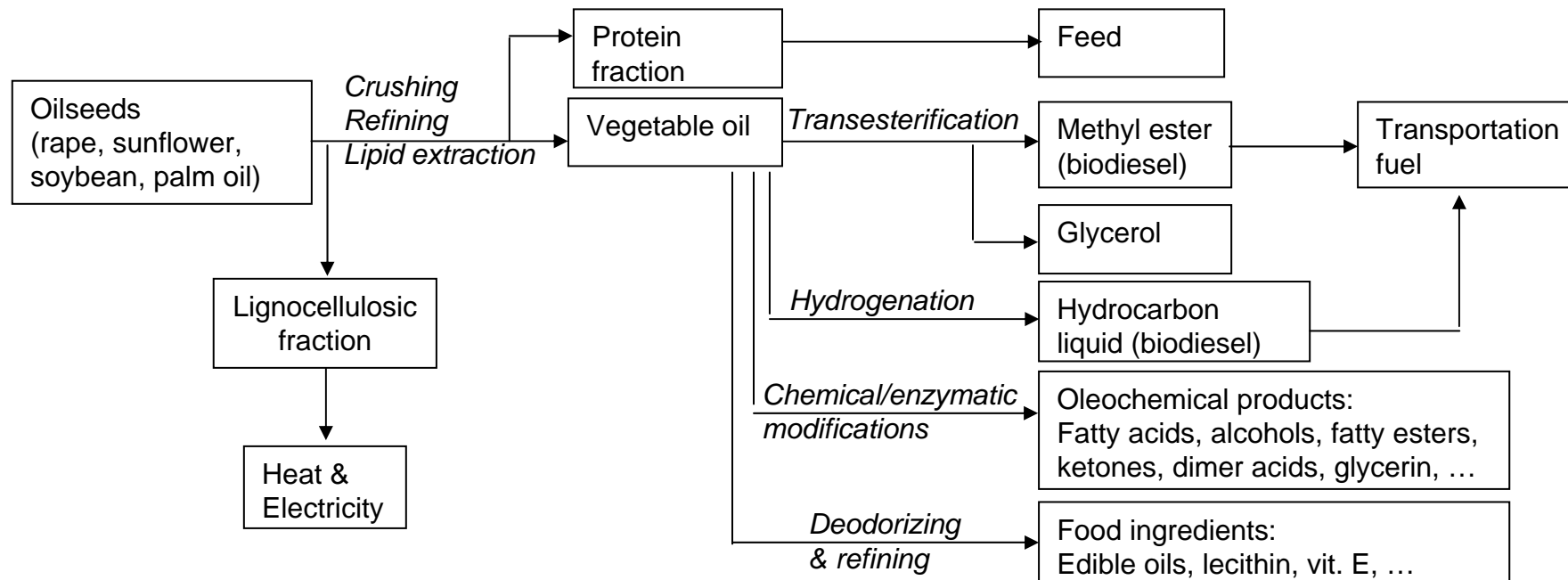
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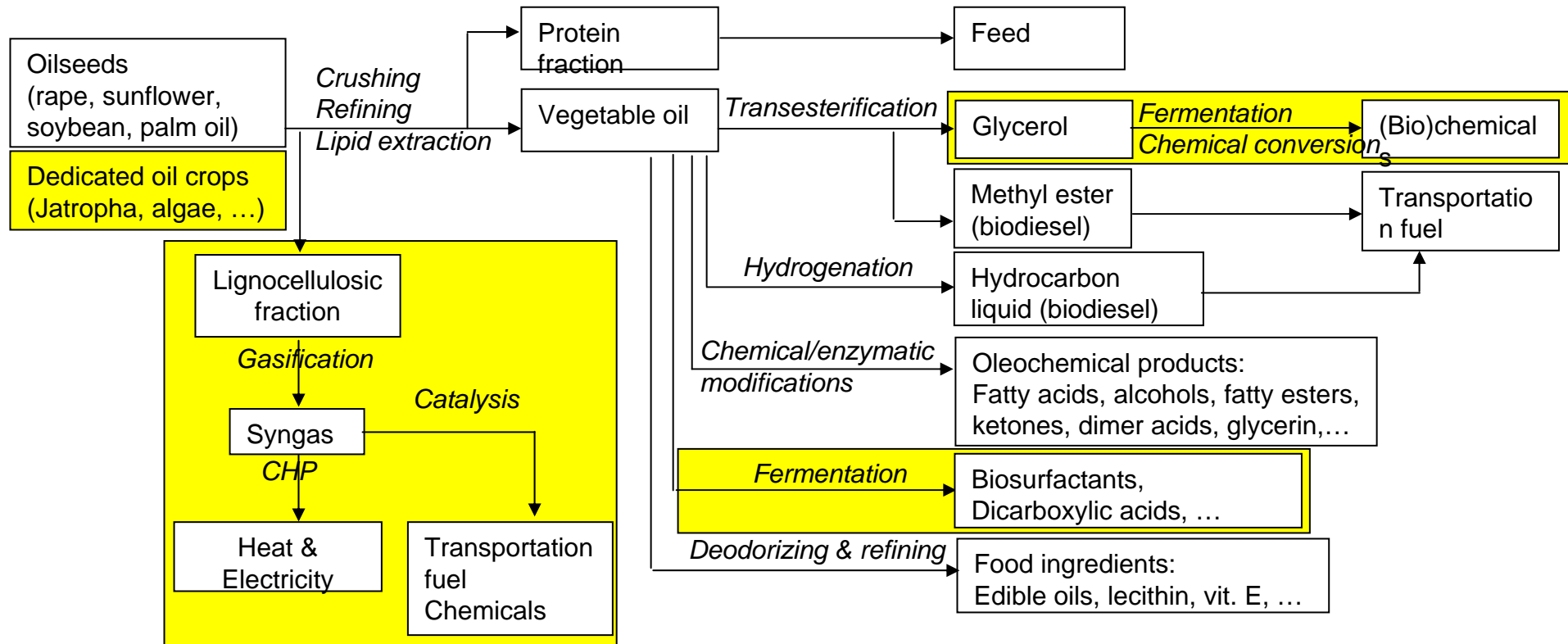
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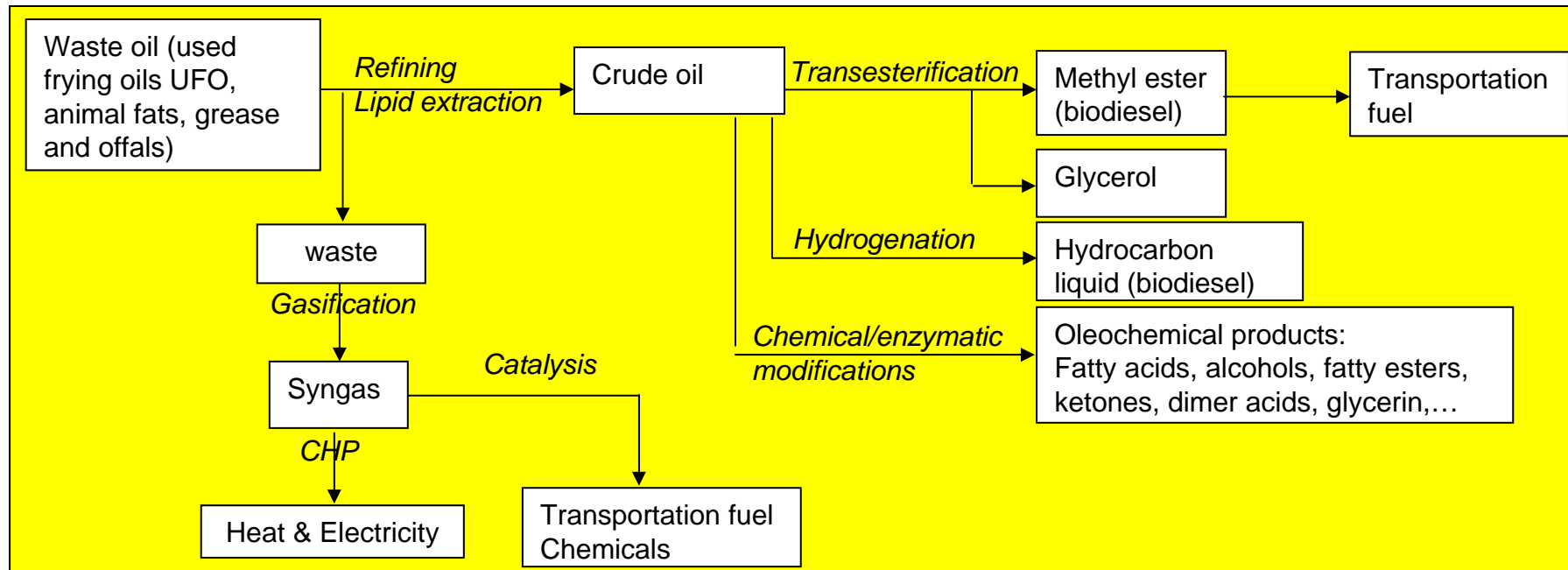
Current oilseed biorefinery



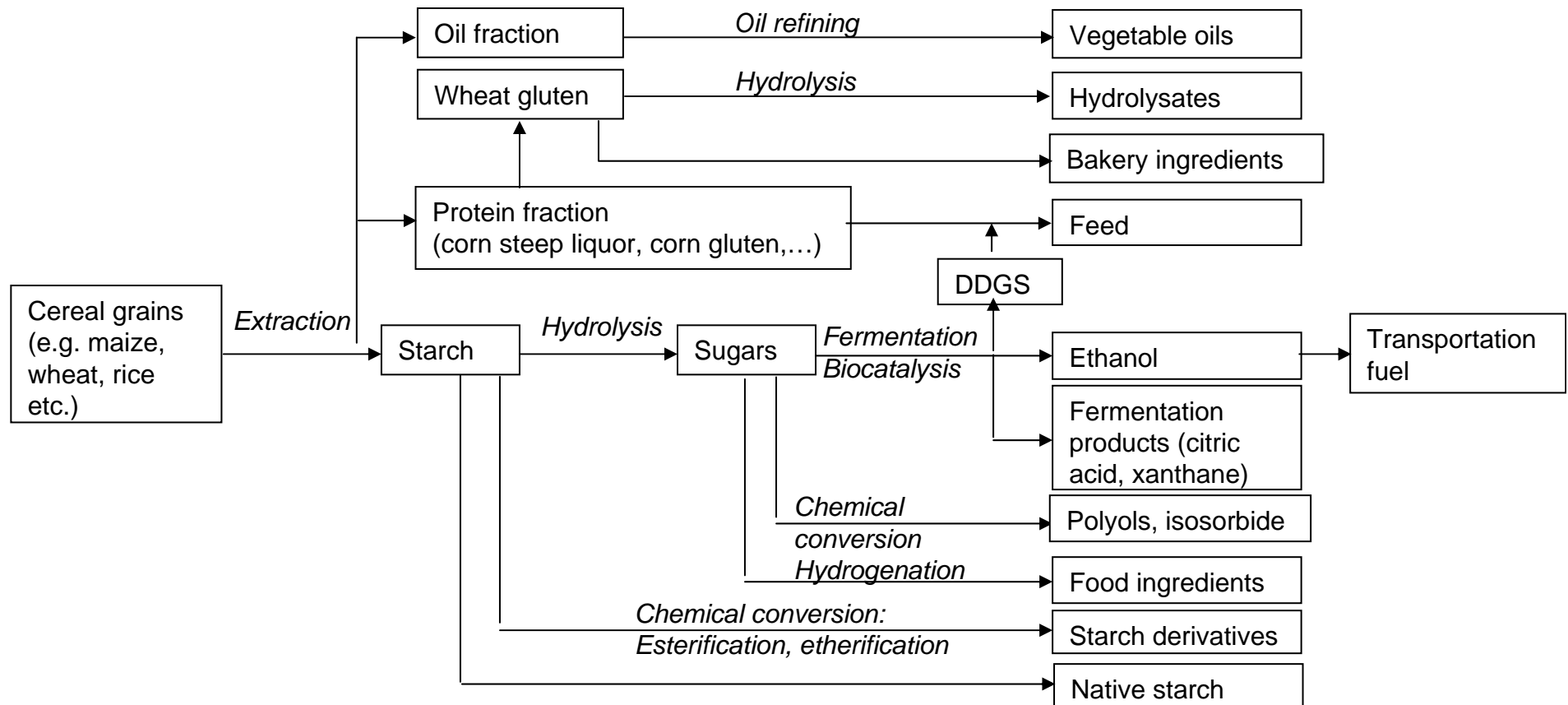
Future Oil & Fat biorefinery



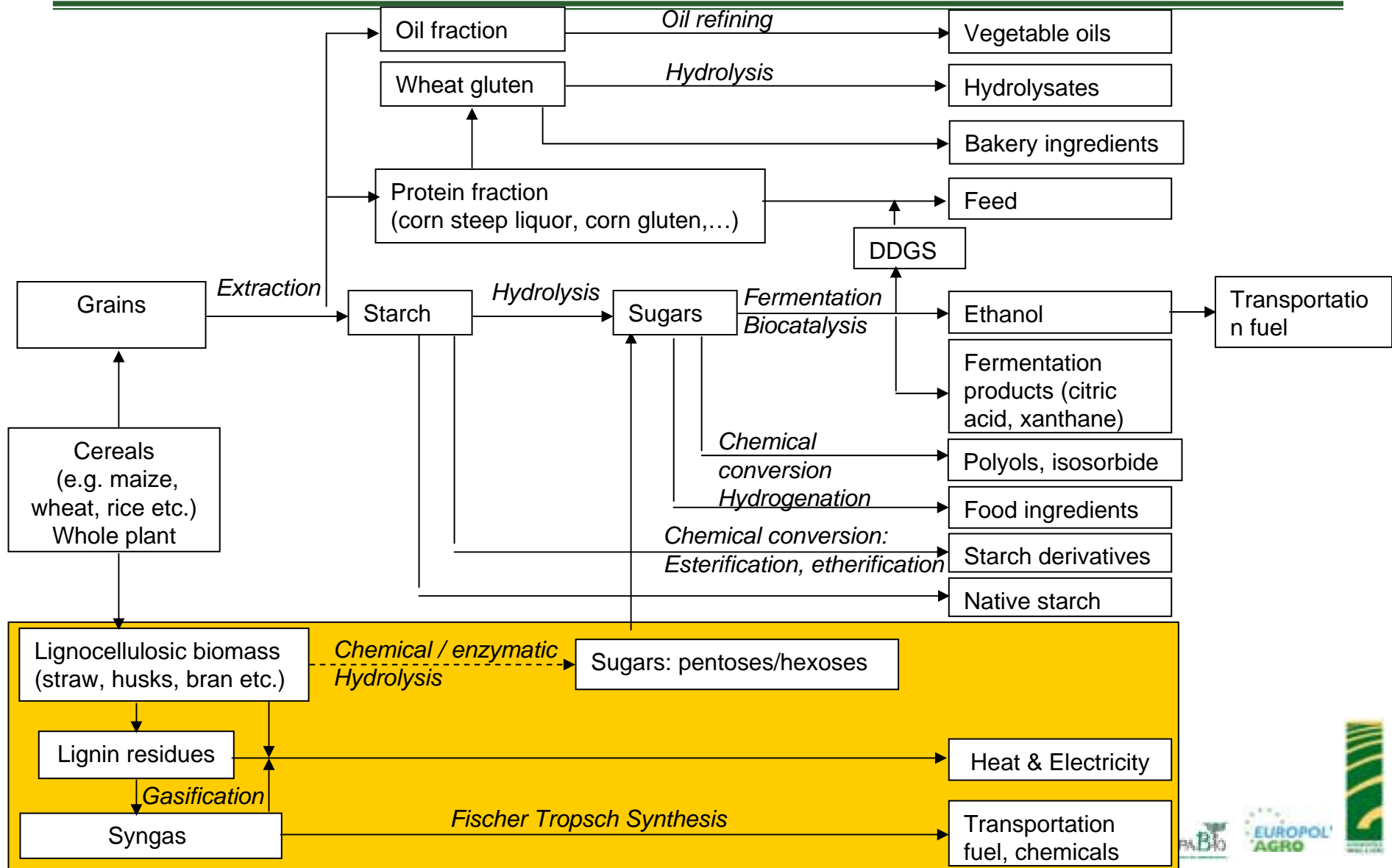
Future 'Waste' biorefinery



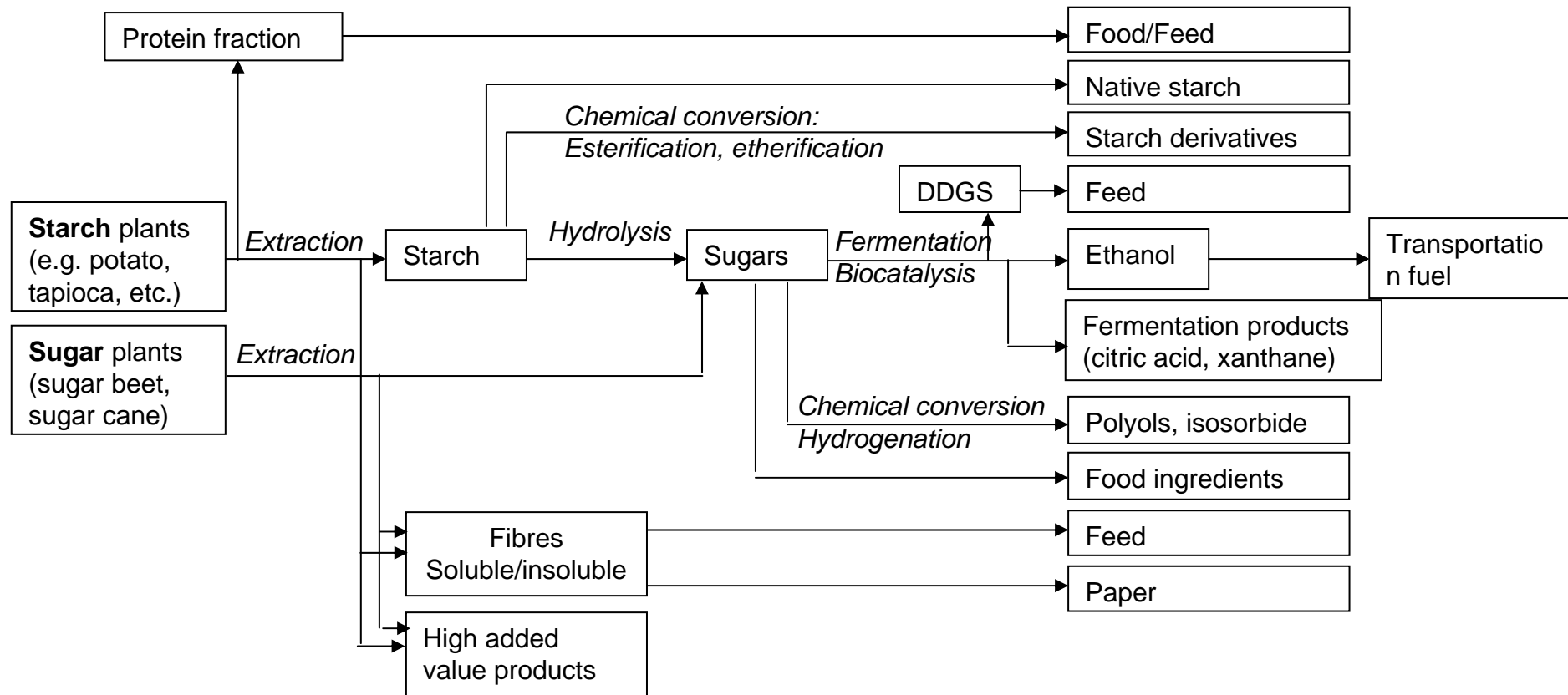
Current cereal biorefinery



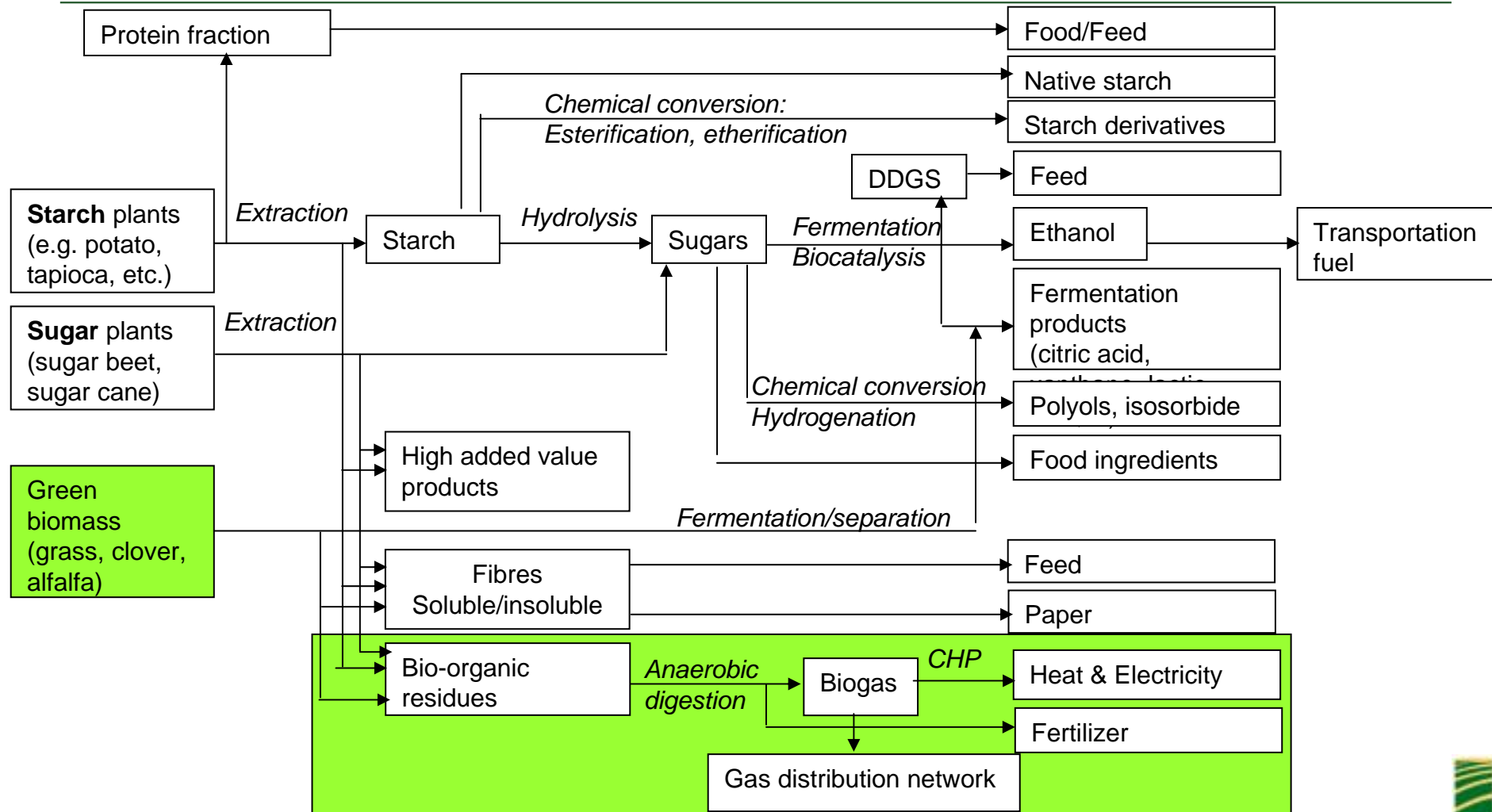
Future cereal biorefinery



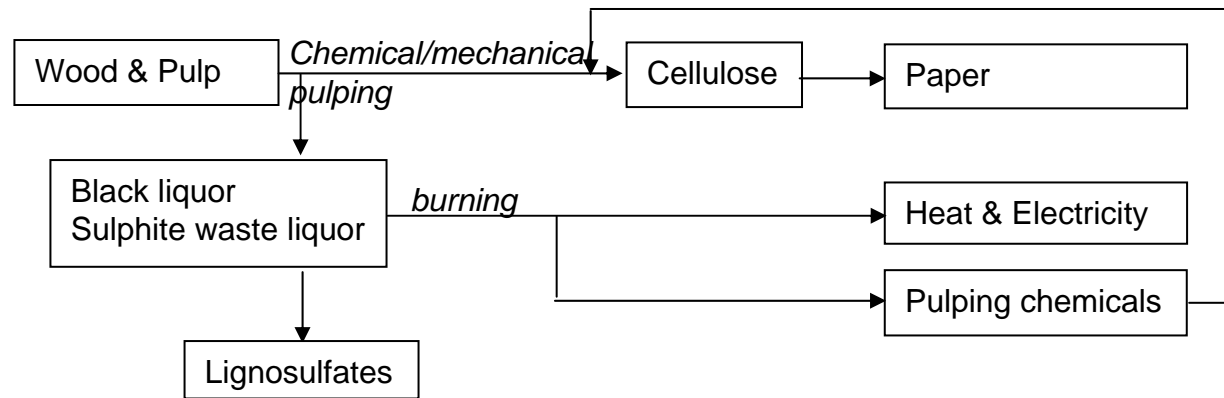
Current green biorefinery



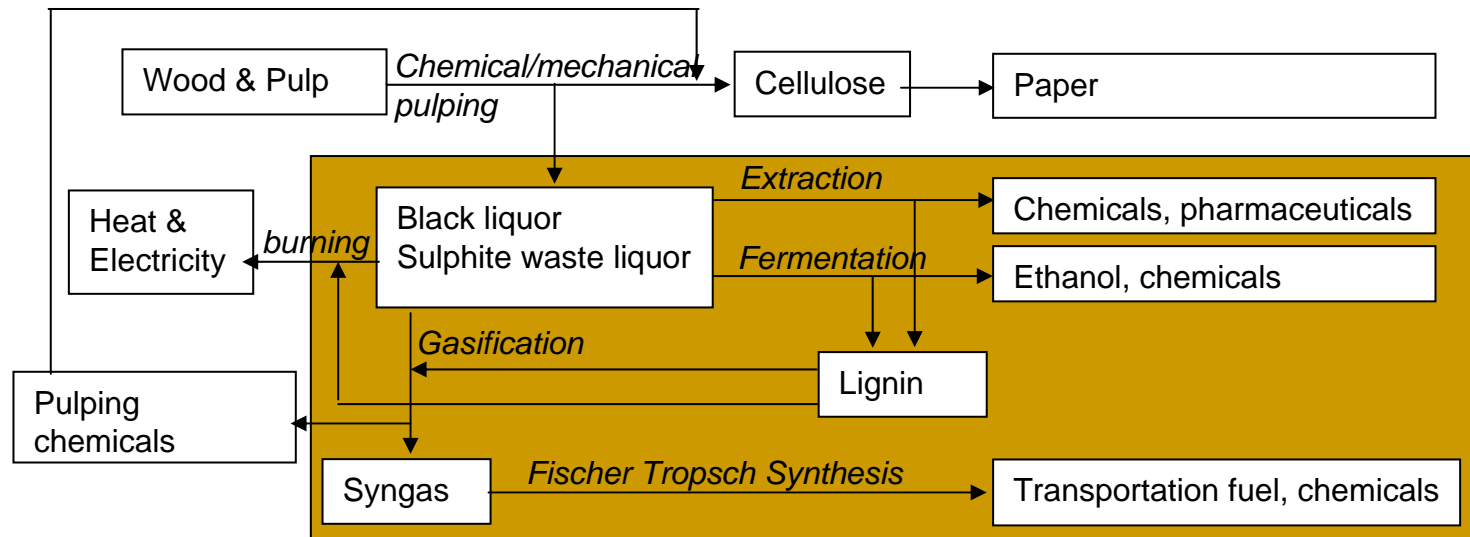
Future green biorefinery



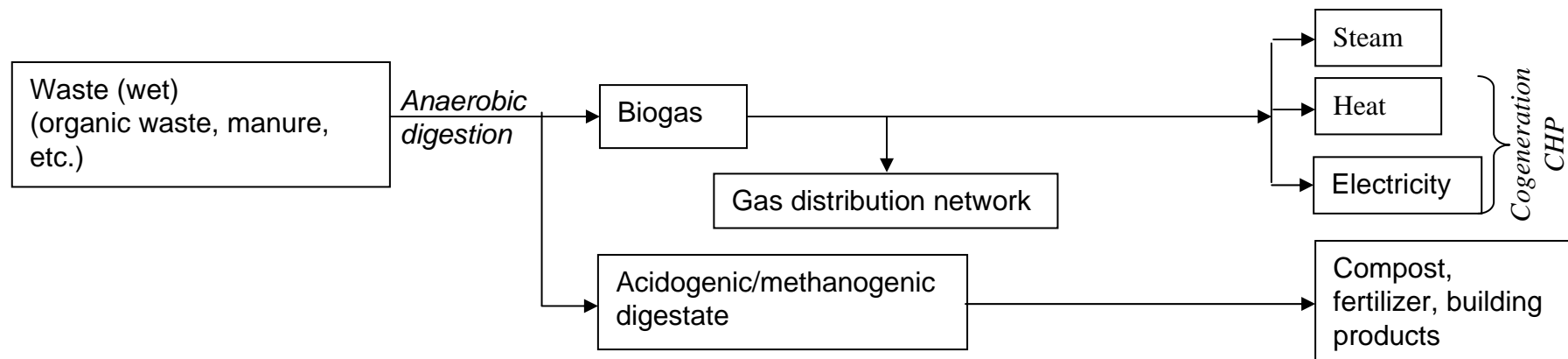
Current Forest-based Biorefinery



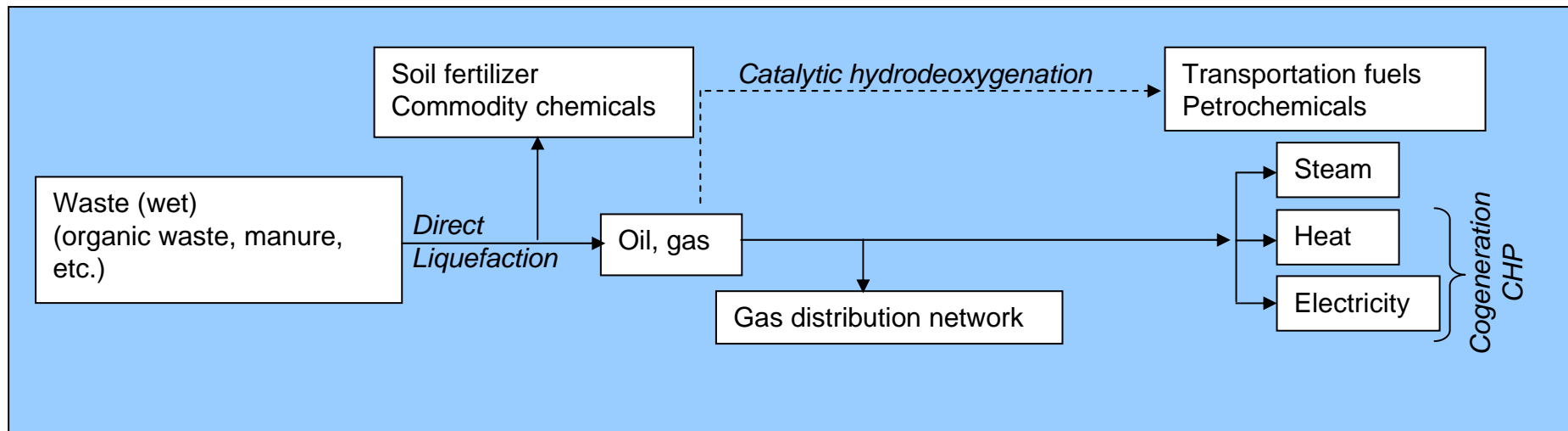
Future Forest-based Biorefinery



Current Waste Biorefinery



Future Waste Biorefinery



Overall conclusions

- Concept depends on EU agricultural policy
- Stimulate conversion of existing agroindustries into (integrated) biorefineries
- Stimulate R&D for 2nd generation conversion technologies
- Facilitate funding of pilot and demonstration plants



Information

Title: **Current situation and potential of the biorefinery concept in the EU: strategic framework and guidelines for its development**

Acronym: BIOREFINERY EUROVIEW

Start date: 1st March 2007

Duration: 24 months

EC Scientific Officer: Dr Piero Venturi, European Commission - DG RTD

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