BioPUSh: Integrated Strategies for Identifying Optimal Bio-energy Production & Utilisation Systems

Copernicus Institute
Research Institute for Sustainable Development and Innovation

Wageningen University

Background of the project

Actual total energy consumption in NL: 2700 PJ y^{-1}

In 2020 ⟶ 270 PJ (10%) from renewable energy

⟶ 120 PJ (45 % of renewables) from biomass

Background of the project

Advantages of biomass:

+ high potentials, CO_2 substitution

+ manyfold applications (energy and material)

+ direct application

Drawbacks of biomass:

- more expensive than fossil energy

- large land resources required, competition with other land use options

- production and utilisation systems not yet optimised

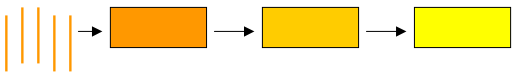
Objective: Identification of biomass systems that will result in cheaper biomass energy and more efficient land use

Background of the project

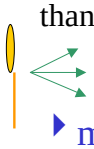
Elements of improved biomass systems

Multiple product crops = crops that produce more than one product of which one product is used as energy source

Cascade use of biomass = harvested biomass is first used as a high quality resource for the production of non-energy products and later on in the life cycle used for lower quality products



Multiple land use = land use aimed at the generation of more than one type of product and/or service



multifunctional multi-product bio-energy systems

Aims of BioPUSh

- identification of promising multifunctional multi-product bio-energy systems and modelling of costs, energetic performance and carbon balance.

- economic interactions between large-scale application of multifunctional multi-product bio-energy systems, the prices of land and competition with conventional agricultural products.

- network and process strategies for innovation, diffusion and implementation in multifunctional multi-product bio-energy systems; barriers and carriers that influence introduction.

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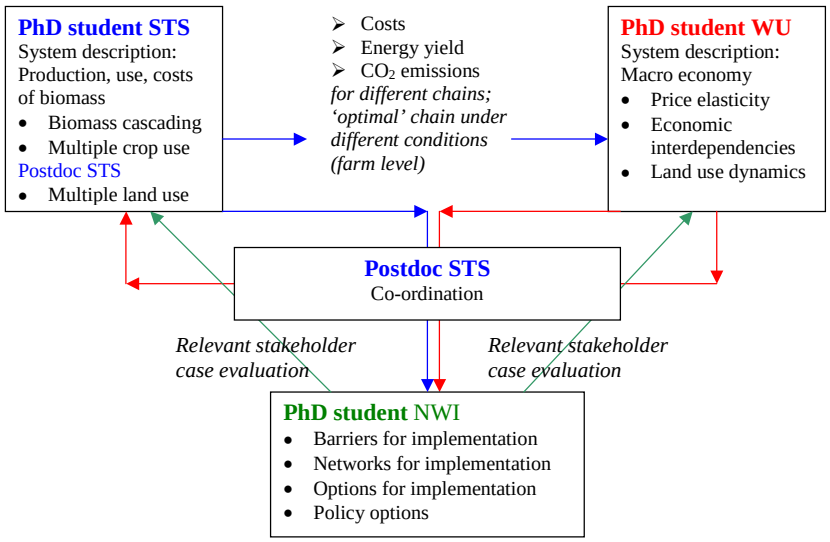
BioPUSh - Structure



Results: Multiple land use functions

1. Identification: for multifunctional multi-product bio-energy systems

Goods	- production of biomass	15 functions identified
	- waste treatment ….	
Services	- Nature management and conservation	
	- Recreation facilities…..	29 functions identified

2. Quantification: economic values and biophysical effects of functions

- Market price
- Willingness to pay
- Prevented costs
- Additional benefit
- Substitution cost method
- Field trials
- Pot trial
- Derivation from other crops
- Modeling
- LCA

3. Assessment of combining abilities

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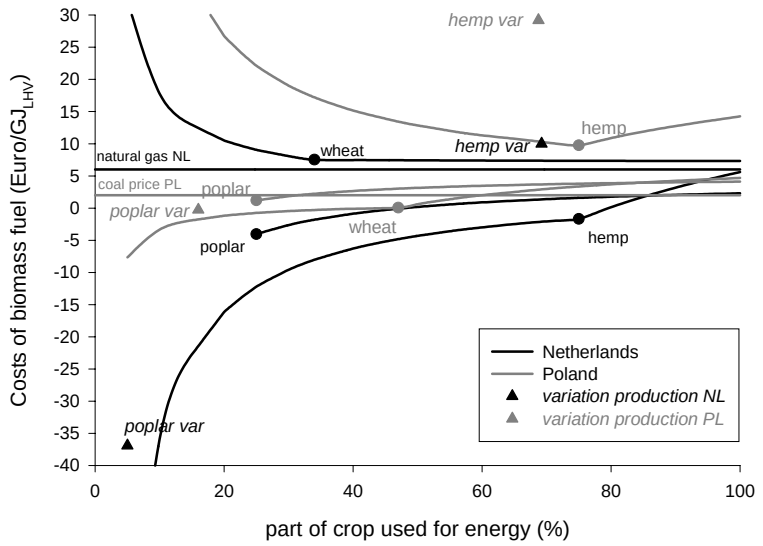
Results: Multi-product crops

Bio-energy costs of multi-product crop systems



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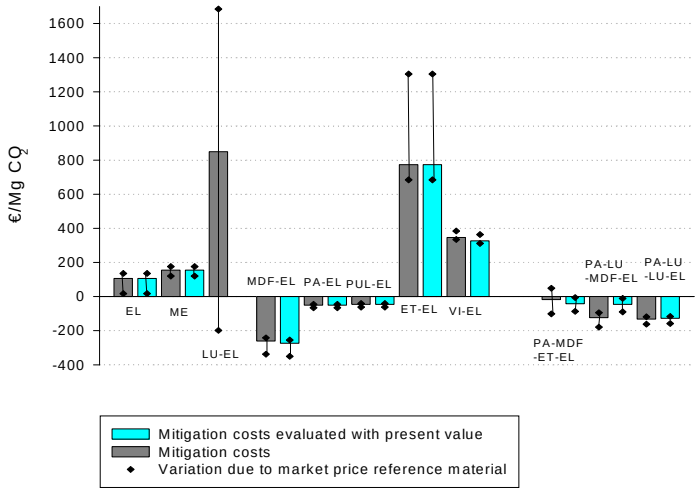
Results: Cascading

comparison of CO_2 mitigation costs of different chains



EL: electricity
ME: methanol
LU: particle lumber
MDF: MDF board
PA: Pallet
PUL: Pulp
ET: Ethylene
VI: Viscose

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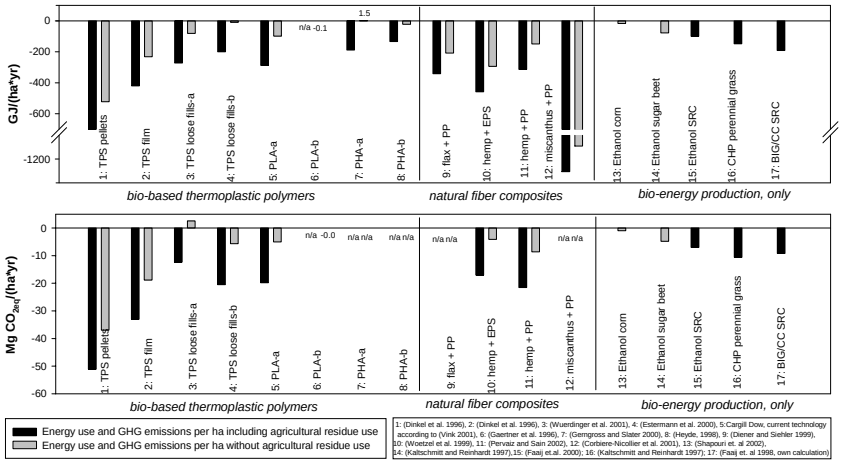
Results: Land use efficiency

Land requirements: bio-based polymers, multi-product bio-based polymers and bio-energy



1: (Dinkel et al. 1996), 2: (Dinkel et al. 1996), 3: (Wuerdinger et al. 2001), 4: (Estermann et al. 2000), 5:Cargill Dow, current technology according to (Vink 2001), 6: (Gaertner et al. 1996), 7: (Gemgross and Slater 2000), 8: (Heyde, 1998), 9: (Diener and Siehler 1999), 10: (Woetzel et al. 1999), 11: (Pervaiz and Sain 2002), 12: (Corbiere-Nicollier et al. 2001), 13: (Shapouri et. al 2002), 14: (Kaltschmitt and Reinhardt 1997),15: (Faaij et.al. 2000); 16: (Kaltschmitt and Reinhardt 1997); 17: (Faaij et. al 1998, own calculation)

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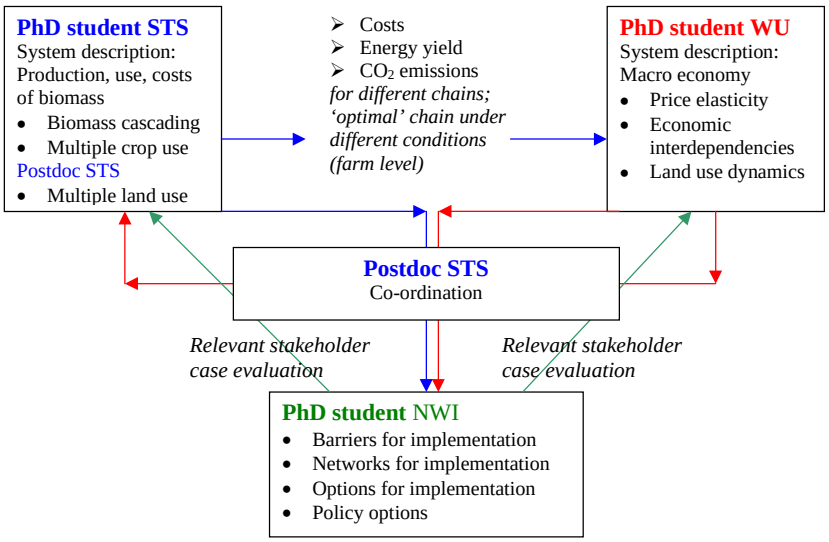
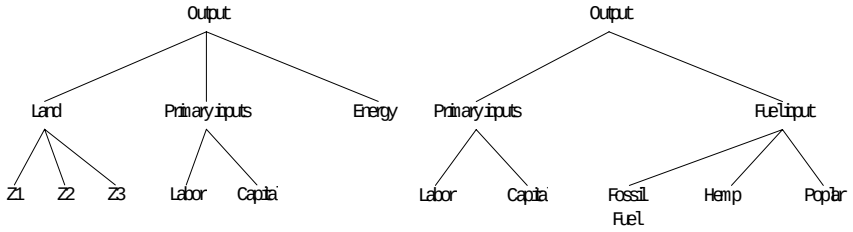


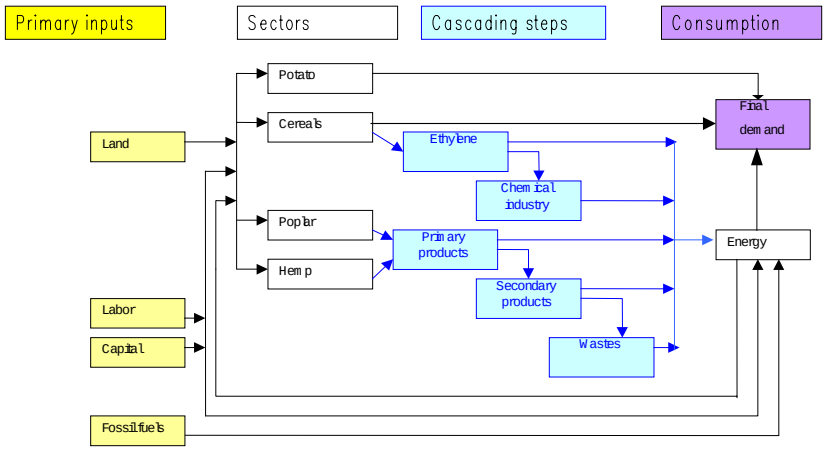
Substitution Possibilities (CES)



Nested structure of a production function of agricultural (Potatoes, Cereals) and biomass (Hemp, Poplar) sectors

Nested structure of a production function of Energy sector

Approach



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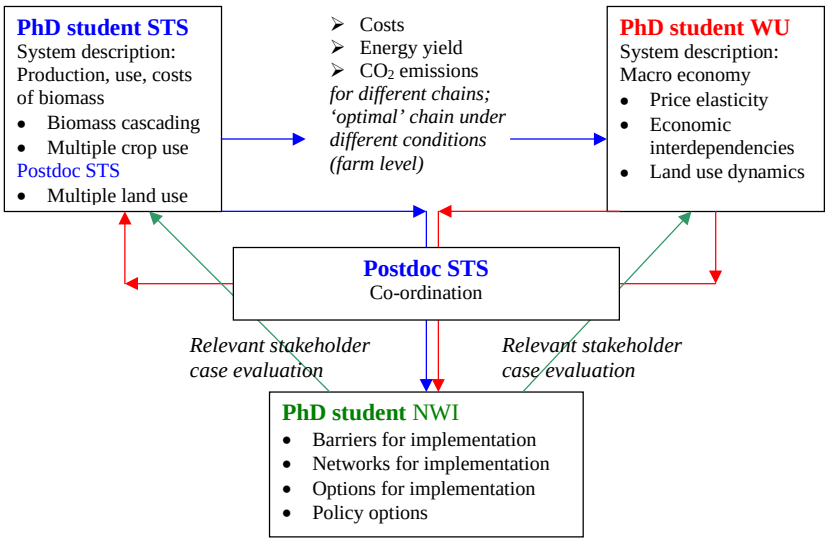

Preparation of workshop for BioPUSh project, using Group System Support Software

Status Quo of case selection

Countries	Land use functions	Crops	Material uses	Energy uses
Poland	Bioremediation	Willow		Ethanol
Germany	Buffer functions	Cereals	Ethylene	Methonal
	Marginal areas	Miscanthus		Electricity
		Forest		
		Poplar	Construction material	
		Hemp		

Which results are expected ?

⇒**Characteristics of different multi-functional biomass systems,** i.e. GHG reduction, costs (bottom up), land requirement

⇒**Quantification of possible benefits** of biomass cascading and multi-product crop use compared to pure energy crop use

⇒**Insight into crucial parameters** that determine whether multi-function biomass systems are advantageous compared to pure bio-energy systems

Which results are expected?

⇒Tool to depict land use competition and to identify optimal land use for biomass production

⇒ Identification of relevant stakeholder and networks

⇒ Identification of barriers for implementation of multi-functional biomass systems

⇒ Innovation concepts that influence the development and diffusion of biomass technology

⇒ Improved tool for decision making on biomass policy

What are the benefits of these results?

Identification of efficient multi-functional biomass chains

- i.e. chains with a high reduction of GHG emissions
- low costs of bio-energy
- efficient land use

Tools for estimating effects of large scale implementation of multi-functional biomass chains

Tools for for enhancing implementation of multi-functional biomass chains