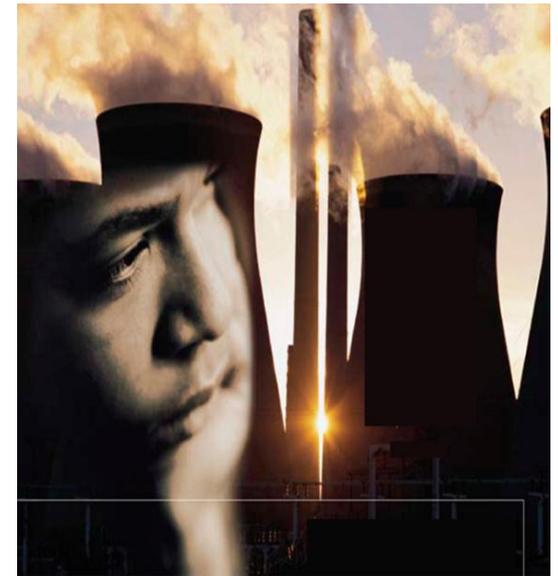

Calculation of GHG emission reductions during cultivation and processing of switchgrass

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Outline of presentation

- Introduction
- Methodology
- Results
- Discussion
- Conclusion



Introduction

Pellets for Power project

The overall aim of Pellets for Power is to meet the growing demand for environmentally sustainable energy production that would meet European standards of environmental sustainability. Using biomass sources that reduce global emissions of greenhouse gases to avoid indirect effects, while maximizing the environmental and social benefits.

There are two specific goals:

1. Development of environmentally sustainable business model for pelletizing of biomass residues, reed and energy crops in Ukraine for domestic and Dutch energy markets.
2. Testing of environmentally sustainable production of biomass that is available and energy crops on bare soil, avoiding at the same time, indirect land use changes (iLUC).



Introduction

Sustainability criteria and GHG emissions

- EU Renewable Energy Directive
 - NTA 8080 / 8081 (Netherlands)
 - ISCC (Germany)
- GHG balance of biomass chain must be positive
- For RED 2009/28/EC:
- Till 2017 at least 35% better than fossil reference
 - From 2017 at least 50% better than fossil reference
 - From 2018 at least 60% better than fossil reference



Introduction

GHG calculation for EU RED 2009/28/EC

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

E = total emissions from the use of the fuel;

e_{ec} = emissions from the extraction or cultivation of raw materials;

e_l = annualised emissions from carbon stock changes from land use change;

e_p = emissions from processing;

e_{td} = emissions from transport and distribution;

e_u = emissions from the fuel in use;

e_{sca} = emission saving from soil carbon accumulation via improved agricultural management;

e_{ccs} = emission saving from carbon capture and geological storage;

e_{ccr} = emission saving from carbon capture and replacement; and

e_{ee} = emission saving from excess electricity from cogeneration

e_{ILUC} = *emissions related to Indirect Land Use Change effects (ILUC) ???*



Introduction

Objective of study

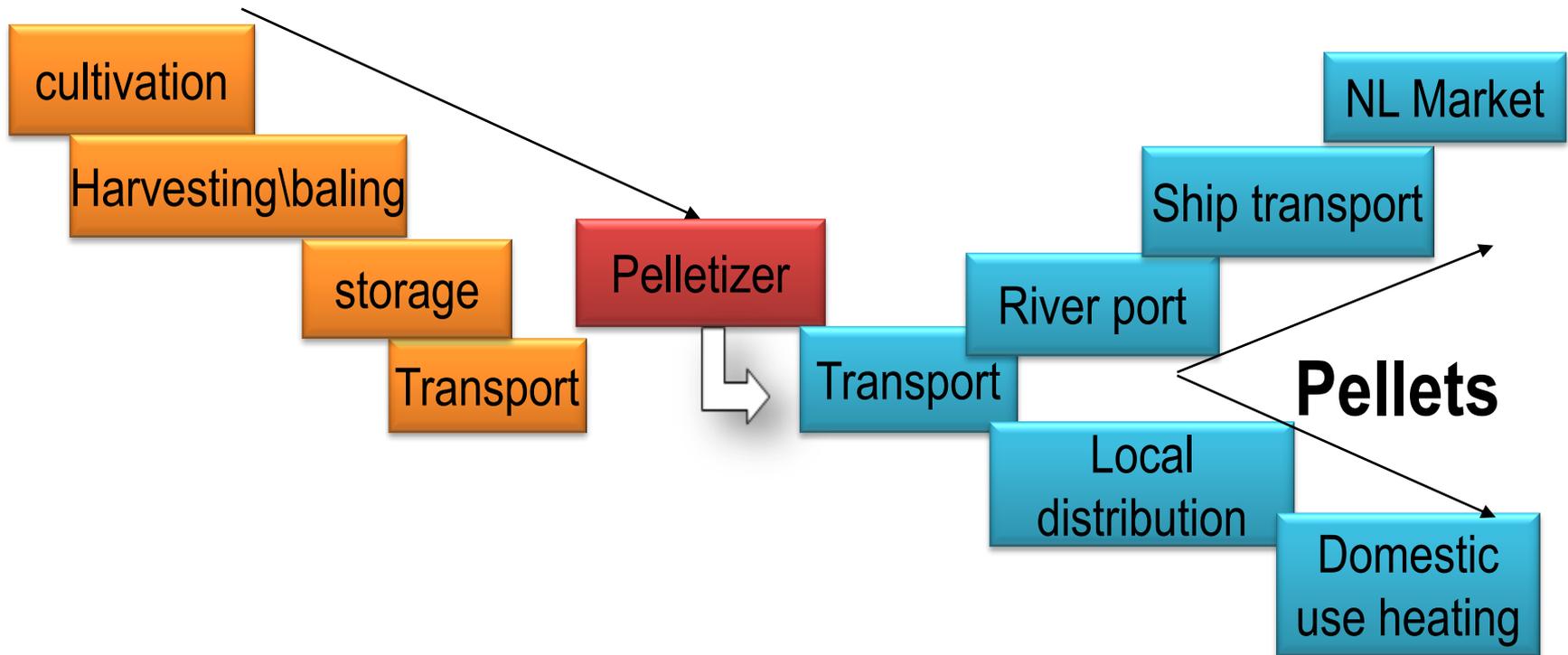
The purpose of this study was, within the requirements of NTA 8080, to develop a greenhouse gas emission model and to quantify the impact of switchgrass chain supply on GHG emissions.

1. Switchgrass cultivation on good versus bad soil
2. Pellet use for electricity production in Netherlands versus local use for heating in Ukraine



Methodology

Assessed switchgrass chains



Methodology

GHG calculation tool switchgrass chain

- Calculation according to RED 2009/28/EC formula
- Simple Excel based model
- IPCC 2006 guidelines and Biograce standard values

Summary results			
GHG emission component	gCO ₂ -e/MJ pellet	gCO ₂ -e/kg pellet	gCO ₂ -e/MJ pellet
Eec1 (emission from inputs)	4.7	4.9	0.29
Eec2 (emission from field operations)	0.5	0.2	0.01
EI (emission from land use change)	0.0	0.1	0.01
Ep (emission from processing)	14.2	2.2	0.13
Etd (emission from transport)	6.2	4.9	0.29
Esca (emission saving improved soil management)	-22.6	0.2	0.01
Total:	3.0	0.1	0.01
		2.2	0.13
		3.3	0.19
		1.1	0.06
		0.4	0.02
		0.7	0.04
		0.7	0.04
Fossil fuel reference	198	0.3	0.02
% saved emissions	98.5	1.2	0.07
		0.3	0.02

Methodology

Calculation soil carbon stock changes

- Based on IPCC 2006 guidelines
- $SOC = SOC_{REF} * F_{LU} * F_{MG} * F_I$
- Assign relative ΔSOC factors
 - Land use (F_{LU}) (0.69 – 1.10)
 - Land management (F_{MG}) (1.00 – 1.15)
 - Carbon input (F_I) (0.92 – 1.44)
- Stock changes calculated over 20 years
- Unit: ton C/ha, of upper 30 cm of the soil

	F_{LU}	F_{MG}	F_I	Good soil		Bad soil	
				SOC_{REF}	SOC	SOC_{REF}	SOC
Arable land	0.8	1	1	125	100	44	35
Switchgrass	1	1.02	1	125	127	44	45
Grassland	1	1	1	125	125	44	44

Methodology

Assumptions for GHG calculation

- No existing switchgrass chain yet in Ukraine
- Inputs and yield levels were estimated based on the preliminary switchgrass manual for Ukraine (Elbersen et al., 2011)
- Fertilizer inputs are based on ‘balanced fertilization’
- Data for field operations were derived from local measurements

Results

Good versus bad soil

	Good soil	Bad soil
GHG emission component	gCO ₂ -e/MJ pellet	gCO ₂ -e/MJ pellet
Eec1 (Emissions from inputs)	4,7	5,1
Eec2 (Cultivation operations)	0,5	0,8
EI (Emissions from carbon stock changes caused by land-use change)	0,0	0,0
Ep (Pellet production)	14,2	14,2
Etd (Switchgrass transport to pelletizer)	6,2	6,2
Esca (emission saving from soil carbon accumulation via improved agricultural management)	-22,6	-12,5
Total:	3,0	13,8
Fossil fuel reference	198	198
% saved emissions	98,5	93,1

Good soil (Vasili Podil)

Yield 12 ton/ha/year

SOC change: 5.0 ton CO₂/ha/year

Bad soil (Yeltushkiv)

Yield 7 ton/ha/year

SOC change: 1.8 ton CO₂/ha/year

Results

Export for electricity production versus local use for heating

	Export NL	Local use
GHG emission component	gCO ₂ -e/MJ pellet	gCO ₂ -e/MJ pellet
Eec1 (Emissions from inputs)	5,1	5,1
Eec2 (Cultivation operations)	0,8	0,8
Ei (Emissions from carbon stock changes caused by land-use change)	0,0	0,0
Ep (Pellet production)	14,2	14,2
Etd (Switchgrass transport to pelletizer)	6,2	0,6
Esca (emission saving from soil carbon accumulation via improved agricultural management)	-12,5	-12,5
Total:	13,8	8,2
Fossil fuel reference	198	87
% saved emissions	93,1	90,5

Discussion

- Lack of actual switchgrass data for Ukraine
- Therefore uncertainty in input data, but overall balance is very positive, and much better compared to arable crops (rapeseed, sunflower, etc.)
- Large SOC gain by conversion of arable land, conversion of abandoned land or grassland will results in lower SOC gain
- If soil is classified as 'degraded land' a bonus of 29 g CO₂-eq/MJ might be subtracted for 10 years
- However, no incentive for switchgrass, since GHG balance is already very positive, but costs on degraded soil will be higher

Conclusions

- GHG balance of switchgrass chain is very positive
- This is partly due to soil carbon sequestration and low emissions from cultivation
- Largest emissions currently occur in processing phase
- Switchgrass cultivation on bad soils has slightly lower GHG balance, but no ILUC effect
- GHG balance depends of final energy use



ФОРЕСБУРГ

QUESTIONS?

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