Short rotation woody crops for bioenergy

a financial, energetic and environmental perspective

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Who are we?
Research Group of Plant & Vegetation Ecology

- Staff of 45 persons – gender ratio of 1/1
- 3 FT professors, over 20 Ph.D.'s, 14 post-docs
- 1/3 non-Belgian – 12 different nationalities
- 10 FT researchers: renewable (bio-)energy
- Different disciplines (biology, engineering, economics, physics,…)

Energy and climate issues

- Increasing global energy consumption
- Increasing atmospheric CO_2 concentration
- Increasing dependency on imported fuels

Bioenergy as a (partial) solution

- Most important and most versatile renewable energy source
- Decreases CO_2 through the substitution of fossil fuels
- Increases the use of indigenous energy sources
- High potential for energy crops, in particular short rotation woody crops

Definition of SRWC

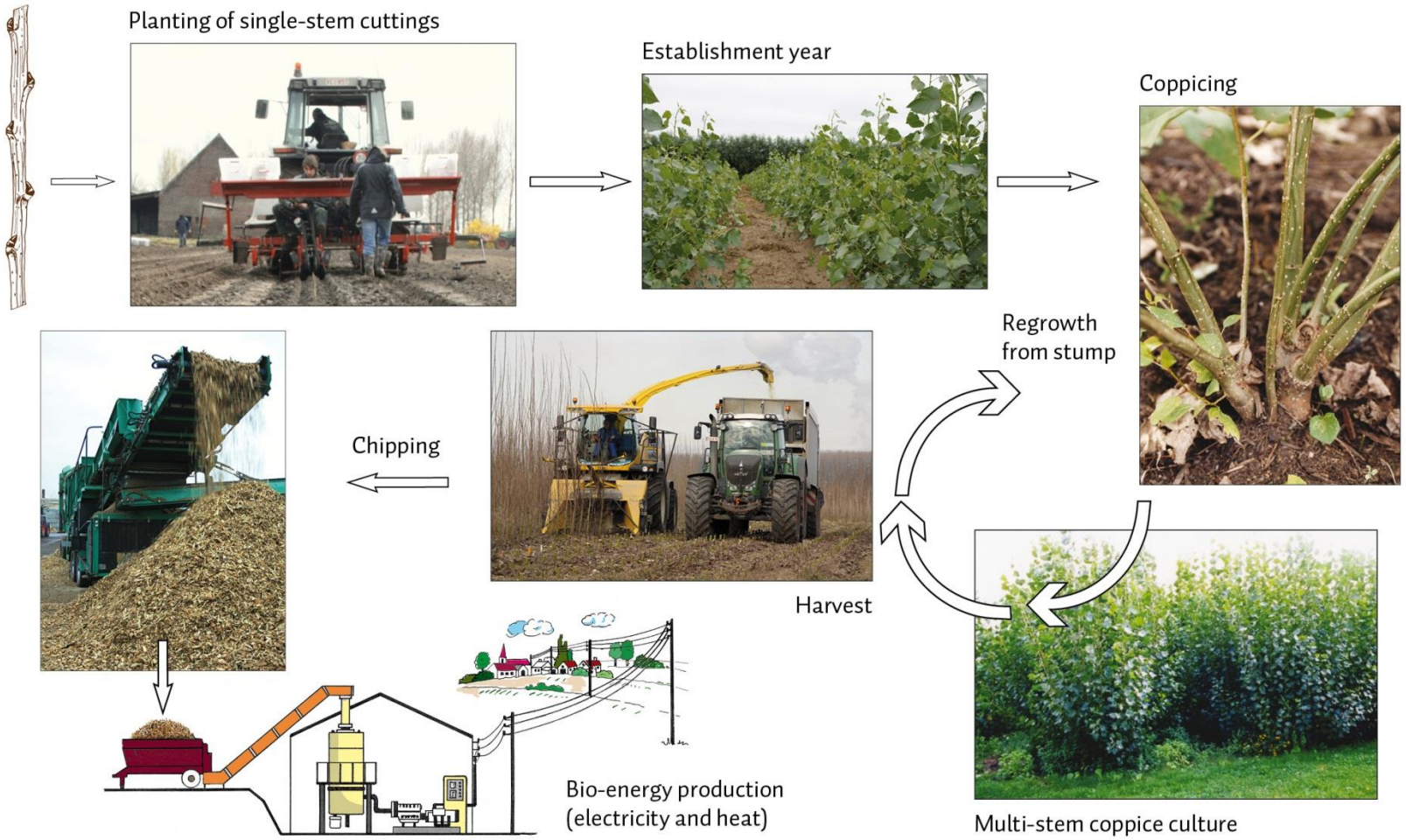
Short Rotation Woody Crops (SRWC):

a culture of fast-growing woody crops, such as poplar and willow, where the above-ground biomass is periodically and entirely harvested

Periodically:

maximum 8 years after plantation establishment or after the previous harvest (in many cases: between 2 and 5 year)

Short rotation woody crops for bioenergy



Unanswered questions?

1. Do SRWC decrease the greenhouse gases (GHG) in the atmosphere?

2. What is the energetic efficiency and economic profitability of SRWC?

3. What is the global warming contribution of SRWC?

POPFULL

1. Complete balance of most important greenhouse gas emissions (CO_2, CH_4, N_2O, H_2O and O_3) using state-of-the-art measurement techniques

2. Full economic and energy balance, incl. overall energy efficiency (E_{output}/E_{input})

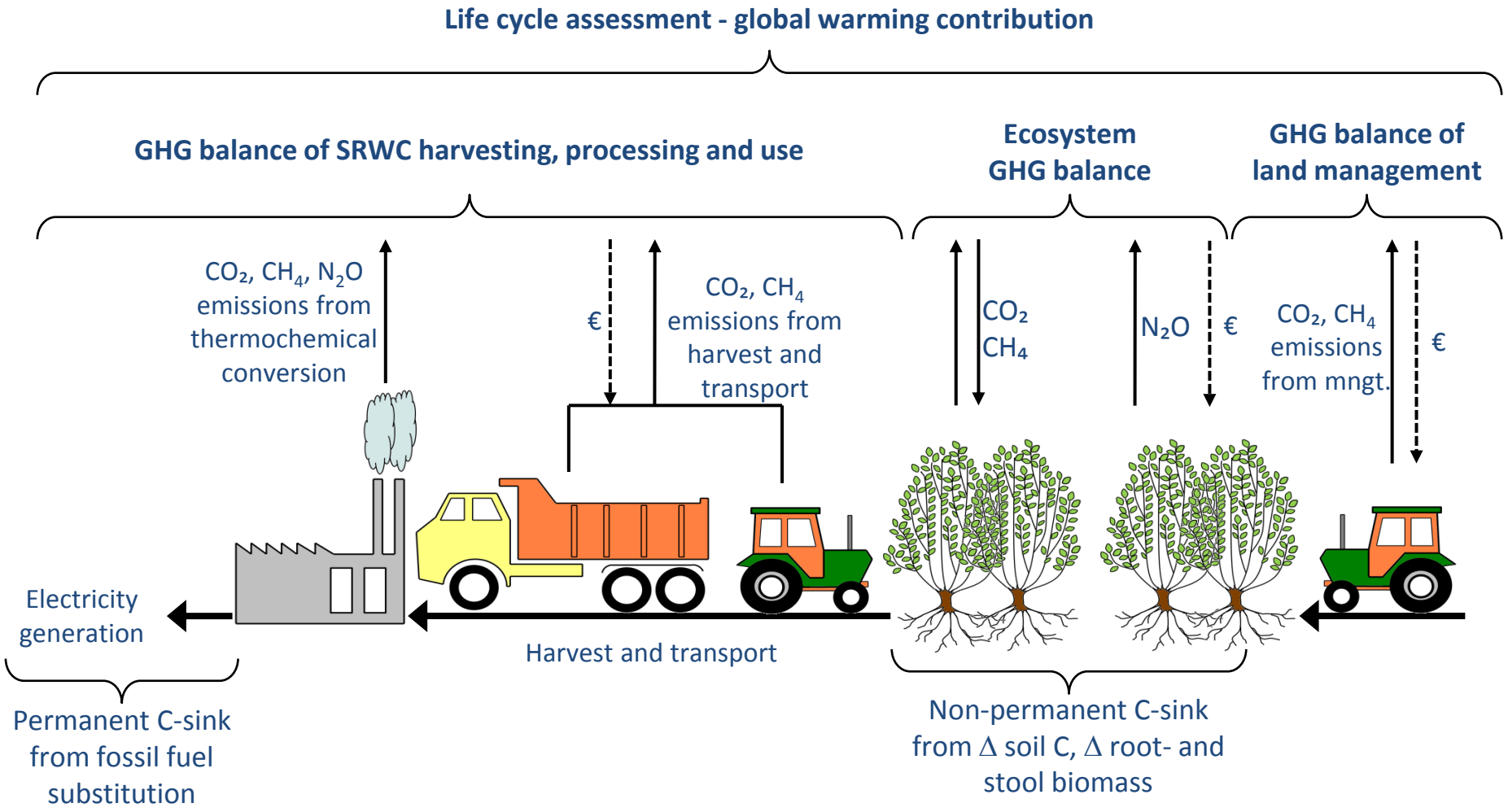
3. Full life cycle assessment (LCA) of global warming contribution of SRC

POPFULL

Operational SRWC plantation of 18.4 ha

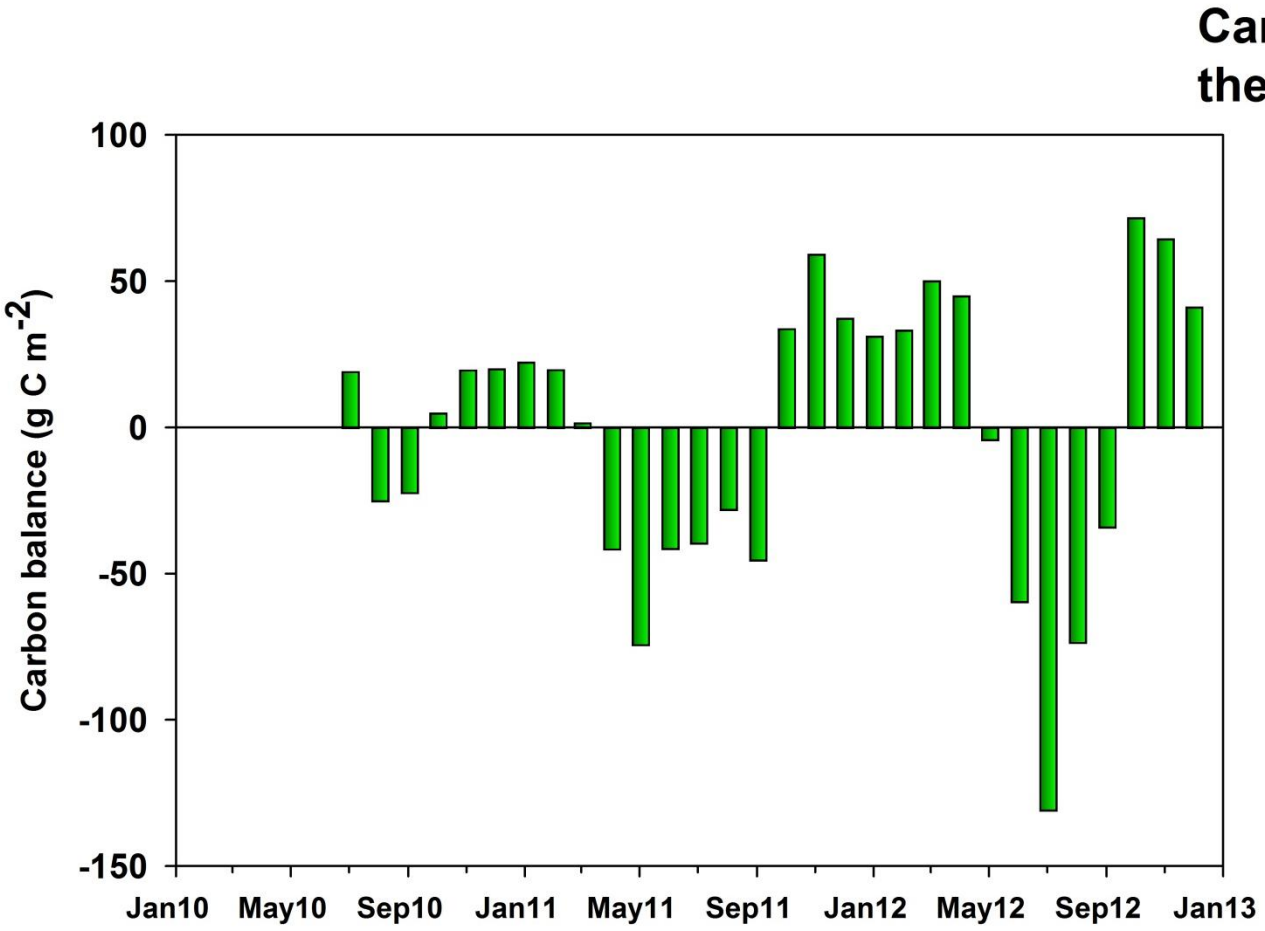
- Planted early April 2010 (14.5 ha)
- Planting density: 8000 plants ha^{-1}
  - 12 poplar clones/genotypes
  - 3 willow clones/genotypes
- No fertilization, no irrigation
- First harvest: 2-3 February 2012
  - Yield (measured): 4 odt ha^{-1} y^{-1}
- Second harvest: February 2014
  - Yield (estimated): 10 odt ha^{-1} y^{-1}

Energy and GHG balance of POPFULL

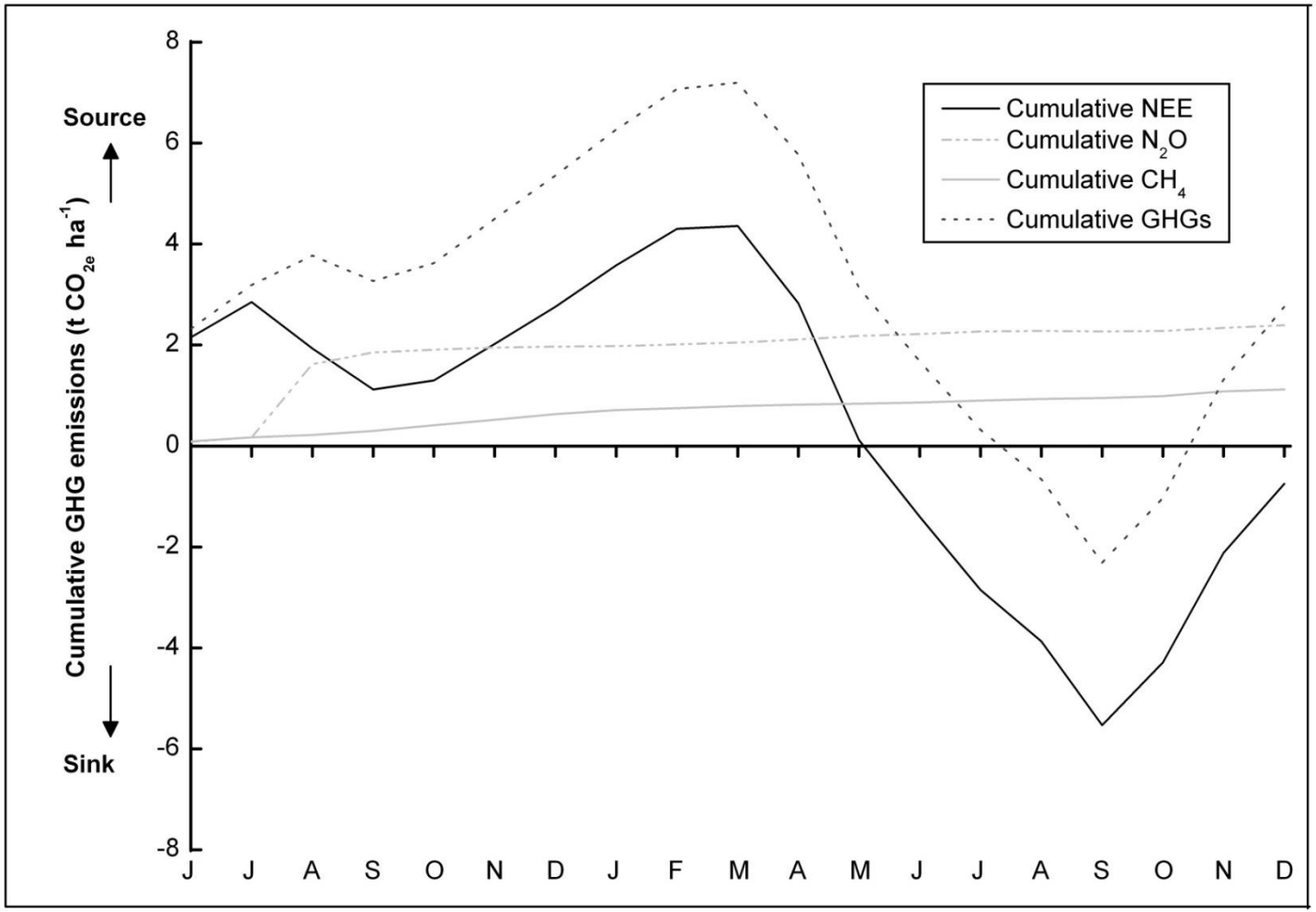


El Kasmioui, 2013 – PhD thesis

Carbon balance of POPFULL

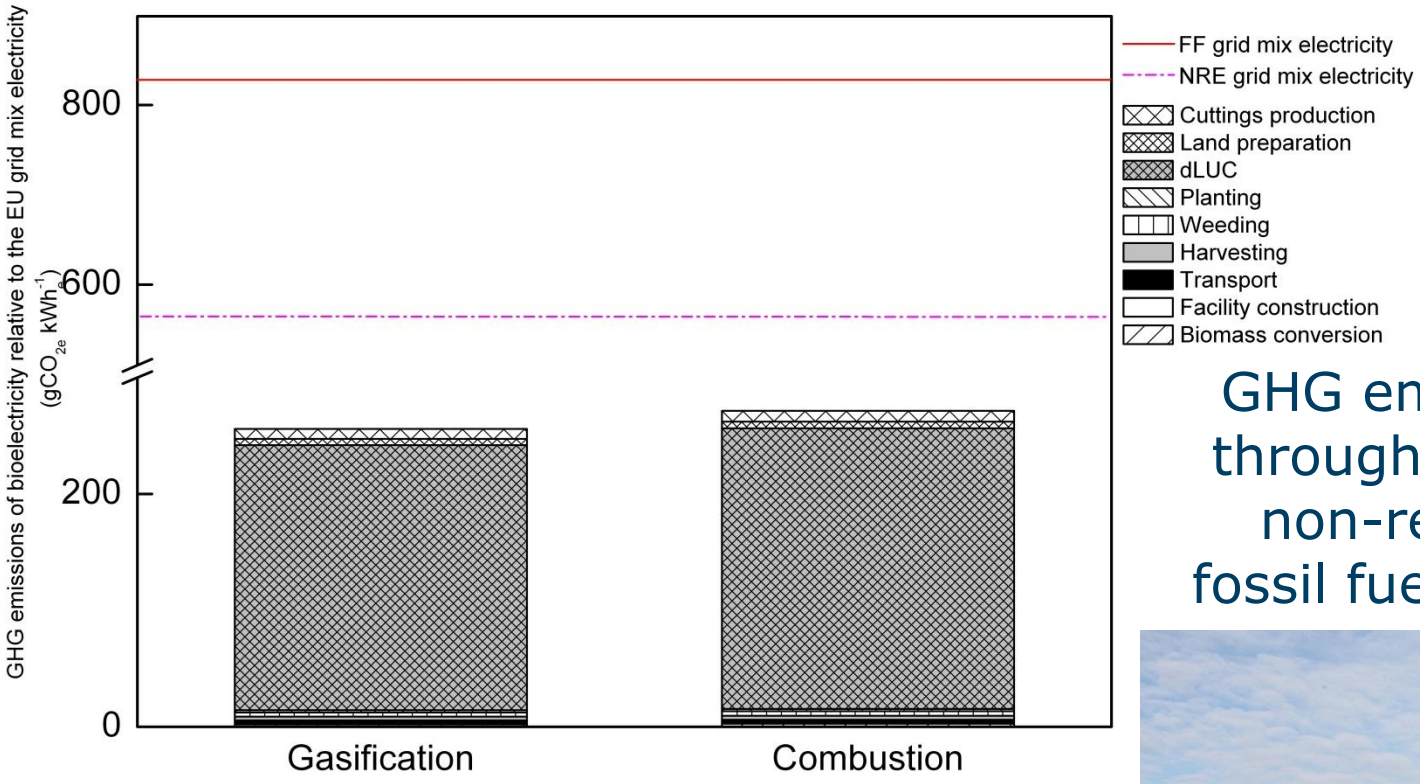


GHG balance of POPFULL



Njakou Djomo et al., 2013 – Applied Energy

Energy and GHG balance of POPFULL



GHG emission savings through substitution of non-renewable and fossil fuel grid electricity

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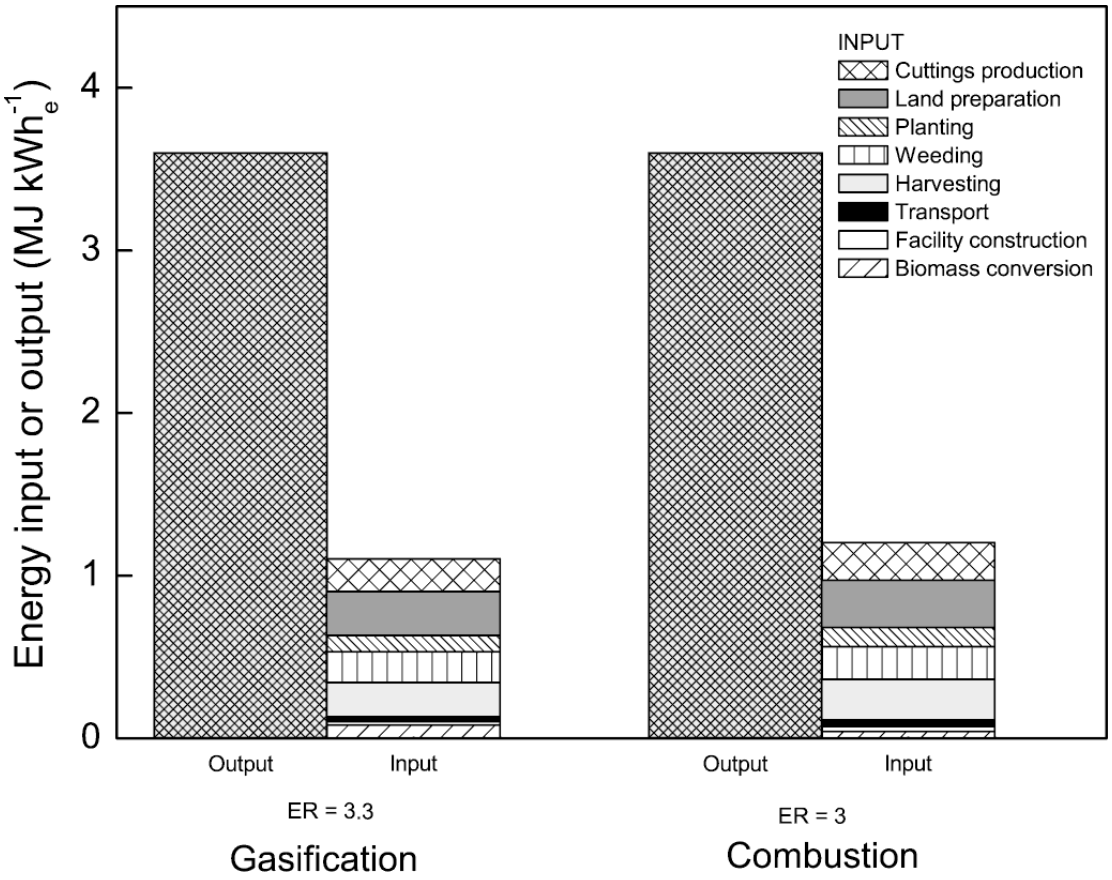
Energy and GHG balance of POPFULL



Gasification is more efficient than combustion

Njakou Djomo et al., 2013 – Applied Energy

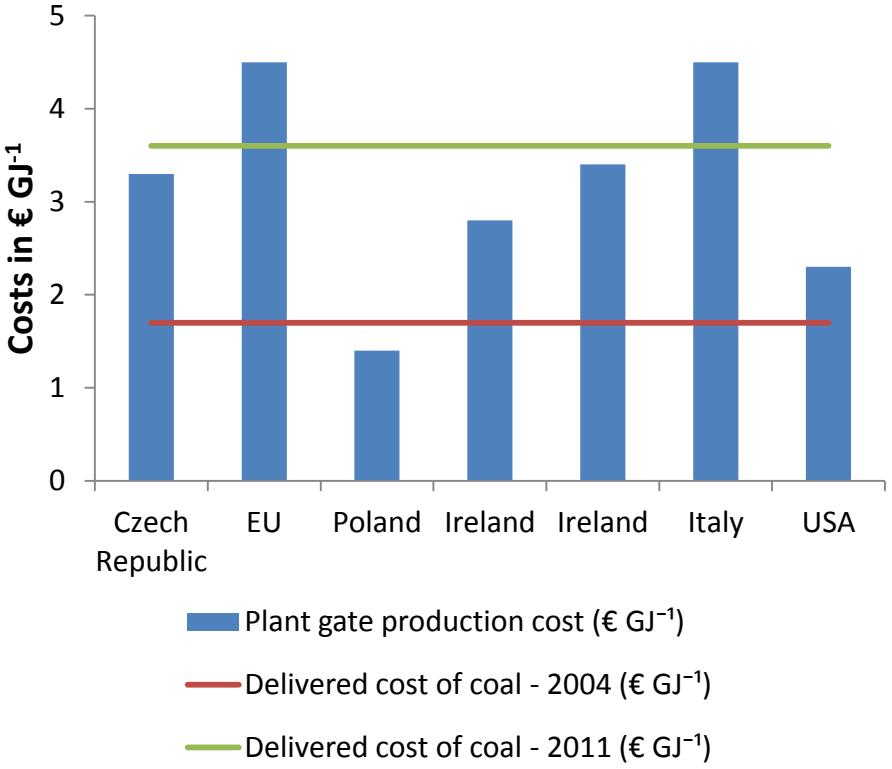
Energy and GHG balance of POPFULL

- Advantages
  - SRWC saves fossil resources (i.e. ER> 0)
  - SRWC has GHG emission reduction potential
- Disadvantages
  - requires land ➔ impacts from land use change
  - water footprint & pollution not known
  - biodiversity might be reduced
- Limited detailed LCA studies on SRWCs for bioenergy based on 'field' data

Financial analysis of SRWCs

Production costs of delivered wood chips

- large variation due to:
  - regional differences in costs of labor and inputs
  - assumptions regarding the cost items included
- increasing fossil fuel prices improve competitiveness

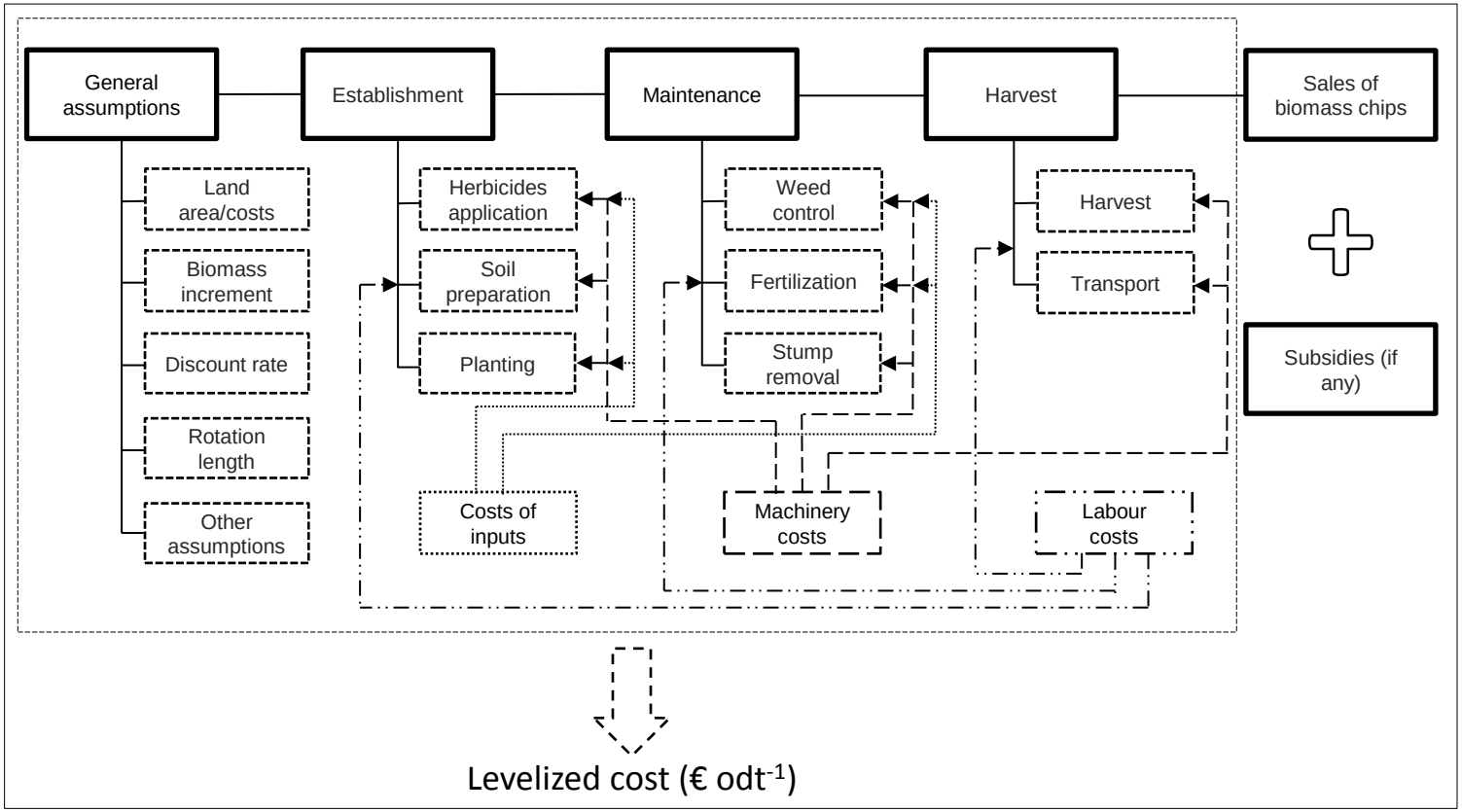


El Kasmioui & Ceulemans, 2012 – Biomass & Bioenergy

Financial analysis of POPFULL - POPFINUA

Model input

Model output



Net present value (€ ha^{-1})
Equivalent annual value (€ ha^{-1} y^{-1})

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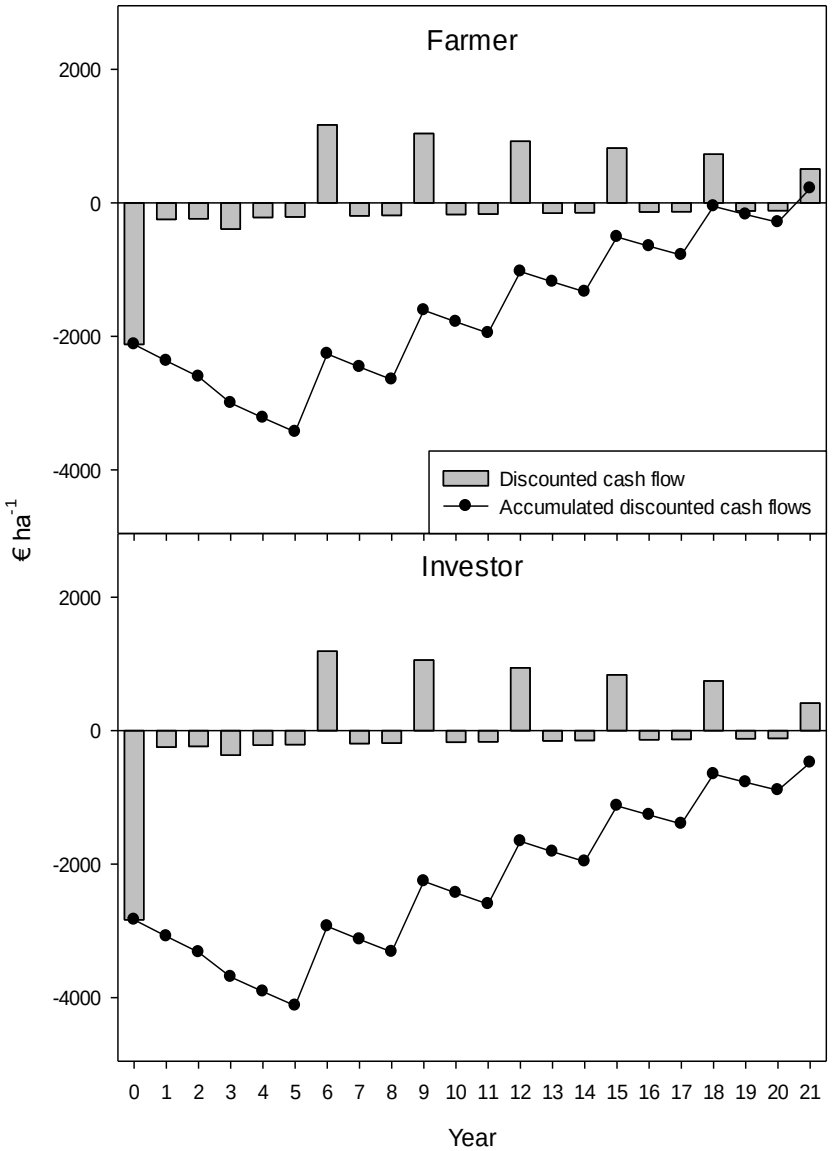
Financial analysis of POPFULL - POPFINUA



Simulations from POPFINUA model:

- Farmer's scenario:
  - Break-even after 21 years

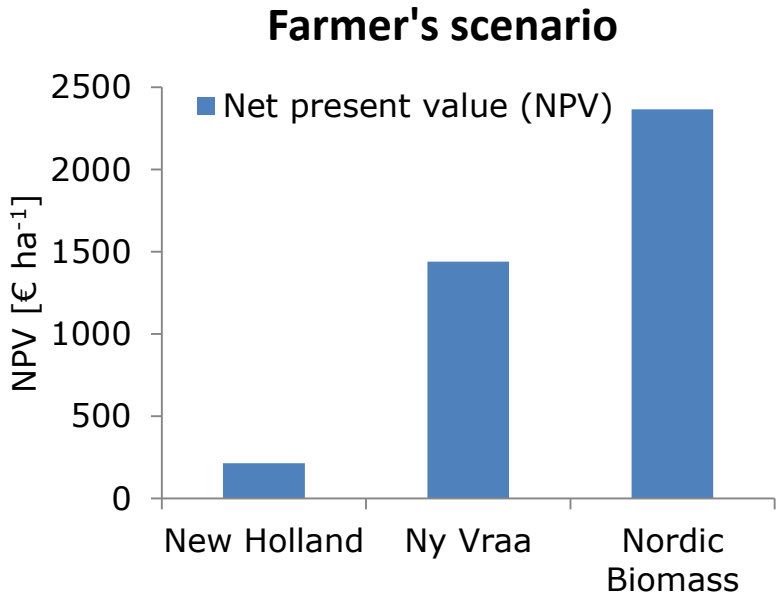
- Investor's scenario:
  - No break-even reached within assumed lifetime

El Kasmioui & Ceulemans, 2013 – Bioenergy Research

Financial analysis of POPFULL - POPFINUA

Impact of harvesting option:

- Preference for small scale harvesters
- Advantages:
  - Lower charges
  - Lower fuel consumption
  - Smaller impact on the soil
  - Higher usability (wet soil)
- Disadvantage:
  - High transportation costs (not available in BENELUX)



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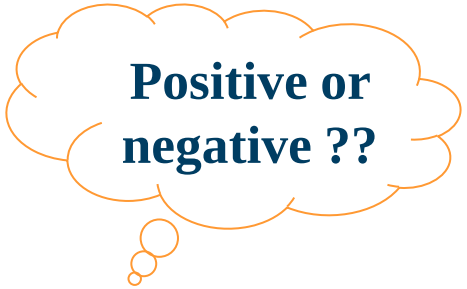
General conclusions

- Currently, SRWCs are only financially feasible with government support in Flanders (Belgium)



- SRWCs save fossil resources (i.e. ER > 0) and have a GHG emission reduction potential

Research cooperation

- ✓ Interest in & research on short rotation woody crops for bio-energy production (30 years experience with SRWC)
- ✓ Ample international recognition, large number of international publications
- ✓ Recently larger-scale operational SRWC plantation in relation with private SME (POPFULL)
- ✓ Increasing focus on techno-economic feasibility and life cycle assessments of bioenergy options

Thank you for your attention!