Combined Biogas an Ethanol Production

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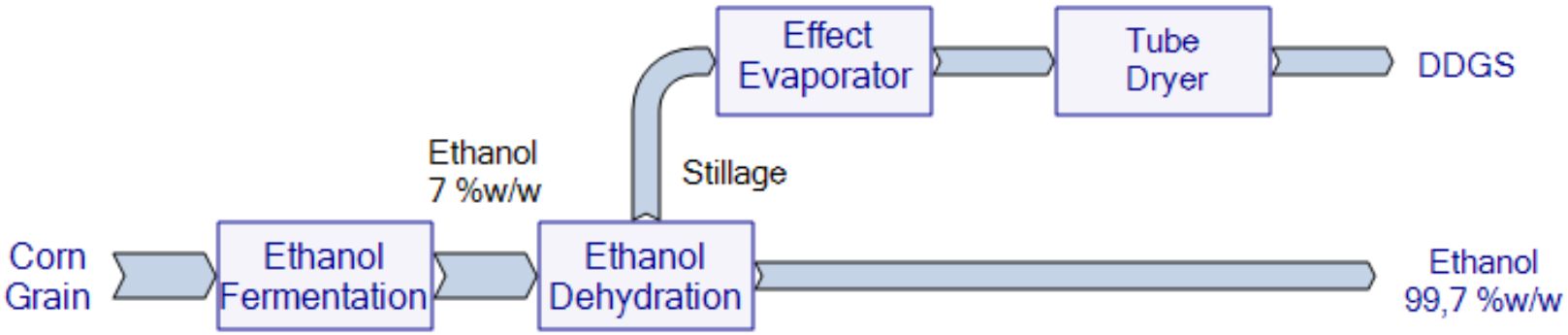
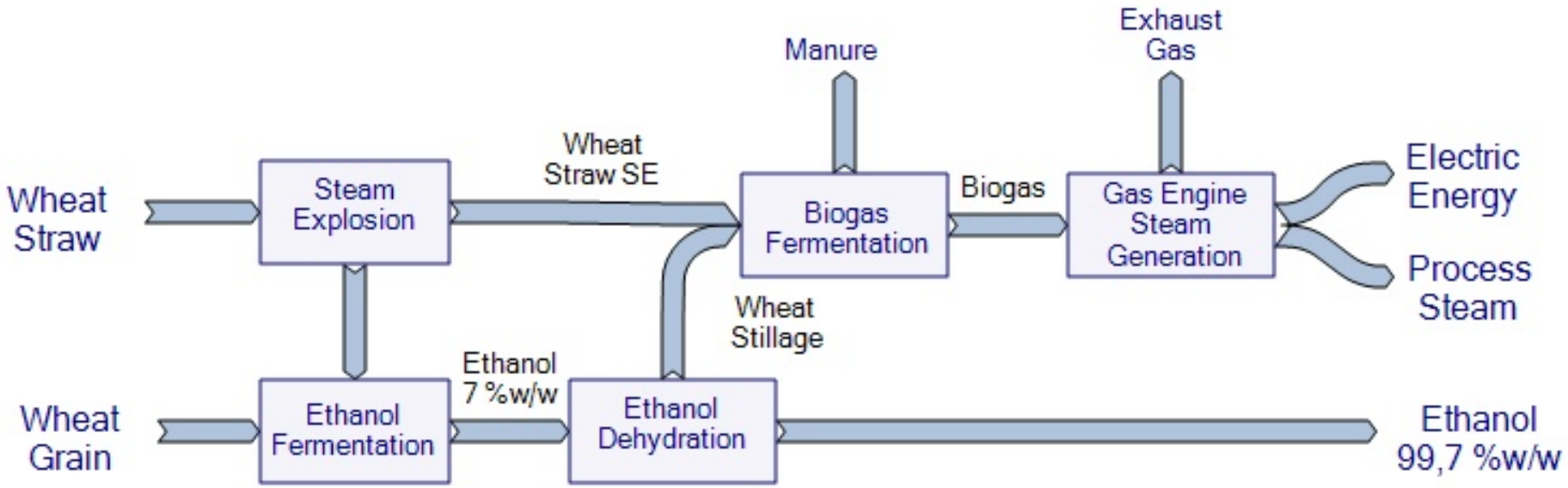
Motivation – Integrated Polygeneration

- Bio-ethanol production
  - Sustainable Energy Sources
  - NO fossil fuels for the process
  - Substrate from Starch/Sugar to Lignocellulosic
- Biogas + CHP production
  - Excellent Power production efficiency even at relative small scale
  - Waste heat problem
- Bio-ethanol production in combination with Biogas production + CHP (or Methane enrichment)
  - Production of Ethanol, Heat (Steam), Electric Power and By-Products (con. Biogas, Fertilizer)

Ethanol Production – Standard



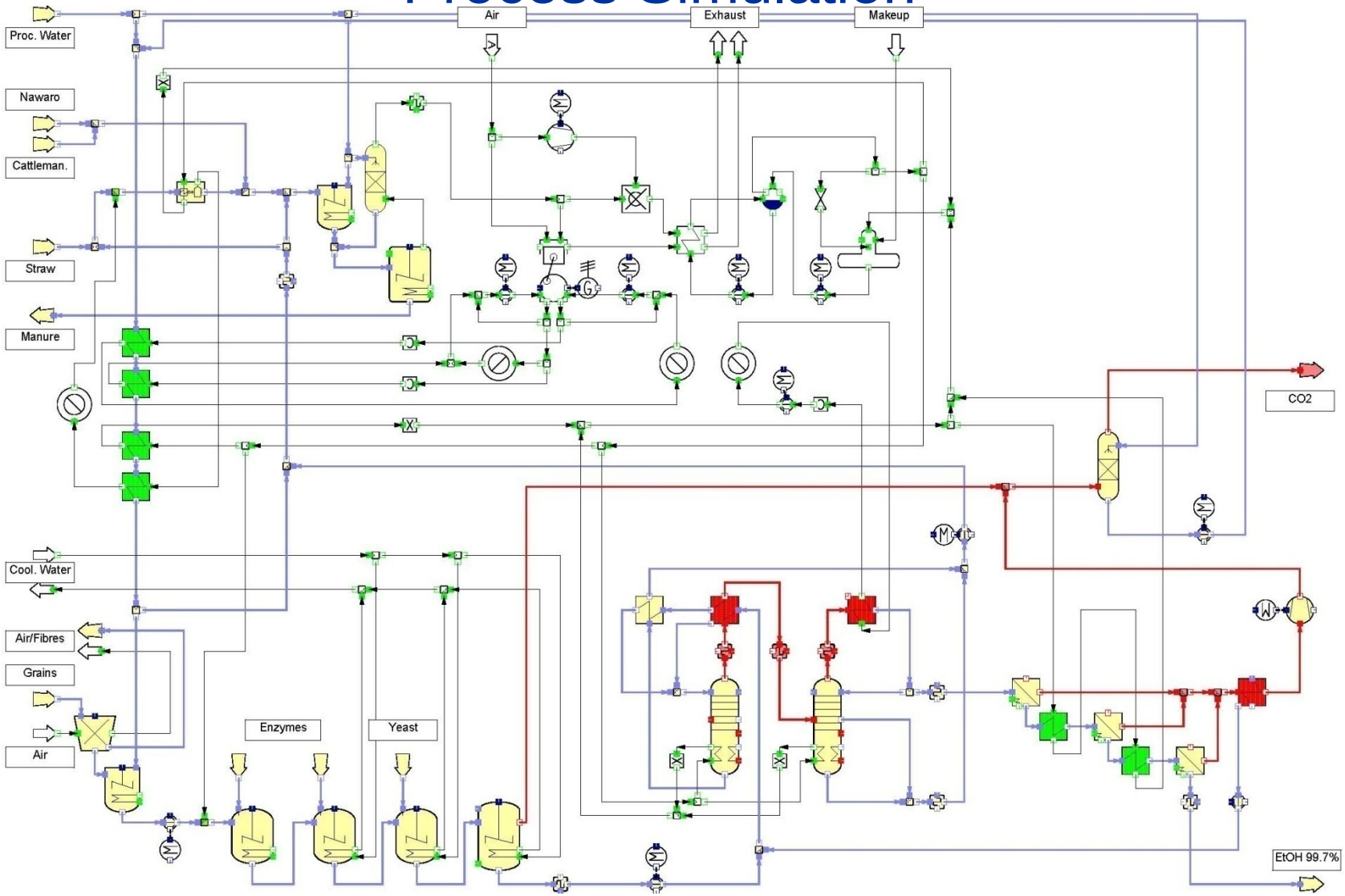
Sustainable Ethanol Production



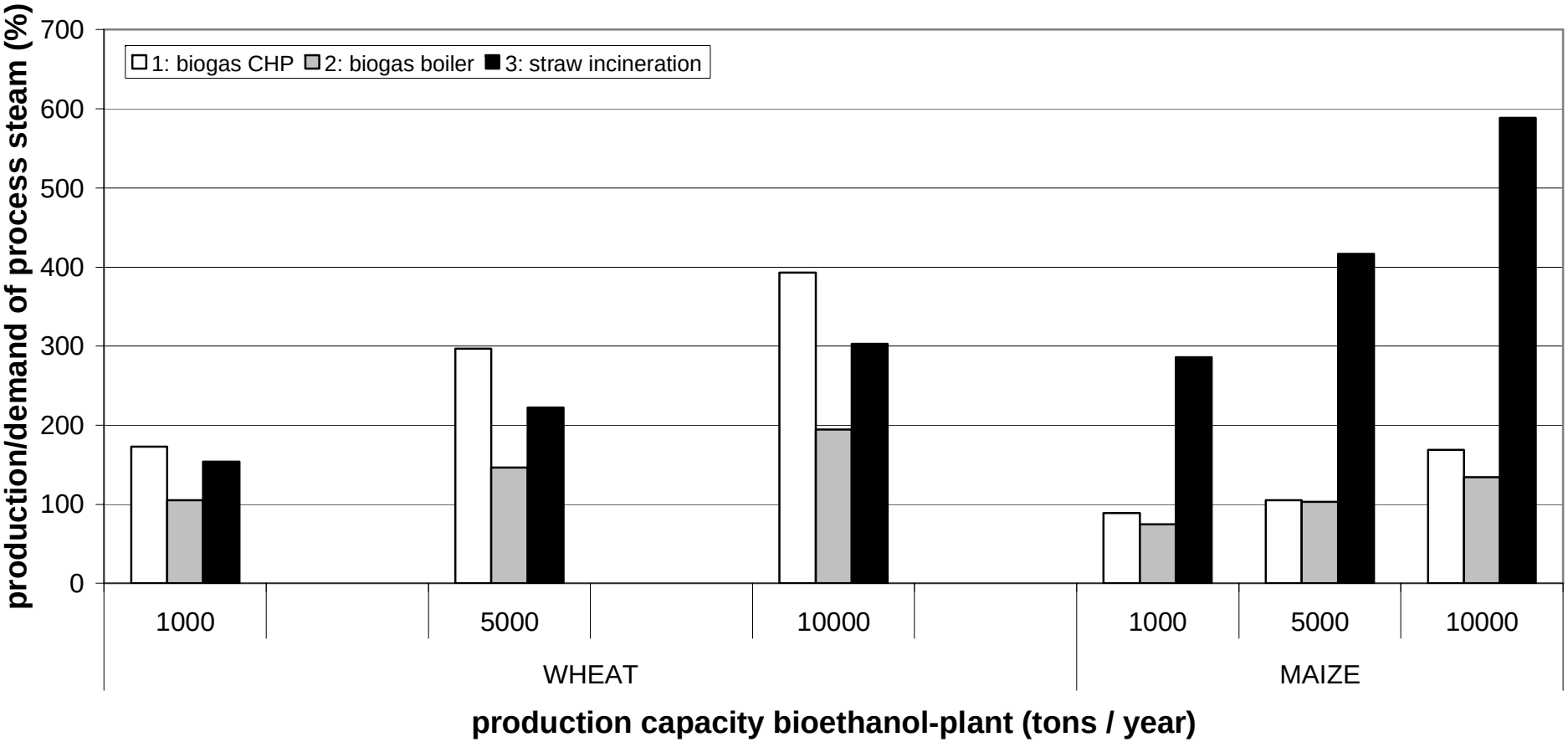
Boundary Conditions for the Study

- Feedstock for bioethanol production
  - Wheat and Maize, Straw
- Investigated Plant Size
  - 1.000 / 5.000 / 10.000 t/a Bio-ethanol
- Investigated Facilities
  - Bio-ethanol Production
  - Biogas Production and CHP (Option 1)
  - Biogas Production and gas fired boiler (Option 2)
  - Straw Combustion (Option 3)
- Combination of different Feedstocks, Plant Sizes and Facilities during Simulation
- Main target – Energy self supply
- Biogas residues recycled to the fields

Process Simulation



Results – Heat Demand/Production



Ref.: Friedl et al; 15th European Biomass Conference & Exhibition, 7-11 May 2007, Berlin, Proc. P 1891-1894

Results – Option 3 Straw Incineration

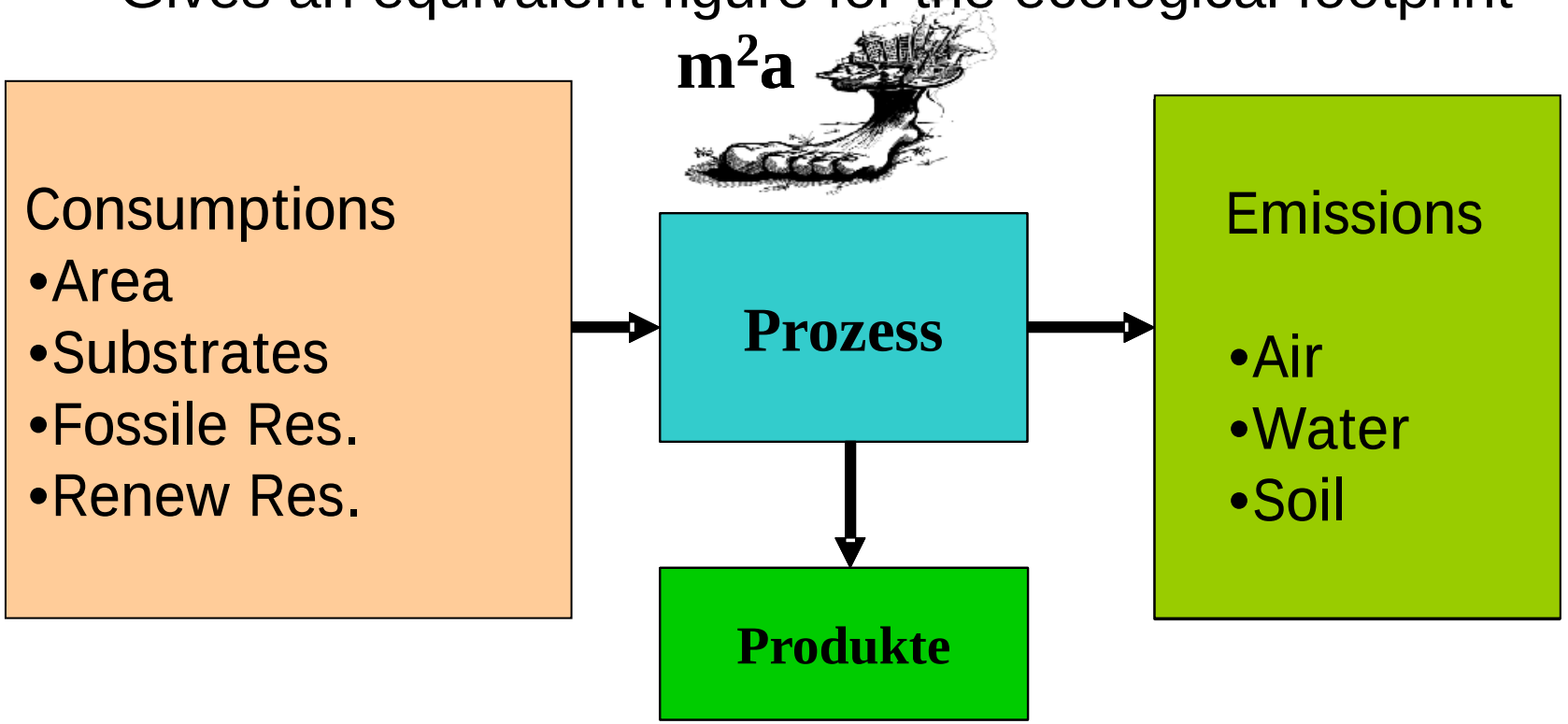
Required percentage of straw for 100 % coverage of bioethanol plants' energy demand by straw incineration, based on total amount of wheat/maize straw available from grain cultivation

bioethanol feedstock		**wheat**			**maize**	
bioethanol plant capacity (t/y)	1000	5000	10000	1000	5000	10000
total straw available (t/y)	3240	15739	30604	5828	28310	55047
straw to cover energy demand (%)	49	34	24	26	18	13

Ref.: Friedl et al; 15th European Biomass Conference & Exhibition, 7-11 May 2007, Berlin, Proc. P 1891-1894

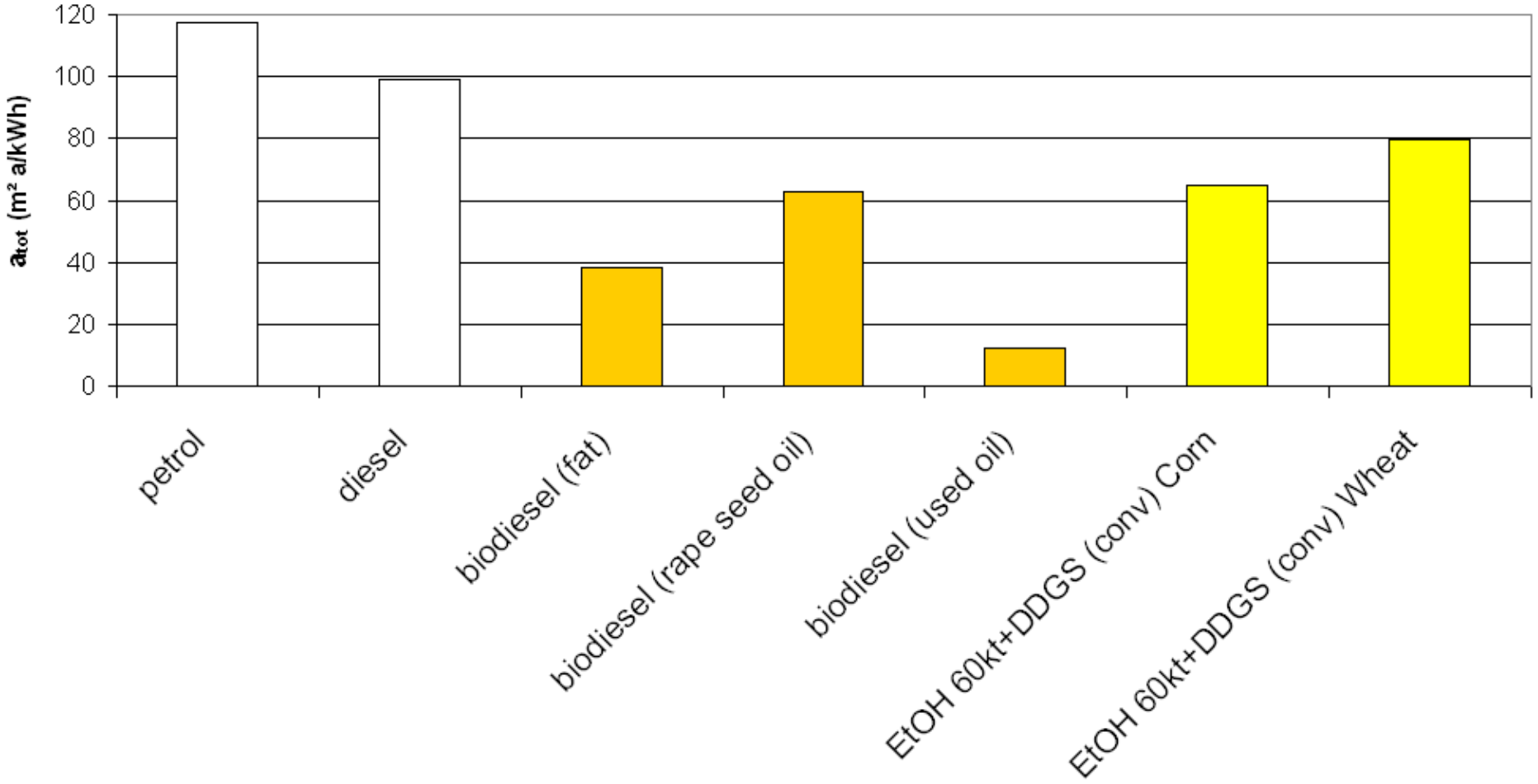
Biofuels-Environmental Aspects

- SPI (sustainable process index) concept
- Gives an equivalent figure for the ecological footprint

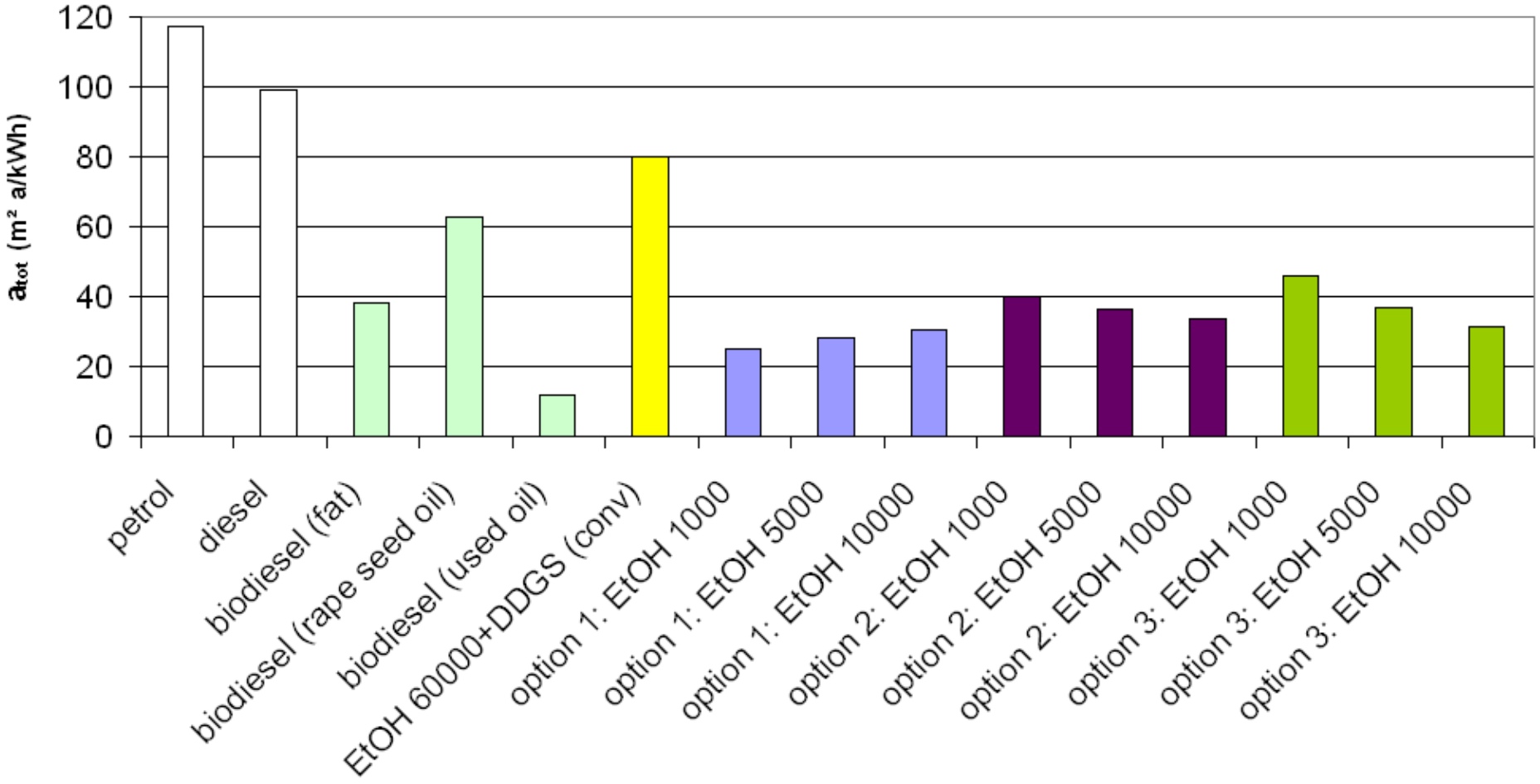


SPIonExcel, v 2.0, Graz University of Technology, Graz, 2006, http://spionexcel.tugraz.at

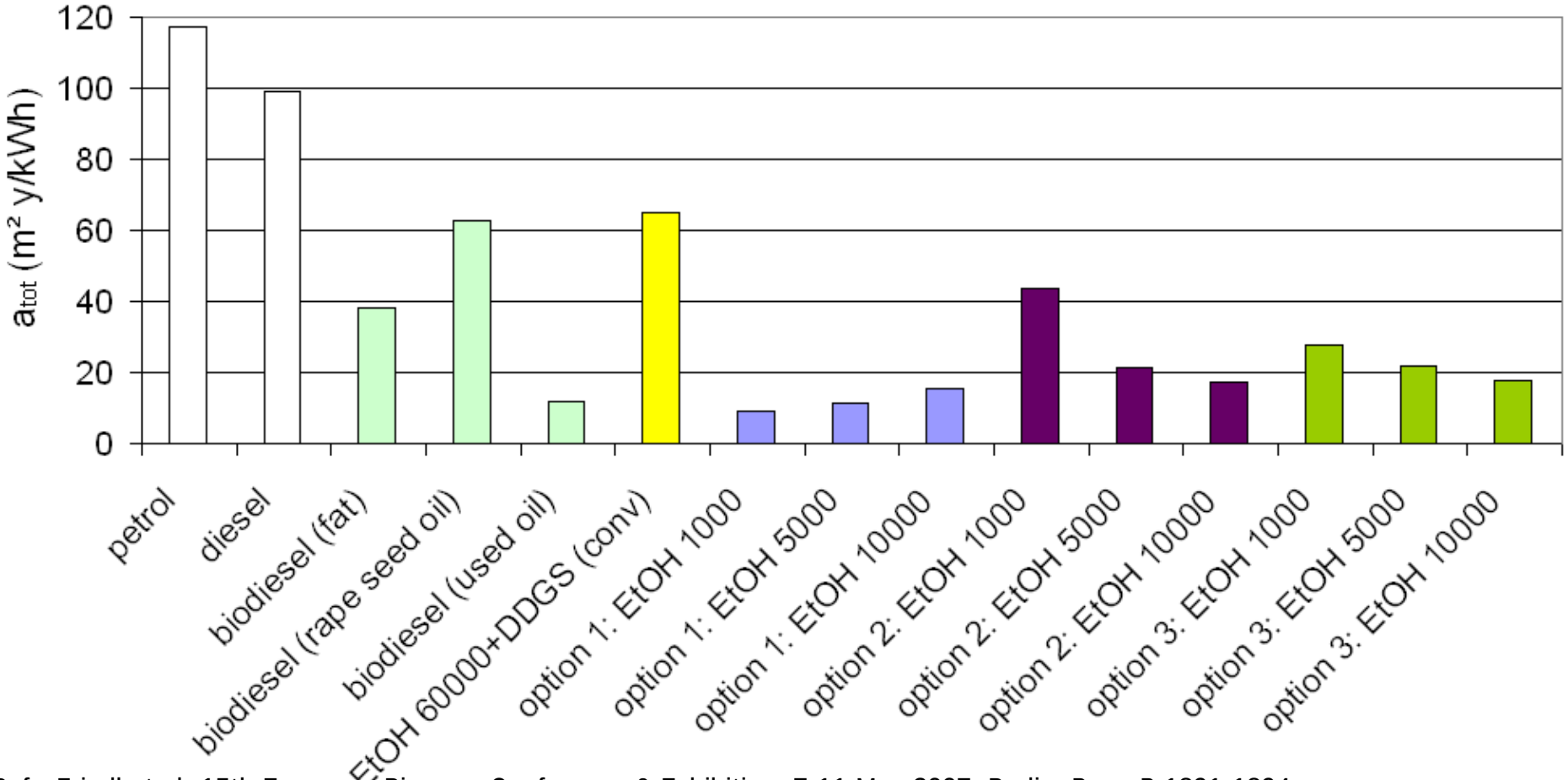
SPI of Large Scale Plants – Powered by Fossile Fuels



SPI of Small-Scale Ethanol Process - Wheat



SPI of Small-Scale Ethanol Process - Maize



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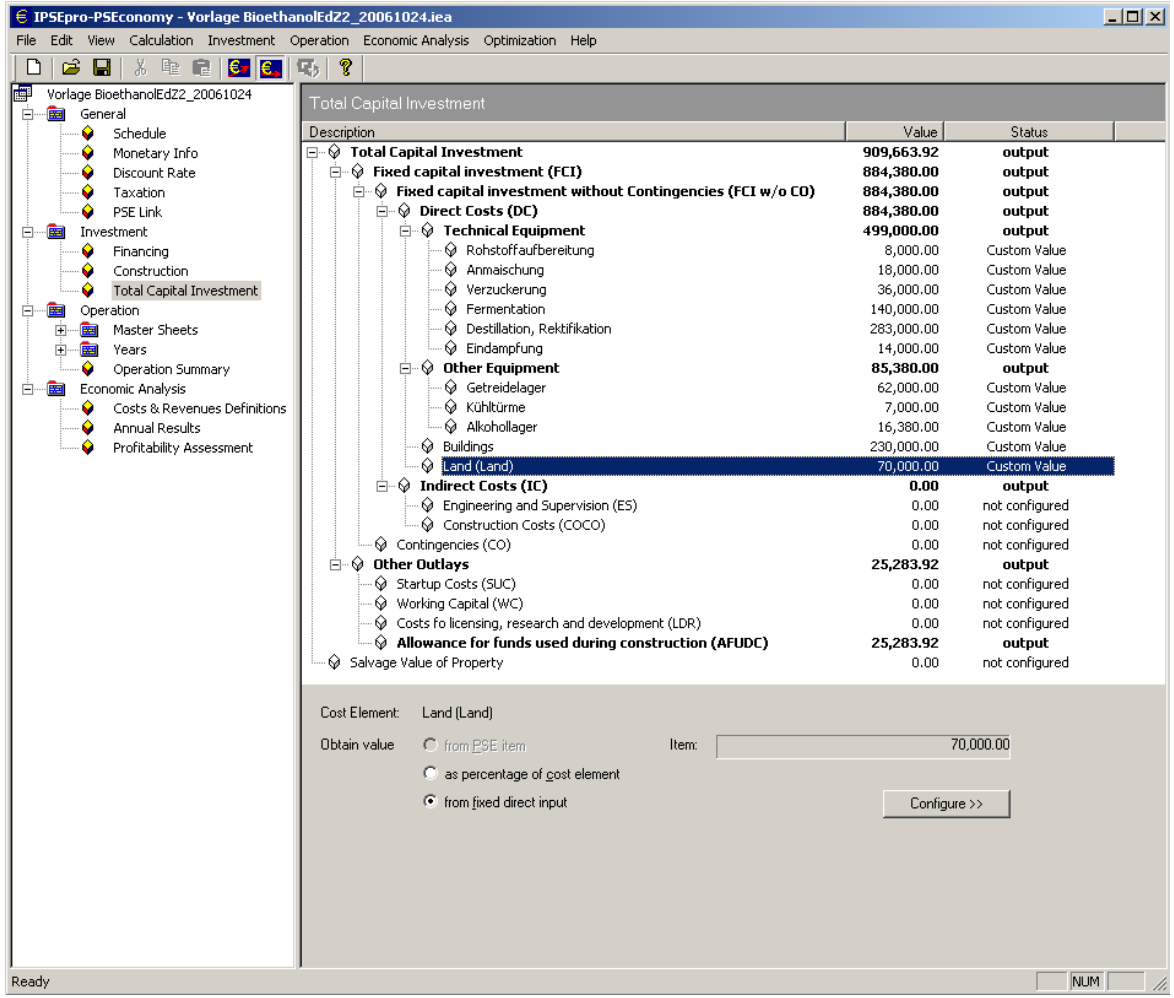
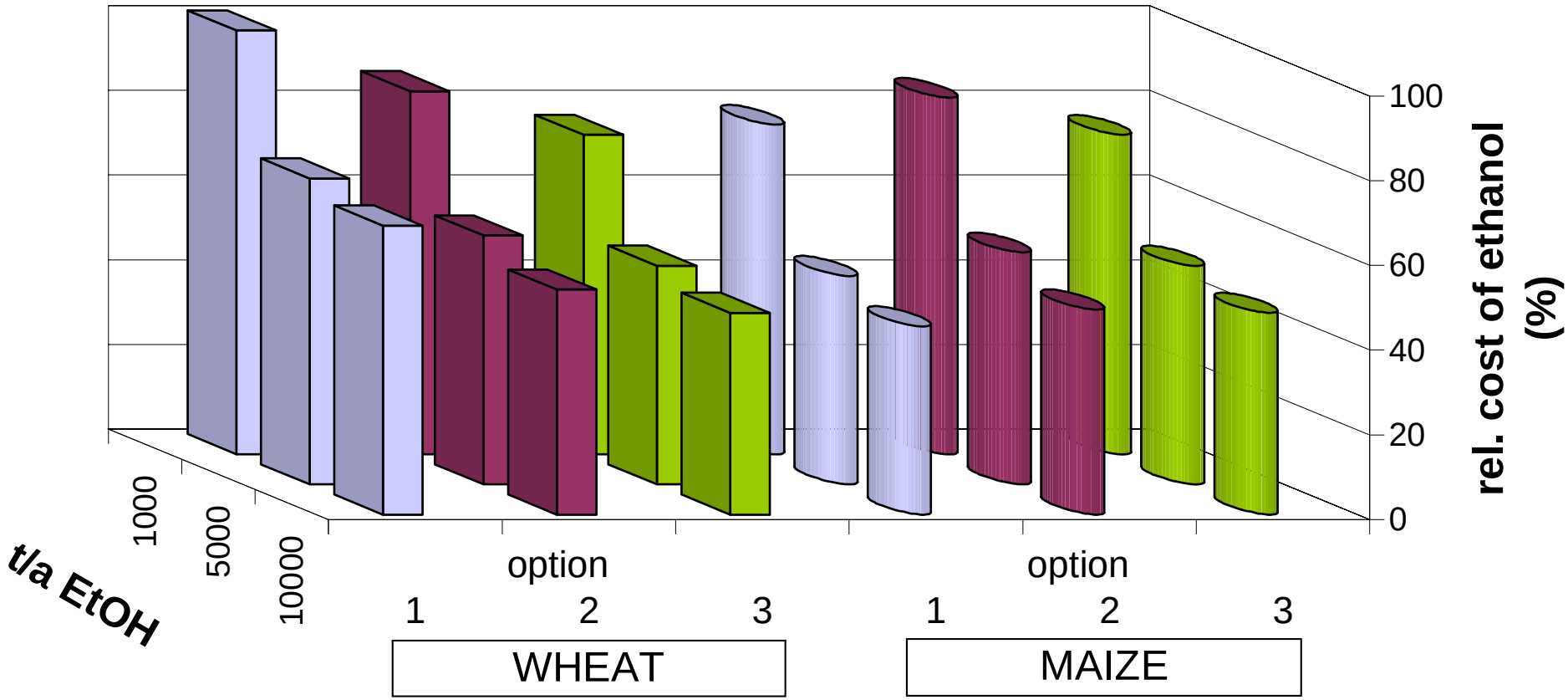
Simulation-Tool IPSE Economy Tool

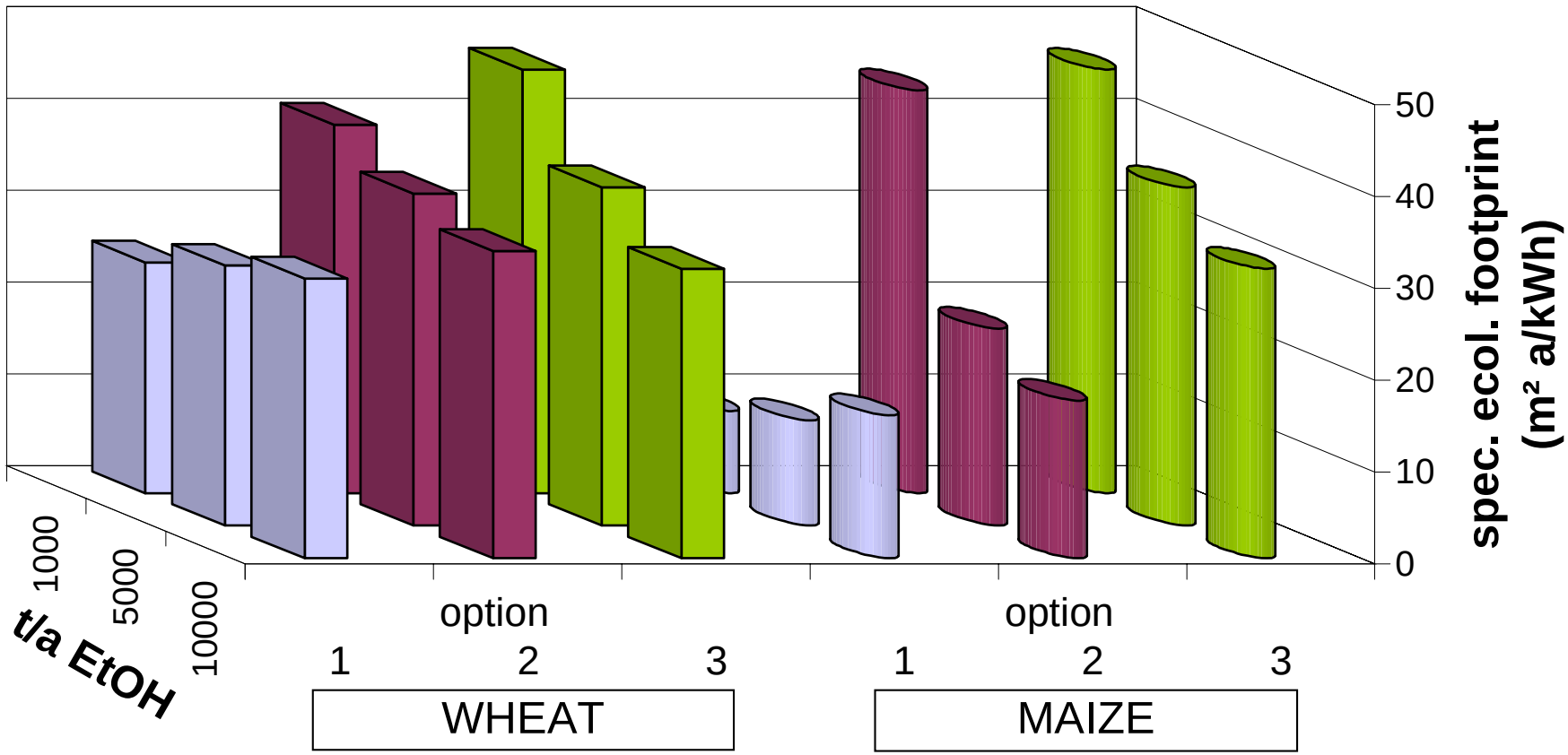


Economic Analysis



Ref.: Friedl et al; 16th European Biomass Conference & Exhibition, 2-6 June 2008, Valencia, Proc. In preparation

Ecologic Analysis



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Summary

- Bio-ethanol production by use of renewable energy from by-products of feedstock and/or combination with biogas production can cover 100% of energy needed
- Specific ecological footprint of bio-ethanol can be reduced up to 10% of the fossil fuels
- Partial combustion of straw from feedstock production covers heat demand in all cases of small ethanol facilities (even drying of DDGS would be possible) in option 3
- High potential in the local integration of small scale plants (feedstock – residues)
- Costs optimization for small-scale bio-ethanol plants combined with biogas plants leads to a compromise between economical and ecological aspects
- Further proof of concept with lignocellulosic feedstock is under investigation

Acknowledgement

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