Biomass logistics

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Characteristics of biomass

Characteristic	Action
small quantities scattered over many sources locations (regions)	collection & transport
inhomogeneous quality	pre-treatment
relatively high moisture content	drying
different types (crops, residues)	pre-treatment & flexible power plants
seasonal patterns	storage
lower energy content than fossil fuels	pre-treatment

Logistics bio-energy chain

- economic feasibility has to be studied carefully, before one can start to build and operate a power plant
- costs of logistics may determine a major part of feasibility, especially when biomass costs only are relatively low

Complexity logistics

- the logistics are often complex and can be set up in many different ways
- this makes it difficult to estimate the logistical costs and energy consumption and therefore modelling the logistics of a design can be very useful

Logistical questions

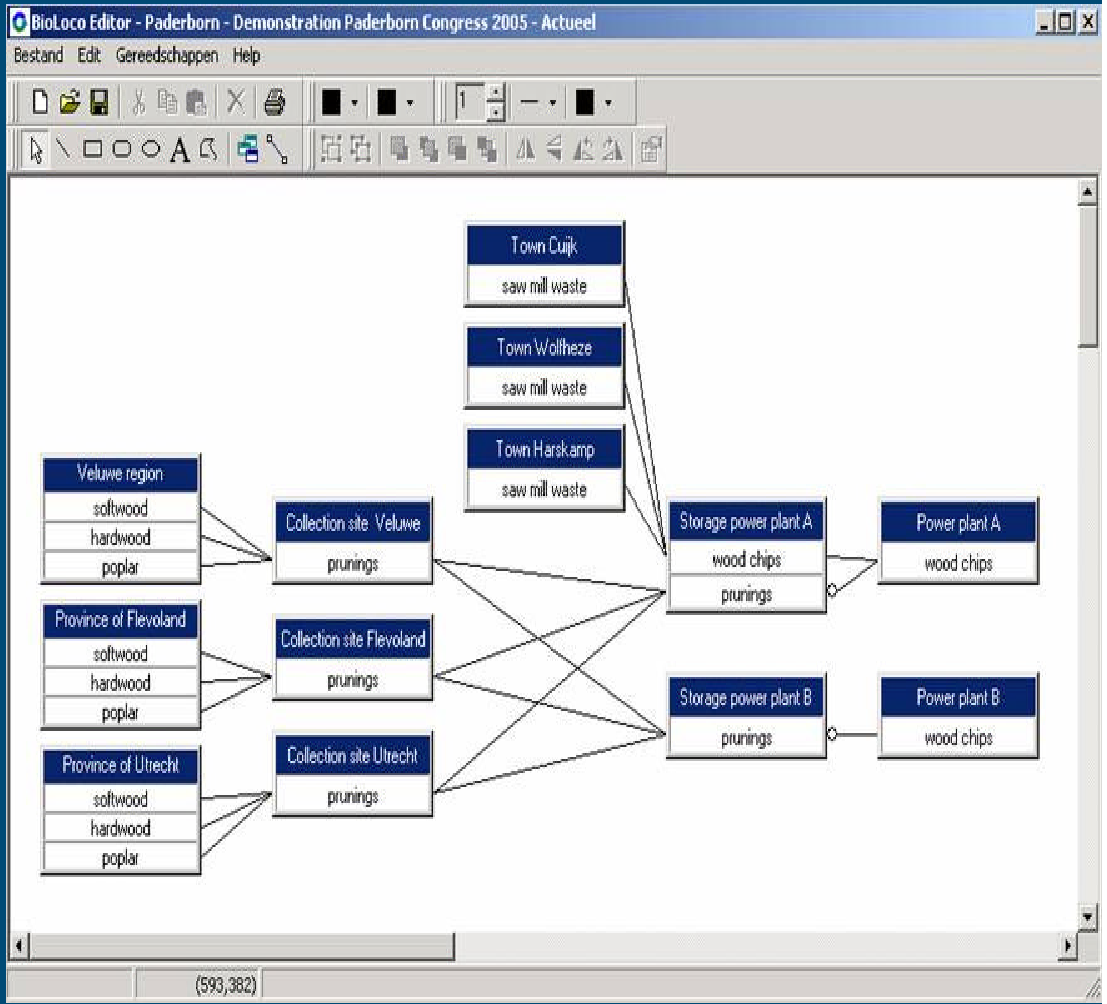
- which biomass from what sources?
- where and what type of pre-treatments?
- what is the best location for conversion plant?
- optimal scale of conversion plant?
- what are chain costs (transport, storage, treatment)?
- what is energy consumption in chain?

Logistical biomass models

- Biomass logistic computer simulation (Biologics)
  - Animation: Virtual Reality Biologics
- Biomass logistic computer optimalisation (Bioloco)
  - Classic
  - Light
  - Emissions

Modelling the logistics of a bio-energy chain

- by means of a network structure
- nodes:
  - source locations
  - collection sites
  - transhipment sites
  - pre-treatment sites
  - conversion site
- arc:
  - transport

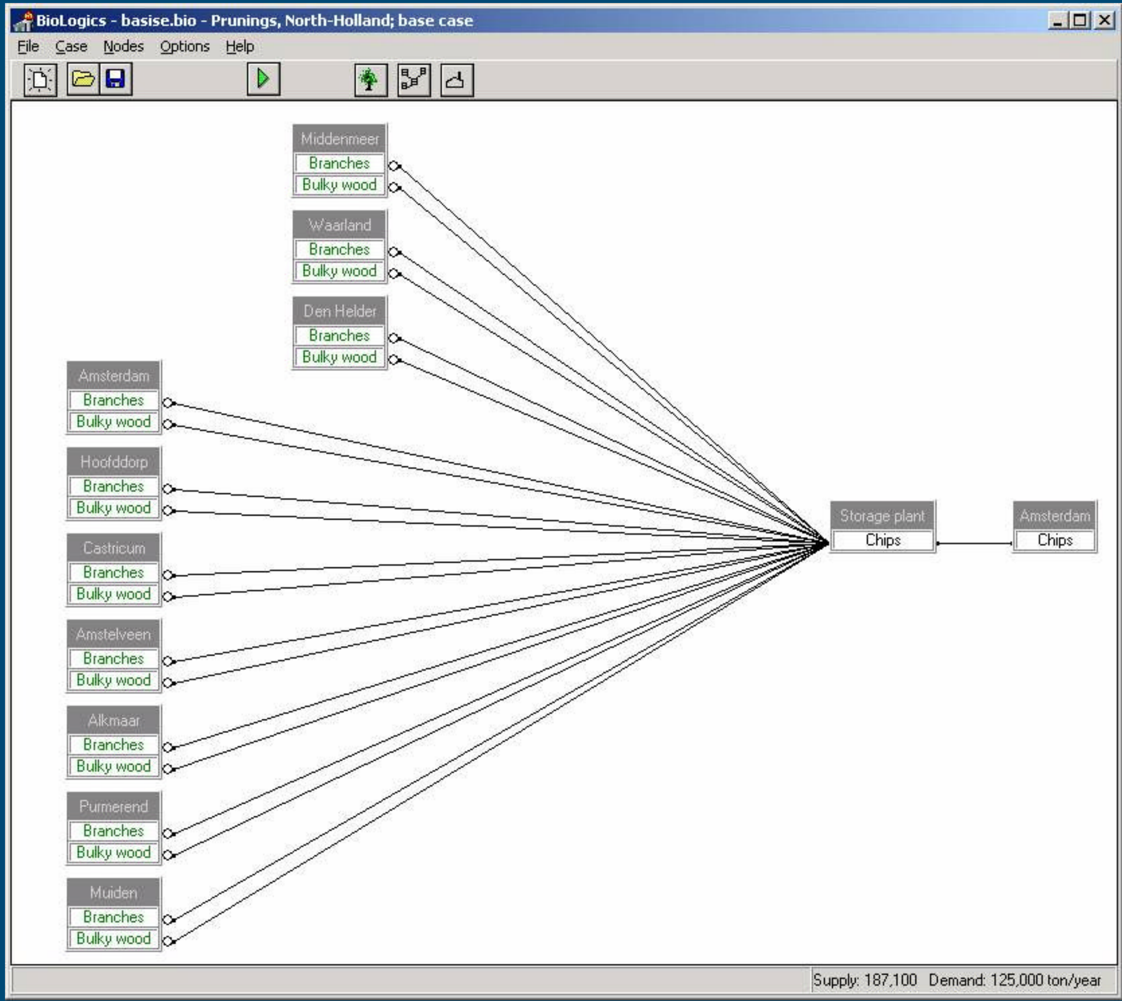


Simulation versus optimization

Simulation (Biologics)	Optimization (Bioloco)
The simulation model takes a given, well defined design of the logistical network, and then calculates the effects of the dimensions of this network. Biologics does not make any choices between alternative source locations, transport systems, energy plants, etc. Therefore slightly different designs need new simulation runs with Biologics.	The optimisation model establishes the optimal design of the logistical network within some broader boundaries e.g. a list of alternative source locations, transport systems, energy plants, etc. Bioloco chooses the best source locations, transport systems, energy plants, etc. It only takes one run of Bioloco to find the optimal network within these specified broader boundaries.
The calculations of the simulation model can be more detailed than the optimisation model calculations. For example Biologics calculates at a day-to-day level	Bioloco has the month as time unit.
Both models calculate the financial and energetic performance. With Biologics, the user has to decide which performance criterion is preferred.	The user of Bioloco has to choose an optimisation criterion at forehand.

Biomass logistic computer simulation

- Biologics
- simulation of given scenario



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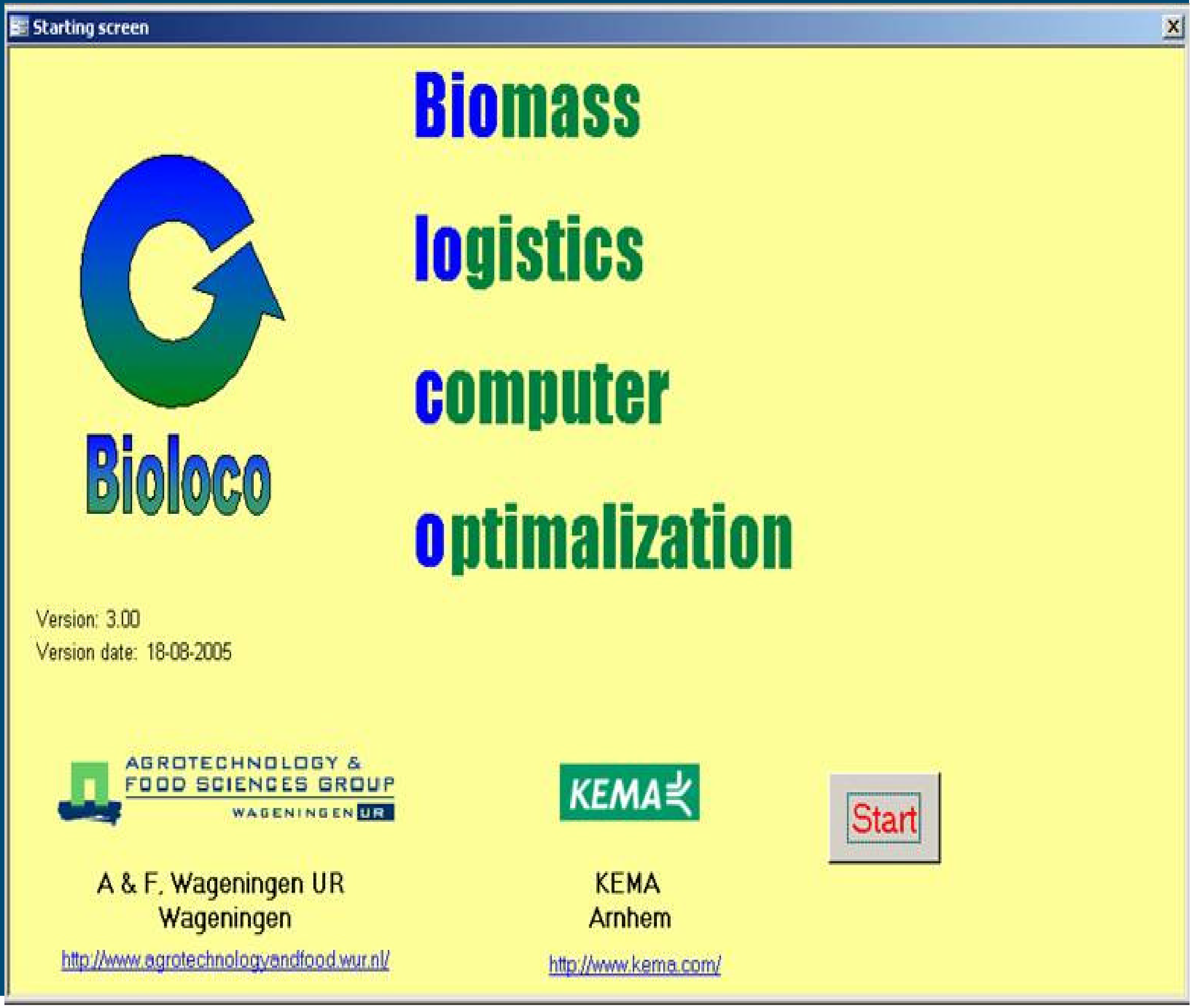
Animation of logistics

- Virtual Reality
- visual analysis

Biomass logistic computer optimization

- Bioloco
- determines an optimal solution under given circumstances



Characteristics of Bioloco

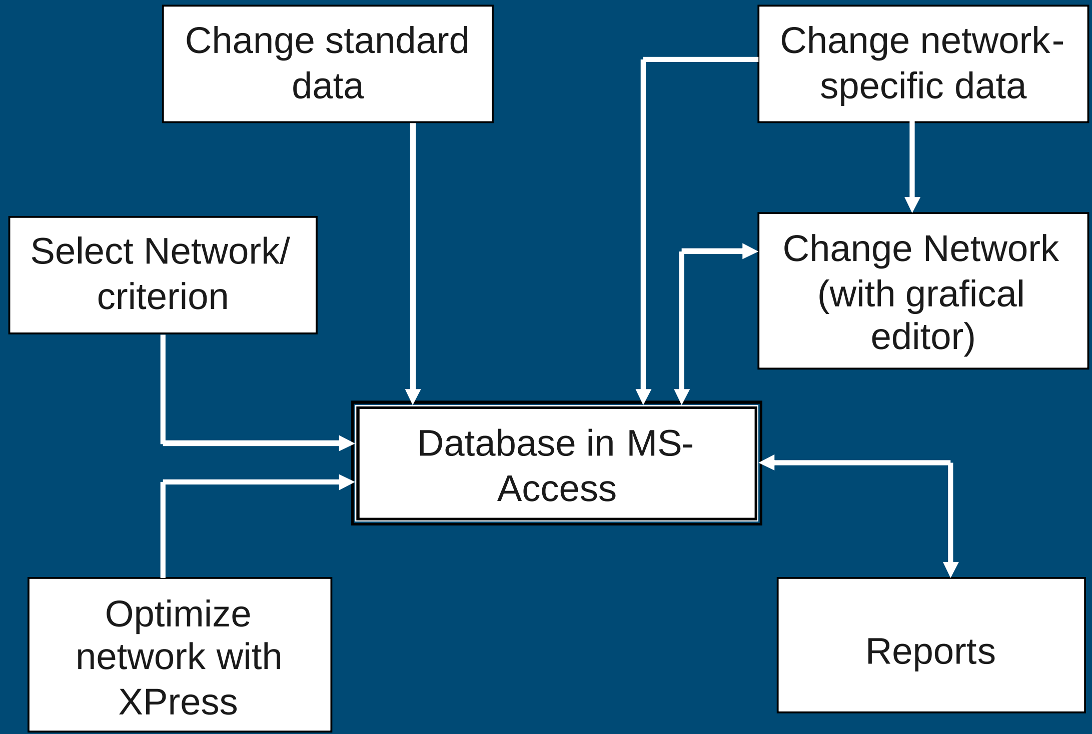
- Bioloco calculates the optimal bio-energy chain (within certain constraints):
  - biomass types
  - transport types
  - storage facilities
  - pre-treatment methods
  - conversion techniques

- based on a chosen optimisation criterion (financial, energetic or emission) or combination (goal programming)

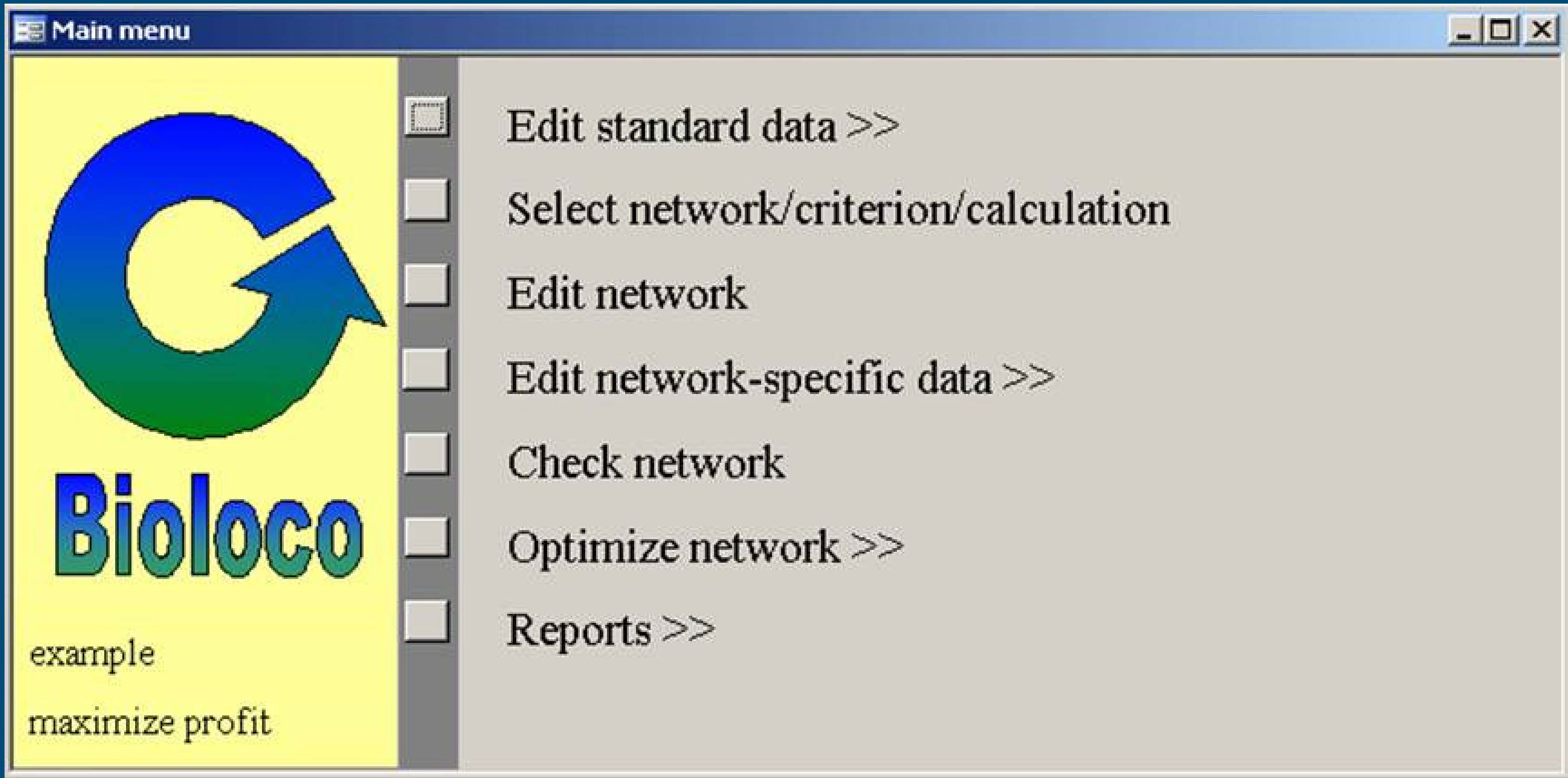
Typical biomass constraints in Bioloco

- During optimisation Bioloco takes into account effects that are typical for biomass:
  - seasonal fluctuations in supply and demand of biomass
  - losses of water due to drying (positive effect)
  - losses of dry matter due to heating (negative effect)

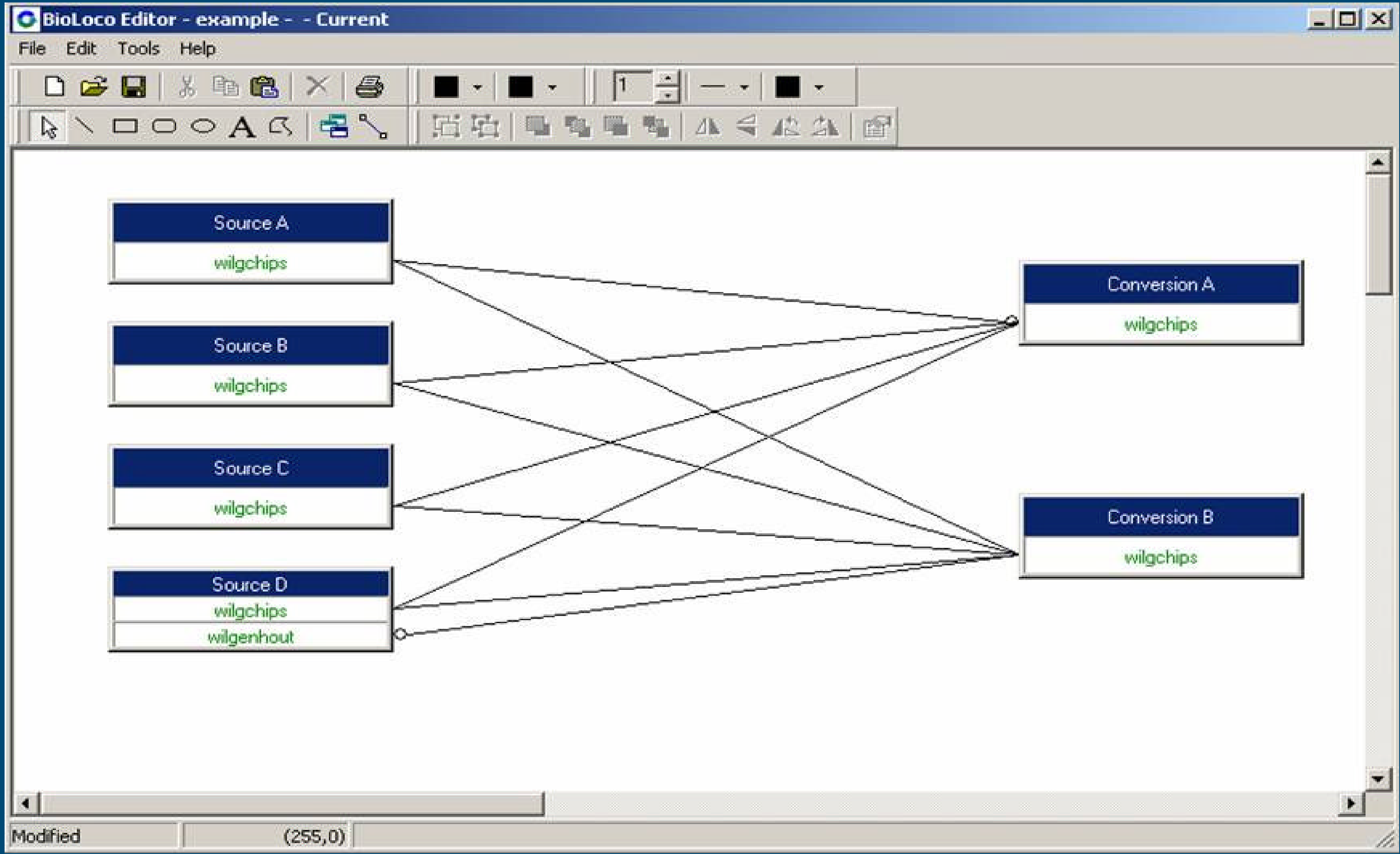
The structure of Bioloco



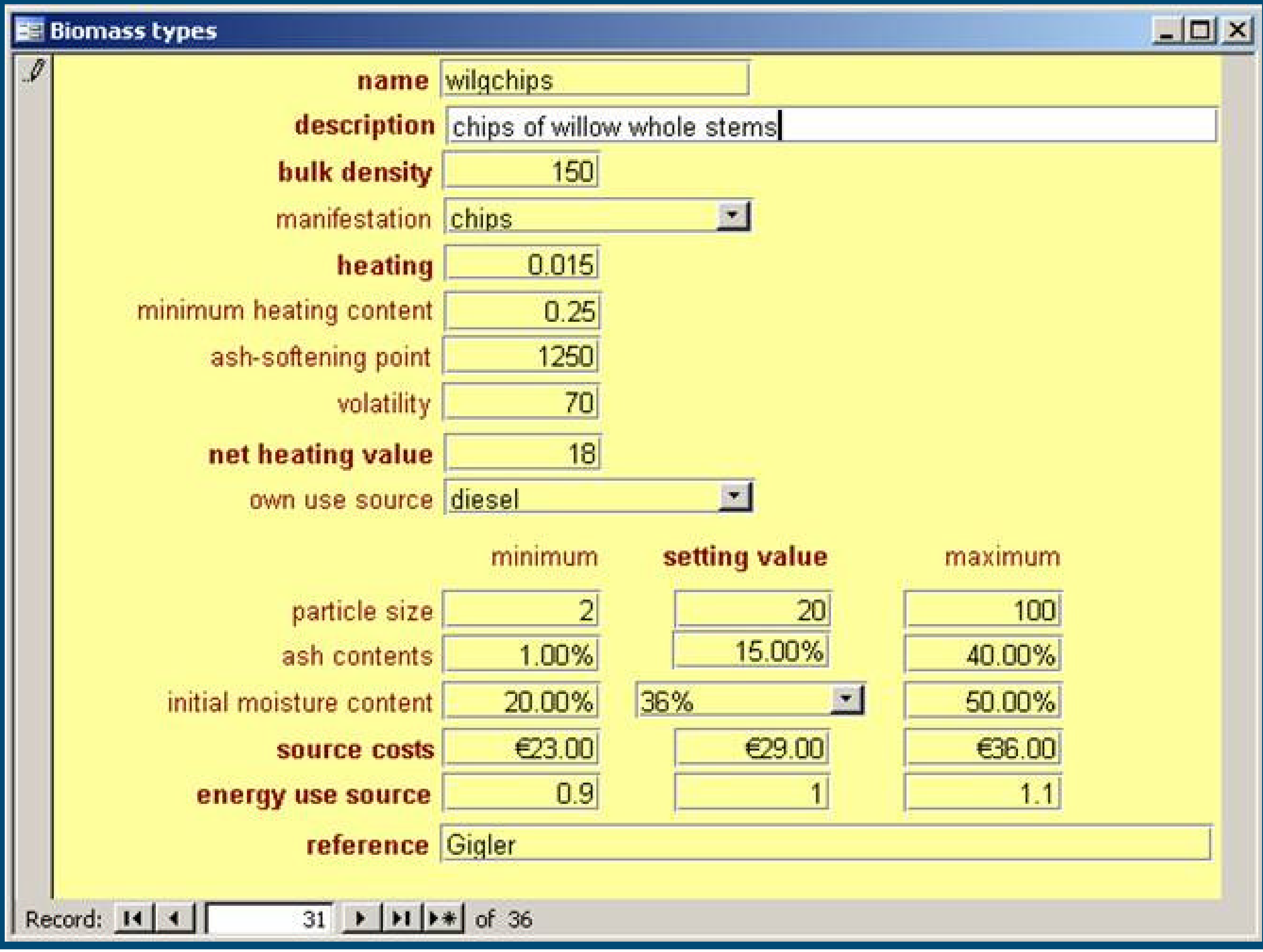
Bioloco - menu structure



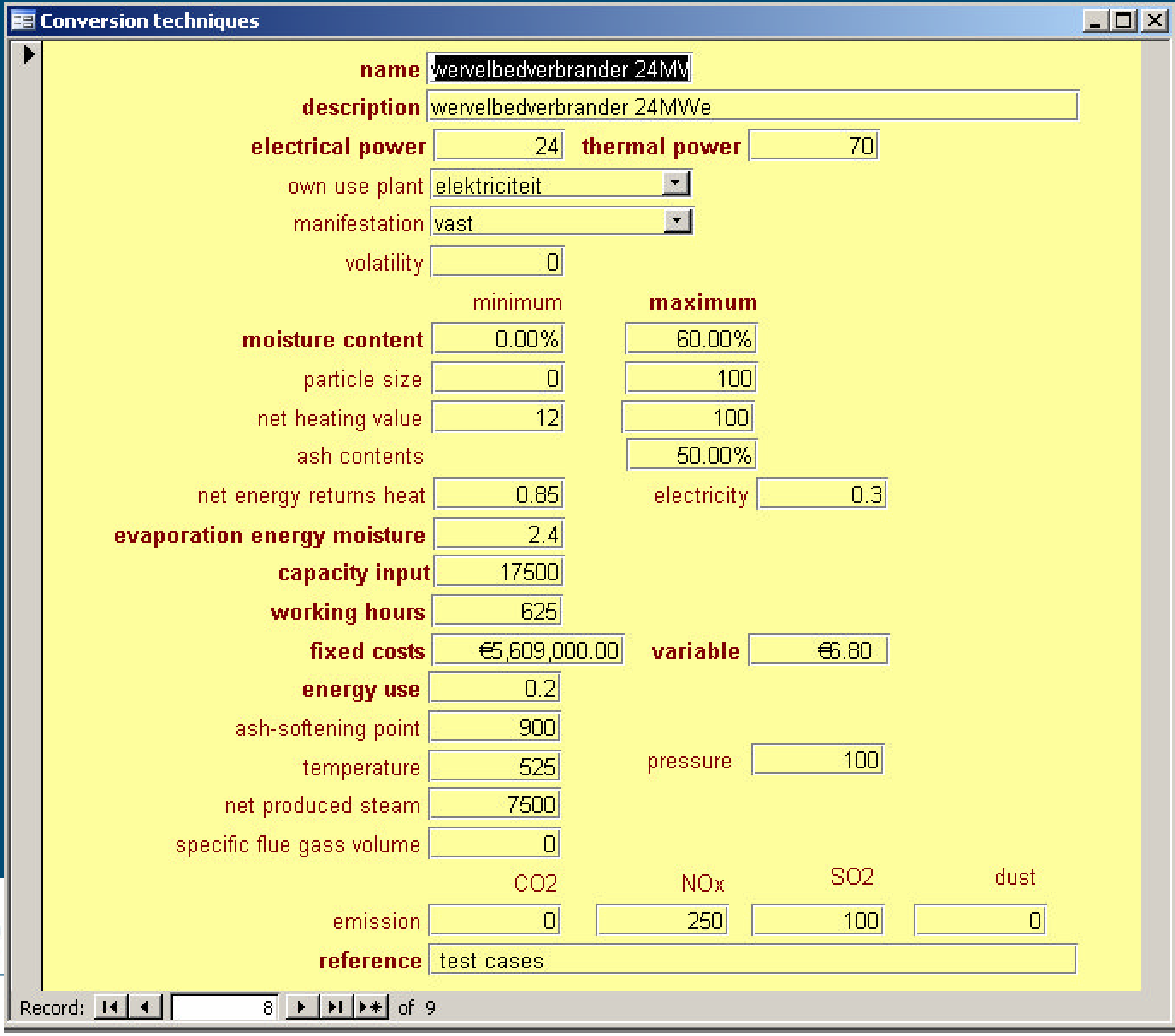
Bioloco – options in a network structure



Bioloco - biomass types



Bioloco - Conversion technology



Conversion techniques

name	wervelbedverbrander 24MW		
description	wervelbedverbrander 24MWe		
electrical power	24	thermal power	70
own use plant	elektriciteit		
manifestation	vast		
volatility	0		
	minimum		maximum
moisture content	0.00%		60.00%
particle size	0		100
net heating value	12		100
ash contents			50.00%
net energy returns heat	0.85	electricity	0.3
evaporation energy moisture	2.4		
capacity input	17500		
working hours	625		
fixed costs	€5,609,000.00	variable	€6.80
energy use	0.2		
ash-softening point	900		
temperature	525	pressure	100
net produced steam	7500		
specific flue gass volume	0		

	CO2	NOx	SO2	dust
emission	0	250	100	0

reference: test cases

Record: 8 of 9

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Reports - Light - Global results (1)

Output Bioloco light: global results

calculation	464	09 March 2006	11:52:51
network	voorbbio		
criterion	10	maximize profit	
model	2	Bioloco light	

Total throughput:

[ton dm]

from sources	220344
to plants	203843

Revenues and costs:

total revenues	€ 49,680,288

purchase costs	€ 9,315,469-
storage costs	€ 14,419,003
transport costs	€ 2,223,968
loading/unloading costs	€ 871,322
pretreatment costs	€ 31,043,309
conversion costs	€ 13,845,355

total costs	€ 53,087,487
profit	€ 3,407,198-

Reports - Light - Global results (2)

Energy returns and use:

[GJ]:

total energy returns	2,614,752

energy used for purchase	228,413
energy used for storage	0
energy used for transport	59,432
energy used for loading/unloading	17,045
energy used for pretreatment	1,242
energy used for conversion	267

total energy use	306,398
energy profit	2,308,354

Emissions:

[kg CO2-eq.]:

total emission savings	248,499,232

emission from purchase	16,798,965
emission from storage	0
emission from transport	4,418,595
emission from loading/unloading	1,253,619
emission from pretreatment	92,319
emission fromconversion	27,241

total emission	22,590,738
emission profit	225,908,494

Calculation 464, on 09-03-2006 11:52:51, for network voorbbio, criterion 10, model Bioloco light

Produced: 29-03-2006 14:19:29

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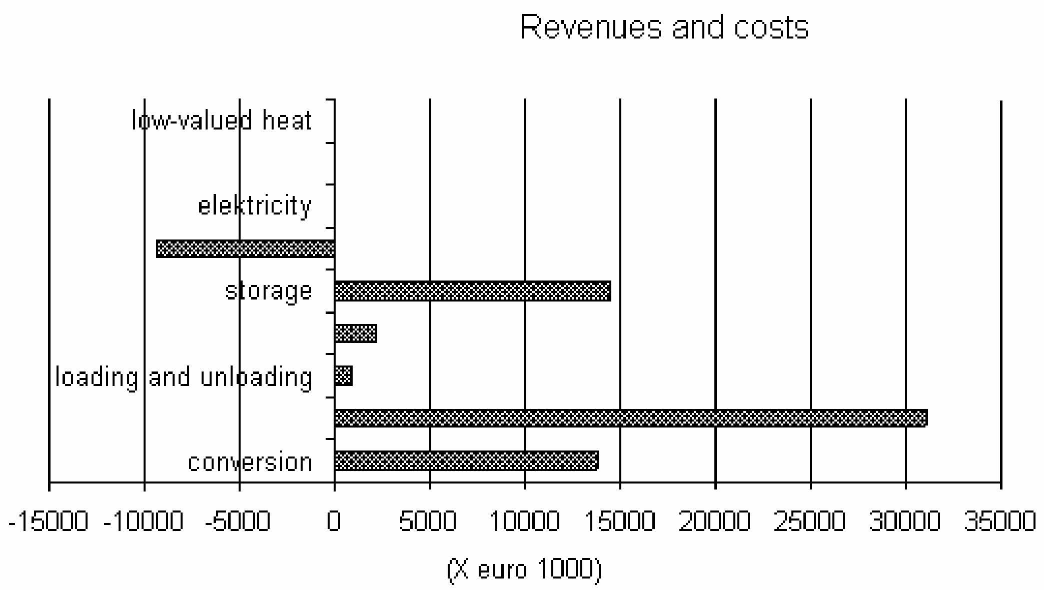
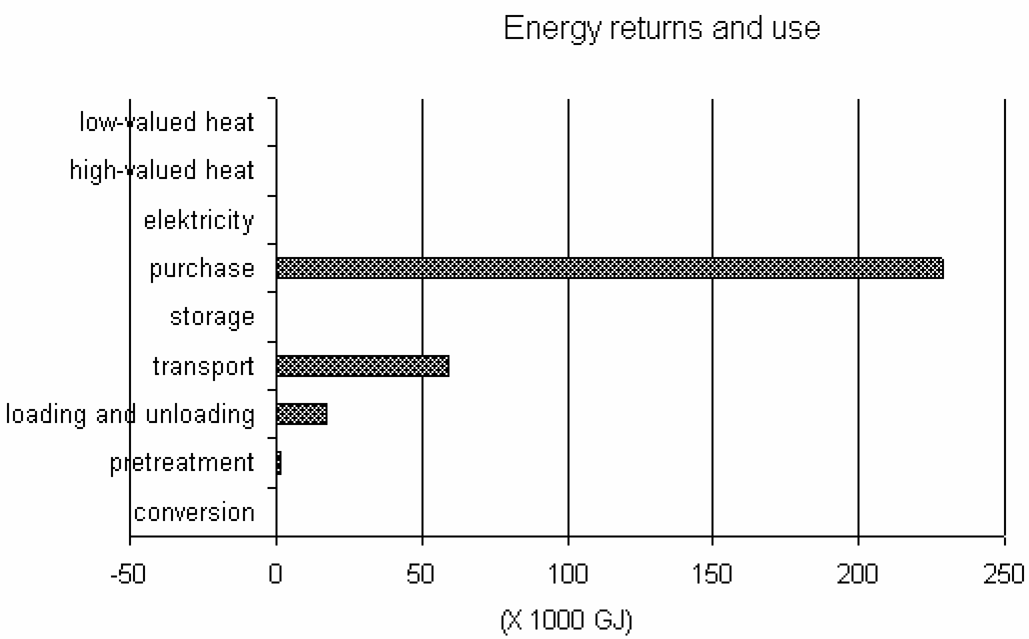
Reports Classic - global results (1)

Output Bioloco classic: column charts of global resultats

calculation	464	09 March 2006	11:52:51
network	voorbbio		
criterion	10	maximize profit	
model	2	Bioloco light	



Reports Classic - global results (2)



Calculation 464, on 09-03-2006 11:52:51, for network voorbbio, criterium 10, model Bioloco light

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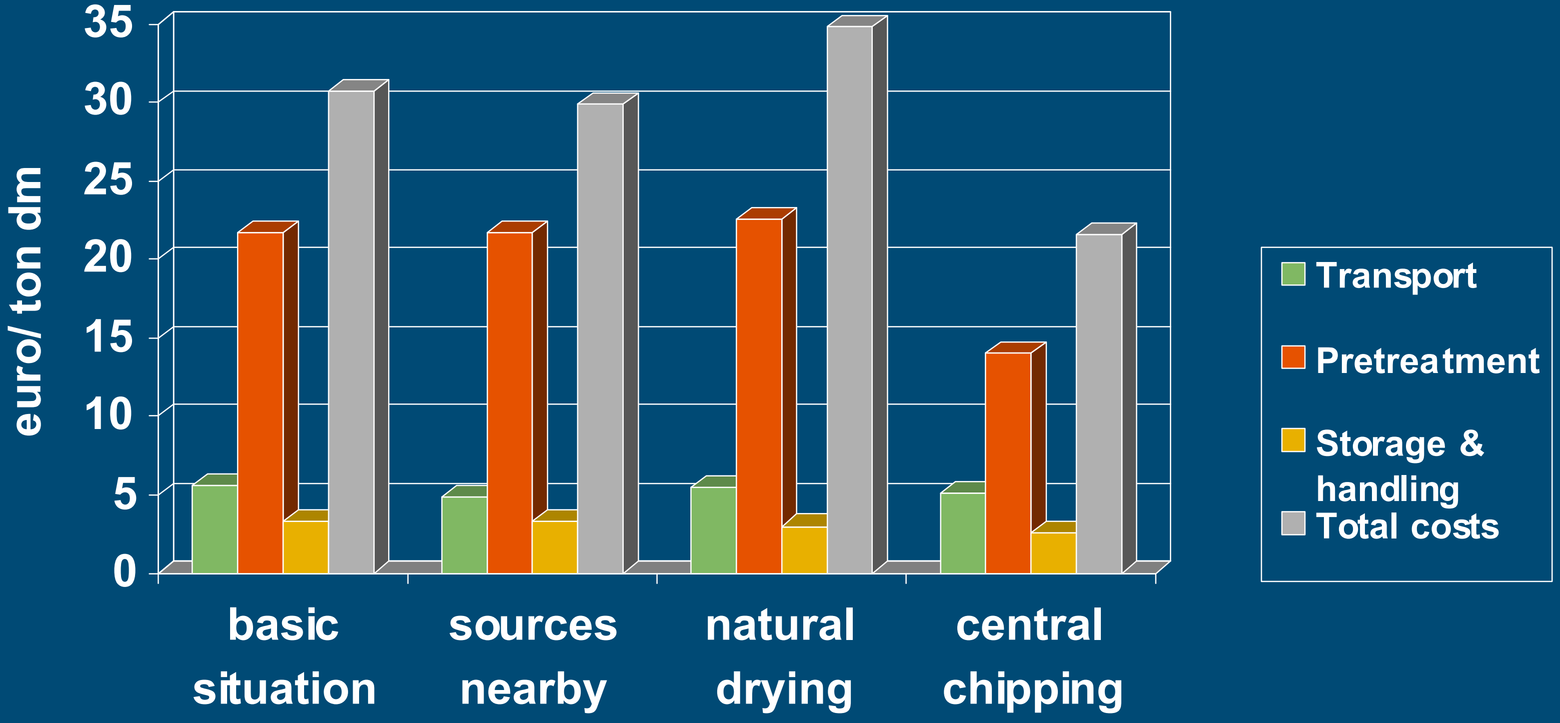
Bioloco used in several regional cases

- provincial plans: biomass power plant in North-Holland
- municipal plans: biomass utilization in Wageningen & multifunctional land use in Hardenberg
- plans of a large petrol company to use straw as an energy source
- environmental effect report
- research plans: biomass cultivation combined with quality improvement of dredging sludge by means of on-site bio remediation

Results: example costs



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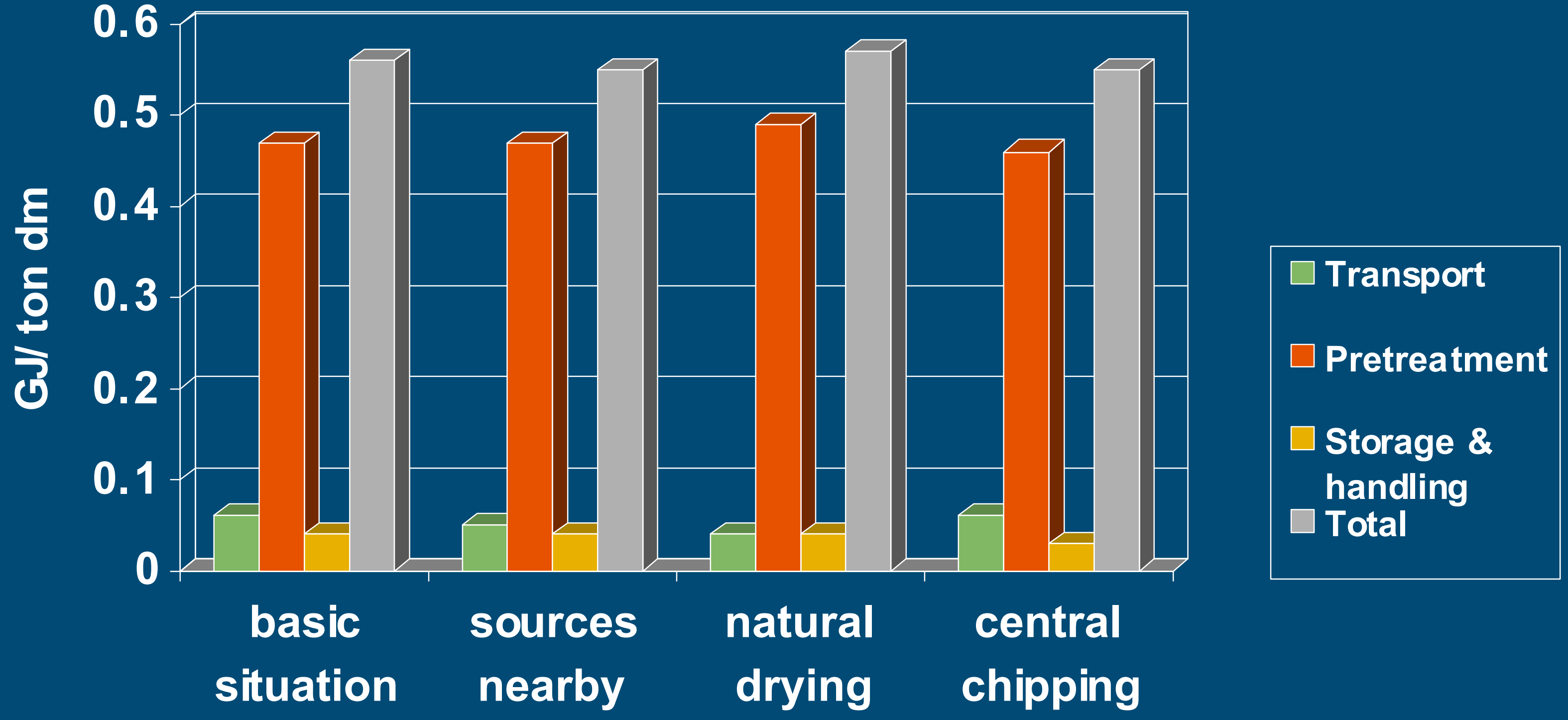
Results: example energy consumption



Conclusion

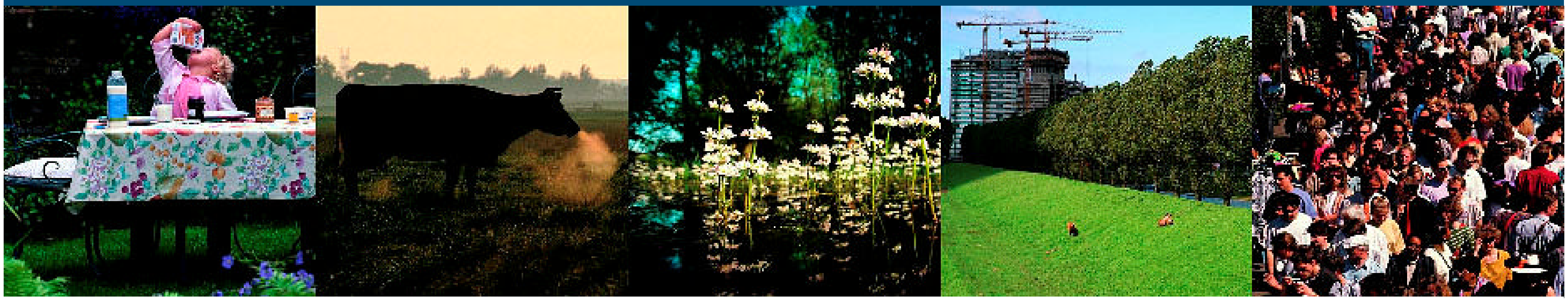
- careful strategic design of logistics is important to obtain feasible bio-energy chains
- simulation and optimization tools are available to support this design process

Further information?

- please contact: bert.annevelink@wur.nl

- www.biomassandbioenergy.nl
- www.biorefinery.nl
- www.biohydrogen.nl
- www.switchgrass.nl
- www.bioethanol.nl
- www.oostwaardhoeve.nl

Conclusion



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