Anaerobic Digestion & Biogas Technology within UK Agriculture

Greenfinch Ltd

cropgen

Greenfinch

GREENFINCH LTD

- Based in Ludlow, south Shropshire.
- Specialise in anaerobic digestion.
- 8 years of R&D into the AD of food waste.
- Constructed 7 on-farm AD plants in Scotland.
- Constructed the UK's first biowaste digester in south Shropshire.

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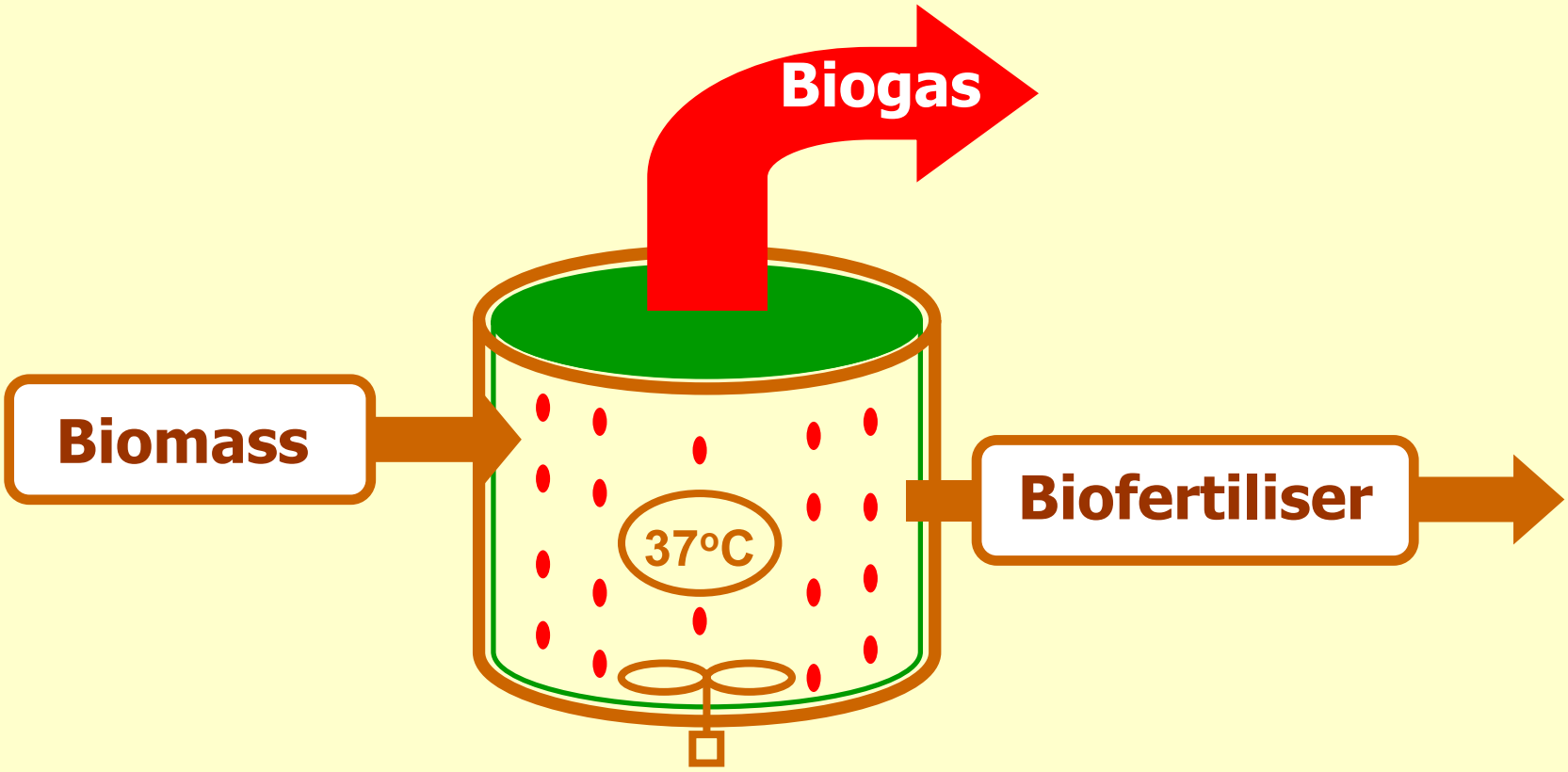
Anaerobic Digestion is a natural biological process



AD is a 3-Product Process

Most renewable energy & bioenergy technologies do only one thing – produce energy.

Anaerobic digestion is a 3-product process:

- **AD is a waste management process;**
- **AD is a nutrient recycling process; and**
- **AD is a renewable energy process.**

As such it has tended to get lost in policy making.

Anaerobic Digestion Feedstock

NON-ABP

- Energy crops
- Animal slurry
- Sewage sludge

ABP

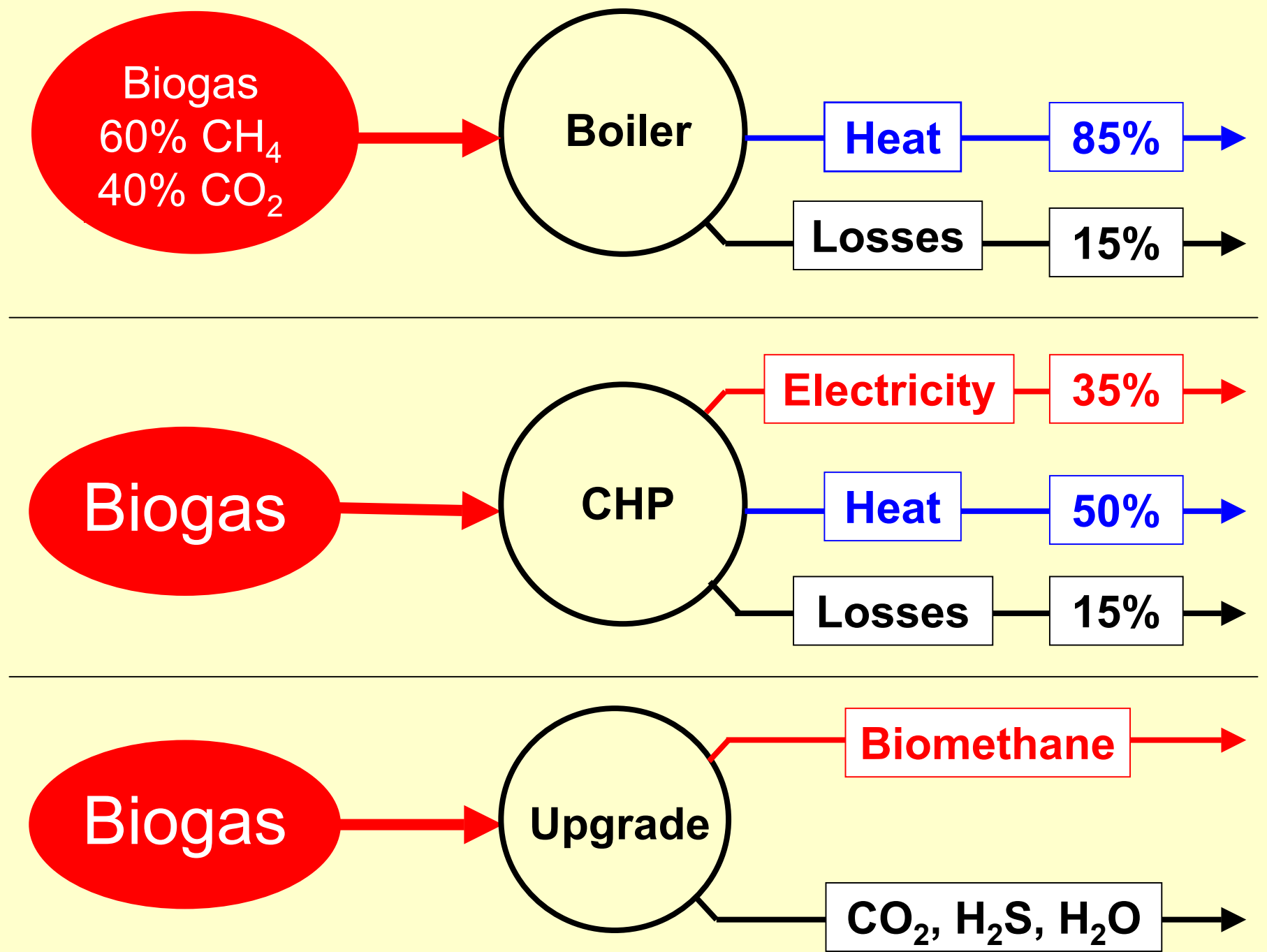
- Food processing and abattoir waste
- Source-separated biowaste
- Commercial catering waste
- Mixtures of the above

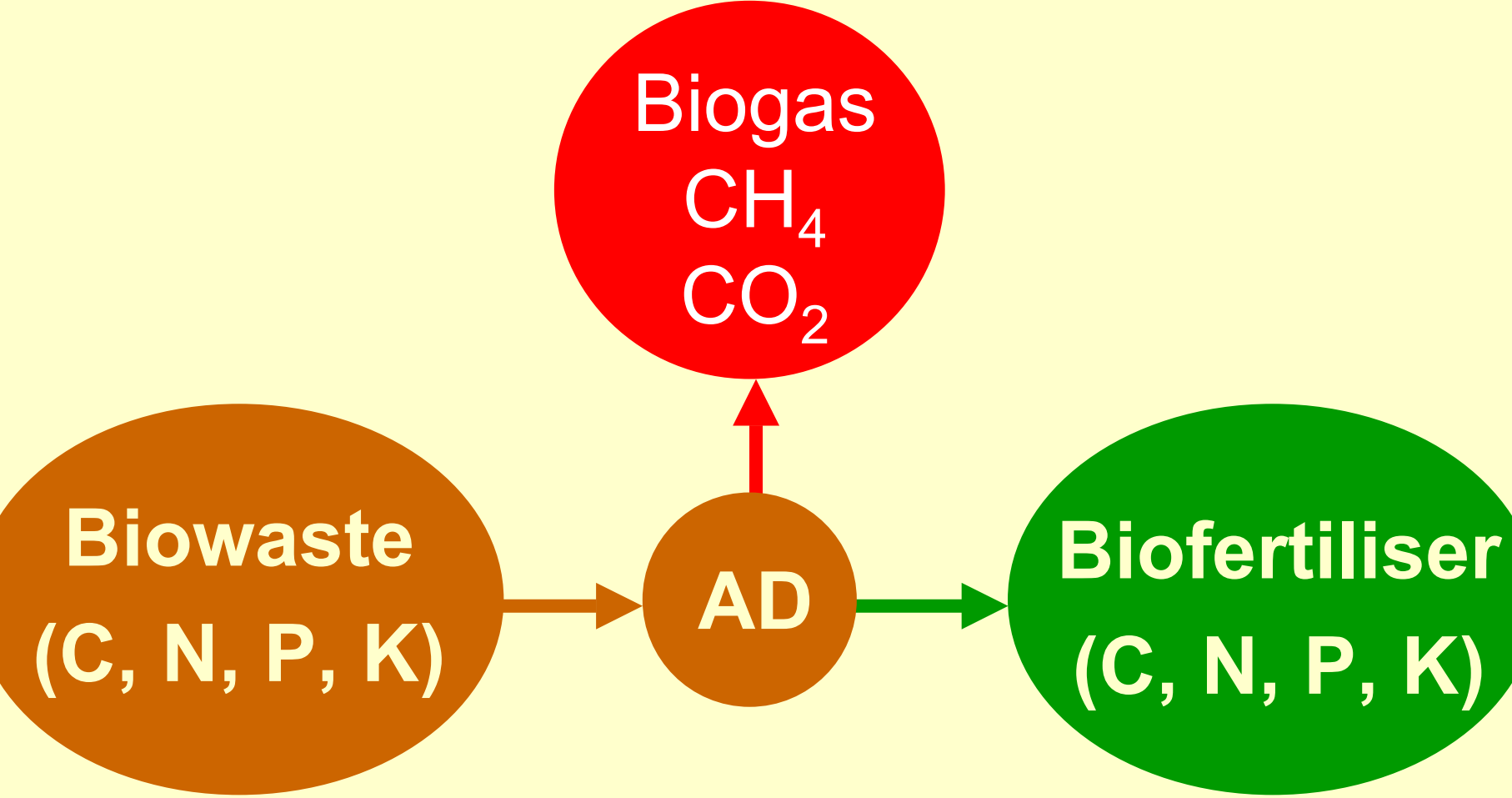
Gas Yields

Feedstock	m^3_{CH4}.t fresh matter^{-1}
Food Waste	66
Sewage Sludge	13
Cow Slurry	11
Pig Slurry	12
Wholecrop Cereal	126

Biofuel Comparison

Crop	Biofuel	Energy Balance $GJ.ha^{-1}.y^{-1}$	Energy Ratio (input:output)
Wheat	Bioethanol	34.67	1:2.3
Wheat	Biogas	68.48	1:3
Oilseed Rape	Biodiesel	18.25	1:1.8


Biogas
60% CH_4
40% CO_2
Boiler
Heat
85%
Losses
15%
Biogas
CHP
Electricity
35%
Heat
50%
Losses
15%
Biogas
Upgrade
Biomethane
CO_2, H_2S, H_2O


Biogas
CH_4
CO_2
Biowaste
(C, N, P, K)
AD
Biofertiliser
(C, N, P, K)

Digestate Nutrient Values

- Nitrogen - 2.3 - 4.2 kg/tonne
- Phosphorus - 0.2 - 1.5 kg/tonne
- Potassium - 1.3 - 5.2 kg/tonne

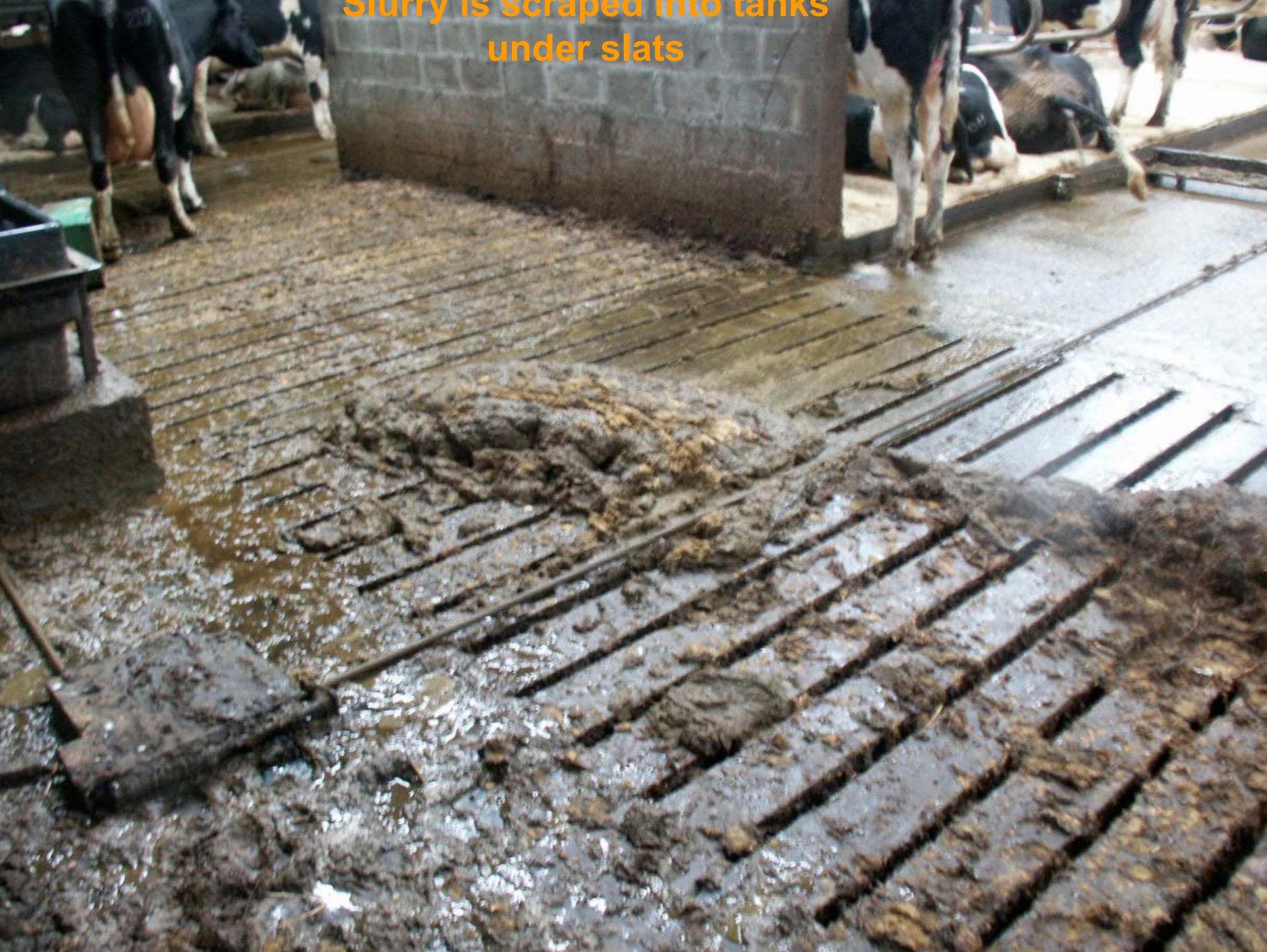
On-Farm AD Plants in UK

Pig Farm Digester (1970s)

Cattle Farm Digester (1980s)

Cow Slurry Digester (2004)

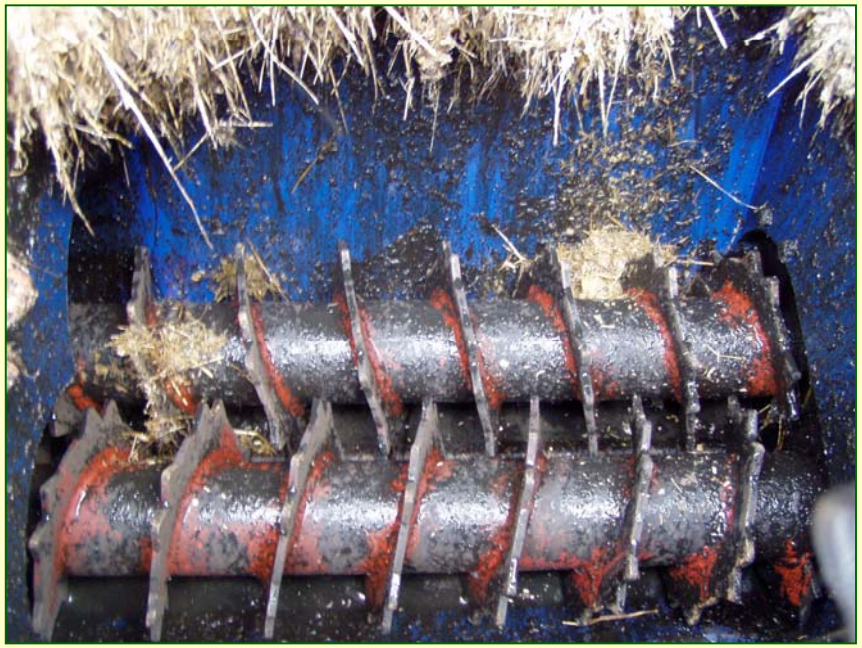
Pig Farm + Food Waste (2006)


Slurry is scraped into tanks
under slats


Slurry is pumped from the
slats by a tractor-pump
NC
NC


Above-ground reception tank

Completed 80 m³ Biogas Plant



Auger Feed Systems

Anaerobic Digestion of Energy Crops

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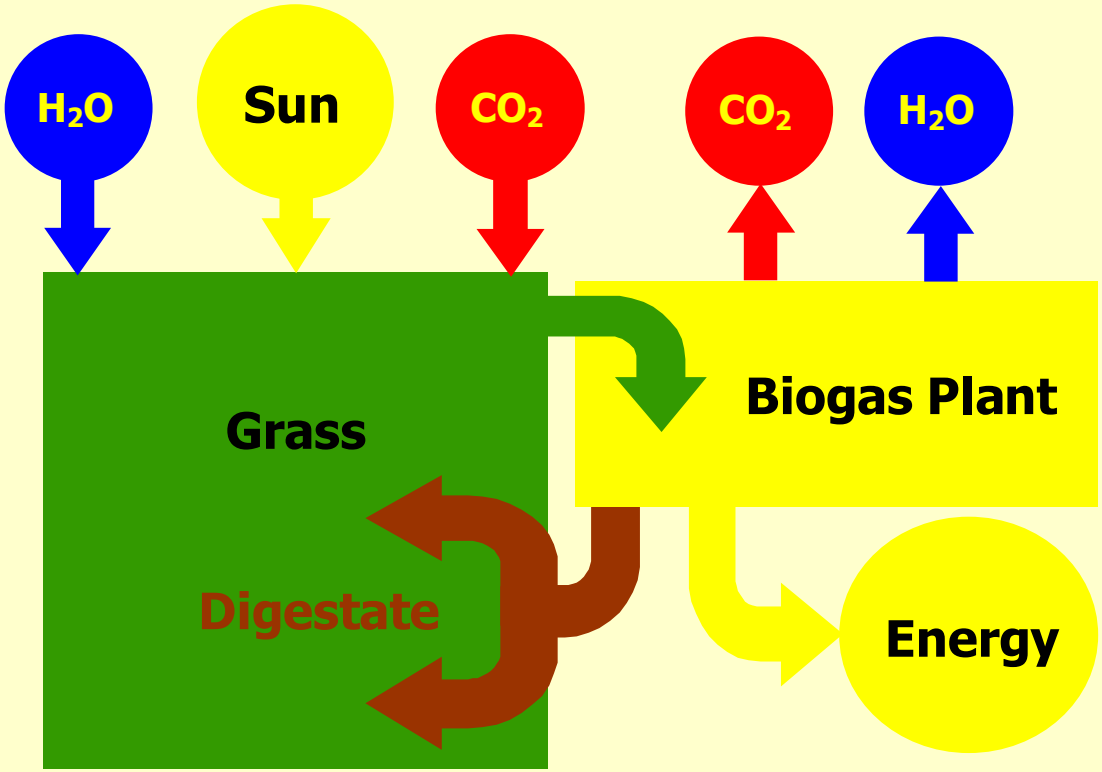
- **A pan-European consortium investigating the production of biogas from agri-waste & energy crops.**

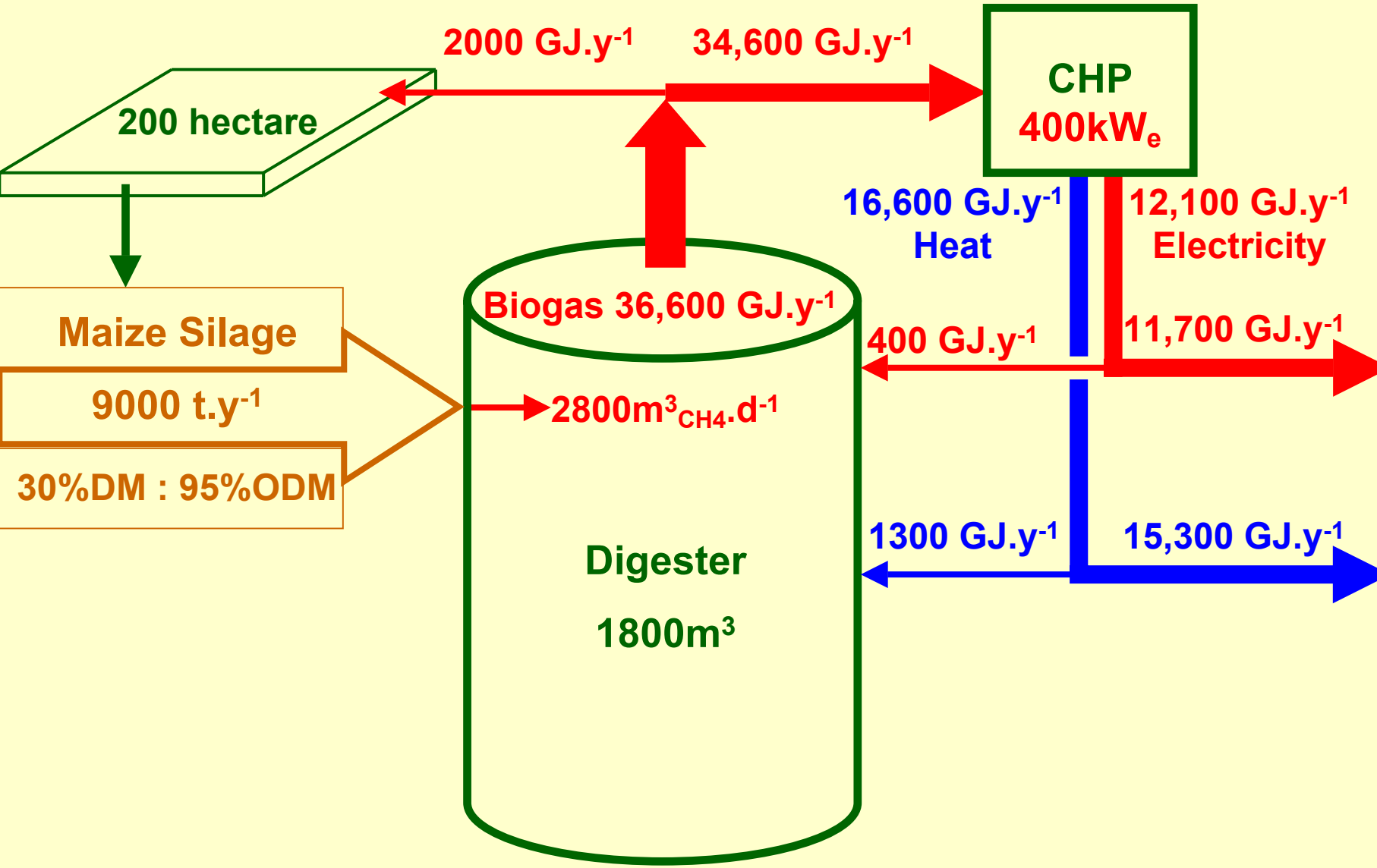


Crop Digestion Trials

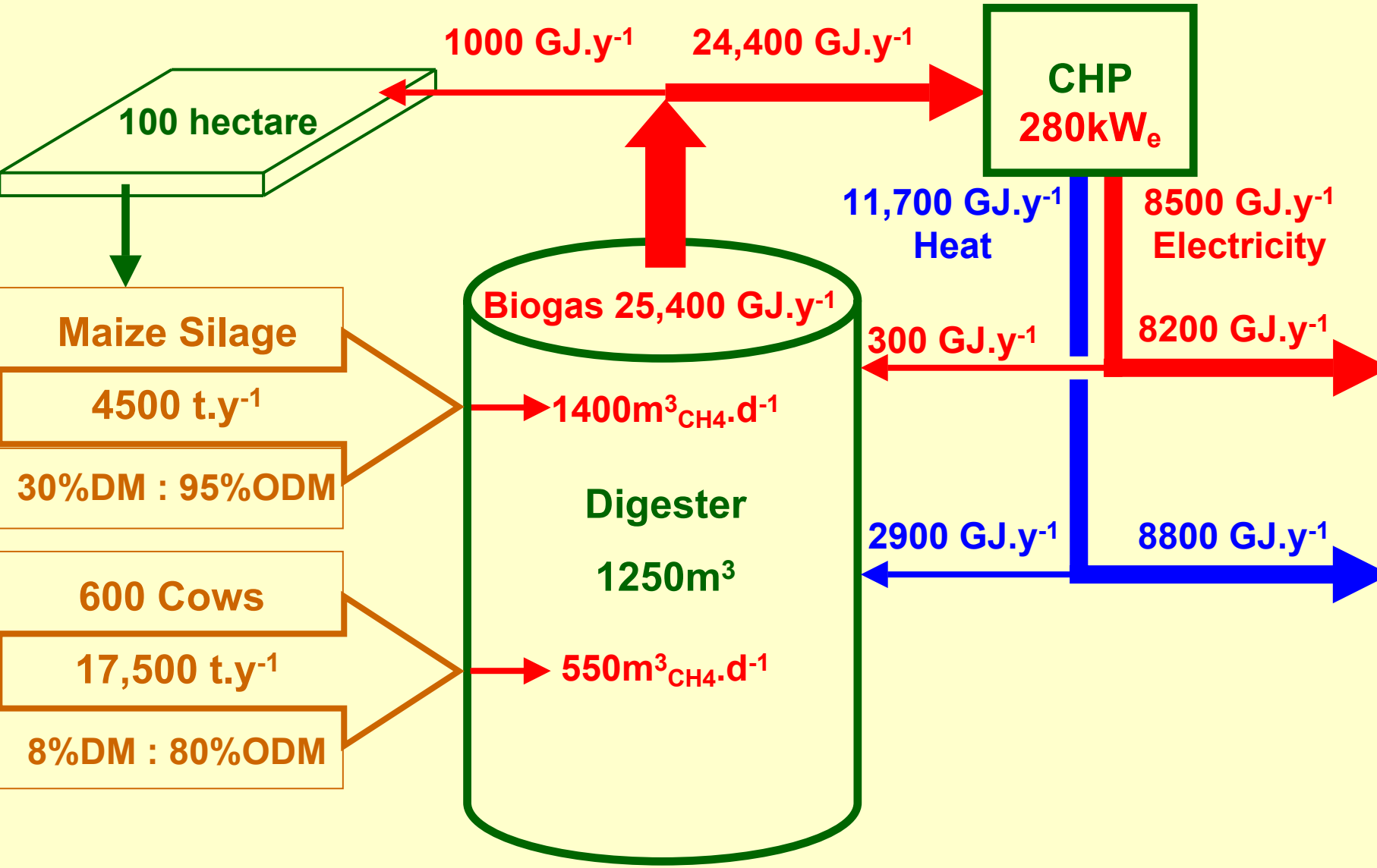
Energy Crop Parameters

Crop Variety		Maize	Ryegrass	WC Winter Wheat
Crop Yield	$t_{WET}.ha^{-1}.y^{-1}$	45	56	36.5
Dry Matter	%DM	30	20	40
Organic Dry Matter	%ODM	95	88	90
ODM Yield	$t_{ODM}.ha^{-1}.y^{-1}$	12.8	9.8	13.1
Methane Yield	$m^3{}_{CH4}.t^{-1}{}_{ODM}$	400	340	350
Gross Energy Yield	$GJ.ha^{-1}.y^{-1}$	182	120	163
Gross Energy Yield	$kW_f.ha^{-1}$	5.8	3.8	5.2
Energy for Crop Production	$GJ.ha^{-1}.y^{-1}$	10	24	10
Energy for Crop Production	$kW_f .ha^{-1}$	0.3	0.8	0.3
Net Energy Output	$GJ.ha^{-1}.y^{-1}$	172	96	153
Net Energy Output	$kW_f .ha^{-1}$	5.5	3.0	4.9
Crop Production Cost	$£.ha^{-1}.y^{-1}$	£720	£450	£625

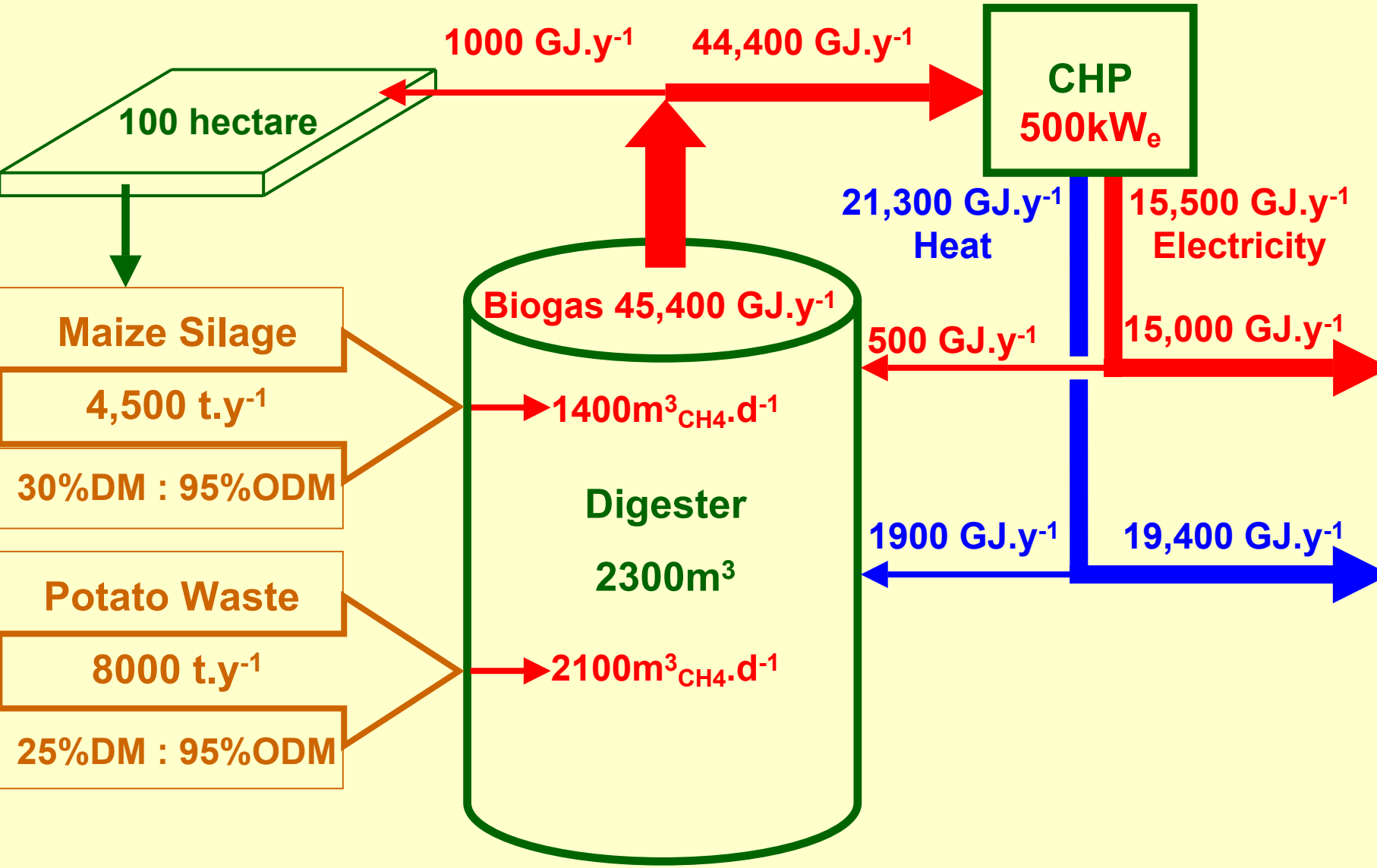
Energy Balance: Maize Silage



Energy Balance: Maize + Cow Manure



Energy Balance: Maize + Potato Waste



Commercial Analysis

		Maize	Maize + Pigs	Maize +Potato
Sale of Electricity	£.y^{-1}	295,000	205,000	376,000
Sale of Heat	£.y^{-1}	17,000	17,000	17,000
TOTAL INCOME	£.y^{-1}	312,000	222,000	393,000
Cost of Energy Crop	£.y^{-1}	144,000	72,000	72,000
Cost of Labour	£.y^{-1}	14,000	14,000	14,000
Cost of Maintenance	£.y^{-1}	57,000	40,000	74,000
TOTAL COSTS	£.y^{-1}	215,000	126,000	160,000
INCOME LESS COSTS	£.y^{-1}	97,000	96,000	233,000
CAPITAL COST	£	800,000	700,000	900,000
PAY-BACK	yrs	8.2	7.3	3.9

Economic Viability Depends on:

- **Housed Time of Stock**
- **On Site Heat Use**
- **Electricity Use**
  - On site = 11p/kWhr
  - Export to grid = 8p/kWhr
- **Production of waste on site**
- **Use of Energy Crops**
- **Sale/Value of Bio-fertiliser**
- **Gate Fees**

Permitting

- Planning Permission: Application to local planning authority; if waste is included it must go to county planning.
- Waste Management License: Application to the Environment Agency.
- Animal By-Products Approval: Application to State Veterinary Service if ABPs are to be processed.
- Renewable Electricity Accreditation: Application to Ofgem.
- Biofertiliser Land Use Exemption: If waste is imported application to EA.

Low-Carbon Process

- Anaerobic digestion reduces greenhouse gas emissions in 4 ways:
- by preventing the uncontrolled emissions of CH_4 (22 times more powerful than CO_2);
- by beneficial use of the biofertiliser in agriculture, displacing mineral fertilisers;
- by reducing the transport of waste; and
- by the production of renewable electricity & heat.

Conclusions

- As yet there are no grants available to help with the high capital cost, which is preventing small scale digesters from emerging.
- Co-digestion of energy crops with food waste & animal manure is becoming economic in the UK.
- The economics are improved if;
  - the electricity is used on site, for example for refrigeration;
  - there is a use for the heat;
  - if there is a market for the bio-fertiliser, on or off-site.
- We expect the first UK energy crop AD plant to be built in 2007…..

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