

Biomass **- our energy future?**

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Biomass is:

- Cellulosic plant material that can be burned or processed to provide energy or other materials.
- Biofuels are liquid fuels produced from crops and by-products. If the grain or oilseed is burned whole the fuel is biomass.

Dedicated energy crops are:

- Defined by Defra as primarily being Short Rotation Willow coppice (*Salix* spp) and *Miscanthus* spp.
- There is a planting grant available for planting these crops in England (but not Wales) if an energy end use can be proven.

Miscanthus spp.

- Clonally reproduced rhizomatous grass.
- Planted as root fragments.
- More efficient C4 photosynthesis (like sugar cane and maize).
- Can be harvested, baled and transported with conventional machinery.
- Relatively high dry matter.
- Carbon balance > 20:1.

Short Rotation Coppice (SRC)

- Mainly willow (*Salix* spp).
- Planted as stem fragments.
- C3 (normal) photosynthesis.
- Harvested as chips or billets.
- Comminution has high power requirement.
- Chipped and dust material can be handled easily.
- Dry matter can be around 50% at harvest.
- Carbon balance >20:1.

Biomass v Fossil

- Carboniferous biomass era lasted 50 -60 million years.
- We will use a lot of the biomass fossilised as fuel over a 300 year period.
- Crudely put, this is 200,000 times faster than it was made - Fossil fuels buy energy input over time!
- Biomass is grown and used on an annual cycle.
- This is 1:1 *cf* 200,000:1.
- Biomass is produced slowly, stores poorly, and is of low density.
- So how does it compare with fossil fuels, and why grow it?

Biomass and Fossil fuels

Lower energy content, higher moisture content

	net	gross	% redn
Coal	25.4	26.7	4.9
Motor spirit	44.8	47.1	4.9
Diesel/Gasoil	43.3	45.6	5.0
Natural gas	35.6	39.6	10.1
Industrial wood	10.0	11.9	16.0
Straw	12.8	15.0	14.7
SRC	9.0	10.6	15.1

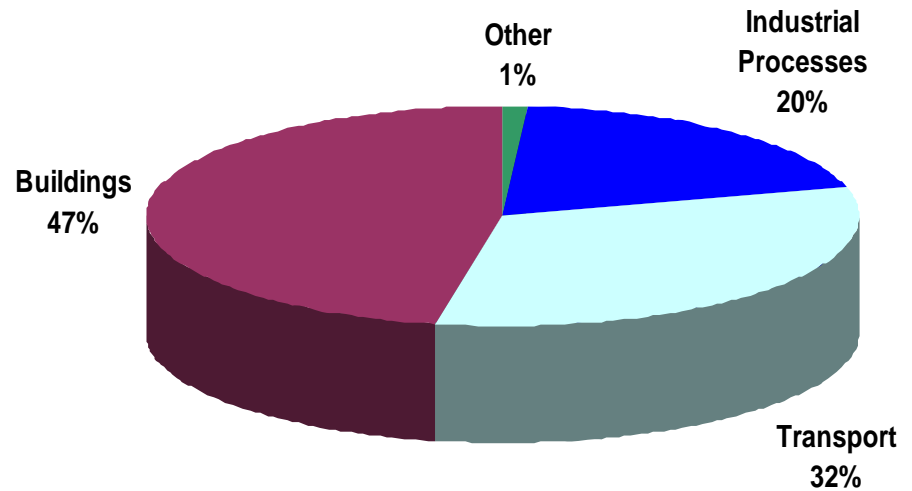
Source: DTI Dukes 2004 data

Ethanol and Biodiesel similar to fossil fuels

UK CO₂ Targets

- Firm Government commitment - UK Climate Change programme
- Legally binding Kyoto GHG reduction target of 12.5% below 1990 levels by 2008-2012
- Tougher domestic goal of reducing CO₂ emissions by 20% by 2010
- Energy White Paper – 60% reduction by 2050

UK Total CO₂ Emissions
473 Million Tonnes



Biomass Task Force

'Biomass is recognized as an important contributor to renewable energy, with potential applications in heat, electricity, combined heat and power and transport'.

Government Response

Biomass task force

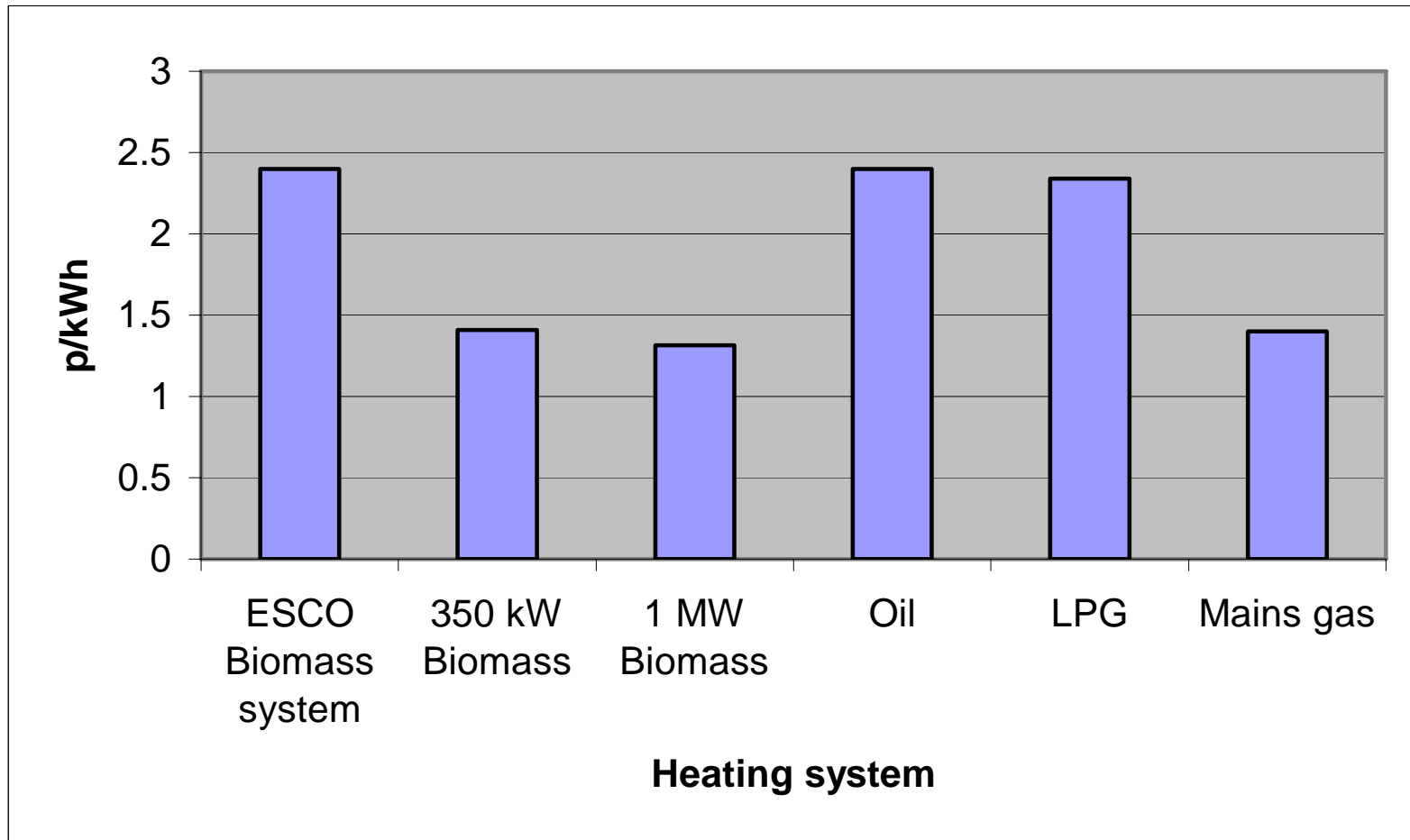
Government response includes

- Capital grant scheme for biomass boilers.
- Support for biomass under new RD programme (2007)
- New Biomass Energy Centre
- Better integration of environmental assessment
- Leadership through public procurement
- Improvement to Renewable Obligation procedures
- Use of planning system to support minimum levels of RE
- Regulatory barriers addressed
- Buildings regs, waste, EU Biomass Action plan

Government are determined to make it work, specifically

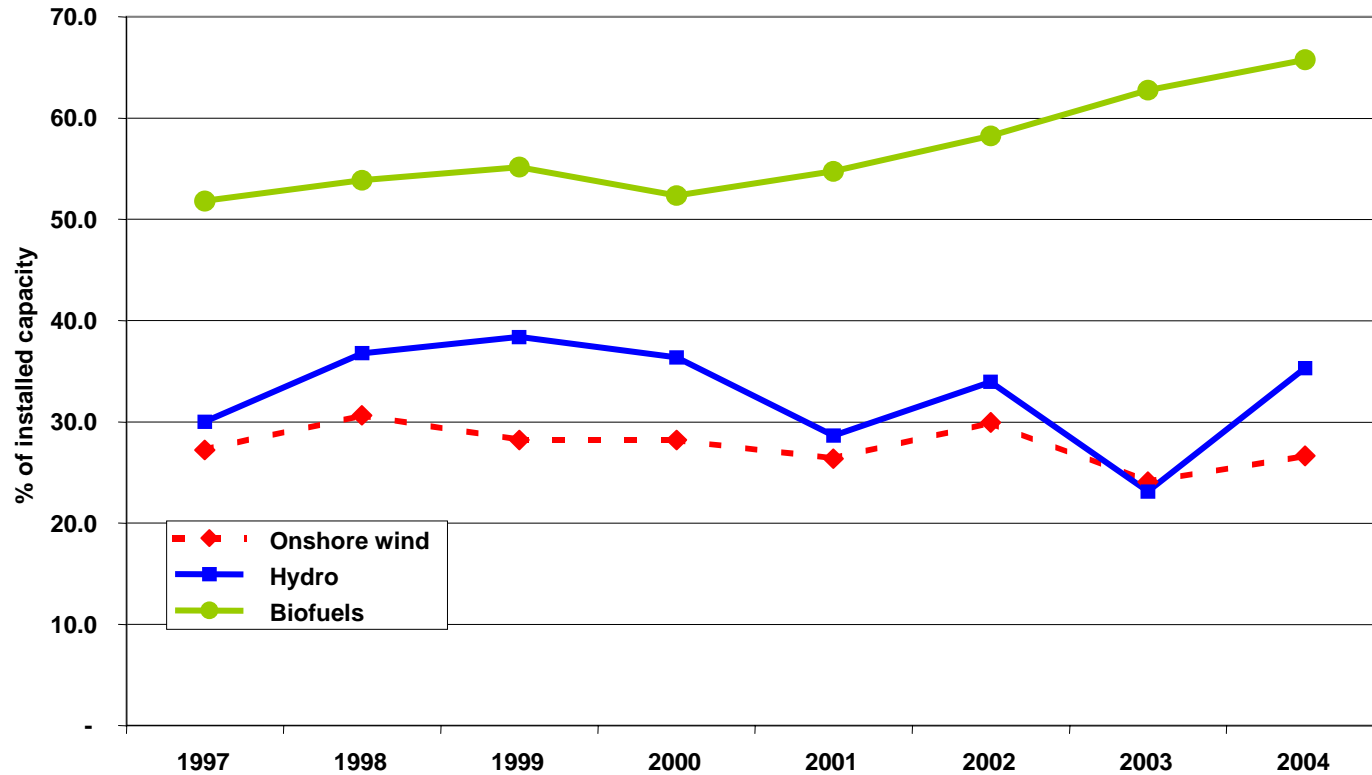
- Capital grants for heat, CHP, electricity
- Energy Crop Scheme (England)
- Energy Crop Infrastructure Scheme
- Enhanced Capital Allowances
- Climate Change Levy
- Continuously developing support measures and incentives

It is CO₂ neutral and can be cheaper



It provides sustained generation

Load factors (per cent)- Electricity generated from renewable resources

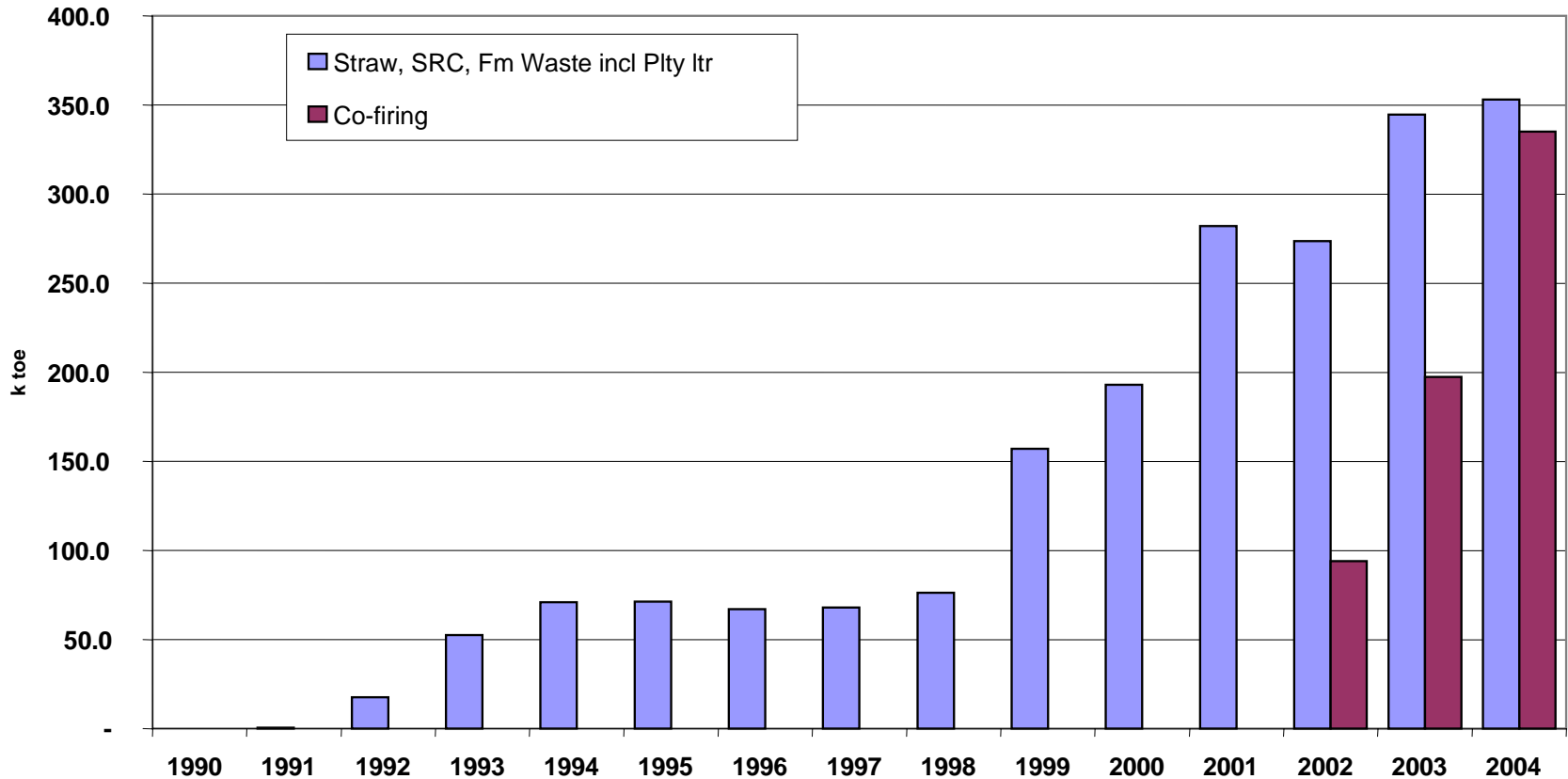


Policy Instruments and Regulations

- The Climate Change Levy - Effective since 2001
- UK Emissions Trading: 2002-2007 and EU Emissions Trading: >2005
- Enhanced Capital Allowance – 100% tax rebate on accredited technology
- ROC Market - 6.7% electricity supply from RE by 2006/7, rising to 15.4% by 2015/16 (3.1% end 2004)
- Building Regulations – Part L and Energy Performance of Buildings Directive – 47% of CO₂ is from buildings
- Waste Regulations limits type of timber that may be burned

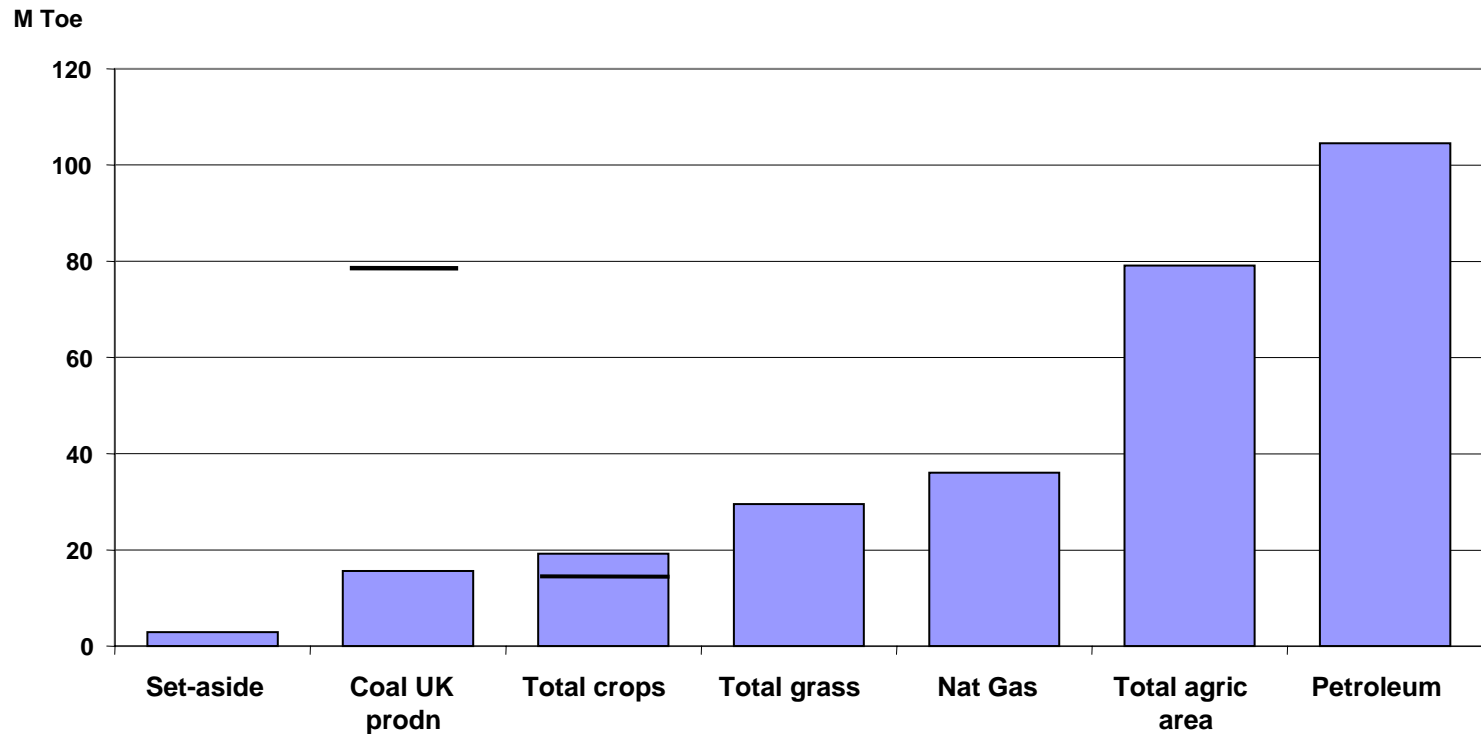
Development of biomass, farm wastes and major co-firing energy use 1990 -2004

Impact of large scale co-firing on the overall energy from Biofuels (kToe)



Production (toe) if *all* land under set-aside, crops, grass and all agriculture were planted to biomass

Biomass and Fossil Fuel Production (Million tonnes oil equivalent)



Ely Power Plant

- 34 MW producing 270 GWh per annum from straw and Miscanthus
- Have developed a sound supply infrastructure - Anglian Straw
- The only operating plant burning Miscanthus for electricity in the UK
- Learning curve: storage, transport, moisture content.
- Operations in the North and West are in higher moisture environments.

Power Station Co-firing

- Legislation forces large coal stations to co-fire with biomass.
- Mix of imported and domestically grown fuels.
- Separate injection or entrained milling with coal.
- Any biomass > 31 March 09.
- Increasing to 75% from energy crops from 1/4/11 - 31/3/16.
- Co-firing 2016 ceases.
- The dedicated biomass plants.

Biomass Task Force

‘We agree in particular with the Task Force’s conclusion that renewable heat provides important opportunities and is a particularly efficient way of cutting carbon emissions.....’

Government response

Heat from Biomass - what makes it work?

- Off mains gas-grid areas.
- High and consistent heat load.
- Larger scale installations.
- 50% capital grant.
- Stand alone rather than district heating systems.
- Enthusiasm for wood heat and willingness to 'push'.

Life cycle analysis of complete systems

- Comparing the use of wood and Miscanthus for two real life small scale heating situations.
- **Similar carbon savings:**
 - Miscanthus system: 44 t CO₂e
 - Wood fuel system: 40 t CO₂e
- Need to develop production systems minimising fossil fuel inputs

Fuel from forestry and wood waste

ADAS experience

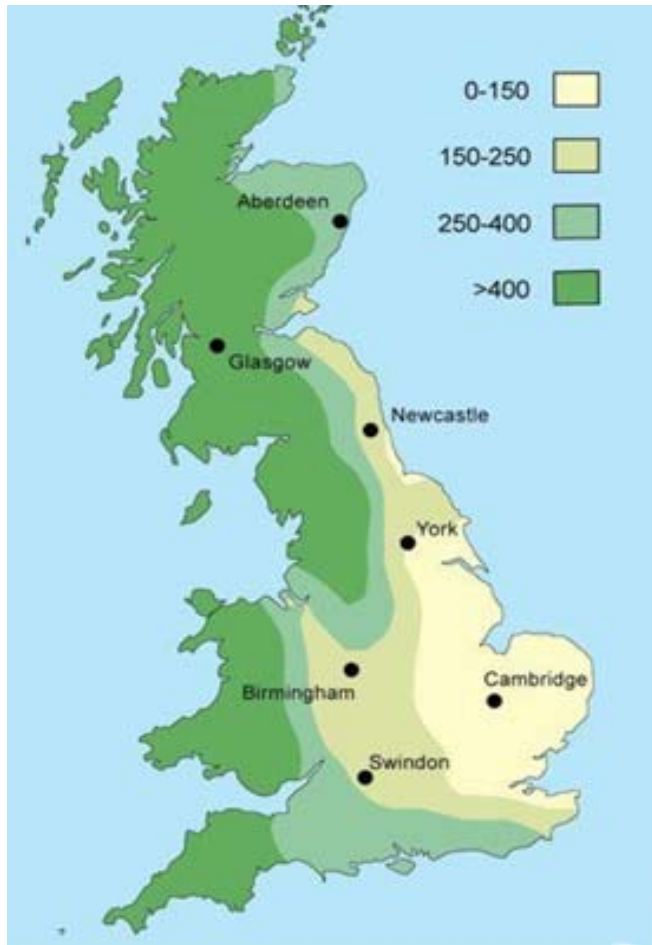
- Regional studies show where wood fuel heating and small scale CHP would work economically.
- Need capital incentives and low cost fuel – importance of using woody waste.
- Need planning laws favouring renewables.
- Wood supply studies for inner city developments show it as a feasible option.
- Logistics and infrastructure; engineering OK.
- Integrating wood fuel, waste and Miscanthus, and seasonality and storage issues.

Potential yield of *Miscanthus* or other biomass crops

Yield is only one of several factors affecting the choice of whether to grow biomass crops:

- **Other land uses (e.g. valuable cash crops like salads)**
- **Local demand for power/heat**
- **Transport links (biomass is low density and transport must be cheap)**
- **Other (competitor renewables) in the area**
- **Water demand**

Biomass & water supply



- High yields need plenty of water.
- Excess winter rainfall (that which recharges reserves) is lower in the east and south.
- Biomass may be more suited to the wetter west.
- Annual biofuel crops (wheat and OSR) need dry(ish) weather for planting and harvest.

Water use - Fuel Supply Chain study

Crop water use as % of SRC

	Clay soil: Notts	Sandy soil: Notts	Sandy soil: Lincs
Bare Ground	53	60	53
Grass	84	89	90
Winter wheat	78	81	88

Results from ARBRE

- Biomass crops use more water than arable crops.
- So growing in the wetter west may be the best option, ploughing up grassland rather than arable.
- BUT we found significant differences in carbon balances for biomass planted on arable land (strongly positive) and after grass land (-11 tonne/ha) negative.
- We need to devise a way of planting that minimises carbon loss.

Energy crops - barriers to planting

Developers need to acknowledge...

- Relatively expensive!
- Yield variation - weather, pests, disease etc
- Specialist equipment
- Field size can be a problem
- Case by case assessment needed
- A combination may be the best option
- Don't plough up high Carbon grassland!

Biomass development - Who

- Power companies (major and renewables)
- Industrial plant with heat need (+ grid)
- Co-operative ventures (grower groups + end users)
- Building developers (with renewable targets)
- Institutional energy users (colleges, offices, 'campuses')
- Individual rural business (farms, farm business parks)
- Domestic use (pelleted stove fuels)
- Domestic use (logs)

Due diligence:

Biomass plans need to assess

- The security and long term availability of the biomass fuel supply?
- Alternative uses for the fuel which may affect its long term cost?
- The market for electricity and/or heat?
- Is it practical to build a plant?
- Can the heat/electricity be sold easily?
- Is there a prospect of funding the project and is it commercially viable?

EU perspective

EU projects:

- Modelling fuel supply chains
- Modelling Kenaf (*Hibiscus cannabinus*) economics
- Framework 6 project: HYVOLUTION

Hyvolution –Non Thermal Production of Hydrogen from Biomass

- Long term goal to establish regional small scale hydrogen production facilities.
- Total budget 13.8 M€, EU contribution 9.5 M€
- Jan 2006 -Jan 2011.
- Pan-European involvement of 11 EU countries, Turkey and Russia.
- Integration of 20 partners from academia and industries – input from specialists in biomass, fermentation and gas technology.
- Joining (bio)hydrogen research results from national projects.

Outputs

- Establish full scale hydrogen generating installations
- Resolve current technical and economic bottlenecks to commercial hydrogen production from biomass
- An analysis of the economic impact of decentralised hydrogen facilities –
- A life cycle analysis – of green house gases and an energy budget
- Dissemination of research findings to inform UK policy on hydrogen research.

Conclusions

- Biomass can provide reliable, low CO₂ heat and power.
- “Horses for courses” - like other renewable energy sources, good planning will give greatest efficiency.
- Can only be part of the ‘answer’.
- Main problems are with infrastructure and logistics, but..
- The fuel is biologically active.
- A prime niche is with rural businesses & housing.
- We are still developing systems for it use.