Defining the key cost areas in a supply chain analysis: The case of woodfuel supply chains in the UK

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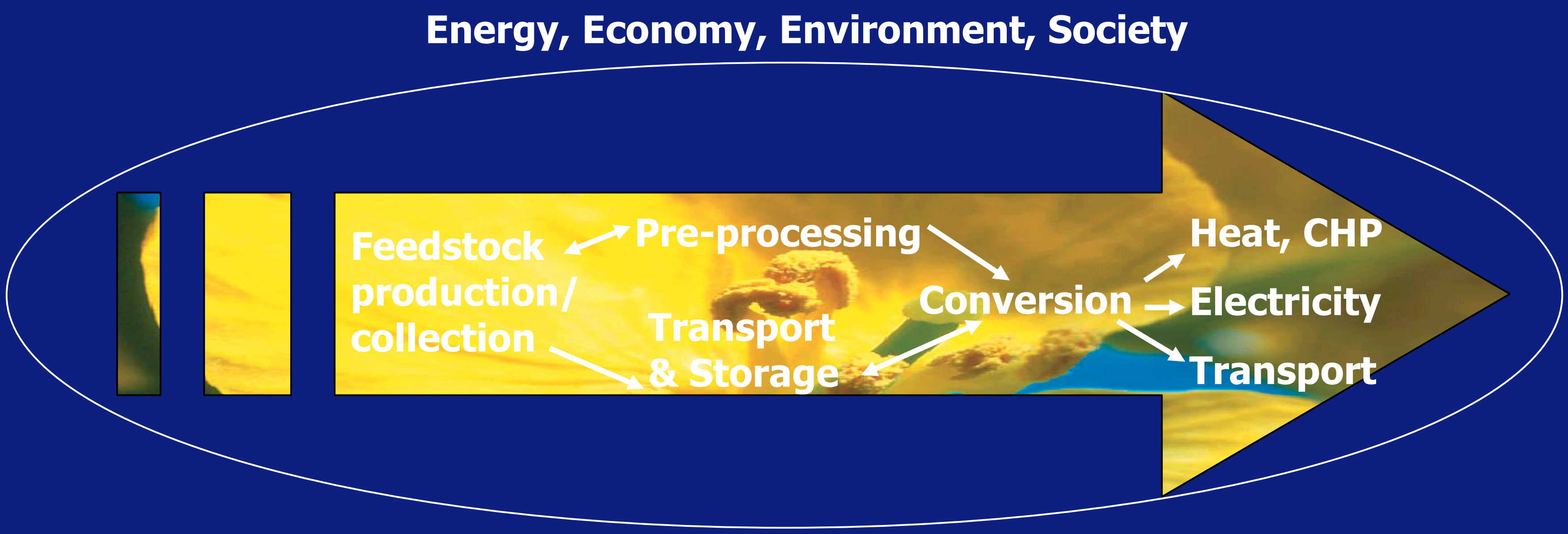
The TSEC-BIOSYS project

Multi and interdisciplinary research from a whole systems perspective

- Analyse the potential bioenergy demand and supply in the UK in the stationary and transport sectors
- Assess the implications and sustainability of wider bioenergy use and its potential contribution to UK energy and environment objectives
- Identify bottlenecks to wider use and suggest measures relevant to technology, policy and stakeholder involvement

The whole systems approach to bioenergy in TSEC-BIOSYS



Objective of this work

- To define the key cost areas in UK woodfuel supply chains. The analysis accounts for feedstock production & handling, logistics and conversion stages
- Focus on biomass supply chains for heat and power in the UK (2 woody chains)
- Quantified results both at plant gate and overall energy production cost

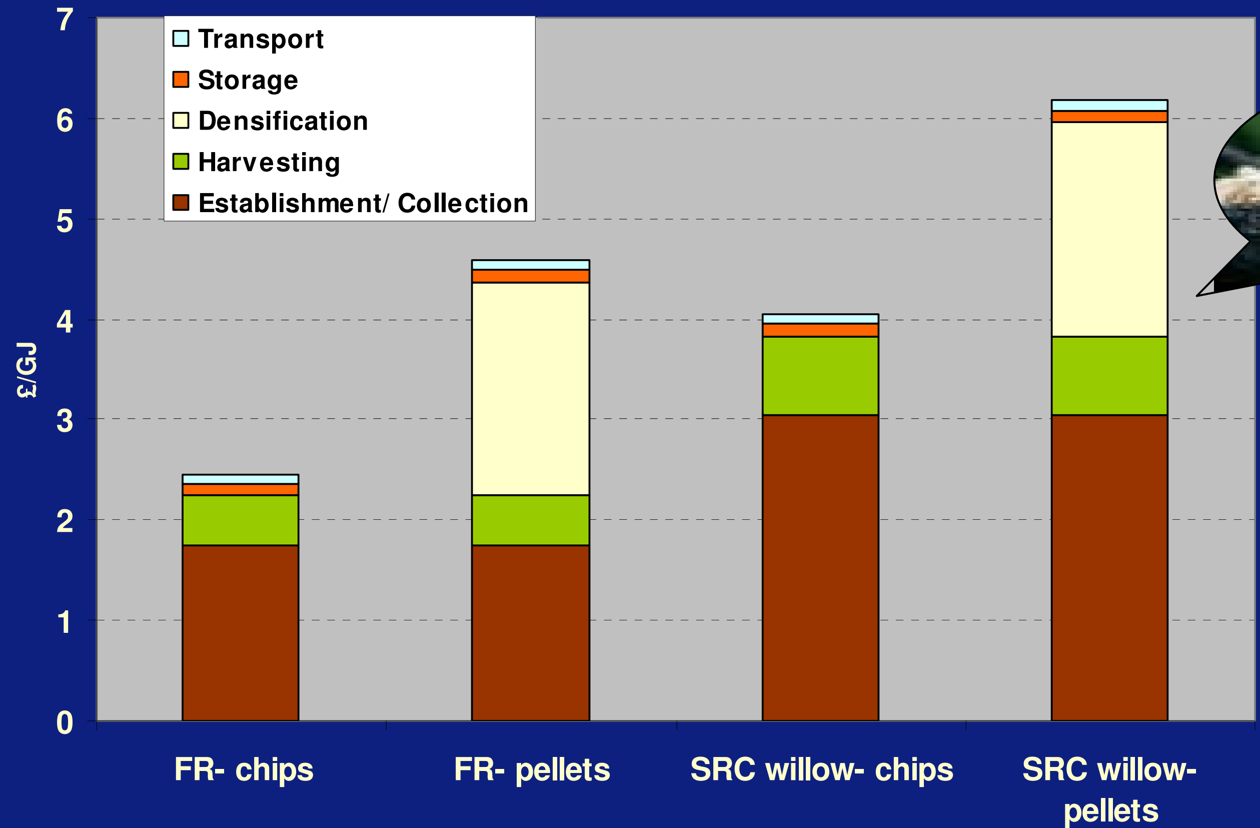
Parameters used in the biomass chain model: inputs, outputs and discrete options along chains

	Options	**Input**	**Output**
Feedstock	Energy crops: SRC willow Residuals: forestry residues	Energy crops: Establishment costs, variable costs, fixed costs. Residual value or collection cost.	Feedstock cost (£ GJ-1)
Harvesting	Harvesting method, Additional processing (i.e. densification).	Costs for harvesting, loading to storage, additional processing and bagging.	Harvesting cost per feedstock (£ GJ-1)
Storage	Outdoors or indoors	Storage costs, storage duration and losses.	Storage cost per feedstock (£ GJ-1)
Transport	Transport mode: Road, rail and sea.	Transport distance, loading to transport.	Transport cost per feedstock (£ GJ-1)
Conversion	Technology type: Combustion, gasification and co-firing. Scale type: Micro, Small, Medium and Large.	Capital cost, O&M costs, capacity, conversion efficiency, load factor.	Feedstock cost per scale and technology type (£ GJ-1)
Support mechanisms	Grants and policy incentives	Energy Crop Scheme and EU Energy Aid payment, Renewable Obligation Certificate.	

The two woody chains modeled and key characteristics

Chain stage	SRC willow	Forestry residues
Establishment or residual collection	Planting density of 15,000	Roadside
Harvesting	Every 3 years using cut-and-chip	Chipping as required
Densification	Into pellets	Into pellets
Storage	Outdoors in piles (uncovered)	Outdoors in piles (uncovered)
Transport	Road	Road
Conversion	Combustion, gasification and co-firing	Combustion, gasification and co-firing

Results (1) Feedstock costs at the plant gate (£/GJ)

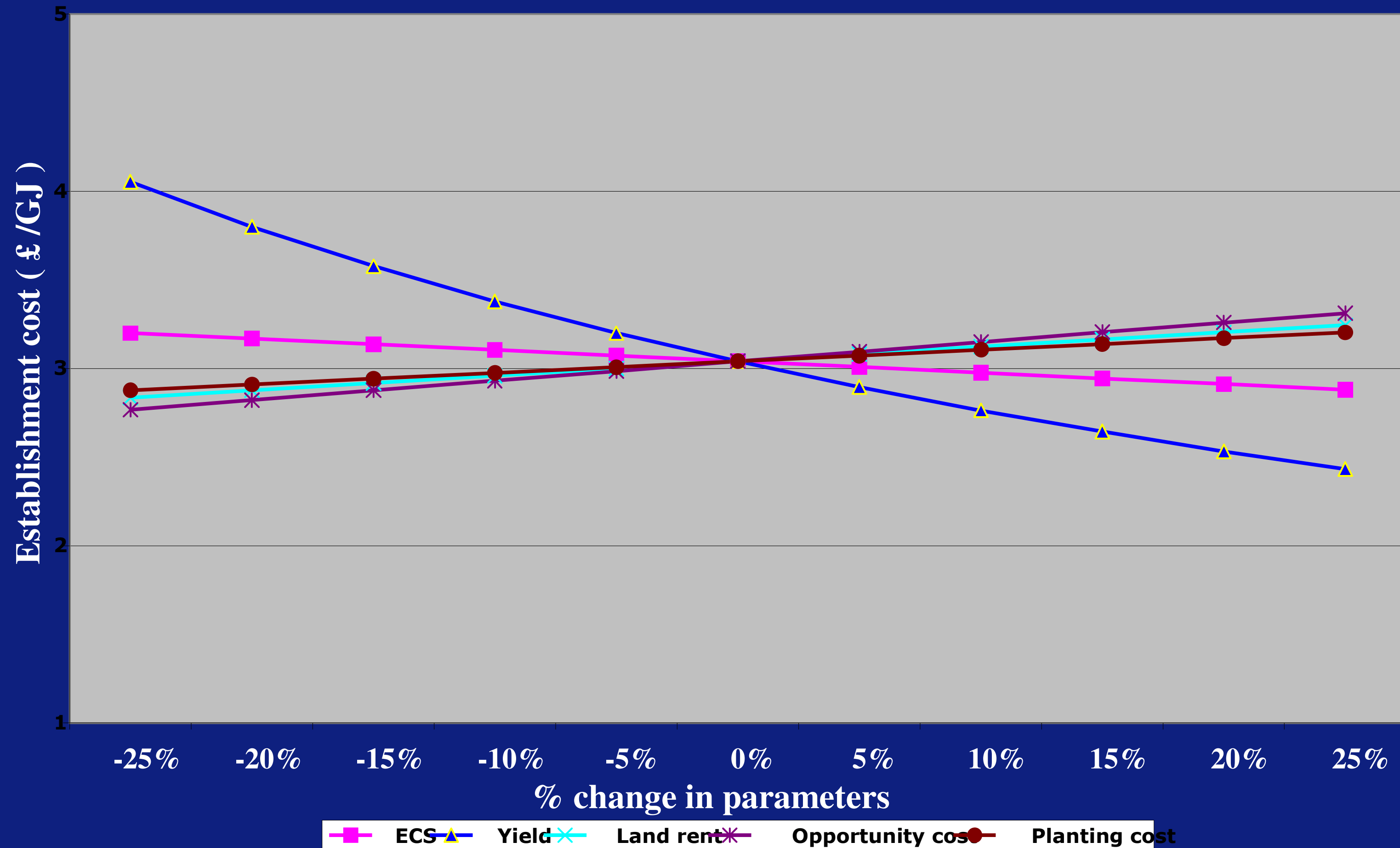


Pellets add **£ 2.04/GJ**

SRC willow: 71% of the cost relates to establishment: **£ 3.04/GJ** (2007).
Costs of cuttings & planting account for up to 50% of this.
Rabbit fencing & exit costs up to 35%

Forestry residues: **£ 1.74/GJ** (2007)
Based on a delivered price for chipped forestry residue of £25/t at 50% MC. (Chipping and transport costs assumed to be approx £5/t and £5/t - £8/t respectively.)

Sensitivity analysis on the effect of key factors to the SRC establishment costs



- **Crop yield has the higher influence**
- **ECS grants (annualised for 20 years), land rent as well as planting costs significantly less**

Woodfuel heat supply chains at domestic scale

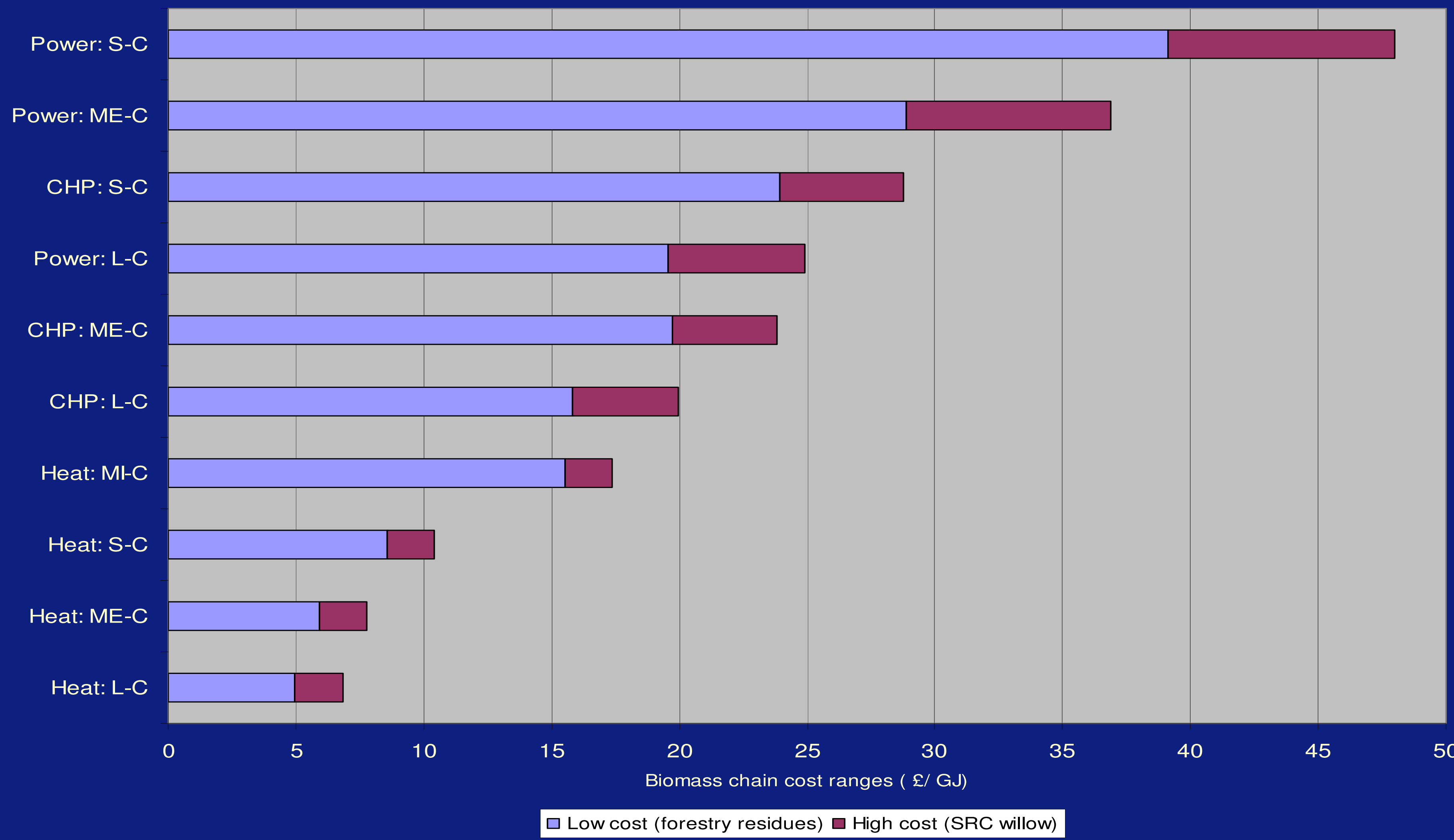
Why heat?

- The current energy utilisation for space heating and hot water in this sector is around 450 TWh yr^{-1}, higher than the combined totals of the commercial and industrial sectors (FES, 2005).
- A significant opportunity exists in rural homes not yet connected to the grid. There are over 4 m domestic properties that fall into this category (FES, 2005).

Results from the model:

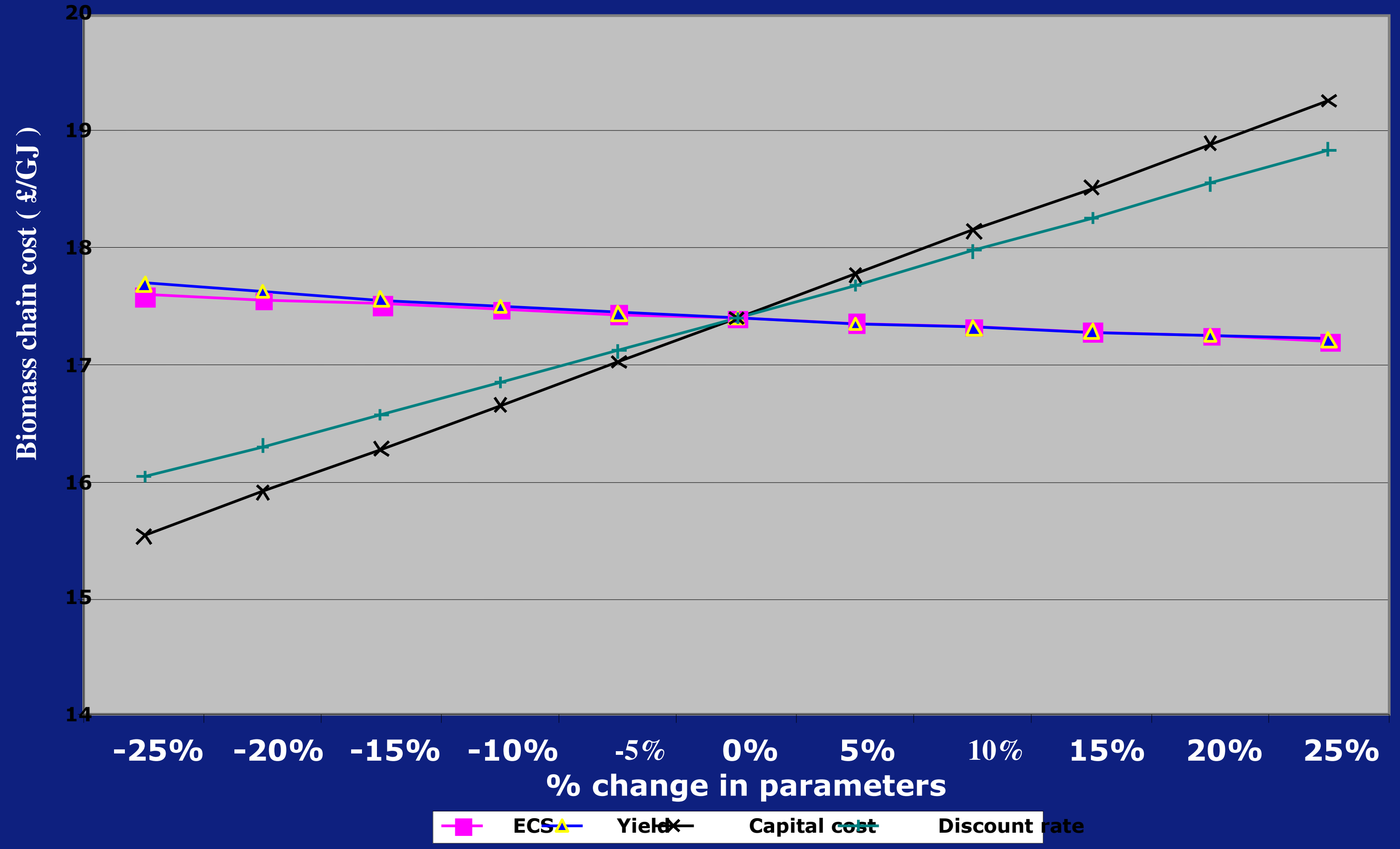
- Heat chains are the most competitive chains without any support.
- Heat chains range from £5.0 $GJth^{-1}$ (large scale forest residues) to £17.4 $GJth^{-1}$ (micro scale SRC). The majority of heat chain costs are under £10 $GJth^{-1}$.
- Low costs can be attributed to the high conversion efficiency and the low capex & opex costs (commercially mature technology)

Results (2) Cost ranges (£ GJth-1) for combustion chains with no capital grants



NB: Combustion technology is presented here at the different scales for heat, power & CHP

Sensitivity analysis on the effect of key factors for domestic scale heat with SRC willow



Capital cost has the most effect on the chain cost. An explanation for this is that the capital cost represents a significant proportion of the total cost (55 - 60%) at the domestic scale due to the very low boiler utilisation (i.e. 25%).

Results (3) Dominant cost areas for each chain

	SRC Willow	**Wood residues**
Micro (Domestic) (< 50 kw)	Feedstock/ Capex	Feedstock/ Capex
Small (50 kW - 500 kW)	Feedstock/ Capex	Feedstock/ Capex
Medium (500 kW - 5 MW)	Feedstock	Feedstock
Large (> 5 MW)	Feedstock	Feedstock

Conclusions (1)

- Establishment costs are the major cost for SRC willow with cuttings & planting comprising almost 50%.
- Pelletisation doubles the price of wood residues (from **£ 1.74/GJ to £ 3.78/GJ).**
- Yields have the higher influence to costs.
- ECS grants have much less influence as they are annualised for the 20- year plantation lifetime.
- Land rent and planting cost have a similar effect on the establishment cost.
- The farmer's opportunity cost has marginally greater impact.

Conclusions (2)

- Heat in the domestic sector is cost attractive due to high conversion efficiencies and despite the low load factors (25-65%).
- Heat chains are the most competitive chains without any support and power chains the least. CHP are intermediate between the two (except for small scale CHP).
- Heat chains range from £ 5 $GJth^{-1}$ (large scale forestry residues) to £17.4 $GJth^{-1}$ (micro scale SRC). The majority of heat chain costs are under £10 $GJth^{-1}$.
- Biomass for heat is not competitive against either gas or oil without capital grant support.
- SRC: Capital grants of 5% and 14% are required to be competitive with oil and gas respectively, while for forestry residues no capital grant is required.

Thank you!

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