



# **TSEC-BIOSYS T1.4**

## **International Bioenergy Trade and the UK**

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# Investigating sustainable UK Bioenergy Trade

## Literature Covers

Global Biomass Availability  
Sometimes cost too

UK Energy Demand

Sustainability of biomass in  
'idealised' scenarios

## But what about?

### Foreign

The implications of imported  
bioenergy demand in a realistic  
scenario?



**CGE case study**

### UK

The role of biomass imports  
- when other energy options exist?



**Need for Qualitative &  
quantitative insight  
(MARKAL!)**

Common need = consider bioenergy trade  
in a realistic setting



# **Consequences of increased biomass export – CGE Analysis for Argentina**

## **Why this analysis?**

- an economic dimension to bioenergy trade and its implications

## **Why Argentina?**

- Argentina is a major agri-commodity exporter soya, vegetable oil, wheat...
- Practical reasons too (data, language etc.)



## Argentina CGE

### The methodology in a nutshell

- 1 - Characterise the baseline (Argentina economy of 2000) as a welfare-maximising closed system.**
- 2 - Create a world price shock to approximate biofuel demand from export markets**
- 3 - Run the model. The economy decides how to allocate resources. **Biomass exported when most profitable option****
- 4 - Observe impacts of shock on the Argentine economy**  
**Changes in export levels, consumer welfare effects, land-use change...**



## Argentina CGE

### 2 - Create a world price shock to approximate biofuel demand from export markets

Here's the shock in the question.  
All other prices remain constant.

Wheat, cereals	↑2%	Rice	↑1.4%
Maize	↑4.2%	Beef	↑0.4%
Vegetable oils & oilseeds	↑7.8%	Poultry	↓2%
Oil meals	↓7.6%		

Based on impact of additional 10 Mt demand for sugar, soybeans and maize<sup>1</sup>

<sup>1</sup> From Schmidhuber, 2006: *Impacts of an Increased Biomass Use on Agricultural Markets, Prices and Food Security: a Longer-term Perspective.*



## Argentina CGE

2 price shocks considered...

<p>'Pure' Biofuel shock</p> <p><b>Price changes as per previous slide</b></p>	<p>General Commodity Shock</p> <p><b>As per previous slide BUT without fall in oil meal price</b></p>
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## Argentina CGE

2 price shocks considered...

'Pure' Biofuel shock

Price changes as per previous slide

3 env/economic regimes considered

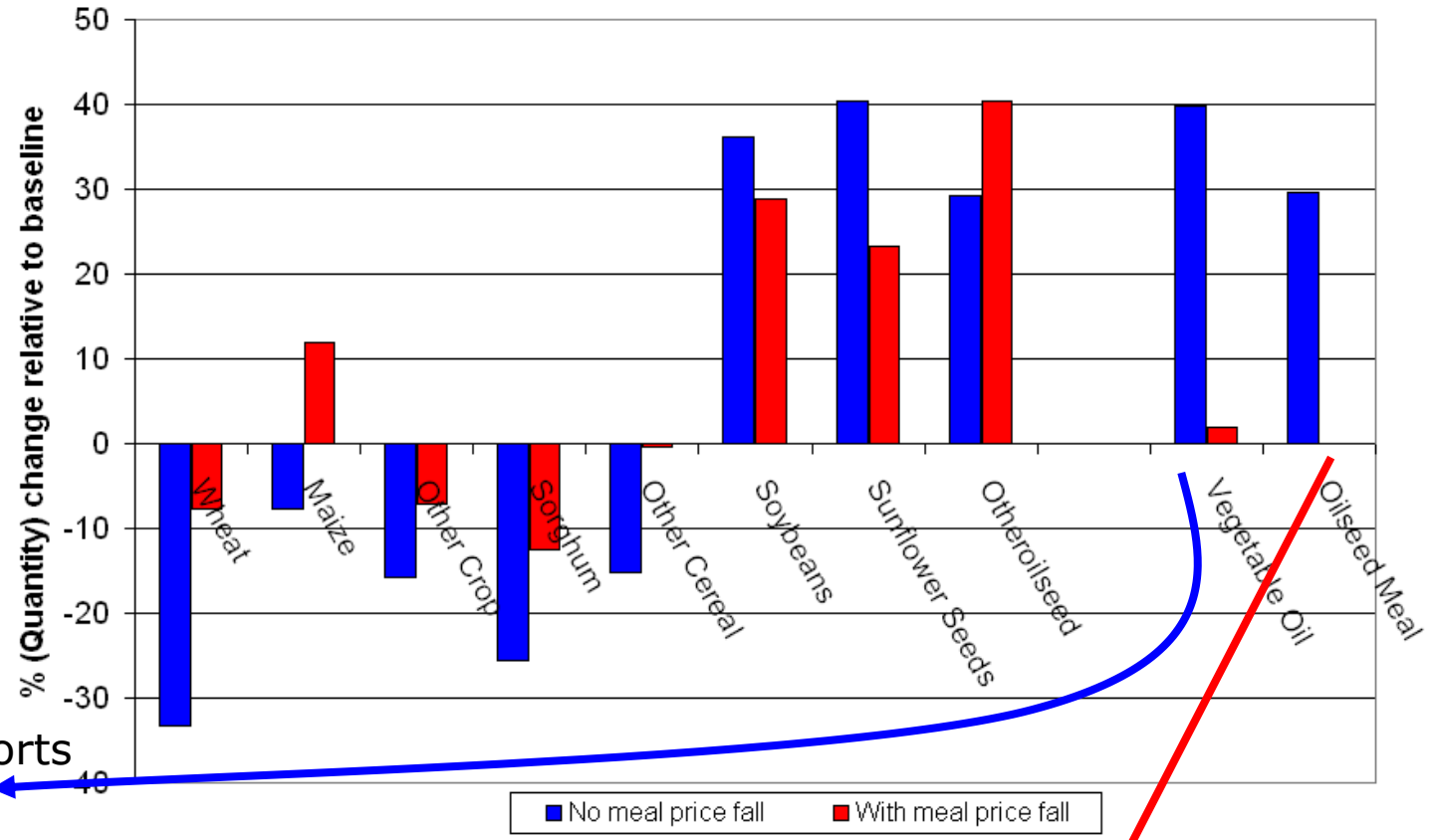


Everything Fixed	Everything Flexi	'Ideal' Policy
<b>Fixed Land Quantity</b> <b>Fixed Capital Stock</b>	<b>Land &amp; Capital available at fixed price</b> <b><u>Therefore model sets quantity</u></b>	<b>Capital – fixed price</b> <b>Land – fixed quantity</b>



# Pure Shock vs. General Shock: Everything Fixed

Exports - % Change from Baseline



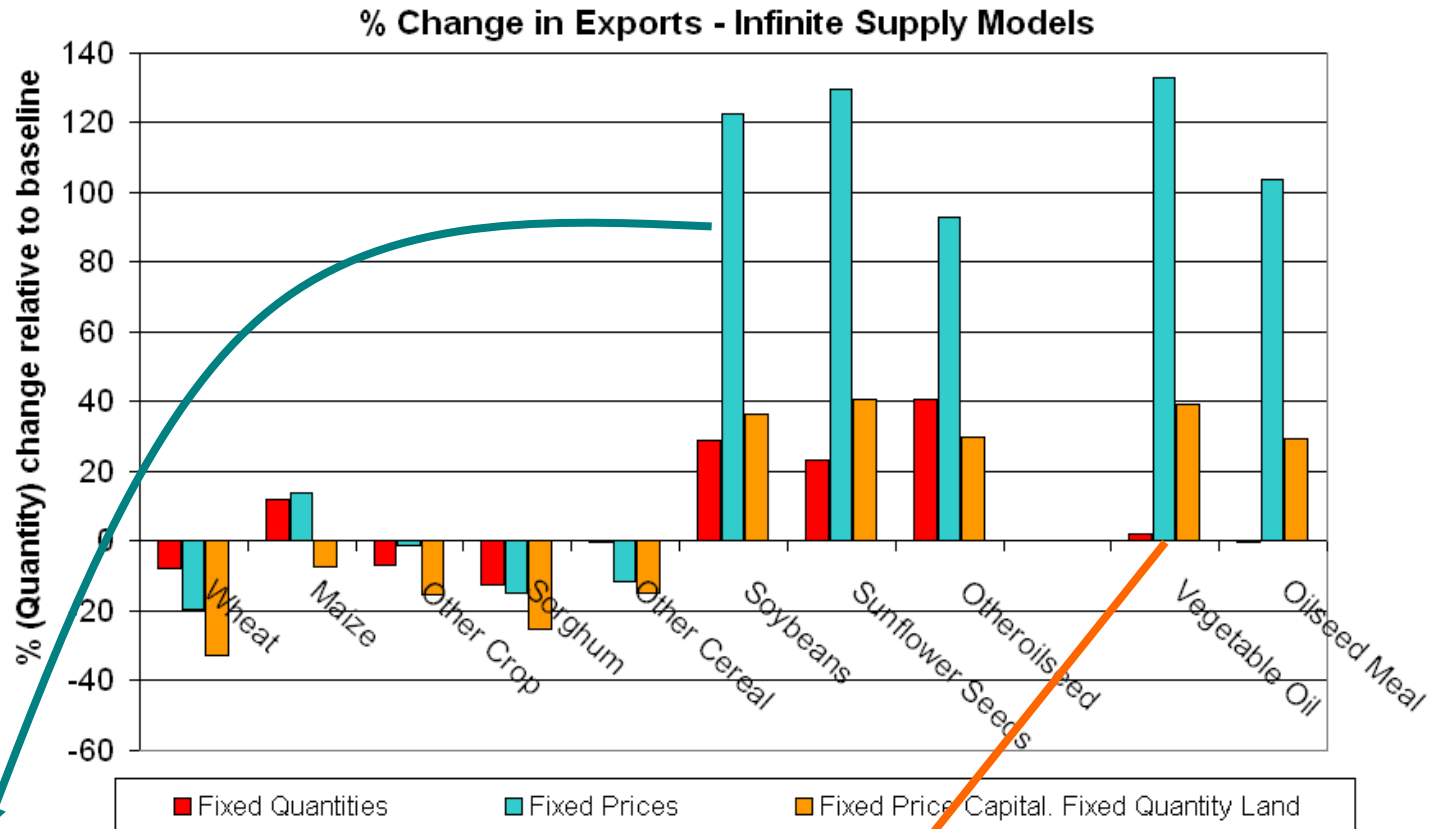
Price shock creates switch to oilseed exports (blue bars)

But vegetable oil sector is dominated by soya (43% of all inputs to sector)

So effect is tempered in a 'pure' biofuel price shock (where meal prices fall)



# What if land &/or capital levels can vary?



Extra land & capital increases export response

When land cannot expand, the effect is limited

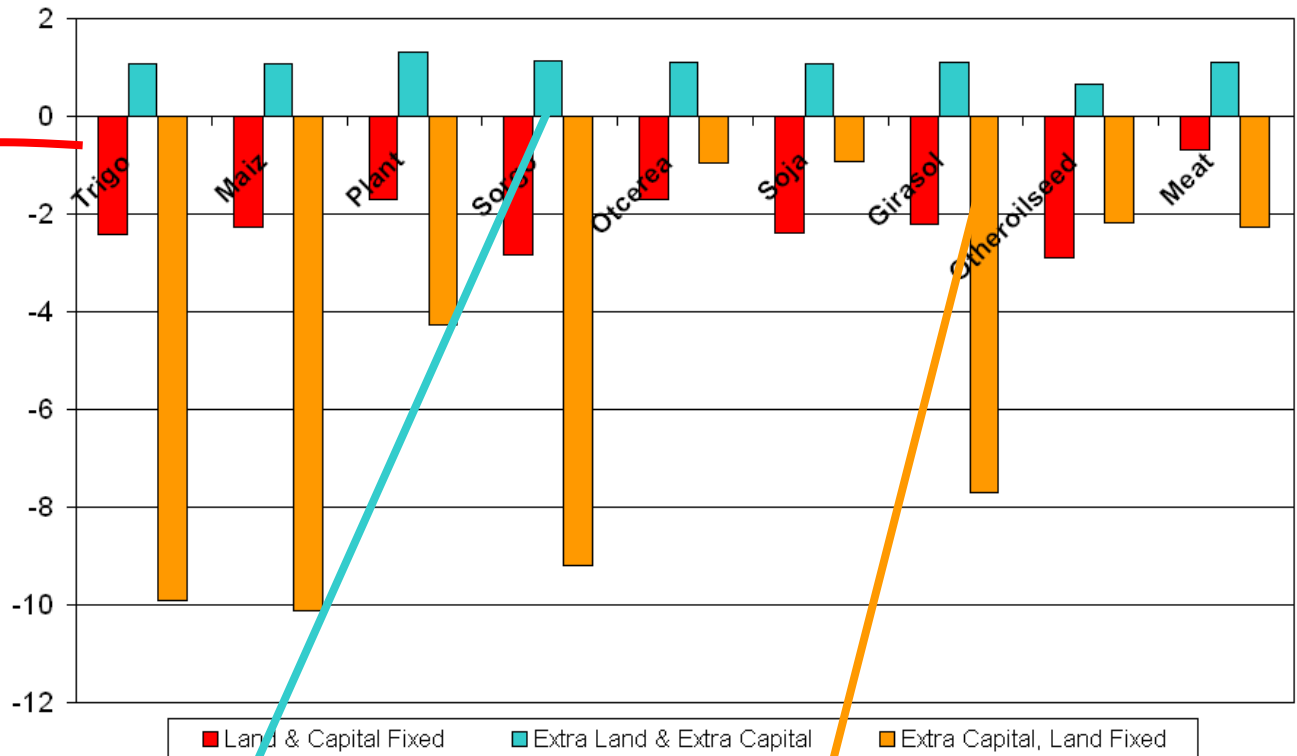
NB – all results are from the same price shock, including fall in world price of oil meals



# What if land &/or capital levels can vary?

## Effects on worker purchasing power

% Change in Wage Purchasing Power



Small negative effect on wage purchasing power with fixed land, labour & capital

Small improvement when extra capital and labour available

The worst case  
Price rises are steepest  
Fixed price of capital leads to net capital decrease!

NB – all results are from the same price shock, including fall in world price of oil meals



## Argentina CGE: Results Summary

'Pure' Biofuel shock

**Price changes as per  
previous slide**



Everything Fixed

**Fixed Land Quantity  
Fixed Capital Stock**

Everything Flexi

**Land & Capital  
available at fixed  
price  
Therefore model sets  
quantity**

'Ideal' Policy

**Capital – fixed price  
Land – fixed quantity**



## Argentina CGE: Results Summary

'Pure' Biofuel shock



Everything Fixed	Everything Flexi	'Ideal' Policy
<b>Oilseed-Exports:</b> <b>0-30%</b> <b>at the expense of</b> <b>other exports</b>	<b>Oilseed-Exports:</b> <b>↑200%</b>	<b>Oilseed-Exports:</b> <b>↑30-40%</b> <b>at the expense of</b> <b>other exports</b>
<b>Agricultural land</b> <b>expansion: 0%</b>	<b>Agricultural land</b> <b>expansion: 23.5%</b>	<b>Agricultural land</b> <b>expansion:</b> <b>0%</b>
<b>Wage purchasing</b> <b>power: ↓5%-7% for</b> <b>crops and</b> <b>vegetables</b>	<b>Wage purchasing</b> <b>power: ↑1% for</b> <b>most commodities</b>	<b>Wage purchasing</b> <b>power: ↓2%-10%</b> <b>for crops and</b> <b>vegetables</b>



## Argentina CGE: The message

### If we want:

- Large quantities of exported biomass
- Without expanding the agricultural frontier
- Without making food less affordable in the exporting country

**Tough! There are trade-offs**

### NB – we assumed:

- Current agricultural technology
- No impediments to free market (except those shown above)

**Various model improvements needed...**



## UK Bioenergy Imports: using MARKAL

### Main Objective:

- Use MARKAL as a tool to assess the role and viability of biomass import into the UK **in the presence of other energy options.**
- Use MARKAL findings as a basis for discussion with stakeholders on the role of imports in UK bioenergy future.

### Progress so far:

- Dataset produced for costs and quantities.
- **but greater coverage / rigour required**



## UK Bioenergy Imports: using MARKAL

### Biomass Imports in MARKAL as of 05/11/08<sup>2</sup>

Fischer-Tropsch biodiesel

Biodiesel

Imported woody biomass (chips)

Ethanol from starches

Pellets (high quality)

Vegetable oils (for biodiesel)

UK permitted to import 2% of world supply in most cases

Fischer-Tropsch biokerosene

Pyrolysis oil

Ethanol from sugar crops

Ligno-cellulosic ethanol

Starch crops (for ethanol)

Need to define prices and quantities for UK availability in 5-year increments to 2050

- without resorting to wild speculation
- or selecting "plausible" data to pre-judge model outcomes



## UK Bioenergy Imports: using MARKAL

### Approach to conceptual difficulties

#### 1- Incremental availability of emerging biomass products

**i.e. how much FT biodiesel will there be in 2025 vs. 2020?**

**S-curve approach chosen to simulate availability before and beyond breakthrough years**

#### 2- *Overlap between feedstocks and products*

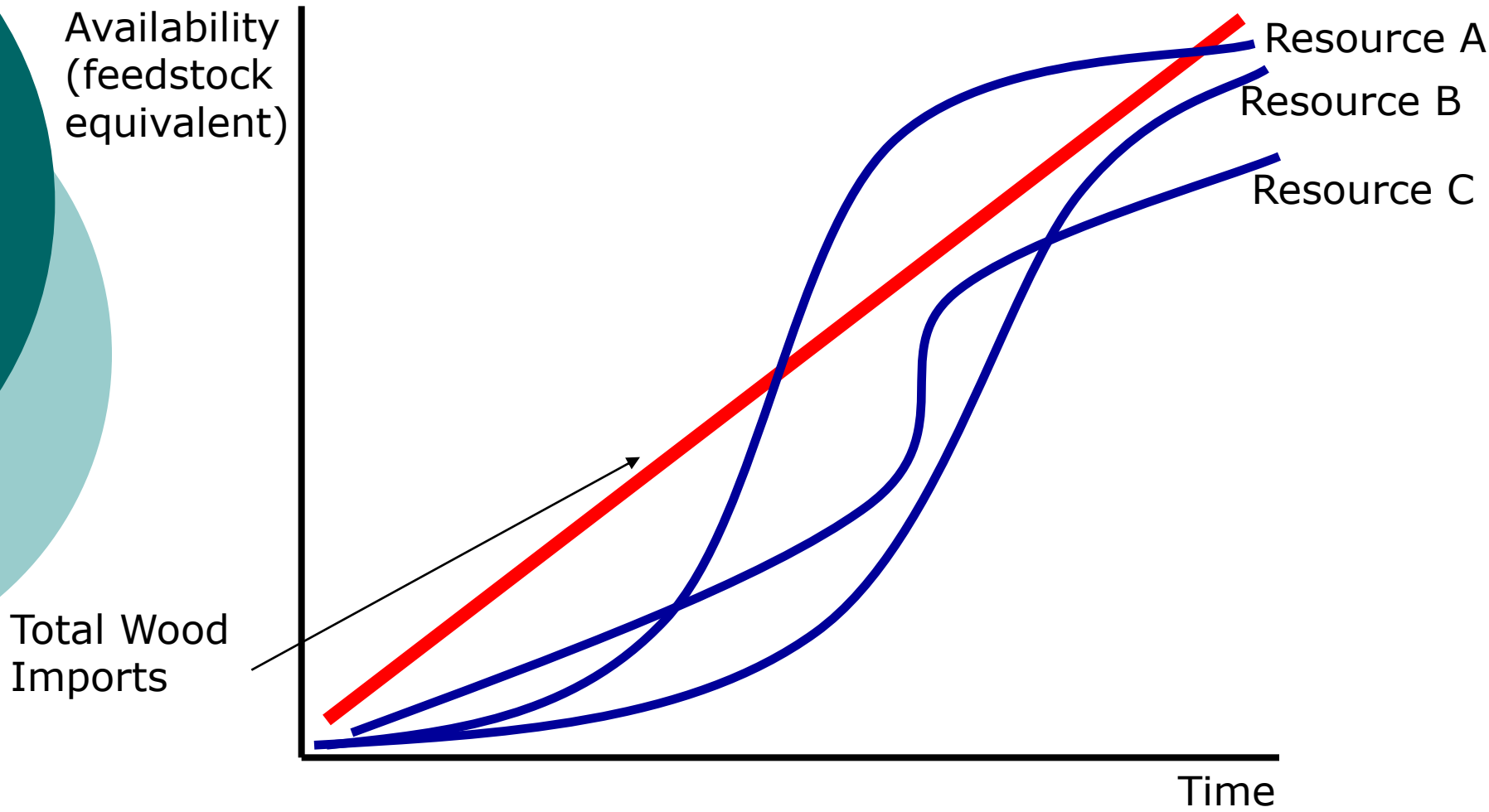
**i.e. how to decide globally whether cellulosic biomass becomes pellet or ethanol?**

**For the case of wood:**

- i) Products (bio-oil, FT diesel etc.) converted to feedstock-equivalent**
- ii) Higher-level constraint placed on total imports of wood-derived biomass**
- iii) Let MARKAL decide which wood-derived products to import into the UK**



# MARKAL Wood Imports: S-curve + constraint





## MARKAL Wood Imports: S-curve + constraint

### S-curve?

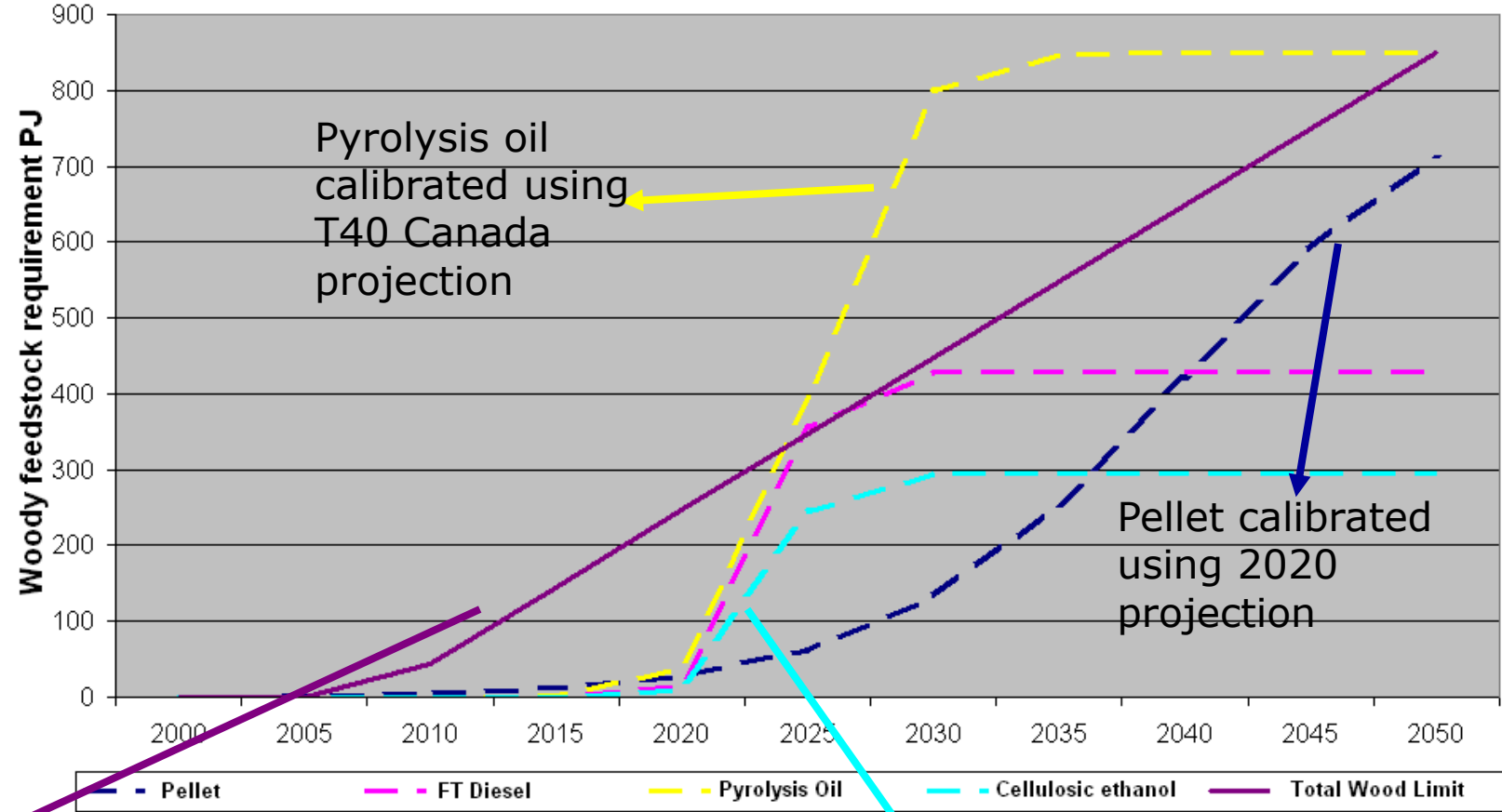
- An S-shaped curve that describes the penetration of a new technology<sup>1</sup>
- To calibrate, you need to know:
  - the year in which production began
  - the level of "total market penetration"
  - the level of production at intermediate time  $t$



# UK Bioenergy Imports: using MARKAL

## Don't believe the hype?

### UK Import Availability vs. Physical Constraint



Wood linear up to 2050 availability from literature

LC ethanol and FT diesel curves calibrated from political estimates



**End of PhD: October 2009**

**Tasks to complete:**

- **Improvement of Argentina CGE study, esp. land-use insight**
- **Improvement of MARKAL data consistency. Use for scenario analysis**
- **Validation of MARKAL import data through consultation with interested parties**
- **Update review sections of research**
- **Write-up**

**Thank You. Questions? Comments?**