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Seminar 2: The potential role of advanced biofuels for road transport from 2017 onward

Low CVP King Review
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York



Prospects for the UK

- To meet potential UK market targets for transport fuels
- Assumes 50/50 diesel/petrol market split & constant sales

Biofuel Target	Biofuel needed (million tpy)	Potential Supply
Up to 5%	~ 2	Conventional technologies - FAME production plus fermentation of cereals
5-10%	2 – 4 (0 – 2 additional)	+ Emerging (Veg oil hydrog & BTL?) + Imports?
10-20%	4 – 8 (2 – 4 additional)	+ Next generation (BTL plus cellulosic ethanol) + Imports?

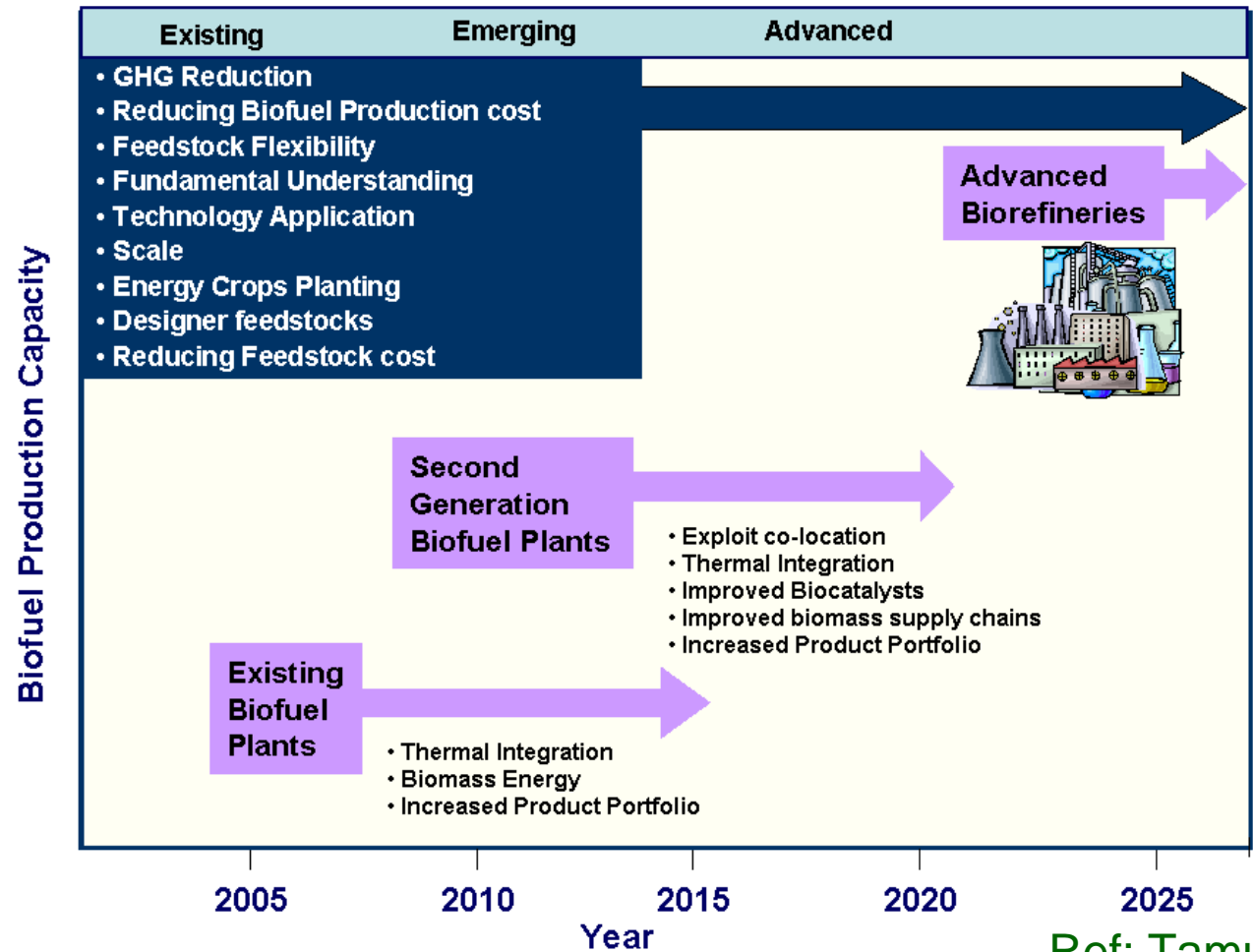


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Current/Future 1st Gen Capabilities

- Current Capacity
 - Biodiesel 400-500KT
 - Further 1MT in planning stages
 - Bioethanol 55KT
 - Further 1MT in planning stages
- Assuming a 50:50 mix for 2010
 - 1million tonnes Biodiesel will need approx 1million tonnes of oil
 - 1 million tonnes of ethanol would need approx 3 million tonnes of wheat
- BUT the UK already has a 3 million tonne grain surplus, enough to supply the Ethanol requirement
- In 2006 the UK grew over 250,000Ha of OSR for Non Food uses and the number is growing

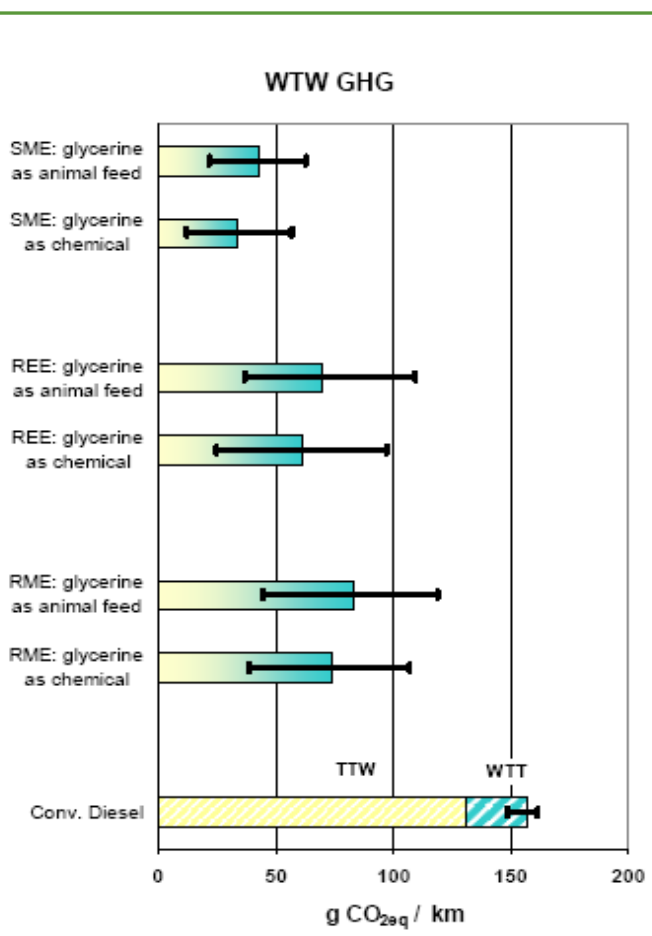
Biofuel Timelines



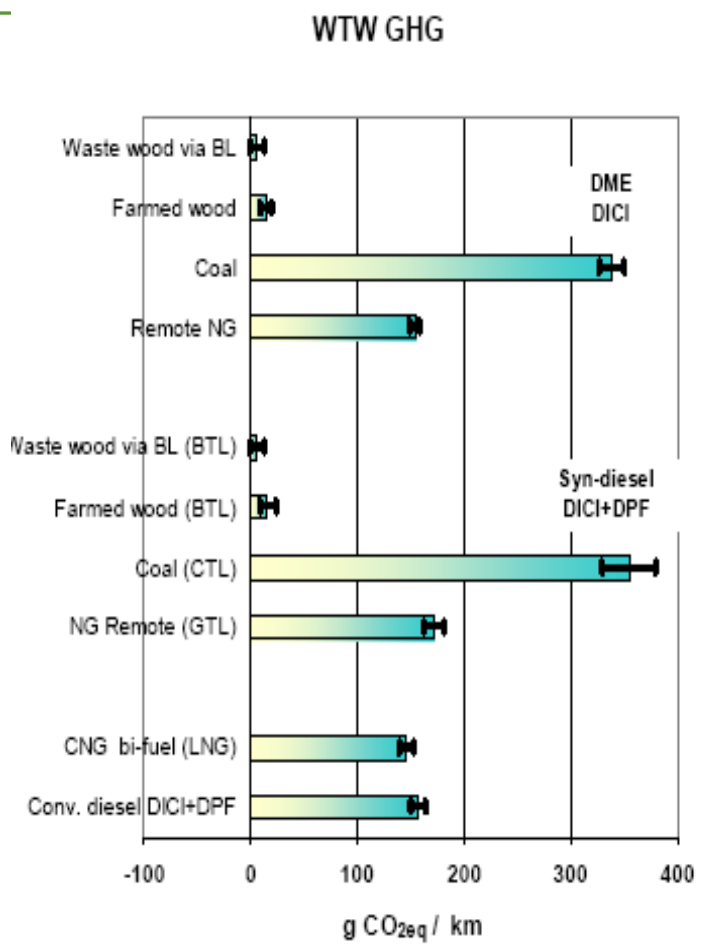


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Biodiesel emission profile



Biodiesel 1st Gen



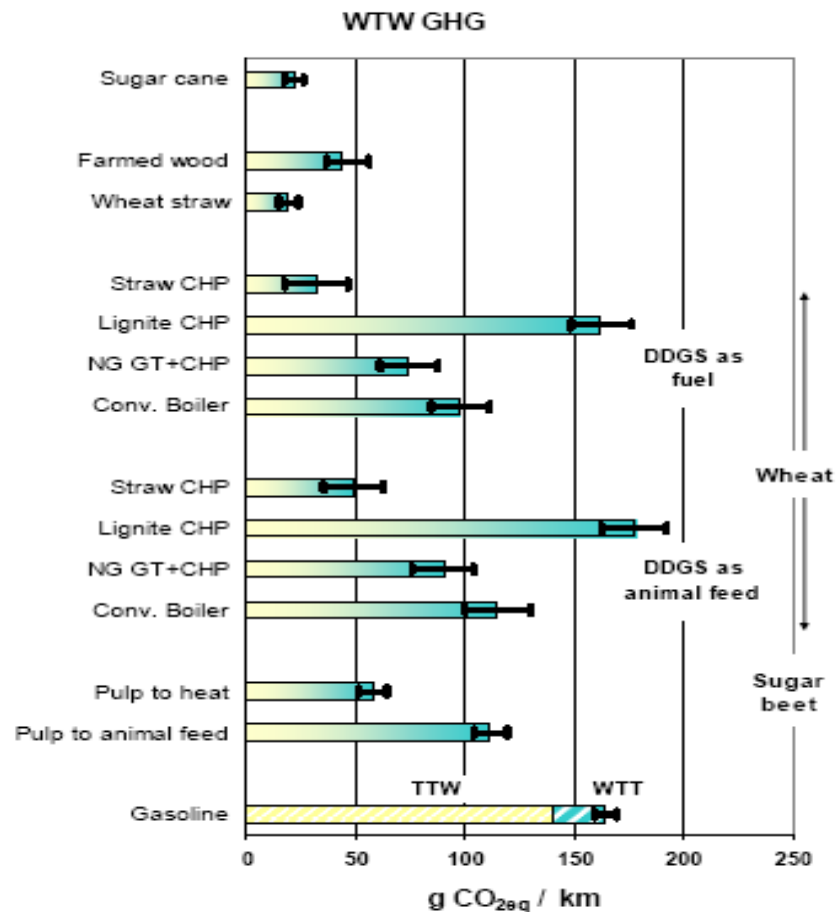
Biodiesel 2nd gen

Concawe/Eucar/JRC Well to Wheel Study



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Bioethanol emission profile



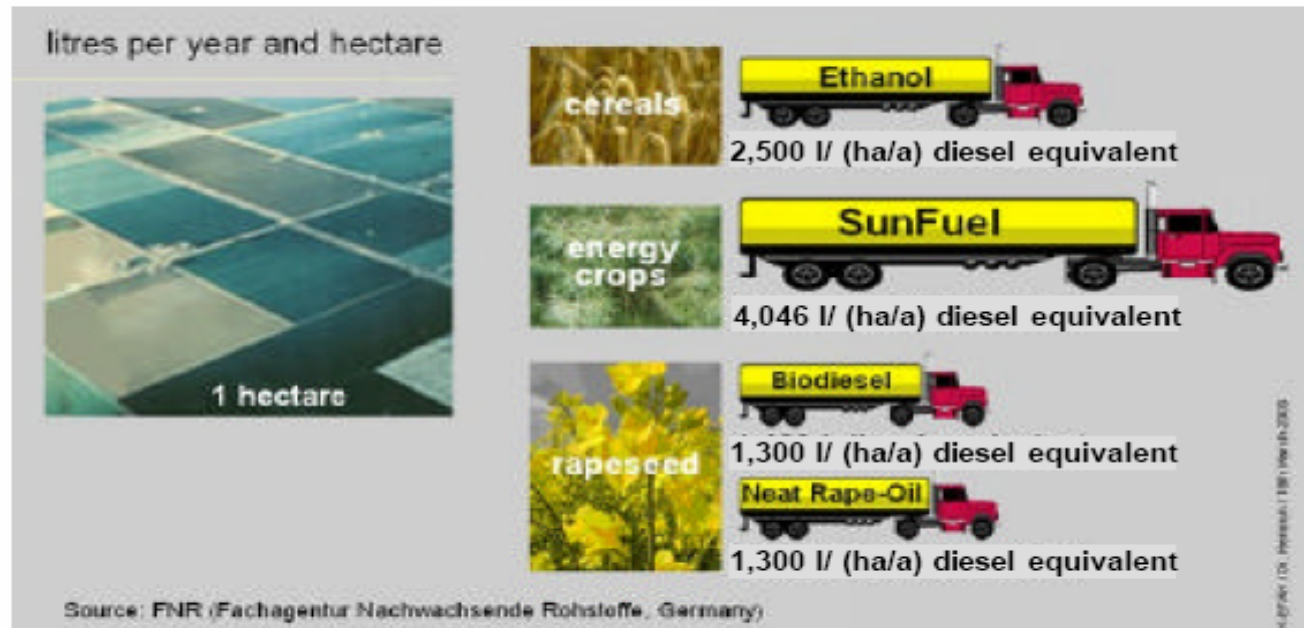
Ethanol 1st and 2nd Gen

Concawe/Eucar/JRC Well to Wheel Study

2nd Generation Biofuels

- Choren JV with Shell
- Biomass to synthesis gas to diesel

Already today, SunFuel has highest per acre yield (3x with 6x potential)





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Potential UK feedstocks

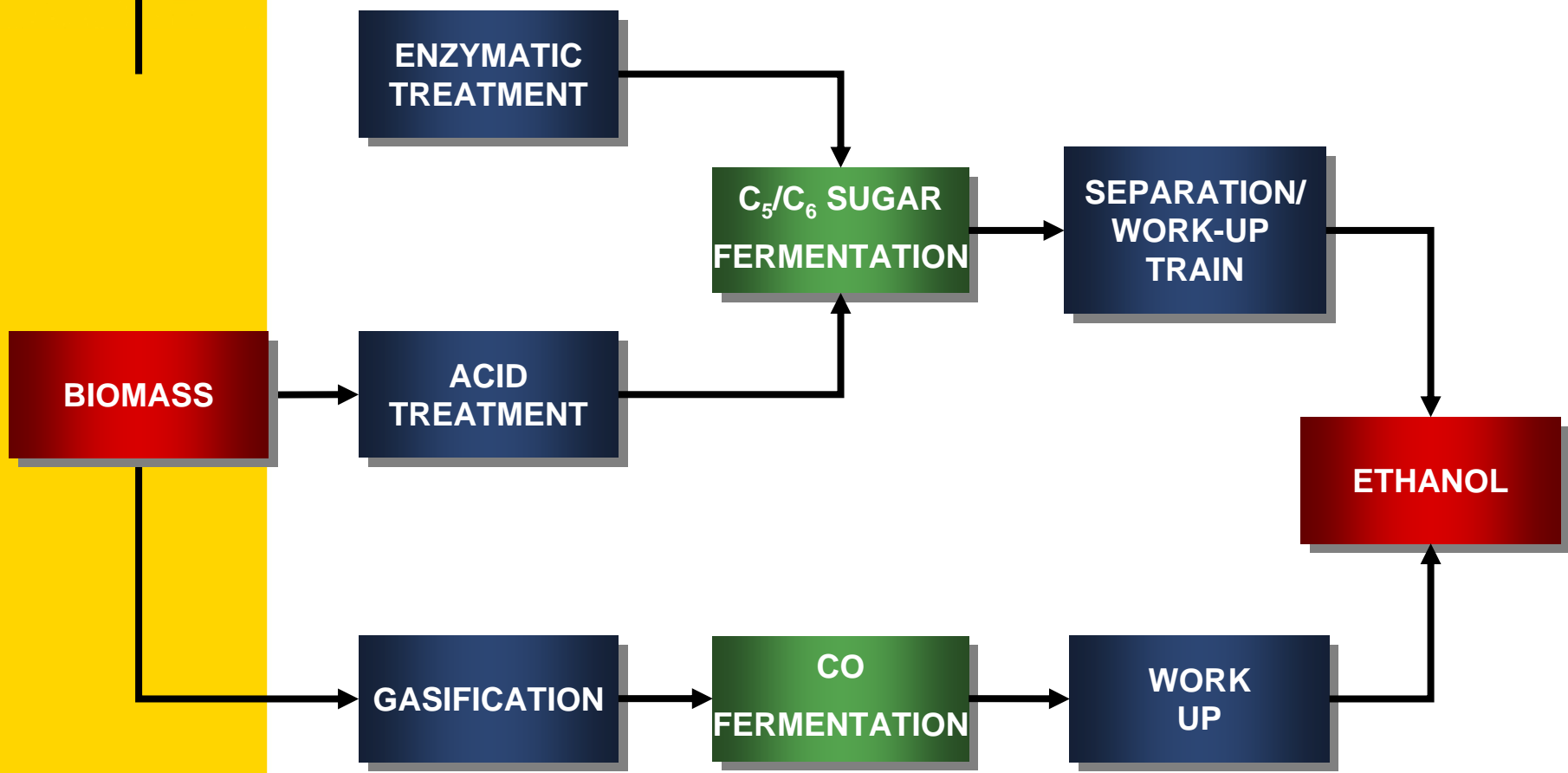
- If predicted targets are correct we may need a further 4MT of biofuel for the period 2020-2030 on top of that generated in previous years.
- If we assume all is met through advanced technologies we would need ca 20MT of 'biomass'

- Current figures show the UK to have
 - 10 MT timber
 - 80MT agricultural wastes
 - 7-10MT waste wood
 - 7.5 MT paper and board

 - 30 MT Food industry by products
 - 4.5MT Digestible kitchen waste



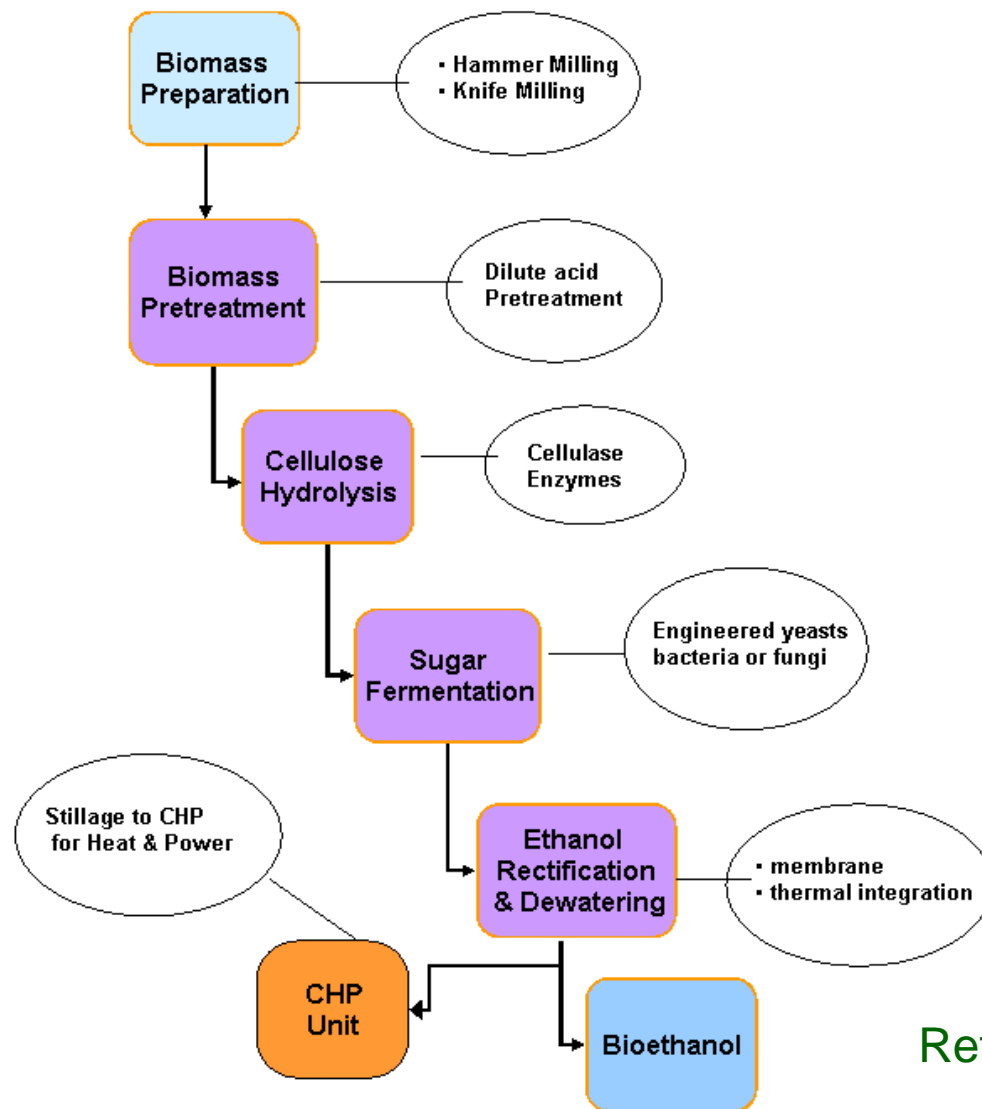
Simplified 2nd Generation Bioethanol Processes



Ref: Nexant



Biomass Conversion: Fermentation Route

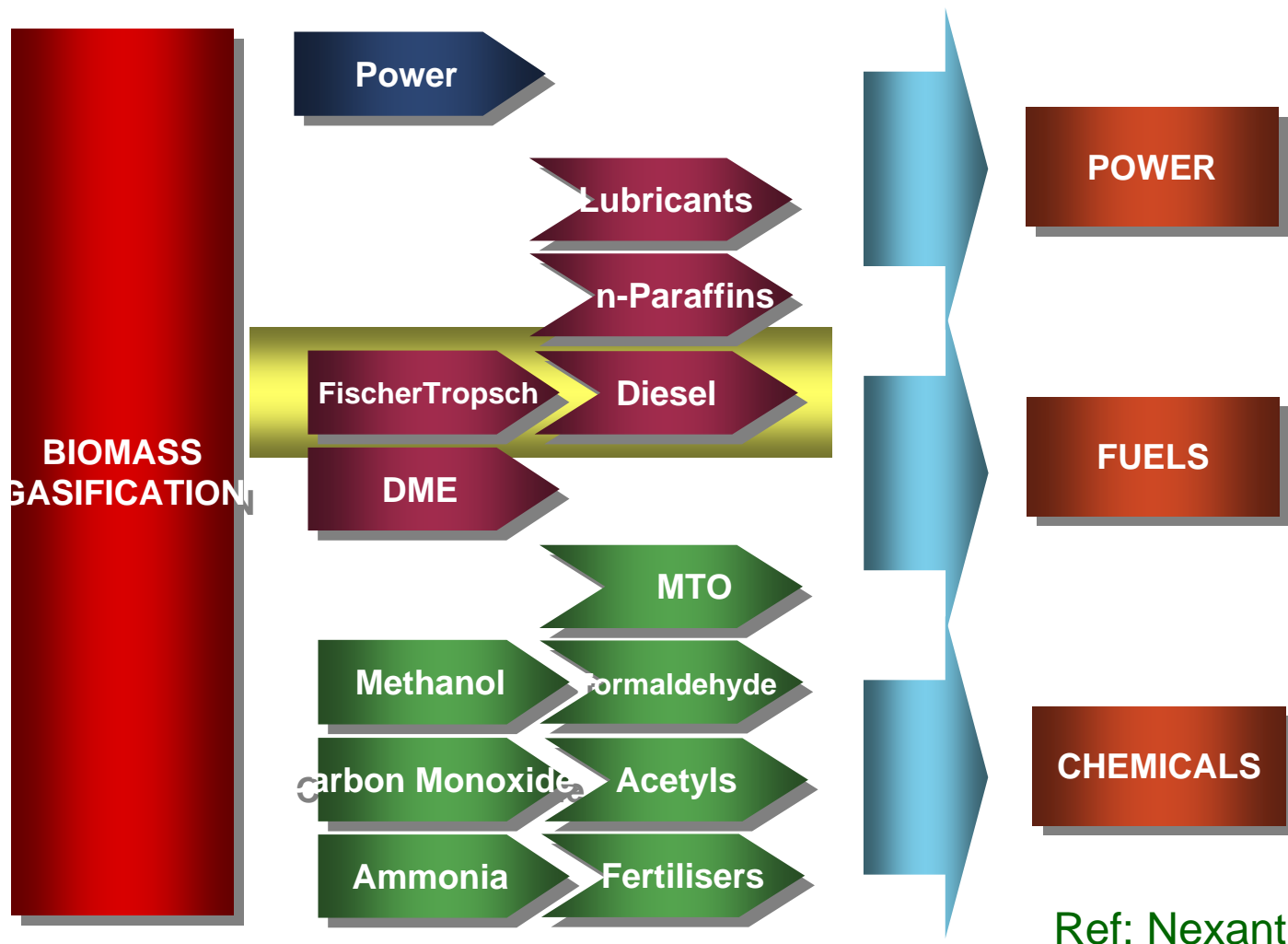


Ref: Tamutech



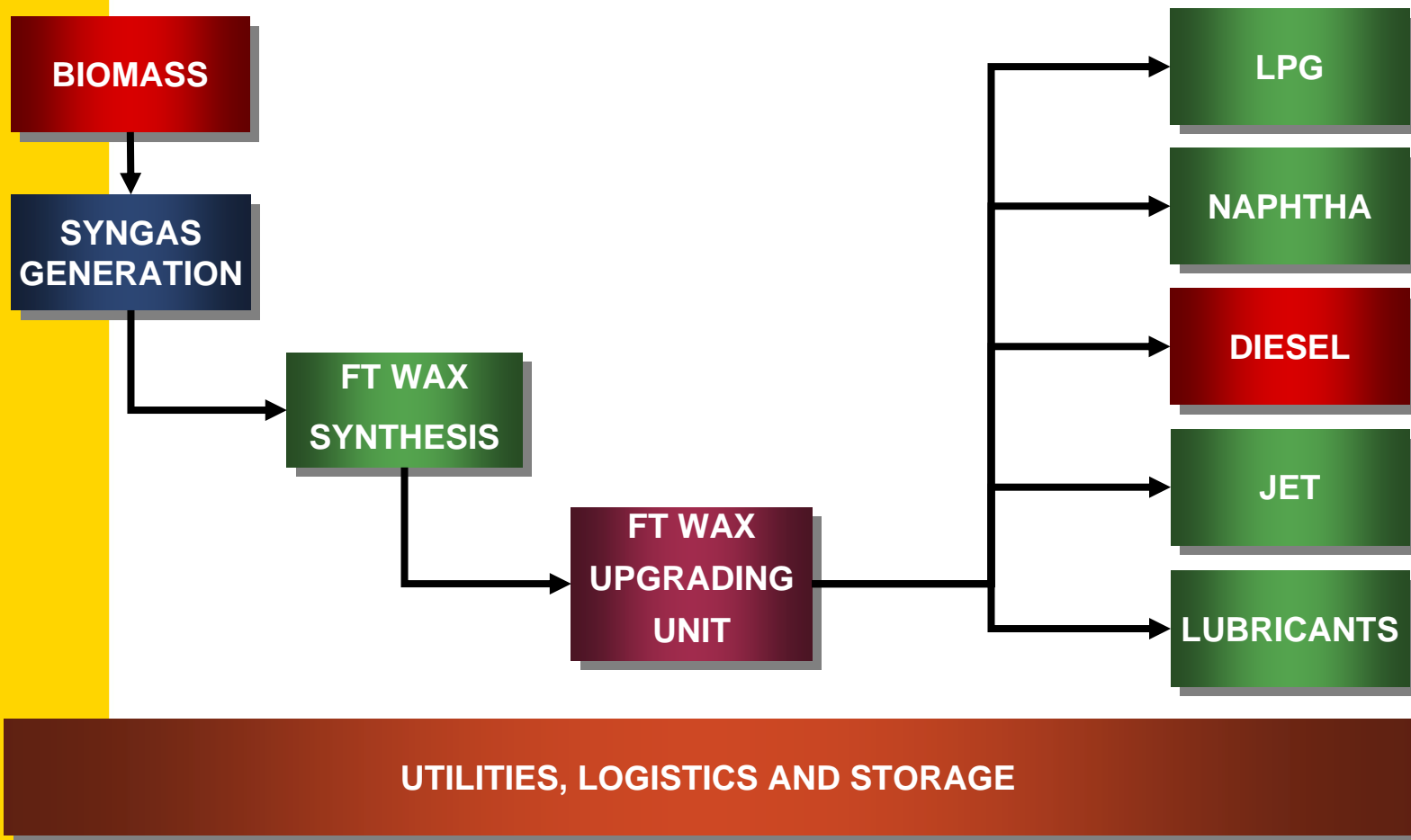
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Gasification opens the way for a number of fuel, energy and chemical production options subject to feedstock availability





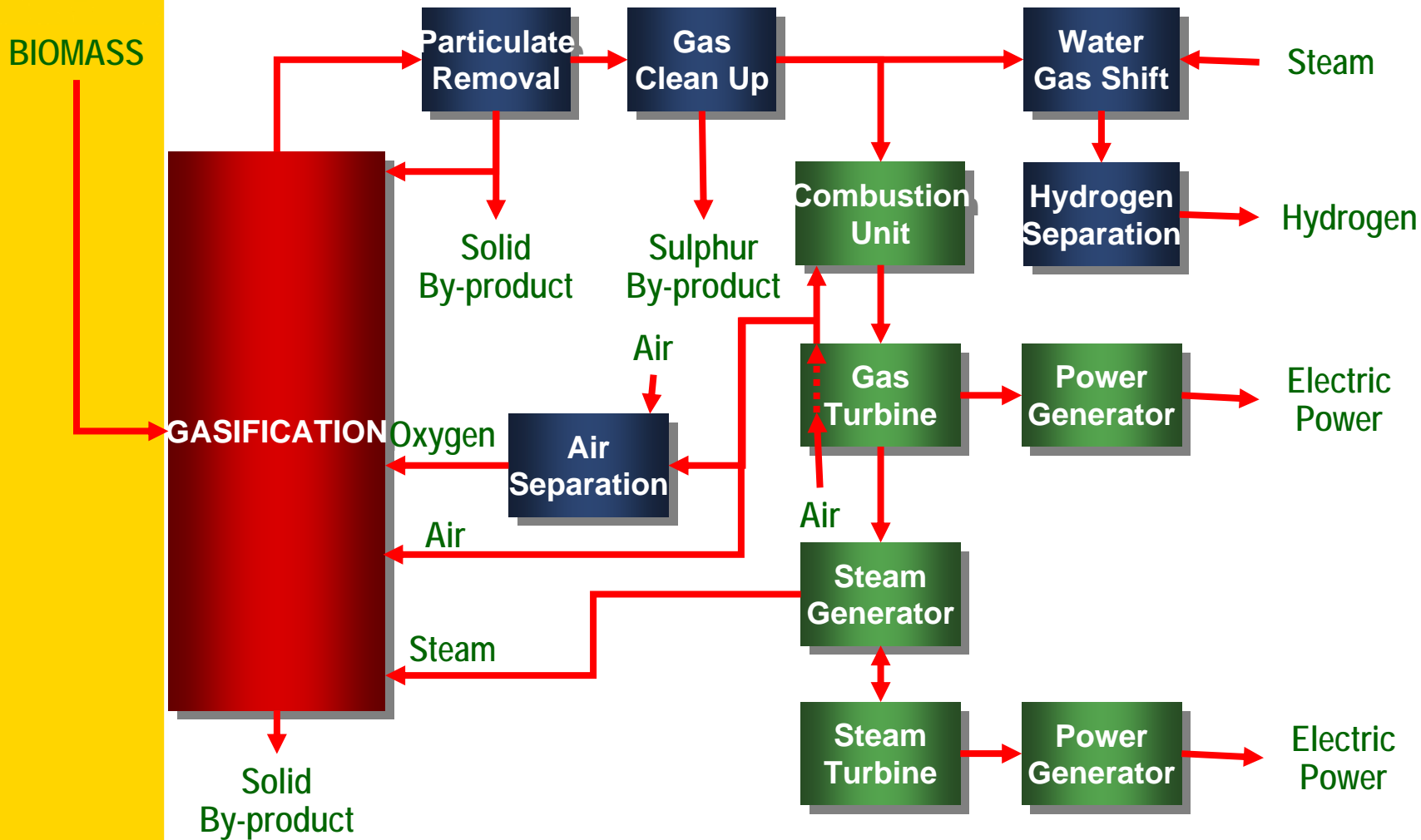
Simplified Second Generation Biodiesel Process – The “Biomass to Liquids” Concept





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Biomass gasification in an IGCC configuration could also be integrated with BTL to benefit from ROC



Ref: Nexant



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There is a strong case for BTL from a number of perspectives

- BTL provides a product refiners want because of its blending properties. It is identical to the product derived from GTL and CTL
- The technology is flexible providing other refined products and even performance lubricant base stocks to meet market needs
- Unlike lignocellulosic ethanol BTL can draw on a broad biomass pool covering wood, straw, energy crops, agricultural waste, etc
- It has strong GHG performance and wider environmental benefits
- Straightforward integration of power generation possible
- Technology available from a number of sources
- All components of the process commercial
 - FT technology (e.g., Shell in Bintulu, Malaysia)
 - FT Wax Upgrading (e.g., Shell in Bintulu, Malaysia)
 - Biomass gasification/co-fired IGCC (e.g., Nuon in Maasvlakte)

LPG
5-15%

Naphtha
15-30%

Middle
Distillates
55-70%



Biofuel technology continues to evolve. The industry is now exploiting readily available “First Generation” technology whilst developing “Second Generation” process for the future

- Benefits
 - Exploitation of wider and hopefully lower cost biomass feedstock base
 - In the case of biodiesel provides a performance blend stock with enhanced properties refiners can exploit
 - Enhanced GHG performance amongst other environmental benefits
 - Opportunities for biomass-driven power-steam co-generation
- Challenges
 - Increased capital cost
 - Major increase in process complexity
 - Reappraisal of agriculture need to meet biomass demands
 - Increased biomass requirement per ton of biofuel leads to a need for an optimised logistics solution to avoid deleterious GHG performance upstream of the biofuel facility
 - In the case of ethanol new specialised micro-organisms needed that need to be tailored to specific feedstocks limiting flexibility.



Of the second generation biofuel technologies the conversion of biomass into liquids appears closest to commercialisation

- CHOREN GmbH is leading the development and commercialisation of BTL for diesel production with the SUNFUEL® brand. CHOREN provides biomass gasification with FT/Upgrading supplied by Shell
- Semi-commercial unit of circa 15KT nearing completion
- CHOREN is reviewing six sites for the first Sigma plant of 200 thousand tons per year (5 KBPSD)
- There are alternative providers of different commercial technologies components for a BTL process, e.g.
 - Sasol for FT/Upgrading (e.g. ORYX GTL in Qatar)
 - Other non-commercial but demonstrated FT/Upgrading platforms include ConocoPhillips, Syntroleum BP, Rentech, Jomec, etc
 - Biomass gasification demonstrated as co-feed (Nuon, others)
- In France CEA and IFP are looking to commercialise their own BTL process, similar in overall concept to CHOREN.



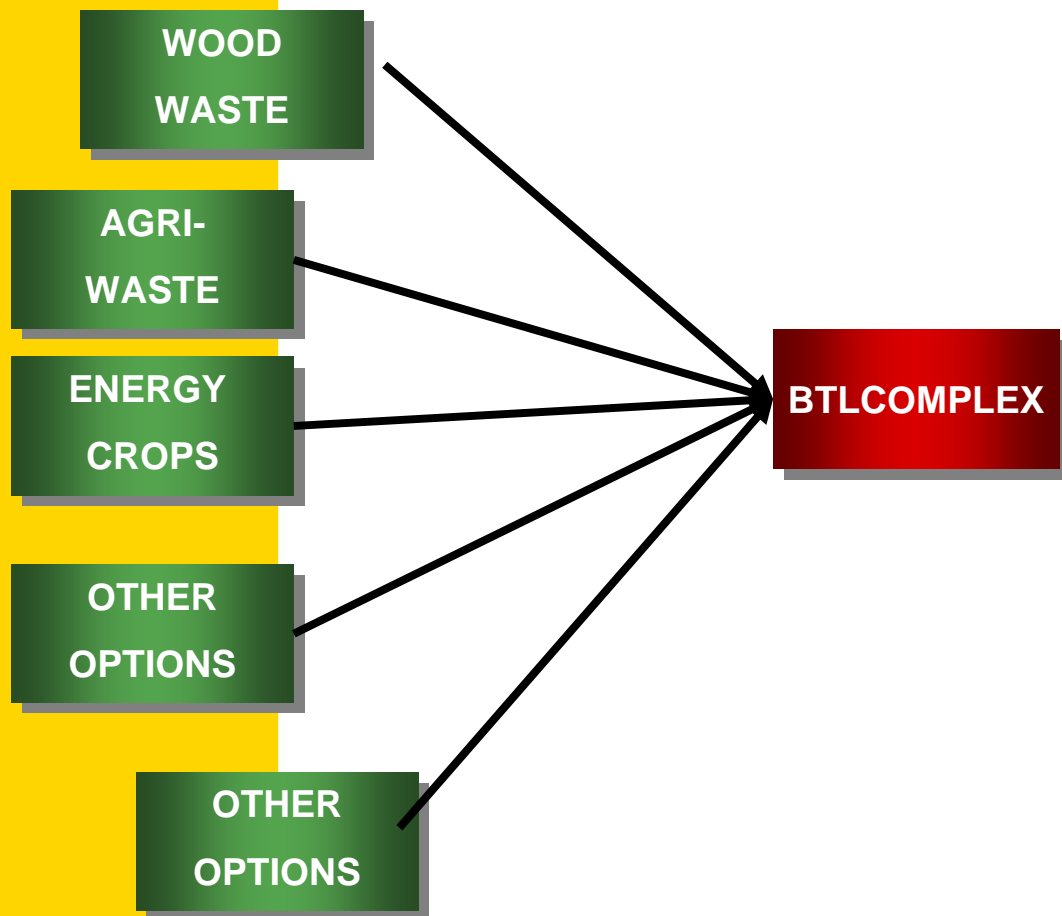
There are a number of issues that face the development of BTL in the United Kingdom

- Biomass supply
 - Optimisation of biomass supply chain is key to BTL variable cost
 - Competition for biomass resource from power, biogas and in due course lignocellulosic bioethanol. Increases in biomass pricing already evident in Germany and other European countries
 - Need to consider the best option to exploit a broad and possibly dispersed biomass supply base
- Legislation and UK Government support
 - The RTFO is providing a useful starting point to support biofuel development in the UK but will need enhancement possibly via a carbon-related performance credit to support BTL financial viability across a range of oil price scenarios
- How to develop a viable UK BTL project
 - Need a project development road-map engaging agriculture, industry, financial markets and UK Government agencies.



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Biomass Supply Issues



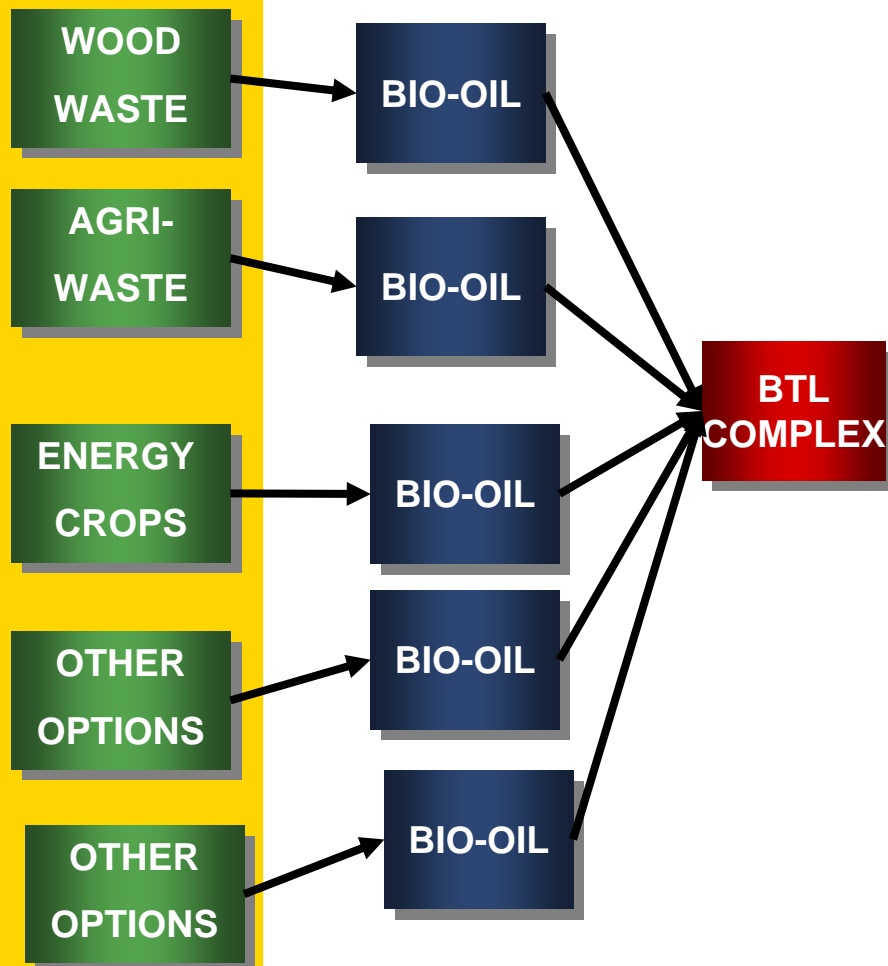
- **Logistics severely impact the cost of supply.**
- **Compromise between logistics and feedstock (variable cost) and scale.**
- **Choren/Shell set at 5KBPSD but reliant on one principle feedstock, namely wood.**
- **UK plant is likely to be a polyfeed facility**

Ref: Nexant



Biomass Supply Issues – Key Questions

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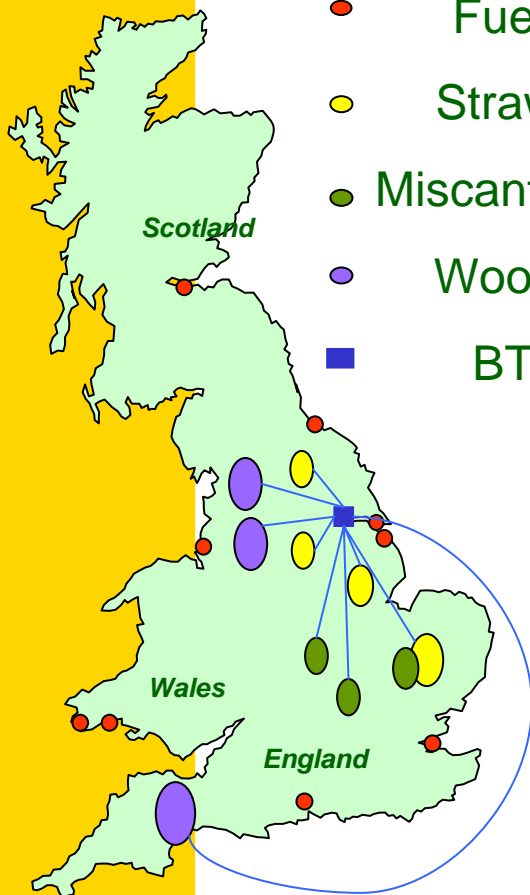
- Bio-Oil or pyrolysis oil may provide the link between a broad range of biomass sources and BTL.
- Pyrolysis units could be localised and Bio-Oil moved in bulk ships to a centralised coastal BTL facility
- ECN in the Netherlands have examined the economics of various BTL pre-treatments with pyrolysis oil looking favourable for a Rotterdam BTL solution

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Biomass for Bio-Oil and BTL



- Fuels refinery
- Straw Sourcing
- Miscanthus Sourcing
- Wood Sourcing
- BTL Facility

- Main forestation in the North West, South West and Scotland.
- Source Wheat straw from the Vale of York and East Anglia
- Source Miscanthus in the South East Midlands and East Anglia
- Logistics suggest movement of bio-oil to a major port site with local refineries.
- Humberside appears to fit simple selection criteria.



A supportive legislative framework can be developed around the UK BTL opportunity and cover

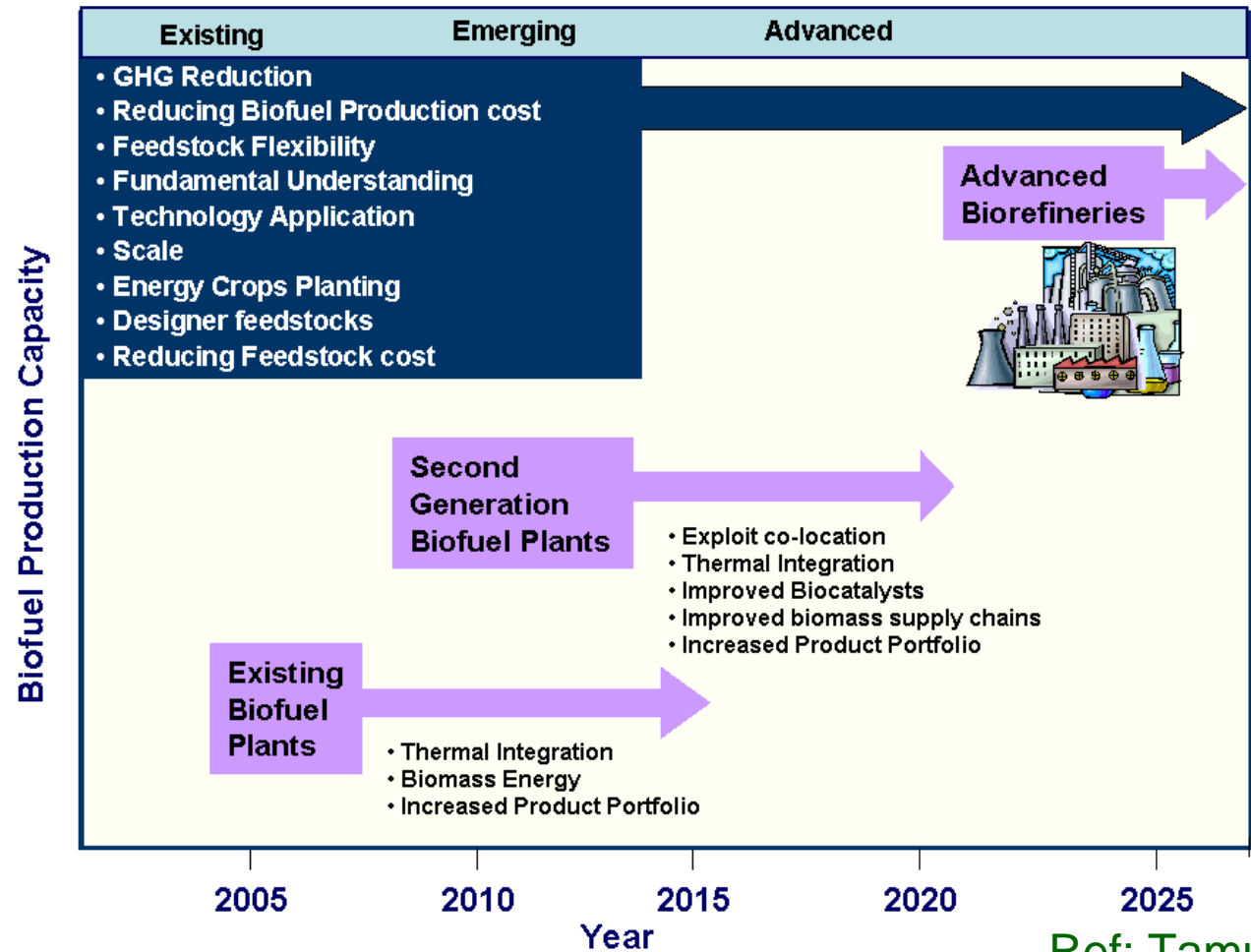
- Biomass supply
 - Continued support for on-purpose energy crops
 - Support for exploitation of set-aside land for on-purpose energy crops provide food versus fuel supply kept in balance
- Fiscal incentive based on GHG
 - Possibly evolve the RTFO to provide new and possibly higher tax breaks based on carbon
 - Increase longevity of fiscal support for RTFO tax breaks and ROC
- Investment support
 - Arm RDA with realistic investment grants to support distributed network of bio-oil facilities
 - Provide soft loans (as per SIDF in KSA, EBRD, World Bank, etc) to support the €500 million to €700 million investment.



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UK Opportunities, Drivers, Status and Activities

Biofuel Timelines





Biorefineries

The biorefinery concept describes a large highly-integrated complex incorporating individual processes that synergistically convert biomass feedstocks into power, biofuels and value-added chemicals.

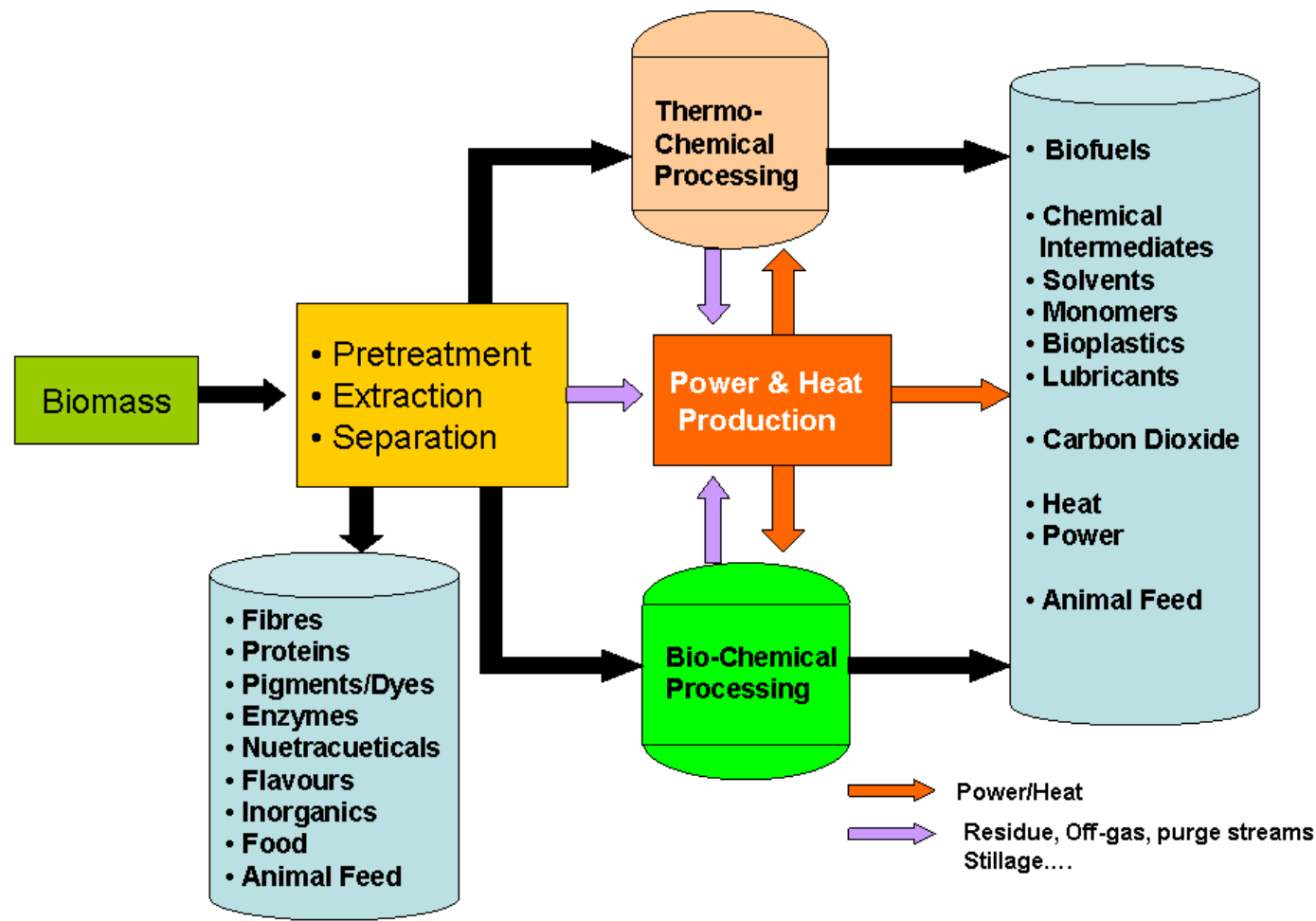
- Exploit well established refinery production methods to provide a step-change in biofuel manufacturing capability
- Maximise energy savings through process integration
- Exploit economies of scale to drive down fixed costs
- Co-produce a value-added portfolio of renewable power, chemicals and materials



Oil/Bio Refinery Comparison

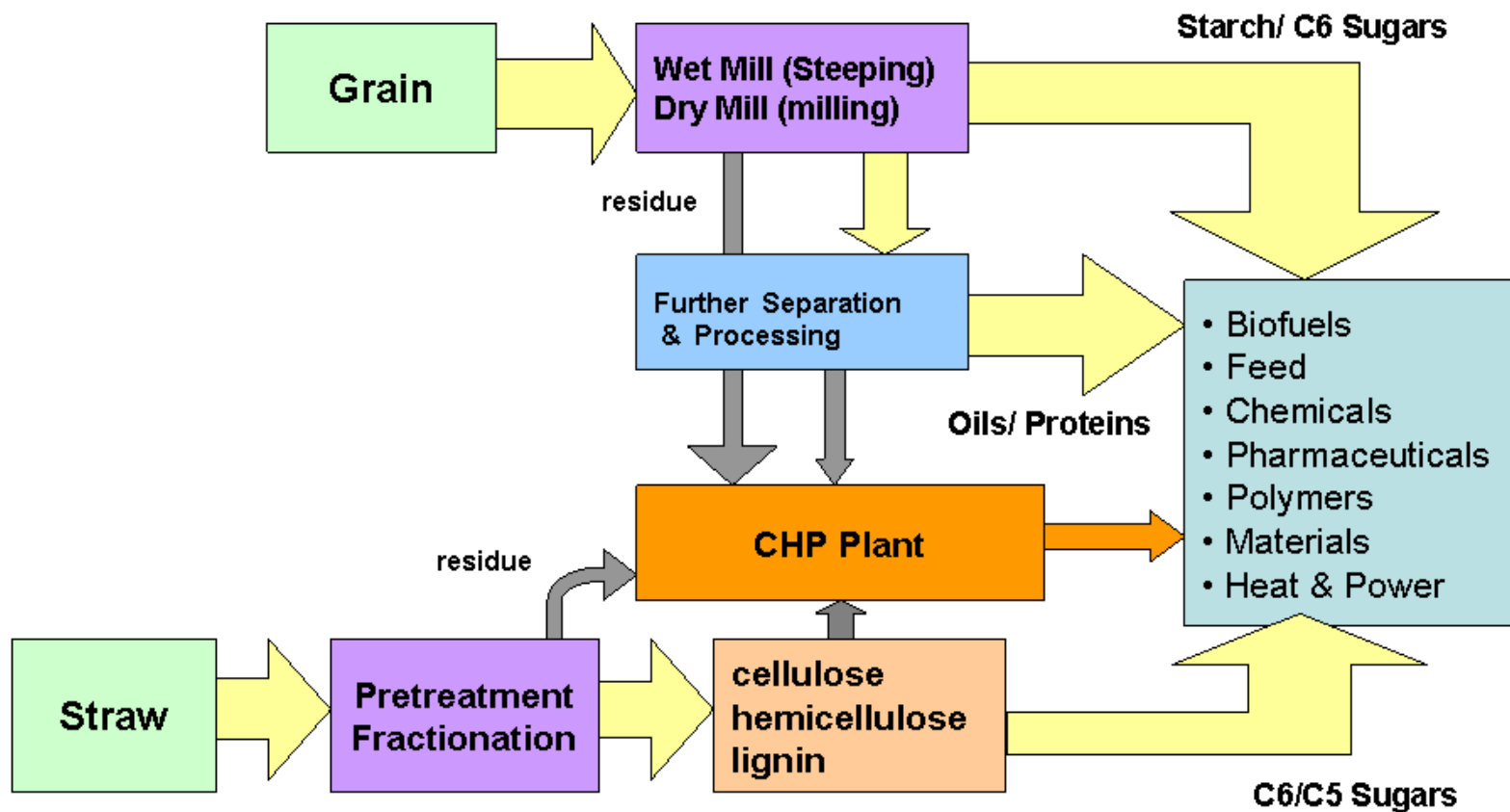
Oil Refinery	Biorefinery
Processing on a vast scale (10MTpa)	Scale limited by biomass logistics but should be maximised
Mature high temperature catalytic processes	High temperature catalytic processes and innovative bio-processes
Flexible production to meet external market demand for different products	Should have similar design. Bioprocessing may offer greater manufacturing flexibility
Every element of crude oil barrel utilised	Every component of plant biomass should be utilised
Self sufficiency in heat and power	Self sufficiency in heat and power
Co-produces valuable chemical building blocks (olefins, aromatics)	Co-produces both large volume platform chemicals and low volume highly functionalised intermediates

Generic Advanced Biorefinery Concept





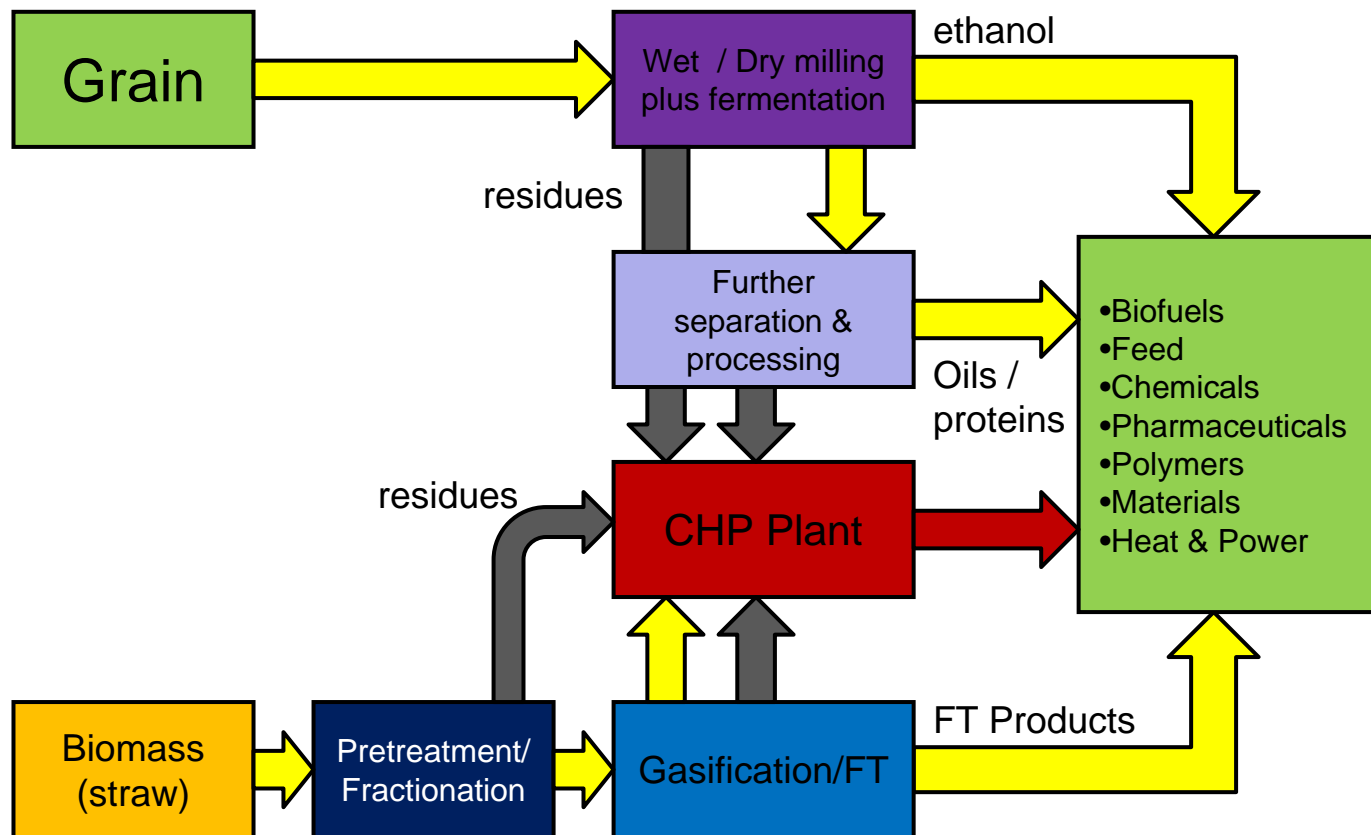
Whole crop Biorefinery Concept



Ref: Tamutech



Whole Crop Biorefinery Concept





Conclusions: Room to Grow

- Bio-Energy and Bio-Fuels are big business. The UK is behind the US, Germany, others, but activity is increasing
- 2nd Generation Fuels are emerging. These need to be developed at large scale for full benefits to be realised
- Carbon savings and value chains can be made in other sectors, e.g. construction, chemicals, polymers.
- Huge potential for both UK agriculture & industry
- Still not making best use of the land we have available to us!



Roadmapping

- See Handout
- www.nnfcc.co.uk for full reports



Thank you



Website: www.nnfcc.co.uk