Programme Area: Bioenergy

Project: Biomass Logistics in the UK

Title: Biomass Logistics Infrastructure Review

Abstract:

A report, detailing how the biomass logistics infrastructure network has developed in the UK to date and the current status of, and issues with, biomass distribution networks in the UK. The report should cover both imported and domestic biomass feedstocks. The report should highlight any future planned investments in biomass logistics infrastructure. The report should also consider lessons that can be learned from other relevant sectors such as coal and oil.

Context:

This project will describe existing biomass import / storage / distribution assets and, using findings from BVCM (ETI's Bio Value Chain Model) and other references, will define and test alternative scenarios for different biomass demand levels.

Deliverable 1: Biomass Logistics Infrastructure Review

CLIENT: Energy Technologies Institute

DATE: 24/04/2017

Version History

Version	Date	Description	Prepared by
0.1	13/12/16	Version 1	Grace Quinn
0.2	28/02/17	Version 2	Grace Quinn
0.3	12/04/17	Version 3	David Balchin

Document Approvers

Team/ Department	Name	Approved on
Project Team (Baringa)	Oliver Rix	09/12/2016
	John Calder	28/02/2017
	John Calder	12/04/2017

Reference Documents

Ref.	Document Name	Prepared by
Deliverable 0	Scoping and Approach Document	Grace Quinn

Contact

Name John.Calder@baringa.com +44 203 327 4372

Biomass Glossary

Glossary of Terms	Description
Bale Trailer Truck	A bale trailer is used for carrying large bundles of hay. It is often attached to a truck for transportation.
Base Feedstock	Base feedstocks are any renewable, biological material that can be used directly as a fuel or converted to another form of fuel or energy product.
Billion	A thousand million
Bioenergy	Bioenergy is renewable energy made available from materials derived from biological sources.
Biomass	Biomass is any organic material which has stored sunlight in the form of chemical energy. As a fuel it may include wood, wood waste, straw, sugarcane, and many other by products from a variety of agricultural processes.
Bulk Tipper Truck	A bulk tipper is a truck in which bulk goods can be emptied without handling. The front end of the platform can be raised so that the load is discharged by gravity.
Bunker	A bunker is a type of storage used for biomass fuel. Usually it is an interim store before being moved to a boiler. It comes in various forms and sizes, however they are often rectangular and covered.
Dead Weight Tonnage	A measure of how much mass a ship is carrying or can safely carry; it does not include the weight of the ship.
Dome	A dome is a large weather resistant storage structure often found at ports and power stations to store pellets.
Flat Back	A flat back truck is a type of truck which can be either articulated or rigid. As the name suggests, its bodywork is just an entirely flat, level 'bed' with no sides or roof.
Greenhouse Gas Emissions (GHG)	Greenhouse Gas is an atmospheric gas that absorbs infrared radiation therefore trapping and holding heat in the atmosphere. By trapping the sun's warmth, this causes the greenhouse effect which leads to global warming.
Green Tonne	The weight measurement of timber freshly felled before any natural or artificial drying has occurred. One green tonne is equivalent to approximately 0.98 m3 underbark softwood or 0.88 m3 underbark hardwood, and to approximately 1.22 m3 overbark standing softwood or 1.11 m3 overbark standing hardwood.
Hardwood	Hardwood is the wood from a broadleaved tree (such as Oak, ash or beech).
Hopper	A Hopper is a storage mechanism to store biomass fuel before boiler use. Hoppers can be built to have a feed mechanism at the bottom so the biomass fuel can be conveyed into the burning chamber of the boiler.
Roundwood	Roundwood is wood in its most natural state as felled, with or without bark. It has not yet been sawn into planks or chopped.
Log Truck	A logging truck or timber lorry is a large truck used to carry logs. Often more than one trailer is attached to carry the logs.
Miscanthus	Miscanthus (also known as Elephant Grass) is a high yielding energy crop that grows over 3 metres tall, resembles bamboo and produces a crop every year without the need for replanting.
Oven Dried Tonne	The metric weight of biomass at 0% moisture content.

Glossary of Terms	Description
Producer Trader	A producer trader is a pellet manufacturer (similar to Balcas or Land Energy) who also distributes and sells direct to customer. They may also sell through agents.
Seasoning	The process of storing wood fuel (logged) to reduce its moisture content, making it suitable for use as a fuel.
Silo	The most common way of storing pellets which can be filled and emptied easily. There are two types of silos. The first is a vertical silo with a tapered bottom that can be emptied by gravity using a discharge tunnel. The second type of silo is the vertical silo with a flat bottom which are emptied using a circulating auger to feed into a discharge tunnel.
Softwood	Softwood is wood from a conifer (such as pine, fir or spruce).
SRC Willow	Short Rotation Coppice (SRC) Willow is a woody crop, typically harvested on a three-yearly cycle over a 21 year lifespan. The harvested crop can be chipped or pelleted for use in bioenergy installations.
Straw	Straw is dried yellow stems of grain which has a wide range of uses, from fodder to use as an energy source.
Virgin Wood	Virgin Wood is wood derived from whole trees and the woody parts of trees including branches and bark derived from forestry works, woodland management, tree surgery and other similar operations.
Wagon	A wagon is another word for truck and is a vehicle used for transporting goods.
Walking Floor Vehicle	A walking floor vehicle (or moving floor) is a hydraulically moving floor conveyance system which can move bulk material or pallets. It automates and facilitates loading and unloading of the vehicle eliminating the need for a forklift.
Warehouse	A warehouse is an indoor storage area where wood chips are often stored.

Abbreviations Table

Abbreviation	Definition
ATEX	Atmosphere Explosibles
BEIS	Department for Business, Energy and Industrial Strategy
CAGR	Compound Annual Growth Rate
CFD	Contract for Difference
CHP	Combined Heat and Power
CP	Control Period
DECC	Department of Energy and Climate Change
DfT	Department for Transport
DEFRA	Department for Environment, Food and Rural Affairs
DSEAR	Dangerous Substances and Explosive Atmospheres Regulations
DWT	Dead Weight Tonne
EAG	Expert Advisory Group
ECS	Energy Crop Scheme
E.G.	For Example
EPC	Engineering Procurement Construction
EU	European Union
GHG	Greenhouse Gas
MT	Metric Tonne
MW	Mega Watt
O&M	Operation and Maintenance
P.A.	Per Annum
RHI	Renewable Heat Incentive
RO	Renewables Obligation
ROC	Renewables Obligation Certificates
SRC	Short Rotation Coppice
SRN	Strategic Road Network
UK	United Kingdom

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Executive Summary

This review is a key deliverable of the Energy Technologies Institute (ETI) Biomass Logistics in the UK project. This project focuses on what will be required to support future supply chains as biomass grows in importance in the United Kingdom (UK) energy system.

The purpose of the Biomass Logistics Infrastructure Review is to provide an overview of the UK's current biomass logistics infrastructure network and how it has developed. Additionally it serves to identify future planned investments and draw on lessons that can be learnt from the development of logistics networks in other relevant sectors such as oil, coal and other commodities.

Up to now the sector has been subsidy-driven and while growth of the biomass market has been evident it is still only a small percentage (4%[1]) of the total energy market despite significant support to date.

A number of key findings are identified as part of this review. Specifically;

- There has been an increase in entrants to the market who have invested primarily across processing and logistics networks. However the supply chain is still fragmented as logistics and infrastructure respond to end user demand.
- There are a number of planned network logistics investments which have the potential to benefit the sector. For example confirmed and biomass specific port capacity investments at the port of Tyne and Teesside will directly impact Drax and Lynemouth biomass logistics to support these plants. In relation to road investments which stand to benefit the sector, of most material impact will be the Smart Motorway programme(s). This will help to reduce congestion and increase motorway capacity for road haulage, although it is unlikely to materially change the mode selection between road and rail. The strategic study work being done is also important to improve east-west connectivity in the North of England, to open up the access to North West ports for imports coming from the United States and Canada (e.g. Liverpool) for import dependent end user groups (mainly non-power generation) situated in the east of England.
- There are lessons that can be learned from established supply chains in other comparable industries; notably oil and gas, agriculture and coal. For instance that safety and compliance should be a first priority, co-operation and collaboration between product vendors/ asset owners/ supply chain partners underpins the ability for sector efficiency in addition to the need for demand certainty to drive investment.
- Confidence in the sector is much needed to attract further investment in supporting infrastructure and supply chain synergies.
- Rail is vital to the UK's economic prosperity. Rail links with ports and airports are essential to support the transportation of goods.
- The extent to which rail transport and freight specifically will be a constraint to the biomass logistics supply chain is dependent upon a range of factors; primarily the Government's energy policy on biomass, willingness of the Government to protect capacity and promote rail freight growth on the network, the extent to which biomass will replace coal and the cost efficiency of using imported fuel sources and rail haulage, as opposed to local fuel supplies and other transport modes. The combination of these factors makes it difficult to estimate future biomass volumes for

[1] See Reference 'v'

rail freight. Even the Governments own forecast for 'steady growth' in total biomass rail freight volumes (for use by power stations) by 2030, ranges from 2.51 – 18.64 million tonnes[i].

The review also finds that the biomass sector is not without challenges. These challenges include; a shortage of drivers who are willing to work in this sector (as well as more generally in road haulage), increasing barriers to entry driven by the emergence of larger and more dominant market players, schedule optimisation to reduce 'empty miles', the need for standard practices which ensure product quality and the clear reduction in Government support and incentives.

In an uncertain UK energy policy context, growth in biomass projects and the logistics supply chain will only occur if the biomass sector continues to receive an allocation of CFDs and/or market prices support project economics without need for subsidy. For growth to occur, it requires the two fundamental factors of revenue and fuel supply certainty to be addressed, together with meeting the opportunities and challenges associated with the future direction of UK energy policy.

1 Introduction

1.1 Project Overview

The Energy Technologies Institute's (ETI) Biomass Logistics in the UK project focuses on what will be required to support future supply chains as biomass grows in importance in the UK energy system. Utilising LLamasoft's supply chain design software the project will model the logistics requirements of future bioenergy scenarios, identifying commonalities and differences across the different scenarios, highlighting potentially key decision points and actions required to ensure logistics infrastructure in the UK can support a growing bioenergy sector.

A key objective of the project is to ensure that the sector is supported to develop in the most efficient and effective way possible, drawing on lessons learned from other sectors where relevant.

This is key for developing a national infrastructure to receive and distribute imported biomass feedstocks across the UK, as well as being able to accommodate increasing levels of domestic feedstock into the system over time.

1.2 Document Purpose

This document serves to provide an understanding of the current biomass logistics infrastructure network for the UK, for both imported and domestic feedstocks, how it has developed and the challenges it faces. It will provide a summary of where biomass logistics networks make use of 'generic' infrastructure (such as the road network) versus where bespoke infrastructure investment is required (such as specialist port handling equipment). Additionally future planned investments will also be identified and where relevant it will draw on lessons that can be learnt from the development of logistics networks in other relevant sectors such as oil, coal and other commodities.

The overall project is split into five 'Work Packages', each with a specific focus area and set of deliverables. This deliverable is part of Work Package 1 which concentrates on gathering data related to the current (as-is) biomass landscape in the UK. This data will then be collated to develop a baseline model which future scenarios can be modeled against.

1.3 Approach

2015 is taken as the baseline year but the report notes any major changes that have taken place between 2015 and the date the report was written. As this deliverable is centered on the biomass sector today and specifically the UK it was necessary to gather data from a range of sources. This data was both qualitative and quantitative in nature. The project team engaged in structured interviews with the Expert Advisory Group (EAG)[2] in addition to gathering the necessary data from publically available sources. This was further enhanced by drawing on existing knowledge within the project team and ETI as required.

[2] Please see Appendix A

1.4 Scope

The scope of this deliverable is limited to the current (as-is) biomass landscape with the exception of identified planned future investments. This scope reflects the need for the baseline model view and is specific to this stage in the project. It does not reflect the overall ETI bioenergy project scope. The scope will expand for the future scenarios to take into account additional variables such as inland and coastal waterways and extra ports.

Table 1 Baseline Scope Overview

Scope Category	Base Feedstock	Processing	Imports	Domestic Ports	Storage	Transport	End User (> 1 Megawatt Thermal)
In Scope Groups	**Products:** - Straw - Miscanthus - Wood - Willow (SRC) - Wood Chips - Wood Pellets	- Pellet Mill - Chipping Facilities - Sawmills	**Source:** - United States - Canada - Portugal - Baltic States Threshold: > 70,000 Tonnes supplied p.a to the UK **Products:** - Wood Pellets - Wood Chips	- Hull - Immingham - Tyne - Liverpool - Newport - Bristol - Dry Bulk Vessel Capacity - Transport Links	- Dry Bulk Port Storage - End User Storage - Processing Site Storage	- Vessels up to Panamax size - Rail - Road	- Power Generation (incl. Gas to hydrogen) - CHP - Large Non Domestic Heating - Domestic Heating
Secondary Scope Groups			**Source:** - Germany - Poland			- Transport from feedstock site to processor	- Reverse waste movements (Ash)
Out of Scope Groups	**Source:** - Postcodes beyond 2nd Level **Products:** - Biofuels - Torrified Material - SRF - Waste Wood - Other waste products	- Pre-processing - Producer Traders - Blending	**Source:** - Rest of world **Product:** - Imported Raw Material pre processing / processing - Waste Wood - Other waste products	- Other UK Ports - Ports that do not handle dry bulk	- Non- Biomass Bulk Storage - Source Storage	- Inland Waterways - Coastal Waterways - Post- Panamax - Capesize - Road Imports	- CCS movements - Paper & Pulp (covered under CHP) - User groups less than 1 Megawatt Thermal

- **In Scope**: Core relevance to subject with data available
- **Secondary Scope**: Some relevance and will be Included in modelling if data is available
- **Out of Scope:** Will not be modelled in baseline

For further details and rationale on why some areas have been deemed out of scope please see Appendix B.

2 History of Biomass in the UK

2.1 Market Overview

The interest in bioenergy and specifically biomass has gained momentum in the UK in recent years. Its advantages, compared to alternative renewable energy options[3] have continued to attract focus due to an increase in Government policies which support supply from renewable energy sources[ii].

The Government has increasingly moved towards decarbonisation and the use of sustainable fuels since the nineties by introducing domestic and commercial incentive schemes. For example:

- In 1990 the Non- Fossil Fuel Obligation (NFFO) legislation came into play and required the former public electricity suppliers (PES) to buy electricity from renewable generators. This, in addition to the Scottish Renewables Obligation, was the Government's primary instrument of renewable energy policy.
- In 2002 the Renewables Obligation (RO) was introduced which is a mechanism designed to support large-scale renewable electricity generation and favours newer biomass technologies, which are designed to support large-scale renewable electricity generation. The level of support provided to technologies is dependent on their maturity with more nascent technologies typically receiving a higher level of support per unit of electricity generated.
- Since 2002, RO has been responsible for the bulk of renewable deployment in the UK, but it is being replaced by the Contract for Difference (CFD) mechanism. RO will close to new applicants at the end of March 2017. Both RO and CfD have contributed to the development of the bioelectricity sector.
- 2007 saw the UK Government agree to an overall European Union target of generating 20% of the European Union's (EU) energy supply from renewable sources by 2020. Each EU member state was given its own allocated target; for the UK it is 15% and was formalised in 2009 with the passage of the EU Renewable Energy Directive[iii].
- In 2008 the Climate Change Act stipulated that the UK must reduce its greenhouse gas (GHG) emissions by at least 80% on 1990 levels, by 2050. Consequently, the UK Government committed to its 2012 Bioenergy Strategy to support bioenergy that delivers genuine carbon reductions and helps to meet the UK's decarbonisation targets (DECC, DfT and DEFRA, 2012)[iv].
- More recently in 2014 the uptake of renewable heat technologies within the domestic and non-domestic heat market have been encouraged through the Renewable Heat Incentive (RHI)[4]. This incentive has been the main contributor to development and growth in the heat sector in recent years.

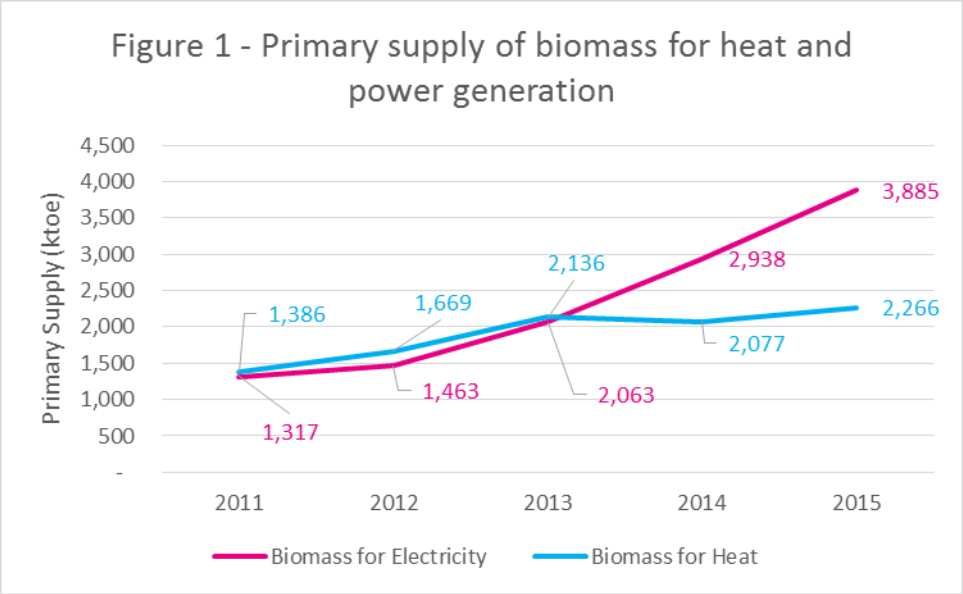
The bioenergy sector as a whole includes energy generated from both biomass (wood, energy crops) and wastes.

The UK biomass market, while experiencing growth from its inception through to present day, is still small relative to other energy sources. In the past five years the use of biomass for electricity and heat has grown from 2,704 ktoe (1000 tonne of oil equivalent) in 2011 to 6,151 ktoe in 2015[v], which is only

[3] Widespread availability, relative independence from environmental fluctuations, employment intensity and its flexibility in terms of energy carrier and diversity of supply options.
[4] The Renewable Heat Incentive (RHI) is a UK Government scheme set up to encourage uptake of renewable heat technologies amongst householders, communities and businesses through financial incentives.

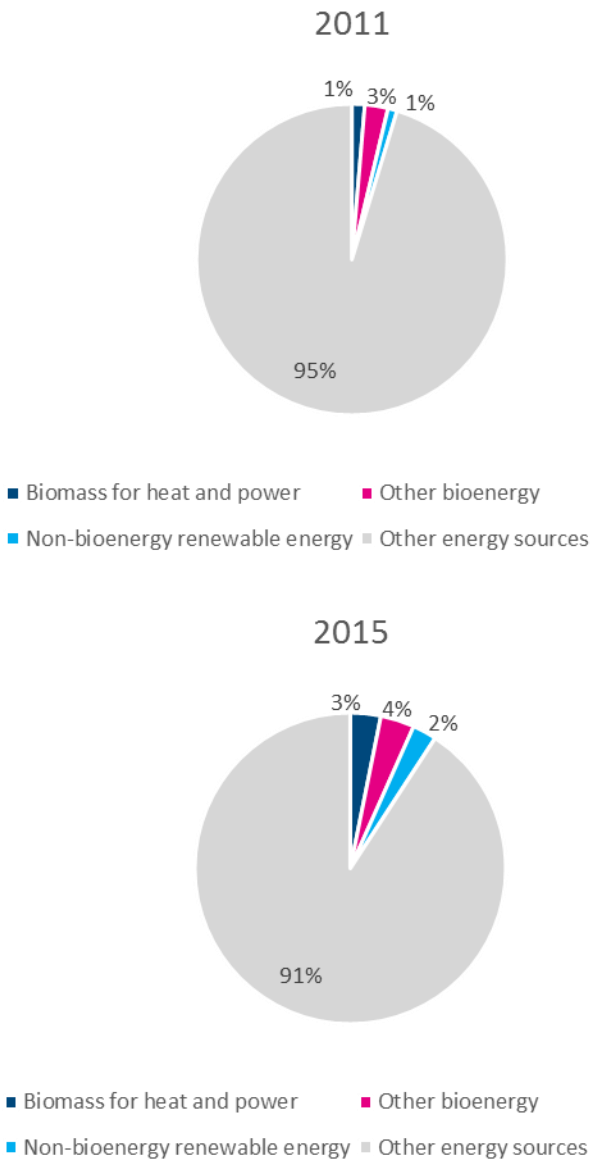
3.2% of the total UK energy market (primary demand). These statistics consider biomass use in heat and power only. They do not include the use of waste or the production of transport biofuels.

Figure 1 Growth in Biomass (Primary Demand)



Biomass grew from contributing 1.3% of the total UK energy market in 2011 to 3.2% in 2015[vi].

Figure 2 Demand for Biomass & Renewables as a % of the UK Energy Market 2011 & 2015



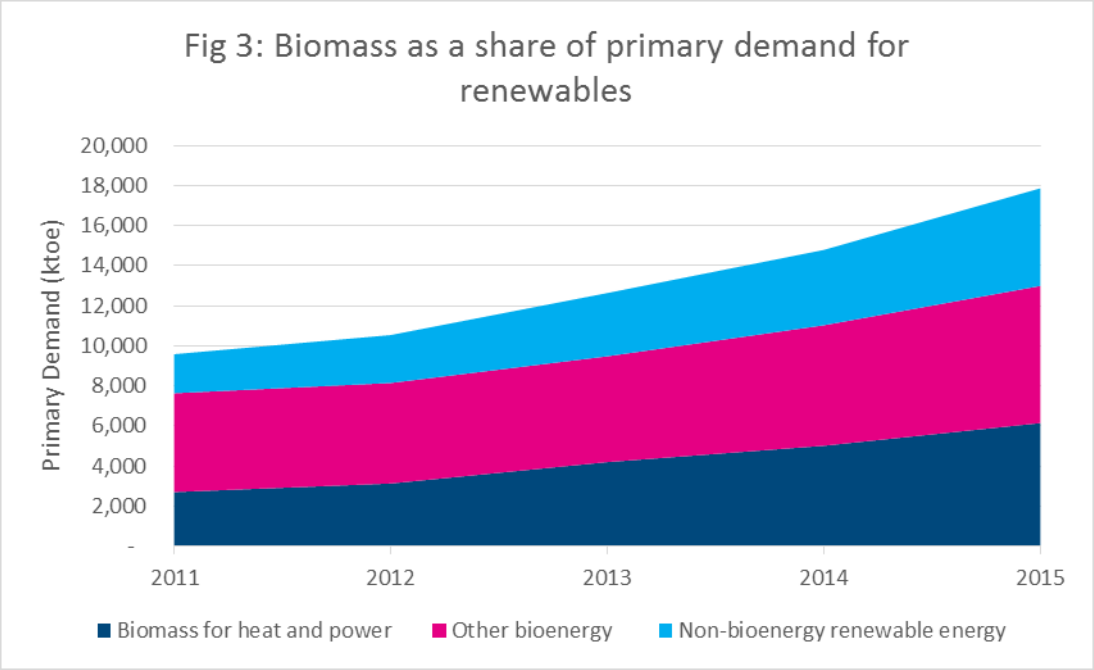
As interest in biomass has grown so have market entrants to the sector. Increased investment and diversification of operating models to support this value chain have been evident, particularly across processing and logistical networks. However, as with all evolving supply chains this has been a fragmented journey to date as logistics and infrastructure respond to end user demand.

By 2015 biomass for heat and power accounted for approximately 34% of the renewable energy market in the UK, up from 28% in 2011. From 2011 to 2012 the market grew by 1.5%, and 3.5% in the following year, mainly through the Drax power plant converting their units to biomass[5]. Market growth

[5] Please see Appendix C

fell to 0.7% from 2013 to 2014, and further to 0.5% in the following year[vii]. Please see Appendix J for a breakdown of this calculation.

Figure 3 Biomass as a share of the Renewable Energy Market (Primary Demand)



As mentioned the UK government support schemes have been instrumental in the development of the bioenergy sector. Firstly through the Non-Fossil Fuel Obligation scheme (NFFO), secondly through the RO for the renewable electricity sector and more recently through the Renewable Heat Incentive (RHI) for domestic and industrial/ commercial heat supply. Biomass energy crop growth has also been incentivised through the Energy Crop Schemes (ECS1 and ECS2). The Energy Crop Scheme is now closed.

In the UK the area of land used to produce crops for energy expanded from 28,000 in 2011 to 122,000 hectares in 2014, the highest percentage of total arable land available since data was first collected in 2008. This covers, short rotation coppice (SRC, like willow and poplar), miscanthus, wheat, barley, oilseed rape, maize (for anaerobic digestion) and sugar beet[viii].

As a percentage of total arable land in the UK, 122,000 hectares equates to approximately 2%. Data from the UK Forestry Commission shows that total softwood harvest grew from 9,722,000 green tonnes in 2011 to 10,273,000 green tonnes in 2015 while hardwood tonnes reduced slightly from 541,000 to 528,000 green tonnes over the same period[ix]. This is the total quantity of roundwood grown in the UK. The majority of this will be used in other industries, such as timber.

3 Biomass in the Supply Chain

3.1 Types of Biomass

Biomass which is used as a source of energy most often refers to plant based materials that are not used for food or feed. Primarily these are conventional energy crops, virgin wood based fuels and straw combusted to produce energy at power plants in the UK.

Table 2 Base Feedstock Types

Base Feedstock	Source – UK Grown	Typical End User Groups	Scale of Supply
Roundwood 	• Throughout the UK but primarily in Scotland.	• Power Generators • Combined Heat & Power (CHP) • Large Non-Domestic Heat • Domestic Heat • Sawmills • Wood Panel Sector • Construction • Animal Bedding • Horticulture	• From a total UK round harvest of 10.8 Mte (green) or 54 terawatt hours (TWh), 2.9 million tonne equivalent (Mte) or 14.29 TWh terawatt hours (TWh) of roundwood fuel was produced direct from UK forests in 2015.
Straw 	• East Anglia, Yorkshire & Humber	• Power Generators • Combined Heat & Power (CHP) • Animal Feed/ Bedding • Packaging • Construction	• Estimated > 10 Mte (38.47 TWh straw is produced in the UK of which 700 kte (2.69 TWh) is used for power production (including CHP) at 3 sites.
Miscanthus 	• Midlands, East Anglia, Yorkshire & Humber	• Power Generators • Animal Feed/ Bedding • Heat Only Sector	• In 2013/2014 approx. 90 kte (0.42 TWh) was grown in the UK of which 22 kiloton equivalent (kte), or 0.1 TWh, was used for biomass energy.
Short Rotation Coppice (SRC) 	• North East England, East Midlands, South East England, Yorkshire and Humber	• Power Generators • Combined Heat & Power (CHP) • Animal Feed/ Bedding • Heat Only Sector	• In 2013/2014 approx. 25 kte (0.12 TWh) was grown in the UK of which 6.6 kte, or 0.03 TWh was used for power generation demand by Drax. Iggesund is the other main user of SRC for energy.

- Conversion factor: GJ to TWH is 0.000000277778

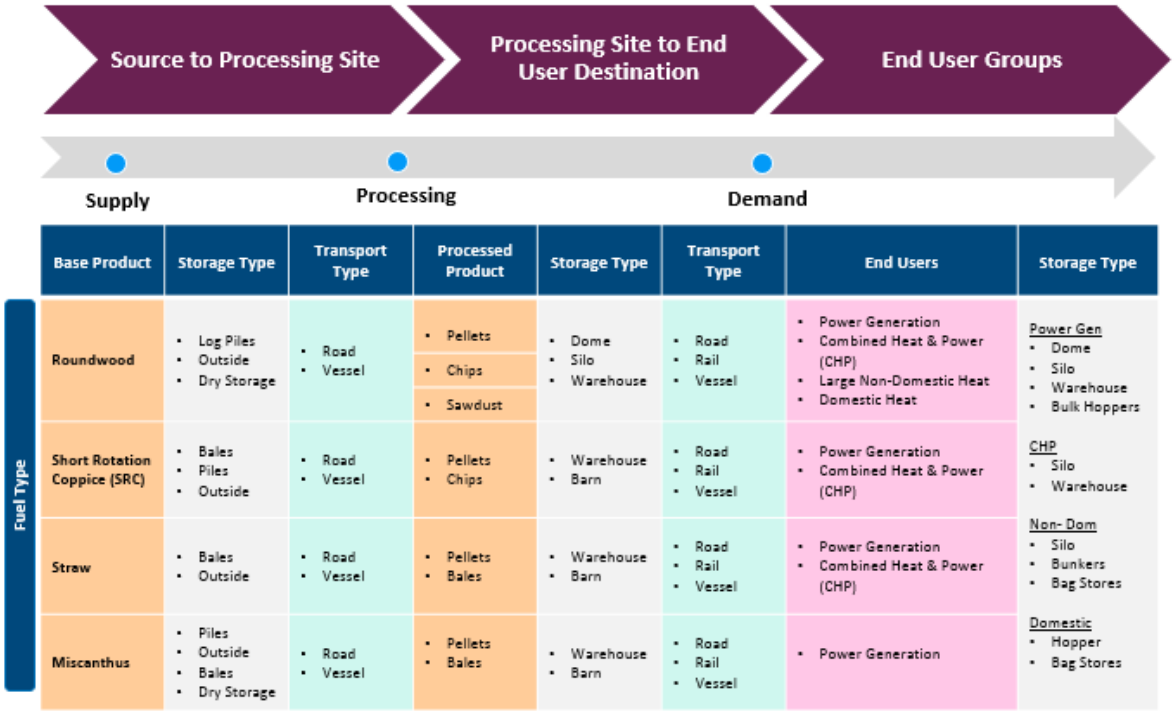
Please see section 4 for further details on the source associated with the figures referenced above.

Appendix D – G includes network maps by end user group which maps each type of base feedstock through to demand point, including associated costs and tonnages.

3.2 Biomass Supply Chain

Domestic Physical Supply Chain

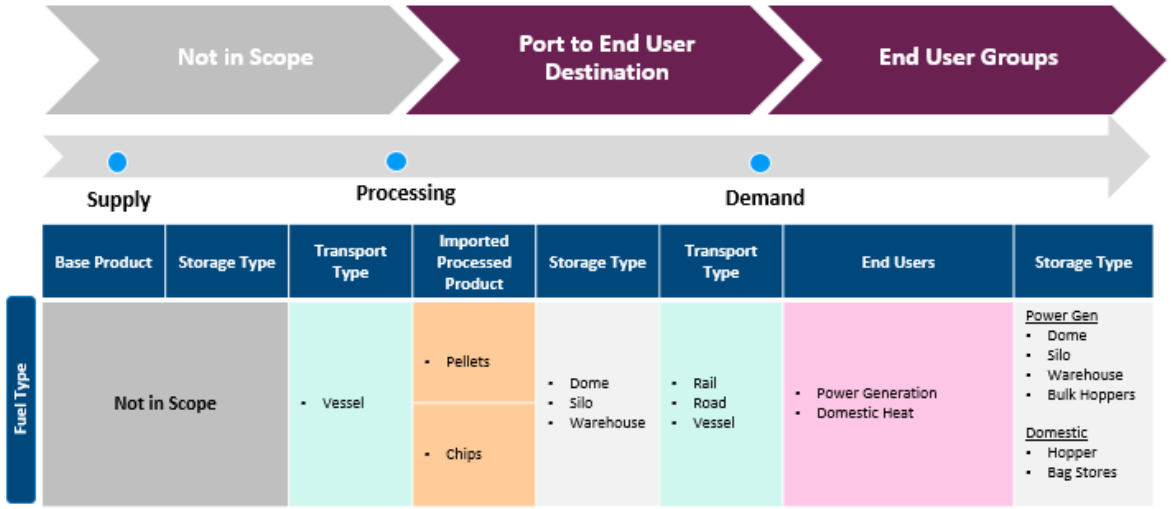
The below matrix represents the potential storage and transport options across each stage of the domestic biomass supply chain. This does not represent the current UK landscape but is representative of the possible options available to biomass supply chains globally. Section 4 details specifics in relation to the UK biomass supply chain today.



Fuel Type	Base Product	Storage Type	Transport Type	Processed Product	Storage Type	Transport Type	End Users	Storage Type
	Roundwood	• Log Piles • Outside • Dry Storage	• Road • Vessel	• Pellets • Chips • Sawdust	• Dome • Silo • Warehouse	• Road • Rail • Vessel	• Power Generation • Combined Heat & Power (CHP) • Large Non-Domestic Heat • Domestic Heat	Power Gen • Dome • Silo • Warehouse • Bulk Hoppers
	Short Rotation Coppice (SRC)	• Bales • Piles • Outside	• Road • Vessel	• Pellets • Chips	• Warehouse • Barn	• Road • Rail • Vessel	• Power Generation • Combined Heat & Power (CHP)	CHP • Silo • Warehouse
	Straw	• Bales • Outside	• Road • Vessel	• Pellets • Bales	• Warehouse • Barn	• Road • Rail • Vessel	• Power Generation • Combined Heat & Power (CHP)	Non- Dom • Silo • Bunkers • Bag Stores
	Miscanthus	• Piles • Outside • Bales • Dry Storage	• Road • Vessel	• Pellets • Bales	• Warehouse • Barn	• Road • Rail • Vessel	• Power Generation	Domestic • Hopper • Bag Stores

Imports Physical Supply Chain

The below matrix represents the potential storage, transport options and end users for biomass imports. This does not represent the current UK landscape but is representative of the possible options available to biomass supply chains globally. Section 4 details specifics in relation to the UK biomass supply chain today.

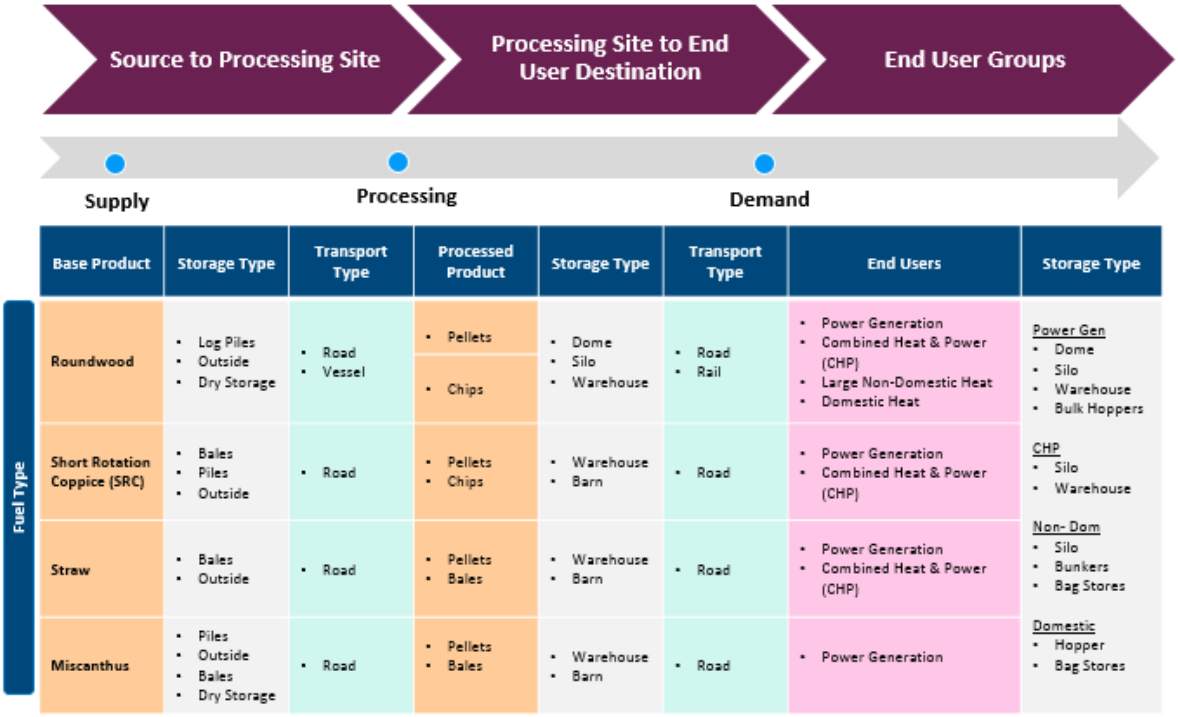


4 UK Physical Landscape Today (2015)

4.1 UK Biomass Supply Chain

Domestic Physical Supply – UK Specific

This matrix represents the current UK physical supply chain. These are the most commonly used feedstocks, types of storage and modes of transport.



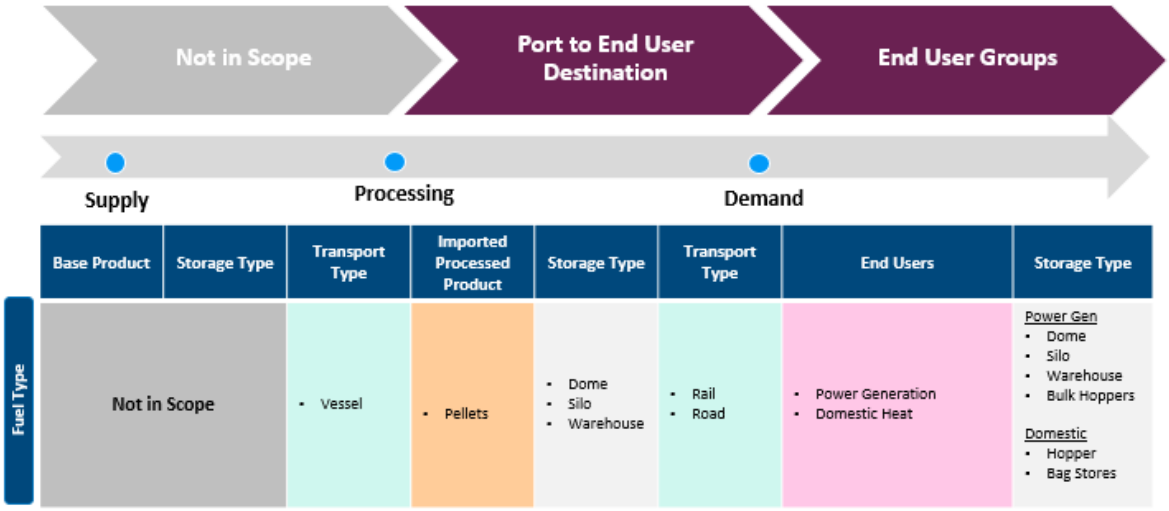
Base Product	Storage Type	Transport Type	Processed Product	Storage Type	Transport Type	End Users	Storage Type
Roundwood	• Log Piles • Outside • Dry Storage	• Road • Vessel	• Pellets • Chips	• Dome • Silo • Warehouse	• Road • Rail	• Power Generation • Combined Heat & Power (CHP) • Large Non-Domestic Heat • Domestic Heat	Power Gen • Dome • Silo • Warehouse • Bulk Hoppers
Short Rotation Coppice (SRC)	• Bales • Piles • Outside	• Road	• Pellets • Chips	• Warehouse • Barn	• Road	• Power Generation • Combined Heat & Power (CHP)	CHP • Silo • Warehouse
Straw	• Bales • Outside	• Road	• Pellets • Bales	• Warehouse • Barn	• Road	• Power Generation • Combined Heat & Power (CHP)	Non- Dom • Silo • Bunkers • Bag Stores
Miscanthus	• Piles • Outside • Bales • Dry Storage	• Road	• Pellets • Bales	• Warehouse • Barn	• Road	• Power Generation	Domestic • Hopper • Bag Stores

Please Note

- Land Energy, a producer of wood pellets, receives 25% of its roundwood via coastal vessel (Source to Processing) from Troon to its Girvan site in Scotland.
- Rail in the UK is only used to deliver imports from the port to Drax. Imports were transported via rail to Ironbridge in the baseline year but this is now closed.
- The UK does not currently use inland waterways as a transport lane.

Imports Physical Supply – UK Specific

The UK imports wood pellets which are primarily consumed by the power generator market.



Appendix D – G includes network maps by end user group which maps each type of base feedstock through to demand point, including associated costs and tonnages.

4.2 Source to Processing

Biomass feedstocks are renewable, biological material that can be used directly as a fuel, or converted to another form of fuel or energy product (e.g. pellets or chips). These energy crops are used for firing power plants, either alone or co-fired with other fuels. Alternatively they can be used for heat or combined heat and power (CHP) production.

The most popular of these energy crops in the UK are virgin roundwood, straw, short rotation coppice and miscanthus. Please note it is virgin roundwood of low economic value or which is unsuitable for other markets that is used in the energy sector. The storage requirements vary for each type of biomass crop.

In some instances the processing site may be at the source or end user site so the road movements required for this supply chain are minimal. Where roundwood, SRC, straw or miscanthus is transported via road from source to processor or end user site this is on average within a 50 mile radius[6] due to the economics of each road movement. The cost levers for road transport are mainly fuel, personnel, lease cost and insurance. To break even, a truck has to make approximately £500/day and prices are set accordingly[x].

4.2.1 Domestic Production Roundwood

Roundwood is grown throughout the UK but primarily in Scotland[7] and processed to become wood pellets and chips. In 2015 2.2 million tonnes of wood fuel was produced direct from UK forests[xi].

The power generation market is supplied by three main sources/regions of virgin Roundwood; South Wales, Scotland and to a lesser extent chipped wood from Thetford Forest in the East of England.

The CHP and domestic heat markets on the other hand are supplied from; South and North West England, Wales, Scotland and Northern Ireland.

Please note that not all roundwood is for use in the energy sector.

4.2.1.1 Roundwood Storage: Source Site

Roundwood can be stored under almost any conditions where it is provided time to season[8] and therefore reduce its moisture content. The simplest and cheapest method is to store it in the forest where it loses moisture over time through air drying. The alternative is artificial drying using a kiln in dry storage which force-dries the timber and speeds up the process, but is more costly. Artificial drying is also likely to reduce the GHG benefit of biomass. On the other hand one of the challenges in holding stock while it dries is the associated working capital it ties up, which force-drying can somewhat

[6] This was derived through interviews with EAG members. It is not applied as a constraint in the modelling.
[7] Scottish wood production in 2015 was 6.889Mte (soft/hard); England 2.619Mte (soft/hard); Wales 1.399Mte (soft/hard); NI 0.389Mte (soft only).Hence Scotland produces 61.2% of all UK wood.
[8] See Biomass Glossary page 4

alleviate[xii]. Force drying would be preferable in instances where the supply of seasoned roundwood with adequate moisture content is constrained and therefore the drying process needs to speed up to meet demand. Alternatively where the working capital cost of holding roundwood stock outweighs the yield it could return from being supplied to the market.

4.2.1.2 Roundwood Transport: Source to Processing Site

Roundwood is mainly transported from source to processing site via road in log trucks. The exception to this is Land energy who transports approximately 800 green tonnes of logs per week to the Girvan site by coastal vessel to ports local to the site. In 2015 10.8 million green tonnes of roundwood were delivered to wood processors and other demand sites. However it is important to note that not all roundwood is used within the energy sector.

4.2.2 Domestic Production Short Rotation Coppice (SRC)

Short Rotation Coppice (willow/ poplar) is grown in North and South East England, East Midlands, Yorkshire and Humber. In 2013/2014 approximately 25 kte (oven dried) was grown in the UK of which 6.6 kte was used for energy[xiii].

4.2.2.1 SRC Storage: Source Site

When willow or poplar (SRC) shoots are harvested as whole stems they are easy to store. SRC is harvested in winter and the stems can be dried for combustion in a pile outdoors; the moisture content of the wood will decrease to about 30% on average until the next autumn[xiv].

4.2.3 Domestic Production Straw

Straw is grown in East Anglia, Yorkshire and Humber. It is estimated that in excess of 10 million tonnes of straw is produced per annum (p.a.) in the UK of which approximately 700 kte is used for power production across three sites[xv].

4.2.3.1 Straw Storage: Source Site

Straw is baled and generally stored on site and uncovered. Investing in covered storage for straw is not seen as a near term prospect as the profit yield from straw is not deemed to warrant the investment. There are however varying stack covers[9] which some farmers use to stop mould and rot in bad winters[xvi].

4.2.4 Domestic Production Miscanthus

Miscanthus is grown primarily in the Midlands, East Anglia, Yorkshire and Humber. In 2013/2014 approximately 90 kte was grown in the UK of which 22 kte was used for energy.[xvii]

4.2.4.1 Miscanthus Storage: Source Site

Miscanthus is cut in January – March and left to wind dry before being baled in April whereupon it is stored either on site covered by tarpaulins or equivalent, or alternatively in barns[xviii]. Non-woody biomass such as straw and miscanthus are stored at source locations post harvesting and collected to meet power plant or pelleting plant demands throughout the year.

[9] An example of stack covers could be plastic sheets, silage sheets or tarp

4.2.4.2 SRC, Straw and Miscanthus Transport: Source to Processing Site

SRC, Straw and Miscanthus are predominantly transported via flat back and trailer[10] delivering 36 Heston bales at a time (20 tonnes total load). Some deliveries can also take place using an articulated vehicle but this requires a special licence[xix]. These special licences refer to a trial of the use of articulated lorries (rather than the more usual truck and trailer combination) with a limited number being granted licences to carry straw, which requires a single length trailer longer than the standard 13metres in order to carry the 36 bales normally carried by the road trains which are up to 18.75metres. No decision has been taken on whether these longer length articulated Lorries will be able to be used in the long term and only a few exist today.

4.2.5 Industry Challenges

There are numerous challenges facing the bioenergy sector in regards to the domestic supply of base feedstock.

The bioenergy sector competes directly with wood based industries for the lower grades of raw forestry products [xx]. The competing uses of wood fibre comes from industrial/commercial heat users in the following industry segments; pulp and paper, chemicals, construction, horticulture, agricultural and the wood panel/ products sector.

Increasing the supply of SRC and Miscanthus requires either government support to encourage and incentivise farmers or end user contracts which underwrite the investment. Energy Crop Scheme (ECS) 1 and 2 were largely instrumental in the current plantations but there has been no further government support since the end of ECS 2 in 2013. For SRC in particular the investment required is significant as it takes four years from planting to the first harvest (harvested in winter) and requires approximately 100 hectares of land to produce enough SRC to generate 1MW of electricity, hence the need for financial stimulus or other means of support for farmers to grow SRC. This is similar in the case of miscanthus where there is 2-3 years from planting to the first harvest. As these are long rotation crops (approximately 20 years) which require upfront investment with a viable revenue stream not accessible for at least 2-4 years from planting, farmers will require certainty that a long term market will exist for their product to justify the investment. In the current market some buyers/aggregators offer loans for the initial planting costs and/or long term contracts for the harvested crop which goes somewhat to mitigating this risk and alleviating the financial burden on farmers in the initial stages of the crop lifecycle[xxi].

Additionally, seasonality presents a challenge to the consistency and quality in supply of SRC, straw and miscanthus to the market as materials are largely stored uncovered at the source location until needed. The industry must therefore allow for this variability or shortfall in supply and ensure contingency stock of roundwood is available to fill the gap. A challenge in itself as the bioenergy sector competes directly with wood based industries as mentioned above. While there is a working capital impact on holding contingency stock, the impact on storage should be minimal if it is stored in the forest where it is provided the time to reduce its moisture content.

As agreed with ETI stakeholder's seasonality will not be reflected in the baseline model.

[10] See Biomass Glossary page 3

4.3 Processing Site to End User Destination

Roundwood, short rotation coppice, straw and miscanthus once sufficiently seasoned are processed from base feedstock into pellet or chip form to be used as fuel across the power and heat markets. Straw and miscanthus can also be used directly in baled form.

Processing takes place at either sawmill, chipping or pelleting facilities depending on product type.

4.3.1 Domestic Sawmill

In 2015 there were 171 sawmills in the UK producing a mix of residue chips, sawdust and sawn timber. Approximately 52% of sawmill product is sawn timber, 48% residues chips and sawdust[xxii].

Processing of roundwood to chips takes place at or near source woodlands in either sawmills or in some cases at end user power plants (e.g. Western Wood/ Thetford/Eye)[xxiii].

4.3.2 Domestic Wood Pellet Production

The UK has a total pellet processing capacity of approximately 400,000 tonnes per annum[xxiv].

Processing of roundwood to pellets takes place near source woodlands in pellet plants.

4.3.3 Domestic Chipping Plants

There are approximately 50[11] wood chipping facilities throughout the UK which primarily provide wood fuel to the CHP and non- domestic heat market. In 2015, about 210 kte of wood chips were consumed by large non-domestic heat boilers, 498 kte by the small/ medium non- domestic heat sector and 2.2 million tonnes were consumed by CHP and power plants[xxv].

Processing of roundwood to chips takes place at or near[12] source woodlands in chipping depots.

4.3.4 Domestic Non- Wood Pellet Production

There are two domestic non-wood processors who between them supply SRC, straw and miscanthus pellets to Drax power station.

- Goole Pellet Plant processes approximately 123,173 tonnes per annum of straw and miscanthus.
- Terravesta processes miscanthus only and has a plant capacity of 100,000 tonnes of miscanthus per annum. In 2015 it had a contract to supply Drax with 25,000 tonnes which is no longer the case[xxvi].

[11] The Biomass Suppliers list has over 700 chip supplier listings but many are duplicates for different wood sources. We estimate there are approximately 50 sites. There is a total of 3 million tonnes supplied which is about 60,000 tonnes annually over approximately 50 sites which does not appear excessive.

[12] This on average refers to within a 50 miles radius. This was derived through interviews with EAG members. It is not applied as a constraint in the modelling.

SRC, straw and miscanthus are supplied locally to appropriate processing facilities.

Figure 4 Wood and Non- Wood Pellet Processors

* **Verdo Renewable pellet production plants are recently closed but in scope for baseline model 2015**

For a detailed view of these pellet plants, volumes, feedstock type and sources of information please refer to the Data Tracker, tab 'Pellet Mills', which is part of Deliverable 2a.

4.3.5 Storage

Processing Site Storage

Within the biomass sector there seems to be very little industry collaboration and shared use of infrastructure, particularly in the case of storage. For instance central storage hubs do not seem to

exist for this sector[13]. However, the increase in force-dried wood could drive centralisation in the storage market as stakeholders look to benefit from economies of scale, utilization rates as well as flexibility of access.

There is also minimal inter-depot movement, only in times of regional supply shortage.

While depots and processing facilities have some storage capacity there is a tendency to avoid storing pellets and chips above a minimum stock base. This is not driven by a desire to keep working capital costs down but due to the health & safety hazards of pellet dust and carbon monoxide production in enclosed storage areas and the fire risk associated with storing large amounts of chips for any length of time, particularly if containing bark. Wood chip suppliers e.g. Forest Fuels and some end users such as Western Wood and Steven's Croft at the Lockerbie sawmill (Jenkinson's), will store harvested timber in roundwood form and chip to demand through the year.

Chips and pellets tend to have distinct storage facilities with suppliers only holding 1-2 weeks stock as contingency. Storage requirements vary for each type of biomass fuel. For instance;

- Wood Chips tend to be stored in large covered barns.
- Wood Pellets after cooling are stored in a large silo to await bagging/ bulk distribution. Alternatively they can be stored in a pellet hopper for smaller quantities (e.g. Domestic Heat)
- SRC, miscanthus and straw pellets require storage which is dry. Barns are generally used for straw and miscanthus bales. Straw pellets are stored in bags for smaller consignments (up to 1000kg) in sheds and warehouses and can be held in silos/bunkers for larger shipments.

4.3.6 Transport

Processing Site to End User Destination

Delivery from domestic processing site to end user destination for all groups is undertaken via road. The exception to this is the 44MWe Steven's Croft power generation plant which is in part serviced from the A.W. Jenkinson Lockerbie sawmill and chipping facility via an overhead conveyor belt. Steven's Croft is also partially supplied by road (e.g. for round wood deliveries for chipping on site) with fuel sourced from southern Scotland and Cumbria.

Currently the use of inland waterways as a route for distribution does not exist. Similarly transporting landed product along the coast of the UK, via domestic ports as opposed to road, is not a utilized supply lane.

Processed product can be distributed by the processors themselves if they have a logistic capability, like Forest Fuels and AW Jenkinson, or alternatively by a dedicated road haulier like Malcolm Logistics. Logistic providers tend to have a mix of company owned and subcontracted vehicles varying in size. In some cases those sub-contracted vehicles are also branded.

Biomass transported via road is mainly in walking floor trailers or bulk tipper vehicles. These vehicles are not specific to biomass but can be utilised for the transport of other commodities. The amount that can be transported will be constrained by vehicle capacity which is on average 21 tonnes for these vehicle types.

[13] This is based on EAG interviews and consultancy research.

A truck carrying wood chips will on average do 1-2 deliveries per day and those carrying pellets will do 5-6[xxvii]. This is due to the varying drop sizes between these products and end users groups. For instance domestically produced pellets are consumed by the domestic heat market and therefore deliveries will be to a larger customer base and in smaller parcel sizes (as they do not have large storage facilities) in comparison to wood chips which are delivered in larger consignments. Hauliers are constantly driven to optimize their schedules and reduce empty miles. UK user group demand satisfied via road requires approximately the following number of truckloads per day[14];

- Power Generation: approximately 260 truckloads per day of domestic product.
- CHP: approximately 280 truckloads per day
- Non-Domestic Heat: approximately 53 truckloads per day
- Domestic Heat: given the fragmented nature of demand in this market it is harder to assign an estimate of truck movements per day that accurately reflects reality.

These numbers have been estimated on total demand for domestic product per end user group and does not take into account number of sites serviced.

4.3.7 Industry Challenges

The need to maintain and further expand processing capacity within the UK is proving to be a challenge. The current business case to support domestic production of wood and non-wood pellets versus imports is not economically viable. The UK has a much lower availability of raw material fibre than many other parts of the world with only 11.6% of its land area devoted to forestry. This compares to the US (33.84%); Canada (49.24%); Brazil (56.1%); Russia (49.4%) and even France (36.7%)[xxviii]. A significant portion on the UK increment is hardwood which is difficult to harvest and therefore comes at a premium making UK produced raw material fibre on the whole more expensive than imports. An increasing reliance on imports to satisfy domestic demand increases the UK's exposure to market pricing and security of supply. The ability to secure a reliable and stable supply of biomass is extremely important for the future of the renewable energy industry.

As a result many processing plants are closing. Evidence of this can be seen in the planned closure of the Goole pellet plant and Verdo Renewables recent decision to cease pellet production and import pellets instead. Both a lack of energy policy and the cost differential[15] between imported and domestically supplied wood pellets serves to undermine investor confidence in supporting much needed processing facilities.

Challenges within the road transport industry are not unique to biomass. These challenges include; a shortage of drivers who are willing to work in this sector, schedule optimisation in addition to road congestion. Hauliers are also constantly trying to reduce the number of 'empty miles' which is difficult to balance with management of vehicle cross contamination.

Additionally there needs to be an increased focus on good and bad practice regarding product processing and handling, to ensure consistent standards are met across the industry, instilling end user confidence in product quality.

[14] Assumes 21 tonne per truck. Please see Appendix I.

[15] Cost differential in 2015 circa £30-£40

4.4 Port to End User Destination

Current UK biomass demand is met through domestic supply and imports. The first large scale UK biomass imports started in 2010 via the Port of Tyne, primarily focussed on satisfying demand within the power sector, specifically for Drax. In the years following imports to support Ironbridge power plant came via Liverpool.

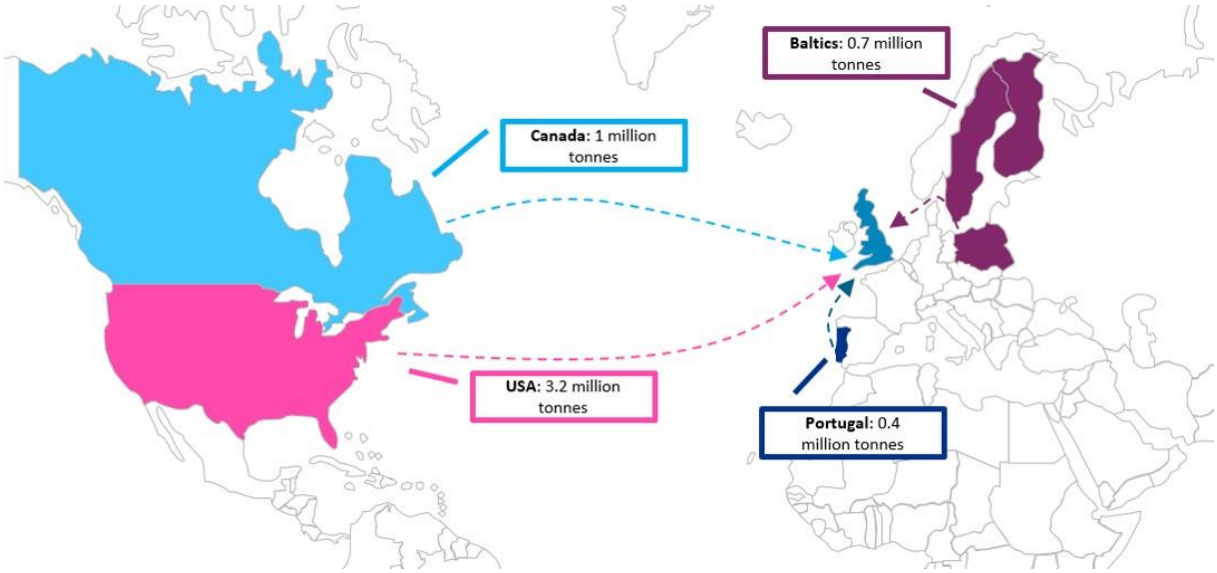
International supply met 54% of UK biomass demand, amounting to imports of 5.31 million tonnes per annum[xxix]. As this report is based on a 2015 view these figures are from 2014-15 statistical data.

4.4.1.1 Product Type

UK imports consist of wood pellets which are sourced from a variety of global locations.

Imports come predominantly from the Unites States, Canada and Europe (primarily Portugal, Estonia and Latvia) to a single port of discharge in the UK. The quantity imported via these trade routes varies depending on demand, route and vessel.

Figure 5 Origins of Biomass Imports



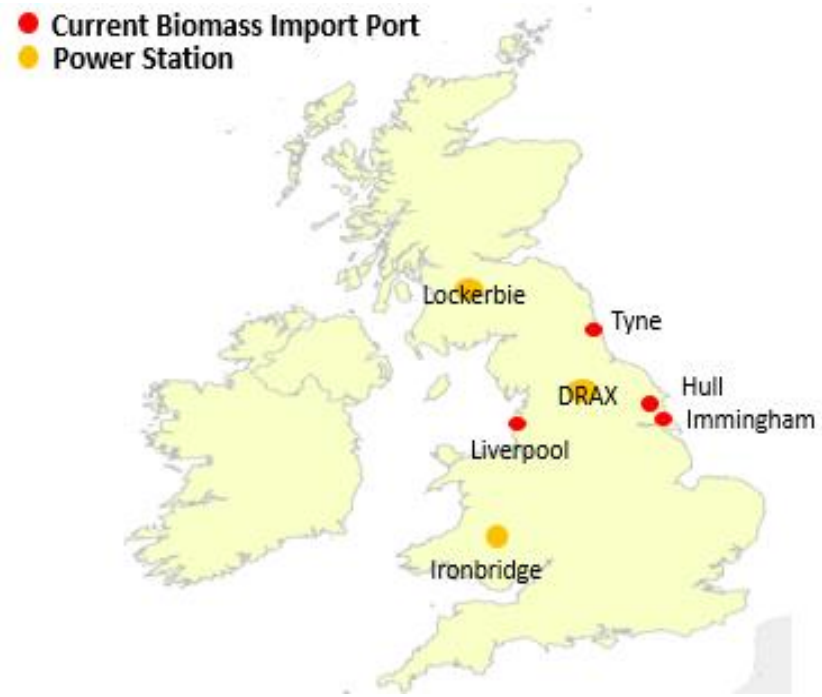
This data is taken from Ofgem Biomass sustainability dataset 2014-15[xxx] which is the latest published data in line with the baseline model view of 2015.

4.4.1.2 Storage

Domestic Port Storage

As ports are the gateway for biomass imports, many in the UK have adapted to support this supply chain. There are many domestic ports which handle dry bulk cargoes, including biomass, but only a few which offer biomass storage facilities. These are outlined in **Figure 6** below.

Figure 6 Import Ports with Biomass Storage



There are many UK ports which currently handle varying scales of biomass imports per annum but who do not have biomass storage facilities e.g. Newport, Bristol, Grimsby, New Holland to name but a few. There are some potential disadvantages associated with utilising these ports for example they potentially lack the HSSE insight and learnings related to handling wood pellets, which dedicated biomass import ports have both sought out and incorporated into their day to day operations. Similarly, having no biomass storage available increases the risk of double handling and in turn product degradation and costs, as product is held elsewhere within the supply chain until it can be received by the end user. These ports while continuing to support the biomass import supply chain also have the potential to play a greater role, particularly should they invest in biomass storage or convert current dry bulk storage. These are in addition to the ports which are confirmed as having future biomass capabilities, for instance Teesside.

Currently imported products are predominantly received by large scale power generators. Not surprisingly the ports which have to date invested in the necessary resources and infrastructure to support the storage, handling and discharge of biomass have also supplied imported coal to these

power stations in the past. In some instances these plant developers have commissioned the required port infrastructure to support their operations[16].

This has taken the form of commissioning new storage facilities, modifying existing dry bulk storage and ensuring the necessary procedures and standards are in place at the port to accommodate biomass. These ports and their storage capacities are highlighted in Table 3. For context please note current port storage capacity is only 8% of current imported tonnage. This highlights how tight the supply chain is and the need for it to be resilient to avoid disruptions.

Pellets are stored at the port in domes, warehouses and silos, with the latter being the most common due to its ease of filling and emptying.

Table 3[xxxi] Confirmed UK Port Biomass Storage Capacity

UK Port	Port Owner/Operator	Biomass Port Storage Capacity (T)	Port Throughput Capacity (p.a.)	Dead Weight Tonne (DWT)	Nearby Power Generation Plants
Hull	ABP	26,000	1 ,000,000	34,000	DRAX
Immingham[17]	ABP	200,000	6,000,000	110,000	DRAX
Liverpool	Peel Ports	100,000	3,000,000	80,000 – 110,000	DRAX/ Ironbridge
Tyne[18]	Port of Tyne	75,000	1,800,000	60,000 -70,000	DRAX

4.4.1.3 Transport

Biomass imports are transported via dry bulk carriers into the UK. As the quantity imported varies via trade route so does the vessel size they are transported on. Smaller parcel sizes and vessels tend to come from Europe (e.g. 3,500 DWT upwards). Wood pellets do not require a dedicated vessel and can therefore be transported on a multi-product carrier.

There are different grades of imported wood pellets depending on whether they are for domestic or industrial use. These pellets would be transported separately and in different consignment sizes. For example imported pellets for the domestic heat market would generally come in smaller vessels (handled either in pre-loaded containers, or transported by sea in bulk and converted to bags at or close to the port) from Europe requiring smaller short sea vessels. Whereas industrial pellets are usually sourced from further afield and transported in larger vessels (Handymax and Supramax), typically moved in bulk and handled at the port using specialist crane, conveyoring, storage and intermodal transfer stations to move quickly and effectively onto rail and occasionally road.

A key consideration in the supply chain of imported biomass is the vessel capacity (draft) of the receiving port and ensuring economies of scale for the voyage. For example imports originating from the US and Canada will require a larger deep sea vessel than those coming from Europe, due to the

[16] UK coal plants are subject to the Large Combustion Plant Directive (LCPD) and the Industrial Emissions Directive. Under the LCPD plants built after 1987 had to comply with specific emission limits. Plants built earlier than that could either 'opt-in' to comply with the emission limits, or 'opt- out' and close by the end of 2015.9 UK generation stations chose to 'opt-out' accounting for 11.5GW of generation capacity by 2015. The associated logistics capacity for fuelling those stations was either diverted for other cargo types or closed down. This creates an opportunity for the biomass industry to capitalize on this available capacity within the logistics network.

[17] Available throughput of 6 million tonnes by 2016

[18] Fully capacity to be delivered by 2018

route and parcel size required to justify the cost of the voyage[19]. However, not every UK port has the capacity to receive such large vessels due to draft restrictions or port infrastructure. Therefore imports should always be considered in line with receiving port constraints[20].

In 2015 port constraints did have an impact on where supply was received in UK ports. For example new capacity at Liverpool was due to come online in 2016 and therefore the ports of Hull, Immingham and Tyne picked up this additional throughput.

Domestic Port to Storage

Once product has been discharged from the vessel it is transferred to a warehouse, dome or silo where it is stored until it is reloaded for transport and distribution to the end user.

Port Storage to End User Destination

Imported product is transferred from the port either directly to Drax by rail or via port storage. More than 80% of Drax's fuel demand is transported to the plant via rail[xxxii]. All domestic ports which service Drax have rail capacity.

The two major rail operators of these train lines are GB Railfreight (Liverpool/Tyne) and DB Cargo (Humber). Drax built and own purpose built wagons, which are the majority of the available fleet for biomass.

Currently each train is composed of approximately 24 wagons carrying 1600-1700 tonnes per train[21]. It is estimated that 12-17 trains per day are required to service the current demand at Drax Power Station[22]. Ironbridge Power Station, the second site serviced via train (until its closure in 2016), required significantly less feedstock – around 3 trains per day. The number of trains will increase during periods of stock building at the demand site (currently Drax)[23].

It is important to be aware that this is not a reflection of the available rail path capacity but current operations.

4.4.2 Industry Challenges

UK ports in the majority of cases are responsible for the discharge, storage and reloading of biomass which comes through the port. Like all products at the port there will be standards and requirements relating to how biomass is handled to ensure health, safety, security and environmental (HSSE) criteria are adhered to. There has been considerable collaboration to encourage shared learnings between the ports which is evidenced by the lack of damaging events in the UK compared to other locations. Areas which have presented challenges in the past are now largely recognized and require constant management. For example;

[19] The baseline model calculates import quantities by taking the total quantity exported divided by average supramax vessel capacity of 55,000 DWT (median of 50-60,000 DWT taken) for those from US/Canada. For those from Europe/ Baltics total quantity exported is divided by handymax vessel capacity of 23,000 DWT (most common size/ between 15k-35k).
[20] The port of Hull could not handle a Panamax size vessel (60, 000-80,000 dead weight tonne (DWT)) as its vessel capacity is approximately 34,000 DWT which is more suitable to the smaller coastal vessels. However the ports of Liverpool and Tyne can accept Panamax size imports. Expert Advisory Group (EAG) interview with John Fitzgerald on 17/11/2016.

[21] This is based on an average wagon capacity of 72 tonne.
[22] Please see Appendix I
[23] Current demand at Drax 4,590,728 tonnes p.a. equates to 21,000 tonne demand per day (based on 220 days a year) and assuming an average wagon capacity of 72 t and 24 wagons per train, this results in 12 trains per day. Demand at Ironbridge Power Station of 1,022,557 tonnes p.a. means a daily delivery volume of 4,650 tonnes that can be serviced with 3 trains.

- The dust created by biomass wood pellets is highly combustible so fall under ATEX and DSEAR regulations[24]. There are also risks associated with human inhalation which fall under Health, Safety and Environment guidelines. These regulations need to be adhered to in addition to developing and managing dust containment strategies. Industry practice sees this managed in a few different ways. For example loading systems which are designed to limit the amount of dust created in the first place to creating areas of negative pressure within the loading facility that extract fugitive dust emissions from the area[xxxiii]. There is also a cost associated with the associated procedures which the port needs to recover.
- Port storage capacities are limited compared to the amount that is required to run the power stations. This restricts the supply chain's capacity to absorb disruptions and heightens the dependency on an efficient and resilient supply chain[xxxiv].
- The cost of imports can also vary significantly due to fluctuations in both the freight and bunker fuel market. When these costs rise they will be most heavily felt in executing spot or short term as they are much more reflective of current market rates. Long term import contracts will not be as exposed to the market shift as they will be subject to a previously negotiated term price. [25]
- It is currently more economical to import wood pellets than to produce wood pellets domestically. This cost differential is a hindrance to encouraging UK investment in much needed additional pellet processing facilities.

[24] The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) are concerned with preventing or limiting the harmful effects of fires, explosions and similar energy-releasing events and corrosion to metals. ATEX is the name commonly given to the two European Directives for controlling explosive atmospheres.

[25] Assumes no hedging takes place.

4.5 End Users

The biomass sector in the UK has four key user groups; power generators, combined heat and power (CHP), non-domestic heat and domestic heat.

As previously discussed storage requirements vary for each type of biomass fuel. They can also vary depending on the scale of product and demand site in question.

4.5.1 Power Generators

The type of biomass required by UK power generators varies by plant as does the source of supply.

Wood chips, wood pellets, non-wood pellets (SRC, straw and miscanthus) and bales (straw and miscanthus) are consumed by a number of power generators throughout the UK.

Table 4 below identifies the UK's dedicated biomass power plants with the exception of Drax and Aberthaw which are/were co-firing plants[xxxv]. Aberthaw will operate on a restricted basis from April 2017 burning coal.

Table 4 Biomass Generation Users

Biomass Generation Users	Plant	Capacity (MWe)	Biomass Type Required	Processing Required	Biomass Consumption (Tonnes) Per Annum
Power Plants	Ironbridge*	485	Wood Pellets (imports)	Yes	1,022,557
	Drax	1935 (biomass only units)	Wood Pellets (imports)	Yes	4,799,772
			Straw Pellets	Yes	
			Miscanthus Pellets	Yes	
			Short Rotation Coppice	Yes	
	Steven's Croft	45.6	Wood Chips	Yes	403,417
	Western Wood	15.3	Wood Chips	Yes	144,189
	Thetford	41.5	Wood Chips	Yes	36,538
	Aberthaw	1612.5	Wood Chips	Yes	70,717
	Eccleshall	2.3	Wood Chips	Yes	32,753
			Miscanthus Pellets		
	Eye	14.316	Wood Chips	Yes	1923
	Westfield	12.5	Wood Chips	Yes	156
	Wilton	33.276	Wood Chips	Yes	205,735
Straw Power Plants	Brigg Renewable Energy Plant	33.276	Straw Bales	No	205,735
			Miscanthus Bales	No	
	Ely Power Station	43	Straw Bales	No	265,000
			Miscanthus Bales	No	

***Ironbridge is now closed but in scope for baseline model which uses 2015 data.**

This data is taken from Ofgem Biomass sustainability dataset 2014-15[xxxvi] which is the latest published data in line with the baseline model view of 2015.

4.5.1.1 Storage

Storage facilities at power generation plants tend to be domes, silos or warehouses, similar to port storage. Larger power stations like DRAX tend to use domes to accommodate the volume of throughput. They have built 4 storage domes at 50m high (164 ft.) with a capacity of 75,000 tonne each which are the largest of their kind in the world and have required construction considerations to

ensure they are fit for purpose and fit in with their environment[26]. Storage requirements for smaller power plants will vary depending on the type of biomass fuel and the quantity. Silos or storage warehouses are most common. Eccleshall for example will have covered storage bays for miscanthus and wood chip whilst using a bulk hopper for pellets.

4.5.2 Combined Heat and Power

Wood chips, straw and SRC pellets are consumed by CHP plants throughout the UK. The majority of this consumption is from plants which are greater than 1 MW.

The majority of this consumption is from a few large scale power plants[27]. A desktop review of power plants in Northern Ireland showed that Ballylumford (gas), Kilroot (coal, oil & GT's), Coolkeragh (CCGT) do not consume any in-scope biomass.

Table 5 Renewables Obligation CHP Plants

This data is taken from Ofgem Biomass sustainability dataset 2014-15 which is the latest published data in line with the baseline model view of 2015.

Biomass CHP End Users	Plant	Plant Size (MWe)	Biomass Type Required	Biomass Consumption (Tonnes) Per Annum
CHP Plants	Iggesund	49.9	Wood Chips Residue Chips Sawdust	573,340
	Caledonian	25.85		245, 582
	Corde	8.124		46,508
	Balcas CHP	8.566		142,951
	Balcas Timber	2.75		99,281
	Shotton	16.65		88,969
	Markinch	56.35		56,247
	Slough Heat & Power	35		390
	Iggesund	49.9	Short Rotation Coppice	8,370
	Sleaford	41	Straw Bales	83,347

4.5.2.1 Storage

Storage at CHP Plants tends to be similar to the smaller power generation plants using covered storage or silos for processed product. For example at Sleaford CHP Plant, bales of cereal straw are stored in

[26] For further details please see http://www.drax.com/technology/how-do-you-build-a-dome-bigger-than-the-albert-hall/
[27] Large scale refers to greater than 1 Megawatt Electric

open stockpiles while processed wood chip used at sites like Markinch CHP are stored in undercover infrastructure, usually a covered silo[xxxvii]. Unlike the big power plants, CHP plants do not use domes for storage of processed (wood chip or pellet) biomass as the size of storage required is much smaller.

Figure 7[xxxviii] **Power and CHP Biomass Plants**

The map below highlights operators under the renewables obligation with > 1 MW capacity. Outputs shown are Mega Watt gross.

4.5.3 Large Non- Domestic Heat

These are end users who are RHI accredited and have a heating system (boiler) greater than 1 MW capacity and are found in commercial, public or industrial premises.

These heat-only users consume approximately 210 kte of wood chips and 20 kte of wood pellets[xxxix].

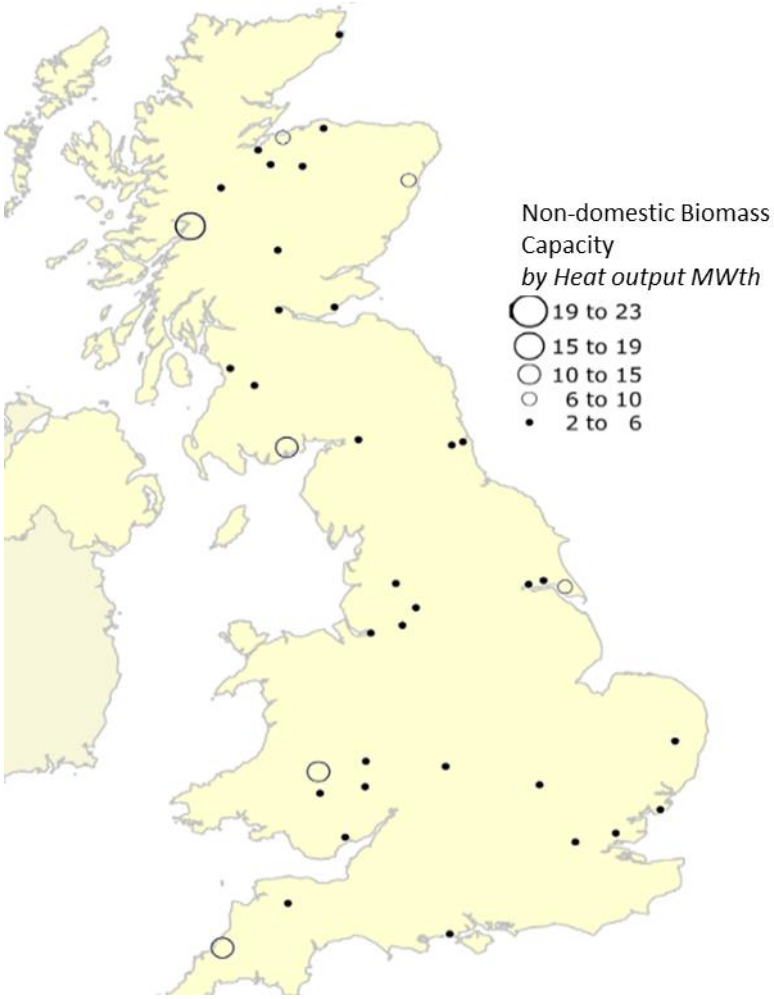
Within the UK there are 38 large commercial biomass boilers accredited by the RHI and 6 identified biomass plants connected to BSW sawmills[xl]. These are displayed in Figure 8 by heat output.

4.5.3.1 Storage

The non-domestic heat market use silos which are smaller than those used by power and CHP plants but greater than the domestic heat market. Standard sizes of storage silos for domestic use in the range of 200 kg to 20 tonnes for large industrial use. Depending on the end user type within the non-domestic heat market the required silo capacity required can vary to suit their operations. These silos are either integrated with the boiler or as a separate store for biomass products. This market has several storage options available as long as it is dry and near a boiler. Depending on the size, space and fuel type the following can be used;

1. Internal stores either integrated (with the boiler), subterranean bunkers, or separate larger silos/hoppers.
2. For wood pellets specifically internal flexible bag stores and cylindrical silos can be used[xli].

Figure 8 Non Domestic Heat Biomass Capacity



4.5.3.2 Small/ Medium Biomass Heat Only Users

These are commercial, industrial, public-building end-users with installed systems less than 200 kWth and MWth. Information supplied under freedom of information act by Ofgem shows there to be approximately 14,250 accredited systems using wood chips, pellets, logs, agricultural residues and recycled woods[xlii].

These heat only users consumed approximately 475 kte of wood chips and 272 kte of wood pellets.

The supply logistics for these end users is the same as the large non-domestic sector. Please see 4.3.6 and 5.1.2 for further details.

4.5.4 Domestic Heat

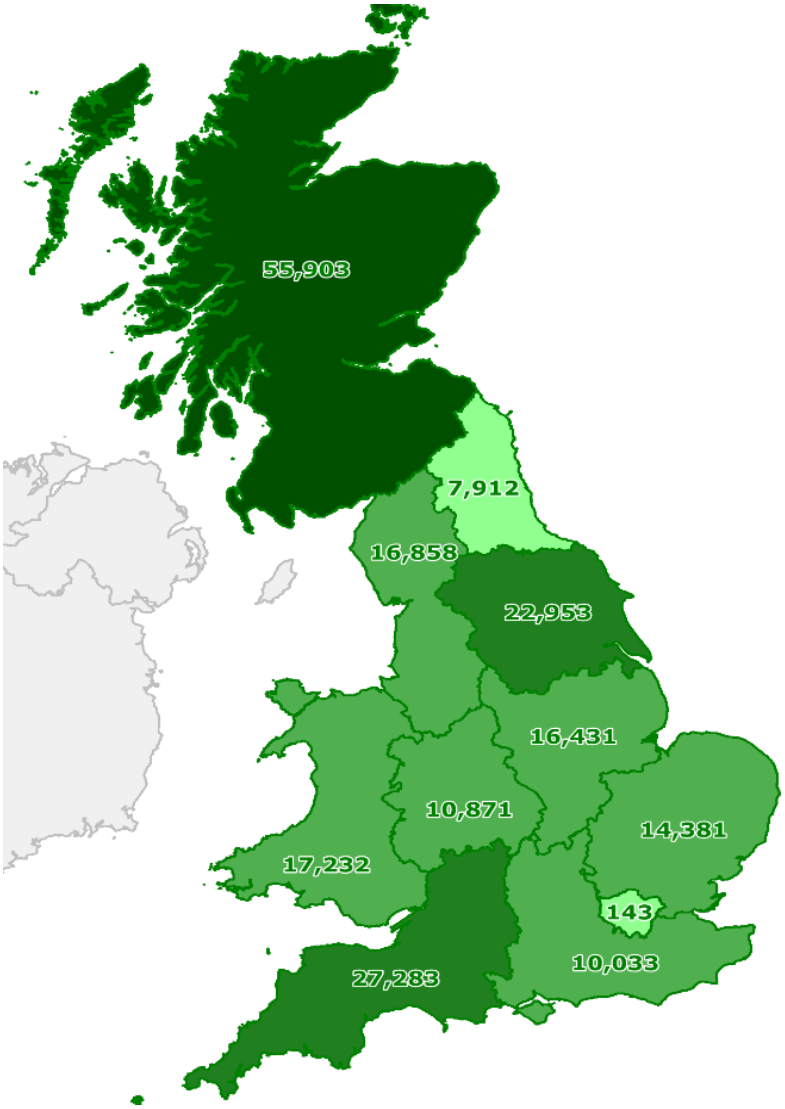
These are end users who are RHI accredited and have a heating system (boiler) that heats only a single domestic property. There were 11,223 biomass boilers accredited under the domestic RHI scheme as of December 2015.

These heat-only users consume primarily wood pellets supplied from imports and domestic supply. In 2014 200,000 kte of pellets were consumed by domestic boiler end users in boilers less than 50kWth.

The use of biomass based heating in the domestic market is primarily seen as a replacement for oil, LPG, coal and electricity based heating systems in predominantly rural areas which are off the national gas grid. The space requirements for biomass boiler systems together with urban air quality concerns has led to deployments in regions with large rural areas and where properties are typically larger to accommodate boilers and fuel storage. Figures issued by DECC show that 85% of biomass boilers were installed in Off Grid situations and over 60% of these were replacements of oil boilers. Please see **Figure 9** below.

Please see Appendix G domestic heat network map for an overview of the current supply chain from base feedstock/imports through to demand point, including associated costs and tonnages.

Figure 9 Domestic Heat Biomass Consumption (tonnes)



Region	Biomass consumption (tonnes)
Wales	17,232
Scotland	55,903
South West	27,283
West Midlands	10,871
Yorkshire and the Humber	22,953
North West	16,858
South East	10,033
East Midlands	16,431
East of England	14,381
North East	7,912
London	143
Total	200,001

4.5.4.1 Storage

Pellet hoppers are the most common form of storage for the domestic heat market as they typically hold a minimum of 3.5 tonnes of wood pellets. For domestic use, wood pellets often come in 10 kg bags. It is not uncommon for a domestic user to manually feed their boiler with a bagged wood pellets, storing these in a dry area as opposed to spending money on a larger hopper[xliii]. Alternatively a silo storage could be used for domestic use starting in the range of 200 kg.

4.5.5 Project Pipeline

The table below provides a snapshot of the major UK biomass projects (private sector) both in development and under construction, which would be the main driver for other UK logistics infrastructure (beyond road, rail and port infrastructure)[xliv].

Table 6 Biomass Project Pipeline 2015- 2020[xlv]

Key Client	Project / Programme Name	ONS Region	Scheme Status	Start of Works / Construction (Projected)	Date in Service (Projected)	Total Capex Cost all funding (£m)	MWe Output
Copenhagen Infrastructure Partners	Brite Biomass	Yorkshire and the Humber	In Construction	2015/16	2017/18	150.0	39.3
Estover - Aesica. Construction to be undertaken by Burmeister & Wain Scandinavian Contractors A/S (BWSC) and Burmeister & Wain Energy A/S (BWE)	Cramlington CHP. Aesica Pharmaceuticals	North East	Consents Approved	2016/17	2017/18	138.0	27.7
Drax	Drax Biomass Conversion	Yorkshire and the Humber	Complete	2014/15	2016/17	759.4	1935
Peel Energy	Ince Biomass Plant	North West	In Construction	2016/17	2017/18	60.5	21.5
Lynemouth	Lynemouth Biomass Conversion	North East	Consents Approved	2016/17	2018/19	173.1	420
Glennmont Partners	Port Clarence Biomass CHP	North East	In Construction	2016/17	2017/18	160.0	40
Copenhagen Infrastructure Partners	Snetterton Biomass Plant	East of England	In Construction	2015/16	2016/17	136.2	44.2
Estover Energy	Speyside Biomass CHP	Scotland	In Construction	2014/15	2016/17	74.00	12.5
MGT Teesside Ltd	Tees Renewable Energy Plant	North East	Consents Approved	2016/17	2018/19	905.2	299
Tilbury Green Power Ltd (100% subsidiary of Express Energy Holdings (UK) BV - part owned by Cargill)	Tilbury Green Power	South East	In Construction	2016/17	2017/18	133.2	40
Burmeister & Wain Scandinavian Contractor A/S (BWSC)	Widnes 3MG Biomass Combined Heat and Power (CHP) Plant	North West	Consents Approved	2015/16	2016/17	110.0	20.2

The current project pipeline (all those listed in Table 6) does not place constraints on the current UK biomass supply chain, however it does highlight a relatively small number of development projects with consents/ under construction in the period to 2020.

4.5.6 Industry Challenges

The bioenergy market is not without its obstacles. The consumption of biomass within the power generation market has increased significantly in recent years, primarily as a result of Drax. However, support for new investment in the sector has reduced over time with support being targeted at developing technologies like gasification and waste to energy schemes, while successive tariff reductions in the RHI are sending signals that the sector must stand on its own two feet.

Additionally, the supply chain is not as robust and sustainable to support future growth scenarios as it could be with an increasing reliance on imports evident and lack of energy policy undermining investor confidence. Up to now the sector has been subsidy-driven and is subject to increasing speculation on its financial sustainability should these subsidies fall away.

Confidence in the sector is much needed to attract further investment in supporting much needed infrastructure and supply chain synergies.

5 Market Participants

5.1 Biomass Supply Chain Major Participants

There are a large number of participants in the UK biomass supply chain ranging from small scale domestic producers and logistics providers, through to larger scale roundwood suppliers and major domestic hauliers. There is no single organisation which has yet covered each of the key stages within the UK biomass supply chain, resulting in a currently fragmented marketplace with a smaller number of significant participants and with a much larger 'tail' of ad hoc market players. The degree of horizontal and vertical integration activity seems to be most prevalent amongst processors and road hauliers.

5.1.1 Processors

The UK market has a number of participants who are involved in the processing of wood, straw, miscanthus and SRC into pellets and chips. These participants vary in size, geographic reach, target market and market share. For example domestic supply to the power generation market is dominated by three domestic providers: Terravesta, Goole Pellet Plants and AW Jenkinson's Sawmill. This is in contrast to the much larger number of market participants involved in wood pellet and chip production for the CHP, domestic and non-domestic markets across the rest of the UK.

Forest Fuels and Balcas are the major wood fuel suppliers in the UK. **Table 7** below lists some of the other major market participants.

Forest Fuels have over 4000 customers with 43 depots that supply pellets and chips across the UK. Like most suppliers their model is a mix of buying wood at source and from the depot[xlvi]. Balcas transport 1 million tonnes of roundwood per year from source to processing facility[xlvii]. They also supply from a number of distribution depots across the UK and Ireland.

In 2015 Balcas, Verdo and Land Energy were the major wood processors who between them supplied the majority of the UK produced wood pellets. In 2014 the wood pellet sector produced 252,000 tonnes[xlviii].

Sawmill and chip operators are focused on supplying to CHP and non-domestic sectors.

There is a certain degree of horizontal and vertical integration emerging from fuel suppliers in this sector. For example Forest Fuels plan to scale up and extend their geographic reach by buying other competitors (horizontal integration). Evidence of this can already be witnessed with the acquisition of English Woodfuels. Horizontal integration can achieve economies of scale, scope and an increase in market power amongst other synergies. There are however potential pitfalls associated with this strategy. These include the risk to specialist skills which may be lost as output homogenises and product offerings change, the wider risk to the market of reduced competition which can drive undesirable practices, and the risk that flexibility in the supply chain may be reduced. At the far end of the potential pitfalls includes the risk that, where firms diversifying are unable to do so successfully, the viability of the whole business suffers with a resultant gap opening in the supply-side and a security of supply risk to those who depend on biomass deliveries. This would also slow the wider development of the sector as potential end-consumers of biomass select alternative technologies.

Processors are also seen to be investing in logistic capabilities to expand their supply chain reach to end user delivery (vertical integration). An example of this is AW Jenkinson who now have access to a fleet of 440 trucks of which approximately 60% are for large scale biomass[xlix]. Similarly Northern Straw who are suppliers of straw maintain responsibility for haulage of their own product to end user. This is not surprising as vertical integration presents an opportunity for investment in greatly specialized assets, reduced transaction costs and higher certainty when it comes to quality. It could however also yield a decrease in flexibility and an inability to increase product variety. This may be why some key industry players have avoided these strategies to date as they wait for an increase in market certainty.

Table 7 Major Participants in the Processing Market

Market	Category	Major Participants/Operators	Market Supplied
Processing *Some processors will have logistic capabilities to support distribution to end user	Domestic Sawmills	• BSW • Pontrilas • AW Jenkinson's	• Power Generation • CHP • Non-Domestic Heat
	Domestic Wood Pellet Producers	• Balcas • Land Energy • Puffin • Verdo (since closed) • Blazier	• Domestic Heat • Non-Domestic Heat
	Domestic Non-Wood Pellet Producers	• Goole Pellet Plant • Terravesta	• Power Generation
	Domestic Chippers	• Forest Fuels • Euroforest • Forestry Commission	• CHP • Non-Domestic Heat

5.1.2 Logistic Providers

Road

Biomass road haulage is dominated by AW Jenkinson and Eddie Stobart, whose operations extend beyond haulage to biomass fuel supply. There are however a number of smaller players, like Malcolm Logistics, who transport biomass from source to processing site and processing site to end users, but for whom this sector is not their main business with only approximately 40% of the fleet catering to biomass[l].

Stobart's acquisition of AW Jenkinson Forest Products in 2010/2011, renamed Stobart's Biomass Products, is an example of vertical integration in this market as they sought to extend beyond providing logistic services to enter the renewable energy market. AW Jenkinson claims to be the market leader in the UK for wood-related biomass, handling over 2.5M tonnes of wood products every year. Access to Stobart's logistics network and brand strength would enable both parties to double deliveries from 1,000 to 2,000 a day and further enhance their reputation among the large utility providers, which require long-term secure supply contracts[li]. Today Stobart Energy is the number one supplier of biomass in the UK, sourcing and supplying fuel to biomass plants under long-term contracts. In 2015 they had secured long- term contracts for 2 million tonnes per annum of biomass by 2017/2018.

Rail

Currently the biomass rail market has two main players; GB Railfreight and DB Cargo UK who support the movement of biomass at port (imports) to Drax power station[lii]. These contracts are operated as a hook & haul service, where the locomotives and drivers are provided under contract with the freight operator, while the wagons are provided by Drax themselves. The rail wagons used can be either converted coal hopper wagons for transport[28], or, for the majority of scheduled transport to Drax, a range of specially designed wagons that were built for and are owned by Drax.

For GBRf this is clearly a market they wish to invest in which is evident with the recent rail haulage contract it has secured with Lynemouth Power (LPL), to build 50 new purpose built high capacity biomass hopper wagons, following a successful tender submission. GBRf previously demonstrated its reliability along this route whilst running coal services to Lynemouth power station when it was owned by RWE npower. The last coal train into the station was April 2015[liii].

Ports

Associated British Ports (ABP), Peel Ports and the Port of Tyne are the major participants (port owners/operators) in the UK. In recent years these owners have commissioned significant port investment to ensure the required infrastructure and capacity is in place to both receive and store biomass. They have responded to the decline in coal imports to make way for the increase in biomass throughput.

Table 8 Major Participants within Biomass Transportation

Market	Category	Major Participants/Operators	Market Supplied
Transport	Road Logistics Provider	• Stobart Woodfuels • AW Jenkinson, • Malcolm Logistics • Allan Morris • Northern Straw	• Power Generation • CHP • Non- Domestic Heat • Domestic Heat
	Rail Logistics Provider	• GB Railfreight • DB Cargo UK	• Power Generation
	Port Logistics & Infrastructure Provider	• ABP • Peele • Port of Tyne	• Power Generation • Domestic Heat

5.1.3 End Users

The demand for UK biomass is driven from four end user groups as listed below. The individual participants within each of these market contribute to the consumption of biomass fuel across the sector in varying scales.

The power generation market is a mix of dedicated biomass power plants and co-fired plants. Drax is a power station where half its boilers are dedicated biomass and half dedicated coal. Aberthaw is a co-

[28] See footnote 16 for further context

firing plant operating on a restricted basis from April 2017. Dedicated biomass plants can also be Combined Heat and Power producing facilities, where on average, one unit of electricity also yields two units of heat. When newly built, they are often built to be flexible in what fuel they can burn, allowing for more options and more resilience in the supply chain.

These plants vary in size and facilities. At some like Steven's Croft for example processing takes place at the plant. It is worth noting that Drax has recently opened two pelleting plants and port facilities in the US, thereby vertically integrating the supply chain and helping to ensure long term continuity of supply at a controlled cost. [liv]

Non-domestic heat users refers to those with renewable heating systems in commercial, public or industrial premises. This can include large businesses, hospitals, school and organisations with district heating systems where one heating system serves multiple homes. Domestic heat users are those with one renewable heating system serving a single household.

As mentioned, the UK government have been instrumental in the development of the bioenergy sector by introducing domestic and commercial incentive schemes which have presented an attractive commercial proposition for these end user groups. The RHI for example offers people who join the scheme and stick to its rules quarterly payments for seven years (domestic) or 20 years (non-domestic) for the amount of clean, green renewable heat their system produces (or is estimated to reasonably produce).

Today these end user groups provide the market with significant insights and learnings from the various business models in play. Specifically what has driven developments in some markets more than others, the cost implications and partnerships required or that have evolved to support growth and what the dependences and opportunities are for growth within the current logistics network. These end users also provide an insight to the scale of logistic requirements within the network to support the end to end value chain.

For more information on these market users please see Section 4.1 which also includes a view of future end users in the pipeline (Table 6).

Table 9 Major End Users of the UK Biomass Market

Market	Category	Major Participants/Operators	Market Supplied
End User	Power Generation	• Western Wood • Aberthaw • Wilton • Steven's Croft • Westfield • Thetford/ Eye • Ironbridge • Drax • Eccleshall	• Power Generation

	Combined Heat & Power (CHP)	• Iggesund • Caledonian • Corde • Shotton • Markinch • Slough Heat & Power • Balcas • Sleaford	• CHP
	Non-Domestic Heat	• RHI Accredited Users	• Non- Domestic Heat
	Domestic Heat	• RHI Accredited Users	• Domestic Heat

5.2 Costs

Supply chain costs will vary depending on for example contract type, volume, product, location, relationships and scale of service required. Rates are in many instances unique to each customer and reflect the scale of their business and service required. This is not unique to the biomass sector.

Service providers have a floor cost which is the minimum they can charge to break even without margin. The degree of margin charged will reflect competitiveness in the market amongst other factors like contact type, terms and relationship.

Contracts and rates will vary depending on the commercial scope. For example entering into a longer term contract with a haulier will provide a stronger negotiating position with the commitment of return business than a spot or shorter term contract will. Evidence of this can be seen in the multi-million pound contract RWE npower renewables (NRL) has placed with leading UK logistics specialists Malcolm Logistics to service the transportation of recovered and virgin wood for use at its state-of-the-art Markinch Biomass Combined Heat and Power (CHP) Plant in Fife.

Within the UK biomass sector the contracts between the ports and end users differ. For example it is common for an end user who relies on the port infrastructure, storage and handling to get charged a rate which includes all of these services and port fees in return for commitment of port throughput. This will be negotiated on these specifics. For those who may require ad-hoc port services a different rate will be applicable based on this customers individual needs.

Table 10 Cost Contributors within UK Biomass Market

Cost Category	Cost Contributors	Cost Basis
Product	• Market Price • Processing • Handling/ Storage • Quality	• Cost per tonne
Road	• Freight/Lease • Personnel • Insurance • Fuel	• Cost per tonne/ per mile or load rate basis.
Rail	• Access • Haulage	• Cost per tonne

	• Personnel • Insurance	
Port	• Port Fees/ Dues • Storage & Handling • Haulage • Insurance	• Cost per tonne
Shipping	• Freight/ Time Charter • Crew • Bunker Fuel • Insurance • Handling • Port Fees/Agents Fees	• Cost per tonne

The individual costs listed as contributors may be a flat fee or tariff but as a collective services will be charged by the provider on rate basis.

For a detailed view of the costs used in the baseline model please refer to the Data Tracker which is part of Deliverable 2a and supports this document. Additionally Appendix D – G includes network maps by end user group which maps each type of base feedstock through to demand point, including associated costs and tonnages.

6 Planned Logistics Network Investments

6.1 Investments in the UK Road Network

6.1.1 Policy overview

The UK road network is the backbone of our transport system, carrying 90% of passenger journeys and almost 70% of freight.

In England, the UK Government is responsible for the long term strategic planning and funding of the Strategic Road Network (SRN), comprising all motorways and trunk roads.

The management of the SRN is undergoing reform, with the Highways Agency becoming Highways England, a government owned strategic highways company.

In Scotland, the Scottish Government has set out its priorities for investment and a long term strategy for the development of public infrastructure within the 2015 Infrastructure Investment Plan[lv]. The key commitment relating to road policy is the upgrading of road connections between all Scottish cities to dual carriageway.

In Wales, the Welsh Government is directly responsible for over 75 miles of motorway and over 1000 miles of trunk road. Investment plans for the period 2015-2020 are set out within the National Transport Finance Plan.[lvi]

Whilst in Northern Ireland, the Department for Infrastructure's Investment Delivery Plan (IDP)[lvii] for roads covers the investments supporting the Regional Delivery Strategy to 2025.

6.1.2 Key investments in Strategic Road Network

The Department for Transport (DfT) has published its Road Investment Strategy (RIS) for the period 2015/16 – 2019/20 (Road Period), which sets out an overarching vision for the SRN over the period to 2040.[lviii]

The RIS includes **over £15 billion of committed capital investment** over the period, and will deliver **127 major schemes** over the course of the first Road Period, summarised in Table 11.

Table 11 Key Investments in the Strategic Road Network

Region	Major schemes
North East and Yorkshire	• 26 major schemes • £1.4 billion invested this Road Period • A1 all motorway Doncaster to Newcastle, all dual Newcastle to Ellingham • Smart motorways linking Sheffield and Leeds to Manchester and London • Comprehensive review of connectivity across north and south Pennines
North West	• 16 major schemes • £1.5 billion invested this Road Period • Biggest increase in capacity into the region since 1971 • Key east-west and north-south links upgraded to Smart Motorways • Comprehensive review of connectivity across north and south Pennines, including the east-west connectivity and Trans-Pennine tunnel
East	• 17 major schemes • £2.0 billion invested this Road Period • £1.5 billion upgrade to the A14 • Cambridge to Milton Keynes link • Phase 1 of major A12 upgrade • Major upgrades to A47
South East and London	• 29 major schemes • £2.2 billion invested this Road Period • Upgrades around 10 out of 31 junctions on M25 • New smart technology on M25, M1, M3, M4, M20, M23, M27 and A1(M) • Tackling 'missing links' on the South Coast A27
Midlands	• 31 major schemes • £1.8 billion invested this Road Period • 145 miles of Smart Motorway to improve links from Birmingham to London, Manchester • 11 schemes unlocking housing and growth across the region
South West	• 8 major schemes plus £500 million further investment in A303 • £2.0 billion worth of investment open or under construction by 2020 • Single largest new scheme in the programme – tunnel at Stonehenge • Expressways for Cornwall, Gloucestershire

In addition to the committed capital investment, the DfT has commissioned a series of **six strategic studies**, focused on making major improvements to the capacity and connectivity of the SRN.

These include the following;

- **Northern Trans-Pennine** - between Leeds and Manchester in the south and Edinburgh and Glasgow in the north, there is no complete dual carriageway link between the east and west of the country. It is one of the most visible gaps in the UK transport network, and is seen as a barrier to business in the north of England. It also leaves the economy of the north of England heavily dependent on one road – the M62 – to provide strategic east-west connectivity.

- **Trans-Pennine Tunnel** – will be an examination of the case for Manchester and Sheffield to be connected by a high-performance link - in conjunction with Transport for the North, this study will examine the strategic options for the tunnel, to understand the viability, costs and deliverability of such a connection, and determine its role and priority within the emerging transport strategy for the north.
- **Manchester North-West Quadrant** – the north-west quadrant of the M60 motorway between junctions 8 and 18 contains some of the busiest stretches of road outside the M25. This study will need to work closely with Transport for Greater Manchester, the Greater Manchester Combined Authority and local transport providers.
- **A1 East of England** - The A1 is one of the oldest UK trunk roads, and also one of the least consistent. With more than fifty years of local upgrades, the road today is a patchwork of different standards, ranging from four-lane motorway to elderly dual carriageway – sometimes in the same ten-mile stretch.
- **M25 South West Quadrant** - the south-west quadrant of the M25 is the busiest road in Britain. Pressure is also increasing fast: since 2004, the stretch between junctions 11 and 12 has gone from carrying 158,000 vehicles a day to over 187,000. And the busiest parts now carry over 220,000. Nine of the ten busiest sections on the SRN are in this area, and severe congestion is a regular occurrence
- **Oxford to Cambridge Expressway** - transport connections between cities such as Cambridge, Milton Keynes and Oxford are notably poor and create an artificial barrier between hubs of knowledge-based growth. With better links, the synergies between these cities would be stronger, and would do more to drive growth in nearby towns.

Committed surface access improvements that will improve the integration of port operations with the wider transport network include;

- A5036 to the Port of Liverpool
- A14 Cambridge to Huntingdon – to improve access to the Port of Felixstowe
- A160 / A180 Port of Immingham Improvement
- A63 Castle Street to the Port of Hull

In addition, a Government study to assess how best to manage 'last mile' road access to international gateways is currently underway and will inform development of the second Road Investment Strategy.

6.1.3 Impact on UK Biomass Logistics

Aside from the general management of congestion on the network, we don't expect the committed initiatives above to have a major impact on the UK Biomass Logistics network.

The RIS has identified eight performance areas in the short term to deliver on the ambitions set for the Strategic Road Network.

These include network safety, user satisfaction, supporting flow of traffic, economic growth, better environmental outcomes, encouraging cycling and walking, achieving real efficiency and keeping the network in good condition.

Of most relevance to UK biomass logistics, will be that the SRN positively supports economic growth by addressing congestion and delay on the network, particularly on the main freight arteries that connect cities and international gateways.

Of most material impact, will be the Smart Motorway programme(s) and the strategic study work being done to improve east-west connectivity in the North of England, to open up the access to North West ports for imports coming from the United States and Canada (e.g. Liverpool) for import dependent end user groups situated in the east of England.

6.2 Investments in the UK Rail Network

6.2.1 Policy overview

Rail is vital to the UK's economic prosperity. If our rail services are not efficient and do not meet people's needs for routing or frequency, business and jobs suffer. Rail links with ports and airports are essential to support travel, tourism and the transportation of goods.

Through the High Level Output Specification (HLOS), UK Government sets out what it expects to be achieved by rail activities over the 5 year control periods, regulated by the Office of the Rail Regulator (ORR). [lix]

The current Control Period 5 (CP5) covers the period April 2014 to March 2019, and is being delivered in the context of strong average growth of 16% in passenger demand and 23% in freight.

It includes £5.2bn of infrastructure enhancements already committed for CP5 to reduce crowding, cut journey times, increase efficiency and improve the passenger experience.

Network Rail is responsible for running, maintaining and develop Britain's rail tracks, signalling, bridges, tunnels, level crossings and many key stations - each Control Period, Network Rail produces a delivery plan, which when taken together with the Enhancements Delivery Plan document, sets out what will be delivered.

This is the 'contract' against which ORR measure Network Rail's performance and it also intended to assist train operators, funders and stakeholders to plan their businesses with a reasonable degree of assurance.

6.2.2 Key rail infrastructure investments in Control Period 5

Within CP5, UK Government has committed the industry to deliver the following infrastructure enhancements;

- High Speed Two (HS2)
- Thameslink
- Crossrail
- Intercity Express Programme
- Birmingham New Street station upgrade
- Reading station upgrade
- West Coast Main Line Stafford capacity upgrade
- West Coast Main Line power supply upgrade
- East West Rail (Oxford – Bedford, Aylesbury – Calvert and links)
- Electrification of the Great Western Main Line to Cardiff, Oxford and Newbury
- Electrification of the 'North West Triangle' (Manchester – Liverpool via Chat Moss, Huyton - Wigan, Manchester - Euxton Junction and Blackpool North – Preston)
- Electrification of the 'North trans-Pennine line' (Manchester Victoria and Guide Bridge – Huddersfield – Leeds – Colton Junction)
- Elements of the Northern Hub (New Ordsall Chord, capacity improvements between Manchester and Sheffield and line speed improvements on Manchester to Sheffield, Preston and Bradford routes)

Specific investment in rail freight infrastructure in CP5 has occurred via the Strategic Freight Network Fund, approximately £235 million for enhancements such as: enhancing the capacity of the Felixstowe Branch Line; enabling 775 metre train operations out of the port of Southampton; improving rail access to the Port of Liverpool.

The Government's strategy for CP5 is built around a rolling programme of electrification, with a strategic intent to develop the network in a way that will enable it to meet demand until High Speed Two (HS2) becomes operational, but is then able to integrate around the high capacity HS2 corridor.

This strategy is built around the following four priorities;

1. **The "Electric Spine"** - a high capacity passenger and freight electric corridor running from the South Coast through Oxford, Bedford and via the Midland Main Line to the East Midlands and South Yorkshire, with a link from Oxford to the West Midlands and the North-West.

   Network Rail have approved the funding for electrification of the overground Barking - Gospel Oak line, which will provide a 2nd electrified pathway for freight going to/ from both Felixstowe and the new London Gateway Port.

   The 'electric spine' development programme will "improve regional and national connectivity and links to ports and airports for both passengers and freight to support economic development" and is due to be delivered in CP6 (2019 - 2024).

2. **Increase capacity and accelerate journey times between our key cities - investing in faster trains (Intercity Express Programme) and route improvements.** For example, the Digital Railway programme is the industry's improved plan to tackle the UK's capacity crunch by accelerating the digital modernisation of the railway. The outcomes will deliver more trains running on existing tracks – safer, faster and cheaper – helping to increase the impact of vital upgrades like HS2 and Crossrail.

3. **Facilitate commuter travel into major urban areas**, helping to expand the effective labour market, and helping people to access a wider range of jobs. Improve railway links to major ports and airports. The Government wishes to see a new railway link to give western rail access to Heathrow Airport. This will be subject to a satisfactory business case and the agreement of acceptable terms with the Heathrow aviation industry.

4. **Port links will be improved**, notably from Southampton with the initiation of the 'Electric Spine' and from Felixstowe with the provision of capacity to cross increasingly busy routes radiating from London.

6.2.3 Impact on UK Biomass Logistics

The extent to which rail transport and freight specifically will be a constraint to the biomass logistics supply chain is dependent upon a range of factors; primarily the Government's energy policy on biomass (and willingness to subsidise long term revenue contracts with the private sector), willingness of Government to protect capacity and promote rail freight growth on the network, the extent to which biomass will replace coal volumes (in terms of both energy generation and rail movements) and the cost efficiency of using imported fuel sources and rail haulage, as opposed to local fuel supplies and other transport modes.

In a recent DfT Rail Freight Strategy Paper[lx] 'steady growth' is forecasted in total biomass rail freight volumes (for use by power stations) by 2030, to a range from 2.51 – 18.64 million tonnes. (2011 baseline of 0.8 million tonnes).

The Arup study within the DfT rail freight strategy paper, also assessed the potential to reduce carbon emissions through greater modal shift from road to rail. The study concluded that, with the right policy interventions and investment, rail freight could make a significant contribution to reducing UK emissions.

This growth potential and range is a very broad estimate, and predicated on a UK energy policy that assumes biomass will replace some of the coal volume but in smaller overall quantities.

Biomass has different handling requirements from coal (e.g. must be kept dry), which will require investment by ports and generators in new facilities and equipment.

The DfT paper also recognises the challenges faced by the rail freight sector including infrastructure capacity, cost barriers, flexibility of rail freight services, including responsiveness of train path allocation, attitudes and awareness and skills, training and innovation.

With the reduction in coal movements via the rail freight network (see Section 8 lessons learned) increased capacity will become available to other forms of rail freight distribution (including biomass). Rail freight services differ to passenger services, in that they are driven by end user and supply chain demand, requiring the efficient use and allocation of capacity.

Whilst rail freight does compete directly with haulier services to transport consumer goods, the use of rail for biomass is arguably easier due to the product's specific requirements (biomass must be shipped carefully to prevent decay/ release of methane). The "electric spine" between Yorkshire and the West Midlands to ports on the south coast will "increase capacity" and will electrify freight lines.

The extent to which capacity improvements secured through projects like digital signalling, can be held to support rail freight growth over time in order to deliver the return on the investment will need careful consideration, and the rail freight industry will need to innovate to respond to these challenges.

Electric traction is an option that requires different traction at terminals, and any investment in new traction will need to run on independent wires for some distance in and out of the terminals.

It is necessary to note that while these proposed investments may serve to improve rail capacity within the network, they will also require temporary line closures amongst other restrictions in order to deliver them. Freight companies will need to accommodate this disruption to service.

Consistency in rail freight policy between transport and energy is important; which will require both investment and industry engagement to achieve.

6.3 Investments in the UK Ports Infrastructure

6.3.1 Policy overview

The UK ports industry is the second largest in Europe, handling over 500 million tonnes of freight as well as 60 million international and domestic passenger journeys per year.[lxi]

Approximately 95% of the UK's goods trade by weight (imports/ exports) and 75% of its value is handled by ports, which operate on a commercial basis.[lxii]

Many of the largest are owned by the private sector, with privately owned ports accounting for 68% of total UK major port traffic, meaning development of capacity is primarily driven by private investment. (The three forms of port ownership are private, municipal or trust.) All three models are open to market forces, and are run independently as stand-alone, self-financing enterprises, and are free from systematic Government support or subsidy.

Private ports are independent privately owned ports which operate in order to generate a profit via the movement of goods through its infrastructure. They are set up as either publically limited or private limited companies (usually dependent on size). They operate in the same manner as any other private commercial organisation, with shareholders appointing a board in order to oversee commercial operation in order to generate profit. Financing is also conducted in the same manner as for any other commercial enterprise, with the full range of financing options available to private port operators. Infrastructure funds continue to be key players in the UK private port sector, looking to generate stable returns from port infrastructure. Large international port operators increasingly operate in this space in the UK market, with Dubai Ports World (DWP) developing the London Gateway marine terminal alongside operations in Southampton.

Municipal ports, which include Bristol City Docks, Portsmouth, and Sunderland, are statutory bodies which are linked to the local authority. They are governed by that local authority and are therefore subject to the rules and regulations which surround local government. This includes rules around investment financing and operations. Municipal ports are usually the responsibility of a specific local authority committee, which is responsible for ensuring effective port operation and compliance. In some instances they may also be directly controlled by the local authority executive. Due to their operation as part of a wider local authority some Municipal ports are essentially loss-making and have been accused of receiving de facto subsidies from the controlling local authority, which in turn risks distorting the wider port market through unfair competition with private and Trust ports.

Trust ports, including the Port of Tyne and Aberdeen, are independent statutory bodies which are governed by specific local legislation. Each trust port is controlled by an independent board whose responsibility is to ensure both effective port operation as well as port compliance with its legislative charter. Trust ports, like other port types, operate for the benefit of their stakeholders. However, unlike other ports, the stakeholders in a trust port have no control over the independent board which oversees port operation. Unlike private ports, Trust ports have no shareholders. This allows them to reinvest profit into the port itself rather than requiring disbursement to shareholders. They are financed through agreements with lenders using port infrastructure as leverage as well as through the reinvestment of all surplus.

The UK Government's support for an independent industry was firmly established in Modern Ports, a full-scale review of national port policy in 2000 and in the National Policy Statement for Ports, released

in 2012, the policy was re-affirmed as a proven approach to sustaining a successful ports industry. Trust ports and Municipal ports were also specifically examined, with the "Modernising Trust Ports" review published in 2000. This was followed in 2006 by the publishing of the "Opportunities for Ports in Local Authority Ownership: A Review of Municipal Ports in England and Wales" document.

Ports are often at the heart of their communities. Whatever their size, they are major providers of employment within their areas.

Trust and Municipal governance structures for Ports are particularly designed to reflect local markets and the needs of local communities. With two thirds of all freight being carried on the Strategic Road Network, effective road links to ports are vital to allow goods and services to be moved into and around the country efficiently and reliably. The first Roads Investment Strategy (2015/16 to 2019/20) sets out a number of projects for delivery and development to improve port access.

6.3.2 Role of Government

UK Government departments with port and maritime interests work with a range of trade partners including the United Kingdom Major Ports Group (UKMPG) and the British Ports Association (BPA).

Typical issues to be addressed include efficiency of operations, light and stable regulation, innovation and investment, effective co-ordination across government and active engagement on safety, environmental and security agendas.

A Government study to assess how best to manage 'last mile' road access to international gateways is currently underway and will inform development of the second Road Investment Strategy.

6.3.3 Key port investments

The National Infrastructure Delivery Plan (2016-2021), captures the following key private and public port related investment projects and programmes between now and 2021.

- **Port capacity investment** – significant investment activity at ports including;
    - the new Liverpool 2 deep-sea container berths
    - construction of a third berth at London Gateway
    - a major acquisition of land that will allow expansion at the Port of Tilbury
    - ongoing improvements at Teesport, as well as the Dover Western Docks Revival scheme and the development of the Green Port Hull project
- **Surface access improvements** – to ensure that airports and ports are better integrated into the wider transport network. This includes road and rail measures:
    - A5036 to the Port of Liverpool
    - A14 Cambridge to Huntingdon – to improve access to the Port of Felixstowe
    - A160 / A180 Port of Immingham Improvement
    - A63 Castle Street to the Port of Hull
- Up to £250 million for a major new permanent lorry park to increase resilience in Kent, by taking pressure off the roads in the event of Operation Stack

6.3.4 Impact on UK biomass logistics

Any infrastructure investment into port infrastructure and logistics requires strong partnership and levels of collaboration between port owner operator and end user(s). Currently imported biomass is transported via vessel as dry bulk but it could also be bagged at source and shipped in containers which would result in differing requirements at port in terms of storage, handling and logistics to support forward distribution.

The following port capacity investments have recently been made or agreed for future construction which directly impact Drax and Lynemouth biomass logistics.

Table 12 Port Capacity Investments

Port	Investment	Supports
▶ Port of Liverpool	£100 Million (Biomass Import Terminal/ Rail)[lxiii]	DRAX Power Station
▶ Port of Immingham	£75 Million (Biomass Handling Terminal/Rail)[lxiv]	DRAX Power Station
▶ Port of Hull	£16 Million (Biomass Handling Terminal/Rail)[lxv]	DRAX Power Station
▶ Port of Tyne (Future)	£13 Million (Storage & Handling Terminal/Rail)[lxvi]	Lynemouth Power
▶ Port of Teesside (Future)	£35 Million (Increased Capacity)[lxvii]	Teesside Energy Plant

In the case of the £100 million investment into a biomass terminal at the Port of Liverpool, this was to meet Drax demand for up to 3 million tonnes of wood pellets per year via rail to Selby.

With the investment made into storage capacity and rail loading facilities, the port is able to provide up to 40% of Drax's total wood pellet annual consumption, and Drax is able to demonstrate its effective decarbonisation conversion from coal to biomass, and create sustainable, affordable renewable power.

The investments at both Liverpool and Immingham have enabled the end to end process from port to power station to take as little as 12 hours. At the port, each step has been automated, designed in close collaboration between Drax and the port owners. The new development at Liverpool port is now open and operational, employing 50 people directly in addition to a construction workforce of over 500.

As a fourth port to serve the Drax operations, Liverpool also provides additional security of supply.

The supporting business model and funding for these port investments varies. For instance ABP Finance Plc financed investment in the Humber ports[lxviii]. The port of Teesside for example secured funding through the Regional Growth Fund whereas the port of Tyne invested in port development alongside Lynemouth Power Limited (LPL). This is a good example of where a commitment from plants, reliant on port infrastructure to support biomass imports, to a minimum throughput per annum supports the ports business case for investment.

Please see appendix D – G for an overview of the current UK supply chain from base feedstock/imports through to demand point, including associated costs, infrastructure and tonnages by end user group. Additionally Section 4 above provides a geographical view of the physical infrastructure (processors/ end users/ports) across the UK biomass landscape.

6.4 Investments in the other UK Logistics Infrastructure

6.4.1 Water Freight

In total, 95 per cent of UK imports and exports are transported by water and each year UK ports handle over 500 million tonnes of freight. The majority, around 80 per cent, is international traffic, but 15 per cent is domestic cargo travelling around the coast. The remainder (5%) is connected with offshore installations and sea dredging, and freight moved on inland waterways.[lxix]

There are a wide variety of companies using water freight within their supply chains. Materials shipped include food and drink, textiles, timber, grain and household waste. The Thames region provides 60% of goods in the UK inland waterways network.

DfT statistics from July 2016[lxx] include the following;

- Inland waters traffic (traffic carried by barge or sea going vessels on the inland waterways network (rivers and canals)) increased by 8 per cent to 1.5 billion tonne-kilometres, primarily due to a 30 per cent increase in goods moved by the River Thames attributable to increases in the movement of oil products and of dry bulk (39 and 26 per cent respectively)
- Coastwise traffic (traffic carried around the coast from one UK port to another), fell by 2 per cent to 19.4 billion tonne kilometres
- One-port traffic (traffic to and from offshore locations, such as oil rigs and sea dredging), fell by 21 per cent to 6.4 billion tonne-kilometres

Investments in waterways are primarily in inner city and restoration projects, with no comment on water freight improvements.

6.5 Logistics Network Investments Summary

The development of the UK logistics network, both for the biomass industry as well as UK plc more generally, is primarily driven by UK Government policy and investment. Investments in the road network, other than roads contained within port sites, remains within the hands of central and local governments and is driven by the wider changes in UK freight and haulage rather than by one specific industry or sector. Increases in trunk road capacity, which are primarily funded by central government, will enable the biomass industry to increase the tonnages distributed by road. This will be key if the biomass sector grows in the domestic and non-domestic heat markets, as end users in these sectors will always have at least the last mile delivery take place via the road network.

As with the road network, increases in rail network capacity or additional infrastructure investment in new lines is again primarily driven by government. Investment in the rail network is not being targeted specifically at biomass, and biomass users (even larger scale power generation sites) have only a limited amount of influence in the development of rail infrastructure – increases in passenger rail transport is expected to remain at the top of the priority list for network investment. The digitisation of the rail network, including digital signalling and full electrification, will help to both increase capacity overall (part of which could be used to increase biomass rail distribution) as well as to increase safety and efficiency, contributing to the wider security of supply of biomass products to end users.

Investment in port infrastructure is less government dominated and is where large biomass developers are able to have a greater impact on future infrastructure investments. Whilst there are a variety of port types, all serve to provide optimal port services to their customers and therefore can react directly to increased demand for biomass throughput. In the past decade a number of ports have reacted to the development of the biomass sector through re-developing existing port infrastructure (berths, railheads and storage) that was previously used to support other UK bulk industries (e.g. coal) which are increasingly in decline. The scale of the private port network, including major port operators like ABP and Peel, is such that where opportunities for ports to increase throughput and profit from increased biomass throughput exist they will attempt to seize that volume. Investments in port infrastructure are directed by the port owners / port operators and are not currently directed by wider government policy, other than where incentives are put in place to encourage ports to invest in specific supply chains.

7 Project Financing

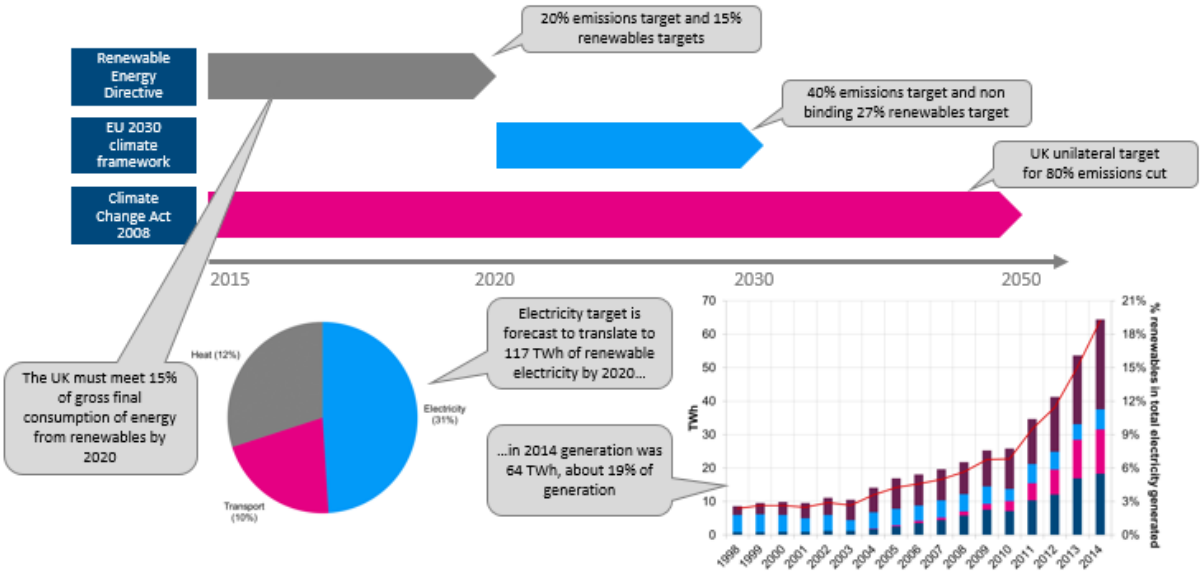
7.1 Current UK Biomass Project Financing Structures

7.1.1 Policy context

The growth in renewable generation in the UK has been a direct response to financial support mechanisms established to achieve the following policy objectives;

- The UK must meet 15% of gross final consumption of energy from renewables by 2020 (a binding target under the European Commission's Renewable Energy Directive) which equates to 117 TWh of renewable energy generation by 2020 (covering electricity, transport and heat demand)
- EU-wide 40% emissions reduction target and non-binding 27% renewable target by 2030, relative to 1990 levels, noting the uncertain status given Brexit
- UK unilateral target for 80% emissions cut by 2050 relative to 1990 levels

Figure 10 Renewable Energy Policy Landscape



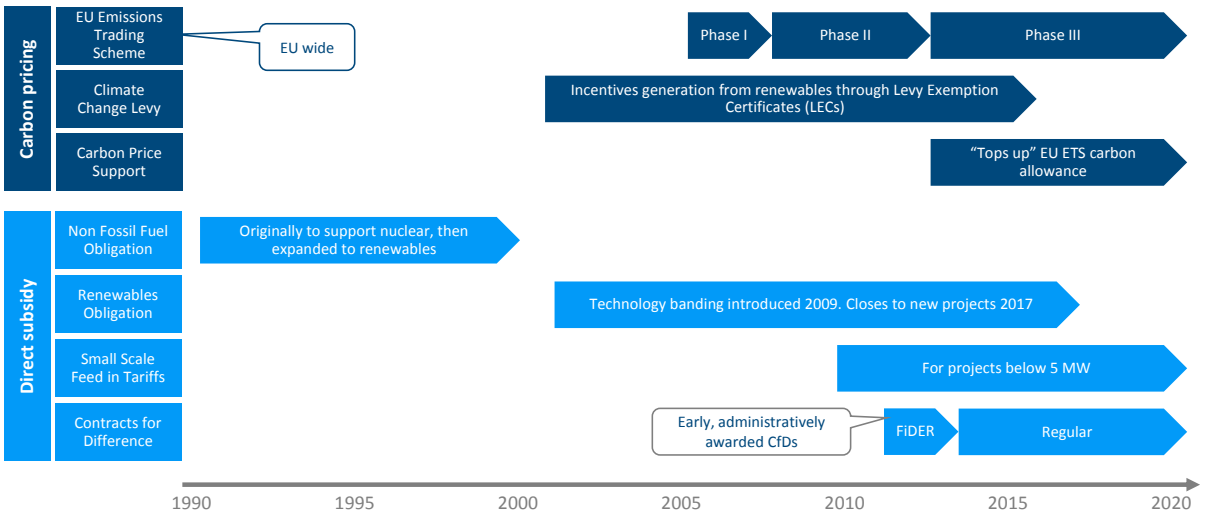
UK government policy[lxxi] suggests bioenergy has the potential to provide approximately 30% of the 2020 target. As 2020 approaches the role of bioenergy is expected to remain critical to achieving that target due to the prominence that it plays within the current renewable energy mix. The exact mix of technologies within the bioenergy sector is expected to continue to evolve to support the overall 2020 target, reflecting the development of new and improved bioenergy technology and increased end consumer demand for lower emission energy production.

7.1.2 Incentive mechanisms

Numerous mechanisms have been established in the UK to incentivise renewable generation and achieve policy objectives through;

- Supporting the power price for zero carbon generators and/or
- The direct subsidy of renewable generation

Table 13 Renewable Energy Generation- Incentive Mechanisms



Incentive mechanisms are funded through levies on electricity bills rather than general taxation, and are subject to a cap. The Levy Control Framework (LCF) covers the cost of support under the RO, small scale FiT (Feed in Tariff) and the CFD mechanism.

Specific Government support for bioenergy has covered electricity and heat generation and the supply of biomass fuel.

7.1.3 Biomass electricity generation

Since 2002, BEIS (formerly DECC) has supported large-scale generation of biomass electricity (>5MW) through the RO.

The RO provides incentives for investors into large-scale renewable electricity by making UK suppliers source a proportion of their electricity from eligible renewable sources.

Through the use of Renewable Obligations Certificates (ROCs), operators of accredited renewable generating stations can trade ROCs with other parties. ROCs are ultimately used by suppliers to demonstrate that they have met their obligation. The ROC value acts as an additional revenue stream to the wholesale power prices.

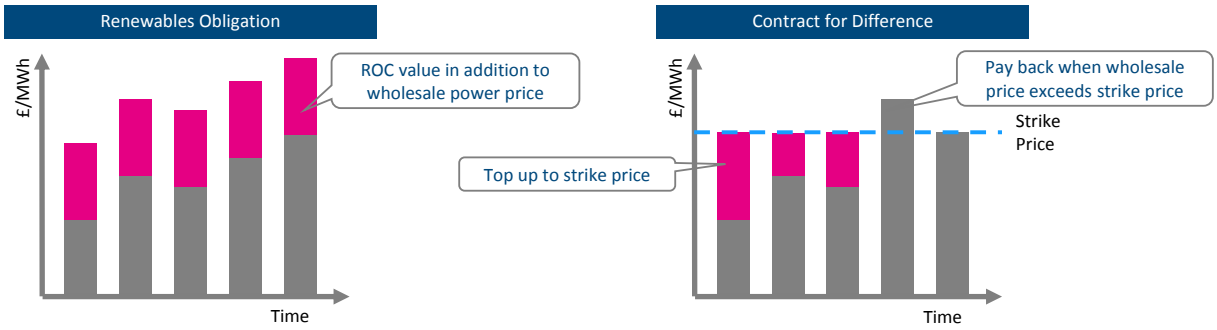
RO has been responsible for the bulk of renewable deployment in the UK, but it is being replaced by the CFD mechanism.

The RO will close to all new generating capacity on 31 March 2017.

The Contract for Difference (CFD) is a contract between a low carbon electricity generator and the Low Carbon Contracts Company (LCCC), a government-owned company. A generator party to a CFD is paid the difference between the 'strike price' – a price for electricity reflecting the cost of investing in a particular low carbon technology – and the 'reference price'– representative of the price that the generation might reasonably secure in the wholesale market (for biomass plant, based on season ahead baseload contract prices). It gives greater certainty and stability of revenues to electricity generators and investors by reducing their exposure to volatile wholesale prices, whilst protecting consumers from paying for higher support costs when electricity prices are high.

For example, two major generation projects, Lynemouth (Biomass conversion) and MGT Teesside Limited (dedicated biomass with CHP), have secured CFD agreements at a strike price of 111.14 £/MWh and 132.24 £/MWh respectively.

Figure 11 Renewables Obligations and Contract for Difference Mechanisms



Smaller scale generation is mainly supported through the FIT scheme (Feed In Tariff), which pays energy users who invest in small-scale, low-carbon electricity generation systems for the electricity they generate and use, and for unused electricity they export back to the grid.

Biomass heat generation

DECC supports large- and small-scale generation of biomass heat through the Renewable Heat Incentive (RHI), which incentivises consumers to install renewable heating in place of fossil fuels. It is open to homeowners and landlords, commercial, industrial, public, not-for-profit and community generators of renewable heat.

Supply of biomass fuel

In England the Energy Crops Scheme was established to provide grants for establishing short rotation coppice (a woody solid biomass) and miscanthus (perennial grasses that can be turned into biofuel) in appropriate locations. Natural England administers the scheme on behalf of Defra but the scheme is closed to new applicants.

In 2008, the Renewable Transport Fuel Obligation (RTFO) was established, which makes companies that supply more than 450,000 litres of fuel per year source a percentage from renewable sources.

7.2 Future Potential Financing Routes for new UK Biomass Projects

UK Energy policy is currently undergoing a 'reset' after a tough early stance was taken by the new Conservative government in May 2015.

2015 witnessed a postponement of the proposed CFD auction, the removal of Levy Exemption Certificates (LECs) for accredited renewable energy generators, early closure of Renewable Obligation (RO) to wind and solar, a cut to the FiT rates for solar generators, Carbon Capture and Storage (CCS) demonstration fund axed, closure of Green Deal (energy saving home improvements) and the sale of the Green Investment Bank (GIB).

The policy commitment to decarbonisation remains, with a focus on where the UK can "make a difference" including;

- a commitment to offshore wind, but with a greater focus on achieving cost reduction
- commitment made to Hinkley Point C and the broader nuclear new build programme (including funding for small modular reactor research)
- indication of increased share of decarbonisation effort in heat and transport

In this context, the CFD mechanism will remain the primary future financing route for biomass electricity generation with CHP. Heat will continue to be supported by the RHI until at least 2021.

The CFD mechanism provides the following benefits;

- Protection from long term price risk
- Protection from short term price risk (cannibalisation – mainly relevant to intermittent generation such as wind and solar)
- Contracts allocated, and strike prices set on a competitive basis within and to some extent between technologies
- Central allocation of budget to different technology 'pots'

The current Government policy on CFD contract allocation is for combined biomass and CHP projects, and the continuing availability of CFD's will be necessary to demonstrate policy commitment to the biomass sector.

Table 14 UK Biomass Projects & Associated Strike Pricing[lxxii]

As at March 2017

Project	Current (as of 2017) Strike Price (£/MWh)	Allocation Strike Price (£/MWh) – 2012 prices	Duration (years)
• MGT Teesside Limited	• 134.87	• 125.00	• 15
• Drax Power Limited	• 108.02	• 100	• Until 2027
• Lynemouth Power Limited	• 113.39	• 105	• Until 2027

A summary of the main investors into current biomass projects are outlined in the table below.

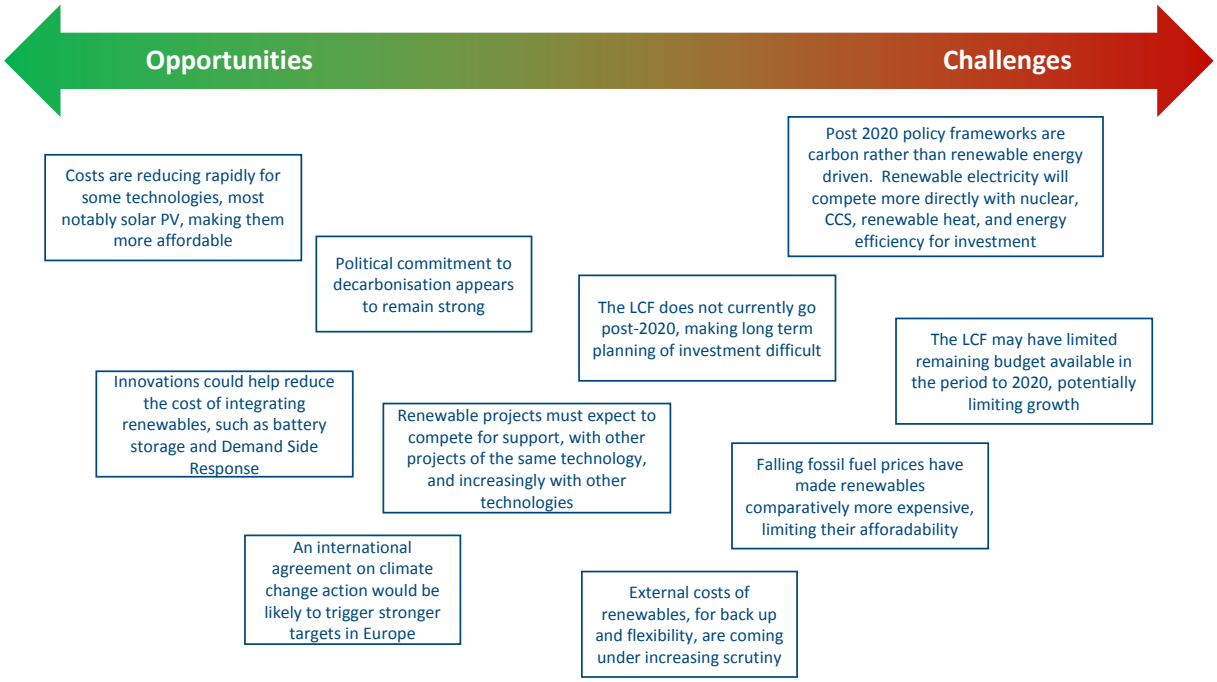
Table 15 UK Biomass Project Investors

Key Client	Project / Programme Name	Investor
• Copenhagen Infrastructure Partners	• Brite Biomass	Copenhagen Investment Partners (n behalf of the Copenhagen Infrastructure II fund (CII)[lxxiii].
• Estover - Aesica.	• Cramlington CHP. Aesica Pharmaceuticals	Copenhagen Infrastructure II fund and Burmeister & Wain Scandinavian Contractor A/S (BWSC)[lxxiv].
• Drax	• Drax Biomass Conversion	Drax
• Peel Energy	• Ince Biomass Plant	CoGen - Ince Bio Power is the first of a pipeline of CoGen projects to be fully financed in an all-equity transaction by Bioenergy Infrastructure Group (BIG), the recently announced waste infrastructure investment platform comprising stakeholders Infracapital, Aurium Capital Markets, Foresight Group and Helios[lxxv].
• Lynemouth	• Lynemouth Biomass Conversion	EP UK Investments Ltd., a subsidiary of Czech utility Energetický a prumyslový holding (EPH)[lxxvi].
• Glennmont Partners	• Port Clarence Biomass CHP	Glennmont Partners
• Copenhagen Infrastructure Partners	• Snetterton Biomass Plant	BWSC PCL – collaboration between Burmeister & Wain Scandinavian Contractor A/S (BWSC) and PensionDanmark (which is financed through Copenhagen Infrastructure I, managed by Copenhagen Infrastructure Partners)[lxxvii].
• Estover Energy	• Speyside Biomass CHP	Estover decided on a debt/equity ratio of approximately 65%/35% and selected infrastructure investor John Laing and the GIB as equity partners. John Laing and the UK Green Investment Bank invest £26m, alongside £48m debt to be raised from the bond market, guaranteed by HM Treasury[lxxviii].
• MGT Teesside Ltd	• Tees Renewable Energy Plant	Macquarie will own 50 per cent of the equity in the Project, with Macquarie Capital introducing Danish pension fund PKA as an equity co-investor and partner who will own the remaining 50 per cent stake[lxxix].
• Tilbury Green Power Ltd (100% subsidiary of Express Energy Holdings (UK) BV - part owned by Cargil)	• Tilbury Green Power	ESB, Green Investment Bank, BWSC and AET Senior debt funding is being provided by the Danish Export Credit Agency (Eksport Kredit Fonden), Investec and Rabobank[lxxx].
• Burmeister & Wain Scandinavian Contractor A/S (BWSC)	• Widnes 3MG Biomass Combined Heat and Power (CHP) Plant	GIB announced that it is providing £16.9m of mezzanine loans and also making a £13.2m equity investment via its Foresight-managed fund, UK Waste Resources & Energy Investments (UKWREI), in which it is the cornerstone investor. The remainder of the £42.1m mezzanine finance is being provided by GCP Infrastructure Investors (GCP). In addition, Investec Bank plc (Investec Bank) and Eksport Kredit Fonden (EKF) have together committed £42.5m of senior loans to the project, while Stobart and BWSC will both take an equity stake with commitments of £9.8m and £2.6m respectively.[lxxxi]

7.3 Investor Pre-Requisites for Future Biomass Project Investment

Looking forward, the UK renewables and biomass sector will be influenced by the key policy and issues and challenges below.

Figure 12 Key Policy Issues and Challenges for UK Renewables



Based upon interviews with current investors in the UK biomass sector, the future interest and appetite for investment in the biomass sector can be summarised into two fundamental factors, namely revenue and fuel supply.

7.3.1 Revenue

- Investors need **long term certainty of revenues**, and the extent to which Government policy is able/willing to centrally allocate CFD contracts to the biomass sector will be critical
- **Simplicity** in supply chain/logistics operations which minimises handling, distribution and storage costs of biomass products
- **Low technology risk** – both gasification and dedicated biomass with CHP have experienced challenges during construction and commissioning.
- **Need for co-location** - with a policy to support combined biomass and CHP projects, developers will need to locate projects adjacent to customers (e.g.; for industrial heating offtake contracts)
- **Long term customer contracts** – investors will require visibility of long term heat offtake agreements (where applicable) and mitigations in place should the customer requirements change over the duration of the contracts – this may require flexibility in the CHP requirements under the CFD contracts

7.3.2 Fuel Supply

- Investors require bankable, secure fuel supply with credit worthy counterparts
- To attract project finance, this will need long term contracts in place which aren't exposed to counterparty risk/ indexation (e.g.; US CPI, stumpage charges etc.), exchange rate fluctuations and restrictive trade agreements
- Biomass product suppliers will need additional credit guarantees

In addition to these two fundamental factors, other factors investors will consider will include Engineering, Procurement and Construction (EPC) and Operations and Maintenance (O&M) contract(s), route to market/ energy off-take agreements, grid connection, licensing and insurance.

7.3.3 Impact on UK biomass logistics

The growth in renewable generation has been a result of direct government support mechanisms that have secured long term revenues for project developers and benefitted the supply chain participants.

In an uncertain UK energy policy context, growth in biomass projects and the logistics supply chain will only occur if biomass sector continues to receive an allocation of CFDs and/or market prices support project economics without need for subsidy.

For growth to occur, it requires the two fundamental factors of revenue and fuel supply certainty to be addressed, together with meeting the opportunities and challenges associated with the future UK energy policy.

8 Lessons Learned

8.1 Introduction

This report sets out the understanding of the current status of biomass logistics infrastructure in the UK, how it has developed and what lessons it could learn in the future from the development of other relevant sectors.

In this chapter, we consider what the UK biomass logistics sector can learn from other comparable industry sectors with established supply chain and logistics networks, namely Oil & Gas, Agriculture and Coal.

Through a series of structured interviews with members of the Expert Advisory Group (EAG), the following themes have been explored;

Industry Supply Chain Overview and Network Planning

- The extent to which any central analysis or planning is carried out in the industry, by market participants to enable optimisation in the development of the supply chain infrastructure?
- How does the supply chain run for your industry? What is the preferred mode of transport, what are the typical volumes moved, what type of suppliers do you use?
- How much is your industry reliant on 'owner operated' supply chain infrastructure compared to the usage of third party and fourth party logistics providers (3PL and 4PL)?
- To what extent is your supply chain network infrastructure shared with other industries? What is unique to your industry and what should be shared which currently isn't (or historically hasn't been)?

Historical and Current Industry Supply Chain Network Issues

- What issues have been encountered within your industry supply chain? How were these resolved?
- Are there issues which exist which have never been satisfactorily resolved?
- What are the blockers which have historically prevented issues within the supply chain network from being resolved? (E.g. fragmentation of logistics providers, no sharing of information between market participants etc.)
- What investments should have been made historically to avoid issues encountered within the industry supply chain? (E.g. central warehousing and logistics depots, improved port facilities etc.)
- To what extent, in your opinion, has the industry moved from an import based business to an increasingly domestic production base or vice versa?
- What is the current and historical usage of different modes of transport within your industry sector? Do you think this split is optimal?
- What have market participants in your industry done to work together to optimise their shared infrastructure (e.g. government lobbying, aggregate investment etc.)?

Industry Network Investments

- What investments are being made within your industry today to improve the overall network infrastructure?

8.2 Oil & Gas Sector

8.2.1 Industry Supply Chain Overview and Network Planning

The oil and gas industry supply chain is global by nature; it includes UK and international transport, procurement, inventory control, materials and storage, import/export facilities and enabling technologies.

The typical value chain can be illustrated as;

Exploration → Production → Refining → Marketing → Consumer

Given the remote nature of many sites and the need for 24/7/365 day operations of facilities, the financial implications caused by logistics complications can be very significant.

Historically, the major industry players sought to manage the supply chain through vertical integration, but with downward pressure on prices, the industry now works with multiple 4PL's (fourth party logistics providers) and 3PL's (third party logistics providers).

The procurement/buying function(s) are typically set up by commodity and category type.

By working alongside 3PL and 4PL providers, oil and gas companies have been able to streamline logistics processes, reduce costs, and add value. For example, in upstream operations, many 4PL's are now brought in to manage, oversee, and improve certain aspects of upstream operations.

These organisations are better experienced and set up to develop local supplier networks, systematically monitor resources, and plan/sequence the capacity needs, optimising the utilisation of the supply chain.

Similarly, in the area of safety and compliance, the use of 4PL's to deliver global standards down through supply chain partners has been an effective method to deliver an approach which can be monitored, managed and improved.

8.2.2 Historical and current Industry Supply Chain Network issues

The key issues emerging from industry interviews were;

- **Safety and compliance** – no oil and gas company would wish to cut supply chain and logistics costs if it were to impact compliance, which means the focus is safety and compliance as a first priority.
- **Transparency** – the ability to get the right people and materials to the right location is fundamental to the sector, and have this information available to all parties in the supply chain.
- **Collaboration –** by the geography and remoteness of many of the locations where Oil and Gas companies operate, there has always been a need for a degree of collaboration within the industry for mutual benefit. Typically, this might include shared supply vessels, joint storage facilities, shared infrastructure investment (road/rail/port) and helicopter transport of staff.
- **Reliability –** oil and gas clients need to have confidence they have employed expertise and experience in logistics that will always deliver, wherever that may be in the globe.

- **Consistency in specification –** with ageing assets, often beyond end of life, there is always an aspiration to standardise component parts through global supplier contracts. The focus tends to be on the bigger pieces of kit and which should cover future spare parts needs within the Operations and Maintenance contracts.
- **KPIs/ performance measures** can be improved, and there is an increasing role that data will play in the industry, such that data sharing between all parties in the supply chain will become a basic requirement and should be measured, monitored and continuously improved[lxxxii].

8.3 Agricultural Commodity / Food Sector

8.3.1 Industry Supply Chain Overview and Network Planning

Our interview focused on a leading player in the arable supply chain.

Agricultural production is always uncertain to an extent, as of result of its exposure to weather; the unpredictability of disease and pests; and, the seasonality of harvest and market cycles.

Agriculture is also dependent on supply chains to cope with the geographical separation of inputs, farming and consumption. The typical agricultural supply chain includes;

Input supply (seeds, fertilizer, energy) → production → post-harvest, →storage → processing → marketing →distribution.

These supply chain elements increasingly span national borders and involve inputs from a wide range of public and private sector participants.

The UK market comprises 21-22 million tonnes of domestic product, comprising wheat, barley, oil seed rape and peas/beans. The market's appetite is based on commodity prices, with wheat being the primary commodity ranging between 15 - 17 million tonnes grown per annum.

Logistics are a critical part of these flows, and weaknesses in them are often a major source of risk in agricultural supply chains that affect the availability, timing, traceability and quality of goods.

UK transportation occurs 100% via road haulage with average journeys from farm to first processor of 80-90 miles.

Barley and wheat production is primarily to the east of the UK, down from North East Scotland, through the Pennines and Yorkshire to Peterborough and the South East and the west of the UK is primarily characterised by grass grown for livestock. Imports typically come from Canada, Germany and France.

Whilst some organisations operate in house haulage fleets, there are multiple 3rd party haulage providers who operate across the farm network ownerships. The current efficiency of the logistics and supply chain is summarised by the quote "***100 days delivered, organised for 130 days***" implying a 30% inefficiency between planned and actual performance.

The root causes of this are multiple, including;

- Cancellations on the day
- Loading equipment break downs
- Weather delays
- End receiver processing time
- End receiver quality issues e.g.; acceptable moisture content
- 5% rejections across the industry
- Seasonality issues and grain ripeness
- Grain going off
- Variance in quality across a load – e.g.; 0.1% threshold for buyers

Supply chain management means addressing the reliability of the delivery process, especially with respect to delays and uncertainty in time, quality and availability of service and risks of interruption.

This delay often occurs at the mills, where storage facilities may not be available (due to physical site constraints), and trucks are left waiting outside.

All of these risks can undermine the fundamental objectives of any supply chain: to provide a grain product at the correct quantity and quality, to the right place, at the right time.

8.3.2 Historical and current Industry Supply Chain Network issues

The key issues emerging from the industry interview were;

- **Process inefficiency at mill locations -** as the primary processor, there has been little appetite over the last 25 years to improve the delivery process (~75% of mills). Where there are bigger, newer plants, there exist storage facilities with different intake arrangements, which deliver 6 minute turnaround times for haulage vehicles.
- **Product quality and customer rejections –** with a 5% load rejection across the industry, the control of quality of final delivered product is critical to supply chain efficiency and effectiveness.
- **Driver education and training** – approximately 10-15% of drivers would benefit from improved understanding of their role and responsibilities in the network – this is a function of the UK haulier industry's appetite to deliver change.
- **Vehicle utilisation** – whilst the interviewer's offices have dedicated route optimisers, there still remains opportunity for improved collaboration in despatch and demand planning across national operations.
- **Co-operation and collaboration** – farmer's co-operatives have invested in central stores for storage with 500,000 tonnes of capacity. This enables increased throughput of larger vehicles (up to 44 tonnes), improved turnaround times and the ability to blend the product to achieve the right specification[lxxxiii].

8.4 Coal Sector

8.4.1 Industry Supply Chain Overview and Network Planning

Coal has played a significant role for over a century in meeting the UK's need for electricity, however, with the increased investment into renewable and new gas station generation, there has been a significant decline in its importance.

Last year coal accounted for just under a quarter of electricity generation and the eight stations that remain operational today represent around 15% of Great Britain's total generating capacity. (Power generation and steel makers represent 90% of the UK customer base for coal.)

In terms of total coal movements, from a relatively stable total movement figure of ~ 70 million tonnes per annum between 1996 – 2006, the volumes have been in decline.

In 2012, there was a spike of 64 million tonnes moved, however in 2015, this figure was down to 37 million tonnes, and in 2016 the forecast figure is ~ 20 million tonnes.

The UK supply chain has shifted from being wholly domestic supply to predominantly import based. Coal movements today occur from port to power station, via rail freight, with Immingham being the main import point today.

The fundamental difference to the biomass sector, is that the coal infrastructure has been built up over centuries, as a foundation of UK rail transport today. (Evidenced by the historic availability of sidings and dedicated branch lines to UK colliery locations.)

Since privatisation of rail assets and infrastructure, there have been significant changes to the rail supply chain and logistics network, in terms of locomotive and wagon fleets, supply patterns, train paths and reduced number of supply – destination points.

Central analysis by supply chain operators has historically placed reliance upon Government forecasts of future demand, and the large generators in house modelling capability.

Major customers typically contract direct with the supply chain, with very little 'in house' or 3PL/4PL arrangements evident.

The contractual arrangements with major customers have relied upon the buoyancy of the market, which, in a declining market, have left many freight operators exposed to uncertainty in demand and stranded assets.

8.4.2 Historical and current Industry Supply Chain Network issues

The key issues emerging from the industry interview were;

- **Unpredictability of flows** – the customer's need for flexibility of supply for reasons such as seasonality, is a fundamental challenge for the coal supply chain, often with no 'take or pay' arrangements available. (For coal, this is less of an issue than it will be for biomass, where stockpiling has historically occurred at customer locations and in dedicated sidings).
- **Unequal market power** – the major customers have been able to benefit from the fragmentation of the freight provider market to secure the supply arrangements they need, e.g.; flexibility, often to the detriment of the supplier.

- **Changes with market development** – as a market develops, it is relatively straightforward to serve a single point – single user model. However, as the market matures, the customer wishes to diversify their supply, and the supplier wants to maximise their asset utilisation, which adds complexity to arrangements. This issue will be very relevant to the biomass sector, if not already emerging.
- **Government regulation and intervention** – Network Rail and the ORR, as owner and regulator of the infrastructure asset(s) upon which freight operations take place have a captive position.
- **Dominant incumbent positions** - freight companies sitting on train paths, makes new market entry difficult, and requires government regulatory intervention to limit this dominance/ inefficiency in the system.
- **Lack of diversification –** freight supply organisations have invested significantly in new locomotives and wagons, however there is limited transferability for use with other commodity types, and a level of complacency in recognising the speed of decline in demand volumes signals very challenging times ahead.
- **Domestic supplier need for certainty –** domestic providers need a level of stability in supply, where international suppliers can provide a degree of flexibility.
- **Collaboration minimal** – the coal rail freight supply market is very competitive space and there has been effectively no collaboration since the days of privatisation.
- **Joined up Government thinking** – the Government's own prediction on the expected market demand for UK coal movements has not been without challenge[lxxxiv].

8.5 Summary lessons for biomass logistics in UK

As the biomass logistics and supply chain market develops over the period to 2055, the identified industry issues are summarised below and their impact upon our future scenario modelling assessed;

Table 16 Industry Issues Summary

Issue identified	Highlighted in EAG interviews?			Applicability to UK Biomass Market Development
	Oil & Gas	Agriculture	Coal	
1. Safety and compliance as first priority	Yes	No	No	- Key to ensuring long term adoption of biomass across each sector – safety failures would have a substantial negative impact on future industry growth. - Biomass power generation & non-domestic usage is subject to the same HSE standards & expectations as other industrial and power generation sites.
2. Transparency of information and product tracking	Yes	No	No	- Required to optimise the biomass supply chain network through reductions in wasted time, tracking of a wider series of biomass product types and qualities, and for industry collaboration between participants across the supply chain. - Information transparency vital where biomass is supported through current or future government incentives as the data is often required to trigger incentive payouts.
3. Co-operations and collaboration between product vendors/ asset owners/ supply chain partners to deliver efficiency	Yes	Yes	No	- Biomass sector growth will be enhanced through improved cooperation to drive efficiencies of scale, infrastructure investments, and to broaden the supplier base within parts of the wider supply chain. - Improved collaboration would provide end customer groups with reduced supply chain costs and improved delivery timescales and product options.
4. Reliability of supply chain delivery schedules	Yes	Yes	No	- Supply reliability is particularly important where future end user sites have limited on-site or near-site biomass storage options. - Enables reduced costs for biomass storage and holding safety stock for larger-scale users - Ensures heating supply reliability for domestic consumers during winter months – critical for consumer confidence in biomass.
5. Consistency in specifications/ product quality (incl. seasonality & weather impacts)	Yes	Yes	No	- Required to provide consumer confidence in the biomass product as part of boosting biomass uptake. Consistent quality is a requirement across sectors and customer groups, particularly as the number of suppliers proliferates. - Quality standardisation is key for power gen users who require consistent MW output.

Issue identified	Highlighted in EAG interviews?			Applicability to UK Biomass Market Development
	Oil & Gas	Agriculture	Coal	
6. KPIs/performance management with 3PL/4PL providers	Yes	N/A	N/A	- Delivery of improved supply chain quality through performance measurement and continuous improvement review. - Drives increased competition in 3PL/4PL provision for larger scale users through standardised quality measurement.
7. Inefficiency/ waste within value chain (e.g.; waiting times, wagon storage)	No	Yes	Yes	- Required to reduce biomass supply chain costs as well as improve productivity of existing assets - Able to leverage learnings from a wide range of sectors to ensure efficiency - Use of 3PL/4PL provides immediate cross-industry learnings (i.e. much smaller time to reduce biomass-specific inefficiencies).
8. Need for demand certainty	No	Yes	Yes	- Required particularly to enable investment in new plant & infrastructure as well as enabling supply chain efficiencies to be developed through consistent fuel demand and supply. - A comparatively short lead times for biomass processing and logistics setup (compared to other industries) allows for some shorter-scale demand certainty.
9. Driver education and behaviours	No	Yes	No	- Enables biomass hauliers to match driver behaviours required in more mature industries - Linked to wider HSE compliance as well as limiting local opposition for road transported biomass
10. Fleet utilisation	No	Yes	Yes	- Optimisation of biomass-specific fleets driven through right-sizing of dedicated fleets serving larger scale biomass demand sites as well as usage of 3rd party providers who can optimise their fleet across multiple delivery drops and customer sites.
11. Government co-ordination, regulation and interventions to limit market dominance/ incumbent positions	No	No	Yes	- Would increase the cohesiveness of the wider biomass market, speaking as 'one voice' to help direct government policy - Potential to reduce the barriers to entry through government intervention to help limit market concentration within the supply chain (e.g. through government support for new entrants)
12. Market development and supply chain diversification	No	No	Yes	- Additional usages of biomass would increase overall market size, driving improved economies of scale. - Management of biomass supply chain assets to diversify into other industries where biomass demand is less than forecast limits non-utilisation and improves costs.

9 Conclusion

In supporting supply from renewable energy sources to help decarbonise UK Energy and meet regulatory targets, the Government has introduced incentive schemes to help develop sectors such as Biomass. The industry has largely developed in response to these subsides and incentive schemes, attracting entrants to the market from consumers and processors to those who have invested in infrastructure and logistics networks. End user groups can be split into four main categories; power generation, combined heat and power (CHP), non-domestic and domestic heat. These industry segments vary not only in scale of demand, fuel type and the industries they serve but also in ownership structure. For example the CHP industry[29] tends to be privately owned whereas the non-domestic heat[30] sector is largely publically owned and operated.

Demand for wood pellets in the UK is largely driven by the power generation market and satisfied by imports through a number of key ports. Imports are favoured due to the price differential and scale of product available so many large power generators have entered into commercial arrangements with UK ports and importers to ensure medium term supply. Domestically produced pellets serve the domestic heat market in much smaller parcels, meaning they are currently unable to match the scale and price required to compete with imports and as a result the role of pellet processors in the UK today is limited. This model may need to change in future to help meet decarbonisation targets or if supply becomes limited, which is probable if other nations also turn to bioenergy to help meet decarbonisation targets.

Wood chips are produced domestically to satisfy demand in the power generation, combined heat & power (CHP) and non-domestic heat sectors. This is quite a saturated market of participants, but the scale and capacity of suppliers differs greatly allowing it to remain competitive. A few major players dominate this market, such as the Forestry Commission who have successfully diversified across sourcing, processing and supply. Given their scale and ownership of the base feedstock, this is unlikely to change but the sector would benefit from greater collaboration between the large scale suppliers and end users groups, to help maximise domestic supply and reduce dependency on imports.

There are a number of tactical and strategic partnerships which have emerged in response to support the large players such as the Forestry Commission and Drax, with many making significant investments to take market share ahead of their competitors and enjoying first mover advantages as a result. The alliance of Stobart and AW Jenkinson and the collaboration of key ports and rail freight operators to support DRAX are examples of this. These partnerships have helped take the industry forward, but if the market continues to grow large players should also consider developing smaller suppliers to help ensure competition and continuity of supply, if it is to become a balanced and sustainable market.

At the other end of the scale, some areas of the supply chain remain fragmented (e.g. small-scale imports to BSL suppliers and logistics in some areas of road haulage, access to rail wagons, network and freight operators. This is typically in smaller scale areas of the sector where supplier involvement is more tactical. At this end of the scale, increased consolidation can result in greater efficiencies, more consistent product quality and reduced transaction costs which would also help benefit the industry.

[29] CHP plants serve the glass, paper and pulp, food and chemical (on a niche basis) sectors.
[30] Non-domestic heat demand comes from commercial properties such as hospitals

Biomass Supply Chain Infrastructure & Lessons Learned

A number of Biomass specific infrastructure investments have been made by the private sector, including the Stobart Jenkinson investments highlighted above, and the investments at the ports of Tyne and Tees, Liverpool and Immingham which will support the network for circa 10 - 15 years.

There are also a number of planned non Biomass specific logistics investments which have the potential to benefit the sector, reducing congestion and increasing both capacity for both road and rail haulage creating better connectivity with the port network.

On roads, the most notable of these to have a material impact to future biomass logistics are as follows:

- Committed road upgrades to 4[31] ports linked to Biomass or with Biomass potential
- The strategic study work being done to improve east-west connectivity in the North of England, the current focal point for biomass imports, specifically the Manchester North West Quadrant, Trans- Pennine Tunnel, Northern Trans- Pennine, review of the A1
- The Smart Motorway programme(s)

Road capacity around port locations is particularly key where rail freight capacity utilisation on the rail spur is already high or where most movements from port locations are via road shipments. The value of investment in port roads however is dependent on those upgrades being linked with the wider motorway and trunk road network. Without these there is a risk that bulk biomass distribution will benefit from higher capacity port roads but will then hit congestion at subsequent road choke points before reaching the long distance road network. In addition, if the government attempts to recoup on motorway and trunk road investment via a toll, as they did for the M6 and the Severn crossings, this may limit the impact of these investments on the industry if it reduces the business case for use of roads.

While there are various rail initiatives in scope for Control Period 5 (CP5) from 2014-2015, the impact on Biomass rail freight is likely to be negligible in the near term as the majority of rail initiatives have been designed to increase capacity for passenger trains over freight movement. The most significant change that is needed to support growth in the transport of biomass via rail is increased government support to protect capacity and promote rail freight growth on the network.

As the UKs reliance on biomass imports continues to grow the government have a key role to play in furthering the robustness of this supply chain. This could be done by supporting investment in new wagons, infrastructure improvements and indicating support in the reallocation of line capacity from coal to biomass[32]. The decline in coal presents an opportunity for the biomass industry to capitalize on the increased available capacity both at ports and on the rail network. As ports and integrated rail heads are such an integral part of the UK's evolving biomass logistics network any future port strategy needs to go hand in hand with rail upgrades.

When considering the future development of biomass logistics in the UK there are already industry lessons that can be taken on board. For example the power generation market should look to build on Drax's supply chain to explore opportunities for upgrades at existing ports which are well located and

[31] Hull, Immingham, Felixstowe and Liverpool

[32] See footnote 16 for context. BEIS have also forecast that a further decline in coal plant usage in the UK will continue, with all remaining coal plants closing by 2022 without government intervention (assuming a rising carbon price floor after 2020)

take advantage of declining industries and their available freight capacities before that capacity is picked up by other industrial sectors.

There are also lessons that can be learned from more established supply chains in other comparable industries; notably oil and gas, agriculture and coal.

Interviews with representatives from these industries has highlighted a number of consistent themes that will impact the efficient and effective development of the UK biomass logistics network, including;

- The level of collaboration and co-operation between product vendors/ asset owners/ supply chain partners
- Consistency in specifications/ product quality (including seasonality and weather effects)
- Inefficiency/ waste within value chain (e.g.; waiting times, wagon storage)
- Need for demand certainty
- Fleet utilisation
- Government co-ordination, regulation and interventions to limit market dominance/ incumbent positions

A Key Future Challenge for the Biomass Supply Chain

A key challenge for all involved in the sector is the lack of a government strategy and which in turn undermines investment and confidence in this sector. This is evident in the lack of support for Energy Crop Scheme 3, the reduction in subsidies available to larger-scale biomass users and in turn a hesitation from the market to invest further in infrastructure to support the development of biomass. A government strategy on UK bioenergy would not only serve to provide industry confidence but would also allow the focus to shift to key innovations in production, supply chain and technology development which would lead to greater efficiencies and in turn a reduction in operational costs.

Up to now the sector has been subsidy-driven and is subject to increasing speculation on its sustainability should these subsidies fall away. Confidence in the sector is needed to attract further investment in supporting infrastructure and supply chain. However given the wider political context with a new government, short term parliamentary focus on Brexit and a lack of a coherent long term energy policy, the long term position on subsidies and support for infrastructure development in the sector is unclear.

As such, this project will seek to separate out low risk supply chain actions and investments needed for the continued development of the sector, to help increase the chances of these areas progressing. It will also set out the key supply chain decision points in the development of the sector where higher risk investments need to be taken. This will be supported by strategies for sector leadership and opportunities for cross industry collaboration. Once defined, the industry can hopefully define an approach to these key decision points so they can engage government and investors early where support (in the form of subsidies, market development, or centrally controlled infrastructure development) is required.

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Appendix

A. Energy Advisory Group (EAG) List

As part of the data gathering process the Project Team have undertaken a number of structured interviews with industry experts across the UK biomass and logistics industries.

Below outlines the interviews completed to date and those still scheduled.

Name	Company/ Expertise	Individual Name	Status
Biomass Logistics Network	UK Ports (ex ABP)	Interviewee 1	Complete
	UK Ports (ex ABP)	Interviewee 2	Complete
	Malcolm Logistics	Interviewee 3	Complete
	Forest Fuels	Interviewee 4	Complete
	Inland & Coastal Waterways	Interviewee 5	Complete
	Balcas	Interviewee 6	Complete
	Terravesta	Interviewee 7	Complete
	Northern Straw	Interviewee 8	Complete
	Woodsure	Interviewee 9	Complete
	Drax	Interviewee 10	Complete
	AW Jenkinson/Eddie Stobart	Interviewee 11	Complete
	Network Rail	Interviewee 12	Complete
Industry Lessons Learned	Oil and Gas	Interviewee 13	Complete
	Frontier	Interviewee 14	Complete
	Coal	Interviewee 15	Complete
Other Specialists	Lynemouth EPH	Interviewee 16	Complete

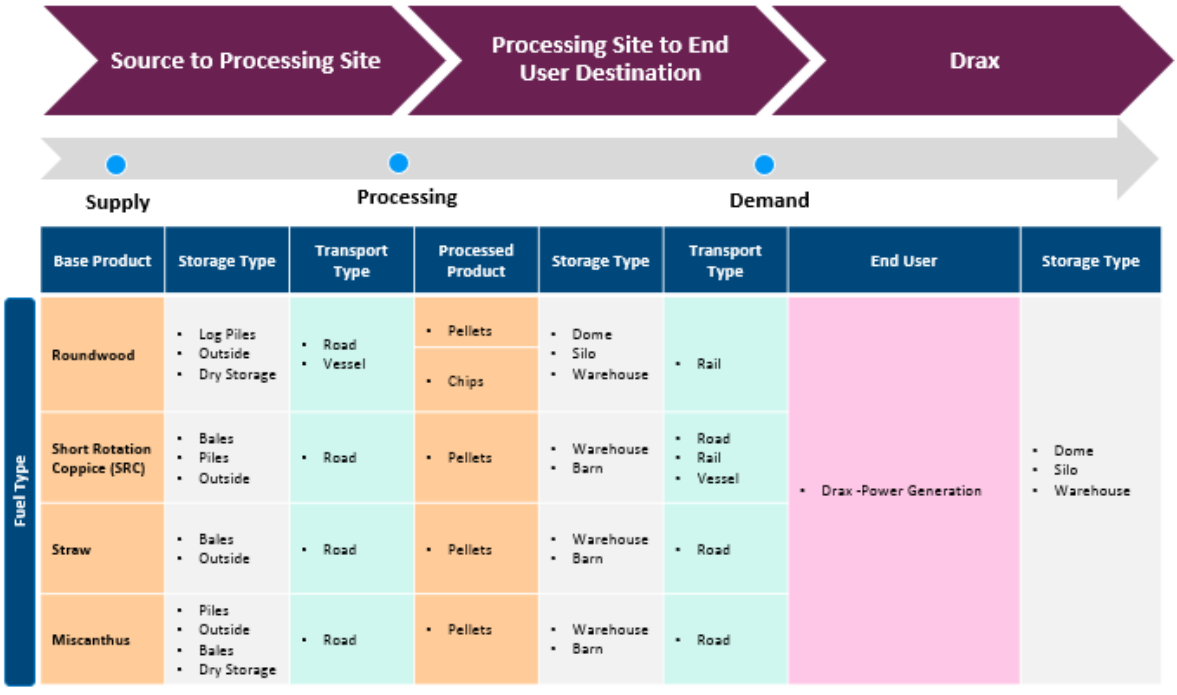
B. Out of Scope Groups and Justification

Out of Scope Groups	Out of Scope Justification
Imports – Rest of the World	• Volumes not significant e.g. less than 70,000 tonnes per annum to the UK
Imports - Raw Material pre processing / processing	• As agreed by ETI stakeholders at Technical Review 1
Imports - Waste Wood	• Non Applicable
Imports - Other waste products	• Non Applicable
Source - Postcodes beyond 2nd Level	• Limited data available due to confidentiality
Domestic Production - Biofuels	• Domestic biofuels production does not use in scope biomass type
Domestic Production - Torrified Material	• Insignificant quantities- agreed in kick-off meeting
Domestic Production - SRF	• Currently no domestic production of SRF. May be considered in future scenarios
Domestic Production - Waste Wood	• Agreed in kick-off meeting
Domestic Production - Other waste products	• Agreed in kick-off meeting
Processing - Pre-processing	• Considered as combined with processing (wood chips/ pellets)
Processing - Producer Traders	• As agreed by ETI stakeholders at Technical Review 1
Domestic Ports - Other UK Ports	• Either these ports do not handle biomass or the volume handled less than 70,000 tonnes per annum
Domestic Ports - Outside of Dry Bulk	• These ports do not do not handle biomass.
Storage - Outside of Dry Bulk Port Storage	• This type of storage is not applicable to biomass
Transport - Inland Waterways	• No significant biomass volumes moved due to size limitations on barges in canals.
Transport - Coastal Waterways	• No significant biomass volumes moved.
Transport - Post- Panamax	• Volumes to fill vessel considered to be too large to source and unnecessary.
Transport - Capesize	• Volumes to fill vessel considered to be too large to source and unnecessary.
Transport - Road Imports	• No significant volumes imported through channel tunnel.
End User - CCS movements	• Transport of CO2 gas is out of scope because it does not impact biomass logistics
End User - Paper & Pulp	• Covered under group CHP.

C. Drax Supply Chain

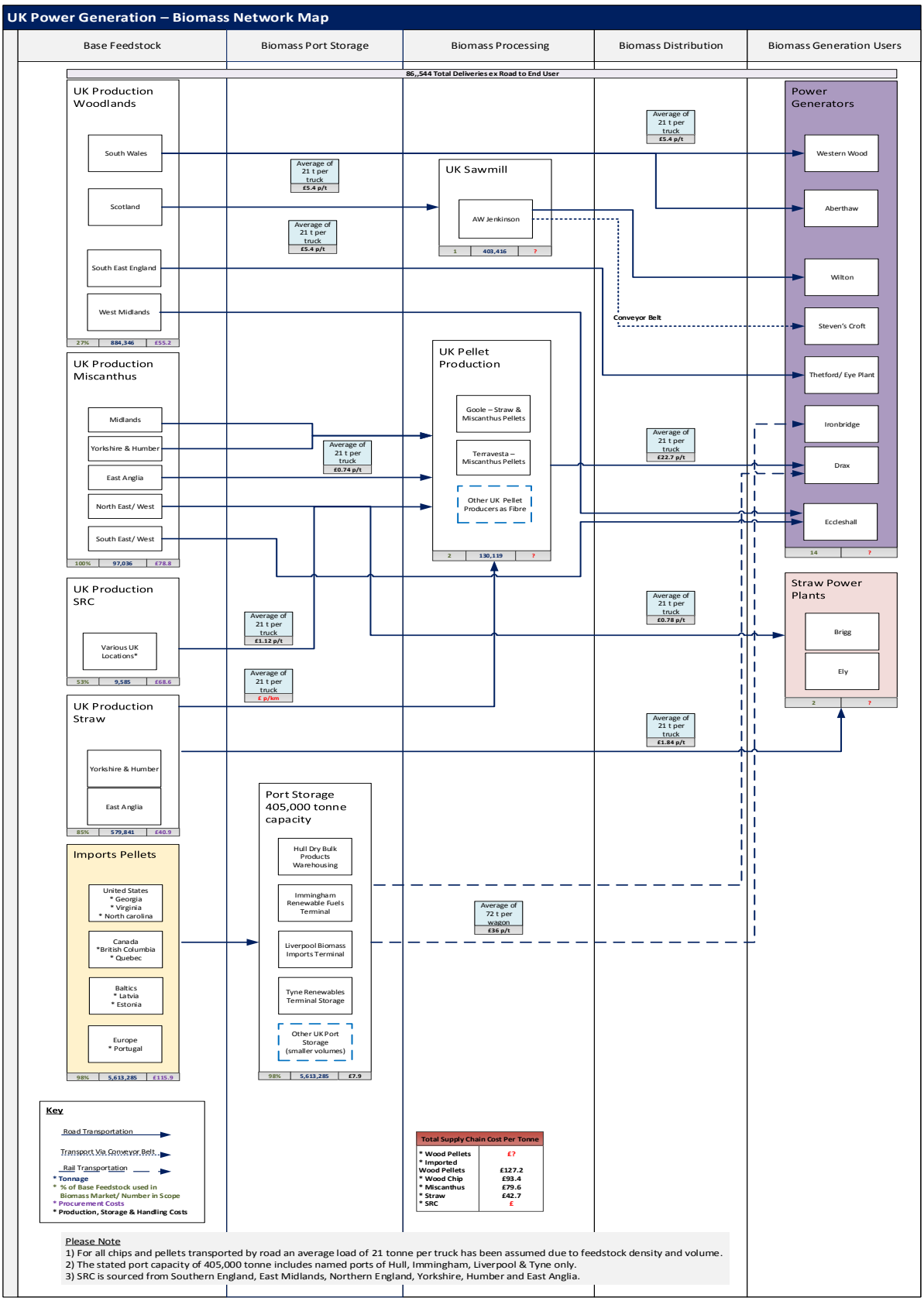
History

- Drax Power Station was officially opened with three coal-fired generators in 1975, with a capacity of 2 gigawatt (GW).
- Ten years later, its capacity doubled through the installation of additional units, making Drax the largest power station in the UK.
- In 2003, it started co-firing biomass as an alternative to coal.
- In 2012, Drax began the process of converting 3 of the 6 units from coal to biomass (using mainly wood pellets).
- In 2013, the first of these three units is upgraded, and the power plant undergoes a large refurbishment, with new facilities to handle, store and burn biomass instead of coal.
- In 2014, the second unit is converted, and four domes for storage are operational. Each can hold 75,000 tonne of wood pellets, and is specially designed to deal with the challenges of biomass storage (combustion, moisture).
- Whilst the third unit was being upgraded in 2015, Drax opened two pelleting plants and a port facility in the US, thereby vertically integrating the supply chain.
- In 2016, Drax produces 70% of the energy it generates from wood pellets, only 30% still coming from coal.

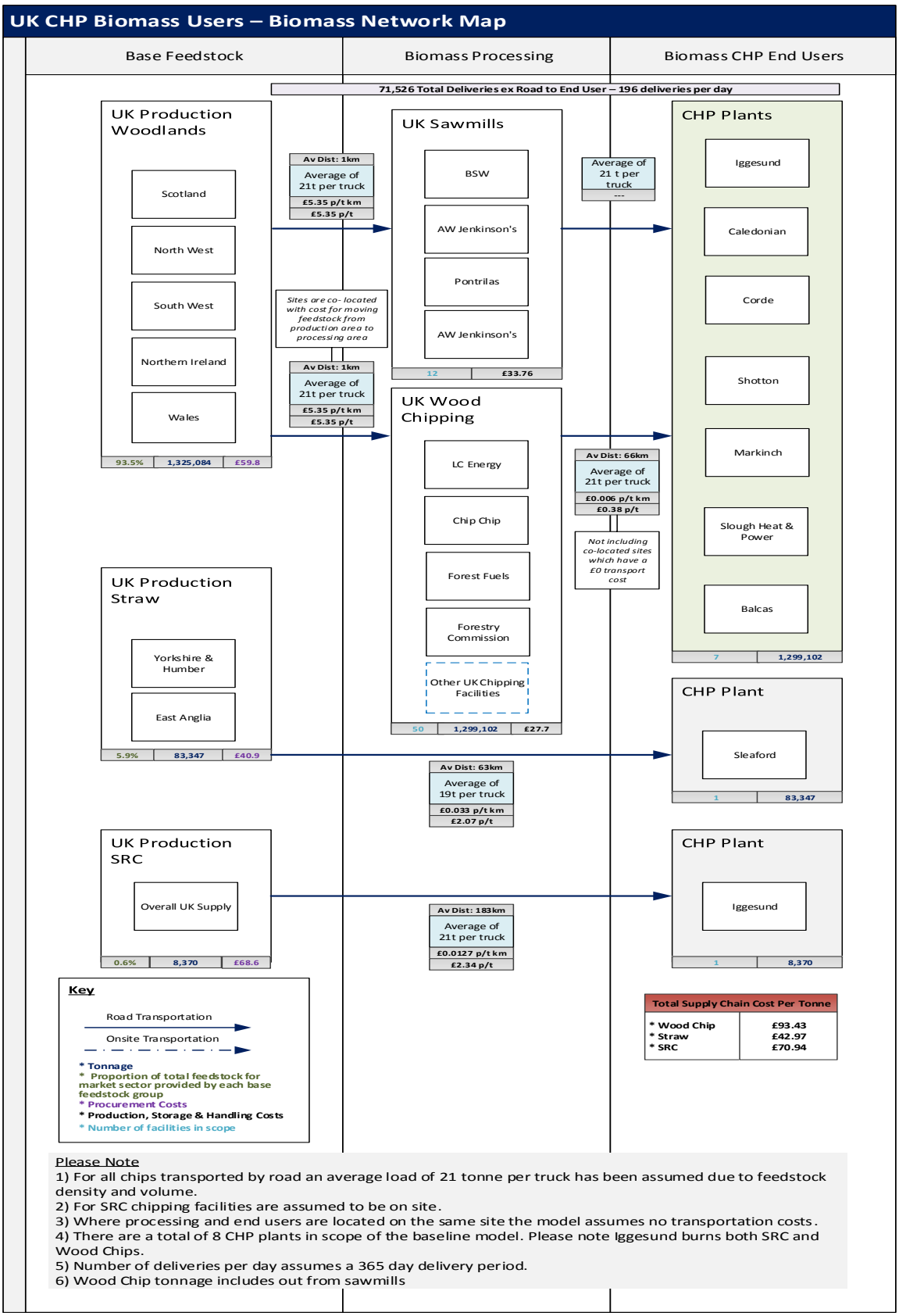


Fuel Type	Base Product	Storage Type	Transport Type	Processed Product	Storage Type	Transport Type	End User	Storage Type
	Roundwood	• Log Piles • Outside • Dry Storage	• Road • Vessel	• Pellets • Chips	• Dome • Silo • Warehouse	• Rail	• Drax -Power Generation	• Dome • Silo • Warehouse
	Short Rotation Coppice (SRC)	• Bales • Piles • Outside	• Road	• Pellets	• Warehouse • Barn	• Road • Rail • Vessel		
	Straw	• Bales • Outside	• Road	• Pellets	• Warehouse • Barn	• Road		
	Miscanthus	• Piles • Outside • Bales • Dry Storage	• Road	• Pellets	• Warehouse • Barn	• Road		

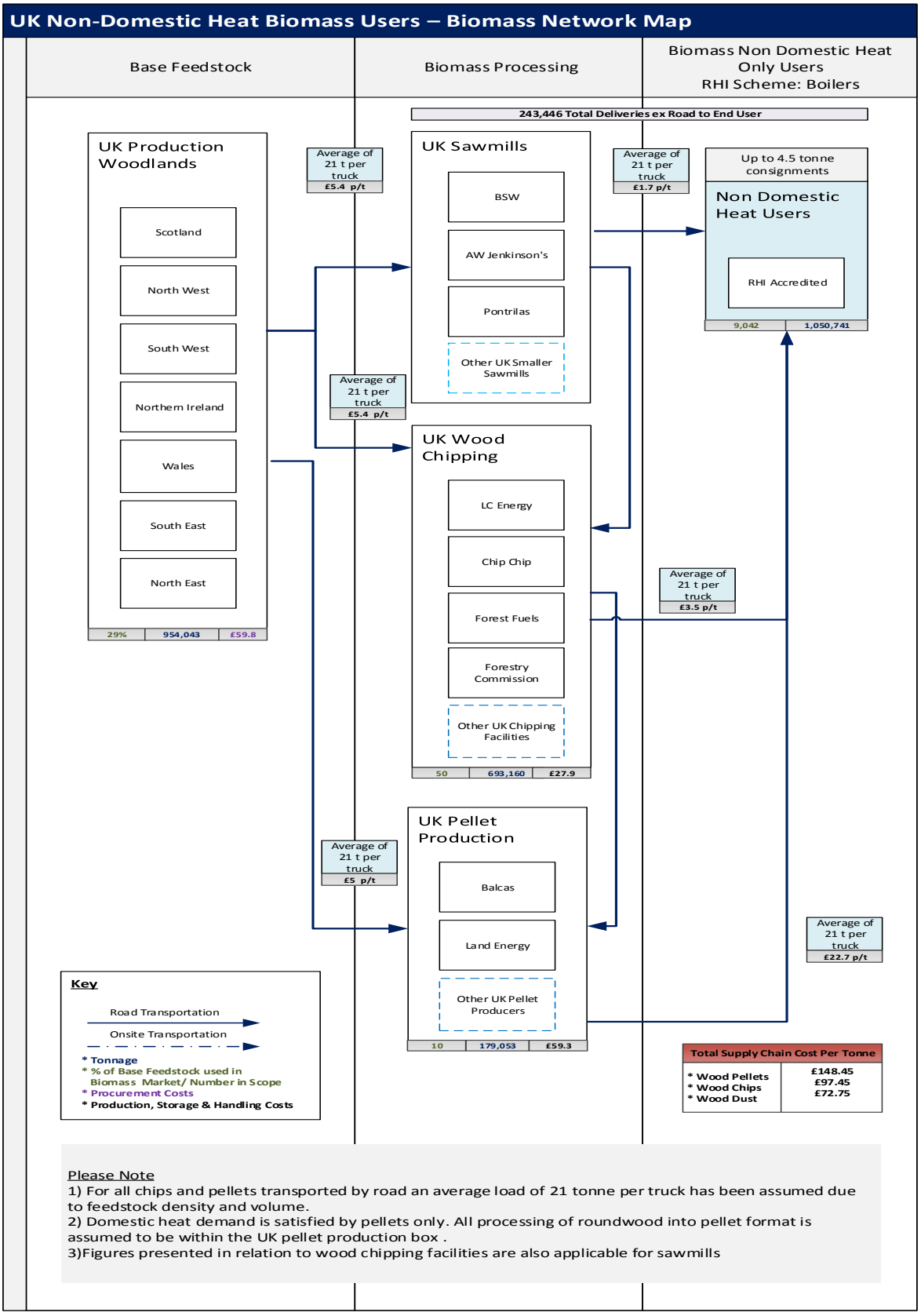
D. UK Power Generation – Biomass Network Map



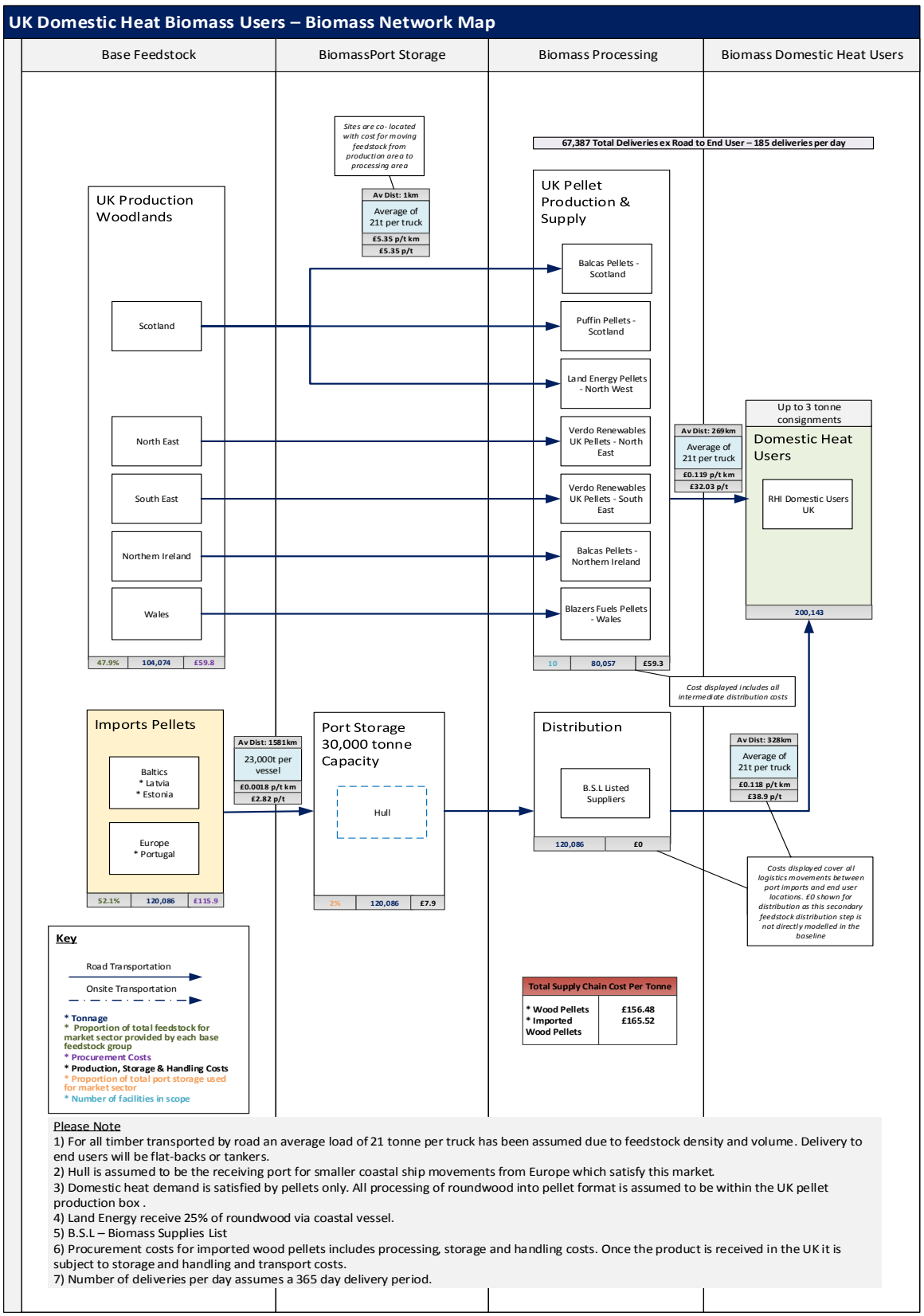
E. UK CHP – Biomass Network Map



F. UK Large Non-Domestic Heat – Biomass Network Map



G. UK Domestic Heat – Biomass Network Map



H. Interview Transcripts

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn, David Balchin*
Interview Date	*15/11/2016*
Interviewee Name(s)	*Forest Fuels: Interviewee 4*
Interview Subject Area	*Supply Chain & Logistics Operations*

Interview Questions

1. *Please talk us through the main operations of your business and supply chain including geographical reach*

- We supply virgin biomass (woodchip & pellets) + very small amount of recycled wood to the small-scale heating market- less than 3MW
- We are growing as a business more recently through the acquisition of smaller biomass suppliers (English Woodfuels)
- We have approx. 4000 customers, 43 depots supplying pellets or biomass, across the entire UK (no presence in Kent & Sussex, Northern Ireland and lacking extended presence in Wales & Scotland)
- We have plans to scale this up and extend our geographic reach, mostly by buying other competitors
- Depots are owned by Forest Fuels or suppliers – we collect from suppliers & some are operational processing sites
- Storage Hubs: no central hubs
- Sites are chip or pellet-specific
- Force-dried wood is increasing in relevance, suspect that this will drive a centralisation in the storage market

2. *What share of the market do Forest Fuels have? What is the total size of the market?*

- Market share: approx. 12%, target 40%

3. *Which supply chain lanes do you cover?*

- Farm/source to processing sites
    - Little capability, mostly subcontracted
    - Bought in depot, bought in wood: 50/50

- Inter-depot transportation:
    - Very little movement between depots
    - Where there's a shortage in a certain region it might be necessary, but try to avoid that

- Port to end user
    - Only for pellets

4. *Do you own your fleet or is it sub-contracted? If applicable what is the length of these contracts?*

- Mixed model --> initially subcontracted, but some are branded
- Own 17 trucks take 15-20% // subcontracted trucks 80%

5. *What is the fleet size and vehicle capacity? Various sizes? Is your fleet made up of dedicated vehicles or multi product or both?*

Bigger walking floor ones 18-20 odd tonne, smaller ones approx. 8 tonne

6. *Vehicle Utilisation- do you have empty kilometres on the return trip?*

- Yes we have empty returns, especially for pellets
- Subcontractors might do other loads
- Contamination of vehicle is the biggest issue preventing them from transporting other goods on the return

7. *Are you able to share any figures on total tonnage moved and/or max tonnage by biomass type?*
   - Estimations on volumes transported will be provided separately

8. *Do you do annual contracts with subcontractors*

Yes

9. *Do you do any hedging in the contract against fuel cost rises etc.?*

- Very little, mostly on renewing negotiations

10. *Is there a large walking floor market in the country*?

- Yes there is, and it allows for spot-market activities

11. *Do you track kilometres travelled? On average how many truck movements are there per day?*

- Yes
- Chip lorries: 1-2 loads per day --> 30k miles per year
- Pellets 5-6 loads per day --> 50k miles per year --> £20/t delivered
- £250- £300 per load (£500/day is the approx. the target pricing for a subcontractor to break even)

12. *What does a weekly schedule look like- is it 7 days? What are the seasonality restrictions?*

- 5 days per week, delivering from 7am to 5pm

13. *Do you have a customer rate card you are willing to share? Do you work on flat tariffs or cost per tonne by km?*

- There is a £40-£50 per tonne difference between UK wood pellets vs imported

14. *What does your storage network look like, and do you have dedicated biomass storage?*

- We have distinct storage between chips and pellets
- Yes, it will be dedicated biomass storage
- Woodchips are mainly stored in barns
- Roundwood can be stored under almost any conditions --> restriction is money, as it is capital
- Pellets: don't hold stock of pellets / buying from ports and suppliers // buying onto the back of the lorries

15. *What is your total storage capacity?*

- ~3000-4000m3 in South West region / ~20,000m3 across the country
- Will hardly ever be utilised fully as we try to avoid storing chips and pellets after processing.

16. *Storage cost per tonne per day?*

- Pellets £4-5/t to store and load it
- Importers pay in the dock's storages
- Chips £1-2/t for storing & loading

17. *What do the storage contracts usually look like?*

- Wood yards are rent-based: £600 – 700 for non-loading yards, ~£1000 for loading yards
- With contract driers they have minimum take (amount of throughput) on green mass

18. *What industry-relevant storages are you aware of?*

- Storage on the docks of the ports

19. *Is there anything like a storage hub where biomass suppliers from an area come in to collectively store?*

- No

20. *Your website says you produce about 700,000m3 of woodchip annually is that still the case?*

- Recently updated, so it's quite accurate
- Pellet volume is on top of that

21. *You have several depots shown on your website, does each site process roundwood timber into chips at the site and is the roundwood supply from woodlands local to the depot? Could you say typically the distance timber/chips are transported in supply and distribution?*
    - Yes a proportion does that "old-fashioned way"; proportion is changing to saw mill chips that are force dried

22. *Do you supply to any power stations or do you mainly supply to industrial customers with CHP or heat plants under the RHI.*

- No power plants, only domestic heating customers

23. *Could you say how many of these you supply?*

- Approx. half of the 36 bigger sites

24. *Typically how much Roundwood storage do you normally carry and does that vary across the year e.g. peaking pre winter?*

- Holding 6000t in the southwest (takes 18 months to dry)
- Chipping is done based on demand

25. *Do you have any planned fleet expansion? If so what is the timing?*

- Probably switching to an own fleet, less subcontractors
- Approx. 50% internal as target

26. *Within Forest Fuels is there any planned changes in regards to target customers and geographies? If applicable what is the timing?*

- Not for the time being. There is a lot of potential in the market but Gill doesn't see a pull from the market yet
- Quality required by customers is a distinction factor for us, that allows us to keep a price differential and we want to keep that

27. *What is the expected impact from external factors such as;*

- Brexit
    - Impact on the importing prices

- Legislative Changes – any in scope?

    - Changes to RHI and incentives schemes

- *Driver shortages- any concern?*
    - Yes, definitely a problem
    - Better in the rural areas
    - Average driver ages approx. 50yrs

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn, Barbara Bormann*
Interview Date	*21/11/2016*
Interviewee Name(s)	*Drax: Interviewee 10*
Interview Subject Area	*Drax Supply Chain*

Interview Questions

1. *Can you share any knowledge you have of biomass being transported via inland waterways/coastal currently?*

We import coasters of biomass from Europe via our port in Hull. I am not aware of others importing today with the majority of the smaller plants in the UK taking their supply from domestic sources. The growing heat market is importing in smaller shipments from Europe to various ports around the UK. I am not aware of any inland waterway use for the types of biomass we use although other locally sourced material may be moved by barge to waste to energy plants. The use of inland and coastal waterways has the potential to supply however, my view would be this will be a niche business for smaller operation.

If you consider we can move 1700 tonnes on one of our trains and we can make multiple trips between port and plant in each day. The largest potential inland barge solution would likely be 1000 tonne and will be limited by many factors. These includes its registration for use in coastal waters or simply inland waters. If the latter, then it may not be able to reach the ports to collect the cargo in the first instance, if the former then it has to be fully equipped navigationally, safety and crew as it would put to sea.

Barges are tidally restricted and so will potentially make a single trip or less in a 24 hour period, which when considered economically for a vessel requiring multiple crew makes the cost very expensive. You also have to consider the import vessel bringing the cargo to port has to be unloaded and paid. The port will then charge further for the re-loading to barge and also will likely charge the barge to enter and leave the dock and make use of the port facilities, finally you then have to consider the infrastructure costs to unload at the power plant assuming it is alongside a waterway, if not you still have further onward transport to consider.

2. *Can you please validate Drax port usage and actual throughput/ storage capacity*

- Immingham: 200k tonnes of storage space, expected maximum throughput of 6M tonne p.a.
- Liverpool: 100k tonnes of storage space, expected maximum throughput of 3M tonnes p.a.
- Tyne: 70k tonnes of storage space, expected maximum throughput of 1M tonnes p.a.
- Hull: 30k tonnes of storage space, expected maximum throughput of 1M tonnes p.a.

We have built the supply chain to allow us to flex between the ports. The main driver is to keep stock in each location allowing a rail programme to operate from each port each day. Hull is specifically for coastal traffic to avoid clashes with our deep sea traffic.

3. *What are the plans/timelines for Drax to bring on the remaining 2 units?*

We have three remaining coal units operating today. We have no plans at this time for their conversion due to Government withdrawing its support for further CFD allocations for biomass generation, at this time. Should the Government change that position we stand ready to bid for further CFD contracts and convert further units at Drax.

4. *Can you provide insight into the charges applicable for loading/ port handling paid by Drax?*

These are commercially sensitive and therefore cannot be shared. I can tell you it has different components including capital recovery, actual handling charges and also port related expenses.

5. *What is the proportion of imports transported via rail vs road to Drax?*

100% Rail

6. *Do Drax only work with GB RF or also with other operators?*

No we work with all the main rail operators; DB cargo move biomass and coal in the Humber region. GBFRF move biomass from Tyne/Liverpool and coal from other domestic sources, Freightliner do not have a contract with Drax at this time however that may change in the future as we tender the business every few years. They do handle other products on site such as ash and gypsum.

7. *Do Drax own the wagons they utilize or lease? Or both? If so who is the supplier?*

Drax own 225 biomass wagons. These wagons were designed and built for Drax and we own the IP to these designs. GB RAILFREIGHT operate 2 set of converted coal wagons into Drax mainly operating from Tyne although occasionally they will run from Liverpool. I believe GB Railfreight lease their wagons from VTG.

8. How many wagons are Drax dealing with on a daily basis? Is the weekly schedule running across 7 days?

In normal operating we need 17 trains per day delivering biomass to the station just to operate. At times of stock building this will be higher. A normal train consists of 25 wagons either GB RAILFREIGHT coal converted type or Drax type. We operate 7 days however the network is generally only operational for 6-6.5 days.

9. *What mode of transport do they see future growth in to support biomass? Road/Rail/Waterways/ Import Vessel Size*

Inland transportation growth should be from rail supplemented by road for local/ final delivery. For imports on our scale I would say larger vessels. To that point, we have worked for several years now to have the International Maritime Organisation rules for the carriage of biomass amended. Thus now, from Jan 17, allows for biomass to be carried in vessels not fitted with CO2, provided no binders are used in the production of the biomass. This in turn means we can start to make use of the global Panamax fleet increasing the shipment capability to >60k tonnes per vessel.

10. *Can you provide insight to customer rail costs?*

Our contracts are commercially sensitive so cannot be shared.

11. How does the pricing model work- per train? Per tonne? Per wagon? Contract term?

For the Drax wagons we hire driver and locomotive resources. We always tender for our rail, normally for 3 or 5 year term. The GB RAILFREIGHT wagons are contracted on a tonnage basis and similarly are subject to a tender process.

12. Are there seasonality impacts?

Minimal as biomass should operate base load.

13. What, if anything, do Drax transport via road?

We buy small amounts of domestically produced biomass, mainly from existing biomass plants or residues from the food industry that have little commercial value for animal feed. These materials tend to come by road.

14. What are the routes, volumes?

Generally local such as from the Drax straw pelleting plant at Goole.

15. What are the pricing structure and contract terms?

Ex works or delivered. Generally short term contracts as suppliers prefer to keep their options open, especially if the animal feed market changes and they can sell for better prices to that market.

16. Any seasonality impacts?

Minimal as they are residues from the food industry and their driver is that market not the fuel or animal feed market. For biomass specific production some seasonality however we did manage to convert our processing plant at Goole to operate straw through the harvest and into the following year and then switch to Miscanthus when that harvest was available.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn, Barbara Bormann*
Interview Date	*21/11/2016*
Interviewee Name(s)	*Malcolm Logistics: Interviewee 3*
Interview Subject Area	*Road Haulage*

Interview Questions

1. *Can you talk us through the main operations of your business, supply chain and geographical reach in the context of biomass?*

As hauliers we entered the biomass industry about 6 years ago having been invited by a long term customer to support some of their operations. Our business model is not one which targets being a major haulier within this sector but one that wants to be known for quality service across all our operations, not limited to biomass. We cater to small service customers and have no intention to be national leaders but to supply and enhance the main business.

We also only work in this sector with current clients as opposed to new customers. Our presence is the central midlands and fife (Scotland).

2. *In terms of operations what are the lanes of the supply chain you provide logistics to?*

In terms of the lanes we service we provide to haulage from; wood to processing and processing to end users.

3. *What is your average number of road movements per day?*

We deliver about 800-1000 tonnes per week which is about 50 loads per week. These deliveries vary from short to long distance.

4. *Can you provide some details on your fleet?*

40%-50% of our fleet cater to biomass. We operate 28 trucks and 37 trailers.

5. *Is your fleet owned by Malcolm Logistics or sub-contracted or a mix of both?*

We own the entire fleet and have built our fleet around volume as opposed to gross tonnage.

6. *What does a weekly schedule look like? Is it 7 days?*

Our schedule is a 5-6 day week.

7. *What in your opinion are some of the main challenges facing the industry both as a haulier and in the increased adoption of biomass?*

Challenges are ongoing for example to reduce the number of empty miles across the fleet and compliance with CO2 exposure. Driver shortage in this sector is also a challenge which continues across the industry and is not limited to biomass.

8. In terms of costing do you work on flat tariffs or cost per tonne per km?

We operate our cost model on load rates or tonnage but preference if for load rates to ensure best return of value. Costs and how they are built up can also vary significantly by material type.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn, Barbara Bormann*
Interview Date	*21/11/2016*
Interviewee Name(s)	*AW Jenkinson: Interviewee 11*
Interview Subject Area	Supplier/ Haulage

Interview Questions

1. *Can you talk us through the main operations of your business, supply chain and geographical reach in the context of biomass?*

- We have 3 owned chippers and have contracts on different sites
- We handle 3.5 million tonnes of timber products per annum of which 2 thirds is virgin fibre. 1.5 million Tonnes of this is recycled fibre.
- Half of the volume moved is biomass from North Scotland into England
- Jenkinson have 60% share of the market
- 20 processing sites in the UK
- To make blends we also cover sawmill/ forest reside to processing sites
- Euroforest produce chip from forest activities which goes into the energy market – 2 Million Tonne harvest.

Our contracts are for supply and we work with Stobart's to execute;

Supply:

- Rofas
- Estover energy
- Balcas for pellets
- Caledonian paper
- Ad hoc RWE Markinch – virgin and recycled
- EPR Markinch – recycles fibre
- Lockerbie – sole supply of 420,000 p.a. 20% recycled fibre
- Wilton 10 – 160,000 tonnes of biomass
- Shotton Paper
- Iggesund – Stobart case supplying 200,000 t p.a. virgin wood
- Land Energy – supply raw feedstock for pellet.
- Verdo

2. *What does your storage network look like?*

- Storage is always either owned or operated by an entity within the Jenkinson group.
- We keep 1-3 week supply on site

3. *What size is your fleet and is it varying in capacity per vehicle type?*

Jenkinson own 440 trucks- of which 100 are Stobart or on a LT contract. About 60% of these are for large scale biomass. We have about 300 contractors.

4. *Can you comment on average truck movements to provide some scale?*

- We have 1500 truck movements a day across the fleet, not specific to biomass.
- We supply Forest Fuels, Stobart's & others small scale demand - 50 x 25 t loads a week of chip
- 60% of truck movements are for biomass- processing sites to end user

5. *Do you operate on a cost per tonne basis or flat tariff?*

- There is a cost per mile that they work on and it's a job by job case.
- It is about £500 per day per truck to break even on contractors

6. *What industry and operational changes would you like to see in the industry going forward?*

In future we need to work across the industry towards more recovery and recycling of wood products.

In terms of further investment - we are continuously reinvesting in the fleet- different units for different jobs. We rotate trucks (not trailers) in a 2-3 year cycle to remain compliant. This ensures we remain fuel compliant in line with legislation.

We are trying to work with people exploring biogas options and are looking into opportunities in that sector.

7. *Do you foresee any legislative challenges facing the industry?*

As a result of Brexit I would anticipate sawmills becoming more buoyant because we will not be as reliant on imports.

8. *We were told that chips have been transported by rail up to Steven's Croft from the South West- is this correct? And if so is it a normal occurrence?*

That is not correct- if it is then its recycled fibre being transported. It is certainly not virgin wood.

9. *Do you supply hardwood and softwood chips? We were told this is problematic and you have to blend them. Is that due to wear and tear or some other reason?*

A large proportion processed is softwood - it can be problematic to handle both hard and softwood.

10. *Is your sawmill input timber (saw logs and roundwood) all sourced locally (say 50 miles radius) to your mills in Penrith and Lockerbie?*

In extremes it could be a 100 mile radius.
60% timber and saw
40% Chip, sawdust and bark (1 tonne of sawdust = 4 tonne of chip)

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn, Barbara Bormann*
Interview Date	*21/11/2016*
Interviewee Name(s)	*Balcas: Interviewee 6*
Interview Subject Area	*Fuel Supplier*

Interview Questions

1. *Can you talk us through the main operations of your business, supply chain and geographical reach in the context of biomass?*

- We transport 1 million tonnes of logs a year; this is split 65% from a forest in Northern Ireland delivered to saw mills and 35% from Invergordan (forest) to pellet manufacturers.
- Balcas are responsible for the logistics of logs from source to sawmill (in Northern Ireland) and then a 3rd party delivers from the sawmill to either the wholesale market or direct to end user. This equates to approximately 200,000 mt collectively.
- From Invergordan Balcas deliver ex road to storage or from forest direct to ship where product is distributed to one of 3 depots. These vessels have a 2-3000 tonne capacity.
- We also import some pellets from Europe
- We are manufacturers with only 5-6 competitors across the UK.
- We facilitate pickups from our depots from 3rd parties which deliver to our customers and theirs.

2. *What does your storage network look like?*

- In terms of storage we have the 3 depots in England and in Belfast we are looking at port storage in the form of our own shed. This is an optionality we are perusing.
- Balcas have 2 plants and access to a port owned and operated storage facility.

3. *What are some of the challenges you see facing the industry?*

- I see one of the biggest challenges being the road network particularly in Scotland which is not efficient and sustainable for growth long term. Rail is the big opportunity that could improve the supply chain and needs further development across the UK.
- I believe Verdo shutting will have a big impact on the industry. If manufacturers start to disappear then the reliance on imports will increase. The domestic business case will further decline unless the industry is given a helping hand or reaches a scale which impacts the cost structure.
- Obstacles in the industry include enforcing compliance to pellet standards. Many don't comply which gives the industry a bad reputation. Lack of storage specifications by product is also a challenge. Some of the technical aspects of the biomass industry need to be thought out.

4. *The Enniskillen plant uses saw mills residues for its pellet production, where is the timber source for the saw mill and does it use any virgin woodland?*

All material is from the forest and no residues from outside- all is provided from harvesting trees then processed.

5. *The Inverness plant uses roundwood material from the local Scottish woodlands, what is the maximum distance material is transported into the plant and can you say how much is processed for pellets and to run the CHP plant?*

On average I would say its 50- 60 miles. We use a software to maximise each log that comes in.

6. *On average how many loads per day do you do?*

- We do about 2.6 loads per day from forest to sawmill depot.
- We have about 300 per week going to Scotland and 500 in Northern Ireland.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn, Barbara Bormann*
Interview Date	*17/11/2016*
Interviewee Name(s)	*Ex ABP: Interviewee 2*
Interview Subject Area	*UK Domestic Ports, Transportation*

Interview Questions

1. *What is your view on the biomass sector in the UK?*

- Biomass sector is split in two: power generation & CHP/heating
- Domestic market: quantities aren't great individually but considered as a whole it is experiencing strong growth
- Lots of ports handle less than 100,000 tonnes p.a. but which taken as a total can be seen to be an overall significant handling of biomass in the UK.

7. *Could you validate the following list of UK domestic ports as those which handle biomass currently and/or in the future?*

- Cardiff: handles only shredded and waste wood
- Newport: yes but smaller scale parcels received for the CHP/domestic market. In the future potentially more throughput if nearby projects in scope go ahead. For example Abathon CHP is looking at a biomass conversion.
- Port Talbot: should have a demand of 1.7 mt of wood chips by 2020
- Ayr: currently handling forestry products (TimberLink)
- Blythe: have not invested in specialised biomass handling facilities, but will probably act as a supply route when needed for Lynemouth
- New Holland: 70k tonnes, for Drax and two EDF co-firing coal plants
    - Imports are olive pellets, especially developed type for domestic heating
- Hull: can take in 34,000 DWT, but actually takes in ships of 20,000 DWT
    - Biomass supply serves only Drax
    - Built as an "insurance" against disruptions in Immingham
    - Receives cargo from Russia, Latvia, Portugal
- Ironbridge: was serviced from the Mersey before closure
- Liverpool: Major supply point for imports to Drax
- Tyne: Further capacity coming online to support Lynemouth
- Port Talbot and Holyhead will also become significant ports for biomass if certain projects go ahead.
- Teesport: Future port – financing confirmed.

2. *Do you know which source ports the imports are coming from?*

<u>United States</u>

- Baton Rouge (storage capacity 2.5 mt storage p.a., 40-50 vessels per year, one a week
    - 2 Pellet plants include; Moorhouse & Amity which distribute to storage in Baton Rouge. These are owned and operated by Drax.

- Port Arthur, Chessapeeka, Savannah, Panama City, Mobeel, Maine

Canada

- Vancouver, Quebec, Prince of Rupert, Belledune

Baltics- Latvia

- Riga, Ventspils

Russia

- St. Petersburg

Portugal

- Aveiro

3. *Do you know how the storage facilities are handled?*
   - Storage in ports is not dedicated generally, it is converted bulk storage
   - Lynemouth will have bespoke storage domes

4. *How is biomass moved out of the ports?*

   - Drax can take in up to 5 trains per day, 5 days a week --> 40k t per week (only in peak times)
   - Drax is predominantly supplied via rail although road transport capabilities are available but limited due to village proximity.
   - Hull has more rail capacity --> can take 25 wagons with 1600-1700 t
   - Immingham has capacity for 24 trains a day (coal or biomass)- of that 12 are currently biomass trains. Currently this could be 20 – 60 trains a week depending on Drax demand.
   - Tyne: 50 paths per week, handling around 7 trains a day typically. I believe this has tailed off a bit but expect it to pick up again with Lynemouth.
   - Liverpool: has capacity for 60 trains per week --> 69k per week
   - Trains consist of 116m3 wagons (2900m3 of biomass in a train, 1600-1700 t per train)
   - Drax built custom wagons and contracted with DB Cargo UK & on hook & haul basis
   - All three large freight train operators have converted coal wagons to accommodate biomass

5. *Could you share some cost estimations?*

Costs will vary for rail forwarding costs to Drax and storage costs per customer and contract basis. Both are on a per tonne basis.

- Shipping: Indicative only to provide context/ ballpark
  - Rates per tonne --> depends on volume, tonnes, terms of contract
  - Example 3,500t vessels €14/t from Portugal (April 2016)
  - From Riga 5,000t shipments €17/t from Latvia (April 2016)
  - From US Northern east cost: $15/t (25k t shipments), $11.5/t (40k t)
  - Savannah: 25k t - $14.5/t & 40k t $11/t
  - Vancouver $20/t

6. *Are you aware of any shipments of biomass via inland or coastal waterways?*

- No. It was considered in the planning stages, since Drax and other power stations have access to the waterways from their history as coal fired plants, but was not viable/feasible
- Reasons: sea-going barges would be required as Immingham has no direct access to the inland waterways and those are too big for the inland canals currently.

7. *What is your view on the future of the supply chain for the biomass sector?*

- Future: Drax and Lynemouth will only be supplied by train and since coal & iron ore have declined so much the additional capacity available can be utilized for biomass once converted.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn, Barbara Bormann*
Interview Date	*17/11/2016*
Interviewee Name(s)	*Ex ABP: Interviewee 1*
Interview Subject Area	*UK Domestic Ports, Biomass Transportation*

Interview Questions

1. *Could you validate the following list of UK domestic ports as those which handle biomass currently and/or in the future?*

- Goole: struggles to make 0.5m t per year --> it does not supply Drax
- Grimsby: moves small amount of woodchips, definitely a lot less 0.5m t therefore minimal
- Hull: yes, services Drax
- Immingham: yes, services Drax
- Tyne: yes, services Drax
- Liverpool: yes, services Drax
- Southampton: no
- Barry: minimal volume
- Cardiff: predominantly doing export of woodchips
- Newport: yes
- Port Talbot: yes, a little, with plans to do more in the future
- Swansea: does minimal volumes, maybe a bit more on exports
- Troon & Ayr: coastal shipments of logs from Campbelltown, going into timber industry
    - This is one of the very few examples where that is working because it is subsidized by the Scottish Government to reduce road congestion
- King's Lynn: minimal volumes
- Garston: no
- Silloth: no
- Barrow: no; had been plans for biomass handling, but didn't happen, as the power station it would have supplied wasn't built
- Clydeport: only exports
- London Medway: no
- Teesport: not yet, plans to handle biomass
- Hartlepool: very little
- Bristol: yes, above 100k tonnes
- Londonderry: does timber and a bit of exports
- Kilroot: no, only coal
- Forth: currently does wood chip exports; but in the future very likely to supply plant in Grangemouth
- Shoreham: handles timber and a bit of woodchip exports
- Milford Haven: not currently, but there are plans for the future to supply Blackridge power plant
- Manchester Ship Canal: did some little volumes of biomass in the past year or so, but only as substitution when there was disruption on the rail

2. *In which ports are you aware of plans to handle biomass in the future?*

- Hull, Goole, Immingham, Barry (aspirational), Cardiff, Newport, Port Talbot, Swansea (aspirational), Liverpool, Tyne, Teesport, Bristol, Grangemouth (Forth), Milford Haven

3. *Do you have insights into the actual biomass volumes the ports handle (2015) and what the plans are for the future?*

- Hull: 1 million tonnes
- Immingham: was 3.5 million tonnes but is now 6 million
- It is fair to assume this full capacity will be utilized going forward.
    - Full capacity only came online in 2016
    - This port supplies only biomass imports to Drax
    - There were plans for Drax to build a power station at the Port of Immingham, but it didn't happen
- Liverpool:
    - Capacity at full commission 3 million tonnes
- Tyne: Recently this has had throughput of approx. 2 million tonnes
    - Expect reduction to 1.8 million tonnes (capacity) due to increased capacity at Immingham coming online.
    - It is building a second terminal for 1.6m-1.8m t for power plant Lynemouth (plan for Q2-2018). Expect 3 million tonne throughput capacity of 2018.
- Teesport: No actuals
    - Plan for 2019 or 2020: 1m – 1.4 million tonnes
- Newport: unknown
    - Current capacity approximately 850,000 tonnes
    - If Oskmouth Power Station is converted from coal to biomass this would require an additional throughput of 600k tonnes
    - Power plant in Nevis would take a further 250k t
- Goole: 50k tonnes current throughput p.a.
- Bristol: has capacity for 200,000 tonnes
    - Future plans for 2 million tonnes but this is not concrete
- Port Talbot: current volumes below 100k tonnes to support a close-by power station
    - Future plans to increase throughput

4. *Do you have a view on the sources of imports and to which ports they are flowing?*

- Hull is being served from Portugal & Baltics
- Immingham, Liverpool and Tyne are being supplied from Canada & US (not Russia)

5. *Could you provide any insight into the types of contracts/ models that have been done between biomass end users and the ports?*

- Drax has underwritten a certain throughput amount per year as commitments were necessary to justify the investments by ABP for bespoke facilities.
- Developments in Teesport and Tyne are a different model as the investments are made by the plant developers for this infrastructure.

6. *In terms of how many imports are received per month/year- can you provide any insights?*

- Usually ships are on berth are 2-3 days as they discharge
- It is not rateable in terms of putting an approximate on how many ships are imported as they are subject to demand and customer nomination and influences of take or pay etc. but if I had to give an approximate of UK imports I think 2 ships a week of varying sizes would be a suitable estimate.

7. *Are you aware of any additional dredging that is planned for the future to improve the capacity of the ports?*

- Teesport is increasing its draft capacity
- Deeper dredging not really required for biomass, as it is a voluminous, but not heavy product
- Panamax is as big as you'll get, Capemax is unlikely to ever come through

8. *Can you comment on some of the considerations the port has specific to the handling/ storage of biomass?*

- Storage capacities are very small compared to the amount that is required to run the power stations, so the supply chain is very tight and has to be resilient to avoid disruptions
- Usually, a storage cost is not charged specifically as it's included in the overall port costs which include logistics and handling
- The cleaning and dust management associated with biomass is a significant factor in the ports handling of biomass- both in discharge and across storage facilities. The risk of fire is prominent due to the amount of dust generated.

9. *How is biomass transported out of the ports?*

- Very little is done via road as Drax has a limitation on the number of trucks they can have coming in (regulations, village nearby)
- Tyne, Hull, Immingham, Liverpool all built new rail facilities to transport product via rail
- Hull & Tyne move goods from ship to storage by truck
- will run trains to Lynemouth
- DB Cargo UK is main operator for Drax
- Drax built customized wagons and does hook & haul contracts (loco & driver only)

10. *What is your view on the future of the biomass sector?*

- The sector is very subsidy-driven so success depends on what the government will do but in general I think it still has a very positive outlook, especially compared to the past 8-10 year as there is now physical proof that power stations are being converted etc.
- Biomass was always set up to be a bridge until new nuclear facilities have been built and are operational
- The supply chain foundation is there thanks to decline in coal and thanks to investments over the past decade which should and seems to be something that us being capitalized on
- Consideration on the impact of bunker fuel restrictions in light of low sulphur emissions and the associated costs should be considered for future scenarios.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Steve Critchley*
Interview Date	*17/11/2016*
Interviewee Name(s)	*Terravesta: Interviewee 7*
Interview Subject Area	*UK Miscanthus Supplies*

Interview Questions

1. *Do you only source and supply miscanthus?*

Interviewee Answer: Yes only miscanthus, we don't supply SRC. We have 255 growers supplying over 5000 hectares of crop and we used to supply Drax but have been released from the contract and 70 of their growers now work for us. Last year we supplied Brigg Power Station with 25,000 tonnes of material and are considering an offer to supply the new plant at Snetterton, but have not yet decided.

2. *How is material supplied?*

Interviewee Answer: Bales to Brigg and we have a pelleting plant in Cambridge which has a capacity of 100,000 tonnes per annum. Last year we pelleted 25,000 tonnes for animal bedding and pre RHI boiler users.

3. *What is the distance you source and supply miscanthus over?*

Interviewee Answer: Typically less than 50 miles but at Brigg 80% is supplied under 50 miles and 20% up to 150 miles from the plant. All shipments are made by road.

4. *The Energy Crop Schemes 1 & 2 have been largely responsible for the planting of miscanthus. A series of maps were produced after ECS1 showing the growing locations in the UK, but not after ECS2. I have assumed that the growing locations did not change much over the two schemes and have distributed the additional hectares over the same postcodes. Would I be correct in doing that? Interviewee went through SC's numbers verbally.*

Interviewee Answer: The hectares per area all sound OK, there may be some small errors but there is nothing major. In addition to the ECS plantings a further 800 hectares has been planted post ECS 2 worth about 25,000 tonnes.

5. *When is the harvesting period?*

Interviewee Answer: January through to early April and we bale at <16% moisture content and are aiming to get average moistures down to 12%.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Steve Critchley*
Interview Date	*11/11/2016*
Interviewee Name(s)	*Northern Straw (Supplier & Hauliers): Interviewee 8*
Interview Subject Area	*UK straw supplies for energy*

Interview Questions

1. *Do you supply straw currently to the operating UK straw burning power stations?*

Interviewee Answer: Yes we do, to Ely and Sleaford and last year supplied to Brigg but not this year. We were also a major supplier to Drax.

2. *Are you the only supplier to Ely and Sleaford?*

Interviewee Answer: No, there are a number of other suppliers, we only haul our own product and we don't let anyone take our straw as we know our own drivers, the loaders and the way they operate. When it comes to any customer issues we need to know where the straw came from etc. There are some farmers who sort out deliveries themselves. Eco2 (plant operators) like to organise plant straw supplies themselves

3. *Are deliveries still only made with a flatback and trailer delivering 36 Heston bales at a time?*

Interviewee Answer: Mostly yes, but you can deliver using an articulated vehicle but a special licence is needed to haul this way. I would say 95% of all deliveries are made as you say.

Follow up comment from Interviewee: There is a trial of the use of articulated lorries (rather than the more usual truck and trailer combination) with a limited number being granted licences to carry straw, which requires a single length trailer longer than the standard 13metres in order to carry the 36 bales normally carried by the road trains which are up to 18.75metres. No decision has been taken on whether these longer length articulated Lorries will be able to be used in the long term. David added that he "probably shouldn't have mentioned it as there are only a few about and they are not as flexible as the road trains where collections are often in restricted spaces, up farm tracks etc."

4. *When is the straw harvest period?*

Interviewee Answer: July through to mid-September, depends obviously on the weather, but in the main it's as I said. The later straw harvest is from Lincolnshire but the later it gets, the harder it gets to justify harvesting.

5. *Approximately what area do you haul straw from to the power stations currently would a 50 mile radius be a relatively accurate assumption?*

Interviewee Answer: The straw growing area is mainly south of Newark, north of the Thames and East of the A1 although there are some small areas to the west of the A1. To a large extent the 50 mile rule works but we can haul further than that, the main thing being that we always try to find a return load

somewhere and that is more possible with more than one power station, you can't have trucks running around empty!

6. *The plants require straw all year round so once harvested is it stored on site and how is it stored?*

Interviewee Answer: It is stored on site none of it is covered. Farmers see straw as a low value product and if conditions aren't right they won't let you have it. The covering of straw is a long way off, there simply isn't enough profit in it to invest in covered storage although there are stack covers of varying types which some farmers use to stop mould and rot due to getting rain soaked in bad winters.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Steve Critchley*
Interview Date	*9/11/2016*
Interviewee Name(s)	*Woodsure: Interviewee 9*
Interview Subject Area	*UK virgin wood chip supplies*

Interview Questions

1. *Do you have a list of the major UK woodchip suppliers and approximate tonnages produced yearly?*

   Interviewee Answer: I don't have a list as such, but could easily put one together. Forest Fuels one of the biggest suppliers has taken over a lot of the suppliers over the last couple of years, such as Midlands Wood Fuels. What sort of quality of wood are you looking for?

   - *Onorm G30 or G50 grade at 30-50% moisture, focussing on larger RHI boilers and RO generators greater then 1MWe/th.*

   Interviewee Answer: Larger installations will be taking chip at 50% moisture. There are some large chip supplies to CHP do you have them covered

   - *Yes through RO list.*

   Interviewee Answer: Have you looked at Stobart's and Jenkinson's?

   - *Not Stobart's as only interested in virgin wood - post chat will look at Jenkinson's as sole supplier of virgin wood to Steven's Croft.*

   Interviewee Answer: Have you spoken to sawmills? The main owners are BSW each saw mill will have a biomass boiler to dry material so they will have good information on wood supply to their boilers and supplying out, Tilhill also LC Energy, Chip Chip (say rivalling Forest Fuels) and Pontrilas.

   In Scotland talk to Angus Biofuels, Callendar

   Other suppliers to approach are Scot Heating and RTS (F) also in Scotland

2. *Would you agree with a 50 mile radius for road borne shipments between suppliers, processors and end users to manage 2 deliveries per day?*

   Interviewee Answer: In general yes

3. *I have heard that Steven's Croft have been transporting woodchips by rail from the South West up to Scotland, have you heard anything about that?*

   Interviewee Answer: I have seen several trains going through Bristol Temple Meads, it's quite spectacular!

4. *How much biomass is produced in the UK, would you know?*

Interviewee Answer: You could ask the Biomass Suppliers List under a 'Freedom of Information' request. Also there is the RO self-reporting.

5. *How much Roundwood storage do chip processors normally carry?*

Interviewee Answer: They only stack up as much as they need for their supply and as felling is seasonal they purchase what they require in advance to cover the winter. As they don't need to season some may purchase 'standing timber' or chip grade thinning from the fellers as and when they need it.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn- Email Correspondence Only*
Correspondence Date	*19/12/2016*
Interviewee Name(s)	*Network Rail: Interviewee 12*
Interview Subject Area	*UK Rail Freight Network*

1. *Which routes for biomass are Network Rail aware of? Particularly anything that is not going to Drax.*

    - Drax is the only station using biomass currently. I understand Lynemouth is in the process of conversion & will commence rail deliveries ex-Hull in due course.

2. *How many paths are currently used for biomass per day/week? Is there strong competition over the paths?*

    - Drax sees some 95 biomass trains per week, predominately from Immingham with others from Liverpool, Hull & Tyne.

3. *Have Network Rail experienced the growth in biomass transport that they were expecting?*

    - No. Back in 2013 when NR produced the industry informed Freight Market Study, forecasts were developed that envisaged Biomass as being a potential near equivalent replacement for coal. However, the removal of government support for burner conversion is widely cited as a key reason for the dearth of facilities now equipped to burn it.

4. *Can you provide indicative pricing per tonne-km for biomass transports?*

    - NR do not operate commercial freight traffic – you'd need quotes from FOC's.

5. *What are the growth expectations that Network Rail has for the biomass sector? Is it expected to cover the growth in biomass through the decline in coal transports?*

    - Incremental growth only; driven by subsequent complete conversion of Drax and commencement of operations to Lynemouth.

6. *Are you aware of any plans to invest in rail heads and other infrastructure for biomass transportation? If so, what & where?*

    - No.

7. *When/under what conditions would Network Rail consider investing in biomass-specific infrastructure?*

    - From my observations of the new handling and storage facilities put in at Drax and at certain of the origin ports; it is clear that Biomass demands a far more controlled storage and loading operation than coal.

8. *What are the challenges/ obstacles to biomass transport in your opinion?*

    - No issues for rail, it's like coal but a bit lighter & for this reason purpose built biomass wagons have sought to maximise volume per vehicle.

9. *Digital Rail- what are the timelines from your perspective on full implementation? Would this be a staggered approach across a few lines?*

    - The current digital railway proposition will see a progressive roll out of such technology route by route – subject to funding. Little direct impact on biomass traffic development.

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Grace Quinn*
Interview Date	*17/11/2016*
Interviewee Name(s)	*Inland Waterways: Interviewee 5*
Interview Subject Area	*Inland Waterways/ Barging*

1. Do you see inland waterways movements being a potential pathway transport for the biomass industry?

    - **Interviewee Answer:** No. To make this supply chain work you need to optimise more than the waterside. There are numerous challenges and restrictions like cross contamination of products that I think in this instance would result in dead freight (return trip) and inefficiencies which other modes of transport would not encounter.

2. Do you see inland waterways movements being a potential pathway transport for the biomass industry?

    - **Interviewee Answer:** Coastal and inland waterways only makes sense if the end user destination is the port as handling product multiple times can lead to degradation. If the product continues an onward journey post discharge at the port it will incur additional transport costs. Multi-modal transport of this nature make for a difficult business case
    - Additionally the increased time and handling costs associated with this form of transport for a relatively small parcel is in most cases not efficient.

3. In Europe where have you seen inland movements work successfully?

    - **Interviewee Answer:** The Netherlands but not this industry. Focused on chemical and ag product movements

4. What are the major constraint you see associated with this transport mode?

    Interviewee Answer:
    - Its currently more expensive than road/rail
    - The logistics network needs to stack up
    - Price of fuel and emissions regulations

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Jon Roberts*
Interview Date	*25/11/2016*
Interviewee Name(s)	*Frontier Agriculture: Interviewee 14*
Interview Subject Area	*Lessons learned – Agriculture/Food*

Interview questions	Interviewee answers
Industry Supply Chain Overview and Network Planning • *The extent to which any central analysis or planning is carried out in the industry, by market participants to enable optimisation in the development of the supply chain infrastructure?* • *How does the supply chain run for your industry? What is the preferred mode of transport, what are the typical volumes moved, what type of suppliers do you use?* • *How much is your industry reliant on 'owner operated' supply chain infrastructure compared to the usage of third party and fourth party logistics providers (3PL and 4PL?* • *To what extent is your supply chain network infrastructure shared with other industries?*	Frontier Agriculture is the UK's leading crop production and grain marketing business, with involvement in all aspects of the arable supply chain. Agriculture sector is dependent on supply chains to cope with the geographical separation of inputs, farming and consumption. The typical agricultural supply chain includes; **Input supply (seeds, fertilizer, energy) → production → post-harvest, →storage → processing → marketing →distribution.** These supply chain elements increasingly span national borders and involve inputs from a wide range of public and private sector participants. The UK market comprises 21-22 million tonnes of domestic product, comprising wheat, barley, oil seed rape and peas/beans. The market's appetite is based on commodity prices, with wheat being the primary commodity ranging between 15 - 17 million tonnes grown per annum. Logistics are a critical part of these flows, and weaknesses in them are often a major source of risk in agricultural supply chains that affect the availability, timing, traceability and quality of goods. UK transportation occurs 100% via road haulage with average journeys from farm to first processor of 80-90 miles. Barley and wheat production is primarily to the east of the UK, down from North East Scotland, through the Pennines and Yorkshire to Peterborough and the South East and the west of the UK is primarily characterised by grass grown for livestock. Imports typically come from Canada, Germany and France. Whilst some organisations operate in house haulage fleets, there are multiple 3rd party haulage providers who operate across the

What is unique to your industry and what should be shared which currently isn't (or historically hasn't been)?	farm network ownerships. The current efficiency of the logistics and supply chain is summarised by the quote "***100 days delivered, organised for 130 days***" implying a 30% inefficiency between planned and actual performance. The root causes of this are multiple, including; • Cancellations on the day • Loading equipment break downs • Weather delays • End receiver processing time • End receiver quality issues e.g.; acceptable moisture content • 5% rejections across the industry • Seasonality issues and grain ripeness • Grain going off • Variance in quality across a load – e.g.; 0.1% threshold for buyers Supply chain management means addressing the reliability of the delivery process, especially with respect to delays and uncertainty in time, quality and availability of service and risks of interruption. This delay often occurs at the mills, where storage facilities may not be available (due to physical site constraints), and trucks are left waiting outside. All of these risks can undermine the fundamental objectives of any supply chain: to provide a grain product at the correct quantity and quality, to the right place, at the right time.
Historical and Current Industry Supply Chain Network Issues • *What issues have been encountered within your industry supply chain? How were these resolved?* • *Are there issues which exist which have never been satisfactorily resolved?* • *What are the blockers which have historically prevented issues within the supply chain network from being resolved? (e.g. fragmentation of*	• **Process inefficiency at mill locations -** as the primary processor, there has been little appetite over the last 25 years to improve the delivery process (~75% of mills). Where there are bigger, newer plants, there exist storage facilities with different intake arrangements, which deliver 6 minute turnaround times for haulage vehicles. • **Product quality and customer rejections –** with a 5% load rejection across the industry, the control of quality of final delivered product is critical to supply chain efficiency and effectiveness. • **Driver education and training** – approximately 10-15% of drivers would benefit from improved understanding of their role and responsibilities in the network – this is a function of the UK haulier industry's appetite to deliver change • **Vehicle utilisation** – whilst the interviewer's offices have dedicated route optimisers, there still remains opportunity for improved collaboration in despatch and demand planning across national operations.

logistics providers, no sharing of information between market participants etc.) • *What investments should have been made historically to avoid issues encountered within the industry supply chain? (E.g. central warehousing and logistics depots, improved port facilities etc.)* • *To what extent, in your opinion, has the industry moved from an import based business to an increasingly domestic production base or vice versa?* • *What is the current and historical usage of different modes of transport within your industry sector? Do you think this split is optimal?* • *What have market participants in your industry done to work together to optimise their shared infrastructure (e.g. government lobbying, aggregate investment etc.)*	• **Co-operation and collaboration** – farmer's co-operatives have invested in central stores for storage with 500,000 tonnes of capacity. This enables increased throughput of larger vehicles (up to 44 tonnes), improved turnaround times and the ability to blend the product to achieve the right specification.
Industry Network Investments C. *What investments are being made within your industry today to improve the overall network infrastructure?*	Some farmer co-op investment in 500,000 ton storage facility (private backing) New mills built to achieve 6 minute turnaround times + storage on site

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Jon Roberts*
Interview Date	*25/11/2016*
Interviewee Name(s)	*Oil & Gas: Interviewee 13*
Interview Subject Area	*Lessons learned – Oil & Gas*

Interview questions	Interviewee answers
Industry Supply Chain Overview and Network Planning • *The extent to which any central analysis or planning is carried out in the industry, by market participants to enable optimisation in the development of the supply chain infrastructure?* • *How does the supply chain run for your industry? What is the preferred mode of transport, what are the typical volumes moved, what type of suppliers do you use?* • *How much is your industry reliant on 'owner operated' supply chain infrastructure compared to the usage of third party and fourth party logistics providers (3PL and 4PL)?* • *To what extent is your supply chain network infrastructure*	The oil and gas industry supply chain is global by nature; it includes UK and international transport, procurement, inventory control, materials and storage, import/export facilities and enabling technologies. The typical value chain can be illustrated as; **Exploration → Production → Refining → Marketing → Consumer** Given the remote nature of many sites and the need for 24/7/365 day operations of facilities, the financial implications caused by logistics complications can be very significant. Historically, the major industry players sought to manage the supply chain through vertical integration, but with downward pressure on prices, the industry now works with multiple 4PL's (fourth party logistics providers) and 3PL's (third party logistics providers). The procurement/buying function(s) are typically set up by commodity and category type. By working alongside 3PL and 4PL providers, oil and gas companies have been able to streamline logistics processes, reduce costs, and add value. For example, in upstream operations, many 4PL's are now brought in to manage, oversee, and improve certain aspects of upstream operations. These organisations are better experienced and set up to develop local supplier networks, systematically monitor resources, and plan/sequence the capacity needs, optimising the utilisation of the supply chain. Similarly, in the area of safety and compliance, the use of 4PL's to deliver global standards down through supply chain partners has been an effective method to deliver an approach which can be monitored, managed and improved.

shared with other industries? What is unique to your industry and what should be shared which currently isn't (or historically hasn't been)?	
Historical and Current Industry Supply Chain Network Issues • *What issues have been encountered within your industry supply chain? How were these resolved?* • *Are there issues which exist which have never been satisfactorily resolved?* • *What are the blockers which have historically prevented issues within the supply chain network from being resolved? (e.g. fragmentation of logistics providers, no sharing of information between market participants etc.)* • *What investments should have been made historically to avoid issues encountered within the industry supply chain? (E.g. central warehousing and logistics depots, improved port facilities etc.)*	The key issues emerging from industry interviews were; • **Safety and compliance** – no oil and gas company would wish to cut supply chain and logistics costs if it were to impact compliance, which means the focus is safety and compliance as a first priority • **Transparency** – the ability to get the right people and materials to the right location is fundamental to the sector, and have this information available to all parties in the supply chain. • **Collaboration –** by the geography and remoteness of many of the locations where Oil and Gas companies operate, there has always been a need for a degree of collaboration within the industry for mutual benefit. Typically, this might include shared supply vessels, joint storage facilities, shared infrastructure investment (road/rail/port) and helicopter transport of staff • **Reliability –** oil and gas clients need to have confidence they have employed expertise and experience in logistics that will always deliver, wherever that may be in the globe • **Consistency in specification –** with ageing assets, often beyond end of life, there is always an aspiration to standardise component parts through global supplier contracts. The focus tends to be on the bigger pieces of kit and which should cover future spare parts needs within the Operations and Maintenance contracts. • **KPIs/ performance measures** can be improved, and there is an increasing role that data will play in the industry, such that data sharing between all parties in the supply chain will become a basic requirement and should be measured, monitored and continuously improved.

• *To what extent, in your opinion, has the industry moved from an import based business to an increasingly domestic production base or vice versa?* • *What is the current and historical usage of different modes of transport within your industry sector? Do you think this split is optimal?* • *What have market participants in your industry done to work together to optimise their shared infrastructure (e.g. government lobbying, aggregate investment etc.)?*	
Industry Network Investments *D. What investments are being made within your industry today to improve the overall network infrastructure?*	Data gathering & analytics Shared storage/asset use - materials & plant, vessels Product tracking & visualisation

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Jon Roberts*
Interview Date	*29/11/2016*
Interviewee Name(s)	*National Coal Board: Interviewee 15*
Interview Subject Area	*Lessons learned – Coal*

Interview questions	Interviewee answers
Industry Supply Chain Overview and Network Planning • *The extent to which any central analysis or planning is carried out in the industry, by market participants to enable optimisation in the development of the supply chain infrastructure?* • *How does the supply chain run for your industry? What is the preferred mode of transport, what are the typical volumes moved, what type of suppliers do you use?* • *How much is your industry reliant on 'owner operated' supply chain infrastructure compared to the usage of third party and fourth party logistics providers (3PL and 4PL)?* • *To what extent is your supply chain network infrastructure shared with other*	Interviewee worked for the National Coal Board from 1977 (~40 years) 20 years of that within transport operations Experienced the privatisation of rail assets & infrastructure Fundamental similarities between coal & biomass, with major difference being that the coal infrastructure built over a century and is the foundation of rail freight transport. Now managing the reduction in infrastructure as total movements have declined very significantly. Coal has played a significant role for over a century in meeting the UK's need for electricity, however, with the increased investment into renewable and new gas station generation, there has been a significant decline in its importance. Last year coal accounted for just under a quarter of electricity generation and the eight stations that remain operational today represent around 15% of Great Britain's total generating capacity. (Power generation and steel makers represent 90% of the UK customer base for coal.) In terms of total coal movements, from a relatively stable total movement figure of ~ 70 million tonnes per annum between 1996 – 2006, the volumes have been in decline. In 2012, there was a spike of 64 million tonnes moved, however in 2015, this figure was down to 37 million tonnes, and in 2016 the forecast figure is ~ 20 million tonnes. The UK supply chain has shifted from being wholly domestic supply to predominantly import based. Coal movements today occur from port to power station, via rail freight, with Immingham being the main import point today. Since privatisation of rail assets and infrastructure, there have been significant changes to the rail supply chain and logistics network, in

industries? What is unique to your industry and what should be shared which currently isn't (or historically hasn't been)?	terms of locomotive and wagon fleets, supply patterns, train paths and reduced number of supply – destination points. Central analysis by supply chain operators has historically placed reliance upon Government forecasts of future demand, and the large generators in house modelling capability. Major customers typically contract direct with the supply chain, with very little 'in house' of 3PL/4PL arrangements evident. The contractual arrangements with major customers have relied upon the buoyancy of the market, which, in a declining market, have left many freight operators exposed to uncertainty in demand and stranded assets.
Historical and Current Industry Supply Chain Network Issues • *What issues have been encountered within your industry supply chain? How were these resolved?* • *Are there issues which exist which have never been satisfactorily resolved?* • *What are the blockers which have historically prevented issues within the supply chain network from being resolved? (E.g. fragmentation of logistics providers, no sharing of information between market participants etc.)* • *What investments should have been made historically to avoid issues encountered within the industry supply*	The key issues emerging from the industry interview were; • **Unpredictability of flows** – the customer's need for flexibility of supply for reasons such as seasonality, is a fundamental challenge for the coal supply chain, often with no 'take or pay' arrangements available. (For coal, this is less of an issue than it will be for biomass, where stockpiling has historically occurred at customer locations and in dedicated sidings) • **Unequal market power** – the major customers have been able to benefit from the fragmentation of the freight provider market to secure the supply arrangements they need, e.g.; flexibility, often to the detriment of the supplier • **Changes with market development** – as a market develops, it is relatively straightforward to serve a single point – single user model. However, as the market matures, the customer wishes to diversify their supply, and the supplier wants to maximise their asset utilisation, which adds complexity to arrangements. This issue will be very relevant to the biomass sector, if not already emerging. • **Government regulation and intervention** – Network Rail and the ORR, as owner and regulator of the infrastructure asset(s) upon which freight operations take place have a captive position. • **Dominant incumbent positions** - freight companies sitting on train paths, makes new market entry difficult, and requires government regulatory intervention to limit this dominance/ inefficiency in the system. • **Lack of diversification –** freight supply organisations have invested significantly in new locomotives and wagons, however there is limited transferability for use with other commodity types, and a level of complacency in recognising the speed of decline in demand volumes signals very challenging times ahead

chain? (E.g. central warehousing and logistics depots, improved port facilities etc.) • *To what extent, in your opinion, has the industry moved from an import based business to an increasingly domestic production base or vice versa?* • *What is the current and historical usage of different modes of transport within your industry sector? Do you think this split is optimal?* • *What have market participants in your industry done to work together to optimise their shared infrastructure (e.g. government lobbying, aggregate investment etc.)?*	• **Domestic supplier need for certainty –** domestic providers need a level of stability in supply, where international suppliers can provide a degree of flexibility • **Collaboration minimal** – the coal rail freight supply market is very competitive space and there has been effectively no collaboration since the days of privatisation • **Joined up Government thinking** – the Government's own prediction on the expected market demand for UK coal movements has not been without challenge
Industry Network Investments *E. What investments are being made within your industry today to improve the overall network infrastructure?*	• None mentioned – industry in decline and little collaboration within supply chain players

Expert Advisory Group – Interview Questions and Notes

Interviewer Name(s)	*Jon Roberts*
Interview Date	*23/11/2016*
Interviewee Name(s)	*Macquarie: Interviewee 16*
Interview Subject Area	*Project Financing*

Interviewer Notes / Actions

In UK, Macquarie with PKA pension fund are owners of MGT Teesside CHP Biomass plant (299 MW)

CFD policy moved to Biomass + CHP in next round.

Teesside combined many characteristics that may well be unique -

Biomass investment based on 2 fundamental questions;

1. REVENUE
    a. long term certainty / support via Government subsidy (CFD)
    b. bankable fuel supply with credit worthy counterparts
    c. Simplicity – e.g.; logistics direct from Port to Storage at MGT
    d. Technology risk – both gasification & dedicated + CHP have challenges, but gasification has struggled in construction & commissioning.
    e. Customer risk – long term heat offtake agreements – need for co-location limits locations/ implications if industrial client(s) relocate?

2. FUEL SUPPLY
    a. To attract project finance, needs long term contracts in place which aren't exposed to counterparty risk/ indexation (e.g.; US CPI), stumpage charges,
    b. Pellet/woodchip suppliers – low credit worthiness
    c. Need a UK CPI & Credit wraparound

Their focus is green field projects where they can use Teesside experience – limited in domestic/precinct

Nothing in UK pipeline

CHP requirements may need relaxing

Needs Government to continue to make sure CFD's available if they are committed to developing biomass sector.

I. Truck Load Calculation

ROAD (wood)	CHP	Domestic Heat	Non-Domestic Heat	PowerGen
pellets / chips (in t per annum)	1299102	200000	245199	1207649
amount per day (in t, 220 days)	5905	909	1115	5489
truck loads per day (21t per truck)	281	43	53	261

ROAD (Straw, Miscanthus, SRC)	CHP	PowerGen
pellets / bales (in t per annum)	91717	625202
amount per day (in t, 220 days)	417	2842
truck loads per day (9t per truck)	46	316

RAIL (imported wood pellets)	PowerGen
pellets (in t per annum)	5305776
amount per day (in t, 220 days)	24117
wagon loads of pellets per day (72t per wagon)	335
number of trains per day (24 wagons per train)	14

J. Compound Annual Growth Rate Calculation

It's the average annual growth rate (last line) of the market share from 2011 to 2015:

	2011	2012	2013	2014	2015
Biomass for heat and power	2,704	3,132	4,199	5,015	6,151
Other bioenergy	4,933	5,016	5,285	6,016	6,843
Non-bioenergy renewable energy	1,949	2,393	3,156	3,761	4,877
TOTAL Renewables	9,586	10,541	12,640	14,792	17,870
Share of biomass for heat and power in total renewables	28.2%	29.7%	33.2%	33.9%	34.4%
Growth Rate (year on year)	N/A	1.5%	3.5%	0.7%	0.5%

All numbers are taken from a 2016 BEIS report: "Renewable sources used to generate electricity and heat and for transport fuels", to be found here: https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes