The potential impact of increases in track access charges on the transport by rail of biomass

by MDS Transmodal for the Office of Rail and Road

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1. INTRODUCTION

As part of its 2018 periodic review (PR18), the Office of Rail and Road (ORR) has been considering how the fixed costs of running the rail network should be recovered by Network Rail from different types of train services. In September 2017, ORR consulted on proposals in relation to charges recovering fixed network costs, which it has called infrastructure cost charges (ICCs), for control period 6 (CP6: April 2019 to March 2024)[1]. These charges are recovered as mark-ups under the European and domestic legislation[2]. A key requirement for the levying of such charges is assessing whether the market segment can bear charges above directly incurred cost (i.e. short-run marginal cost) – this is what the ORR has called the market-can-bear test.

In its September 2017 consultation, ORR proposed to retain the existing approach to market segmentation for freight services, based on commodities carried. ORR also proposed to continue defining freight trains carrying electricity supply industry (ESI) coal, iron ore and spent nuclear fuel, as market segments able to bear ICCs in CP6. In addition, ORR proposed to define trains carrying biomass for the electricity supply industry as a market segment able to bear infrastructure cost charges in CP6.

ORR has commissioned MDS Transmodal to assess the impact of introducing ICCs on the carriage of biomass by rail. This analysis will be an input to its market-can-bear assessment in relation to biomass. The key issue that is to be assessed is the extent to which such a mark-up would lead to a reduction in the amount of biomass carried by rail by 2023/24. This analysis has been undertaken by developing a logit model to represent the competition between sources and routes to supply power stations with biomass. It incorporates an elasticity of biomass consumption with respect to the average delivered cost of the fuel.

The structure of this report is as follows:

- Section 2 gives some background on the transport of coal and biomass to power stations, and introduces the approach we have adopted;
- Section 3 reviews the UK energy market and the impact of recent changes in policy;
- Section 4 describes the model that we have developed to analyse the impact of rail charges on the transport of biomass, and shows its results;
- Section 5 considers a gaming approach to Drax's choices of ports; and
- Section 6 provides a summary and conclusions.

[1] This consultation is available here: http://orr.gov.uk/__data/assets/pdf_file/0008/25649/pr18-consultation-on-charges-recovering-fixed-network-costs-september-2017.pdf
[2] European Directive 2012/34/EU and The Railways (Access, Management and Licensing of Railway Undertakings) Regulations 2016.

Our overall conclusion is that in 2023/24 the effect of increasing charges (including any ICCs) by the equivalent of doubling VUC (from control period 5 (CP5)[3] exit levels) would reduce biomass traffic by rail (as measured in tonne kilometres) by 11.2%. Most of this reduction (as shown by our modelling) would be due to re-routing biomass from distant ports to nearby ports. Only a small proportion (1.6%) would be due to a reduction in the amount of biomass transported / burned.

[3] Control period 5: April 2014 to March 2019.

2. BACKGROUND & APPROACH

Coal carried to power stations by rail fell from 48 million tonnes in 2013 to 5 million tonnes in 2017, and is expected to more or less disappear by the end of 2025 due to UK Government legislation. The carriage of coal by rail has been subject to a mark-up in CP5 because of the limited alternatives that power generators had to move their feedstock to power stations. There has been a limited amount of substitution of coal by biomass, allowing some power generators to extend the useful life of power stations. The principal such generator is the operator of the Drax power station.

By way of background, in Section 3, we provide an overview of the UK energy market and explain the basis for recent changes within the context of the Low Carbon Transition Plan and Electricity Market Reform. Together, these policies initially implied that biomass would play a major role in substituting for coal generated electricity. However, the falling cost of alternative renewables (both recent and projected) has reduced the scope for biomass generation, weakening its competitive position suggesting increased transport costs are likely to lower the proportion of electricity generated from biomass.

The great majority of biomass consumed at power stations is imported and reaches the UK through deep-water ports. Importers have therefore to select which ports to use. This involves trade-offs between shipping, port and inland (mainly rail) transport costs. The charges levied for access to the rail network are a material factor in the decision as to which port is selected by the generator[4].

Most access charges for rail freight in Britain are charged on the basis of the weight and type of wagon and the distance travelled, with a mark-up for some commodities where the market can bear that extra charge without a significant loss of traffic to other modes. In CP5, three rail freight commodities have been subject to mark-ups: ESI coal, iron ore and spent nuclear fuel. These commodities have been subject in CP5 to the Freight Specific Charge and Freight Only Line charge, which the ORR has confirmed will be merged in CP6 into one mark-up or ICC.

In order to quantify the impact that an increase in access charges would have on the biomass market, this report employs two approaches: (i) using a logit model that seeks to explain current port and mode choice through the comparative costs faced; and (ii) qualitative analysis based on a gaming approach that considers the negotiating position of the principal commercial actors.

The absence of any distance based charging is particularly important where cargo may be captive to rail but the source of that cargo is subject to market competition. This applies in several parts of the rail freight market. For example, planning conditions often affect choice of mode (i.e. favour rail) in the aggregates sector so that the choice of supplier can be based on competition between different

[4] We make the assumption that any change in charges would be passed on in full from the freight operating company to the customer.

rail connected quarries; a mark-up (ICC) would adversely affect one quarry instead of another where other material factors could also apply (e.g. the length of train that can be hauled). Similar issues apply in the case of imported ESI coal with respect to the choice of port where different port conditions (mainly the size of ships that can be berthed) affect the cost elsewhere in the supply chain (i.e. the cost at sea). This issue was examined by MDS Transmodal for ORR in 2012[5]. The way in which different ports competed for traffic to different power stations was studied using a logit-based model: the 'Coal Power Station Transport Model' (CPSTM). The primary objective of the study was to determine whether a proposed mark-up would lead to a transfer of coal from rail to road for a handful of flows from Scottish ports to Drax. However, it was first important to determine how a change in charges would affect the distribution of coal between each port or pit and power station. Our overall conclusion in that case was that there would be changes in the distribution/port of discharge of coal that would reduce the mean length of haul for coal, but that there would be negligible transfer of coal from rail to road through the application of mark-ups. We have adopted a consistent approach in this case by employing a simplified version of that model to review the impact of raised access charges on biomass flows.

We believe that the issues examined in the 2012 study are relevant to the current position for biomass. To provide an alternative perspective to the use of a logit model, we have considered the gaming or commercial relationship between the power generators and the ports they have available to them. Biomass is overwhelmingly destined for Drax, with a much smaller future volume to Lynemouth, and is relatively captive to rail. Much smaller volumes of biomass pass to Fiddlers Ferry Power Station and to specialised stations such as that at Thetford. Drax receives biomass from four ports; Liverpool, Immingham, the Tyne and Hull.✂

The key transport choice lies in port of entry and not between road and rail. A secondary issue concerns the competitiveness of biomass as a feedstock for electricity generation for which an increase in cost would in turn risk the volume of traffic carried by rail.

[5] "Impact of changes in track access charges on freight traffic. Stage 2 Report", MDS Transmodal. July 2012: http://orr.gov.uk/__data/assets/pdf_file/0016/1780/mdst-freight-tac-changes-jul2012.pdf

3. REVIEW OF UK ENERGY MARKET AND IMPACT OF POLICY CHANGES

3.1 Introduction

This section provides:

- An overview of the impact of recent changes in UK energy policy on demand for fossil fuels and renewable energy sources including biomass; and
- A description of trends in the UK market for imported commodities used in energy generation.

3.2 Background to key policy changes

The UK is moving from being a major producer of oil and gas, as well as historically having significant domestic coal reserves, to a position where the UK imports much of its gas for electricity generation, coal imports are drastically reduced and a high proportion of the crude oil feedstock for refineries will also be imported. As a significant proportion of these energy imports will pass through UK ports, energy policy has a significant impact on port throughput and rail freight forecasts.

The thrust of UK Government policy in the last decade has targeted two main challenges: the need to reduce the UK's greenhouse gas emissions and its reliance on and use of fossil fuels, and the need to secure the UK's energy supplies. The UK government has signed up to international, legally-binding obligations and has engaged in revisions to energy policy to carry through the first of these targets.

Two of the most important changes in Energy Policy in the last few years include the Low Carbon Transition Plan (LCTP) and the Electricity Market Reform (EMR). The EMR was introduced under the Energy National Policy Statement EN-1 (Energy NPS) in 2011 and was legislated for under the Energy Act 2013.

Low Carbon Transition Plan

The LCTP, in part, is the UK Government's response to the European Union Large Combustion Plants Directive (LCPD 2001/80/EC) which seeks to reduce emissions of sulphur dioxide, nitrogen oxides and particulates from large-scale industrial works such as power stations, refineries and steelworks. The LCPD was superseded by the Directive on Industrial Emissions (IED), which required transposition into UK law by no later than 6 January 2013.

The IED has already led to many older coal-fired power stations closing, with only a handful converting to alternative fuel sources. The IED came into effect on 1 January 2016, but a derogation (Article 33, the Limited Life Derogation or LLD) did make it possible for plants that have opted out of the necessary upgrades to continue to run without fitting further abatement technology for a total of 17,500 hours or to the end of December 2023, whichever is the earlier.

Electricity Market Reform

The EMR is the main instrument for meeting the EU's legally binding target that 15% of UK energy demand is met from renewable sources by 2020. The EMR was accompanied by a Renewables Roadmap which outlined plans to achieve the target of ensuring that 30% of electricity supplies are met from renewable sources.

The cornerstone measures to achieve the policy objectives are:

i Carbon Price Floor (CPF) to establish a fair price on carbon and provide a stronger incentive to invest in low carbon technology;

ii Contracts for Difference (CfDs) to provide stable financial incentives to invest in all forms of low-carbon electricity generation plant and infrastructure; and

iii Capacity market (CM) introduced to provide a regular retainer payment to reliable forms of capacity (both demand and supply side) in return for such capacity being available when the system is tight.

The CM provides revenue in the form of capacity payments to potential capacity providers. In return, participants must commit to delivering electricity at times of system stress and face penalties if they fail to do so. Capacity payments are determined via competitive auctions, held four years (T-4 Auction) and one year (T-1 Auction) before each delivery period. Prospective capacity providers must meet certain eligibility requirements and prequalify before they can participate in the CM auctions.

The incentives helped to spur the overall increase in biomass burning at UK power plants and to the partial or complete conversion of a number of power plants to biomass as a feedstock.

Under the EMR, government predictions were for biomass burning capacity of between 1.7 and 3.4 gigawatts from co-fired or converted power stations by the end of this decade. However, it later anticipated that these predictions would be exceeded and that additional capacity, together with extra spending on biomass co-firing and conversions under the Renewables Obligation (RO), could eventually lead to a breach of its subsidy spending cap (the Levy Control Framework or LCF). The LCF restricts the aggregate amount levied from consumers by energy suppliers to implement Government policy. This cap was due to rise from £3.2bn in 2013/14 to £7.6bn by 2020/21. In 2017 evidence suggested that significant un-forecast deployment of biomass conversion and co-firing under the RO could result in additional costs to government, and ultimately consumers, of around £110m to £195m per annum (central estimate).

A consultation on changes to support for biomass conversions and co-firing was called in September 2017 and, as a result, new legislation on the level of subsidies was due to come into force from 1 April 2018.

Contracts for Difference

Contracts for Difference (CfD) were introduced as a market mechanism at the end of 2014 under the Energy Act 2013. CfD is the regulatory regime for supporting low carbon generation in Great Britain and replaces the former RO mechanism. The CfD reduces the risks faced by low-carbon generators by paying a variable top-up between the market price and a fixed price level, known as the 'strike price'.

Under the CfD, a generator is entitled to be paid the difference between the strike price (a price for electricity reflecting the cost of investing in a particular generation technology) and a notional electricity market reference price. The generator therefore receives revenue from two sources: from the sale of electricity in the market and from difference payments under the CfD. The cost of CfDs will ultimately be met by consumers via a levy on electricity suppliers.

3.3 UK energy mix

Coal

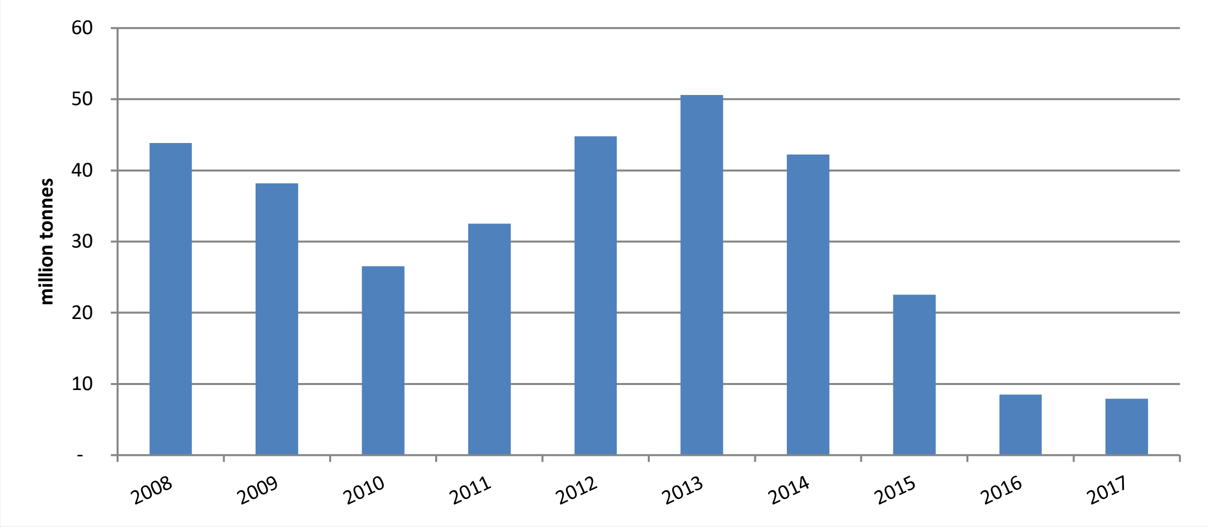
The recent changes in UK energy policy have led to a dramatic change in the supply and use of coal. Indigenous production fell to 4.2 million tonnes in 2016, 51% less than the previous year. The most recent data published by BEIS covering the first three quarters of 2017 indicates that production had fallen by a further 23% in 2017 compared with the same period in the previous year (2.3 million tonnes compared with 2.8 million tonnes).

Demand for coal was also down by 52% to 17.9 million tonnes in 2016 compared with 37.6 million tonnes in the previous year. For the period up to third quarter 2017 demand was down by a further 27% to 9.5 million tonnes compared with 13.9 million tonnes in 2016. The decrease reflected the fact that consumption by electricity generators was down by 28%. The decrease in the last quarter was shallower than in the year to date, due to Fiddlers Ferry and Eggborough coming back online as part of the Supplementary Balancing Reserve (SBR) - a short term safety net to cover peak demand periods.

As a result of the changes taking place in the industry, imports have also declined dramatically. Data issued by BEIS in December 2017 indicated that coal imports to the UK were 8.5 million tonnes in 2016, a decrease of 62.3% on the previous year's amount, mainly as a result of reduced power station demand. HMRC data for the full year indicates that total imports in 2017 were down by a further 7% to 7.9 million tonnes.

Trends in coal imports over the last 10 years are shown in Figure 1 below.

Figure 1: UK coal imports, 2008 to 2017



Source: BEIS Energy Trends/HMRC.

Most of the UK's coal-fired stations have closed or have switched to dual firing with biomass. A summary of the status of the remaining coal power stations can be found in Appendix 2.

Three large coal plants closed during 2016: Longannet, Ferrybridge C and Rugeley. Fiddlers Ferry had planned to close, but has put those plans on hold. Its future is uncertain as it has no contract to generate using coal for 2019/20 or 2020/21, but is reported to have prequalified for 2021/22. E.ON's Ratcliffe station (2 gigawatts) appears fully prepared for IED compliance and will continue to burn coal. Eggborough will close after September 2018.

Aberthaw Power Station is remaining open but will generate on reduced hours, providing power during periods of high demand. Aberthaw was designed to burn semi-anthracitic, low-volatile coal. A high percentage of this coal is sourced locally, mined in Wales, and is transported to the power station by rail. RWE invested over £9.5 million in Aberthaw, enabling the co-firing of carbon neutral biomass fuels such as sawdust and wood chips in the processing facility. This facility could supply up to 55 megawatts into the existing generating plant, replacing some of the coal burned. However the station has reported that there are no plans to use biomass as a fuel after mid-2017.

Cottam and West Burton will continue to operate at least until 2023 under the Limited Life Derogation scheme. This means that the plants can run without further modifications to reduce emissions for a further 17,500 hours or to the end of December 2023, whichever is the earlier.

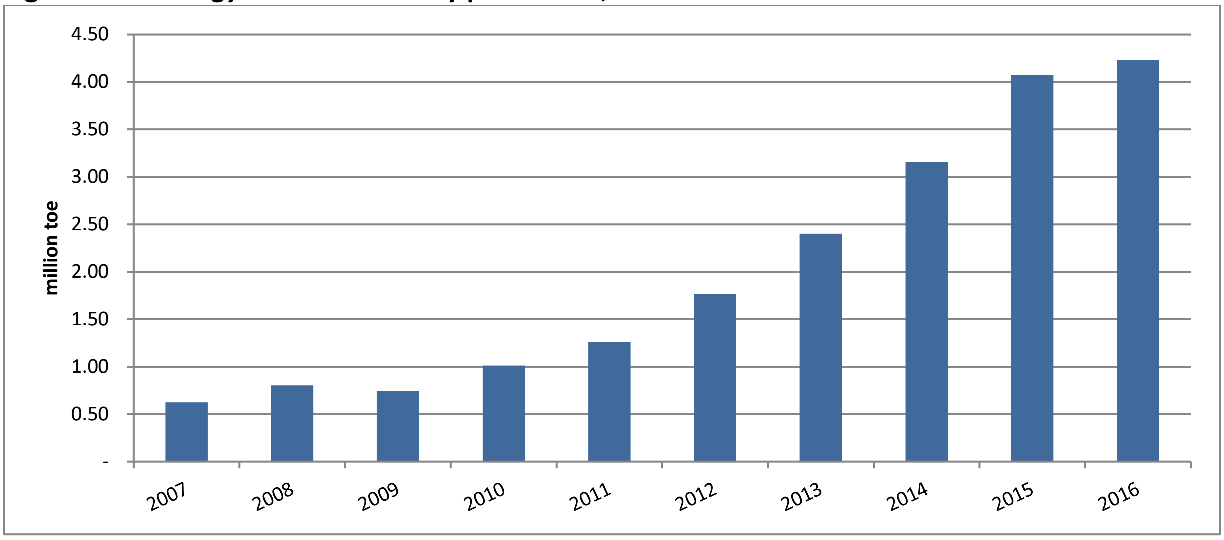
Renewables

Energy generated from renewable sources has been steadily increasing since 2000 as a result of national and international incentives including the EU Renewable Energy Directive, which requires the EU as a whole to derive 20% of its energy from renewable sources by 2020 (the UK's target is set at 15%).

The UK has a varied mix of renewable technologies, including biomass, which is a key fuel source in both electricity generation and heat. Wind, solar photovoltaics, hydro and shoreline wave and tidal also contribute to electricity generation and active solar, heat pumps and deep geothermal are used in heat generation.

Although solar photovoltaics was the leading technology in 2016 in capacity terms (a third of total capacity), in generation terms, bioenergy[6] accounted for the largest proportion (36%) followed by onshore wind (25%) and offshore wind (20%).

Figure 2: Bioenergy used in electricity production, 2007 to 2016



Source: BEIS.

UK biomass stations

A list of existing biomass stations is shown in Table 1 below. The principal biomass station is Drax, with almost 2,000 megawatts of installed capacity. The new biomass plant at Lynemouth (converted from coal) was expected to become operational in February 2018. The other stations are small in comparison and derive supplies for firing from domestic sources.

[6] Bioenergy consists of: landfill gas, sewage gas, energy from waste, plant biomass, animal biomass, anaerobic digestion and co-firing (generation only).

Biomass supplied from domestic sources consists largely of relatively small consignments of energy crops (straw, miscanthus, agricultural residues and short rotation coppice (SRC)) and are delivered by road transport.

Table 1: UK Biomass stations (as at May 2017)[(1)]

Company name	Station name	Fuel	Installed capacity (megawatts)	Year of commission or year generation began	Location: Scotland, Wales, Northern Ireland or English region
Drax Power Ltd	Drax - biomass units	Biomass	1,980	1974	Yorkshire and the Humber
E.On UK	Blackburn Meadows	Biomass	33	2015	Yorkshire and the Humber
	Steven's Croft *	Biomass	50	2007	Scotland
EPR Eye Ltd	Eye Suffolk	Biomass	14	1992	East
EPR Scotland Ltd	Westfield	Biomass	13	2000	Scotland
EPR Thetford Ltd	Thetford	Biomass	42	1998	East
Ferrybridge MFE Limited	Ferrybridge Multi-fuel	Biomass	79	2015	Yorkshire and the Humber
RWE Innogy UK Ltd	Markinch CHP *	Biomass	65	2014	Scotland
SSE[(2)]	Fiddler's Ferry[(2)]	Coal / biomass	1,961	1971	North West
	Slough *	Coal / biomass / gas / waste derived fuel	35	1981	South East
Sembcorp Utilities (UK) Ltd	Wilton 10	Biomass	38	2007	North East
* indicates combined Heat & Power (CHP) plant					

(1) *This list covers stations owned or operated by Major Power Producers (companies that produce electricity from nuclear sources plus all companies whose prime purpose is the generation of electricity), apart from non-thermal renewable sites under 30 megawatt capacity.*

(2) *Fiddlers Ferry Power station fires mainly with coal. Its future is uncertain as it has no contract for 2019/20 or 2020/21, but is reported to have prequalified for 2021/22. Although able to co-fire with biomass the station did not co-fire with biomass in 2015/16 and has not done so since.*

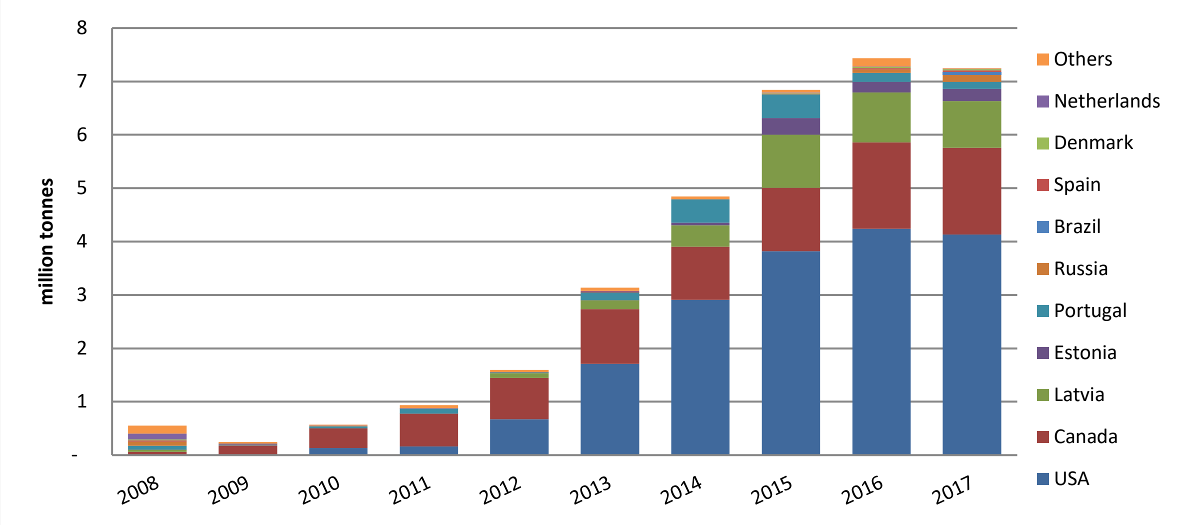
Source: DUKES/MDS Transmodal.

UK biomass imports

One of the main constituents of bioenergy in electricity production is wood pellets, most of which has to be imported. HMRC data confirms that imports had reached 7.4 million tonnes in 2016. The volume dipped slightly in 2017 to 7.2 million tonnes.✂

As shown in the chart below, USA and Canada are the principal origins of biomass imports to the UK. Secondary sources are the Baltic States of Latvia and Estonia.

Figure 3: UK imports of wood pellets imports by country of origin, 2008 to 2017

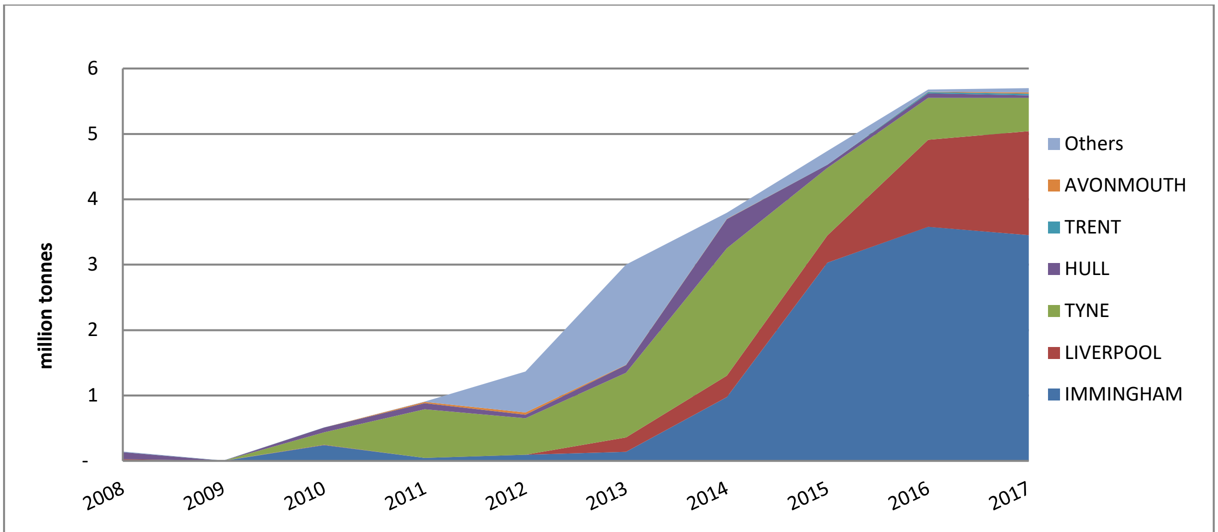


(1) Commodity code: Standard International Trade Classification (SITC) 24620.
Source: Based on HMRC statistics.

The principal ports involved in importing biomass are Immingham, Liverpool and Tyne (Figure 4). Hull is used to a lesser degree and more specifically for the smaller European supplied cargoes.

Imports from outside the EU by port of entry are shown in the chart below.

Figure 4: UK imports of biomass (1) from non-EU countries by port (2), 2008 to 2017



(1) Commodity code: Standard International Trade Classification (SITC) 24620.
(2) Note: Imports from EU member states is not available by port of entry.
Source: Based on HMRC statistics.

Main importers of biomass

It is a requirement of the RO that all operators of power stations submit details to Ofgem (Office of Gas and Electricity Markets) each year stating the fuel type, volume and country of origin of all materials used in energy production. Ofgem is a non-ministerial government department and an independent National Regulatory Authority, recognised by EU Directives.

The following figures are sourced from Ofgem's annual biomass sustainability report 2015/16. Data for 2016/17 is not yet published.

There are no records in the 2015/16 dataset for Fiddlers Ferry, and SSE has confirmed that the station did not co-fire with biomass in 2015/16 and has not done so since then. Records for Aberthaw station (which appears in the list of coal fired stations in Appendix 2) show that the station burns only domestically sourced material including woodchip and sawdust from local sawmills and oat husks from Scottish sources.

Drax

Drax has converted three units from coal to biomass. Ofgem data indicates that Drax co-fired with 6.6 million tonnes of biomass material in 2015/16.✂

Overseas supplies primarily come from North America (US and Canada), with lesser quantity from Brazil, and the balance coming from the Baltic States and Portugal. Most of this material is shipped to the UK in Panamax consignments[7] (60-80,000 tonnes).

[7] In ships built as large as practically possible, while still able to fit through the Panama canal.

4. LOGIT MODEL TO DISTRIBUTE BIOMASS TONNAGES BETWEEN A POWER STATION'S SOURCING OPTIONS

4.1 Biomass sources and transport routes

Drax uses several sources of biomass and several different transport routes to serve its biomass power station. Drax is likely to favour the cheapest source and transport route combination, and to choose to allocate the most traffic to that source and route. However to have better resilience in times of disruption and to avoid being dependent on any one source and route, Drax chooses several source and transport route combinations. These are primarily:

- From North America to a deep sea port (Tyne, Immingham or Liverpool), then by train to Drax;
- From European origins (mainly the Baltic) to Hull, then by train to Drax; and
- From domestic sources in Britain by road to Drax ✂.

Any change in the overall cost of sourcing via any of these routes is likely to change the balance between the options. For example if any one route became more expensive, some biomass would be likely to transfer to the other routes.

The objective of this report and the associated modelling is to establish how Drax would change its source and route options if some options were to have increased costs as a result of the introduction of ICCs (and therefore higher charges). As ICCs are charged on a per tonne kilometre basis, longer journeys pay higher ICCs per tonne. Increased ICCs are likely to result in a switch of some biomass from the routes involving long rail journeys (Liverpool and Tyne) to the routes involving short rail journeys (Immingham and Hull) and domestically sourced biomass by road. Drax would experience a higher overall cost for its delivered biomass, and the amount of rail freight moved (measured in tonne kilometres) would decrease, even if the overall tonnes delivered to Drax remained the same.

4.2 Developing a logit model

A logit model reflects the choice between several options based on cost, so it is a good model for reflecting the route shares in the base year, and then investigating how this balance changes when those costs are changed.

We have developed such a logit model (Biomass to Drax Transport Model (BDTM)) for the biomass traffic that travels from the four ports of Tyne, Hull, Immingham and Liverpool by rail, and domestically sourced biomass by road, to Drax, based upon the flow of traffic moving by rail[8] and road[9] in 2017 and the transport costs which are used in MDS Transmodal's GB Freight Model (Appendix 1).

[8]Source: HMRC trade data and Network Rail traffic data processed by MDS Transmodal.
[9] Source: Drax.

The logit model considers the five main route options open to Drax:

1. From North America to Tyne, then by train;
2. From North America to Immingham, then by train;
3. From North America to Liverpool, then by train;
4. From the Baltic to Hull, then by train; and
5. From domestic sources by road from Crewe.

The model then shares the traffic between these options based on the full cost of delivering biomass via each route (including all purchase and transport costs to Drax). The higher the cost of a particular route, the smaller the proportion of the overall market it is able to capture. Mathematically for biomass route option 'A':

$$S_A \propto e^{-\frac{C_A}{\beta}}$$

where:

- S_A = Route A's share of all the biomass traffic to Drax
- $\propto$ means: "is directly proportional to"
- e is the exponential function
- C_A = Full cost of delivering biomass to Drax via route A (including purchase costs)
- β = Logit distribution parameter. This defines how the traffic is spread amongst the various sourcing options. If a very high value is chosen, the cost of the route options is not very important and the model will allocate similar volumes of traffic to all five options unless there are very large differences in cost. If a very low value for β is chosen, cost is too important and the model will allocate nearly all of the traffic to the cheapest option, even if other options are only slightly more expensive.

We calibrated the model for the base year (2017) to ensure the proportions allocated by the model to each option reflect the actual volumes. This calibration involves choosing an appropriate logit distribution parameter (β) and then adding some "intangible" costs to each option to reflect the fact that our model cannot encompass all factors relevant to Drax's decision making process. Those 'intangibles' effectively include shipping and port costs.

In calibrating the model for 2017 and on the basis of our experience from the analysis of coal traffic in 2012 and our 'gaming' exercise (see Section 5) we concluded that an appropriate logit distribution parameter β was £0.50 per tonne.
In principle, the model can also make mode share choices from each port, but even for the nearest port (Hull), rail is much cheaper than road per tonne, even if rail charges increased significantly. For example, in 2023/24, transport costs are estimated to be £5.76 per tonne by road from Hull to Drax. Even in the extreme scenario where the variable usage charge (VUC) is quadrupled (+300%), the transport costs are still only £3.13 by rail. Therefore we made the assumption that biomass traffic from the four ports to Drax will all travel by rail. Domestically sourced biomass is assumed to be

transported by road because it was in 2017, and none of the cost-change options to be investigated involve rail becoming significantly cheaper. Volumes available domestically will not generate train load (and therefore economic) volumes from individual sources.

The logit model only outputs the changes in the *proportion* of traffic using each source and route as a result of changes in costs. However, following the logic of supply and demand, if the cost of delivered biomass to Drax increases overall, this will make their electricity more expensive to produce and they are likely to be able to sell less of it in the competitive electricity market. The results of the BDTM shown in Sections 4.3 and 4.4 ignore any reduced consumption as a result of increased costs. However, we consider this reduction in Section 4.5.

4.3 Biomass to Drax Transport Model (BDTM) results (without reduced consumption as a result of increased costs)

In 2017, tonnages and throughputs were as shown in Table 2, together with our estimates for road and rail costs. The logit model was calibrated to reproduce these 2017 tonnages. We forecast volumes for the 2023/24 base case[10] using the logit model, with the following changes in inputs from 2017:

- VUC increases in line with already published changes for 2018/19;
- Rail capacity charge abolished;
- Fuel duty for road diesel and rail diesel increased in line with WebTAG (TAG data book, December 2017. Table A1.3.7);
- HGV fuel purchase prices increased in line with Green Book supplementary guidance[11]. Rail fuel purchase prices derived; and
- Drivers' wages increased in line with WebTAG (TAG data book, December 2017. Table A1.3.7).
- ✂

[10]No increase in ICCs above that already committed to the end of Control Period 5 (2019).
[11]Green Book supplementary guidance: Valuation of energy use and greenhouse gas emissions for appraisal. Data tables 1 to 19: supporting the toolkit and the guidance. Table 8: Retail Road Fuel Prices (real 2017 p/litre).

Table 2: Port market shares: Biomass to Drax (base case)

	Immingham rail	Hull rail	Tyne rail	Liverpool rail	Domestic road	Total
Base 2017						
	✂	✂	✂	✂	✂	✂
	✂	✂	✂	✂	✂	✂
2023/24						
share	58.7%	7.9%	10.1%	23.1%	0.2%	100%
Estimated cost (£/tonne)	£2.40	£2.28	£3.59	£3.81	£13.94	
of which VUC	£0.30	£0.28	£0.54	£0.64	-	-
rail million tkm(1)	386	50	120	336	-	892

(1) Tonne kilometre.

Source: Biomass to Drax Transport Model (BDTM).

Notes

- The 2017 rail tonnes are from Network Rail traffic data processed by MDS Transmodal;
- The 2017 domestic road tonnes were provided by Drax;
- ✂
- The costs are based on cost models in MDS Transmodal's GB Freight Model (GBFM). They are based on generic modelling and do not imply access to any confidential information;
- The domestic road distance for the cost model is based on data sourced from Drax ✂; and
- In this report, tonne kilometres always refers to cargo (net) tonne kilometres i.e. not including the weight of the wagons themselves.

We then used the logit model to forecast the impact of increasing ICCs. These are represented as a percent increase in the VUC from the 2023/24 base case scenario. Essentially using the logit model in this way represents the decision making process of Drax in selecting port and mode when ICCs are higher.

Table 3: Biomass traffic to Drax in 2023/24 with increased ICCs

	Immingham rail	Hull rail	Tyne rail	Liverpool rail	Domestic road	Total
Base case						
share	58.7%	7.9%	10.1%	23.1%	0.2%	**100.0%**
‘000s tonnes	3,818	511	659	1,502	14	**6,504**
rail million tkm	386	50	120	336	-	**892**
VUC + 75%						
share	66.6%	9.1%	8.0%	15.8%	0.4%	**100.0%**
‘000s tonnes	4,335	595	522	1,028	25	**6,504**
rail million tkm	438	58	95	230	-	**821**
VUC + 100% (Central)						
Share	68.9%	9.5%	7.3%	13.8%	0.5%	**100.0%**
'000s tonnes	4,479	620	478	897	30	**6,504**
rail million tkm	452	60	87	201	-	**801**
VUC + 150%						
Share	72.6%	10.2%	6.1%	10.4%	0.6%	**100.0%**
'000s tonnes	4,725	665	396	676	42	**6,504**
rail million tkm	477	65	72	151	-	**765**
VUC + 200%						
Share	75.6%	10.8%	5.0%	7.7%	0.9%	**100.0%**
'000s tonnes	4,915	704	324	502	60	**6,504**
rail million tkm	496	68	59	112	-	**736**
VUC + 300%						
Share	79.2%	11.7%	3.2%	4.1%	1.7%	**100.0%**
'000s tonnes	5,151	762	210	268	114	**6,504**
rail million tkm	520	74	38	60	-	**692**

Source: Biomass to Drax Transport Model (BDTM).

Table 4: Biomass traffic to Drax, VUC revenue and composite costs in 2023/24 with increased ICCs

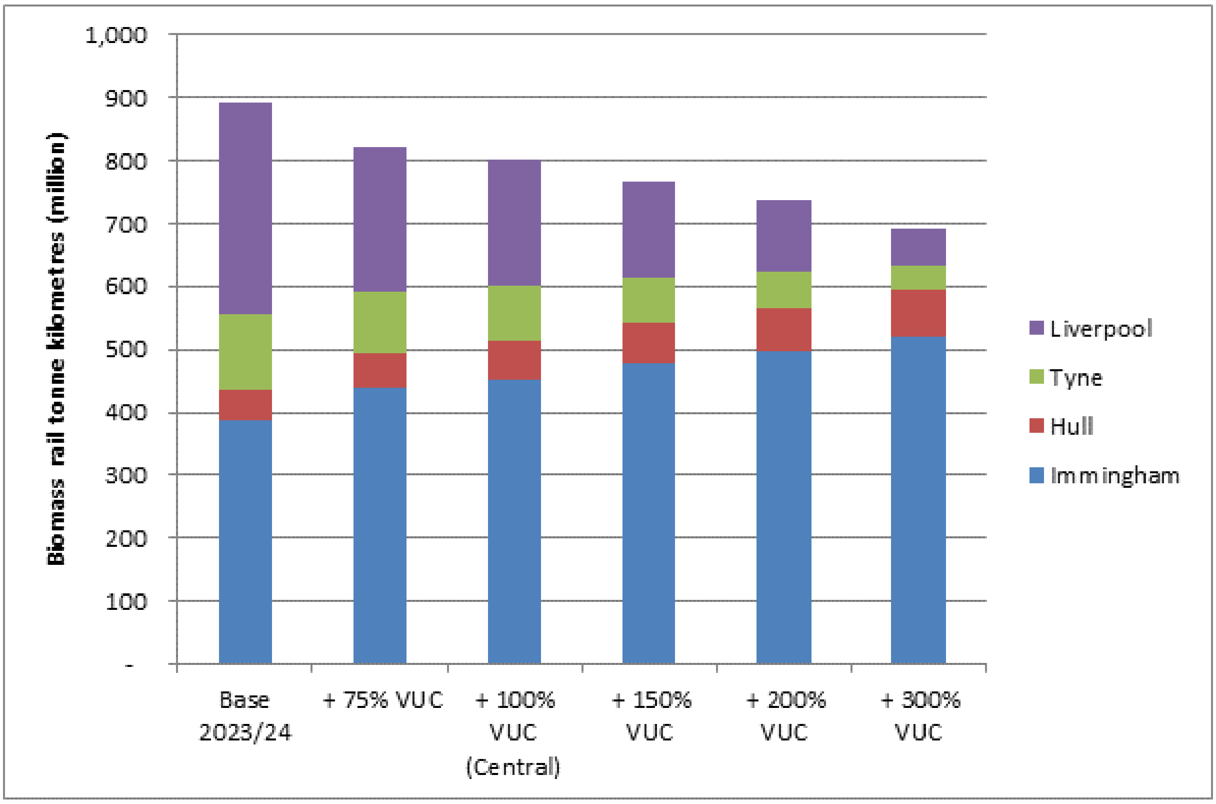
	Million tkm by rail, 2023/24 by VUC option	Annual VUC revenue (£m) to Network Rail for biomass destined for Drax	Composite delivered cost, 2023/24 (£/tonne)
Base VUC 2023/24	892	2.61	147.14
VUC +75%	821	4.21	147.43
VUC +100%	801	4.70	147.52
VUC +150%	765	5.63	147.69
VUC +200%	736	6.51	147.86
VUC +300%	692	8.19	148.19

Source: Biomass to Drax Transport Model (BDTM).

Notes:

- The ‘Composite delivered cost’ is a standard output from a logit model that represents the overall cost that Drax faces to receive biomass from its variety of sources (incorporating purchase and transport costs). It can be thought of as an average cost which also incorporates the benefits of having several choices. The purchase costs are sourced from UK trade statistics (HMRC); and
- In the base 2023/24 scenario, rail costs make up just 1.9% of the composite delivered cost, while VUC makes up just 0.3% of the composite delivered cost.

Figure 5: Biomass traffic to Drax in 2023/24 with increased ICCs



It can be seen that raising VUC has the effect of both reducing the total volume of rail tonne kilometres and raising the composite cost of biomass received at Drax.

The model suggests a doubling of VUC would lead to a 10.2% reduction in rail freight traffic (tonne kilometres) and a 0.26% increase (£0.38 per tonne) in the delivered cost of biomass, raising the total cost of inputs to Drax by £2.5m per annum in 2023/24. VUC revenue[12] to Network Rail per annum in 2023/24 for biomass traffic to Drax would rise by 81% from £2.61m to £4.70m.

4.4 Lynemouth (without reduced consumption as a result of increased costs)

Our forecast for 2023/24 is for 1.05 million tonnes of biomass to travel by rail from the Port of Tyne to Lynemouth[13] assuming no increase in ICCs above that already committed to the end of Control Period 5 (2019).

Lynemouth is planned to be supplied with biomass via the nearby port of Tyne. This is a short rail journey where VUC in the base 2023/24 scenario is only £0.14 per tonne. Large increases in VUC would have little impact on the choice of source or port because the proportion of overall costs made up by VUC is so small that large percent increases have little effect on overall delivered cost, and there are no other nearer suitable ports that the traffic could be easily transferred to.

Table 5: Transport costs and volumes from Tyne to Lynemouth and resultant VUC revenue and delivered costs in 2023/24, with increased ICCs

	Rail cost round trip £ per delivered tonne	Million tonne kms by rail, 2023/24 by VUC option	Annual VUC revenue (£ thousand)	Delivered cost, 2023/24 (£ per tonne)
Base VUC 2023/24	1.598	49	145	146.29
VUC +75%	1.702	49	254	146.39
VUC +100%	1.736	49	291	146.42
VUC +150%	1.805	49	363	146.49
VUC +200%	1.875	49	436	146.56
VUC +300%	2.013	49	582	146.70

Source: MDS Transmodal rail cost model for biomass rail costs.

Note:

- The delivered cost estimate is made up of the purchase costs (sourced from UK trade statistics (HMRC)) plus the rail costs from Tyne.

[12] ICC increases are represented in the model as VUC increases.

[13] Average of the 4 scenarios in the 2023/24 rail freight forecasts for Network Rail currently being consulted on.

4.5 Reduced consumption as a result of increased costs

The results above in Sections 4.3 and 4.4 assume that increases in ICCs (represented as percentage increases in VUC) only have an impact on the choice of biomass sources and transport routes, and have no impact on the overall consumption of biomass. However following the logic of supply and demand, if the cost of delivered biomass to the power stations increases, this will make their electricity more expensive to produce and they are likely to be able to sell less of it in the competitive electricity market.

In previous work in 2012 on the coal market for ORR[14] we estimated the elasticity of coal demand with respect to overall delivered cost for each power station. From this coal elasticity we derived an approximate elasticity for biomass, accounting for its lower calorific value per tonne. According to this elasticity, adding £1.08 per delivered tonne reduces biomass burn by 5%.

The nature of the electricity market has changed since 2012, so it is likely that the elasticities are different now. However this 2012 elasticity figure is an indication of the likely response to increased VUC if we make the assumption that the competitive responses in the electricity market in 2023/24 will be broadly similar to that in 2012.

In the central case (+100% VUC), we have a £ per delivered tonne increase of £0.38 per tonne for Drax and £0.138 per tonne for Lynemouth relative to the 2023/24 base. This results in a 1.8% decrease in biomass consumption at Drax and a 0.6% decrease in biomass consumption at Lynemouth. Overall this is a 1.6% decrease in biomass consumption across the two power stations.

In the central case (+100% VUC), these reductions in tonnes consumed reduce the overall rail tonne kilometres and VUC revenue slightly further than the results in Sections 4.3 and 4.4.

[14] "Impact of changes in track access charges on freight traffic. Stage 2 Report", July 2012: http://orr.gov.uk/__data/assets/pdf_file/0016/1780/mdst-freight-tac-changes-jul2012.pdf

Table 6: Biomass traffic and VUC revenue in 2023/24 incorporating reduced consumption elasticity in the central case (+100% VUC)

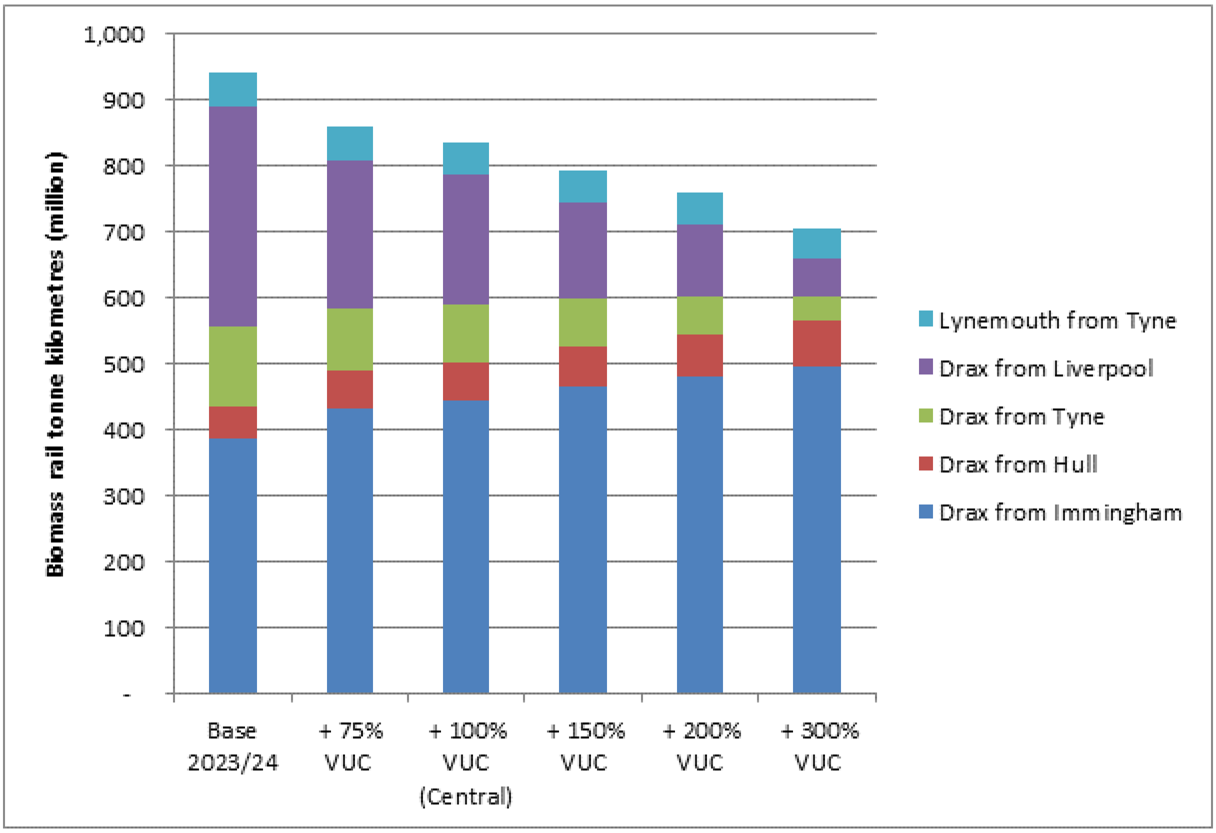
	Base 2023/24	Base 2023/24 + 100% VUC (Central). No reduced consumption elasticity	Base 2023/24 + 100% VUC (Central). Incorporating reduced consumption elasticity
Drax: Million tonnes	6.50	6.50	6.39
Rail million tkm	892	801	786
VUC revenue (£m)	£2.606	£4.704	£4.621
Lynemouth: million tonnes	1.050	1.050	1.043
Rail million tkm	49.0	49.0	48.7
VUC revenue (£m)	£0.145	£0.291	£0.289
Total biomass: million tonnes	7.55	7.55	7.43
Rail million tkm	941	850	835
VUC revenue (£m)	£2.75	£4.99	£4.91

Table 7 and Figure 6 show the resultant total rail tonne kilometres for each VUC increase scenario.

Table 7: Biomass traffic (rail million tonne kilometres) in 2023/24 for each ICC increase scenario, incorporating reduced consumption elasticity

Scenario	Drax by rail from…				Lynemouth from Tyne	Total	Change from 2023/24 base
	Imm'gham	Hull	Tyne	Liverpool			
Base 2023/24	386	50	120	336	49	941	
+ 75% VUC	432	57	94	227	49	859	-8.7%
+ 100% VUC (Central)	444	59	85	197	49	835	-11.2%
+ 150% VUC	465	63	70	147	49	794	-15.6%
+ 200% VUC	480	66	57	109	48	760	-19.2%
+ 300% VUC	495	70	36	57	48	707	-24.9%

Figure 6: Biomass traffic in 2023/24 for each ICC increase scenario, incorporating reduced consumption elasticity



These results show that increasing ICCs by the equivalent of doubling VUC would reduce biomass traffic by rail (as measured in tonne kilometres) by 11.2% and would increase VUC revenue from biomass by 78.5%.

MDS Transmodal

5. A GAMING APPROACH TO DRAX'S CHOICES OF PORTS

Only around 1% of total material input to Drax power station is sourced from within the UK ✂. The cargo from the ports moves almost exclusively by rail ✂.

In order to use maritime transport, Drax made significant investments within the ports' estates in storage and handling facilities and to make commitments to carriers. The reason that Drax chose to supply its feedstock through several ports can be assumed to be to enable it to retain negotiating strength over the different ports available and to ensure continuity of supply in the event of disruption. However, the transport costs faced by using the different ports are not the same.

An advantage that the port of Liverpool offers is that it is closer to the point of supply for most of that feedstock (North America), which cuts down sailing distances and ship's time. At current bunker and charter rates we estimate that this reduces costs by £0.60 per tonne compared with East Coast ports. However, Liverpool is the furthest by rail from Drax (224km by the main loaded route taken), which adds to inland transport costs. It is also faced with some difficulty in finding rail paths to reach Drax. The paths that are available result in trains operating very slowly, averaging only 37 kph. Furthermore, the number of paths available appears to be limited to around 5 per day, as compared with the 8 required every day if the full capacity of the port terminal is to be exploited (3 million tonnes).

We estimate that at present VUC levels and current rail asset utilisation, for trains from Liverpool, rail costs are £3.71 excluding handling (£3.81 per tonne in 2023/24) as compared with £2.35 ex Immingham (£2.40 in 2023/24, see Table 2). ✂. This implies Liverpool offers a discount in charges as compared with Immingham.

Tyne faces almost as long a rail freight journey (182km) for a cost of £3.51 per tonne but the same maritime cost as to Immingham. The Tyne must therefore offer a higher discount than does Liverpool to be competitive.

Hull handles the minority of feedstock that is from the Baltic (around 10% of total feedstock used) and cannot handle the Panamax ships that are used to ship Drax's North American cargo. ✂. We would not expect that a change in track charges would lead to a switch of any traffic to road in the long-term, because road costs per tonne are much higher (we estimate £5.55 per tonne versus £2.23 per tonne by rail). There would be a marginal impact on the competitiveness of Baltic versus North American feedstock and therefore an impact on volumes between ports.

Immingham handles the largest of the biomass flows into Drax and is probably able to charge the highest rates because its proximity and its deep-water provide it with a competitive advantage. It is important to note that under the 1963 Harbours Act, individual ports are entitled to charge whatever the market will bear, being effectively regulated only by competition from other ports. In principle, therefore, port companies are able to reflect the geographical advantage their location offers them in their pricing, which will, of course, reflect the costs faced by users in accessing the road and rail networks that connect the ports to inland origins and destinations.

We believe the impact of a change from the current cost structure from the three deep-water ports can be represented as follows, together with the consequences of 'game playing' between the commercial actors:

- A substantial increase in VUC would lead to little or no impact on flows from Tyne to Lynemouth (the power station already uses the nearest deep-water port and is rail connected).
- A substantial increase (say a doubling) in VUC to Drax would lead to Drax feeling forced to reduce its costs to retain competitiveness in the energy market by transferring its cargo from Tyne to Immingham (to reduce rail costs) and also Drax considering switching some Liverpool traffic to Immingham.
- However, Drax would fear Associated British Ports (ABP) would raise charges if there was no competition from other ports, more than eliminating any saving made through concentrating traffic on the nearest deep-water port by reducing rail length of haul.
- We believe Drax would therefore leave sufficient traffic at Liverpool to justify a regular flow of traffic ✂ to protect its otherwise weakened negotiating position.

6. SUMMARY & CONCLUSIONS

We have considered the impact of an increase in track access charges (modelled as an increase in VUC) on the biomass market on the volume of freight carried in Great Britain in 2023/24, measured by tonne kilometres. The majority of biomass material used for power generation in Britain will be used by the Drax power station, with a smaller amount to Lynemouth. We have considered the wider energy market, the position of biomass within that market and the prospects for any extension of the use of biomass for power generation. We believe that the prospects for making further use of biomass for power generation are low given the level of competition it now faces from other renewables.

We have developed a logit model to model the effects of the introduction of ICCs on biomass traffic. This is similar to the model developed in 2012 for ORR to analyse the impact of higher VUC for the coal market. We have supported this by considering the gaming that could take place between the commercial actors.

Our approach was to model the way in which transport routes are selected and the impact on cost to the electricity generators. We believe that the principal impact of a rise in VUC will be for the principal generator to make greater use of nearby ports, effectively substituting rail freight use in favour of maritime transport and potentially reducing the number of ports used.

Our conclusion is that the principal impact would be to divert biomass from those ports furthest from Drax (Liverpool and Tyne) to Immingham and Hull and therefore reduce the amount of rail freight moved. There would also be an increase in the overall cost of inputs to Drax and Lynemouth, which would have a marginal and negative impact on the volume of biomass moved because it would be less competitive versus alternative energy sources.

Our modelled impacts on rail tonne kms of biomass traffic are summarised below considering various potential increases in ICCs (represented as percentage increases in VUC).

Table 8: Biomass traffic (rail million tonne kilometres) in 2023/24 for each ICC increase scenario, incorporating reduced consumption elasticity

Scenario	Drax by rail from…				Lynemouth from Tyne	Total	Change from 2023/24 base
	Imm'gham	Hull	Tyne	Liverpool			
Base 2023/24	386	50	120	336	49	941	
+ 75% VUC	432	57	94	227	49	859	-8.7%
+ 100% VUC (Central)	444	59	85	197	49	835	-11.2%
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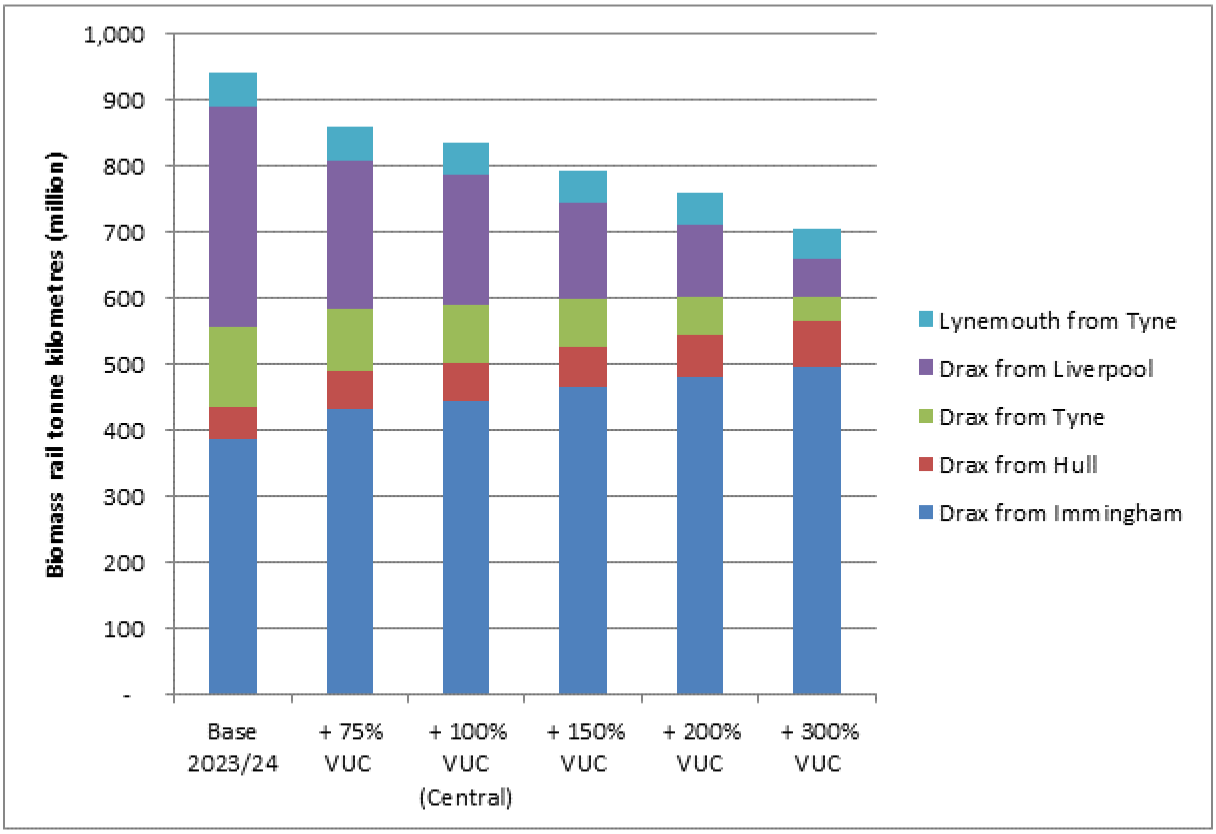
+ 200% VUC	480	66	57	109	48	760	-19.2%
+ 300% VUC	495	70	36	57	48	707	-24.9%

(1) Table 8 is the same as Table 7.

Figure 7: Biomass traffic in 2023/24 for each ICC increase scenario, incorporating reduced consumption elasticity



(1) Figure 7 is the same as Figure 6.

Our overall conclusion is that in 2023/24 the effect of increasing ICCs by the equivalent of doubling VUC would reduce biomass traffic by rail as measured by tonne kilometres by 11.2% as compared with there being no change, and would increase VUC revenue from biomass to Network Rail by 78.5%. This would be the result of the principal consumer of imported biomass, Drax, concentrating more of its import traffic through nearby ports.

APPENDIX 1: TRANSPORT COST MODELS IN 2023/24

We have derived generic road and rail cost models for inland biomass traffic in the UK. This involves a bottom-up approach incorporating the various cost inputs that a road or rail haulier faces such as fuel, drivers' wages, asset purchase or leasing costs and track charges.

For 2023/24, the cost models incorporate changes from 2017 as follows:

- VUC increases in line with already published changes for 2018/19;
- Rail capacity charge abolished;
- Fuel duty for road diesel and rail diesel increased in line with WebTAG (TAG data book, December 2017. Table A1.3.7);
- HGV fuel purchase prices increased in line with Green Book supplementary guidance. Rail fuel purchase prices derived; and
- Drivers' wages increased in line with WebTAG (TAG data book, December 2017. Table A1.3.7).

Rail

The resultant cost model for rail in 2023/24 per tonne is:
£0.915 + £0.00836 per km loaded (port to power station) + £0.00626 per km unloaded (power station to port)

Road

The resultant cost model for road in 2023/24 per tonne is:
£2.08 + £0.0322 per km

APPENDIX 2: UK COAL POWER STATIONS

The table below summarises the status of the remaining coal power stations in the UK (including Kilroot in Northern Ireland). Only the first four in this list will definitely remain open up to 2021. The far right column provides a summary of the outcome of the latest Capacity Market mechanism - part of the EMR package in the UK which aims to secure supply by guaranteeing revenues to reliable sources while phasing out older power stations.

UK coal power stations – status (as at March 2018)

Site	Owner	Capacity (megawatts)	Age (years)	Status	Notes	Capacity market
Ratcliffe	E.On UK	2,000	50	No plans to close	Compliant with the EU Industrial Emissions Directive.	Yes – all 4 units contracted for the three winters 2018/19-2020/21.
Drax units 4-6	Drax Power	1,935	32	No plans to close	4th unit will convert to biomass in late 2018. Plans to convert remaining 2 to gas.	Yes –2 remaining coal units contracted for 2018/19-2020/21.
Cottam	EDF Energy	2,008	49	No plans to close	"Exploring options".	Yes – Contract for 2018/19 but not beyond.
West Burton A	EDF Energy	2,012	51	No plans to close	"Exploring options"	Yes (3 of 4 units) – contracts for 2018/19 and 2020/21 but missed capacity market milestone for 2019/20.
Aberthaw B	RWE Npower	1,586	47	Planning reduced running	Operated on reduced hours from April 2017. Lost EU legal challenge over air pollution rules.	Yes – contracts for 2018/19-2020/21.
Fiddlers Ferry	SSE	1,961	47	Not clear	4th unit failed to win contract for 2018/19.	Yes (3 of 4 units) for 2018/19 but no contract for 2019/20 or 2020/21. Prequalified for 2021/22.
Kilroot	AES	520	37	Plans to close after May 2018	Failed to win "All-Ireland" capacity market contract and so plans to close.	N/A (Cap Mkt is GB only).
Eggborough	Eggborough Power	1,960	51	Plans to close after September 2018	Announced closure after missing out on 2018/19 capacity market. Hopes to build gas plant on the site.	Yes – contract for 2017/18 but not beyond.
Rugeley	ENGIE	1,006	46	Closed	Switched off 8/6/2016.	No
Lynemouth	Lynemouth Power	420	46	Closed pending	Biomass conversion got EU State Aid approval in 12/2015.	No

Site	Owner	Capacity (megawatts)	Age (years)	Status	Notes	Capacity market
				biomass conversion	Coal generation ended in 2015. Due to become operational in February 2018.	
Longannet	Scottish Power	2,260	48	Closed	Switched off 22/3/2016.	No
Ferrybridge C	SSE	980	52	Closed	Official shutdown 31/3/2016.	No
Uskmouth	SIMEC	363	59	Not clear	New owner plans to convert to burn waste; had planned biomass conversion. Currently mothballed and not generating since April 2017.	No

Source: CarbonBrief, Feb 2016/ MDS Transmodal March 2018.