Impact of changes in track access charges on freight traffic

Stage 2 Report:
Impact of increases of above 100% on specific commodities

by

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EXECUTIVE SUMMARY

Following on from our stage 1 study[1] (which considered the impact of Variable Track Access Charge (VTAC) increases of up to the equivalent of 100% of current Variable Usage Charges (VUC) on all rail freight sectors), the ORR commissioned MDS Transmodal to consider the impact of significantly larger increases in VTAC for those commodities that appeared to be the most inelastic from the stage 1 study: Electricity Supply Industry (ESI) coal, Biomass, Nuclear, Metals, Ores and Other coal.

ORR asked us to consider increases in VTAC for each commodity of: +£5, +£10 and +£15 per thousand net tonne kms. ORR proposed these options on the basis that a charge set to recover freight avoidable costs might be around this range. Current average VUC rates vary between commodities but for these commodities they are in the range £2.20 to £3.00, with the exception of nuclear, which is over £9.00[2].

ESI Coal: For this study MDS Transmodal have developed the Coal Power Station Transport Model (CPSTM). The CPSTM:

- Suppresses the demand for coal as a function of a delivered price that includes inland transport costs: we estimate that +£1.53 per delivered tonne reduces coal burn by 5% at each power station, based on parallel work by NERA[3]
- Redistributes the origins and destinations of ESI coal within Great Britain
- Adjusts the mode share of coal traffics upon changing the transport costs
- Allows *cost absorption responses* to be input for each pit and port to indicate how they may adjust their gate prices upon changes in demand.
- Calibrates to existing flows so that pit-specific production costs and port-specific relative costs such as deep water (lower shipping costs) at Hunterston can be represented
- Uses a multinomial logit algorithm to assign traffic

Our central case scenario assumes that rail freight traffic for the modelled year of 2018/19 does not change from the current distribution and levels, apart from the removal of traffic to power stations that are due to close. It also assumes that all pits accept a £1.00 per tonne decrease in gate price if they experience a 10% decrease in demand, and that all ports are half as responsive as the pits[4]. Modelled results for a VTAC increase of £10 / thousand net Tkms suggest that:

- Overall coal tonnes to power stations decrease by 2.6%, with tonnes transported *by rail* decreasing by 3.7% from 34.9m to 33.6m.
- Tonne kms by rail decrease by 23% from 5.49 to 4.23 billion.
- Average Length of Haul (ALOH) – decreasing by 20% from 157km to 125km. This is still substantially higher than the ALOH in 1990 (pre-privatisation) of 66km.
- Average price increases by £0.80 per delivered tonne of coal to power station. Delivered prices of coal vary in the market place but are around £90 per tonne.
- Modelled VTAC paid for ESI coal (existing VUC + extra VTAC) would be £51.8m: up from £12.35m under current VUC.

[1] www.rail-reg.gov.uk/pr13/PDF/mdst-freight-tac-changes-feb2012.pdf
[2] For ESI coal, an increase of £10 per thousand net tonne kms equates to an increase of £8 per thousand ***GROSS*** tonne ***MILES***
[3] www.rail-reg.gov.uk/pr13/PDF/nera-coal-report-may-2012.pdf
[4] This relationship is based on our considered judgement, and is subject to sensitivity testing.

- Pits, ports and power stations that require long distance transport experience increased cost and reductions in demand: Ayrshire pits lose 24% of their traffic despite reducing gate prices by £2.50. Conversely those requiring short hauls such as pits near to the Aire Valley power stations benefit due to reduced competition.
- Overall road traffic would be little affected: Traffic from road-only pits direct to power station by road would increase, but traffic from road-only Scottish pits to rail heads would decrease.

Nuclear: Transporting spent nuclear fuel by rail is already significantly more expensive than it would be by road, but security and political reasons prevent road being used. Current VUC is £9.13 / thousand net Tkms. Increasing VTAC by £15 / thousand net Tkms would increase transport costs by 4.2% for the most distant power station. An alternative transport solution of a small roro ferry service completing a weekly circuit of Britain was investigated. This would approximately double transport costs compared to using rail. An increase in VTAC of £15 per thousand net Tkms is therefore unlikely to impact on nuclear traffic.

Iron Ore: Iron ore is transported from Immingham to Scunthorpe for the steel industry. Rail costs are significantly lower than road costs, so there would be no modal switch to road upon increasing VTAC. A £10 / thousand net Tkms increase in VTAC would raise rail costs by £0.36 per tonne. This would add approximately 0.3% to the delivered cost of iron ore and 0.1% to the cost of steel production.

Other Coal: Several types of traffic make up “other coal” including:
1: Coking coal or coke to steelworks. Rail is significantly cheaper than road so there is little prospect of mode shift to road upon increasing VTAC. However there may be some switching of sources for the longer distance flows, and increased VTAC would feed through into increased steel production costs.
2: Coal to other industrial plants – largely cement works. Not all cement works have maintained rail connectivity, and traffic volumes rarely warrant full daily trains – which reduces rail’s attractiveness. Significant increases in VTAC would therefore lead to some loss of rail traffic.

Biomass: Biomass is a developing market with various uncertainties. Co-firing with coal at existing power stations is likely to be the most suitable traffic for rail. There is competition between sources and from road – with many domestic sources not rail connected. However imports to inland power stations would remain competitive by rail upon increased VTAC, but sourcing from distant ports would be discouraged. VTAC increases may also deter future investment.

If VTAC was increased by £10 / thousand net Tkms for ESI coal, coal and iron ore to steel blast furnaces and for nuclear flasks, this would raise an additional £44m VTAC revenue per year.

1. INTRODUCTION

MDS Transmodal recently completed a study for the ORR into the impact of changes in track access charges on all rail freight commodities for the year 2018/19 where the maximum increase in Variable Track Access Charges (VTAC) was no more than the equivalent of 100% of current Variable Usage Charges (VUC) for all commodities (Stage 1 report[5]).

The ORR then commissioned MDS Transmodal to consider the impact of significantly larger increases in VTAC for those commodities that appeared to be the most inelastic from the previous study: Electricity Supply Industry (ESI) coal, Biomass, Nuclear, Metals, Ores and Other coal (Stage 2 report). The ORR proposed that we should consider these commodities further because its preliminary analysis suggested that the revenue that they would generate would be sufficient to recover the associated freight avoidable costs. For more details please refer to the ORR's consultation (www.rail-reg.gov.uk/pr13/consultations/freight-charges.php).

The maximum VTAC increases equivalent to a 100% increase in VUC considered in the Stage 1 report correspond to the following absolute increases in the cost of rail freight transport measured in net tonne kilometres:

- ESI Coal: +£2.25 / Thousand ***Net*** Tonne km
- Biomass: +£2.30 / Thousand ***Net*** Tonne km
- Metals: +£2.55 / Thousand ***Net*** Tonne km
- Ores: +£2.39 / Thousand ***Net*** Tonne km
- Other Coal: +£2.97 / Thousand ***Net*** Tonne km

For this follow-on work, the absolute ***increases*** considered for each of these more-resilient commodities are:

- + £5 / Thousand ***Net*** Tonne km
- + £10 / Thousand ***Net*** Tonne km
- + £15 / Thousand ***Net*** Tonne km

Nuclear traffic is dealt with separately as described in chapter 7 below.

The most significant component of this new work has been developing the Coal Power Station Transport Model (CPSTM) for ESI coal. This market has been considered in detail and has involved developing a model specifically for this study, in discussion with NERA who were commissioned in parallel to assess the impact of the changes on the demand for coal in the energy market. In the case of the other commodities, a quantified approach has been adopted based upon available evidence by undertaking an analysis of the comparative costs for the competing modes.

[5] Impact of changes in track access charges on rail freight traffic. Stage 1 report by MDS Transmodal. Feb 2012: www.rail-reg.gov.uk/pr13/PDF/mdst-freight-tac-changes-feb2012.pdf

2. VUC, COST MODELS AND VTAC

The Variable Usage Charge (VUC) is currently levied on a per ***GROSS*** tonne km basis rather than per ***Net*** tonne km. Current charges are based on the track damage caused by the wagons and locomotives including any empty return journeys are charged for. The average *net* figures for each commodity are calculated by dividing the total VUC payable by the total *net* tonne kms. Similarly the average *gross* figures are calculated by dividing the total VUC payable by the total *gross* tonne kms. The calculated average VUC rates per ***net*** tonne km are typically around double the per ***gross*** tonne km rate. Currently the average per net and per gross tonne km rates are:

- ESI Coal: £2.25 / Thousand ***Net*** Tonne km, or £1.12 / Thousand ***Gross*** Tonne km.
- Biomass: £2.30 / Thousand ***Net*** Tonne km, or £1.15 / Thousand ***Gross*** Tonne km.
- Metals: £2.55 / Thousand ***Net*** Tonne km, or £1.19 / Thousand ***Gross*** Tonne km.
- Ores: £2.39 / Thousand ***Net*** Tonne km, or £1.27 / Thousand ***Gross*** Tonne km.
- Other Coal: £2.97 / Thousand ***Net*** Tonne km, or £1.32 / Thousand ***Gross*** Tonne km.
- Nuclear: £9.13 / Thousand ***Net*** Tonne km, or £1.47 / Thousand ***Gross*** Tonne km.

Road and rail cost models were used in both the stage 1 study and this stage 2 study. The cost models are built up by summing the various costs experienced by a freight haulier, including fuel, drivers' wages, loco / wagon / HGV depreciation, taxes, maintenance, insurance etc. For rail, track access charges also need to be included for the relevant commodity and wagon/loco: VUC, freight-only line charges, coal spillage and coal spillage reduction charges. These costs come from a wide variety of sources – both public domain (ORR, RHA, DVLA, HMR&C, Motor Transport cost tables etc), our industry experience and industry data held by MDST.

The cost models are regularly used and validated by both public and private sector clients (including operators), and have been used to inform a number of high profile projects for the DfT (e.g. longer semi-trailers). They are inputs into MDS Transmodal's GB Freight Model (GBFM). GBFM has been independently validated by the DfT and forms part of the National Transport Model.

Variable Track Access Charges (VTAC) include the current VUC. The increases in VTAC considered in this study are compared to current VUC levels in this report, but these increased charges (if levied) would be a separate new VTAC charge.

3. ESI (POWER STATION) COAL

In MDS Transmodal's stage 1 report, the most significant impact of increasing VTAC on ESI coal was judged to be on competition between coal and other energy sources. In most cases other effects such as changing the origin to destination pattern and mode switch to road, sea or barge were considered less significant because at the level of charges being considered the cost advantages of rail over other modes where most traffic was between rail connected sites was small. These secondary effects were not modelled in stage 1.

However increases of the order considered here are such a radical departure from the status quo that such secondary effects do need to be considered, alongside modelling competition with other energy sources.

MDS Transmodal have therefore developed the Coal Power Station Transport Model (CPSTM). The CPSTM:

- Suppresses the demand for coal as a function of a delivered price that includes inland transport costs (drawing on NERA's analysis of the energy market)
- Redistributes the origins and destinations of ESI coal within Great Britain and
- Adjusts the mode share of coal traffics to power stations upon changing the transport costs.

The engine behind the CPSTM is a multinomial logit algorithm which allows for changes in both route choice and mode choice.

The **modelling methodology** for the first stage of the ESI coal modelling is as follows:

1. Establish the recent traffics between port and pit, and power station – both by rail and road.
2. Calculate the transport costs for all these traffics, of which VTAC is a component for that by rail.
3. Input these origin to destination costs into a logit-based model to arrive at an uncalibrated estimate of all traffics.
4. Adjust the logit parameter such as to reflect the spreading of origins and destinations – i.e. the extent to which power stations are keen to source their coal from sources other than just the lowest cost option largely to increase the diversity of supply. This should approximately recreate the average length of haul for coal traffics.
5. Calibrate the model by introducing a calibration cost for each pit, port and power station. Repeatedly run the model with different calibration costs until the modelled tonnages for each pit, port and power station match the observed traffics.
6. Revisit the logit parameter if necessary and recalibrate.

The power station coal origin destination matrix used in this modelling as the base case (i.e. no increases in VTAC) is intended to be indicative of the likely traffic pattern in 2018/19. It is based on actual annual rail traffics (source: Network Rail) for the 12 months up to the end of September 2011. However because Ironbridge, Didcot and Cockenzie power stations will have closed by 2016, their traffics have simply been removed from the matrix thus reducing total ESI coal tonnes by rail by 4.7%. There are various factors that suggest there may be a decline in coal burnt for electricity generation in the coming years such as the need to purchase carbon allowances under the EU Emissions Trading Scheme, and to pay for the UK Government's Carbon Price Floor. However recent data for the 6 months from October 2011 to March 2012 (i.e. the 6 months after the end of the base year for this study) shows an increase in tonnes of 13% compared to the same 6 month period the previous year.

Rail covers the vast majority of ESI coal transport in Britain. However there are also road movements – both direct from pit to power station, and in Scotland from pit to railhead for onward rail transport. The rail matrix has therefore been supplemented by these road movements. To avoid double-counting, those road movements from road-only pit to nearby railhead have been linked to the onward rail movements to generate a through journey from road-only pit to power station.

The road data is sourced from the DfT's Continuing Survey of Road Goods Transport (CSRGT). This is a continuous survey of GB-registered HGV movements whereby a random sample of HGV owners are asked to keep a diary of all their movements for one week. The results are then scaled up to represent all movements on the road network. However, because the sample size is relatively small, when considering specific origins and destinations for coal, the results can be based on very few surveyed HGVs, and the results are often 'lumpy'. Highly disaggregated CSRGT data is also commercially confidential. When sufficiently aggregated, the data is not commercially confidential and we can be more confident in the results as shown in the matrix below.

There is also modal competition for coal from Hunterston to Fiddlers Ferry - between a direct rail service and the option of feeder ship to Ellesmere Port plus a short rail journey to the power station. This is dealt with in the model by considering Ellesmere Port as a separate port in competition with all other sources. As the rail journey from Ellesmere Port to Fiddlers Ferry is short, increased VTAC adds little to the cost, compared to the cost impact on the direct rail route from Hunterston to Fiddlers Ferry.

Table 1: (Actual traffics. Origin destination matrix: base case. Thousand Tonnes per year: *redacted from the published report for confidentiality reasons*) shows that total tonnes by rail in the base case 12 month period was 35.1 million tonnes. Total tonne kms by rail was 5.493 billion Tkm so that the Average Length Of Haul (ALOH) for rail was 156 km. Road journeys (both direct to power station and to a railhead) make up 10% of tonnes.

The transport cost models used for ESI coal per tonne produce these results:

- Rail: £0.90 + £0.0135 x one-way-distance (km).
- Road: £1.40 + £0.0729 x one-way-distance (km).

These represent the round trip costs (including returning empty) for each mode.

The VUC component of the rail cost is 17% of the total per km cost under current conditions (VUC = £0.00225 per net tonne km). Therefore the total VUC that would be paid at current rates on this traffic would be: £12.36 million (5.493 billion tonne km @ £0.00225).

If these traffic levels and their travel patterns continued unaffected by increases in VTAC (i.e. zero elasticity with respect to transport costs), the VTAC (existing VUC + extra VTAC) paid by ESI coal would be:

- £39.8m for a VTAC increase of + £5 / Thousand ***Net*** Tonne km
- £67.3m for a VTAC increase of + £10 / Thousand ***Net*** Tonne km
- £94.8m for a VTAC increase of + £15 / Thousand ***Net*** Tonne km

In the modelling, the calibration process ensures that the *total* traffic for each pit, port and power station matches actual base case traffics. However the nature of a logit model is that it is continuous: with traffic going between each origin and each destination, albeit often in very small volumes. The real world is much more ‘lumpy’ than this, but the modelled OD matrix should be a reflection of the real world OD matrix if many of the smaller modelled flows switched to similar larger flows.

Table 2: Modelled calibrated recreation of base case traffics. Thousand Tonnes per year

	Power Stations								
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Total
Daw Mill	194	257	104	1,447	0	9	872	0	2,883
Ayrshire	353	58	112	13	150	0	12	28	726
Kellingley / Hatfield	1,869	435	43	125	0	0	18	0	2,490
Welbeck / Thoresby	435	737	33	440	0	0	63	0	1,708
South Wales	10	14	11	77	0	1,093	73	0	1,278
Ravenstruther	416	68	132	15	336	0	14	33	1,016
But'well / Wid'ton	444	73	10	21	1	0	3	261	812
Maltby / Harworth	181	192	4	41	0	0	6	0	424
Total rail-conn pit	3,902	1,834	450	2,179	487	1,102	1,060	323	11,338
Ports (all rail-connected)									
Humber	7,007	2,983	72	536	0	0	76	1	10,675
Hunterston	904	149	288	33	1,948	0	30	72	3,424
Tyne / Blyth	1,557	256	36	73	1	0	10	284	2,217
Liverpool	407	95	1,421	126	0	0	115	0	2,163
Avon/Portb	27	36	30	202	0	817	191	0	1,303
Redcar	730	120	17	34	0	0	5	12	918
Ellesmere Port	104	45	445	56	0	0	51	0	703
Leith	79	13	12	1	103	0	1	44	254
Newport	1	1	1	7	0	96	7	0	113
Total port	10,816	3,698	2,321	1,070	2,052	913	488	413	21,771
Road-only pits England and Wales. Mostly direct by road to power station	29	662	578	175	0	5	53	54	1,556
Road-only pits in Scotland. Direct to PS	0	0	0	0	272	0	0	0	272
Road-only pits in Scotland. Via railhead	838	138	267	31	375	0	28	66	1,744
Grand Total	15,585	6,332	3,616	3,455	3,187	2,021	1,630	856	36,680

Modelled results are:

- Tonnes by rail: 34.9m (actual 35.1m)
- Tonnes kms by rail: 5.49 billion (actual 5.49 billion)
- ALOH: 157 kms (actual 156 kms)

Modelled total VUC paid at current rates would be £12.35m, of which £2.35m would be paid for use of tracks in Scotland.
Modelled road journeys (both direct to power station and to a railhead) make up 9.7% of tonnes.

These summary figures are all very close to the actual traffics. The individual modelled origin to destination traffics are representative of the sorts of flows that currently exist although the specific links between origin and destination are not necessarily the same as the actual traffics.

The calibration costs required for each pit and port to arrive at the modelled base case traffics are shown below:

Table 3: Calibration costs (£ per tonne)

Rail-connected pits	Total
Daw Mill	11.7
Ayrshire	9.2
Kellingley / Hatfield	12.7
Welbeck / Thoresby	12.8
South Wales	10.9
Ravenstruther	9.4
But'well / Wid'ton	11.2
Maltby / Harworth	13.7
Ports (all rail-connected)	
Humber	11.3
Hunterston	7.8
Tyne / Blyth	10.9
Liverpool	11.8
Avon/Portb	11.0
Redcar	11.9
Ellesmere Port	12.5
Leith	10.2
Newport	12.8
Road-only pits England and Wales	6.9
Road-only pits in Scotland	5.4

These calibration costs are port and pit-specific constants which represent the *relative* price of coal upon leaving the pit or port. They include unmodelled cost factors such as Hunterston being able to accommodate very large ships (i.e. cheaper cost per tonne to reach the port), a pit having particularly high or low costs or a port or pit being able to charge a higher margin than its competitors because of its own locational or physical advantages. For example, the comparison of the calibration factors for Hunterston and the Humber suggests that coal is over £3 per tonne cheaper as it leaves Hunterston than coal from the Humber. Similarly coal from rail-connected pits in Ayrshire appears to be £2 to £3 cheaper than coal from English pits. There are also other unmodelled factors, so this comparison of calibration factors should not be assumed to rigorously represent the relative costs of pits and ports. Nevertheless, our results do appear to reflect the maritime cost savings of large ships through Hunterston, the ship feeding costs from Hunterston to Ellesmere Port, the ability of the Humber to charger more than the Tyne and the lower relative prices accepted by the Scottish pits.

By using the origin to destination transport costs and adding in the calibration factors, the *relative* delivered costs for each cell in the origin destination matrix can be calculated. These *relative* costs are more meaningful if they are uplifted by a fixed £/tonne for each cell such that they represent the modelled delivered cost of coal to power stations as described. Recent trade data suggests that the average delivered cost of coal to power stations in Britain is approximately £90 per tonne (i.e.

including the cost of transport and the coal itself). Table 4 takes that price as a mean value and uses transport costs to reflect how this varies by pit or port to power station flow.

Table 4: Delivered costs to power station £ per tonne

	Power Stations								
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Weighted Average
Daw Mill	91.0	90.8	91.4	89.8	99.3	92.8	90.1	96.2	90.1
Ayrshire	90.6	91.7	91.3	92.6	91.1	96.1	92.7	92.1	91.0
Kellingley / Hatfield	89.6	90.5	91.9	91.2	98.5	96.0	92.4	94.8	89.9
Welbeck / Thoresby	90.5	90.2	92.0	90.5	99.5	95.2	91.7	95.7	90.4
South Wales	92.7	92.6	92.7	91.5	100.7	89.9	91.6	98.0	90.2
Ravenstruther	90.5	91.6	91.2	92.5	90.6	96.0	92.6	92.0	90.8
But'well / Wid'ton	90.5	91.6	92.7	92.3	94.3	97.0	93.5	90.8	90.8
Maltby / Harworth	91.0	91.0	93.3	91.9	100.0	96.6	93.1	96.2	91.1
Humber	88.8	89.3	91.6	90.4	98.3	95.1	91.5	94.5	89.1
Hunterston	90.1	91.1	90.7	92.0	89.6	95.5	92.1	91.6	90.0
Tyne / Blyth	89.7	90.8	92.0	91.6	94.5	96.3	92.7	90.7	90.1
Liverpool	90.5	91.4	89.8	91.2	97.5	94.7	91.3	95.5	90.2
Avon/Portb	92.2	92.0	92.1	91.0	100.1	90.1	91.0	97.4	90.5
Redcar	90.2	91.3	92.4	92.0	97.1	96.7	93.2	92.6	90.5
Ellesmere Port	91.3	91.9	90.5	91.7	98.5	95.2	91.8	96.3	90.9
Leith	91.5	92.6	92.7	94.0	91.4	97.5	94.0	91.9	91.6
Newport	94.2	94.0	94.1	92.9	102.1	91.4	93.0	99.4	91.7
Road-only pits England and Wales. Mostly direct by road to power station	92.5	90.3	90.6	91.2	99.5	93.2	92.0	91.7	90.6
Road-only pits in Scotland. Direct to PS	108.2	112.0	107.7	116.8	91.2	131.3	114.4	97.7	91.2
Road-only pits in Scotland. Via railhead	90.7	91.8	91.4	92.7	91.2	96.2	92.7	92.2	91.1
Weighted Average	89.6	90.1	90.5	90.5	90.2	90.1	90.8	91.2	90.0

Unsurprisingly the *weighted* average delivered cost for each pit, port or power station is lower than most of the figures in the table for that pit, port or power station – confirming that more traffic comes from the cheapest sources for each power station.

Once the model is calibrated, given that it is a logit model, changes in transport costs can be introduced that result in a different OD matrix – with locations with high transport costs suffering a loss of traffic and locations requiring short distance transport gaining traffic.

The first stage of the ESI coal modelling so far described only redistributes origins and destinations and modes as a result of changing costs. However a further modelling stage is required: incorporating a *suppression response* whereby power stations that experience a higher cost of delivered coal reduce their electricity production. Similarly there needs to be a *cost absorption response* whereby pits and ports with reduced traffic may choose to absorb some of the extra transport costs to retain more of their traffic. Conversely pits, ports and power stations with increased traffic may choose to increase their charges – partly to increase profits, but also for example some pits may not have the capacity to be able to extract more coal easily. These effectively represent the price elasticity of supply for pits, ports and power stations.

To deal with suppression of coal burned at power stations, the model described above is run through many iterations, whereby after each iteration, traffic to each separate power station is scaled down depending on the increase in the price of its delivered coal. Power stations remote from their coal sources are affected more than power stations with sources nearby.

Parallel work on competition in the energy market by NERA suggests that an increase in VTAC of £10 per thousand net Tkm would reduce coal demand by approximately 5%, largely in favour of demand for gas, assuming there is no switching of origins and destinations and that all increased costs are passed through the transport chain on to the power stations. Given a current average length of haul of 153km, this increase in VTAC equates to an average of £1.53 per tonne. We have used this relationship whereby for every £1.53 per tonne increase in the delivered cost of coal to each power station, its coal burn is reduced by 5%. A linear elasticity has been assumed to simplify the calculations.

Similarly after each iteration, each pit and port must have a *cost absorption response* to allow it to absorb some of the cost or benefit. That is, a price elasticity of supply is required for each pit and port - describing how gate prices would be increased or reduced if their demand is affected by increased transport costs, to mitigate the impact. This cost absorption response is represented as the £ per tonne decrease in gate price if a pit or port experiences a 10% decrease in demand. A high figure indicates that the pit/port will absorb much of the cost (or benefit) by changing their gate prices to keep traffics at a level similar to what they were before transport costs increased. A low figure indicates the pit/port is unwilling or unable to change gate prices in response to changes in demand. These cost absorption responses apply in the beneficial direction too and therefore equate to a £ per tonne ***increase*** in gate price if they experience a 10% ***increase*** in demand.

There is an interdependency whereby if remote pits and ports are reluctant to absorb increased costs, and therefore lose traffic, the local pits and ports would be able to take advantage of the reduced competition. However if remote pits and ports absorbed most of the increased costs, the competing local pits and ports would have less scope for increasing their traffic and absorbing the benefit.

As mentioned before the real world is much more lumpy than that described by a continuous logit model such as this. Instead of gradually decreasing, real world flows are likely to continue until costs increase to a tipping point when they will stop – for example when a pit becomes unviable.

It is beyond the scope of this work to estimate the viability of specific pits and when these tipping points would be reached. Therefore this continuous modelling approach whereby gate prices are reduced to partly counter reduced demand enables the gate prices and corresponding traffics for each pit and port to be estimated for each VTAC increase scenario. We have not evaluated whether specific pits could survive commercially with these gate prices and traffics.

Another interpretation of this continuous modelling approach is to consider each pit location as a group of pits. For example, in Ayrshire if our modelling was suggesting that traffics would decrease by 15%, this could be interpreted as 15% of the pits in the area closing and the others remaining at their original rate of production.

It is difficult to reliably estimate what these cost absorption responses would be in the real world for each pit and port. We have therefore taken a generic approach and assumed that

- all ***pits*** accept a £1.00 per tonne decrease in gate price if they experience a 10% decrease in demand.
- all ***ports*** accept a £0.50 per tonne decrease in gate price if they experience a 10% decrease in demand.

The port gate price decrease is assumed to be lower than that for pits because ports are more able to switch their operations to other commodities.

These responses by each power station, pit and port are applied linearly after each iteration, and are summarised below:

Response type	**Input**	**Response**
Suppression of coal burnt at a power station	Cost of delivering coal to this power station increases by £1.53 per tonne	Reduce coal burn by 5%
Cost absorption by a pit	Demand for coal from this pit decreases by 10%	Reduce this pit’s gate price by £1.00 per tonne
Cost absorption by a port	Demand for coal from this port decreases by 10%	Reduce this port’s gate price by £0.50 per tonne

The suppression of coal burn response is based on the parallel work by NERA. The cost absorption response by pits and ports is based on our experience of the market. This is subject to sensitivity testing.

A further stage is added to each iteration to increase/reduce all gate prices by a fixed amount per tonne to ensure that the average gate price per tonne does not change. This retains stability in the results during the many iterations of the model.

After running the model through many iterations, where pit, port and power station prices are varied, the model converges to produce results. The central case is for an increase of £10 / Thousand Net Tkm.

Coal Power Station Transport Model Results.

Table 5: Modelled traffic with VTAC increasing by £10 / Thousand Net Tkm. Th tonnes / year

	Power Stations										
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Total	Increase from base case (Th tonnes)	Increase from base case %
Daw Mill	21	61	10	1,839	0	0	1,108	0	3,039	156	5%
Ayrshire	287	23	55	2	170	0	3	13	554	-172	-24%
Kellingley / Hatfield	2,352	337	5	57	0	0	3	0	2,754	264	11%
Welbeck / Thoresby	218	993	3	600	0	0	29	0	1,843	135	8%
South Wales	0	1	0	26	0	1,138	34	0	1,200	-78	-6%
Ravenstruther	264	21	51	2	475	0	3	12	827	-189	-19%
But'well / Wid'ton	294	23	1	4	0	0	0	446	768	-44	-5%
Maltby / Harworth	143	290	0	29	0	0	1	0	463	40	9%
Total rail-conn pit	3,579	1,748	125	2,560	645	1,138	1,182	472	11,449	111	1%
Ports (all rail-connected)											
Humber	8,019	3,300	4	247	0	0	12	0	11,581	906	8%
Hunterston	178	14	34	2	1,769	0	2	8	2,006	-1,418	-41%
Tyne / Blyth	1,525	120	3	20	0	0	1	302	1,971	-246	-11%
Liverpool	162	23	2,011	56	0	0	71	0	2,322	159	7%
Avon/Portb	2	5	3	154	0	757	204	0	1,125	-179	-14%
Redcar	795	62	2	11	0	0	1	2	872	-46	-5%
Ellesmere Port	35	15	608	32	0	0	40	0	729	26	4%
Leith	25	2	1	0	106	0	0	35	170	-85	-33%
Newport	0	0	0	3	0	102	4	0	108	-5	-5%
Total port	10,741	3,541	2,666	524	1,874	859	333	348	20,884	-887	-4%
Road-only pits England and Wales. Mostly direct by road to power station	51	768	659	222	0	6	56	19	1,780	224	14%
Road-only pits in Scotland. Direct to PS	0	0	0	0	365	0	0	0	365	94	34%
Road-only pits in Scotland. Via railhead	640	50	123	5	391	0	7	30	1,246	-498	-29%
Grand Total	15,010	6,107	3,572	3,311	3,276	2,003	1,578	867	35,724	-956	-2.6%
Increase from base case (Th tonnes)	-575	-225	-44	-144	89	-18	-51	11	-956		
Increase from base case %	-4%	-4%	-1%	-4%	3%	-1%	-3%	1%	-2.6%		

Overall coal tonnes are modelled to decrease from the base case by 2.6%. Tonnes transported *by rail* would decrease by 3.7% from 34.9m to 33.6m. Comparison with the NERA figure of a reduction of approximately 5% with VTAC increasing by £10 / Thousand net Tonne km (with no change in the origin and destination pattern) shows that the rationalisation of origins and destinations along with a switch to road halves the overall impact in terms of total tonnes of coal delivered to power stations. The estimated results are that:

- Tonne kms by rail decrease by 23% to 4.23 billion
- Rail ALOH falls by 20% to 125 kms
- Modelled VTAC (existing VUC + extra VTAC) paid would be £51.8m, of which £7.9m would be paid for use of tracks in Scotland.

Modelled road journeys (both direct to power station and to a railhead) make up 9.5% of tonnes. This is slightly lower than the road mode share in the base case which might initially be a surprise given that the cost increases are only being added to rail. However in the base case, around half of the road traffic was from Scottish road-only pit to a railhead in Scotland. This road traffic to a Scottish railhead has declined by 29% (-498,000 tonnes) because of the increased onward rail costs, which is to be expected. The fact that these pits are remote from their market and not rail-linked makes them particularly vulnerable. This negative impact on Scottish road-only pits has been slightly mitigated by increases in traffic direct by road from Scottish pits to power stations (+94,000 tonnes) . Traffic from road-only pits in England and Wales direct to power stations has increased by 14% (+224,000 tonnes).

Table 6: Delivered costs to power station £ per tonne with VTAC increasing by £10 / Thousand Net Tkm

	Power Stations									
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Weighted Average	Increase from base case
Daw Mill	93.7	93.0	93.6	91.2	105.4	95.7	91.3	100.6	91.3	1.2
Ayrshire	92.1	93.6	92.5	95.2	90.1	100.5	94.8	92.6	91.6	0.6
Kellingley / Hatfield	90.8	92.0	94.0	93.3	103.5	100.7	94.9	97.6	91.0	1.1
Welbeck / Thoresby	92.2	91.3	94.2	91.9	105.0	99.3	93.4	99.2	91.7	1.2
South Wales	96.2	95.6	95.4	93.7	107.2	90.2	93.3	103.1	90.4	0.2
Ravenstruther	92.1	93.7	92.6	95.2	89.5	100.6	94.8	92.6	90.7	-0.1
But'well / Wid'ton	92.1	93.6	95.3	94.9	95.9	102.3	96.5	90.4	91.2	0.4
Maltby / Harworth	92.5	92.1	95.7	93.7	105.3	101.1	95.3	99.4	92.3	1.2
Humber	90.1	90.6	94.1	92.4	103.7	99.9	94.0	97.8	90.3	1.2
Hunterston	92.4	93.9	92.8	95.5	88.7	100.8	95.1	92.8	89.2	-0.8
Tyne / Blyth	91.1	92.6	94.3	93.9	96.5	101.4	95.5	90.7	91.1	1.0
Liverpool	92.4	93.6	90.4	93.3	101.6	98.6	92.9	98.9	90.7	0.5
Avon/Portb	95.1	94.5	94.3	92.7	106.1	90.5	92.3	102.1	91.1	0.6
Redcar	91.5	93.0	94.7	94.3	100.6	101.7	95.9	93.6	91.6	1.1
Ellesmere Port	93.3	93.9	91.1	93.6	103.0	99.0	93.3	99.9	91.5	0.6
Leith	93.5	95.1	94.8	97.4	90.4	102.8	97.0	92.0	91.3	-0.3
Newport	97.6	96.9	96.7	95.1	108.5	91.7	94.7	104.5	91.9	0.2
Road-only pits England and Wales. Mostly direct by road to power station	93.5	91.5	91.3	92.6	100.2	93.4	93.2	92.4	91.7	1.1
Road-only pits in Scotland. Direct to PS	105.7	109.4	105.1	114.2	90.2	128.7	111.8	96.2	90.3	-0.9
Road-only pits in Scotland. Via railhead	92.1	93.6	92.5	95.2	90.2	100.5	94.8	92.6	91.6	0.5
Weighted Average	90.7	91.2	90.9	91.8	89.3	90.4	91.7	90.8	90.8	0.8
Increase from base case	1.1	1.1	0.4	1.3	-0.8	0.3	1.0	-0.4	0.8	0.8

The delivered costs to power stations (table 6) increase by £0.80 per tonne on average. The weighted average changes from some specific pits may not seem as large as one might first assume. For example the weighted average delivered cost from Ayrshire's rail-connected pits only increases by £0.60 from £91.0 to £91.6 per tonne. However this is after the Ayrshire pits have already reduced gate prices by £2.50 per tonne.

Because the Scottish pits and ports are having to reduce their gate prices so much in order to compete with English sources, the delivered price of coal to Longannet actually *reduces* by £0.80 per tonne.

Table 7: Change in gate prices chargeable at each pit and port (£ per tonne) with VTAC increasing by £10 / Thousand Net Tkm

Rail-connected pits	Total
Daw Mill	0.3
Ayrshire	-2.5
Kellingley / Hatfield	0.6
Welbeck / Thoresby	0.5
South Wales	-0.8
Ravenstruther	-2.1
But'well / Wid'ton	-0.8
Maltby / Harworth	0.6
Ports (all rail-connected)	
Humber	0.2
Hunterston	-2.2
Tyne / Blyth	-0.7
Liverpool	-0.0
Avon/Portb	-0.8
Redcar	-0.3
Ellesmere Port	-0.1
Leith	-1.8
Newport	-0.5
Road-only pits England and Wales	1.1
Road-only pits in Scotland	-2.2

Table 7 shows the changes in gate prices than can be charged at pits and ports. The big reductions are for the pits and ports for which longer journeys are required to get to power stations with Ayrshire rail-connected pits reducing their gate price by £2.50 and still losing 24% of their traffic. It is a similar story for remoter ports. The pits in England which are typically near to power stations have the largest opportunity for increases in gate prices. Those English and Welsh road-only pits can increase gate prices by £1.10 and still increase production by 14%, because their competition by rail struggles to compete.

The equivalent modelled results for increases in VTAC of £5 and £15 / Thousand Net Tonne km are given in appendix 1.

As we do not have empirical evidence to support our estimates of the likely capacity for cost absorption by the ports and pits, our results are indicative. However we have conducted 2 sensitivity tests on the VTAC increasing by £10 / Thousand Net Tkm central case to give an illustrative range of potential impacts:

1. **High response:** All pits absorb £2.00 instead of £1.00, and all ports absorb £1.00 instead of £0.50
2. **Low response:** All pits absorb £0.50 instead of £1.00, and all ports absorb £0.25 instead of £0.50

The higher cost absorption response scenario (1) results in less rationalisation of the origin destination matrix. The results of these sensitivity tests are given in appendix 2.

Diversity of supply

This modelling approach has sought to recreate the current diversity of supply for power stations by not sourcing all coal from the cheapest source, but sharing the traffic on the basis of a cheapest-gets-more algorithm (multinomial logit). It has assumed that when transport costs increase, the market will respond and alter the origins and destinations to reduce the average length of haul. However there may be various other reasons that encourage diversity of supply that are not captured by the model such as specific types of coal being required, contractual relationships etc. In reality, these other reasons are likely to persist and therefore our modelled responses to increased VTAC in terms of changes to the origin and destination pattern, and resultant reductions in ALOH should be considered the maximum response.

When calculating the costs to the industry, no cost has been put on the loss of diversity of supply. This desire for diversity of supply would lessen the impact of increased VTAC on the origin – destination pattern.

Summary for ESI coal

Table 8 summarises the different anticipated outcomes based upon the scenarios tested.

Table 8: Summary of modelled scenarios compared, with base case assumption of pit and port cost absorption response

Increase in VTAC / thousand net tonne km		Base-	+£5	+£10	+£15
Tonnes to power stations (m)		36.68	36.14	35.72	35.33
Tonnes by rail to power stations (m)		34.85	34.14	33.58	32.90
Tonne kms by rail to power stations (b)		5.49	4.79	4.23	3.79
VTAC (existing VUC + extra VTAC) revenue (£m)		12.35	34.7	51.8	65.4
Increased cost/tonne to users (£/tonne)		-	0.4	0.8	1.1
Increase in implied revenue/tonne from (£)		-			
Pits:	Daw Mill	-	0.2	0.3	0.4
	Ayrshire	-	(1.2)	(2.5)	(3.7)
	Kellingley/Hatfield	-	0.4	0.6	0.8
	Wellbeck/Thoresby	-	0.3	0.5	0.7
	South Wales	-	(0.4)	(0.8)	(1.2)
	Ravenstruther	-	(1.1)	(2.1)	(3.0)
	But'well/Wid'ton	-	(0.4)	(0.8)	(1.2)
	Maltby/Harworth	-	0.3	0.6	0.8
Ports	Humber	-	0.1	0.2	0.2
	Hunterston	-	(1.2)	(2.2)	(3.0)
	Tyne/Blythe	-	(0.3)	(0.7)	(1.1)
	Liverpool	-	0.1	-	(0.2)
	Bristol	-	(0.4)	(0.8)	(1.2)
	Redcar	-	(0.1)	(0.3)	(0.6)
	Ellesmere Port	-	0.0	(0.1)	(0.2)
	Leith	-	(0.9)	(1.8)	(2.6)
	Newport	-	(0.2)	(0.5)	(0.8)
Road only English & Welsh pits		-	0.6	1.1	1.4
Road only Scottish pits		-	(1.1)	(2.2)	(3.1)

Note: Brackets indicate negative numbers

Table 8 is based upon a given level of responsiveness by pits and power stations. If we consider a range of responsiveness around an increase in £10 per thousand net tonne kms, we arrive at the results in table 9.

Table 9 Summary of sensitivity tests - impact of levels of pit and port cost absorption responses compared

		Low response	Base response	High response
Increase in VTAC / thousand net tonne km		£10	£10	£10
Tonnes to power stations (m)		36.03	35.72	35.47
Tonnes by rail to power stations (m)		33.59	33.58	33.50
Tonne kms by rail to power stations (b)		3.86	4.23	4.52
VTAC (existing VUC + extra VTAC) revenue (£m)		47.3	51.8	55.4
Increased cost/tonne to users (£/tonne)		0.5	0.8	1.0
Increase in implied revenue/tonne from (£)				
Pits:	Daw Mill	(0.1)	0.3	0.6
	Ayrshire	(2.4)	(2.5)	(2.5)
	Kellingley/Hatfield	0.3	0.6	0.9
	Wellbeck/Thoresby	0.1	0.5	0.8
	South Wales	(0.9)	(0.8)	(0.6)
	Ravenstruther	(1.9)	(2.1)	(2.1)
	But'well/Wid'ton	(0.9)	(0.8)	(0.6)
	Maltby/Harworth	0.3	0.6	0.8
Ports	Humber	(0.1)	0.2	0.4
	Hunterston	(1.7)	(2.2)	(2.5)
	Tyne/Blythe	(0.9)	(0.7)	(0.5)
	Liverpool	(0.3)	-	0.2
	Bristol	(0.9)	(0.8)	(0.7)
	Redcar	(0.5)	(0.3)	(0.1)
	Ellesmere Port	(0.3)	(0.1)	0.2
	Leith	(1.5)	(1.8)	(2.0)
	Newport	(0.7)	(0.5)	(0.3)
Road only English & Welsh pits		0.7	1.1	1.3
Road only Scottish pits		(1.9)	(2.2)	(2.2)

Note: Brackets indicate negative numbers

Overall, the effect of raising VTAC charges by £10 per thousand tonne net kms (equivalent to a 440% increase in VUC) is forecast to reduce total tonnes consumed by power stations by 2.6% and not the 5% without mitigation from a realignment of sources. This could vary between 1.8% and 3.3% depending on the willingness of ports and pits to vary their charges.

Based on an increase of £10, total tonne kms by rail would fall by 23% (responsiveness range 18% - 30%) and VTAC (existing VUC + extra VTAC) revenue increase by 320% (responsiveness range 280% - 350%).

An increase in VTAC by £5 per thousand tonne kms would reduce total tonne kms by rail by 13.6% and increase VTAC (existing VUC + extra VTAC) revenue by 181% to £34.7m.

An increase in VTAC by £15 per thousand tonne kms. would reduce total tonne kms by rail by 31% and raise VTAC (existing VUC + extra VTAC) revenue by 430% to £65.4m, an increase of £53m per annum.

The impact on other interested parties would be to reduce the bargaining position for Scottish pits and the more remote ports. On the basis of an increase of £10 per thousand net tonne kms and our central assumption on levels of response, the Ayrshire pits would face a reduction in demand and find they would need to cut charges by £2.5 per tonne. Hunterston would have to cut charges by £2.2 per tonne and the Tyne and Blythe by £0.7 per tonne. In practice, Hunterston would drop out of the English power station market as the impact of such a drop would exceed its current net revenues.

By contrast, pits that are close to the Aire Valley power stations would benefit (+£0.6 per tonne) as would (marginally) the Humber ports.

Our overall conclusion is that the loss of coal tonnages by rail as a consequence of a substantial increase in VTAC for coal would be small as the main impact will be to encourage power stations to source more locally. Overall tonne kms by rail would fall substantially. On the basis of our central estimates, the impact of a +£10 / thousand net tonne km increase in VTAC would be for tonnes by rail to fall by only 3.7% and tonne kms (and, presumably, incremental infrastructure costs) to fall by 23%. ALOH would fall from 157 km to 125 km and VTAC revenue would increase by £39.5m per annum. To put it into context, this reduced ALOH is still substantially higher than the ALOH in 1990 (pre-privatisation) of 66km.

Volatility of coal prices

It is worth comparing these changes in delivered costs of coal to power stations to fluctuations in the market price of coal.

Table 10: UK coal imports prices from quarterly trade data

Year	Quarter	Price £ per Tonne
2004	1	44
	2	54
	3	52
	4	54
2005	1	52
	2	55
	3	58
	4	54
2006	1	55
	2	52
	3	51
	4	51
2007	1	50
	2	52
	3	56
	4	60
2008	1	73
	2	82
	3	107
	4	103
2009	1	97
	2	78
	3	68
	4	71
2010	1	75
	2	90
	3	88
	4	87
2011	1	88
	2	91
	3	100
	4	87

It is clear that even though the impact on specific pits and ports, and the transporters of the coal may be significant, the increase in average costs of delivered coal as a result of increased VTAC is relatively small compared to recent fluctuations in coal prices.

4. BIOMASS

4.1 About Biomass

Terms & Definitions

Bioenergy is produced from organic materials, either directly from plants or indirectly from industrial, commercial, domestic or agricultural products. Bioenergy falls into two main categories:

- **Biomass** includes forest products, untreated wood products, energy crops, by-products of agricultural crops (principally dry solid residues of olive oil and palm oil production) and short rotation coppice (SRC) e.g. willow, miscanthus. These are generally used for stationary heat or electricity generation.

- **Biofuels** are made from animal wastes, industrial and bio-degradable municipal products from food processing and high energy crops e.g. rape, sugar cane, maize. Biofuels are normally used as transport fuels.

Co-firing refers to the simultaneous combustion of a supplementary fuel (i.e. biomass) with a base fuel (i.e. coal). Co-firing biomass with coal is seen as the cheapest way of generating green power in utility plants. In addition, it also reduces the emissions of fossil based carbon dioxide and is supported under the Renewables Obligation.

Restrictions have been placed on the types of fuels that can be co-fired, and from 2009 onwards an increasing proportion of the fuel used in co-firing has had to be sourced from energy crops. This is designed to encourage the development of domestic supplies of feedstock and to limit reliance on imported material. Typical fuel choices for co-firing have been 'clean' plant derived biomass including wood pellets, sawdust pellets, palm kernel, olive stones and pelletised cereal co-products.

Renewables Obligation (RO) – this was introduced in 2002 and is effective to 31 March 2027. Renewables Obligation Certificates (ROCs) are green certificates issued by Ofgem to operators of accredited renewable generating stations for the eligible renewable electricity they generate. Operators can then trade the ROCs with other parties, with the ROCs ultimately being used by suppliers to demonstrate that they have met their obligation. The objectives of the RO are to increase the amount of electricity generated from renewable energy sources to 15% of total supply in 2015 and to support the development of UK biomass production. It requires all licensed electricity suppliers in the UK to supply a specified proportion of their electricity sales from renewable energy sources.

Renewable Heat Incentive (RHI) – launched in November 2011 the RHI is targeted at supporting emerging technologies that can generate heat from renewable energy sources. Currently more of the UK's carbon emissions come from energy used to produce heat compared to electricity generation as around 95% of heat production in the UK relies on fossil fuels including North Sea oil, the supply of which is in decline.

Renewable heat is a term used to mean any heat that is generated using a renewable technology or source, for example, equipment that uses the sun, ground, or water as a means to generate heat.

Also included are renewable fuels such as sustainably-harvested wood and other plants, biogas and the biomass content of eligible waste streams.

Policy changes

The percentage of co-fire ROCs that could be redeemed under the original RO was to reduce to zero in 2016/17 and the minimum proportion of energy crops within the co-fire biomass fuel was to increase. Since its introduction in 2002, the RO has been subject to various reforms. In April 2009, the introduction of banding gave different technologies different levels of support. In April 2010, the end date for support was extended to 2037 or 20 years (whichever is the earlier) for new projects.

The number of coal plants co-firing increased following the introduction of the Renewables Obligation (RO), from two in 2002/03 to sixteen in 2005/06, which represents all of the major coal plants in the UK. The RO provides financial incentives – which are available in the form of Renewable Obligations Certificates (ROCs) – for coal plants to co-fire with biomass.

In July 2011, DECC released the new Renewable Energy Roadmap in which it set out plans to reform the electricity market structured around a new Feed-in-Tariff with Contracts-for-Difference and a transition away from the RO system.

Further changes to the RO subsidy regime were introduced in October 2011. Essentially DECC plans to reduce support for onshore wind, waste and biomass schemes accredited from April 2013, but wants to increase support for offshore wind, wave and tidal projects. The changes cover renewable electricity projects becoming operational from 2013 to 2017. The greatest proposed RO change concerns dedicated biomass plants. These currently are awarded 1.5 ROCs/MWh and DECC intends to keep support at that level for all new plants until April 2016, after which it will drop to 1.4 ROCs/MWh. The RO is due to be closed to new projects in 2017 as a result of the new Feed-in Tariff (FiT).

There are thought to be two reasons for this change. On the one hand DECC believes that the subsidy will only help to bring forward smaller biomass plants (less than 50MW) and that larger plants will need a greater subsidy which will not be forthcoming. This it believes, will discourage larger biomass plants on which DECC believes the UK should not become reliant because of questions over the sustainability of imports of woodchips and pellets. At the same time we believe that DECC is trying to incentivise developers that already have approval or proposals in place to bring projects on stream quickly, before the 2015 Renewable target deadline is reached.

DECC is also proposing to increase support for co-fired biomass stations from the current 0.5 ROCs/MWh to 1 ROC/MWh for those plants that burn above 15% biomass. DECC also has created a new ROC band specifically for coal plants that convert to run entirely on biomass. DECC believes that co-firing is the most cost-effective way to meet the UK's 2020 electricity target.

With regard to the Renewable Heat Incentive (RHI), the Government announced revised rules for non-domestic generators in November. Initially due to be announced in September the (RHI) tariff for large biomass had to be withdrawn as the European Commission expressed concerns that this was set too high in comparison to smaller operators and therefore did not meet State Aid guidelines. EC approval has now been given subject to the large biomass tariff being reduced from 2.7p to 1p per kWH.

These recent changes suggest that it will become more difficult to gain consent for large biomass stations in the future. As it stands, consent for stations larger than 300MW capacity will not be given unless the plant includes carbon capture technology.

4.2 Imported biomass products

A breakdown of the total biomass burned in co-firing operations in 2005 is shown in Table 11 below. A significant volume of the 1.4 million tonnes of fuel burnt was imported palm residues (mainly from Malaysia and Indonesia) and olive residue (mainly from Spain). Of the wood products used for co-firing the majority was also imported. To date the majority of co-firing has been fuelled by imported bio-wastes such as olive pits and palm kernels. The use of energy crops (such as miscanthus) has been limited because of limited availability of this type of fuel. Table 12 lists the co-firing power stations and the types of fuel being used. It is estimated that of the 1.42 million tonnes of biomass fuels consumed by co-firing in 2005, imports amounted to 0.76 million tonnes, or approximately 54%[6].

Reports to Ofgem show that olive residues from Spain are largely imported in 3-4,000 tonne consignments in small coasters for transport to stations including Cottam, Drax and West Burton. It is known that wood pellets from Canada are imported in larger consignment sizes in 40-75,000 tonne consignments.

Table 11: Feedstock for Co-firing by type, quantity and source, 2005

Feedstock	Quantity burned (tonnes) in 2005	% quantity burned (tonnes) in 2005	Likely country of origin	Mode of transport	Total transport-related emissions (kg CO_2/tonne biomass)
Energy crops (SRC,granulated willow, miscanthus)	4,306	0.3	UK	Road	1.7
Shea residues (meal and pellets)	5,420	0.4	Africa	Ship	55.4
Sunflower pellets	20,331	1.4	Romania	Road & ship	47.1
Sewage sludge and waste derived fuels	49,155	3.5	UK	Road	3.4
Cereal co products and pellets	102,246	7.2	UK	Road	1.7
Tallow	119,828	8.5	UK	Road	1.7
Olive waste (residue and expeller)	283,222	20.1	Greece, Italy Spain	Road & ship	21.2
Wood (sawdust, chips, pellets, tall oil)	377,956	26.8	UK, Canada, Latvia, Scandinavia	Road & ship	1.7 (UK) to 42.9
Palm residues (palm kernel expeller, shell, pellets, oil)	449,657	31.8	Indonesia, Malaysia	Road & ship	106.5 (Indonesia) to 107.4 (Malaysia)
Total mass	1,412,121				
Total energy (PJ)	14.1				

Source: Evaluating the Sustainability of Co-firing in the UK, report to DTI from Themba Technology Ltd, September 2006.

Source: UK Biomass Strategy, May 2007

[6] UK Biomass Strategy document

Table 12: UK Transmission Connected Co-Firing Capacity and Fuels (1)

Station Name	Station Size, MW	Co-Firing Fuel
Solid Biomass		
Aberthaw	1,553	Wood/Sawdust/Tallow
Cockenzie	1,200	Wood Pellets
Cottam	2,000	5% Blend Biomass - Olive Cake, Wood & some Energy Crops
Didcot A	2,100	2% Energy Crops
Drax	4,000	3% Energy Crops/Wood Pellets
Eggborough	2,000	3.5% Palm Kernels
Ferrybridge	2,035	10% Biomass
Fiddlers Ferry	1,995	10% Biomass
Ironbridge	964	Palm Kernel Expeller
Kilroot	390	Olive Pellets
Kingsnorth	2,034	Cereal Residues
Longannet	2,400	Sewage Sludge/Wood Pellets
Ratcliffe	2,000	None
Rugeley B	1,000	None
Tilbury	1,085	3% Palm Kernel Expeller
West Burton	2,000	5% Biomass Blend – Wood, Shea, Miscanthus
Liquid Biomass		
Littlebrook	685	Palm Oil

Source: The Economics of Co-Firing, July 2006. Report to DTI by IPA Energy Consulting & Mitsui Babcock

(1) Since the publication of this report we know that Cockenzie power Station and Kingsnorth will close by 2013, while Tilbury has converted to 100% biomass (mainly wood pellets from the US).

A more up to date and detailed analysis of the situation was published in the ENDS Report of June 2011. This data comes from Ofgem's online biomass sustainability register. Under the Renewables Obligation (RO), biomass plants must report annually to Ofgem detailing the types of biomass burned in the previous year, its origin and whether it caused land-use change.

Its findings, summarised in Table 13, suggest that of the 1.5 million tonnes of biomass burned in UK coal-fired power stations in 2010/11, just 18%% was UK sourced. By comparison data collected by ENDS on 13 dedicated biomass plants, summarised in Table 14, indicated that of the 2.9 million tonnes of product consumed by those stations, 99% was UK sourced.

The data also suggests that there has not been much movement in the overall volume being burned compared with 2005. What has been noticeable is the drop in the use of palm residues suggesting the operators are responding to environmental concerns over the use of this product.

Over 2.8 million tonnes of material was burned in the UK's major dedicated biomass power plants in 2010/11, according to figures obtained from Ofgem. Almost all of it came from the UK. The small amount of imported material was by the Alcan plant (Northumberland) and included olive residues from Spain (17,000t Spain) and sunflowers (266t unknown origin, but probably Russia).

By far the greatest user of imported biomass is Drax, the UK’s largest power station. It co-fired just over one million tonnes of biomass in 2010/11 – more than double any other plant's consumption –

but only 25,289 tonnes of that was UK energy crop and 20,071 tonnes came from UK forests. A breakdown of the types of biomass used and sources of supply are summarised in Table 15.

Of the wood products burned at Drax over 400,000 tonnes was imported from Canada, 200,000 tonnes from the USA and 60,000 tonnes from Portugal.

Figure 1: Location of Co-firing power Stations

Figure 2: Location of Dedicated biomass plants

Source: ENDS Report Issue 437, June 2011

Table 13: Biomass co-fired in Coal Burning Plants 2010/11

Product	Tonnes	UK sourced
Wood*	791,570	11%
Olive waste	288,229	0
Sunflower	179,973	0
Oat pellets	57,887	98%
Peanuts	50,140	0
Straw	47,034	100%
Sludge	45,965	100%
Palm kernel	17,734	0
Willow	17,142	100%
Miscanthus	10,813	100%
Shea Nut	10,116	0
Cocoa meal	1,614	0
Wheat pellets	281	100%
Total	**1,486,508**	**17.7%**

* includes 59,318t waste wood

Table 14: Material burned in major dedicated biomass plants 2010/11

Product	Tonnes	UK sourced
Wood*	1,750,133	100%
Poultry litter	525,479	100%
Sludge	217,326	100%
Straw	148,627	100%
Meat, bone meal	97,763	100%
Horse bedding	74,868	100%
Miscanthus	25,864	100%
Olive	16,998	0
Willow	2,133	100%
Refuse Derived fuel	1,956	100%
Sunflower	266	0
Other	8,162	100%
Total	**2,869,575**	**99%**

* includes 408,564t waste wood, 158,670t sawmill dust & offcuts

Table 15: Origin of Drax Biomass co-fire products

Product	Volume consumed (tonnes)	Origin
Wood	716,847	Canada (57%) USA (28%) Portugal (9%) UK (2.8%) South Africa (2.2%) New Zealand (0.5%) Russia (0.5%)
Sunflower	178,975	Russia (100%)
Peanut	50,140	USA (100%)
Straw	47,034	UK (100%)
Oats	44,738	UK (96%) Germany (3%) Finland (1%)
Miscanthus (energy crop)	9,995	UK (100%)
Willow (energy crop)	15,294	UK (100%)
Olive residues	3,875t	Spain (100%)
Cocoa meal	1,614	West Africa (100%)
Wheat	291	Unknown origin
Tall Oil	0.13	Sweden (100%)
Total	**1,068,803**	

Source: ENDS Report

Of the other co-firers the next largest was Cottam on the River Trent, which by comparison co-fired 114,748t (up from 79,869t in 2009/10), of which 98% was olive residues, mainly imported from Spain. Fiddlers Ferry in the North West Midlands imported 93,095t (down from 140,590t in 2009/10), of which 70% was also olive residues mainly sourced from Spain.

The conclusion we derive from these figures is that despite the introduction of ROCs in 2002, the impact on use of biomass and the use of imported materials so far has not been as great as was perhaps anticipated. Drax has complained that the low regulatory support has hindered the full use of the co-firing capacity of the renewable facilities installed at the station, with the suggestion that its renewable output could be increased by 50%. Drax is one of the most import-dependent facilities, yet a 50% increase in use does not translate into substantially more in terms of imports. The Port of Tyne currently is meeting most of Drax's need.

Similarly the 3 million tonnes of biomass currently being consumed by the major biomass plants is not being met from imports. However, unlike co-firing power stations, imports of biomass by dedicated biomass plants are likely to grow substantially in future. Several gigawatts of biomass plant are in development, mainly near ports, and almost all expect to rely on imported woodchip. ENDS has estimated that a 300MW plant would need about 2.4Mt of imported woodchip a year, equivalent to all wood burned in coal and biomass plants in 2010/11.

The new ROC bandings, indicated in Table 16, indicate that the greater level of financial support is now being targeted at facilities that co-fire with energy crops and to facilities that generate both heat and power. These facilities are more likely to be located in areas of energy crop production in order to minimise transport requirements.

Table 16: ROC tariff bandings

Generation type	Definition	ROCs/MWh
Co-firing of Biomass	Electricity generated from biomass by a generating station in a calendar month in which it has generated electricity partly from fossil fuel and partly from biomass	0.5
Co-firing of Energy Crops	Electricity generated from energy crops by a generating station in a calendar month in which it has generated electricity partly from fossil fuel and partly from energy crops	1
Co-firing of Biomass with CHP	Electricity generated from biomass by a qualifying combined heat and power generating station in a calendar month in which it has generated electricity partly from fossil fuel and partly from biomass, and where the fossil fuel and biomass have been burned in separate boilers	1
Co-firing of Energy Crop with CHP	Electricity generated from energy crops by a qualifying combined heat and power generating station in a calendar month in which it has generated electricity partly from fossil fuel and partly from energy crops, and where the fossil fuel and energy crops have been burned in separate boilers.	1.5
Dedicated Biomass	Electricity generated from biomass, except for electricity generated by a generating station in a calendar month in which it has generated electricity partly from fossil fuel and partly from biomass	1.5
Dedicated Energy Crops	Electricity generated from energy crops, except for electricity generated by a generating station in a calendar month in which it has generated electricity partly from fossil fuel and partly from energy crops	2
Dedicated Biomass with CHP	Electricity generated from biomass by a qualifying combined heat and power generating station in a calendar month in which it is fuelled wholly by biomass.	2
Dedicated Energy Crops with CHP	Electricity generated from energy crops by a qualifying combined heat and power generating station in a calendar month in which it is fuelled wholly by biomass. .	2

"Energy crop" means a plant crop planted after 31st December 1989 which is grown primarily for the purpose of being used as fuel or which is one of the following:
(a) *miscanthus giganteus*;
(b) *salix* (also known as short rotation coppice willow); or
(c) *populus* (also known as short rotation coppice poplar).

4.3 Biomass by rail

At present, our conclusion is that in spite of changes in energy policy aimed at increasing the amount of energy produced from sustainable sources, the transport consequences have not greatly benefited rail freight. The only significant movement of biomass by rail in the base year (up to the end of September 2011) is from the Port of Tyne to the Drax co-firing power station at in Yorkshire.

In the near term the increase in rail freight is unlikely to come from the development of new dedicated biomass stations inland, as most of the planned and proposed larger projects are sited within or in close proximity to a deep water port estate where they can receive imports directly. Given the propensity for additional biomass resources to be sourced from abroad, it is self evident that the optimum location will be at deep-water ports with the space to locate new power stations next to existing quays or jetties.

The principal exception maybe at Drax. However, Drax has recently cancelled plans to develop a 299MW biomass plant at Selby, adjacent to the power station, because of changes to the ROC support levels, which Drax alleges make the financial case for the plant unviable. Drax is also reviewing plans to drop another plant it had planned to build at Immingham – again a deep water port. Forth energy has also cancelled plans to build a similar size plant close to the port of Leith. Instead, Drax is now preparing to invest £50m in scaling-up plans to increase co-firing at the coal power station. In 2011, it co-fired 1.3Mt of biomass, equivalent to 9% of its output. Approximately 650,000 tonnes or 50% of this was delivered by rail. The investment will mean it could burn up to 20%, possibly doubling the amount of biomass feedstock. If it reaches that level it will be recognised as an ‘enhanced co-firer’ under the ROC scheme and qualify for a greater level of support.

At present Drax receives 0.5 ROC per MW hour of electricity produced from biomass. From April 2013 this would increase to 1 ROC/MWh. One ROC is worth about £50. Drax has previously stated that it could be operated on up to 50% biomass – about five times the current level, but this would require more investment in the plant and wood and straw pellet plants to improve product sourcing.

The more likely inland flows to develop will be where existing power stations expand the co-firing of biomass with existing coal flows, or where existing gas fired stations become life-expired and biomass is seen as a means of satisfying requirements to generate energy from renewable resources. This will be a means of exploiting existing power network infrastructure.

Table 17 describes the costs that would be associated (by road or rail) with existing and potential flows of biomass by rail. Only the flow from Tyne to Drax is currently significant.

Table 17 Existing and potential biomass flows by modelled 2018/19 costs by road and rail

Biomass

		Estimated £ per tonne				
Import Port	**Power Station**	**Current**	**Cargo VUC +£5**	**Cargo VUC +£10**	**Cargo VUC +£15**	**Current HGV**
Tyne	Drax	£3.86	£4.82	£5.78	£6.74	£14.81
Immingham	Drax	£2.33	£2.76	£3.19	£3.61	£7.60
Immingham	Eggborough	£2.41	£2.86	£3.32	£3.77	£7.96
Immingham	Ferrybridge	£2.56	£3.07	£3.58	£4.08	£8.68
Immingham	Ratcliffe	£3.55	£4.41	£5.26	£6.11	£13.36
Immingham	Cottam	£2.33	£2.76	£3.19	£3.61	£7.60
Immingham	Fiddlers Ferry	£4.32	£5.44	£6.56	£7.67	£16.97
Seaforth	Fiddlers Ferry	£1.95	£2.25	£2.54	£2.83	£5.79
Seaforth	Rugley	£3.17	£3.89	£4.61	£5.33	£11.56

		% increase		
		Cargo VUC +£5	**Cargo VUC +£10**	**Cargo VUC +£15**
Tyne	Drax	24.9%	49.7%	74.6%
Immingham	Drax	18.3%	36.5%	54.8%
Immingham	Eggborough	18.8%	37.6%	56.4%
Immingham	Ferrybridge	19.8%	39.5%	59.3%
Immingham	Ratcliffe	24.0%	48.0%	72.0%
Immingham	Cottam	18.3%	36.5%	54.8%
Immingham	Fiddlers Ferry	25.9%	51.8%	77.8%
Seaforth	Fiddlers Ferry	15.0%	30.0%	45.0%
Seaforth	Rugley	22.7%	45.3%	68.0%

The table shows that costs per tonne by rail are far lower than by road; £3.86 per tonne from Tyne to Drax using the cost models employed in this study as compared with £14.81 by road. An increase in VTAC by as much as £15 per thousand tonne kms would only raise rail charges to £6.74 per tonne - still well below that by road.

However, the rail freight cost differential as between a route via the Tyne (£6.74 per tonne) and via Immingham (£3.61), a difference of £3.13 per tonne, would have grown from a current rail cost difference of only £1.53 per tonne. It is most unlikely that the Port of Tyne would absorb such a gap so, as with the coal market, the receiver would be tempted to switch source to a more local (port) supplier and the increase in VTAC received by Network Rail would be less than might otherwise be expected. VUC per train ex Tyne at present is estimated at £588. If VTAC rose by £10 per thousand net tonne km but the source of cargo became Immingham (to Drax), VTAC (existing VUC + extra VTAC) revenue would rise to £1,321, an increase in VTAC revenues of only 125%. The absolute increase in VTAC costs per tonne ex Immingham at +£10 / thousand net tonne km in VTAC would be an extra 60p as compared with present costs ex Tyne. Such an increase would probably have little impact on overall demand because, unlike for coal, there is less of an issue with respect to elasticity between coal and gas. The propensity to consume biomass is a function of the level of subsidy Government is prepared to offer to switch towards biomass. While domestic sources of biomass are available, they appear inadequate to cover anticipated demand so that, on the margin, the impact of an increase in VTAC is likely to be on the choice of importing port.

It may therefore be that future flows of biomass by rail follow the economic characteristics of coal from port to power station quite closely so that it could be argued that a similar charging regime could be introduced, after making allowance for biomass having a lower cargo density than coal. However, there are three important reservations:

1. The biomass flows that are envisaged do not yet generally exist (except Tyne to Drax) and may be less likely to develop if charges are raised in the same way as for coal.

2. This would particularly apply in the case of smaller biomass power stations that may be associated with industrial plants and therefore not necessarily located near a port or an existing coal fired power station, the imposition of high VTAC could easily discourage the use of rail. A 50 MW facility consuming (say) 250,000 tonnes per annum (a daily trainload) and located 100 kms inland of a port would face an additional VTAC of £250,000 per annum if VTAC rose by £10 per thousand net tonne kms. That figure could correspond to the annualised cost of developing a private siding to handle material by rail and could therefore be significant in a receiver making a choice not to use rail.

3. Some biomass maybe moved in multi-user networks by container. We understand that neither waste wood or wood chip can be readily moved in bottom discharge wagons. Furthermore, residual domestic waste may also be used in 'biomass' power stations, confusing categorisation of the material. Note also that some imported biomass materials could be defined as 'waste' products.

In these circumstances, one option that might be worth considering would be to develop a VTAC based upon the calorific content of different materials entering power stations. However, it might be more practical to classify cargo for VTAC purposes by the scale of the power station being served, linking a specifically high VTAC that corresponds to that levied on coal flows to large power stations engaged in co-firing.

5. OTHER COAL FLOWS (NON ESI)

Table 18 describes transport costs for the leading current flows of coal by rail where the destination is not a power station and compares costs by rail and road in the same way as we have considered biomass.

Table 18 Current other coal flows by modelled 2018/19 costs and increases in VTAC

Other Coal

		Estimated £ per tonne				
Origin	**Destination**	**Current**	**Cargo VUC +£5**	**Cargo VUC +£10**	**Cargo VUC +£15**	**Current HGV**
Immingham	Scunthorpe	£1.38	£1.53	£1.68	£1.83	£4.35
Redcar	Scunthorpe	£3.44	£4.23	£5.01	£5.80	£15.17
Redcar	Port Talbot	£8.03	£10.24	£12.45	£14.66	£50.29
New Cumnock	Hope Cement	£5.77	£7.28	£8.79	£10.30	£27.42
New Cumnock	Clitheroe	£4.74	£5.93	£7.12	£8.31	£22.02
New Cumnock	Penyffordd	£5.84	£7.37	£8.90	£10.43	£27.78
Onllwyn	Immingham	£7.07	£8.98	£10.90	£12.81	£34.27

		% increase		
		Cargo VUC +£5	**Cargo VUC +£10**	**Cargo VUC +£15**
Immingham	Scunthorpe	10.8%	21.5%	32.3%
Redcar	Scunthorpe	22.9%	45.8%	68.7%
Redcar	Port Talbot	27.6%	55.1%	82.7%
New Cumnock	Hope Cement	26.2%	52.4%	78.6%
New Cumnock	Clitheroe	25.1%	50.3%	75.4%
New Cumnock	Penyffordd	26.2%	52.5%	78.7%
Onllwyn	Immingham	27.1%	54.2%	81.2%

By applying 2018/19 costs to current flows, we are implicitly assuming these flows will remain broadly stable in the base case (where there is no increase in VTAC).

The largest flow is that from Immingham to the only remaining inland steel industry blast furnace site at Scunthorpe. Present VUC for this short haul are only £0.08 per net tonne. The cost of rail haulage is far less than by road haulage, even if VTAC rose by £15 per thousand tonne kms (rail cost £1.83 per tonne versus £4.35 per tonne). Providing the extra absolute costs do not threaten the viability of the Scunthorpe plant, given the fact that Immingham is already the closest deep-water port to Scunthorpe it is difficult to see how even a substantial increase in VTAC would have any impact in actual rail freight moved. The next two largest 'other coal' flows are also flows involving steel blast furnace sites; from Redcar to Scunthorpe and to Port Talbot. They reflect the capacity of the coke ovens at Redcar which, because Redcar steel plant has been mothballed, dispatch coke to the other steel works. This traffic can also be considered captive to rail if it operates at this scale; the re-opening of Redcar steel plant may reduce traffic.

The steel plant operator would have the option of expanding the output of local coke ovens, which would either raise coal traffic from Immingham to Scunthorpe or across the jetty at Port Talbot. In either case, traffic by road would not increase as a consequence on any increase in VTAC.

Different arguments apply in the case of the coal traffic to cement plants. The largest current coal flows by rail to cement works are long distance flows (from New Cumnock to cement plants at Hope, Clitheroe and Penyfford) - indicating that short distance flows are generally not viable in competition with road. This suggests that simply comparing the transport costs above does not account for other disadvantages of rail: low volumes generally not justifying full daily trains, rail handling facilities not being as efficient as for coal power stations - e.g. not merry-go-round (block trains of hopper wagons which both load and unload their cargo while moving) and lacking scale economies.

There are several cement works that have had or still have rail connections, yet do not receive coal by rail (e.g. Rugby and Aberthaw). This suggests that a decision has been made to stop receiving coal by rail for these cement works, despite them having rail connections, either in favour of using road, or in favour of alternative heat sources. It is therefore unlikely that there is a clear advantage to using rail for those remaining flows, and possible that any rail transport cost increases could encourage further cement works to stop receiving coal by rail.

Only where most of a category is by rail is it generally captive, and VTAC can be raised without diversion. There are many "other coal" traffics by road - which again shows rail is often not the preferred mode, and suggests it may be vulnerable where it currently is the preferred mode.

The implication is that except for "other coal" traffic to blast furnaces, increased VTAC may lead to some loss of rail traffic.

6. IRON ORE

The only iron ore traffic remaining by rail is that from Immingham to Scunthorpe, following the same route and pattern as for ‘other coal’. Table 19 summarises the increase in revenue per tonne that would be applied to iron ore if VTAC charges were raised substantially.

Table 19 Current iron ore flow by modelled 2018/19 costs and increases in VTAC

		Estimated £ per tonne					
Origin	**Destination**	**Current**	**Cargo VUC +£5**	**Cargo VUC +£10**	**Cargo VUC +£15**		**Current HGV**
Immingham	Scunthorpe	£1.35	£1.53	£1.71	£1.89		£4.35
		% increase in rail leg cost					
			Cargo VUC +£5	**Cargo VUC +£10**	**Cargo VUC +£15**		
Immingham	Scunthorpe		13.3%	26.5%	39.8%		

Again by applying 2018/19 costs to current flows, we are implicitly assuming these flows will remain broadly stable in the base case (where there is no increase in VTAC).

As in the use of coal, it is self evident that a substantial increase in VTAC for iron ore would not lead to a diversion of traffic from rail to road as it would remain much more cheaply moved by rail. An increase of £10 in VTAC raises costs per delivered tonne by only £0.36.

Iron ore cost around £110 per delivered tonne in 2011 (source: UK trade data) so this £10 VTAC increase would add around 0.3% to the cost of iron ore delivered to Scunthorpe.

Accounting for inflation, 10 years ago the cost was less than one fifth of this (around £20 per tonne in 2011 prices). An increase of £0.36 is therefore very much less than the variability of the commodity price.

Iron ore is used to make steel. Typically around 1.6 tonnes of iron ore is required to make 1 tonne of steel. Therefore increasing VTAC by £10 per thousand net Tkm for iron ore ***alone***, would increase the cost of steel produced in Scunthorpe by around £0.58 per tonne. The value of steel is around £600 per tonne depending on the type of steel, so this increase would add around 0.1% to the price of steel produced at Scunthorpe.

7. NUCLEAR TRAFFIC

Nuclear traffic in 55 tonne flasks on 80 tonne gross weight wagons is moved solely between Sellafield and 8 different nuclear power stations.

Table 20 models the relative costs of using rail versus specialised heavy load road haulage (up to 80 gross tonnes) using a secondary vehicle and second driver to provide added security. The table also considers the option of employing a small ro-ro vessel that could, weekly, complete a circuit of Great Britain to serve all the power stations, using local road haulage to deliver the flasks.

Table 20 Current nuclear flows by modelled 2018/19 costs and increases in VTAC

		Estimated £ per Flask				
Power Station	**Reprocessing site**	**Current**	**Cargo VUC +£5**	**Cargo VUC +£10**	**Cargo VUC +£15**	**Current HGV**
Torness	Sellafield	£4,578	£4,637	£4,696	£4,754	£1,654
Hartlepool	Sellafield	£4,196	£4,249	£4,302	£4,356	£1,560
Sizewell	Sellafield	£9,770	£9,906	£10,042	£10,177	£3,368
Dungeness	Sellafield	£10,228	£10,371	£10,513	£10,656	£3,480
Hinkley Point	Sellafield	£8,243	£8,356	£8,469	£8,582	£2,993
Wylfa	Sellafield	£6,258	£6,342	£6,425	£6,509	£2,506
Heysham	Sellafield	£2,440	£2,467	£2,494	£2,521	£1,129
Hunterston	Sellafield	£5,036	£5,102	£5,167	£5,233	£1,766
		% increase				
Power Station	**Reprocessing site**		**Cargo VUC +£5**	**Cargo VUC +£10**	**Cargo VUC +£15**	
Torness	Sellafield		1.3%	2.6%	3.9%	
Hartlepool	Sellafield		1.3%	2.5%	3.8%	
Sizewell	Sellafield		1.4%	2.8%	4.2%	
Dungeness	Sellafield		1.4%	2.8%	4.2%	
Hinkley Point	Sellafield		1.4%	2.7%	4.1%	
Wylfa	Sellafield		1.3%	2.7%	4.0%	
Heysham	Sellafield		1.1%	2.2%	3.3%	
Hunterston	Sellafield		1.3%	2.6%	3.9%	

Again by applying 2018/19 costs to current flows, we are implicitly assuming these flows will remain broadly stable in the base case (where there is no increase in VTAC).

It will be seen that in this case rail is already substantially more expensive than road haulage (e.g. £2,924 per flask more expensive (£4,578 – £1,654) for the short haul from Torness to Sellafield. The reason is quite clear. The size of each load is very small relative to the capacity of a train; rail is employed because it is perceived as safer and more secure.

Table 21 RoRo Ferry				
	Distance from	Sailing time (hrs) from		Time in
	previous port (nm)	previous port (16knots)		port (hrs)
Barrow				
Heysham	22	1.5		3
Holyhead	75	5.0		3
Bristol	226	14.5		3
Dover	445	28.0		3
Felixstowe	63	4.0		3
Hartlepool	219	14.0		3
Leith	125	8.0		3
Barrow	624	39.0		3
Total	1,799	114.0		24.0
	Total time (hrs)	138.0		
	Days	5.75		
Daily charter	€ 7,000			
Daily operating cost	€ 4,000			
Daily cost	€ 11,000			
Weekly cost	€ 77,000			
Bunkers	€ 109,725	Assume 1.75 tonnes/hr at €550/tonne		
Port entry costs	€ 24,000	Assume €3,000 per entry		
Total	€ 210,725			
Total	**£178,581**			
Flasks collected per port	2			
Total flasks per voyage	16			
Cost per flask collected	**£11,161**			

The cost of a ro-ro shipping service (table 21), including local road deliveries, appears to be marginally higher than that of rail at around £11,000 per flask moved as compared with between £2,500 and £10,000 per flask by rail.

The imposition of much higher VTAC does not actually have much impact on the cost per flask for the simple reason that the weight of the flask is so insignificant in its contribution to charges. For the longest haul to Dungeness, an increase in VTAC of £10 per thousand tonne kms would raise charges by just £285. Typical increases would be around £200 per flask or between £125,000 and £150,000 p.a.. It is most unlikely that such a cost increase would induce a switch to road. A substantial increase in VTAC would not therefore lead to a switch of cargo from rail to road.

8. METALS

A very wide range of different metals flows run across the GB rail network, ranging from inter-works movements such as Port Talbot to Llanwern, Shotton and Corby etc. to traffic between ports and inland terminals where the traffic is in direct competition with domestically produced steel.

Table 22 compares road and rail costs for the leading flows where it is assumed that each flow is between rail connected sites. Where this is not the case, an extra delivery charge of £5 - £7 per tonne can be assumed including handling.

Table 22 Current metals flows by modelled 2018/19 costs and increases in VTAC

		Estimated £ per tonne exc. road delivery					
Origin	**Destination**	**Current**	**Cargo VUC +£5**	**Cargo VUC +£10**	**Cargo VUC +£15**		**Current HGV***
Port Talbot	Llanwern	£2.40	£2.76	£3.12	£3.48		£6.94
Port Talbot	Shotton	£5.71	£7.06	£8.41	£9.76		£14.76
Port Talbot	Round Oak	£4.51	£5.50	£6.49	£7.48		£11.91
Port Talbot	Corby	£6.32	£7.85	£9.38	£10.91		£16.18
Port Talbot	Wolverhampton	£4.66	£5.69	£6.73	£7.76		£12.27
Port Talbot	Trostre	£1.79	£1.97	£2.15	£2.33		£6.23
Port Talbot	Hartlepool	£9.03	£11.37	£13.71	£16.05		£22.57
Scunthorpe	Skinningrove	£4.21	£5.11	£6.01	£6.91		£11.20
Scunthorpe	Dollands Moor	£6.92	£8.63	£10.34	£12.05		£17.60
Scunthorpe	Dalzell	£7.22	£9.02	£10.82	£12.62		£18.31
Scunthorpe	Wolverhampton	£4.06	£4.91	£5.77	£6.62		£10.85
Scunthorpe	Lackenby	£4.13	£5.01	£5.89	£6.76		£11.03
Scunthorpe	Aldwarke	£2.17	£2.46	£2.76	£3.05		£6.41
Llanwern	Shotton	£4.66	£5.69	£6.73	£7.76		£12.27
Llanwern	Round Oak	£3.45	£4.13	£4.80	£5.48		£9.43
Llanwern	Dollands Moor	£6.32	£7.85	£9.38	£10.91		£16.18
Llanwern	Middlesborough	£7.83	£9.81	£11.78	£13.76		£19.73
Tinsley	Immingham	£2.70	£3.15	£3.60	£4.05		£7.65
Shotton	Round Oak	£3.60	£4.32	£5.04	£5.76		£9.78
Hartlepool	Leith	£4.89	£5.99	£7.09	£8.19		£12.80
Immingham	Wolverhampton	£4.51	£5.50	£6.49	£7.48		£11.91
			% increase in rail leg cost		** assumes backload except Port Talbot-Trostre*		
			Cargo VUC +£5	**Cargo VUC +£10**	**Cargo VUC +£15**		
Port Talbot	Llanwern		15.0%	30.0%	45.0%		
Port Talbot	Shotton		23.6%	47.2%	70.8%		
Port Talbot	Round Oak		22.0%	43.9%	65.9%		
Port Talbot	Corby		24.2%	48.4%	72.6%		
Port Talbot	Wolverhampton		22.2%	44.4%	66.6%		
Port Talbot	Trostre		10.0%	20.1%	30.1%		
Port Talbot	Hartlepool		25.9%	51.8%	77.7%		
Scunthorpe	Skinningrove		21.4%	42.8%	64.2%		
Scunthorpe	Dollands Moor		24.7%	49.4%	74.1%		
Scunthorpe	Dalzell		24.9%	49.8%	74.7%		
Scunthorpe	Wolverhampton		21.1%	42.1%	63.2%		
Scunthorpe	Lackenby		21.2%	42.5%	63.7%		
Scunthorpe	Aldwarke		13.5%	26.9%	40.4%		
Llanwern	Shotton		22.2%	44.4%	66.6%		
Llanwern	Round Oak		19.5%	39.1%	58.6%		
Llanwern	Dollands Moor		24.2%	48.4%	72.6%		
Llanwern	Middlesborough		25.3%	50.6%	75.9%		
Tinsley	Immingham		16.7%	33.3%	50.0%		
Shotton	Round Oak		20.0%	39.9%	59.9%		
Hartlepool	Leith		22.6%	45.1%	67.7%		
Immingham	Wolverhampton		22.0%	43.9%	65.9%		

** costs implicitly exclude the cost of old wagons held at works awaiting cargo*

Again by applying 2018/19 costs to current flows, we are implicitly assuming these flows will remain broadly stable in the base case (where there is no increase in VTAC).

In the case of the inter-works flows, it is evident that even if VTAC was raised by £15 per thousand net tonne kms that road haulage costs would still be higher than costs by rail. If we consider the flow from Port Talbot to Llanwern for example, even with a VTAC raised by £15 per thousand tonne kms, the cost by rail would be only £2.76 per tonne versus £6.94 by road haulage.

However, this implies a high tonnage per train. For many of the smaller flows, tonnages per train are much lower. Around 25% of tonnes moved by rail are flows of less than 50,000 tonnes per annum, which is less than a weekly train of 1,000 tonnes carried. More important, the fact that onward road delivery will be required for many flows (e.g. from Wolverhampton terminal) makes the cost by rail similar to road haulage costs under present conditions. The typical cost of road delivery over a relatively wide area, plus handling, will cost around £7/tonne. It follows, for example, even at 1,178 tonnes per train (19 wagons @ 62 tonnes cargo), that once the cost of road delivery is added to the Port Talbot to Wolverhampton rail costs of £4.66 per tonne, the door to door cost using rail will be similar to direct road haulage costs estimated at £12.27. Any significant rise in the cost of carriage by rail would render road cheaper than rail.

Our conclusion is that there are a substantial number of flows of metals where rail is in direct competition with road haulage and that competition is very similar to that of containers from rail connected ports to non-connected destinations. In such circumstances, it is inevitable that a substantial proportion of the market finds that, on a door to door basis, road and rail are already in close competition.

It would therefore be an inevitable consequence that raising VTAC for all 'metals' would divert some freight from rail to road.

9. CONCLUSIONS

We have examined the case for raising VTAC for power station and other coal, nuclear traffic, biomass, metals and ores.

We conclude that VTAC can be raised substantially in the case of power station coal without the diversion of a significant amount of traffic to road. We believe mean lengths of haul will fall considerably but, overall, an additional VTAC equating to £10 per thousand net tonne kms could increase Network Rail revenue by £40m per annum.

There would be knock on impacts for some pits and ports; there would be ‘winners’ and ‘losers’ in terms of impact on profitability or, conceivably, viability.

If the same approach was adopted for coal and iron ore to blast furnaces and for nuclear flasks, this would raise a further £4m per annum, raising total potential additional VTAC revenue from these sources to £44m p.a..

The volume of biomass to be moved within Great Britain in the future remains speculative. Where users move biomass to existing coal fired power stations for co-firing a similar VTAC could be levied to that for coal. The power station operators are in many respects obliged to follow such a co-firing approach; in this respect biomass is simply a substitute for coal.

However in the case of biomass-only power stations, much higher VTAC rates could constitute a deterrent to building such new stations inland. In the long term, this potential biomass traffic is therefore more vulnerable to increased VTAC than co-fired biomass. However, on balance there appears little likelihood that many such proposed biomass-only projects are likely to proceed.

In the case of coal to other types of customer (e.g. cement works) levying a much higher VTAC raises more complex problems. There is much more existing competition from road.

This would also apply in the metals sector, where some flows are effectively captive to rail and others are in direct competition with road; any increase in VTAC would render them vulnerable so that to charge more for the carriage of all metals would lead to a loss of rail freight.

It would therefore appear to follow that the most practical way of proceeding would be to raise levels of VTAC substantially on the basis of the type of receiver involved rather than a commodity based definition of the cargo. VTAC could be raised to existing coal fired power stations, present and future nuclear power stations and existing blast furnaces. This approach would avoid penalising (for example) coal dispatched from GB pits to cement works.

APPENDIX 1: COAL POWER STATION TRANSPORT MODEL RESULTS FOR VTAC INCREASES OF £5 AND £15 / THOUSAND NET TKM

Table A1.1: Modelled traffic with VTAC increasing by £5 / Thousand Net Tkm. Th tonnes / year

	Power Stations										
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Total	Increase from base case (Th tonnes)	Increase from base case %
Daw Mill	66	134	36	1,706	0	1	1,019	0	2,963	80	3%
Ayrshire	338	39	90	6	145	0	6	21	644	-82	-11%
Kellingley / Hatfield	2,130	395	16	85	0	0	7	0	2,632	142	6%
Welbeck / Thoresby	316	891	12	523	0	0	43	0	1,785	77	4%
South Wales	2	4	3	50	0	1,127	55	0	1,241	-37	-3%
Ravenstruther	366	42	97	6	379	0	7	22	919	-97	-10%
But'well / Wid'ton	377	43	3	9	0	0	1	357	791	-22	-3%
Maltby / Harworth	163	243	1	35	0	0	3	0	445	22	5%
Total rail-conn pit	3,758	1,792	257	2,421	524	1,128	1,141	400	11,420	83	1%
Ports (all rail-connected)											
Humber	7,488	3,181	18	361	0	0	30	0	11,078	403	4%
Hunterston	489	56	130	9	1,944	0	9	30	2,666	-758	-22%
Tyne / Blyth	1,565	180	11	39	0	0	3	299	2,098	-119	-5%
Liverpool	248	46	1,754	81	0	0	86	0	2,214	50	2%
Avon/Portb	8	15	11	194	0	781	214	0	1,223	-80	-6%
Redcar	781	90	6	19	0	0	2	6	904	-14	-2%
Ellesmere Port	59	26	549	41	0	0	44	0	718	16	2%
Leith	51	6	5	0	102	0	0	45	210	-44	-17%
Newport	0	0	0	5	0	97	5	0	108	-5	-4%
Total port	10,689	3,601	2,484	748	2,046	879	393	379	21,219	-552	-3%
Road-only pits England and Wales. Mostly direct by road to power station	38	723	637	194	0	5	54	33	1,684	128	8%
Road-only pits in Scotland. Direct to PS	0	0	0	0	315	0	0	0	315	43	16%
Road-only pits in Scotland. Via railhead	777	90	206	14	352	0	15	47	1,501	-243	-14%
Grand Total	15,262	6,205	3,583	3,377	3,237	2,012	1,603	860	36,139	-541	-1.5%
Increase from base case (Th tonnes)	-323	-127	-33	-78	50	-9	-26	4	-541		
Increase from base case %	-2%	-2%	-1%	-2%	2%	0%	-2%	0%	-1.5%		

Table A1.2: Delivered costs to power station £ per tonne with VTAC increasing by £5 / Thousand Net Tkm

	Power Stations									
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Weighted Average	Increase from base case
Daw Mill	92.3	91.9	92.5	90.5	102.4	94.3	90.7	98.4	90.7	0.6
Ayrshire	91.4	92.7	91.9	93.9	90.7	98.3	93.7	92.4	91.4	0.4
Kellingley / Hatfield	90.3	91.3	93.0	92.3	101.1	98.4	93.7	96.3	90.5	0.6
Welbeck / Thoresby	91.4	90.8	93.2	91.2	102.3	97.3	92.6	97.5	91.1	0.7
South Wales	94.5	94.1	94.0	92.6	103.9	90.1	92.4	100.5	90.3	0.1
Ravenstruther	91.3	92.6	91.9	93.9	90.1	98.3	93.7	92.3	91.0	0.2
But'well / Wid'ton	91.3	92.6	94.0	93.6	95.1	99.7	95.0	90.7	91.1	0.4
Maltby / Harworth	91.8	91.6	94.6	92.8	102.7	98.9	94.2	97.9	91.8	0.6
Humber	89.5	90.0	92.9	91.4	101.0	97.5	92.8	96.2	89.7	0.7
Hunterston	91.1	92.5	91.7	93.7	89.1	98.1	93.5	92.2	89.7	-0.2
Tyne / Blyth	90.4	91.8	93.2	92.8	95.5	98.9	94.2	90.8	90.7	0.6
Liverpool	91.6	92.6	90.2	92.3	99.6	96.8	92.2	97.3	90.5	0.4
Avon/Portb	93.7	93.2	93.2	91.8	103.1	90.3	91.6	99.7	90.9	0.3
Redcar	90.9	92.2	93.6	93.2	98.9	99.3	94.6	93.1	91.1	0.6
Ellesmere Port	92.4	92.9	90.9	92.7	100.8	97.2	92.6	98.2	91.3	0.4
Leith	92.5	93.8	93.7	95.7	90.9	100.1	95.5	91.9	91.7	0.0
Newport	95.9	95.5	95.4	94.0	105.3	91.5	93.8	101.9	91.8	0.1
Road-only pits England and Wales. Mostly direct by road to power station	93.1	91.0	91.0	92.0	99.9	93.3	92.7	92.1	91.2	0.6
Road-only pits in Scotland. Direct to PS	107.0	110.8	106.4	115.6	90.7	130.0	113.1	96.9	90.7	-0.5
Road-only pits in Scotland. Via railhead	91.4	92.7	92.0	93.9	90.7	98.4	93.8	92.4	91.5	0.4
Weighted Average	90.2	90.7	90.8	91.1	89.7	90.2	91.3	91.1	90.5	0.5
Increase from base case	0.6	0.6	0.3	0.7	-0.5	0.1	0.5	-0.1	0.5	0.5

Table A1.3: Change in gate prices chargeable at each pit and port (£ per tonne) with VTAC increasing by £5 / Thousand Net Tkm

Rail-connected pits	Total
Daw Mill	0.2
Ayrshire	-1.2
Kellingley / Hatfield	0.4
Welbeck / Thoresby	0.3
South Wales	-0.4
Ravenstruther	-1.1
But'well / Wid'ton	-0.4
Maltby / Harworth	0.3
Ports (all rail-connected)	
Humber	0.1
Hunterston	-1.2
Tyne / Blyth	-0.3
Liverpool	0.1
Avon/Portb	-0.4
Redcar	-0.1
Ellesmere Port	0.0
Leith	-0.9
Newport	-0.2
Road-only pits England and Wales	0.6
Road-only pits in Scotland	-1.1

For the VTAC increasing by £5 / Thousand Net Tkm scenario, overall coal tonnes would decrease from the base case by 1.5%. Tonnes transported *by rail* decrease by 2.0% from 34.9m to 34.1m.

Tonne kms by rail have decreased by 13% to 4.79 billion with the rail ALOH reducing to 140km.

Modelled VTAC (existing VUC + extra VTAC) paid would be £34.7m, of which £6.0m would be paid for use of tracks in Scotland. Modelled road journeys (both direct to power station and to a railhead) make up 9.7% of tonnes.

Table A1.4: Modelled traffic with VTAC increasing by £15 / Thousand Net Tkm. Th tonnes / year

	Power Stations										
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Total	Increase from base case (Th tonnes)	Increase from base case %
Daw Mill	7	29	3	1,957	0	0	1,178	0	3,174	291	10%
Ayrshire	205	10	25	1	239	0	1	7	488	-238	-33%
Kellingley / Hatfield	2,629	278	1	35	0	0	1	0	2,943	453	18%
Welbeck / Thoresby	159	1,113	1	651	0	0	18	0	1,941	233	14%
South Wales	0	0	0	13	0	1,170	20	0	1,203	-75	-6%
Ravenstruther	129	7	16	0	582	0	1	5	739	-277	-27%
But'well / Wid'ton	220	11	0	1	0	0	0	530	762	-50	-6%
Maltby / Harworth	131	344	0	23	0	0	1	0	498	74	17%
Total rail-conn pit	3,478	1,792	46	2,681	822	1,170	1,220	542	11,749	412	4%
Ports (all rail-connected)											
Humber	8,406	3,189	1	148	0	0	4	0	11,747	1,072	10%
Hunterston	40	2	5	0	1,423	0	0	1	1,472	-1,952	-57%
Tyne / Blyth	1,407	72	1	9	0	0	0	287	1,776	-442	-20%
Liverpool	107	11	2,053	36	0	0	52	0	2,259	96	4%
Avon/Portb	0	2	1	111	0	722	173	0	1,009	-294	-23%
Redcar	800	41	0	5	0	0	0	1	847	-71	-8%
Ellesmere Port	22	9	642	24	0	0	34	0	730	28	4%
Leith	9	0	0	0	110	0	0	19	139	-116	-46%
Newport	0	0	0	1	0	99	2	0	102	-11	-10%
Total port	10,790	3,325	2,703	333	1,533	821	267	309	20,080	-1,691	-8%
Road-only pits England and Wales. Mostly direct by road to power station	77	867	762	237	0	6	70	11	2,030	474	30%
Road-only pits in Scotland. Direct to PS	0	0	0	0	405	0	0	0	405	133	49%
Road-only pits in Scotland. Via railhead	447	23	55	2	531	0	2	16	1,075	-669	-38%
Grand Total	14,792	6,007	3,565	3,253	3,291	1,997	1,558	877	35,339	-1,341	-3.7%
Increase from base case (Th tonnes)	-793	-325	-51	-202	105	-24	-71	21	-1,341		
Increase from base case %	-5%	-5%	-1%	-6%	3%	-1%	-4%	2%	-3.7%		

Table A1.5: Delivered costs to power station £ per tonne with VTAC increasing by £15 / Thousand Net Tkm

	Power Stations									
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Weighted Average	Increase from base case
Daw Mill	94.9	94.0	94.6	91.8	108.3	97.0	91.7	102.6	91.8	1.7
Ayrshire	92.8	94.6	93.2	96.5	89.7	102.7	95.9	92.8	91.3	0.3
Kellingley / Hatfield	91.3	92.6	95.0	94.2	105.9	103.0	96.0	99.0	91.5	1.5
Welbeck / Thoresby	93.0	91.8	95.2	92.4	107.7	101.3	94.2	100.8	92.1	1.7
South Wales	97.9	97.0	96.7	94.8	110.4	90.3	94.2	105.6	90.4	0.2
Ravenstruther	93.1	94.9	93.5	96.8	89.1	103.0	96.2	93.1	90.0	-0.8
But'well / Wid'ton	92.8	94.6	96.5	96.1	96.6	104.9	97.9	90.2	91.0	0.3
Maltby / Harworth	93.1	92.5	96.8	94.4	107.8	103.3	96.2	100.9	92.7	1.6
Humber	90.6	91.2	95.3	93.3	106.3	102.1	95.1	99.4	90.8	1.7
Hunterston	93.8	95.6	94.2	97.5	88.6	103.7	96.9	93.8	88.8	-1.2
Tyne / Blyth	91.7	93.4	95.4	95.0	97.5	103.8	96.8	90.6	91.6	1.5
Liverpool	93.2	94.5	90.5	94.2	103.6	100.4	93.6	100.5	90.8	0.7
Avon/Portb	96.6	95.7	95.4	93.5	109.1	90.6	92.9	104.3	91.3	0.8
Redcar	92.0	93.8	95.7	95.3	102.3	104.2	97.1	93.9	92.1	1.6
Ellesmere Port	94.2	94.7	91.2	94.4	105.0	100.7	93.8	101.5	91.6	0.7
Leith	94.7	96.5	96.0	99.3	90.1	105.6	98.7	92.2	90.7	-0.9
Newport	99.3	98.4	98.0	96.2	111.7	91.8	95.5	107.0	91.9	0.2
Road-only pits England and Wales. Mostly direct by road to power station	93.8	92.0	91.4	93.2	100.4	93.5	93.6	92.6	92.0	1.4
Road-only pits in Scotland. Direct to PS	104.4	108.1	103.8	112.9	90.0	127.4	110.5	95.9	90.0	-1.2
Road-only pits in Scotland. Via railhead	92.8	94.6	93.2	96.4	89.7	102.7	95.9	92.8	91.3	0.2
Weighted Average	91.2	91.6	90.9	92.3	89.2	90.5	92.1	90.5	91.1	1.1
Increase from base case	1.6	1.6	0.4	1.8	-1.0	0.4	1.3	-0.7	1.1	1.1

Table A1.6: Change in gate prices chargeable at each pit and port (£ per tonne) with VTAC increasing by £15 / Thousand Net Tkm

Rail-connected pits	Total
Daw Mill	0.4
Ayrshire	-3.7
Kellingley / Hatfield	0.8
Welbeck / Thoresby	0.7
South Wales	-1.2
Ravenstruther	-3.0
But'well / Wid'ton	-1.2
Maltby / Harworth	0.8
Ports (all rail-connected)	
Humber	0.2
Hunterston	-3.0
Tyne / Blyth	-1.1
Liverpool	-0.2
Avon/Portb	-1.2
Redcar	-0.6
Ellesmere Port	-0.2
Leith	-2.6
Newport	-0.8
Road-only pits England and Wales	1.4
Road-only pits in Scotland	-3.1

For the VTAC increasing by £15 / Thousand Net Tkm scenario, overall coal tonnes would decrease from the base case by 3.7%. Tonnes transported *by rail* decrease by 5.6% from 34.9m to 32.9m.

Tonne kms by rail have decreased by 31% to 3.79 billion with the rail ALOH reducing to 115km.

Modelled VTAC (existing VUC + extra VTAC) paid would be £65.4m, of which £8.9m would be paid for use of tracks in Scotland. Modelled road journeys (both direct to power station and to a railhead) make up 9.9% of tonnes.

APPENDIX 2: COAL POWER STATION TRANSPORT MODEL RESULTS FOR SENSITIVITY TESTS

Sensitivity test 1:

For the central scenario (VTAC increasing by £10 / Thousand Net Tonne km), ***DOUBLE*** the cost absorption response for pits and ports:

- all ***pits*** accept a £2.00 per tonne decrease in gate price if they experience a 10% decrease in demand.
- all ***ports*** accept a £1.00 per tonne decrease in gate price if they experience a 10% decrease in demand.

Table A2.1: Modelled traffic under sensitivity test 1. Th tonnes / year

	Power Stations										
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Total	Increase from base case (Th tonnes)	Increase from base case %
Daw Mill	18	57	9	1,777	0	0	1,048	0	2,909	26	1%
Ayrshire	374	31	75	4	125	0	4	15	628	-98	-13%
Kellingley / Hatfield	2,120	326	4	57	0	0	3	0	2,510	20	1%
Welbeck / Thoresby	194	951	3	594	0	0	28	0	1,770	62	4%
South Wales	0	1	1	32	0	1,135	41	0	1,210	-69	-5%
Ravenstruther	379	32	76	4	386	0	4	16	896	-120	-12%
But'well / Wid'ton	313	26	1	5	0	0	0	424	769	-44	-5%
Maltby / Harworth	129	280	0	29	0	0	1	0	440	16	4%
Total rail-conn pit	3,526	1,706	170	2,500	511	1,135	1,130	455	11,132	-205	-2%
Ports (all rail-connected)											
Humber	7,471	3,300	4	255	0	0	12	0	11,042	367	3%
Hunterston	365	31	73	3	2,053	0	4	15	2,544	-880	-26%
Tyne / Blyth	1,624	137	3	24	0	0	1	287	2,076	-142	-6%
Liverpool	146	22	1,902	56	0	0	69	0	2,196	32	2%
Avon/Portb	2	6	3	188	0	755	243	0	1,197	-106	-8%
Redcar	792	67	2	12	0	0	1	2	874	-44	-5%
Ellesmere Port	32	14	589	32	0	0	40	0	708	5	1%
Leith	43	4	2	0	101	0	0	53	204	-51	-20%
Newport	0	0	0	3	0	98	4	0	106	-8	-7%
Total port	10,474	3,581	2,580	574	2,154	853	374	357	20,946	-825	-4%
Road-only pits England and Wales. Mostly direct by road to power	45	694	620	195	0	5	50	15	1,625	69	4%
Road-only pits in Scotland. Direct to PS	0	0	0	0	347	0	0	0	347	75	28%
Road-only pits in Scotland. Via railhead	837	70	168	8	291	0	10	35	1,419	-325	-19%
Grand Total	14,882	6,052	3,538	3,277	3,303	1,993	1,563	862	35,469	-1,211	-3.3%
Increase from base case (Th tonnes)	-703	-280	-78	-178	117	-28	-66	6	-1,211		
Increase from base case %	-5%	-4%	-2%	-5%	4%	-1%	-4%	1%	-3.3%		

Table A2.2: Delivered costs to power station £ per tonne under sensitivity test 1.

	Power Stations									
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Weighted Average	Increase from base case
Daw Mill	93.9	93.3	93.9	91.5	105.6	96.0	91.5	100.8	91.5	1.4
Ayrshire	92.1	93.6	92.6	95.2	90.2	100.5	94.8	92.6	91.9	0.9
Kellingley / Hatfield	91.1	92.2	94.3	93.5	103.8	101.0	95.1	97.9	91.3	1.4
Welbeck / Thoresby	92.5	91.6	94.5	92.1	105.3	99.6	93.7	99.4	91.9	1.5
South Wales	96.3	95.7	95.5	93.9	107.3	90.4	93.5	103.3	90.6	0.4
Ravenstruther	92.1	93.6	92.6	95.2	89.5	100.5	94.8	92.6	91.1	0.3
But'well / Wid'ton	92.2	93.7	95.4	95.0	96.0	102.5	96.6	90.6	91.4	0.6
Maltby / Harworth	92.7	92.3	96.0	93.9	105.6	101.4	95.5	99.7	92.6	1.4
Humber	90.3	90.9	94.4	92.6	103.9	100.1	94.2	98.0	90.5	1.4
Hunterston	92.1	93.7	92.6	95.2	88.5	100.6	94.8	92.6	89.2	-0.7
Tyne / Blyth	91.2	92.8	94.4	94.1	96.7	101.5	95.6	90.8	91.3	1.2
Liverpool	92.7	93.8	90.6	93.5	101.9	98.9	93.2	99.2	91.0	0.8
Avon/Portb	95.3	94.6	94.4	92.8	106.2	90.6	92.4	102.2	91.4	0.8
Redcar	91.7	93.2	94.9	94.5	100.8	101.9	96.1	93.8	91.8	1.3
Ellesmere Port	93.6	94.1	91.3	93.9	103.2	99.2	93.5	100.1	91.7	0.8
Leith	93.4	94.9	94.7	97.3	90.3	102.6	96.9	91.9	91.5	-0.1
Newport	97.7	97.1	96.9	95.3	108.7	91.8	94.9	104.7	92.1	0.4
Road-only pits England and Wales. Mostly direct by road to power	93.8	91.8	91.6	93.0	100.4	93.6	93.5	92.6	92.0	1.3
Road-only pits in Scotland. Direct to PS	105.7	109.5	105.1	114.3	90.1	128.8	111.8	96.1	90.1	-1.0
Road-only pits in Scotland. Via railhead	92.1	93.7	92.6	95.2	90.2	100.6	94.8	92.6	91.9	0.8
Weighted Average	91.0	91.4	91.2	92.0	89.1	90.5	92.0	91.0	91.0	1.0
Increase from base case	1.4	1.4	0.7	1.6	-1.1	0.4	1.3	-0.2	1.0	1.0

Table A2.3: Change in gate prices chargeable at each pit and port (£ per tonne) under sensitivity test 1

Rail-connected pits	Total
Daw Mill	0.6
Ayrshire	-2.5
Kellingley / Hatfield	0.9
Welbeck / Thoresby	0.8
South Wales	-0.6
Ravenstruther	-2.1
But'well / Wid'ton	-0.6
Maltby / Harworth	0.8
Ports (all rail-connected)	
Humber	0.4
Hunterston	-2.5
Tyne / Blyth	-0.5
Liverpool	0.2
Avon/Portb	-0.7
Redcar	-0.1
Ellesmere Port	0.2
Leith	-2.0
Newport	-0.3
Road-only pits England and Wales	1.3
Road-only pits in Scotland	-2.2

For the sensitivity test 1 scenario (high response), overall coal tonnes would decrease from the base case by 3.3%. Tonnes transported *by rail* decrease by 3.9% from 34.9m to 33.5m.

Tonne kms by rail decrease by 18% to 4.52 billion with the rail ALOH reducing to 135km.

Modelled VTAC (existing VUC + extra VTAC) paid would be £55.4m, of which £9.6m would be paid for use of tracks in Scotland. Modelled road journeys (both direct to power station and to a railhead) make up 9.6% of tonnes.

Sensitivity test 2:

For the central scenario (VTAC increasing by £10 / Thousand Net Tonne km), ***HALVE*** the cost absorption response for pits and ports:

- all ***pits*** accept a £0.50 per tonne decrease in gate price if they experience a 10% decrease in demand.
- all ***ports*** accept a £0.25 per tonne decrease in gate price if they experience a 10% decrease in demand.

Table A2.4: Modelled traffic under sensitivity test 2. Th tonnes / year

	Power Stations										
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Total	Increase from base case (Th tonnes)	Increase from base case %
Daw Mill	29	75	13	1,944	0	0	1,234	0	3,295	412	14%
Ayrshire	157	11	30	1	242	0	1	9	450	-276	-38%
Kellingley / Hatfield	2,765	352	5	51	0	0	3	0	3,176	686	28%
Welbeck / Thoresby	313	1,264	5	656	0	0	34	0	2,270	562	33%
South Wales	0	1	0	17	0	1,147	23	0	1,189	-90	-7%
Ravenstruther	126	9	24	1	592	0	1	7	759	-257	-25%
But'well / Wid'ton	240	17	0	2	0	0	0	439	698	-114	-14%
Maltby / Harworth	157	283	0	24	0	0	1	0	465	42	10%
Total rail-conn pit	3,786	2,010	78	2,696	833	1,147	1,297	455	12,303	965	9%
Ports (all rail-connected)											
Humber	8,531	3,111	4	200	0	0	10	0	11,856	1,181	11%
Hunterston	50	3	9	0	1,292	0	0	3	1,359	-2,065	-60%
Tyne / Blyth	1,468	102	3	15	0	0	1	351	1,940	-278	-13%
Liverpool	172	22	2,097	46	0	0	60	0	2,397	234	11%
Avon/Portb	1	4	2	96	0	738	133	0	974	-329	-25%
Redcar	716	50	1	7	0	0	0	3	777	-141	-15%
Ellesmere Port	36	13	614	25	0	0	33	0	720	18	2%
Leith	10	1	1	0	108	0	0	17	135	-119	-47%
Newport	0	0	0	2	0	117	3	0	122	9	8%
Total port	10,983	3,306	2,732	390	1,400	855	240	373	20,280	-1,491	-7%
Road-only pits England and Wales. Mostly direct by road to power	60	829	734	274	0	6	64	25	1,993	437	28%
Road-only pits in Scotland. Direct to PS	0	0	0	0	440	0	0	0	440	169	62%
Road-only pits in Scotland. Via railhead	347	24	65	2	549	0	3	19	1,011	-733	-42%
Grand Total	15,177	6,170	3,609	3,362	3,223	2,009	1,604	873	36,027	-654	-1.8%
Increase from base case (Th tonnes)	-408	-162	-7	-93	36	-12	-25	17	-654		
Increase from base case %	-3%	-3%	0%	-3%	1%	-1%	-2%	2%	-1.8%		

Table A2.5: Delivered costs to power station £ per tonne under sensitivity test 2.

	Power Stations									
Rail-connected pits	Aire Valley	Trent Valley	Fiddlers Ferry	Ratcliffe	Longannet	South Wales	Rugeley	Lynemouth	Weighted Average	Increase from base case
Daw Mill	93.2	92.6	93.2	90.8	104.9	95.3	90.8	100.1	90.9	0.8
Ayrshire	92.2	93.7	92.7	95.3	90.3	100.6	94.9	92.7	91.3	0.2
Kellingley / Hatfield	90.5	91.7	93.7	92.9	103.2	100.4	94.5	97.3	90.7	0.7
Welbeck / Thoresby	91.8	90.9	93.8	91.4	104.6	98.9	93.0	98.7	91.2	0.8
South Wales	96.1	95.4	95.3	93.6	107.0	90.1	93.2	103.0	90.2	0.0
Ravenstruther	92.3	93.9	92.8	95.4	89.7	100.8	95.1	92.8	90.4	-0.5
But'well / Wid'ton	91.9	93.5	95.2	94.8	95.8	102.2	96.4	90.3	91.0	0.2
Maltby / Harworth	92.2	91.8	95.5	93.4	105.0	100.8	95.0	99.1	92.0	0.9
Humber	89.8	90.3	93.9	92.1	103.4	99.6	93.7	97.5	90.0	0.9
Hunterston	92.9	94.4	93.4	96.0	89.3	101.3	95.6	93.4	89.4	-0.5
Tyne / Blyth	90.9	92.4	94.1	93.7	96.3	101.1	95.3	90.5	90.9	0.8
Liverpool	92.1	93.3	90.1	93.0	101.4	98.4	92.6	98.7	90.4	0.2
Avon/Portb	95.0	94.4	94.2	92.6	106.0	90.4	92.2	102.0	90.9	0.3
Redcar	91.3	92.8	94.5	94.1	100.5	101.6	95.7	93.4	91.4	0.9
Ellesmere Port	93.1	93.6	90.9	93.4	102.7	98.7	93.0	99.6	91.2	0.3
Leith	93.9	95.4	95.1	97.7	90.8	103.1	97.4	92.3	91.2	-0.4
Newport	97.4	96.7	96.5	94.9	108.3	91.5	94.5	104.3	91.6	-0.1
Road-only pits England and Wales. Mostly direct by road to power	93.2	91.2	91.0	92.1	99.9	93.3	92.8	92.0	91.4	0.7
Road-only pits in Scotland. Direct to PS	105.8	109.6	105.2	114.4	90.5	128.8	111.9	96.5	90.5	-0.7
Road-only pits in Scotland. Via railhead	92.2	93.7	92.7	95.3	90.3	100.6	94.9	92.7	91.3	0.1
Weighted Average	90.4	90.8	90.6	91.3	89.8	90.3	91.3	90.6	90.5	0.5
Increase from base case	0.8	0.8	0.1	0.8	-0.3	0.2	0.5	-0.6	0.5	0.5

Table A2.6: Change in gate prices chargeable at each pit and port (£ per tonne) under sensitivity test 2

Rail-connected pits	Total
Daw Mill	-0.1
Ayrshire	-2.4
Kellingley / Hatfield	0.3
Welbeck / Thoresby	0.1
South Wales	-0.9
Ravenstruther	-1.9
But'well / Wid'ton	-0.9
Maltby / Harworth	0.3
Ports (all rail-connected)	
Humber	-0.1
Hunterston	-1.7
Tyne / Blyth	-0.9
Liverpool	-0.3
Avon/Portb	-0.9
Redcar	-0.5
Ellesmere Port	-0.3
Leith	-1.5
Newport	-0.7
Road-only pits England and Wales	0.7
Road-only pits in Scotland	-1.9

For the sensitivity test 2 scenario (low response), overall coal tonnes would decrease from the base case by 1.8%. Tonnes transported *by rail* decrease by 3.6% from 34.9m to 33.6m.

Tonne kms by rail decrease by 30% to 3.86 billion with the rail ALOH reducing to 115km.

Modelled VTAC (existing VUC + extra VTAC) paid would be £47.3m, of which £6.0m would be paid for use of tracks in Scotland. Modelled road journeys (both direct to power station and to a railhead) make up 9.6% of tonnes.