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Impact of Proposed New Charge for Freight Only Lines on Demand for ESI Coal

Revised Report Prepared for Office of Rail Regulation

NERA
Economic Consulting

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1. Introduction

The Office of Rail Regulation commissioned NERA Economic Consulting to examine the impact of a new charge for freight only lines on the demand for coal for power generation.

In its consultation on the caps for freight track access charges,[1] ORR proposed a new charge for freight only lines for certain categories of commodities, including ESI (electricity supply industry) coal. To inform the preparation of its consultation, ORR commissioned MDS Transmodal to examine the impact of increased track access charges on rail freight traffic. MDS Transmodal used a detailed freight transport model to examine charging options on demand with respect to different commodities.[2] Its study did not focus on modelling the electricity supply industry, and instead drew on ESI demand elasticities prepared by the Department for Trade and Industry. MDS Transmodal estimated that an increase of track access charges of 50 per cent would increase the delivered cost of coal by 1 per cent, reducing demand for coal by rail by around 1 per cent.

NERA has examined the impact of increasing rail freight track access charges on the demand for coal for power generation using a bottom-up model of the ESI over the period 2009 to 2014 (the period for which ORR's forthcoming track access charge proposals would apply). For the purpose of our study, we have relied on our in-house model, EESyM, which is a classic stacking model of the Great Britain electricity market that produces estimates of generation, fuel consumption, prices and margins.

The structure of the remainder of our report is as follows:

- In chapter 2 we set out our representation of track access charges and other rail freight transport costs in our model of the ESI;
- In chapter 3 we describe our modelling methodology;
- We present the results of our analysis in chapter 4;
- Our report findings are summarised in chapter 5;
- We show graphs of our fuel price forecasts in Appendix A.

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1 ORR (December 2006) *Periodic Review 2008 - Consultation on Caps for Freight Track Access Charges.*

2 MDS Transmodal (November 2006) *Impact of track access charge increases on rail freight traffic*. Published on www.rail-reg.gov.uk.

2. Estimating Coal Transport Costs

NERA examined the impact of increasing variable track access charges (TAC) for ESI coal services by 50 per cent. This option is broadly in line with that proposed by ORR in its December consultation.[3] To do this, we first calculated the impact of the TAC increase on the cost per tonne of coal delivered to each of the GB power stations affected. We found that the TAC increase represented between 1 and 2 per cent of the cost of coal delivered, depending on the power station concerned. These estimated cost increases were then used as inputs to our EESyM model, which is described in the next chapter.

We calculated the TAC using the unit charge contained within MDS Transmodal's report, Table 3, namely £4.84 per thousand coal tonne km. This figure is derived using assumptions concerning locomotive and wagon mix and load factors for ESI coal. We used traffic and mileage matrices provided to ORR by MDS Transmodal to translate this charge per tonne km into a charge per tonne for each of the power stations concerned. MDS Transmodal's data were for 2005 (derived from outturn data) and 2014 (forecasts); we interpolated our results for the two years to derive estimates for intermediate years.

We also revised our estimates of coal rail transport costs for each power station, to provide a robust baseline against which to measure the impact of the ORR's proposals. We found that our transport cost estimates compared well with those presented in MDS Transmodal's published report.

3 Op. cit.

3. ESI Modelling Approach

The effect of ORR's proposed revised TACs on coal-fired power stations in Great Britain (GB) depends on how the increased costs of rail freight feeds into the production decisions of coal-fired generators. In this chapter, we describe how the electricity market works in order to identify the range of factors, including freight charges, that drive the production decisions of power stations. We then outline the approach we take to modelling the effect of the proposed changes in freight track access charges and describe the inputs to this modelling process.

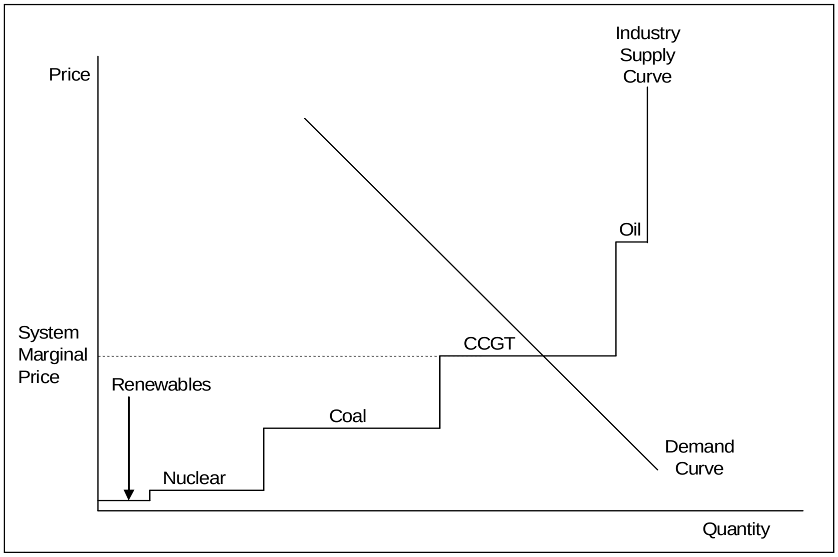
3.1. The GB Generation Market

Generators in GB compete within a market framework known as the British Electricity Transmission and Trading Arrangements (BETTA), which includes rules for accessing the GB transmission system and making generation sales. A variety of market places exist within the BETTA framework that provide alternative outlets for generation, including the automated power exchange (APX), over the counter (OTC) markets and the balancing market for last minute adjustments operated by National Grid (NG). However, the possibilities for arbitrage across these markets means that they are closely integrated, and hence we treat these markets as comprising a single wholesale market for the purpose of our analysis.

As in any market, prices in the GB wholesale electricity market adjust to match available supplies to demand, as illustrated in Figure 3.1, with the market price set by the marginal cost of the most expensive generator operating at a given demand level. Figure 3.1 shows that differences in the marginal cost of plants define a ranking or "merit order" of generators, in which plants are ranked in order of increasing marginal cost, with the lowest marginal cost plants ranked at the top. In this simplified example, renewable and nuclear generators produce first. Then if more electricity is demanded, coal generators produce, then Combined-Cycle Gas Turbine (CCGT) plants, then oil-fired generators.[4]

[4] In this simplified example, the marginal cost of coal fired generation is lower than the marginal cost of generation from a CCGT plant, but this ranking is just a schematic illustration.

Figure 3.1
Stylised Industry Supply and Demand Curve



In practice, the GB wholesale electricity market operates by each plant making an "offer" stating the lowest price at which it is willing to supply a given quantity of electricity in each half hour period, with the set of all offers making up the industry supply curve. The intersection of this industry supply curve with the market demand curve (constructed based on demand "bids") determines the market price.

3.2. Competition between Coal and Gas Generators

Coal-fired power stations in Great Britain (GB) mainly compete with gas-fired CCGT power stations to supply electricity in the GB wholesale market. Up until recently, production from coal plants has been significantly cheaper than production from CCGTs *in winter*, when gas prices are high due to the high levels of winter gas demand, and more expensive *in summer*, when gas prices are low due to low summer demand for gas. Hence, historically coal plants have tended to operate as baseload plant in the winter (i.e., 24 hours a day and 7 days a week), and as peaking plant in the summer (day-time on working days).

Within this framework, the theoretical, simplified, impact of an increase in track access charges on production from coal plant depends on whether the increase is small or large, as illustrated in Figure 3.2 and Figure 3.3.

As illustrated in Figure 3.2, in winter a small increase in freight costs reduces the profits captured by coal-fired power stations without affecting their level of production. In the summer, when coal plants are the marginal source of supply, the increase in freight costs increases the price coal-fired power stations need to charge and hence the market price, but again, without affecting the level of production from coal-fired plants – because electricity demand (depicted by the vertical line D) is effectively inelastic.

With a large increase in track access charges, the picture in summer is similar to the one we saw with a small increase in freight charges, as illustrated in Figure 3.3. However, in winter the large increase in track access charges leads to a switch in the merit order, with coal-fired plant becoming the marginal source of supply. In this case, as shown in Figure 3.3, *the production from coal plants falls as a result of the increase in freight charges.*

Figure 3.2
The Impact of a *Small* Increase in Track access Charges

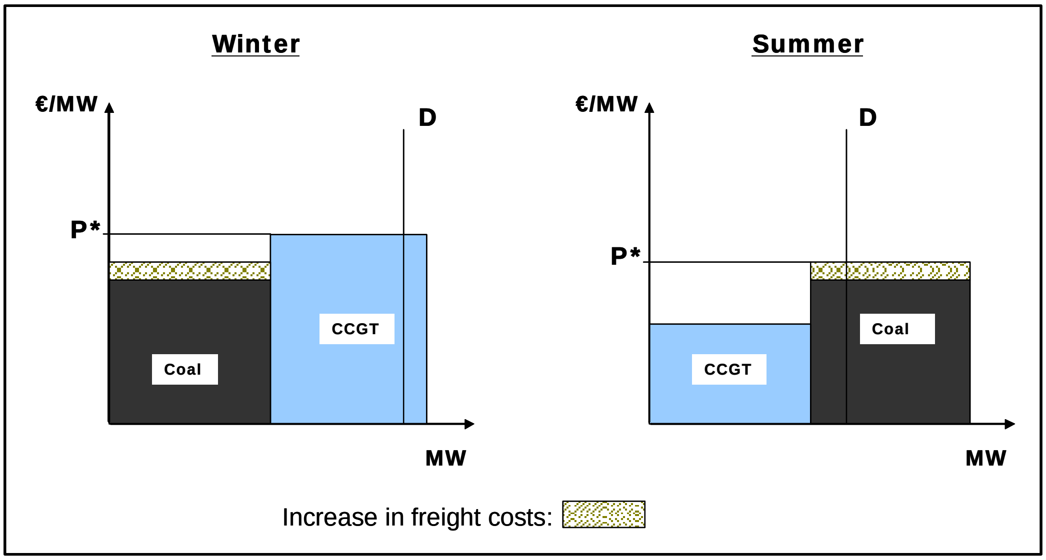
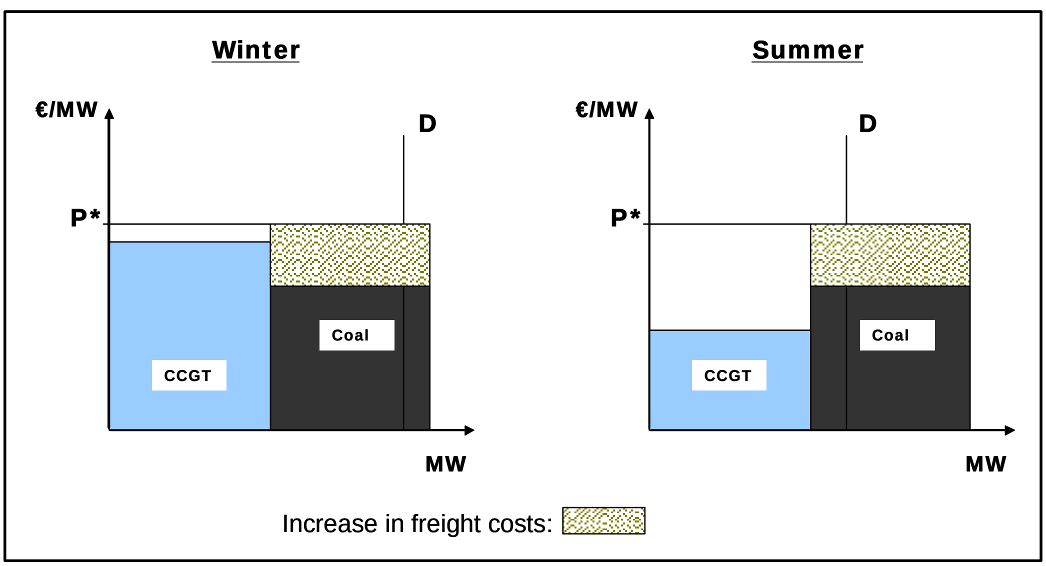


Figure 3.3
The Impact of a *Large* Increase in Track access Charges



Hence, within the schematic framework illustrated in Figure 3.2 and Figure 3.3, an increase in track access charges may affect production from coal-fired power stations depending on the scale of the increase.

In reality, however, the thermal efficiency of coal-fired and CCGT plants (i.e., the efficiency with which they convert fuel to electricity) varies on a spectrum, which may create some overlap between the marginal costs of these plant both in winter and summer, and both plant types also compete at the margin with other sources (e.g., open cycle gas turbines, oil plant, imports). In addition, the recent surge in oil prices and consequently gas prices in GB and the introduction of the EU emissions trading system (ETS) for CO_2 have altered the historic picture shown in Figure 3.2 and Figure 3.3. Looking forwards, therefore, the impact of a given increase in track access charges depends on a variety of factors, including:

- *relative trends in underlying coal and gas prices*: recently gas prices have reached record levels in GB, giving coal plants an increased cost advantage over CCGTs in winter and making them competitive with CCGTs in summer. Despite recent falls in spot prices, this situation looks set to continue in the next few years based on the latest market forward curves, but the long-term outlook is uncertain;
- *trends in CO_2 prices*: the recently introduced EU ETS has put a price on emissions of CO_2. As coal-fired power stations emit three times more CO_2 per unit of output than CCGTs, the CO_2 trading system has reduced the competitiveness of coal plant relative to CCGTs. So far the CO_2 price has been extremely volatile, creating an uncertain long-term outlook;
- *trends in investment*: the remaining Magnox nuclear power stations are due to close over the next five years, creating scope for coal-fired power stations and CCGTs to expand their output. In addition, a number of new CCGTs are in various stages of development, and recently a number of developers have announced plans to build new coal-fired power stations using clean-coal technology; and
- *competition from other technologies*: for example, open cycle gas turbines, oil-fired plants, imports, etc.

These factors affect the relative competitiveness of coal and CCGT plants, the size of the market within which they compete, and/or the availability of such plant on the system, and thus they each have the potential to influence the impact of track access charges on production from coal plants.

3.3. NERA's EESyM Model

To take into account all the factors discussed above, we have examined the impact of an increase in freight charges using our model of the GB electricity market, EESyM.[5] We used EESyM to construct a range of realistic scenarios of GB market evolution based on our analysis of key price drivers (including trends in fuel and CO_2 prices, investment, demand, etc).

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[5] EESyM is a tested and proven proprietorial model of the UK and European electricity markets, which we have used extensively on a range of regulatory, due diligence and competition policy assignments.

Based on the fuel price, CO_2 price, demand, capacity and transport cost inputs, EESyM constructs a merit order of GB power stations in each quarter, and thereby generates forecasts of how much electricity is produced from each (type of) plant. Given the modelled output of each plant, EESyM then derives forecast prices, fuel consumption, revenues and margins. This information will allow us to forecast the impact of the proposed changes in access charges on the Coal-ESI.

3.3.1. Modelling the effect of increased access charges

EESyM includes assumptions about the cost of domestic freight transport of coal to GB power stations, which has allowed us to assess the impact of revised TACs on coal plants by comparing coal consumption under the following two options:

§ *Business-as-usual or existing TACs*: in which we assume that the existing regime for calculating track access charges for domestic freight continues; and

§ *Revised TACs*: in which we that variable TACs for ESI Coal freight services are increased by 50 per cent for 2009 onwards.

The change in the volume of coal burn between these two options gives us an estimate of the impact of the increase in freight access charges on the demand for power station coal, and consequently the demand for coal by rail.

3.3.2. Key modelling assumptions

§ **Plant Efficiencies**

We used historic plant production and emissions data, published as part of the National Allocation Plan (NAP), to derive plant-level efficiencies for GB thermal power stations.[6] Where NAP data were unavailable for individual plants, we extrapolated efficiency for these plants using information on the efficiencies of similar types of plant.

We model the effect of increasing freight track access charges on each GB coal-fired generator separately. For other types of plant, we group similar types of generator together. To account for the differing efficiencies (and hence marginal costs) of CCGT plants, we group CCGT generators into seven efficiency bands, ranging from 41% to 52% (gross calorific value). We assume all new plants that are due to come on line over the modelling period have an efficiency of 52%.

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[6] For emissions data, we used NAP Phase I data from Defra's *Installation Level Allocations* spreadsheet: http://www.defra.gov.uk/environment/climatechange/trading/eu/nap/install.htm.
For historic generation data we used NAP Phase II data from the DTI. See: http://www.dti.gov.uk/energy/environment/euets/phase2/allocation/page27064.html.

§ Plant Capacities

We source plant capacity information from National Grid's 2006 Seven Year Statement (SYS).[7] National Grid (NGC) publishes capacity information for all plants connected to the GB transmission network, which are currently online or which NGC believes may come online over the coming seven years. Because generating companies often announce new generation projects that do not come to fruition, NGC's capacity data gives an upper limit on the amount of capacity which will be online over the seven year period, and the actual volume of capacity might be much lower.

Due to this uncertainty over what capacity will come online over the next seven years, in our central case scenario, we consider only that plant which is online or under construction during 2006/07.[8] As a variant, we have also examined a scenario where we include all the plants listed in NGC's SYS.

§ Fuel and CO_2 Prices

In our central case, we construct gas, oil, coal and CO_2 price forecasts using forward curve information (as at 9 January 2007) up to the end of 2009.[9] From 2010 onwards, we assume that the fuel prices remain constant in real terms at the 2009 forward price.

To test the sensitivity of our modelling results to variations in relative fuel prices, we have also looked at low and high crude oil price scenarios, using $40 per barrel of oil (bbl) and $70 per bbl long-term Brent prices, compared to approximately $55 per bbl in our central case.[10] The oil price scenarios feed through into high and low gas price scenarios, based on the observed historical correlation between oil prices and GB gas prices. Appendix A shows graphs of our fuel and CO_2 price assumptions.

§ Gas Transport Costs

Large gas users (such as CCGT operators) pay for gas transport on the British gas transmission network through capacity and commodity charges for use of the transportation network. Under current arrangements, the capacity charge is invariant to utilisation, and so does not affect the short-run marginal cost of generation. The commodity charge is levied on a volumetric basis, and so does affect the marginal cost of generation. We include the commodity charge of gas transport in our model as indicated in NGC's Statement of the Gas Transportation Charging Methodology (effective October 2006).[11]

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[7] National Grid Seven Year Statement 2006, Table 3.5.

[8] We rely on Platts *Powervision* database for information on which plants are classed as "under construction".

[9] Gas and oil forward prices from Bloomberg. Coal forward prices from Heren. CO2 forward prices from Point Carbon. In constructing our forecasts, we have used forward curve information for exchange rate forecasts from Bloomberg. We have also used forecasts of US and Eurozone inflation, drawn from Consensus Forecasts Global Outlook: 2006-2015, Consensus Economics Inc., 2006.

[10] Oil prices quoted in real 2006 price terms.

[11] See http://www.nationalgrid.com/uk/Gas/Charges/statements/.

3.4. Summary

In this chapter, we have outlined the framework and modelling approach we use to simulate the GB wholesale electricity market, together with the sources of our key assumptions. Our EESyM model works by matching available generation to demand using a “merit order” of plants, which is a standard approach to modelling production decisions in the electricity industry. By running EESyM with and without the ORR’s proposed revised TACs, we can get an estimate of the impact of the ORR’s proposals on coal consumption in the electricity industry, and hence the demand for coal freight transport by power stations.

In the next chapter, we give a summary of the results we have found from our modelling exercise.

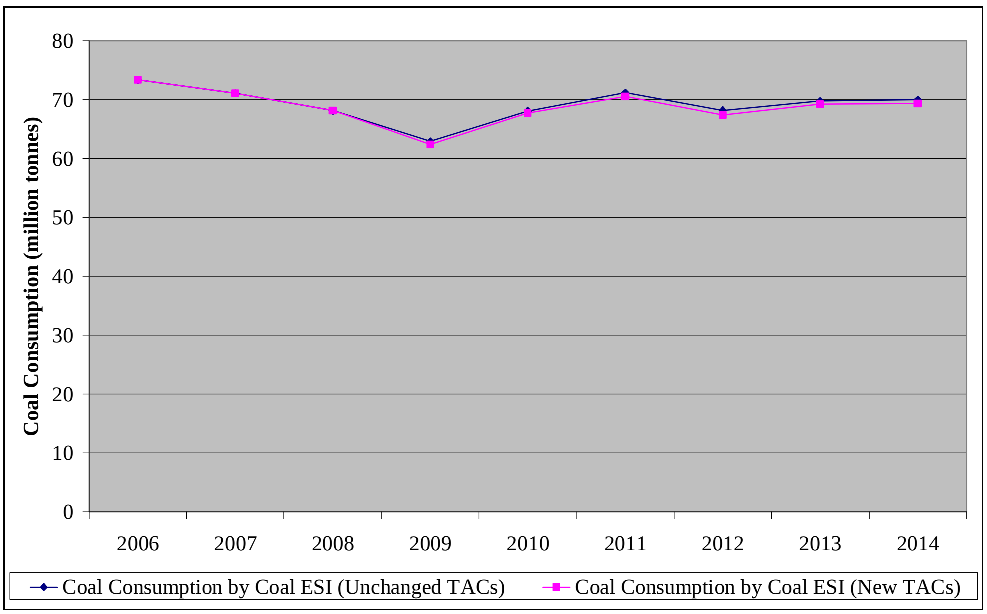
4. Modelling of the Impacts on ESI Coal

4.1. Central Case

We have run EESyM to calculate the impact of increasing variable TACs by 50 per cent on coal consumption by ESI coal over the period 2009 to 2014. We use the ORR's definition of "coal ESI", which comprises all coal-fired power stations whose primary activity is the production of electricity for public electricity supply. As over 80% of electricity generated at Alcan's 420MW Lynemouth coal-fired plant was used to supply on-site aluminium smelters over the period 2001-05, with less than 20% exported to the national grid, this definition of "coal ESI" excludes Lynemouth.[12]

As can be seen from Figure 4.1, we forecast the impact, in terms of the reduction in annual coal consumption by the Coal ESI, to be small.

Figure 4.1
Coal Consumption: ESI Coal Plants



As shown in Table 4.1, over the TAC control period 2009-14 as a whole, we estimate coal consumption by ESI coal will fall by approximately 1%.[13]. (Given the underlying uncertainties concerning demand and capacity and fuel price forecasts, etc., quoting the results rounded to the nearest whole number gives a more reasonable guide to the impacts we have identified.) Two of the power stations included in the coal ESI receive deliveries of coal direct into their own ports (Tilbury and Kingsnorth), and hence do not use rail transport

12 Source of Lynemouth production data: www.iema.net/download/events/northeast/20051118/John%20Clarkson.pdf). Lynemouth's exports to the grid represented approximately 0.4% of all coal-fired electricity generation on average over this period.

13 This figure is rounded to the nearest whole number.

for their coal supplies. To take account of this fact, Table 4.1 also shows our forecast of the reduction in coal consumed at ESI coal power stations that receive coal by rail,[14] which equates to the reduction in ESI coal delivered by freight operating companies (FOCs). As can be seen from the table, this impact is also approximately 1%.

Table 4.1
Central Case Impacts on Coal ESI[15]

2009 Q2 - 2014 Q1	Coal Consumption (million tonnes)		
	Existing TACs	Revised TACs	% Change
Impact on the Coal ESI	342	339	-0.8%
Impact on Freight Operators	302	299	-0.9%

We have briefly examined the impact of the new freight access charges on domestic coal producers. From our analysis of the proposed changes in access charges, we estimated that domestic pits would face an increase in charges that is on average £0.26/tonne to £0.33/tonne higher than that for imported coal, assuming the pattern of transport flows is unaffected by the change in TACs. Pits in Scotland in particular will face relatively large increased costs, assuming current distribution patterns, whereas pits in the East Midlands and Yorkshire, for example, experience cost increases that are less than those for imported coal.

As the price of coal at the station gate is capped by the cost of imports, whose prices are fixed in international markets, certain domestic pits may have to bear some or all of the cost of any relative increase in their freight charges in the form of lower margins. However, a significant number of power stations do not currently use imported coal, so there is the possibility that domestic pits will have the headroom to pass-on a portion of their increased TACs to the power stations. Assuming, in a worst case scenario, that the pits had to bear the whole of the relative increase in freight access charges, the loss in margin would be equivalent to less than 1 per cent of the price of delivered coal.

4.2. Sensitivity Analysis

To test the sensitivity of our results, we have examined three further scenarios as follows:

- Low and high oil price scenarios, as summarised in Chapter 3;and
- A high new entry scenario, in which we assume all the new plants listed in NGC's Seven Year Statement come online as planned, as compared to our central case where we only include new plants that are classed as under construction.

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[14] All coal-fired power stations excluding Kingsnorth and Tilbury.

[15] In addition, our model predicts that the impacts on the revenues and margins of the coal ESI will be of a similar order of magnitude to the impacts on coal consumption and transport, with revenues falling by 0.6% and margins by 1.4%.

As illustrated in Table 4.2, we estimate the impact of the revised TACs on the Coal ESI, as well as coal freight transport to serve the coal ESI in these alternative scenarios is similar to that in our central case, i.e., in the range of approximately 1-2%.[16]

Table 4.2
Sensitivity Analysis Results

2009 Q2 - 2014 Q1		Central Case	Low Fuel Price Scenario	High Fuel Price Scenario	High Entry Scenario
Change Resulting from New TAC Regime	Coal Consumption by the Coal ESI	-0.8%	-1.3%	-0.3%	-1.6%
	Coal Delivered by Rail to the Coal ESI	-0.9%	-1.7%	-0.3%	-2.0%

4.3. Summary

In our central case, we find that the ORR's proposed revised TACs would reduce coal consumption and coal freight transport by the coal ESI by approximately 1%. We have tested the sensitivity of our results to variations in our underlying assumptions on relative fuel prices and the scale and timing of new entry, and found that our results are robust to variations in these assumptions.

[16] The relative size of the impacts on the coal ESI in our fuel price scenarios may appear counter-intuitive, but it stems from the fact that we calculate the change in coal consumption between the existing TACs and revised TACs against a common set of fuel prices in each case. The fuel price scenario sets the starting point for the ranking of plants in the existing TACs case, and crucially the marginal cost differences between each plant. The revised TACs then shifts the ranking, with impacts that depend on the starting marginal cost differences. What happens in the high oil price scenario is the starting marginal cost differences are bigger than in the central case, resulting in less change to the ranking of plants and hence coal consumption. Whereas the reverse is true in the low oil price scenario.

5. Summary and Conclusions

We have examined the impact of a 50 per cent increase in the variable track access charge (TAC) on the demand for coal for power generation over the period 2009 to 2014, using our stacking model of the electricity supply industry, EESyM.

Our work has built on the earlier study by MDS Transmodal, published in November 2006, which examined the impact of increased TAC on a variety of rail freight commodities. MDS Transmodal did not model the ESI explicitly, and instead relied on demand elasticities prepared by the Department for Trade and Industry. MDS Transmodal estimated that a 50 per cent increase in track access charges would increase the delivered cost of coal by 1 per cent, reducing demand for coal by rail by around 1 per cent.

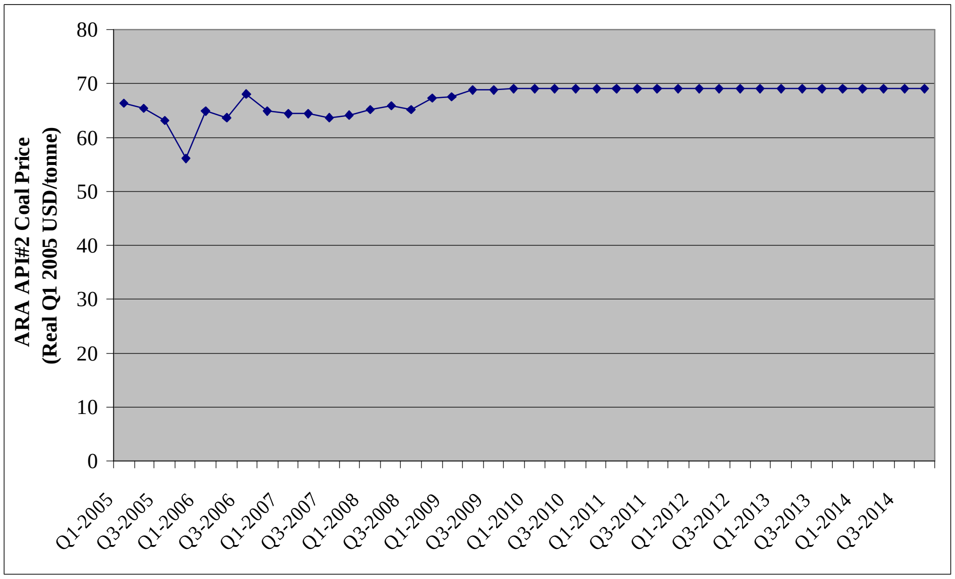
We estimated the impact of a 50 per cent increase in TAC on the cost of coal delivered, and found it to represent an increase in cost per coal tonne of between 1 and 2 per cent, depending on the location of the power station concerned.

We then tested the impact of this cost increase on demand for ESI coal, using our ESI model EESyM. We examined a central case scenario as well as several variants covering alternative fuel price and new entry assumptions, to test the sensitivity of our results to these underlying assumptions. We forecast that the impact of a 50 per cent increase in TAC would reduce coal demand for the ESI by approximately 1 to 2 per cent across the range of scenarios we have modelled.

Appendix A. Input Price Forecasts

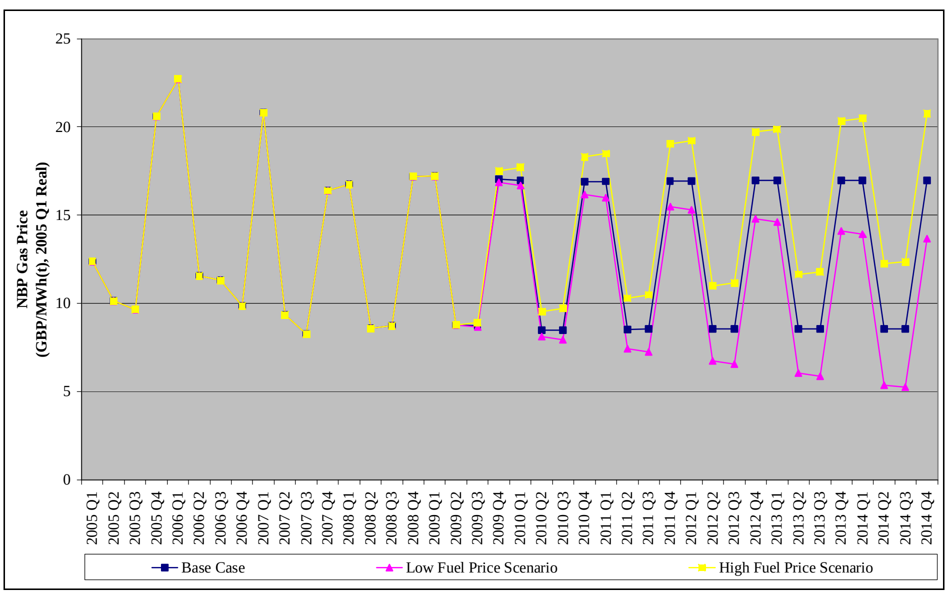
A.1. Coal Price Forecasts

Table A.1
ARA CIF Coal Price Forecast



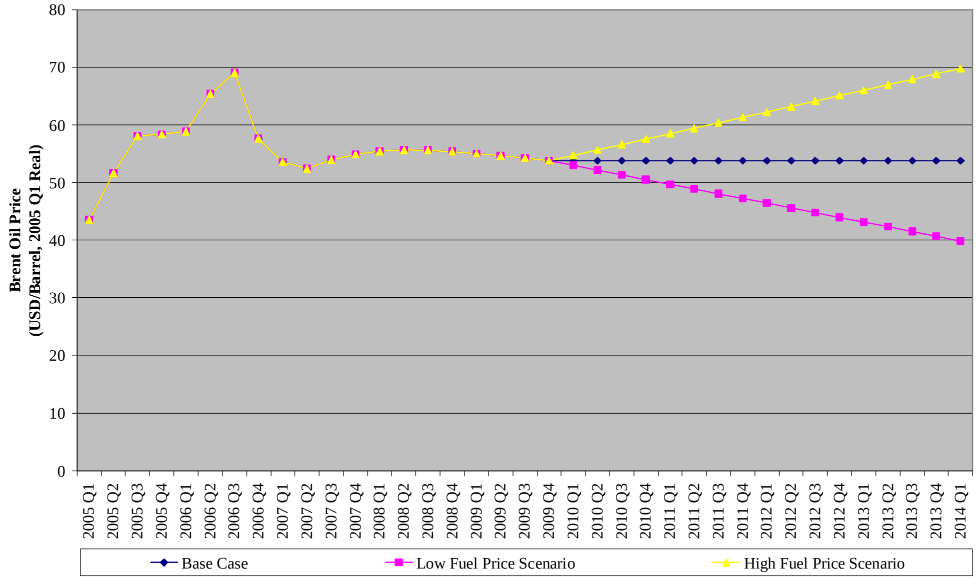
A.2. Gas Price Forecasts

Table A.2
NBP Gas Price Forecasts



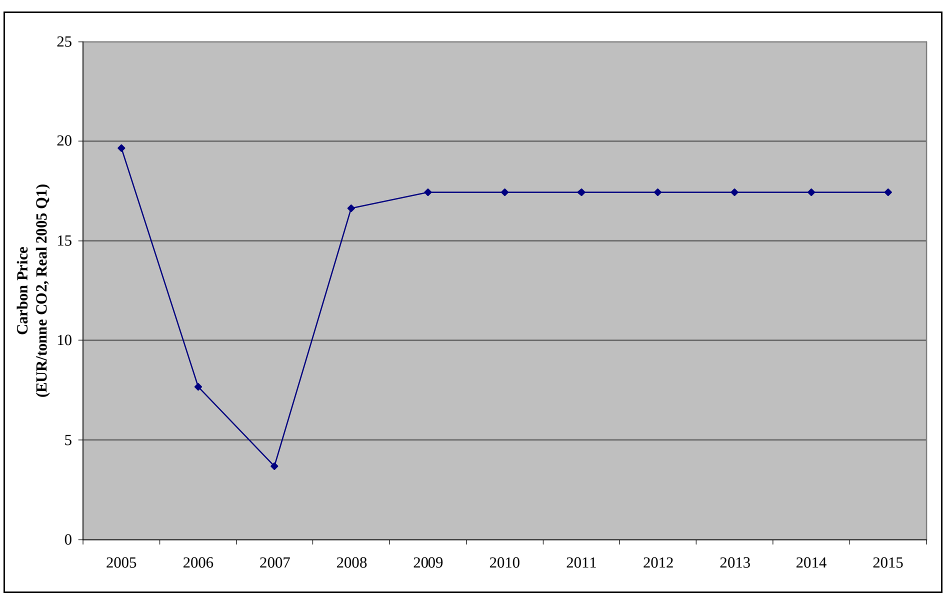
A.3. Oil Price Forecasts

Table A.3
Brent Crude Oil Price Forecasts



A.4. CO_2 Price Forecasts

Table A.4
Carbon Price Forecasts



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