

IN APRIL 2004 AVERAGE ZONAL TRANSMISSION LOSSES (AZTL) CHARGING IS DUE TO BE INTRODUCED IN ENGLAND AND WALES. IN APRIL 2005, THE BRITISH ELECTRICITY TRADING AND TRANSMISSION ARRANGEMENTS (BETTA) ARE DUE TO GO-LIVE THROUGHOUT GREAT BRITAIN WITHOUT AZTL. **JANUSZ BIALEK, MURRAY HARTLEY AND STEPHEN TOPPING** ANALYSE THE ARGUMENTS SURROUNDING THE INTRODUCTION OF LOCATIONAL LOSS CHARGING.

# AVERAGE ZONAL TRANSMISSION

**P**ower losses occur when electricity flows through the transmission system. Most of these losses are a function of the current flowing through the line or transformer winding. "Variable" losses are roughly proportional to the square of the current through the element, while "fixed" losses tend to be proportional to the voltage and constitute about 20% of total transmission losses at peak load (see Table 1).

Currently, losses in England and Wales are paid for by generators and suppliers through the scaling of metered volumes using transmission loss multipliers (TLMs). Losses are split in the ratio 45:55 between generators and suppliers, and are recovered uniformly across the country. In Scotland, losses are recovered by smearing the cost across suppliers.

Changes to the Balancing and Settlement Code (BSC), which governs settlements, the Balancing Mechanism and trading, are generally proposed to a Panel by BSC parties. Modification P75 was submitted in April 2002 and proposed the introduction of zonal transmission losses, calculated *ex post* on a marginal basis for each half-hour settlement period. Modification P82 was submitted shortly afterwards and proposed zonal transmission losses calculated *ex ante* every year on an average rather than a marginal basis. This latter approach gives less pronounced loss charging signals, a consequence of the fact that variable losses increase with the square of the power flow.

In December 2002 the BSC Panel decided to recommend the rejection of both the proposed modifications. Despite this, the Office of Gas and Electricity Markets (Ofgem) decided to approve P82 on 17 January 2003 for

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implementation from 1 April 2004. Four electricity companies sought a judicial review of this decision, but the application was rejected by the High Court in July 2003.

Figure 1 illustrates how TLMs are calculated under the P82 methodology:

- ◆ a load-flow model of the network is used to estimate transmission loss factors (TLFs), which give the marginal effect of power flows at different nodes on the network on the level of transmission losses;
- ◆ TLFs from the load-flow model are averaged across the nodes within a zone and across time periods and then divided by two in order to give average rather than marginal losses. This gives adjusted annual zonal TLFs (ATLFs);
- ◆ TLMs for each half-hour period are then calculated to recover the actual level of losses in the ratio 45:55 from generators and suppliers, with the differential between zones determined by ATLFs.

As shown in Figure 2, within Great Britain there tends to be a surplus of generation in the north of the country and a concentration of electricity demand in the south, leading to prevailing north-south flows on the network. As a consequence of this, the P82 methodology would lead to a higher proportion of losses being allocated to northern generators relative to southern generators, and to southern consumers relative to northern consumers.

# LOSSES

Despite the expected start of BETTA within a year of the implementation of P82, Ofgem did not assess the modification on a GB-wide basis due to legal reasons. The decision on whether AZTL is embodied in the BETTA codes rests with the Secretary of State for Trade and Industry rather than Ofgem. Following a consultation exercise and a comprehensive study carried out by economic consultants Oxford Economic Research Associates (OXERA), the government announced that it is minded not to apply AZTL throughout GB under BETTA.

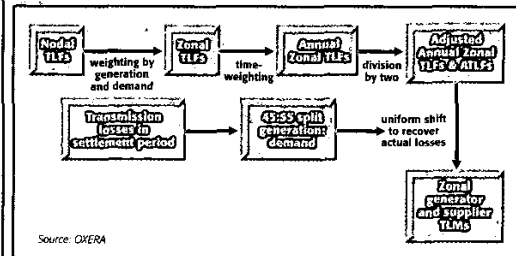
Despite the DTI's statement, Ofgem has subsequently rejected a BSC modification to halt the work and expenditure underway to implement P82, making clear that it believes the implementation of AZTL in England and Wales should proceed. This raises the possibility that AZTL might be implemented in England and Wales in April 2004 but abandoned a year later when BETTA is due to start.

In favour of AZTL, Ofgem argues that "better charging signals will lead to more efficient use of existing plant and more informed locational decisions." On the other hand, the DTI's decision was underpinned by OXERA's analysis of the costs and benefits of applying AZTL throughout GB, which found large overlapping ranges for estimated costs and benefits. Based on these findings, the DTI reached the view that it had not been proven that the benefits of AZTL would outweigh the costs.

## MODELLING

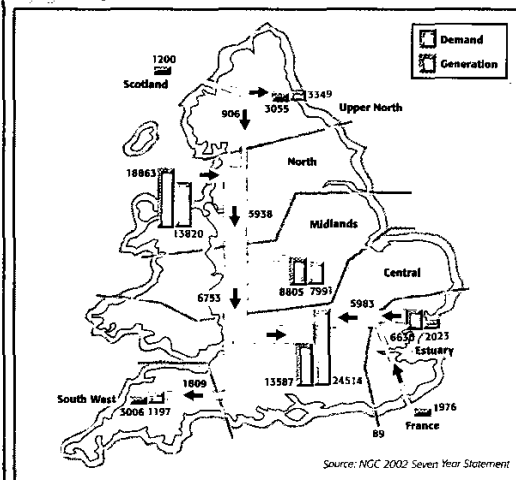
In analysing the policy implications of AZTL, the OXERA study combined load-flow modelling of the GB transmission system carried out by Professor Janusz Bialek with modelling of the wholesale market under →

**FIGURE 1: DERIVATION OF ATLs AND TLMs UNDER P82 METHODOLOGY**



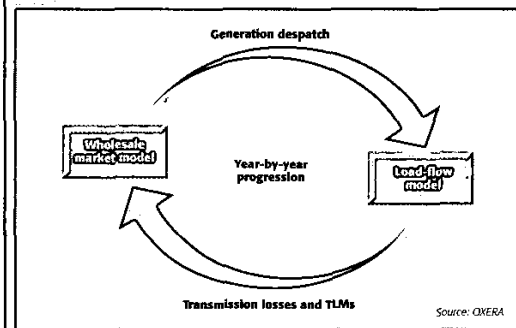
Source: OXERA

**FIGURE 2: PREDICTED POWER FLOW PATTERN FOR WINTER PEAK 2002/3**

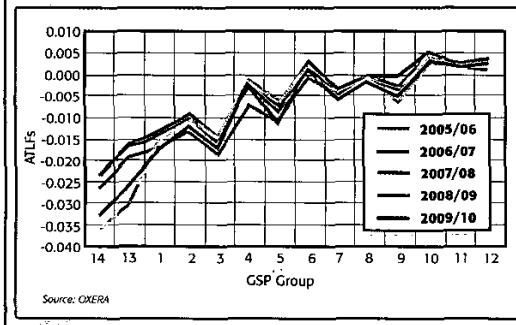


Source: NGC 2002 Seven Year Statement

**FIGURE 3: MODELLING METHODOLOGY**

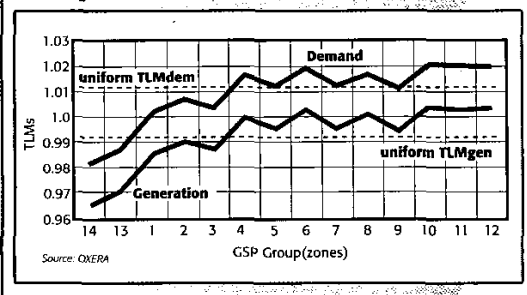


**FIGURE 4: ESTIMATED ATLs**



Source: OXERA

**FIGURE 5: AVERAGE TLMs FOR GENERATION AND DEMAND IN 2005/06**



BETTA. This joint modelling exercise is illustrated in Figure 3, and was carried out for demand snapshot periods.

Following this joint exercise, separate modelling runs were carried out to assess the impact of the estimated TLMs on the wholesale market across all demand periods (rather than just snapshot periods). Further calculations were undertaken to quantify the potential effect of AZTL on consumers and the level of electricity demand in different regions; the potential loss-reducing and carbon-saving impact of AZTL via its impact on the location of generation; and the possible change in the profitability of renewables projects in different locations.

Figure 4 shows the values of estimated ATLFs under OXERA's base case scenario. The zones have been ordered so that moving from left to right across the graph broadly corresponds to moving from northern zones to southern zones. Northern generation would be exposed to a substantial loss charge, whereas generation in the south would tend to benefit. The effect on suppliers and consumers will be the converse of the effect on generators.

Figure 5 shows the estimated values of average TLMs in 2005/6. The zonal TLMs retain the relative spatial differences of ATLFs shown in Figure 4, but are

uniformly shifted up or down to ensure exact loss recovery and a 45:55 split of charges between generation and demand. Note that in Scotland, consumers are effectively being given a rebate as TLMs are less than one.

Once TLMs had been estimated, analysis could be undertaken of the potential effect of AZTL on the behaviour of market participants and hence the economic benefits and costs of the policy. OXERA identified the following as the key national resource impacts of AZTL:

- ◆ reduction in losses (and hence the requirement for generation) due to changes in despatch, the long-run location of generation and possibly the regional pattern of consumption;
- ◆ offsetting increases in other costs eg, generation fuel costs;
- ◆ implementation and operation costs.

The modelling results suggested that the loss-reduction benefits from AZTL's impact on generation despatch might be relatively modest, perhaps in the order of £0.2million-£1.3million per annum. The reduction in losses stemming from demand response was found to be even smaller. Any significant benefits from AZTL would come from its longer-term impact on the location of generation, through its impact on closure, mothballing and new-build decisions. However, the extent to which AZTL will lead to such relocation is subject to a high degree of uncertainty. In particular, there are other factors that may have a more significant effect on generators' decisions than loss charges, including regional differences in NGC's transmission network use-of-system (TNUoS) charges and non-cost factors such as planning consent.

To reflect the uncertainties surrounding the level of long-run benefits, OXERA constructed three scenarios for the national resource impact of AZTL, shown in Table 2. The low scenario assumes long-run benefits of £1 million per annum, rising to £4m in the medium scenario and

**TABLE 1: SYSTEM POWER LOSSES AT PEAK IN NCG NETWORK**

	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10
Transmission heating losses excluding GPS transformers (MW)	609	642	629	799	798	807	806
% of losses (MW)	59	60	59	65	65	65	64
Fixed losses (MW)	208	207	208	208	208	208	208
% of losses (MW)	20	19	20	17	17	17	17
GPS transformer heating losses (MW)	110	114	116	121	124	128	133
% of losses (MW)	11	11	11	10	10	10	11
Generator transformer heating losses (MW)	112	113	112	103	102	103	105
% of losses (MW)	11	11	11	8	8	8	8
<b>Total losses (MW)</b>	<b>1,039</b>	<b>1,076</b>	<b>1,065</b>	<b>1,231</b>	<b>1,232</b>	<b>1,246</b>	<b>1,252</b>

Source: NCG 2002 Seven Year Statement

**THE BENEFITS OF AZTL WERE AMBIGUOUS IF IMPLEMENTATION COSTS IN ENGLAND AND WALES WERE TAKEN INTO ACCOUNT**

£10m per annum in the high scenario. Based on theoretical analysis, the scenarios assume that offsetting cost increases represent 25% of the loss-reduction benefits. Under these scenarios, the net present value (NPV) of future benefits from AZTL through to 2019/20, net of offsetting cost increases, ranges between £6.7 million and £55.5 million. These figures must be compared with the implementation and operation costs of AZTL in order to determine whether there is likely to be a net national resource benefit.

The study considered estimates of implementation and operation costs put forward by various parties. There was reasonable data on central system costs, which were estimated to amount to an NPV of £3 million. However, different parties have produced very different estimates of the implementation costs (eg, IT and legal costs) for market participants. On the one hand, Ofgem has suggested that these costs are relatively low, while other parties have put forward figures which might suggest total costs as high as £31 million in NPV terms. It would appear reasonable to suggest that the additional implementation costs of extending AZTL to Scotland, once it had already been introduced in England and Wales, would be small.

One of the crucial issues is whether the implementation costs of introducing AZTL in England and Wales are considered sunk for the purposes of the analysis. If P82 is introduced in April 2004 regardless of the government's decision with regard to AZTL under BETTA, as seems likely to happen, this would be an appropriate assumption and would change the comparison of costs and benefits.

Overall, the study concluded that if implementation costs in England and Wales are included in the analysis, the direction of the net national resource effect of applying AZTL under BETTA is ambiguous, whereas it is likely to be small but positive if these costs are treated as sunk.

## OTHER IMPACTS

AZTL might affect carbon emissions in a number of ways. Changes in despatch might affect the generation fuel mix and hence emissions, although the direction of this effect is ambiguous. Any reduction in losses due to the redespach and relocation of generation would also be associated with carbon savings. Calculations suggested that for each £1 million per annum of direct loss-reduction benefit, the estimated carbon savings could be valued in the range £30 000 per annum (at a low carbon value of £5/t) to £420 000 per annum (at a high carbon value of £70/t).

To assess the impact of AZTL on renewables, OXERA constructed a simple financial model based on scenarios of future prices for Renewables Obligation Certificates (ROCs) and estimates of the costs of onshore and offshore wind projects. The modelling showed that AZTL would have a minor effect on the profitability of renewable projects, with the potential percentage change (not the

change in basis points) in the internal rate of return of hypothetical onshore wind projects in different regions ranging from -1.5% to 0.8%. The small size of this effect reflects the high value of ROC prices and the fact that loss scaling only affects the wholesale price element of the revenue received by renewables generators. Based on these findings, the study concluded that AZTL would be unlikely to have a significant impact on the growth of the renewables sector.

AZTL would lead to significant redistributive effects between generators and consumers in different regions when compared to uniform loss charging. As shown in Table 3, AZTL could have a significant financial impact on some generating companies depending on the geographical location of their generating portfolio. However, calculations showed that the impact of AZTL on individual customers is likely to be small, particularly in the domestic sector.

**TABLE 2: SCENARIOS OF FUTURE BENEFITS OF AZTL (£M)**

	High	Medium	Low
Assumed annual benefits			
Generation redispach	1.29	0.74	0.19
Demand response	0.25	0.19	0.19
Relocation of generation (from 20 10/11)	1.29	0.74	0.19
Proportion of above benefits assumed to be offset by change in her costs (%)	25%	25%	25%
NPV of future benefits to 20 18/20 net of offsetting cost increases	55.50	24.08	0.07

Note: See OXERA report for a full discussion of these costs.  
Source: OXERA

**TABLE 3: CHANGE IN ANNUAL LOSS PAYMENTS FOR HYPOTHETICAL GENERATIONS (£M)**

Hypothetical generator	Location of assumed portfolio of four 1 GW plant	Total loss payments	
		Uniform	Zonal
Northern	14 15 1 2	5.54	11.04
Southern	9 10 11 12	5.54	-0.05
Balanced	13 1 10 11	5.54	4.02

Source: OXERA

The DTI has announced that it is minded not to include AZTL in the GB BSC, partly informed by a cost-benefit study undertaken by OXERA in conjunction with Dr Janusz Bialek. This study brought together technical and economic modelling in order to assess the policy implications of AZTL. The analysis found that the benefits of AZTL were ambiguous if implementation costs in England and Wales were taken into account, and that it would lead to large transfer effects. Nevertheless, the final outcome with regard to AZTL remains uncertain, as Ofgem has signalled that it will press ahead with the implementation of P82 in England and Wales prior to BETTA.

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