Environment and Sustainability Committee

Inquiry into Energy Policy and Planning in Wales

EPP 59 – Tony Burton

To the Clerk of the Environment and Sustainability Committee:

Dear Ms Hawkins,

Inquiry into Energy Policy & Planning in Wales

I believe that the considerable public opposition to the Welsh Government TAN 8 policy in relation to the siting of wind farms in Mid-Wales, which has arisen this year and been expressed in Petition P-04-324 “Say No to TAN 8 – Wind farms and High Voltage Power Lines Spoiling out Community”, has been largely stimulated by National Grid’s and Scottish Power’s unnecessarily grandiose plans for a new grid connection to Mid Wales. As someone who recognises that wind energy provides the most economical source of sustainable low carbon electricity currently available, I find it very regrettable that the recent furore against wind farms themselves has been catalysed by these proposals for a 400 kV overhead line on 47 m tall pylons and multiple 132 kV overhead lines on 26 m tall pylons all converging on a single 132 kV/400 kV substation.

The wind farms we need for electricity production do not require the imposition of pylons on the Mid Wales landscape. The attached paper entitled “Mid Wales Grid Connection – Low Visual Impact Alternatives”, Issue 2, examines options for transmitting electricity from the new wind farms using 132 kV overhead lines on wooden poles – the method traditionally used in Mid Wales. Transmission at 132 kV as opposed to 400 kV incurs a transmission loss penalty, and this is quantified in the paper, which argues that this additional cost is justified in order to avoid inflicting pylons on beautiful countryside.

I would be prepared to give oral evidence, if invited.

Yours sincerely,

Tony Burton

MID WALES GRID CONNECTION

LOW VISUAL IMPACT ALTERNATIVES

Introduction

National Grid have proposed a new 400 kV connection between a new 132 kV/400 kV substation located between TAN 8 Strategic Search Areas (SSA's) B & C and a suitable point between Oswestry and Baschurch on the existing 400 kV overhead line between Legacy and Ironbridge. It is designed to carry the output from proposed wind farms in SSA's B, C and D with a total capacity of 874 MW (see National Grid "Strategic Optioneering Report" Issue 1 para 3.6), while at the same time providing a margin for future growth. Unless the new 400 kV connection was undergrounded at considerable extra cost, this would involve an overhead line supported on pylons 47 m high, which has aroused considerable public opposition, as manifested by the very large protest demonstration outside the National Assembly of Wales on May 24th.

The purpose of this note is to examine the feasibility of alternative solutions having as low a visual impact as possible without excessive additional cost. The options considered are:

1. Two 132 kV 490 MVA overhead lines supported on 26 m tall pylons, joined at the extremities to form a continuous loop
2. Five 132 kV 174 MVA overhead lines supported on wooden poles
3. Two 132 kV 490 MVA overhead lines supported on wooden poles, joined at the extremities to form a continuous loop
4. Three 132 kV 490 MVA overhead lines supported on wooden poles

After looking at the different options in turn, the costs of Options 1, 3 and 4 are compared with that of the current proposal over the 43 km distance from the proposed 132 kV/400 kV substation to the existing 400 kV line. Inevitably transmission losses are significant for 132 kV lines, so the discounted cost of the lost energy over a 40 year lifetime is included in the comparison.

Option 1: 132 kV 490 MVA loop on pylons

It is understood that Scottish Power are currently investigating a 132 kV loop connecting TAN 8 Strategic Search Areas B & C direct to the existing 400 kV overhead line between Legacy and Ironbridge. This would involve the construction of a new 132 kV/400 kV substation at the point of connection, which would be somewhere between Oswestry and Baschurch. This option had not been investigated before, because, until recently, National Grid had indicated that the connection point would have to be at either Legacy or Ironbridge, involving a significantly longer 132 kV connection and, consequently, higher losses.

The 132 kV loop would consist of twin 245 MVA circuits, using 500 sq mm RUBUS AAAC (= All Aluminium Alloy Conductor) conductors, providing a total capacity of 980 MVA – in excess of the 874 MW required by presently contracted windfarms in SSA's B, C and D.

Aesthetics

The L7 pylons carrying twin 245 MVA circuits would be 26 m high – almost half the height of the 47m high pylons required for a 400 kV connection. However, two routes would be required instead of one, so the area of countryside over which the pylons would be a dominant feature would be much the same.

Costs

The Options Evaluation Forms in SP Energy Networks "Initial Strategic Optioneering Report" gives the circuit costs for several options for Mid Wales connections utilising double circuit L7 tower (ie pylon) lines. For example, option E1 consists of three connections having lengths of over 72 km, over 75 km and over 73 km – ie 220 km or over in total. The circuit cost is stated to be £188 m, implying a maximum cost per km of £188/220 m/km, ie £0.85 m/km.

Losses

The length of the proposed 400 kV Mid Wales connection is approximately 43 km (see National Grid "Strategic Optioneering Report" Issue 1 Table 7), so 400 kV and 132 kV transmission (I^2R) losses should be compared over this distance. In the case of twin 245 MVA circuits operating at rated capacity, the transmission loss over 43 km would be 3.42 %. However, assuming the twin 245 MVA circuits carried the output from wind farms with the same total rating, the *average* percentage losses would be less, because the ratio I^2R/VI reduces as current reduces. For Siemens 2.3 MW turbines operating at a site with a 7.5 m/s mean wind speed, the average percentage loss would be only 2.34 %.

Option 2: Five 132 kV 174 MVA wooden pole lines

According to the SP Energy Networks "Initial Strategic Optioneering Report", new heavy duty wooden pole lines can, in certain circumstances, support 300 sq mm UPAS AAAC conductors (one per phase) giving a single circuit rating of 174 MVA. Five such lines would have a capacity of 870 MVA, which would be sufficient for the output of wind farms of 874 MW total capacity with only a few per cent of downrating in consistent high winds, depending on the power factor.

The impact of these five lines would be minimised if they radiated out from SSA's B, C and D in different directions.

Aesthetics

There is a consensus that wooden pole lines have much less visual impact that OHLs supported on pylons. This is presumably because wooden pole supports are not so tall and because their colour and simple form enables them to blend into the landscape. Or, to quote the SP Consultation Document on the 132 kV line between Legacy and Oswestry, "It was also considered that wooden poles, which are lower in height and have a more slender and simple appearance than lattice towers, would be more sympathetic than lattice steel towers to the predominantly rural and well-treed landscape through which the line would be routed." Certainly it is often difficult to discern wooden pole lines in the landscape at all at a distance of over one kilometre.

Unfortunately the current design of wooden pole supports for a single circuit 174 MVA OHL includes a simple steel lattice structure at the top, which stands out more that the single horizontal steel beam used on the existing Welshpool-Newtown 132 kV line. Accordingly this option is far from ideal, but worth including as it is an existing design for which costs should be readily available.

Costs

Information on costs has been requested from Scottish Power.

Losses

The power transmitted per unit conductor area for the 174 MVA line (174/300 = 0.58 MVA/sq mm) is greater than in the case of the 2 x 245 MVA line used for Option 1 (245/300 = 0.49 MVA/sqmm), so the percentage transmission loss is correspondingly higher at 2.77 % on average.

Option 3: 132 kV single circuit 490 MVA loop on wooden poles

This option replicates Option 1, but with a single 132 kV 490 MVA circuit supported on wooden poles rather than twin 132 kV 245 MVA circuits supported on pylons. As with Option 1, the line would be in the form of a loop, starting from the 132 kV/400 kV substation on the existing 400 kV line between Oswestry and Baschurch, and running to SSA B, on to SSA C and then back to the substation.

The conductor support concept is similar to that used for the Welshpool-Newtown 132 kV line, where the conductors are suspended from insulators hanging down from a steel cross-beam supported by twin wooden poles, as illustrated in Figure 1.

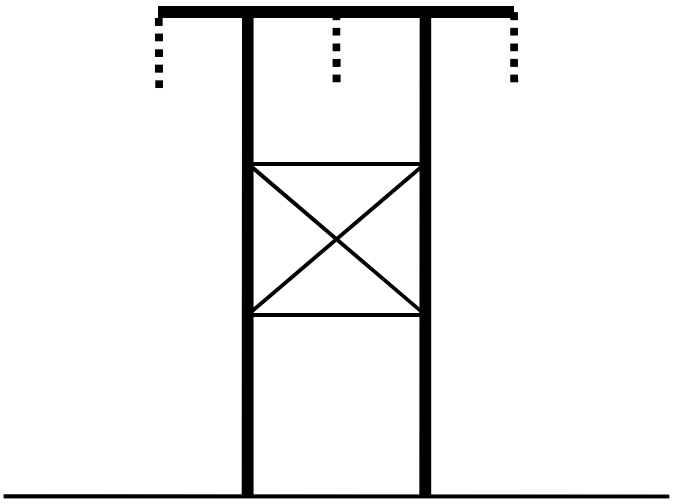

Figure 1: Schematic of wooden H-pole supporting 3-phase 132 kV single circuit below the cross-beam

Two RUBUS AAAC 500 sq mm conductors in a bundle would be provided per phase, each bundle being attached to the base of a single insulator suspended from the cross-beam. This would require insulators with greater weight bearing capacity than normally used for 132 kV overhead line, but 400 kV insulators would have adequate strength and could be used instead, albeit with a much reduced number of discs.

It is recognised that the weight of two 500 sq mm conductors would be significantly greater than that of the single 300 sq mm conductor used in Option 2. A significantly stronger cross-beam would be needed to carry the extra weight, but it is anticipated that a 203 mm deep Universal Beam section would be adequate.

Aesthetics

The existing Welshpool-Newtown 132 kV line has low visual impact because of the simple support arrangement. Option 3, as proposed, builds on this advantage and avoids the use of a “busy” lattice cross-beam.

Costs

These obviously need to be investigated, but it is assumed that they would be less than for the equivalent connection supported on pylons (Option 1).

Losses

These would be the same as for Option 1.

Option 4: Three 132 kV 490 MVA lines on wooden poles

This is the same as Option 3, but with three lines instead of two. It is included to test the costliness of the 132 kV option relative to 400 kV if 50% more capacity is required in the future.

Cost comparison

Capital costs

The assumptions on which the comparison of capital costs is based are set out below.

a) 400 kV overhead line plus substation

Table 1 of the National Grid "Strategic Optioneering Report" indicates that the capital cost per km of a two circuit 400 kV tower (= pylon) route with total rating of 6000 MVA would be £1.6 m/km. This results in a cost of approximately £70 m over the 43 km route length (Table 7). Table 7 also gives the cost of the new 132kV/400 kV Mid Wales substation and the cost of upgrading existing substations as £88 m and £20 m respectively.

b) 400 kV underground line plus substation

Table 7 of the National Grid "Strategic Optioneering Report" gives the cost of a 43 km underground connection as £454 m. The substation costs are the same as for the overhead line connection.

c) Two 132 kV 490 MVA overhead lines supported on 26 m tall pylons plus substation (Option 1)

The cost per km of a 132 kV 490 MVA overhead line on pylons is estimated at £0.85 m/km, based on figures in the SP Energy Networks "Initial Strategic Optioneering Report" – see Option 1 description above. Hence the cost per km of two such lines would be £1.7 m/km. The 132 kV/400kV substation would be relocated to a site adjacent to the existing 400 kV line, but it is assumed the cost would be unchanged.

d) Two 132 kV 490 MVA overhead lines supported on wooden poles plus substation (Option 3)

Wooden pole supports approximately 13 m tall should be less costly than 26 m tall lattice structures, even if the former have to be provided at half the spacing. However, in the absence of firm information, it is assumed here that the cost per km of a 132 kV 490 MVA overhead line supported on wooden poles would be the same as for one supported on pylons.

Cost of discounted transmission losses

The transmission losses on each 132 kV, 490 MVA line are estimated on the basis that each is connected to wind farms of 490 MW total rated capacity operating at unity power factor. For Siemens 2.3 MW turbines at

a 7.5 m/s annual mean wind speed site, the capacity factor would be a maximum of 35.6%, ignoring availability and array losses, and the average percentage transmission loss on the 43 km length of line would be 2.34%. Hence the annual transmission loss is 490 x 8766 x 0.356 x 0.0272 = 35,870 MWh. Adopting the price of £60 per MWh assumed by Ofgem in Project Discovery, this is worth £2.152 m per year.

Taking the lifetime of the connection as 40 years (the lifetime of transmission assets assumed by National Grid) and a discount rate of 6.25% (being the allowed cost of capital for National Grid), the discounted value of the transmission losses comes to 15.5 years worth – ie £33.4 m. This applies to one 490 MVA connection, so the discounted transmission losses for two 490 MVA connections come to £67 m. Note that this is a pessimistic value as the connection is currently intended to carry only 874 MVA rather than 980 MVA (2 x 490 MVA).

Results

The results of the comparison are shown in Table 1 below.

	400 kV Overhead line	400 kV Under-ground line	Two 132 kV, 490 MVA overhead lines on pylons (Option 1)	Two 132 kV, 490 MVA overhead lines on wooden poles (Option 3)	Three 132 kV, 490 MVA overhead lines on wooden poles (Option 4)
	£ million	£ million	£ million	£ million	£ million
Substations	108	108	108	108	108
Connection cost per km	1.6/km		1.7/km	1.7/km	2.55/km
43 km connection cost	70	454	73	73	110
Total Capital Cost	178	562	181	181	218
Assumed rating (MVA) of connected wind farms			980	980	1470
Discounted cost of Transmission Losses	Negligible	Negligible	67	67	100
Capital + Trans Losses	178	562	248	248	318
Total Cost Index	100	316	139	139	179
Thermal Rating (MVA)	2 x 3000	2 x 1500	2 x 490	2 x 490	3 x 490
Max Rating permitted, if different (MVA)	1800	1800			

Table 1: Comparison of costs of 132 kV options with baseline

It is seen that the capital cost of two 132 kV, 490 MVA connections (Options 1 & 3) is very close to that of the 400 kV connection, but that when the discounted transmission costs are included, Options 1 & 3 cost about 40% more. Nevertheless, these options remain much cheaper than undergrounding the 400 kV connection over its full length.

Conclusion

The option of supporting a single 132 kV, 490 MVA circuit on wooden poles shows promise and its feasibility should be investigated further.

A L Burton 12.9.11