



SP ENERGY NETWORKS

Crewe & Lister Drive 132kV Switchgear Replacement: Review of Cost Benefit Analyses

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EXECUTIVE SUMMARY

In March 2014 SPEN submitted a revised RIIO-ED1 business plan to Ofgem along with several annexes providing additional supporting information and enhanced justification, including an increased number of Cost Benefit Analyses (CBAs) relative to the previous fast-track submission from July 2013.

Ofgem assessed the revised RIIO-ED1 DNO business plans and published draft determinations on 30 July 2014. Ofgem's assessment indicated an efficient expenditure for SPM during ED1 to be £178m (9.7%) lower than SPEN forecasts, with approximately £100m of the reduction attributable to the 132kV network programme.

PA Consulting Group (PA) has been engaged to undertake an independent assessment of the CBAs submitted by SPEN in support of proposals to replace the 132kV Switchgear at Crewe and Lister Drive, which represent a significant element of the 132kV network renewal programme.

Scope of this review

Ofgem accepted the requirement to renew the 132kV switchgear at each site but contested SPM's view that the replacement of existing outdoor Air Insulated Switchgear (AIS) configurations at Crewe and Lister Drive with indoor Gas Insulated Switchgear (GIS) are the most cost-effective options. As a consequence SPEN has re-examined the two associated CBAs and commissioned a critical independent review. PA was required to assess and validate the CBA inputs for completeness and accuracy and also to review the methodology employed along with any assumptions made. Site visits to Crewe and Lister Drive were conducted on commencement of the assignment to obtain a detailed understanding of asset condition, switchgear configuration and any associated site constraints to be considered in evaluation of potential CBA options.

Conclusions

PA's assessment of the CBAs submitted for the two schemes has confirmed that SPEN has adopted the standard CBA model provided by Ofgem and applied the methodology consistently in support of its forecast proposals. A number of minor refinements were made to some input parameters and assumptions and the models re-run to produce a revised CBA for each site.

Crewe 132kV Switchgear Replacement

The revised CBA result shows that the GIS Offline option continues to be more cost effective than the AIS Offline option. During the course of this review investigations have confirmed that the opportunities to acquire land for an AIS Offline solution are not considered viable.

There is effectively no difference in NPV between the GIS Offline and the AIS Inline options. If SPEN's more stringent SF6 leakage specification is considered, the GIS Offline option becomes marginally more cost beneficial. In addition, the AIS Inline solution introduces a number of substantial consequential risks for the RIIO-ED1 132kV and EHV investment programme in the Crewe network that are currently not factored in the CBA. These include:

- Enhanced 'return to service' requirements to support customer service obligations for Crewe and the adjacent network,
- An AIS Inline build would effectively impose significant operational restrictions on the 132kV and EHV network, severely impacting SPEN's scope to schedule other outages over this period, and potentially deferring other ED1 schemes,
- SPEN would need to re-evaluate the risks arising from operating HI5 assets for an extended period and re-prioritise its investment programme, and
- There is potential to interrupt neighbouring NGC and WPD work programmes over a prolonged period that may incur additional costs.

The neutral NPV result, coupled with the risks outlined for the AIS Inline option, and the perpetuation of a non-standard, inflexible operational configuration, favours the adoption of the proposed GIS Offline option.

Lister Drive 132kV Switchgear Replacement

PA analysis confirms that the revised CBA for Lister Drive indicates that the GIS Offline solution continues to be the most cost-effective when compared to both the AIS Offline and Inline options. It has also been determined that there are unlikely to be practical, cost-efficient opportunities to acquire land for an extensible, sustainable AIS Offline solution. A GIS Offline solution remains the optimum solution for replacement of the 132kV switchgear at Lister Drive.

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1 PROJECT SCOPE & APPROACH

SP Energy Networks (SPEN) owns and operates electricity distribution networks in Central and Southern Scotland (Scottish Power Distribution – SPD) and also Cheshire, Merseyside, North Shropshire and North Wales (Scottish Power Manweb – SPM).

In March 2014 SPEN submitted a revised RIIO-ED1 business plan to Ofgem in accordance with the prescribed RIIO assessment process. This revised business plan incorporated several annexes providing additional supporting information and enhanced justification, including an increased number of Cost Benefit Analyses (CBAs) relative to the previous fast-track submission from July 2013.

Ofgem assessed the revised RIIO-ED1 DNO business plans and published draft determinations on 30 July 2014. The draft determination indicates the Ofgem assessed efficient expenditure for SPM during ED1 to be £178m (9.7%) less than forecast by SPEN, prior to the application of RPEs and smart grid savings. Approximately £100m of the assessed reduction relates to the 132kV network in SPM.

PA Consulting Group (PA) has been engaged to undertake an independent assessment of CBAs submitted by SPEN in support of proposals to replace the 132kV Switchgear at Crewe and Lister Drive.

1.1 Background and context

To support its RIIO-ED1 well justified business plan SPEN submitted a number of associated CBAs. The robustness and quality of the CBAs provided for the fast-track process was commended by Cambridge Economic Policy Associates Ltd (CEPA) in their report to Ofgem, commenting that “SP’s analysis shows good adherence to the Guidance provided by Ofgem throughout the analysis. In general they are the only Group to consistently provide detailed information on the costings underpinning their different options, rather than just including the costs in the different options”.

SPEN employed the same approach for the additional CBAs submitted with the slow-track plan. The CBAs utilised the standard template provided by Ofgem to all DNOs.

The three relevant CBAs relating to SPM 132kV switchgear replacement submitted to Ofgem with the revised business plan were:

- 52 – Lister 132kV GIS – AIS Offline Rebuild – Updated V2.xlsx
- 53 – Crewe 132kV GIS – AIS Offline Rebuild – Updated V2.xlsx
- 54 – Birkenhead 132kV GIS – AIS Offline Rebuild – Updated V2.xlsx

Ofgem’s draft determination acknowledges the need to replace the 132kV switchgear at these three sites and has agreed with SPEN that a GIS option is the most appropriate option at Birkenhead. However, Ofgem is contesting that the replacement of outdoor AIS configurations at Crewe and Lister Drive with indoor GIS are the most cost-effective options. As a consequence SPEN has taken the decision to re-examine the two CBAs and conduct a critical independent review.

1.2 Scope of the assignment

PA Consulting Group (PA) was appointed to conduct an independent assessment of the CBAs for Crewe and Lister Drive.

The review undertaken by PA commenced with site visits to Crewe and Lister Drive to obtain a detailed understanding of asset condition, switchgear configuration and any associated site constraints to be considered in evaluation of potential CBA options. The remainder of PA's assessment has been a desk-top exercise to validate the CBA inputs and methodology employed. PA understands that Ofgem and its consultants conducted similar visits prior to the draft determination but neither had the opportunity to review the associated CBAs submitted by SPEN [in detail].

PA's consultants worked in SPEN's offices in Blantyre and Prenton, to review relevant material produced by SPEN staff, interrogating reports, checking calculations (based on revised data where necessary), and validating decision-making processes.

1.3 Our approach

PA's approach to reviewing the relevant CBAs for SPM 132 kV asset investments had three main areas of focus:

- A review of the CBA model and evaluation of the CBAs submitted in March 2014 for completeness and accuracy,
- A more detailed examination of; the options considered, scope of works associated with each option, input costs, project timing, risk assessment and mitigation costs and the potential impact on the overall 132kV investment programme with dependencies for the Crewe and Lister Drive projects.
- Re-evaluation of CBA results incorporating any revisions and refinements identified.

Throughout the review, we have challenged SPEN assumptions to test their validity, consistency and level of confidence.

2 REVIEW OF CBA MODEL & INPUTS

PA has reviewed the Ofgem CBA model and the inputs to it, including Capex and Opex components and the modelling of investment timing.

2.1 CBA Model

Ofgem provided a standard and comprehensive CBA model to all DNOs with the capability to itemise and resolve a wide variety of cost factors. In this review, PA identified the possibility of misinterpreting the relevant CBA NPV results for the 132 kV investment options considered and has sought to minimise the scope for such misinterpretation accordingly.

2.2 Capex

The capital cost data used in the slow-track CBAs submitted to Ofgem was consistent with the costs derived from the bottom-up assessments of specific scheme requirements.

In reviewing the slow-track CBA submissions, it was discovered that some Capex figures had been unintentionally overestimated in the AIS Inline switchgear replacement option as a consequence of using a previous scheme template. This was subsequently amended in the CBA revisions performed in this review.

2.3 Opex

Maintenance

SPEN has derived maintenance costs from actual Opex data and presents these as annual costs in the analysis.

In the CBAs submitted, the maintenance of oil circuit breakers (CB) was unintentionally included in years when the GIS CBs would be in service. This has been amended to reflect the timing of substitution of new assets.

SF6 Leakage

In the submitted CBAs, there was no provision for GHG emissions costs arising from the introduction of SF6 circuit breakers. The revised CBAs include a valuation of SF6 leakage to differentiate between the volumes of SF6 contained in the AIS and GIS options. This is derived from published leakage data and gas volumes, consistent with Business Carbon Footprint reporting. This has the effect of reducing the NPV of the GIS Offline options, due to the larger volume of SF6 gas used in such installations.

SPEN specifies a more stringent SF6 leakage performance¹ to that specified by the appropriate IEC standards. However, manufacturers only guarantee their product performance against the IEC standards. Calculation of the carbon cost of SF6 leakage in the CBAs utilises the IEC standard figures rather than the more onerous SPEN values, resulting in a worst case scenario.

¹ Reference SPEN ED1 Business Plan _ Environmental Strategy Annex

Construction-related risk

SPEN has included probabilistic risk costs based on an assumption of increased probability of loss of supply due to construction activity related to the AIS Inline replacement option. This is considered to be a reasonable provision and is assumed to be constant over the five year construction period for the AIS Inline option. During our review of the CBAs, it was discovered that the five year period for loss of supply related costs had been incorrectly allocated in the AIS Inline (i.e. the Baseline) option as an avoided cost. The benefit of reduced CI and CML risk for the Offline options (i.e. avoided costs) was therefore negated in the NPV calculation. This is amended in the PA revisions to the CBAs.

2.4 Investment timing

PA and SPEN have reconsidered typical project durations of AIS Inline, AIS Offline and GIS Offline programmes to take account of differing construction techniques and practical issues including obtaining network access, land purchase and planning consent processes.

For the AIS Inline option, this means that the original S Curve profile has been replaced with a flat profile to represent an even spread of construction work over the five year period.

In the submitted CBAs, the cost of land and remediation was included in the S Curve profile and, therefore, spread over the construction period. Expenditure profiles have been adjusted to place these costs more realistically at the start of the project.

3 REVIEW OF CREWE 132KV SWITCHGEAR REPLACEMENT

This section provides a review of the options considered by SPEN for the replacement of the 132kV switchgear at Crewe and critiques the supporting CBA from March 2014. Amendments to the CBA to better reflect option timing and expenditure profiles have been evaluated, along with recognition of cost feedback from the Draft Determination.

3.1 Scope of Work and Options Considered

In the Draft Determination, Ofgem has acknowledged the need to replace the existing 132kV AIS at Crewe 132kV switching station. This recognition of the case presented by SPEN was informed in part by the visit of Ofgem's representatives and consultant to the Crewe site.

The slow-track CBA concluded that a GIS Offline option was the most favourable option. However, Ofgem's consultant took the view that a new AIS Offline option should be achievable, despite it having been discounted in the CBA provided. It was accepted that additional land would have to be acquired for this, and there was some discussion of the potential to use adjacent plots of land which had been observed during the site visit.

PA has re-examined the proposal with SPEN, to consider the full range of potential options:

- Asset replacement of all AIS assets (circuit breakers, isolators etc) 'inline' (AIS Inline)
- Asset replacement by AIS on a new site (AIS Offline)
- Asset replacement by GIS on a new site (GIS Offline)

These were considered to be viable options in the initial submission, and Ofgem's email response dated 04 June 2014 suggested agreement with SPEN's consideration of these options.

Subsequent enquiries regarding land availability have found that it is highly unlikely that a suitable plot of land would be available to develop an adjacent AIS Offline option. Recent investigations have confirmed that;

- Land on the other side of the railway, to the north, is no longer available as it is currently being developed as a car showroom and car park, and
- Land on the far side of Middlewich Road is designated as 'Protected Countryside' and planning permission for development is considered unlikely.

In addition to the fundamental problem of the availability of land, SPEN has concluded that the overall scheme cost for a full AIS Offline option is higher than the proposed GIS Offline option, once the additional costs of land purchase, longer cabling and site establishment are taken into account. The impact of these additional costs is confirmed by the CBA review in section 3.2.

In summary, the principal practical factors affecting option selection are shown in Table 1:

Table 1 - Practical factors affecting option selection

Option	Future Extension capability	Interdependence with other projects	Land requirement
AIS Inline	Switchgear is extendible within existing site	Operational restrictions of AIS Inline project could defer other ED1 projects for 5 years	SPEN already owns land for this option
AIS Offline	Switchgear would be extendible within new site	Offline would allow other projects to proceed	Land for a suitable new site is unavailable
GIS Offline	Switchgear would be extendible within new site	Offline would allow other projects to proceed	SPEN already owns land for this option

The revised CBA shows that the complete AIS Inline replacement and GIS Offline options have a similar NPV over 45 years. However, it is considered that the potentially severe practical and operational limitations associated with an AIS Inline scheme mean that this option is unlikely to support any holistic development of the Crewe network.

3.1.1 Associated correspondence

PAs review of the options considered included correspondence between Ofgem’s consultants and SPEN and relevant document references:

- 132kV Substation Plant Strategy – March 2014. This document detailed SPEN’s Non Load Network Investment Strategy for 132kV substation assets.
- Clarification of 132kV Circuit Breakers and Associated Plant Replacement Options: Alyn Jones, 2nd June 2014. This document included further details of the factors influencing the selection of option for Crewe and Lister Drive.
- Email from Pearse Murray to Alis Kalogeropoulos, 06 June 2014, responding to email of 04 June. This email provided further details of the factors influencing the selection of options for Crewe and Lister Drive.

With respect to Crewe, the issues concerning the potential to develop adjacent plots of land have been summarised in Table 1 above.

3.1.2 Interdependence of other schemes in Crewe 132kV network

Following good engineering practice the selected option should provide sufficient space for normal extension over the projected life of the installation, nominally to 2065.

SPENs investment plan for the Crewe area includes a LRE scheme to install a Phase Shift Transformer at Crewe in 2020, requiring two additional 132kV CBs.

Such an extension is considered achievable for all three options and in the short to medium term, the ability to extend is not considered to be a determining factor in selecting an Inline or Offline option.

The existing switchgear arrangement is a complex and non-standard design incorporating a ‘wrap over’ main Busbar. The Crewe 132kV busbar is the normal operational split point between the

Fiddlers Ferry - Carrington NGC Supergrid group and Cellerhead NGC Supergrid group, where a significant voltage angle difference applies. This operational constraint means that it is not possible to utilise the normal flexibility of a traditional double busbar arrangement.

Although a like-for-like AIS replacement is feasible it presents considerable construction and operational risk and would also perpetuate the non-standard configuration. The mitigation required to manage these constraints and associated risk would disrupt SPEN's necessary programme of work to replace adjacent 132kV assets during ED1. Based on an initial high-level assessment, SPEN expects that it would be necessary to defer the following projects, already prioritised for condition-driven replacement, by at least 5 years;

- Crewe to Whitfield to Cellerhead 132kV Overhead Steel Tower YS Line asset replacement and refurbishment,
- Asset replacement and refurbishment of 4 other overhead lines; PK, BH, A, HA,
- Lostock LRE,
- Elworth Grid transformer & AIS Other switchgear replacement, and
- The load driven Crewe 132kV reinforcement.

3.2 Cost Benefit Analyses for Crewe 132kV Switchgear

PA has conducted a critical review of CBA #53 regarding the replacement of the 132kV switchgear at Crewe, and submitted to Ofgem with the March 2014 business plan. Further versions of the CBA model have been run to assess the impact of minor amendments to some inputs and reflecting Ofgem observations provided in the Draft Determination.

3.2.1 CBA #53 submitted to Ofgem - V2

Results of the CBA submitted are replicated in Table 2 indicating that the GIS Offline option was marginally the most cost effective option at Crewe.

Table 2 – Slow-track business plan CBA results

Option	Scheme cost £M	NPV (£m) 16 years	NPV (£m) 24 years	NPV (£m) 32 years	NPV (£m) 45 years
AIS Inline	10.94	baseline	baseline	baseline	baseline
GIS Offline	12.3	0.78	0.67	0.59	0.52
AIS Offline	15.1	-1.93	-2.52	-2.92	-3.32

PA's review identified a number of items that required minor adjustment to the treatment of model inputs for the slow-track CBA that are discussed in the next section.

3.2.2 PA amendments to submitted CBA #53 - V2.1

The adjustments made to the slow-track CBA model inputs were to;

- remove the uplift in some of the costs (described in Section 2.2) to reduce the AIS Inline capital cost from £10.94M to £10.41M.
- include GHG emission costs for SF6 volumes related to AIS SF6 CB and GIS CB (described in Section 2.3).

- revise the treatment of probabilistic CI and CML risks to remove the costs which were initially included in the baseline case in the original CBA (described in Section 2.3).
- remove inappropriate plant maintenance costs in Y1-Y5 of the AIS Inline option (described in Section 2.3).

Table 3 – Slow-track CBA results incorporating PA adjustments

Option	Scheme cost £M	NPV (£m) 16 years	NPV (£m) 24 years	NPV (£m) 32 years	NPV (£m) 45 years
AIS Inline	10.41	baseline	baseline	baseline	baseline
GIS Offline	12.3	0.28	-0.03	-0.28	-0.57
AIS Offline	15.1	-1.27	-2.01	-2.5	-3.03

Table 3 indicates that when the input adjustments identified are applied to a revised version of the CBA, V2.1;

- The GIS Offline option at Crewe is NPV positive in the early years, becoming marginally negative compared to the AIS Inline in later years.
- The annual GHG costs impact negatively on the NPV for the GIS Offline due to the larger volume of SF6 in this option.

PA's review of the CBA then considered modifications arising from observations, particularly regarding unit costs, provided by Ofgem in the Draft Determination.

3.2.3 Post DD Revisions to CBA #53 - V2.2

PA reviewed and contrasted Ofgem and SPEN switchgear unit costs, concluding that the costs relating to AIS (outdoor) switchgear did not appear to be comparable but that scheme costs for GIS (indoor) switchgear were broadly aligned. It would appear that the difference in AIS (outdoor) unit cost is attributable to a variance in the scope of work associated with changing a circuit breaker; SPEN costs are based on whole bay replacement and necessary associated works, whereas Ofgem's appear to be based on circuit breaker only replacement.

For this review, AIS (outdoor) unit costs were reviewed with SPEN and whole bay replacement costs reconstructed from indicative Ofgem figures. The review also considered the works necessary to develop the only remaining plot of land for the AIS Offline option (noting that Section 3.1. shows that this is unlikely to be achievable). The resulting estimated cost for the AIS Offline option increases from £15.1M to £16.6M.

The AIS Inline estimate was also reviewed with SPEN to consider the specific design and construction differences between a 'standard' AIS design and the complex 'wrap over' busbar configuration at Crewe; including additional high-level busbar structures and an additional Reserve Busbar section bay. Retaining this as an operational site would also require enhanced security fencing to meet current specification. The resulting estimated cost for the AIS Inline option increases from £10.41M to £11.49M.

The expenditure phasing for the AIS Inline option has also been revised from S Curve to Flat profile to account for the even spread of construction work over the five year period (described in Section 2.4).

The expenditure phasing for the Offline options has been changed to align with typical offline construction programmes, with land-related costs applied in the first year of the proposed project.

Table 4 outlines the construction programme used for the CBAs. The programme is based on commissioning the full replacement of Crewe 132kV switchgear by 2020, as part of the overall investment portfolio.

Table 4 – Option programme to achieve project delivery in Year 5

Option	V2 duration (years)	Revised duration (years)	Principal activity Year 1	Principal activity Year 2	Principal activity Year 3	Principal activity Year 4	Principal activity Year 5
AIS Complete Inline	5	5	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement
AIS Offline	5	4		Land purchase Ground-works Erection of switchgear	Erection of switchgear Transfer circuits	Transfer circuits	Transfer circuits Decommission AIS
GIS Offline	2	3			Ground-works Erection of building and switchgear	Erection of building and switchgear Transfer circuits	Transfer circuits Decommission AIS

Table 5 – CBA results incorporating revised timing and cost considerations

Option	Scheme cost £M	NPV (£m) 16 years	NPV (£m) 24 years	NPV (£m) 32 years	NPV (£m) 45 years
AIS Inline	11.49	baseline	baseline	baseline	baseline
GIS Offline	12.3	0.54	0.35	0.19	0.0
AIS Offline	16.62	-2.4	-3.18	-3.71	-4.25

The CBA results from the model input changes due to project timing and reconstruction of bay replacement costs are replicated in Table 5 indicating;

- that the GIS Offline option at Crewe is effectively neutral in NPV terms over 45 years compared to the AIS Inline option.
- the AIS Offline option retains a negative NPV relative to both baseline and the GIS Offline options.
- It should be noted that this CBA includes the pessimistic assumption of SF6 leakage performance. Accounting for any assumed SF6 leakage reduction over the IEC standard would result in a marginally positive NPV for the GIS Offline option compared to the AIS Inline option.

3.2.4 Other factors to be considered at Crewe

It is considered likely that the full range of potential consequences arising from selection of the AIS Inline option outweigh the small NPV advantage. To summarise, these consequences include:

- The very high level of operational complexity involved in the complete decommissioning and re-planting of every working asset within a major live 132kV substation will require enhanced Return to Service arrangements across a large network, spread over 5 construction seasons.
- The increased security of supply related risks from construction activity is accounted for in the CBA using a probabilistic costs based on estimates of CI and CML.
- The 5 year programme for AIS Inline replacement will effectively impose significant operational restrictions on the 132kV and EHV network, severely impacting SPEN's scope to schedule other outages over this period. SPEN's overall submission includes a portfolio of schemes selected for priority and programme efficiency, and it is highly dependent on pursuing the offline option at Crewe 132kV. A list of schemes that would be deferred by implementation of the AIS Inline option is provided in section 3.1.2.
- An AIS Inline option would require SPEN to reprioritise its investment programme to carry out lower priority work where network access permits.
- In addition, SPEN would need to review the effects of deferred reinforcement and risks arising from operating HI5 assets for an extended period.
- The inline option could also adversely impact the flexibility of NGC's network and potentially WPD's work programme. The RIIO-ED1 stakeholder engagement included discussions with National Grid and WPD concerning the delivery of the GIS Offline option for Crewe and both parties indicated their acceptance in principle. Further consultation would be necessary to examine the changed circumstances and NGC or WPD may wish to renegotiate their requirements.

3.2.5 Conclusion

Based on the option analysis and CBA results, the AIS Offline option is not considered to be a realistic option to the replacement of the 132kV switchgear at Crewe. There is effectively no difference in NPV between the GIS Offline and the AIS Inline options. If SPEN's more stringent SF6 leakage specification is included in the CBA, the GIS Offline option becomes more cost beneficial. The GIS Offline option is considered to provide greater long-term network flexibility than the current complex configuration perpetuated by the AIS Inline option. Additional improvement to the GIS Offline NPV is also likely to be achieved when the AIS Inline risk factors, such as those highlighted in 3.2.4, are quantified and factored into the CBA; the only risk quantified in the CBA to date is that due to the risk of trip from construction activities.

4 REVIEW OF LISTER DRIVE 132KV SWITCHGEAR REPLACEMENT

This section provides a review of the options considered by SPEN for the replacement of the 132kV switchgear at Lister Drive and critiques the supporting CBA submitted to Ofgem in March 2014. Amendments to the CBA to better reflect option timing and expenditure profiles have been evaluated along with recognition of cost feedback from the Draft Determination.

4.1 Scope of Work and Options Considered

In the Draft Determination, Ofgem has acknowledged the need to replace the existing 132kV AIS at Lister Drive 132kV switching station.

The slow-track CBA concluded that a GIS Offline option was the most favourable option. However, Ofgem's consultant took the view that a new AIS Offline option should be achievable, despite it having been discounted in the CBA provided. It was accepted that additional land (i.e. the C&L Developments plot) would have to be acquired, decontaminated and re-consolidated for this option to be viable.

PA has re-examined the proposal to replace the 132kV switchgear at Lister Drive with SPEN, to consider the full range of potential options:

- Asset replacement of all AIS assets (circuit breakers, isolators etc) 'inline' (AIS Inline)
- Asset replacement by AIS on a new site (AIS Offline)
- Asset replacement by GIS on a new site (GIS Offline)

These were considered to be viable options in the initial submission, and Ofgem's email response dated 04 June 2014 suggested agreement with SPEN's consideration of these options.

Following good engineering practice, the selected option should provide sufficient space for normal extension over the projected life of the installation, nominally to 2065.

Subsequent enquiries regarding land availability have found that the available plot of land is insufficient to develop a standard design for an extensible AIS Offline option. The opportunities to extend this plot are limited in practice and, even if achievable, are likely to be very high cost as;

- The land to the north contains a thriving business in a large Victorian building that would likely require demolition, and any planning restrictions are currently unknown,
- Extending into the Council owned landfill site to the south, if available, would entail the removal of a large overburden of reclaimed material and the diversion of an existing 275kV cable at considerable cost.

In addition to the fundamental problem of obtaining suitable land, SPEN has concluded that the overall scheme cost for a full AIS Offline option is higher than the proposed GIS Offline option, once the additional costs of land purchase, site establishment and land remediation are taken into account. The negative impact of these additional costs is confirmed by the CBA review in section 4.2.

In summary, the principal practical factors affecting option selection are shown in Table 6 below:

Table 6 – Practical factors affecting option selection

Option	Future extension capability	Interdependence with other projects	Land requirement
AIS Inline	Switchgear is not extensible within existing site	AIS Inline project would defer other projects for 5 years	Land not required
AIS Offline	Switchgear only extendable within new site if an extension plot could be acquired	Offline would allow other projects to proceed	Land for new site will be difficult and expensive to obtain
GIS Offline	Switchgear would be extendable within new site	Offline would allow other projects to proceed	SPEN already owns suitable land

Subsequent to minor amendments by PA the revised CBA shows that the GIS Offline replacement remains the most cost-efficient of the three potential options (GIS Offline, AIS Offline and AIS Inline).

4.1.1 Associated correspondence

PAs review of the options considered by SPEN included the correspondence between Ofgem’s consultants and SPEN and relevant document references:

- This assessment notes the correspondence between Ofgem’s experts and SPEN and relevant documents: 132kV Substation Plant Strategy – March 2014. This document detailed SPEN’s Non Load Network Investment Strategy for 132kV substation assets.
- Clarification of 132kV Circuit Breakers and Associated Plant Replacement Options: Alyn Jones, 2nd June 2014. This document included further details of the factors influencing the selection of option for Crewe and Lister Drive.
- Email from Pearse Murray to Alis Kalogeropoulos, 06 June 2014, responding to email of 04 June. This email provided further details of the factors influencing the selection of option for Crewe and Lister Drive.

With respect to Lister Drive, the correspondence between SPEN and Ofgem has acknowledged the need for additional land for the AIS Offline option and a proposed budget of £900k for acquiring the available parcel of land identified (the C&L Developments land), together with a proposed budget of £1200k for decontamination and re-consolidation has been considered reasonable and incorporated in the CBA analysis. SPEN also confirmed that it intends to retain the land which is occupied by the existing switchgear for next generation asset replacement.

The correspondence confirmed that it would be necessary to acquire additional land to accommodate the existing SPEN and NGC bays and provide expansion capability that could fully exploit the available capacity.

The issues concerning the potential to acquire and develop the additional land to facilitate future extension have been summarised in Table 6. However, cost estimates for this additional land have not been factored into the CBA.

4.2 Cost Benefit Analyses for Lister Drive 132kV Switchgear

PA has conducted a critical review of CBA #52 regarding the replacement of the 132kV switchgear at Lister Drive, and submitted to Ofgem with the slow-track business plan. Further versions of the CBA model have been run to assess the impact of minor amendments to some inputs and in consideration of Ofgem observations provided in the Draft Determination.

4.2.1 CBA #52 submitted to Ofgem - V2

Results of the CBA submitted are replicated in Table 7 indicating that the GIS Offline option was deemed the most cost effective option at Lister Drive.

Table 7 – Slow-track business plan CBA results

Option	Scheme cost £M	NPV (£m) 16 years	NPV (£m) 24 years	NPV (£m) 32 years	NPV (£m) 45 years
AIS Inline	9.97	baseline	baseline	baseline	baseline
GIS Offline	9.23	2.57	2.79	2.92	3.08
AIS Offline	11.43	0.33	0.11	-0.03	-0.18

PA's review identified a number of items that required minor adjustments to model inputs used in the March 2014 CBA as discussed in section 4.2.2.

4.2.2 PA amendments to submitted CBA #52 - V2.1

The adjustments made to the March 2014 CBA model inputs were to;

- remove the uplift in some of the costs (described in Section 2.2) to reduce the AIS Inline capital cost from £9.97M to £9.49M.
- account for the recovery from NGC of 25% of the substation building costs, thus reducing the capital costs in the revised CBA.
- include GHG emission costs for SF6 volumes related to GIS switchgear investments as described in Section 2.3.
- revise the treatment of probabilistic security of supply (CI and CML) risks to remove the costs from the offline options which were initially included in the baseline case in the original CBA (described in Section 2.3).
- remove inappropriate plant maintenance costs in Y1-Y5 of the AIS Inline option (described in Section 2.3).

Table 8 – Slow-track CBA results incorporating PA adjustments

Option	Scheme cost £M	NPV (£m) 16 years	NPV (£m) 24 years	NPV (£m) 32 years	NPV (£m) 45 years
AIS Inline	9.22	baseline	baseline	baseline	baseline
GIS Offline	8.95	2.11	2.14	2.12	2.07
AIS Offline	11.15	0.85	0.51	0.28	0.03

Table 8 indicates that when these input adjustments are applied to a revised version of the CBA, V2.1; The GIS Offline option at Lister Drive remains the most cost effective option.

- The annual GHG costs impact negatively on the NPV for the GIS Offline due to the larger volume of SF6 in this option.

PA's review of the CBA then considered modifications arising from observations, particularly regarding unit costs, provided by Ofgem in the Draft Determination.

4.2.3 Post DD Revisions to CBA #52 - V2.2

PA reviewed and contrasted Ofgem and SPEN switchgear unit costs, concluding that the costs relating to AIS (outdoor) switchgear did not appear to be comparable but that scheme costs for GIS (indoor) switchgear were broadly aligned. It would appear that the difference in AIS (outdoor) unit cost is attributable to a variance in the scope of work associated with changing a circuit breaker; SPEN costs are based on whole bay replacement and necessary associated works, whereas Ofgem's appear to be based on circuit breaker only replacement.

For this review, AIS (outdoor) unit costs were reviewed with SPEN and whole bay replacement costs reconstructed from indicative Ofgem figures. The resulting estimated cost for the AIS Offline option increases from £11.15M to £12.26M.

The expenditure phasing for the AIS Inline option has also been revised from S Curve to Flat profile to account for the even spread of construction work over the five year period (described in Section 2.4).

The expenditure phasing for the Offline options has been changed to align with typical offline construction programmes, with land-related costs applied in the first year of the proposed project.

Table 9 outlines the construction programme used for the revised CBAs. The programme is based on commissioning the full replacement of Lister Drive 132kV switchgear by 2020, as part of the overall investment portfolio.

Table 9 – Option programme to achieve project delivery in Year 5.

Options	V3 duration (years)	Revised duration (years)	Principal activity Year 1	Principal activity Year 2	Principal activity Year 3	Principal activity Year 4	Principal activity Year 5
AIS Inline	5	5	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement	Bay-by-bay circuit breaker replacement
AIS Offline	5	4		Land purchase and remediation Ground-works Erection of switchgear	Erection of switchgear Transfer circuits	Transfer circuits	Transfer circuits Decommission AIS
GIS Offline	5	3			Land purchase and remediation Ground-works Erection of building and switchgear	Erection of building and switchgear Transfer circuits	Transfer circuits Decommission AIS

Table 10 – CBA results incorporating revised timing and cost considerations

Option	Scheme cost £M	NPV (£m) 16 years	NPV (£m) 24 years	NPV (£m) 32 years	NPV (£m) 45 years
AIS Inline	9.22	baseline	baseline	baseline	baseline
GIS Offline	8.95	1.93	1.97	1.96	1.93
AIS Offline	12.26	-0.46	-0.93	-1.25	-1.57

The CBA results from the model input changes due to project timing and reconstruction of bay replacement costs are replicated in Table 10 indicating;

- that the GIS Offline option at Lister Drive continues to be the most cost effective option.

4.2.4 Conclusion

Based on the option analysis and CBA results, the GIS Offline option is confirmed to be the most cost-effective option to the replacement of the 132kV switchgear at Lister Drive. It has also been determined that there are unlikely to be practical, cost-efficient opportunities to acquire land for an extensible, sustainable AIS Offline option.

5 CONCLUSIONS

PA Consulting Group (PA) has undertaken an independent assessment of the CBAs submitted by SPEN in support of proposals to replace the 132kV Switchgear at Crewe and Lister Drive. This section provides PA's conclusions and includes an opinion on the most effective solution at each location.

5.1 CBA Model & Inputs

PA's assessment of the CBAs submitted for the two schemes has confirmed that SPEN adopted the standard CBA model provided by Ofgem and applied the methodology consistently in support of its proposals.

PA identified minor amendments to the inputs of the CBAs from March 2014 including:

- the treatment of probabilistic costs arising from construction-related outage risks,
- accounting for appropriate GHG emissions,
- removal of incorrect maintenance expenditure, and
- downward adjustment to the estimated capital costs of AIS Offline options.

These amendments were incorporated into the CBA to produce a revised model that further considered;

- a revision to project phasing to reflect typical offline construction programmes for each type of switchgear,
- a change in the expenditure profile, from S shape to flat, for the AIS Inline option to align with the expected even spread of construction activity, and
- consideration of Ofgem's Draft Determination observations with regard to unit costs and associated scope of work.

Incorporating all amendments identified by PA into the CBA model has revised the NPV results for Crewe and Lister Drive as summarised in sections 5.2 and 5.3 below.

5.2 Review of Crewe 132kV switchgear replacement

The revised CBA result shows that the GIS Offline option continues to be more cost effective than the AIS Offline option. During the course of this review investigations have confirmed that the opportunities to acquire land for an AIS Offline solution are not considered viable.

There is effectively no difference in NPV between the GIS Offline and the AIS Inline options. If SPEN's more stringent SF6 leakage specification is considered, the GIS Offline option becomes marginally more cost beneficial.

In addition to this sensitivity, the AIS Inline solution introduces a number of substantial consequential risks for the RIIO-ED1 132kV and EHV investment programme in the Crewe network that are currently not factored in the CBA. These include:

- Enhanced 'return to service' requirements to support customer service obligations for Crewe and the adjacent network,
- An AIS Inline build would effectively impose significant operational restrictions on the 132kV and EHV network, severely impacting SPEN's scope to schedule other outages over this period, and potentially deferring other ED1 schemes,
- SPEN would need to re-evaluate the risks arising from operating HI5 assets for an extended period and re-prioritise its investment programme, and
- There is potential to interrupt neighbouring NGC and WPD work programmes over a prolonged period that may incur additional costs.

The neutral NPV result, coupled with the risks outlined for the AIS Inline option, and the perpetuation of a non-standard, inflexible operational configuration, favours the adoption of the proposed GIS Offline option.

5.3 Review of Lister Drive 132kV switchgear replacement

The revised CBA for Lister Drive indicates that the GIS Offline solution continues to be the most cost-effective solution when compared to both the AIS Offline and Inline options. It has also been determined that there are unlikely to be practical, cost-efficient opportunities to acquire land for an extensible, sustainable AIS Offline solution. A GIS Offline solution remains the optimum option for replacement of the 132kV switchgear at Lister Drive.



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