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RESPOND

Cost Benefit Analysis and Buy Order of Respond Fault Mitigation Solutions – Interim Report

30 June 2017

1 RESPOND PROJECT SUMMARY

1.1 Project objective and background

The Respond project is seeking to demonstrate that a network's fault level can be estimated in near real time, and in responding to that estimation a series of innovative technical and commercial techniques can be initiated to reduce the fault level without the need for expensive and time consuming asset replacement. As this approach could maximise the use of existing assets and minimise the need for capital investment, Respond has the potential to realise significant cost savings to customers and improve the connection of generation to the network Fault Level Assessment Tool.

One of the project's success criteria is to update the cost benefits analysis figures based on actual installed costs and provide a buy order of Respond, FlexDGrid and traditional reinforcement fault level mitigation solutions.

The project is trialling three fault level mitigation techniques to manage fault current on the distribution network namely:

- **Adaptive Protection:** also known as sequential tripping, retrofitted to existing substations to re-sequence the operation of circuit breakers
- **Fault Current Limiting (FCL) service:** a commercial solution whereby industrial commercial and generation customers agree to disconnect their equipment to provide a fault level management service
- **I_S-limiters**: devices which use electronics to detect the rate of rise in fault current to calculate the peak value; if it is higher than a predetermined level the device operates in less than one millisecond.

The WPD FlexDGrid project is also investigating system fault levels and fault level mitigation techniques on an existing network with fault level issues as follows:

- **Enhanced Fault Level Assessment:** uses enhanced data to improve the accuracy of the calculation system fault level while the second technique
- **Real Time Fault Level Management:** monitors system fault level to allow control engineers to actively manage the network
- **Fault Level Mitigation Technologies:** use fault current limiters to restrict the passage of fault current.

2 BUY ORDER

Adaptive Protection and I_S-limiters have been installed as part of the trial and the costs of the installation are summarised in the table below. The operating and maintenance costs for I_S-limiters are based upon the experience in the trial to date, whereas in the absence of any other data, those for the procurement of a Fault Current Limiting service are those used in the project submission document.

Summary of costs

Equipment	Capital Cost	Additional O&M costs	Advantages compared to traditional reinforcement	Disadvantages compared to traditional reinforcement
Traditional reinforcement (replace HV cables from primary substation)	£1,115k	• None	• N/A	• N/A
Traditional reinforcement (change primary HV switchgear)	£442k	• None	• N/A	• N/A
Adaptive protection HV	£43k	• None	• Lower capital cost • Reduced design and installation times	• Reduced network security • Operational failure could cause existing equipment to exceed rating
Fault Current Limiting service	£10k	• £30k -£540k	• Low capital cost	• Ongoing annual payments required • Service could easily be terminated.
Is-limiter (Protecting primary switchgear)	£402k	• £12k pa refurbishment of inserts	• Reduced capital cost • Ability to relocate IS limiter to other sites	• Additional space required • Additional civil costs • Ongoing operating costs
Is-limiter (Protecting HV Cables)	£402k	• £12k pa refurbishment of inserts	• Reduced capital cost • Ability to relocate IS limiter to other sites	• Additional space required • Additional civil costs Ongoing operating costs

3 COST BENEFIT ANALYSIS

There are a number of considerations to be taken into account when determining a 'buy order' for level mitigation techniques.

- The capital cost of the Fault Current Limiting service. For Adaptive Protection this will include the costs of remote terminal units for communications, replacement relays and associated installation costs. For an I_S-limiter the costs will include the purchase of the unit together with the housing, civil works plus HV switchgear and cabling to connect to the existing network
- Any ongoing costs for the solution such as equipment maintenance, replacement parts and availability payments to customers
- The length of time remaining until the programmed replacement date of the asset with the fault level restriction when it would be replaced with a modern unit having sufficient capability
- The costs of removal of the fault level mitigation solution following the eventual replacement of the asset causing the fault level restriction.

Consequently there is no 'one size fits all' solution and in order to determine the buy order for a particular scenario it is necessary to undertake a cost benefit analysis (CBA).

For the purpose of this document a number of options have been considered using the CBA model that was developed for the RIIO-ED1 submission and excerpts from these are shown in Appendix A.

At this stage the costs of the WPD FlexDGrid solution have not been made available and therefore are not included in this interim report.

APPENDIX A – EXCERPTS FROM CBA MODELS

Summary sheet showing the cost benefit of installing Adaptive Protection to defer changing primary HV switchboard

Purpose of CBA: describe the stated aim of the investment decision

To investigate the cost benefits of installing adaptive protection to defer changing the HV switchgear at a primary substation

If investment is to replace an existing asset / asset class, please state the condition of the asset / asset class (HI / CI etc.)

List below all options considered to meet the stated aim

Options considered	Comment
"do minimum" option	Change primary switchboard in year 1
Adaptive protection 2 years	Change primary switchboard in year 2
Adaptive protection 3 years	Change primary switchboard in year 3
Adaptive protection 4 years	Change primary switchboard in year 4
Adaptive protection 5 years	Change primary switchboard in year 5

List below the short list of those options which have been costed within this CBA workbook

Option no.	Options considered	Decision	Comment	Spend area (from Table C1) (relevant only to adopted option)	NPVs based on payback periods				
					16 years	24 years	32 years	45 years	DNO view
1	Adaptive protection 2 year		No cost benefit		-£4.38	-£12.82	-£18.61	-£24.84	
2	Adaptive protection 3 year				£21.00	£10.85	£3.72	-£4.29	
3	Adaptive protection 4 year				£45.76	£33.90	£25.43	£15.64	
4	Adaptive protection 5 year				£69.92	£56.36	£46.54	£34.98	
5									

Summary sheet showing the cost benefit of installing an Is-limiter to defer replacing the HV cables feeding from a primary substation

Purpose of CBA: describe the stated aim of the investment decision

To investigate the cost benefits of installing an Is-limiter to defer replacing HV cables feeding from a primary substation

If investment is to replace an existing asset / asset class, please state the condition of the asset / asset class (HI / CI etc.)

List below all options considered to meet the stated aim

Options considered	Comment
Replace HV Cables	Traditional reinforcement solution
Install Is-Limter to defer reinforcement by 5 ye	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 10 y	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 20 y	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 30 y	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 40 y	Includes installation and removal plus costs of replacing/refurbishing inserts

List below the short list of those options which have been costed within this CBA workbook

Option no.	Options considered	Decision	Comment	Spend area (from Table C1) (relevant only to adopted option)	NPVs based on payback periods				
					2 years	5 years	10 years	20 years	DNO view
1	Is-limiter 5 year		Cable replacement should be deferred longervthan 5 years to achieve a cost benefit		£147.49	£79.83	-£18.12	-£18.12	
2	Is-limiter 10 year		Positive benefit		£147.49	£235.77	£210.33	£19.62	
3	Is-Limiter 20 year		Positive benefit		£147.49	£235.77	£345.38	£366.81	
4	Is-Limiter 30 year		Positive benefit		£147.49	£235.77	£345.38	£462.56	
5	Is-limiter 40 year		Positive benefit		£147.49	£235.77	£345.38	£462.56	

Summary sheet showing the cost benefit of installing an Is-limiter to defer replacing the HV cables feeding from a primary substation

Purpose of CBA: describe the stated aim of the investment decision

To investigate the cost benefits of installing an Is-limiter to defer replacing the HV switchboard at a primary substation

If investment is to replace an existing asset / asset class, please state the condition of the asset / asset class (HI / CI etc.)

List below all options considered to meet the stated aim

Options considered	Comment
Replace primary switchboard	Traditional reinforcement solution
Install Is-Limter to defer reinforcement by 5 ye	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 10 y	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 20 y	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 30 y	Includes installation and removal plus costs of replacing/refurbishing inserts
Install Is-Limter to defer reinforcement by 40 y	Includes installation and removal plus costs of replacing/refurbishing inserts

List below the short list of those options which have been costed within this CBA workbook

Option no.	Options considered	Decision	Comment	Spend area (from Table C1) (relevant only to adopted option)	NPVs based on payback periods				
					2 years	5 years	10 years	20 years	DNO view
1	Is-limiter 5 year		No benefit		£4.35	-£60.83	-£150.66	-£150.66	
2	Is-limiter 10 year		No benefit		£4.35	£0.02	-£71.93	-£234.31	
3	Is-Limiter 20 year		No benefit		£4.35	£0.02	-£16.93	-£112.11	
4	Is-Limiter 30 year		No benefit		£4.35	£0.02	-£16.93	-£73.12	
5	Is-limiter 40 year		No benefit		£4.35	£0.02	-£16.93	-£73.12	