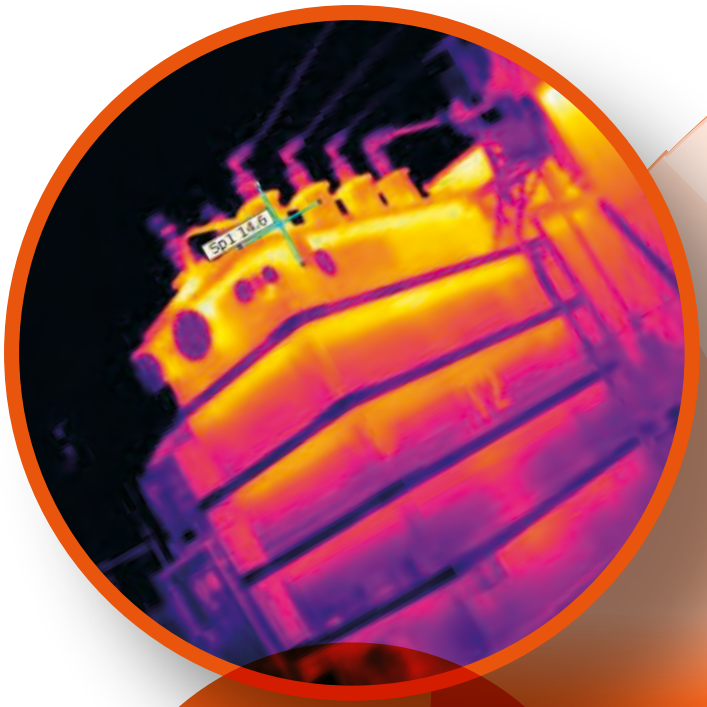
SP ENERGY NETWORKS

Flexible Networks for a Low Carbon Future



Project Cost Benefit Analysis

- Dynamic Thermal Rating (Primary Transformers)

September 2015

Part A – Costs of the trial and future roll-out

1. Introduction

This document provides cost versus benefit analysis of the deployment of Dynamic Thermal Rating (DTR) or 'Enhanced Rating' on 33/11kV Transformers. The document aims to quantify the cost per kVA of capacity gain by applying a "smart" or new technology solution against the cost per kVA of the traditional business as usual reinforcement solution.

2. Planned Innovation and Benefits

The objective of the work package was to achieve an increase in the network capacity headroom on 33/11kV primary transformers, to avoid the large step change reinforcement for relatively small levels of demand growth, for potential Low Carbon Technology loads. The target for this work package was a 7% increase in capacity headroom within the trial sites.

3. Activities of the Work Package

The elements of the work undertaken for this technology trial are listed below:

- To assess the condition of the assets identified for possible dynamic rating.
- To undertake monitoring of the demand loading, the thermal operation of selected transformers and also the environmental cooling conditions.
- To implement any required IT systems or changes.
- To undertake any works to the assets health prior to employing a dynamic rating.

4. Work package Outturn against budget (Trial Project Cost)

The original submission budget for this work package was £783K for both Transformers and Overhead Lines. The costs were not split between DTR of transformers and overhead lines.

Table 1 below is a summary of the overall work package 2.1 expenditure and lists the original budget against the actual spend for the trial.

Activity	Budget (£k)	Actual (£k)	Variance (£k)	Commentary
Labour	203	90	-113	Contractors used instead of internal labour
Equipment	295	229	-66	Real-time rating changed to 'enhanced' rating. Lower spend on condition monitoring.
Contractors	97	337	+240	Contractors used instead of internal labour. Transformer condition improvement work required for enhanced rating.
IT	150	149	-1	
Travel/Exp's	-	-	-	
Contingency & Others	39	20	-19	Condition works necessary for application of DTR to certain transformers.
Payments to users	-	-	-	
Totals	**783**	**825**	**+42**	

Table 1

Labour – The internal labour costs were significantly lower than budget, due to not being able to release staff from the businesses with the required skills to the project for the 3+years.

Equipment – One aspect of the budget which was envisaged at the project concept was that to apply DTR to the trial transformers, they would each need; i) on-line dissolved gas analysis (DGA), ii) transformer winding temperature monitoring and iii) local weather data, all in real-time and with the appropriate user IT systems in place. As the project progressed it was determined that the on-line DGA equipment was not required and a real-time control system was not required.

Contractors – This included the additional contract resource and the condition improvement to the St Andrews transformers in preparation for enhanced rating.

Contingency – Some of the contingency budget was used across a number of elements of the work package. E.g. some transformer condition improvements at St Andrews were undertaken after the assessment which identified that they required some remedial works to prepare them for an increased rating. Also some additional costs were over budget for the analysis work by TNEI and University of Strathclyde.

5. Future Roll out cost of DTR of transformers

The table 2 below shows a breakdown of the Trial Project Costs versus Repeated Method Cost deployment for the DTR of transformers only, so as to allow evaluation of the cost/benefit for the technique. The base cost shows the cost of undertaking the trial for the DTR on the 8 transformers. The repeated method costs illustrate the costs of further deployment to another 8 transformers. The benefit column shows the capacity gain through the deployment. The bottom of table 2 shows how the costs relate to a cost per substation.

Activity	Base cost (£k)	Repeated Method Cost	Benefit (kVA)
Asset condition assessment	105000	24000	
Thermal monitoring	30000	16000	
Environmental monitoring	25000	16000	
Modelling/analysis	35000	1000	
Asset DTR preparation	120000	40000	
Engineering & project management	116000	24000	
Total	431000	121000*	

*Total repeated method cost is for 8 transformers

Per substation SPD		£30250	2000
Per substation SPM		£15125	1000

Table 2

Asset Condition Assessment – This was the assessment/reporting costs for the 8 selected transformers in the trial sites, to determine their suitability for applying DTR to them.

Thermal monitoring – This was the installation, connection and commissioning of electronic transformer temperature sensors to the transformers which could transmit the temperature information back to the data server.

Environmental monitoring – This was for installation, connection and commissioning of several weather stations to factor-in weather related parameters in the analysis work of determining the loading trials of the transformers. The weather stations also supported aspects of the other work packages.

Asset DTR preparation – During the condition assessments it was reported that the St Andrews transformers required some refurbishment work to the cooling system ensure satisfactory operation under increased loading conditions. This was not originally expected and while was an increased equipment cost, this was compensated somewhat by the omission of the on-line DGA. For the roll-out costs a provisional sum of £5k per transformer is included which whilst may not cover the DTR preparation costs, is an average amount across a population of transformers.

Engineering & project management – This covers the practical aspect of delivery of DTR to transformers.

Part B – Financial Assessment

Reinforcement Base Cost at 11kV

The trial for the dynamic (enhanced) rating of primary transformers was undertaken across the two differing network types of SPD (radial – dual transformer substations) and SPM (interconnected – single transformer substations). The base costs for reinforcement of these substation types is typically similar at £225/kVA.

Using the pro-rata base cost of £225/kVA for additional transformer capacity, the capacity release or avoiding network reinforcement is;
SPD substations = 2000kVA = £450,000
SPM substations = 1000kVA = £225,000
This is the typical pro-rata estimated cost of reinforcement in order to allow for this amount of load to be connected to the network that is currently at full capacity. (Note: These costs are calculated as a proportion the total cost of constructing a new primary substation because small incremental increases in primary substation capacity of these levels can't normally be provided through conventional reinforcement.)

Carbon Saving:

No carbon savings can directly be attributed to this project.

Benefit rating: 0 (nil)

Social and Environmental Benefit

The project provides additional headroom capacity which would allow the connection of additional loads without reinforcement. The speed of deploying the enhanced rating measures would often be much quicker than traditional reinforcement works of a particular network which is at capacity, thereby allowing an accelerated connection of low carbon technologies such as heat pumps or electric vehicles.

Benefit rating: 2 (Minor)

Financial Benefit:

SPD Transformers:
Base Cost: £450,000
Method Cost per substation = £30,250
Financial Benefit = Base Cost – Method Cost
Financial Benefit = £450,000 – £30,250
Financial Benefit = £419,750

SPM Transformer:
Base Cost: £225,000
Method Cost per substation = £15,125
Financial Benefit = Base Cost – Method Cost
Financial Benefit = £225,000 – £15,125
Financial Benefit = £209,875

Benefit rating: 4 (significant)

Safety Benefit:

None envisaged standard health and safety processes will be applied and any new learning gained from the project will be shared.

Benefit rating: 0 (nil)

Network Reliability Benefit:

The project has no measureable reliability benefit to the network.

Benefit rating: 0 (nil)

Benefit Scorecard

Grading of Benefit	Financial Benefit	Safety Benefit Per Reported Case	Social and Environmental Benefit	Network Reliability Benefit	Carbon Saving
High (5)	Major £1M+	Lead to the reduction of fatalities >£1m	Managed realignment (significant) –High incurred costs and environmental benefit/value > £50k	Leads to significant and permanent improvement in Regulatory performance targets >£100k	Major >£30k £/tCO2e
Significant (4)	Significant £100k-£1M	Significant improvement to public safety £100k-£1m	Managed realignment (minor) –Minor to medium incurred costs and environmental benefit/value > £25k	Leads to sustainable improvement in Regulatory performance targets >£50k	Significant >£10k £/tCO2e
Medium (3)	Medium £10k-£100k	Reduction of reportable injuries >£20k	Improve (significant) Significantly improve existing processes and systems to adapt the existing environmental characteristics > £10k	Leads to improvement in performance >£10k	Medium >£5k £/tCO2e
Minor (2)	Small £1k-£10k	Lead to the reduction of absence due to ill health >£11k	Improve (minor); Improve existing processes and systems to adapt the existing environmental situation > £1k	Contributes to improvement in performance £1k	Minor >1k £/tCO2e
Low (1)	Low £0-£1k	Avoidance of minor injury >£0.33k	Do minimum; This is a continuation of existing processes and maintenance, delaying but not avoiding or improving < £1k	Small but measurable improvement <£1k	Low <£1k £/tCO2e
Nil (0)	None or Negative	No Tangible Benefit	No Tangible Benefit	No Tangible Benefit	No Tangible Benefit

	Financial Benefit	Safety Benefit Per Reported Case	Social and Environmental Benefit	Network Reliability Benefit	Carbon Saving
Benefit Rating	4	0	2	0	0
Total	**6**				