Heatherton Terminal Station (HTS) Redevelopment - 66kV Line & Secondary Works

Project № UE-DOA-S-17-002

EDPR BUSINESS CASE

This document justifies capital expenditure on the United Energy network and forms supporting documentation for the EDPR submission.

REPEX Road Map

1. Asset Replacement – Modelled

a. 6 modelled asset categories

2. Asset Replacement – Modelled & Unmodelled

a. Pole top structures + SCADA/protection

3. Other Repex - Unmodelled

a. ZSS Primary Asset Replacement

(i) CEES - Capacitor Banks + Earth Grid + Neutral Earthing Resistors

(ii) CEES - Buildings

b. Non VBRC Safety Projects

(i) Intelligent Secure Substation Asset Management (ISSAM) – UE PL 2401 e.g.CCTV

c. Operational Technology

(i) OT Safety

- Service Mains Deterioration Field Works – PJ1385
- In Meter Capabilities IMC) – PJ1386
- Light Detection and Ranging (LiDAR) Asset Management – PJ1400
- OT Security – PJ1500
- DNSP Intelligent Network Device – PJ5002

(ii) OT Reliability

- Distribution Fault Anticipation Data Collection and Analytics (DFADCAA) – PJ1599
- Fault Location Identification and Application Development – PJ1600

(iii) OT Other

- Dynamic Rating Monitoring Control Communication (DRMCC) – PJ1413
- Test Harness – PJ1398
- Pilot New and Innovative Technologies – PJ1407

d. Network Reliability Assessment UE PL 2304 – Projects

(i) Automatic Circuit Re-closers (ACRs) and Remote Control Gas Switches (RCGSs)

(ii) Fuse Savers

(iii) Rogue Feeders

(iv) Clashing

(v) Animal Proofing

(vi) Communications Upgrade

e. CEES – Environment

f. CEES – Power Quality Maintained

g. Terminal Station Redevelopment HTS and RTS - UE-DOA-S-17-002 & UEDO-14-003

4. VBRC Projects

a. HV Aerial Bundled Cable Strategic Analysis Plan - UE PL 2053

b. DMA and MTN Zone Substation Rapid Earth Fault Current Limiter (REFCL) Installation

c. Other VBRC projects

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

1.1 Project Overview

Heatherton Terminal Station (HTS) is owned by AusNet Transmission Group and operates at 220kV and 66kV and supplies the UE network. It has three 150MVA (220/66kV) transformers and feeds key loads within the Melbourne bayside suburbs. Much of the terminal station equipment has reached the end of its economic life and as such AusNet Transmission Group is currently replacing most of the aging assets within HTS to improve security of supply.

The project assessed in this business case is the proposal to replace the 66kV line exits at HTS and realign and reconnect the existing line exits to the new circuit breakers inside HTS. This work shall be coordinated with AusNet Transmission Group's project to rebuild HTS. The project also includes the installation of new protection relays to replace the old equipment and to allow the new protection and control equipment installed at HTS to integrate with remote end relays.

The existing HTS 66kV outdoor switchyard is shown in Figure 1 and connects to the UE owned overhead lines. The circuit breakers in the outdoor yard will be replaced by AusNet Transmission Group in 2016 and as such the overhead line exits will need to be reconnected by UE, to maintain supply. As part of these works some of the protection and control systems need to be replaced.

Figure 1: Existing HTS 66kV Switchyard

UE is required to undertake relocation works to maintain the security and reliability of supply to UE's zone substations HT (Heatherton), CM (Cheltenham) and SR (Sandringham) supplied from HTS. Combined, these zone substations supply around 30,000 customers.

Failure to undertake these works will result in UE being reliant on a single source of supply to HT, CM and SR through the HT feeder only. Such arrangements would result in the 30,000 UE customers supplied from HT, CM and SR zone substations experiencing a significant deterioration in the reliability of their electricity supply.

Figure 2: Existing HTS 66kV System Supplying UE's HT, CM and SR zone substations

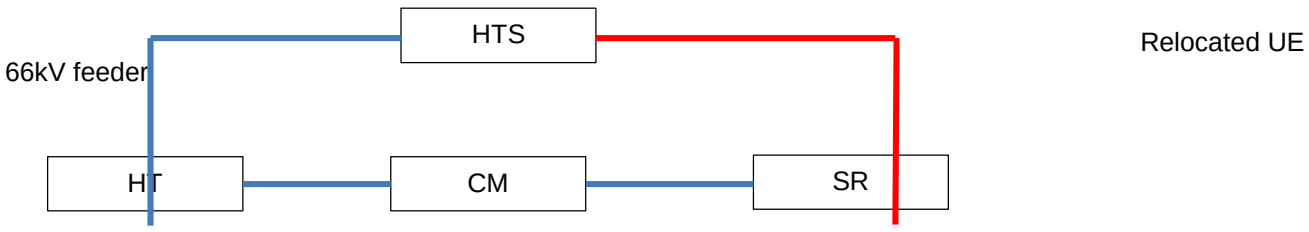
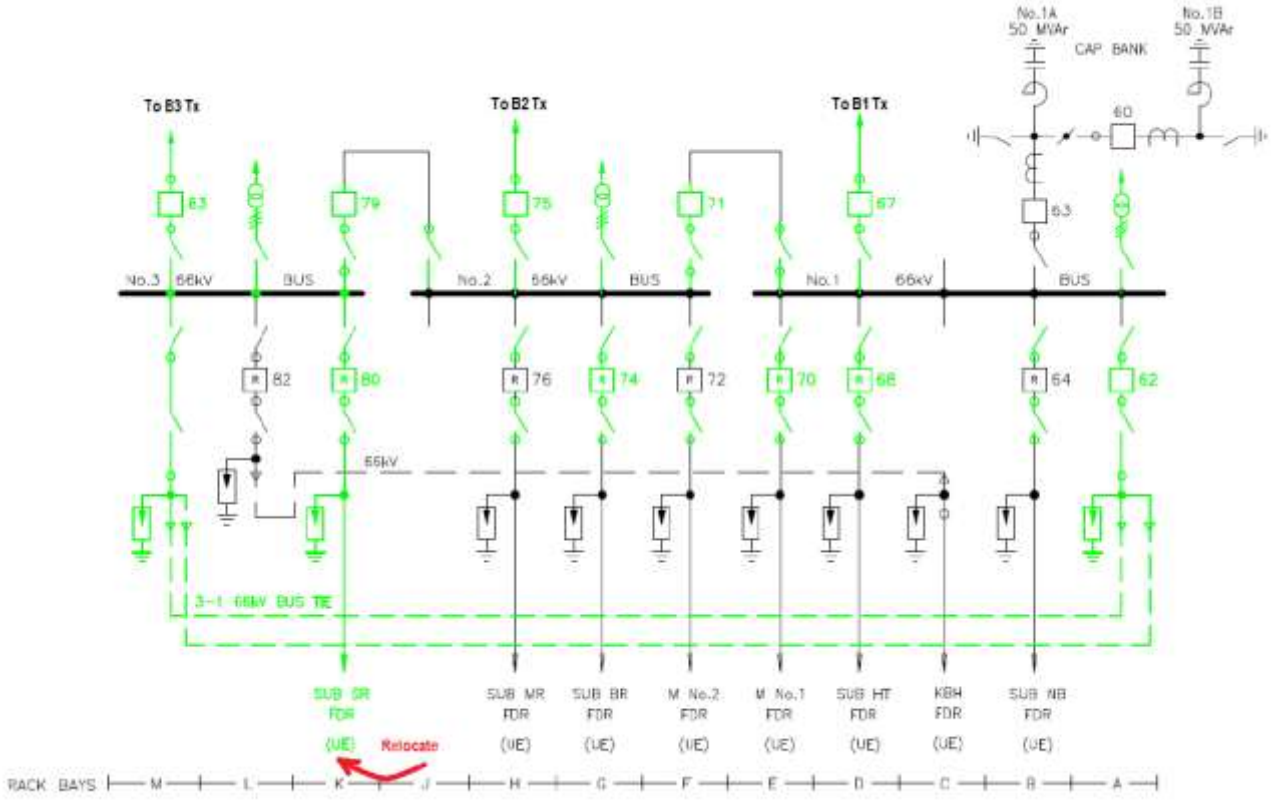


Figure 3: Works Required at HTS 66kV triggered by AusNet Transmission Group showing SR feeder relocation

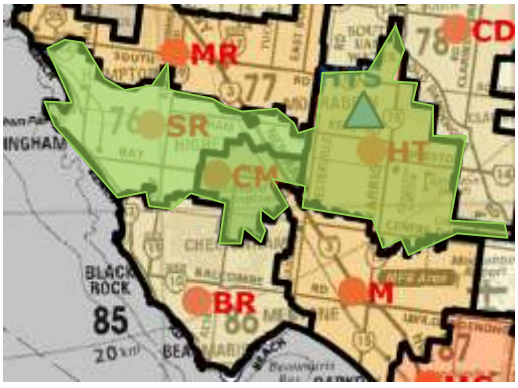


1.2 Project Need

One emerging operational issue associated with the sub-transmission network that supplies HT, CM and SR zone substations has been identified, as described below:

- **Security and Reliability of Supply:** As a result of the replacement works on the transmission connection assets at HTS, if UE does not undertake this project to relocate its overhead feeder exits ex HTS and thus connect its feeder to the new transmission connection assets, then HT, CM and SR will need to be operated radially from the HT feeder. This is a security of supply issue as zone substations are not typically designed to operate radially during system normal operations. Radial operation of HT, CM and SR will impact reliability performance of all of these zone substations as loss of supply will result for any sub-transmission line outage until the fault is repaired. If the proposed work does not proceed, reliability of supply to the green shaded areas shown below will substantially deteriorate, resulting in long duration outages in the event of a single fault at any time of the year.

Figure 4: HTS 66kV Supply Area to CM, HT and SR zone substations



In order to address this issue, relocation of the SR 66kV overhead line exit and the upgrade of the protection and control servicing these zone substations to interface with HTS has been identified as the preferred option.

1.3 Alternative Options Considered

The following alternative options were considered to address the emerging operational issue at HT, CM and SR.

- Option 1: Do nothing. This option involves no incremental capital expenditure, and will necessitate radial operation of UE's sub-transmission network.
- Option 2 (preferred): Undertake HTS redevelopment 66kV line works to maintain existing network arrangements, and to maintain present levels of supply reliability.

1.3.1. Option 1: Do nothing - Radial operation of the sub-transmission network

This option involves operating the HTS-HT-CM-SR-HTS sub-transmission loop radially by disconnecting the SR connection at HTS and relying on supply via the HT feeder. This option:

- Involves no incremental capital expenditure;
- Results in the loss of United Energy's 66kV connections to HTS for SR zone substation;
- Does not enable UE to maintain present levels of supply security and reliability to the customers supplied from HT, CM and SR zone substations;
- Adversely affects the reliability performance of UE's network, with long duration outages of tens of thousands of customers in the bayside areas of Melbourne becoming a frequent occurrence; and
- Puts AusNet Transmission Group's main replacement project at HTS at risk of stalling.

This is not the least lifecycle cost option for UE. On this basis this option is not preferred.

1.3.2. Option 2 (preferred): HTS Redevelopment 66kV line works to maintain existing supply arrangements

This option involves relocation of the SR 66kV overhead line exit, to enable connection with the new 66kV switchgear being installed by AusNet Transmission Group to replace the existing outdoor 66kV switchyard. It also involves the upgrade of the protection and control servicing the zone substations to interface with HTS. This will allow HTS-HT-CM-SR-HTS to remain in a secure loop arrangement. This option:

- Enables UE to maintain present levels of supply security and reliability, and thus addresses the security of supply issues that would arise if the works did not proceed.
- Does not adversely affect the reliability performance of UE's network, compared to the outcomes that Option 1 would deliver.
- Allows AusNet Transmission Group's main project at HTS to proceed as planned.

This is the least lifecycle cost option for UE. For these reasons, this is considered the preferred option.

1.3.3. Technical Summary

Alternative	Option 1- Do nothing - Radial operation of sub-transmission network	Option 2 - 66kV line works to maintain current supply arrangements (Preferred)
Technically viable	Yes	Yes
Addresses security of supply risk; Maintains existing levels of security and reliability of supply to customers	No	Yes
Provides network configuration and operational flexibility in accordance with good electricity industry practice	No	Yes
Integrates as planned with AusNet Transmission Group's HTS rebuild project	No	Yes

1.3.4. Financial Summary

An evaluation of the technically feasible options on a least cost basis for UE over a 20 year lifecycle has been undertaken.

Alternative	Option 1 - Do nothing - Radial operation of sub-transmission network	Option 2 - 66kV line works to maintain current supply arrangements (Preferred)
Gross Capex ($)	0	$0.6M
AusNet contribution	N/A	$0.3M
Net Capex ($)	N/A	$0.3M
Opex ($)	N/A	N/A
Unserved Energy ($)1	$191M	$46M
Total Cost ($)	$191M	$47M
Present value of total cost ($)	$71M	$17M
Ranking	2	1

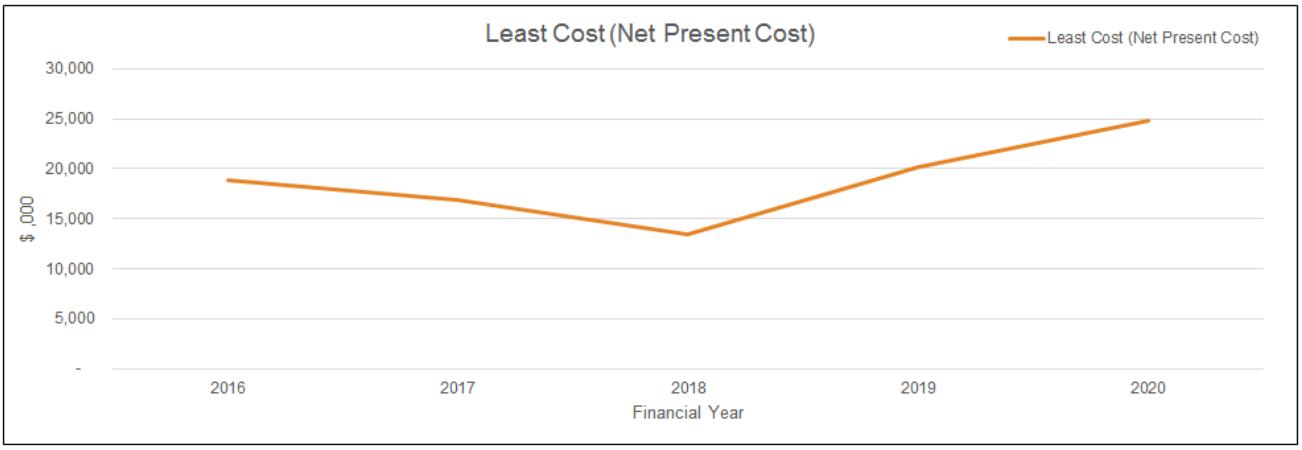
Further details of the costs of the options are presented in Appendix B. Appendix C provides a financial evaluation summary.

1.4 Optimum Timing

The economic timing of the project has been determined by comparing the annualised cost of Option 1 (do nothing) against the annualised capital cost of the preferred option (Option 2). This is basically a comparison of the annualised cost of expected unserved energy under Option 1 and the annualised cost of Option 2 (which involves capital expenditure to avoid the unserved energy outcomes that arise under Option 1).

The net annual cost of foregoing the preferred option and being exposed to the unserved energy costs under Option 1 is shown in the graph below. It can be seen that in 2018, costs of $14 million can be avoided if Option 2 (the preferred option) is implemented instead of Option 1. The graph also shows that this avoided annual cost - a net benefit of Option 2 - continues to rise over the period to 2020, reflecting the forecast increase in demand, and the increasing level of expected unserved energy over the period.

[1] This is the expected level of unserved energy incurred from all outages ex HT, CM and SR zone substations over 20 years. The difference in unserved energy costs between the two options represents the impacts of sub-transmission outages when operating the network radially rather than in the standard loop configuration.



On this basis, the economic timing for the preferred option is now.

1.5 Recommendation

The detailed economic assessment indicates that relocating the overhead 66kV line exits at HTS and the associated protection and control upgrade is the least lifecycle cost solution to address the emerging issue. Therefore it is recommended to proceed with the preferred option in alignment with the AusNet Transmission Group redevelopment works at HTS.

With a total project cost of $574,059, it is recommended to proceed with the project with AusNet-supported contribution funding to allow AusNet Transmission Group's replacement works at HTS to continue.

2. PROJECT FINANCIALS

2.1 AMP Status of Preferred Option

The status of the preferred project is detailed below.

PROJECT COST	
AMP Approved Project?	Yes
Year Budgeted	2016
Required Service Date	June 2016
Budgeted Total Cost ($A excluding GST)	$574,059
Business Case Cost ($A excluding GST)	**$574,059 (Note 1)**

Note 1: Approximately $0.3M of the $0.6 M budgeted cost is a contribution from AusNet Transmission Group. AusNet Transmission Group has agreed to fund the 66kV cabling works component of the project through a contribution, as this reduces the total cost of AusNet Transmission Group's HTS redevelopment project.

2.2 Option 2 HTS Redevelopment – Costs

The major costs of the preferred Option 2 are set out below. Appendix A sets out a high level scope of work.

COSTS (Capex, Opex, Risk, Unserved Energy)	Driver	NPV Cost
Capex (before AusNet contribution)	$574,059	$538,507
SAIDI Costs (minutes per annum)	3.58	$9,185,388
SAIFI Costs (interruptions per annum)	0.04	$7,998,942

2.3 Option 1 Radial Operation – Costs

The major costs of Option 1 are set out below.

COSTS (Capex, Opex, Risk, Unserved Energy)	Driver	NPV Cost
Capex	$0	$0
SAIDI Costs (minutes per annum)	18.65	$55,112,329
SAIFI Costs (interruptions per annum)	0.08	$15,997,884
Costs per minute	$56,500	$0

APPENDIX A – HIGH LEVEL SCOPE OF WORK

A summary of the scope of works for the project is presented below.

66kV Line Works – Relocate the overhead line exits

- The Service Provider shall physically relocate the existing SR 66kV line from Bay J to Bay K. This relocation involves installing a single strain pole and re-terminating the 37/3.75 AAC Triton conductor designed for 100oC operating temperature onto an AusNet Services 61/3.75 AAC Venus conductor.
- Installation of new pole may require trimming of the existing vegetation in the vicinity.
- The existing overhead connection between the new pole and the existing SR circuit breaker is to be retired;

Secondary Works – Retire old pilot wire and supervisory and install modern protection and fibre optics.

- HT-HTS 66kV Line
    - The 66kV circuit breaker will be replaced at HTS. A continuous (multi-day) outage is required. The line will however remain in service by AusNet Services using a temporary 66kV circuit breaker and a temporary protection:
    - SEL311L (X temporary protection) – will be set the same as the existing X protection relay (SEL311L);
    - SEL351 (Y temporary protection) – will be set the same as the existing Y protection relay (SEL351) with the exception of the remote trip functionality which will be disabled.
    - No changes or temporary protection settings are required at HT, however full end to end testing of the differential and remote trip schemes shall be performed.
- BR-HTS 66kV Line
    - The 66kV circuit breaker will be replaced at HTS. A continuous (multi-day) outage is required. The line will however remain in service by AusNet Services using a temporary 66kV circuit breaker and a temporary protection:
    - SEL311L (X temporary protection) – will be set the same as the existing X protection relay (SEL311L);
    - SEL351 (Y temporary protection) – will be set the same as the existing Y protection relay (SEL351) with the exception of the remote trip functionality which will be disabled.
    - No changes or temporary protection settings are required at BR, however full end to end testing of the differential and remote trip schemes shall be performed.
- M No.1-HTS 66kV Line
    - The 66kV circuit breaker will be replaced at HTS. A continuous (multi-day) outage is required. There will be no temporary protection arrangements at HTS i.e. the line will be out of service during the works at HTS. No changes or temporary protection settings are required at M.
- M No.2-HTS 66kV Line
    - Existing isolators for the 66kV circuit breaker will be replaced at HTS. A single day outage is required. No changes or temporary protection settings are required at M. The line will be out of service during the works at HTS.
- NB-HTS 66kV Line
    - Existing isolators for the 66kV circuit breaker will be replaced at HTS. A single day outage is required. No changes or temporary protection settings are required at NB. The line will be out of service during the works at HTS.
- MR-HTS 66kV Line
    - Existing isolators for the 66kV circuit breaker will be replaced at HTS. A single day outage is required. No changes or temporary protection settings are required at MR. The line will be out of service during the works at HTS.

- SR-HTS 66kV Line
  - The 66kV feeder exit will be relocated at HTS. A single day outage is required. No changes or temporary protection settings are required at SR. The line will be out of service during the works at HTS.
- KBH-HTS 66kV Line
  - No works at HTS associated with this line. No outage required. No changes or temporary protection settings required at KBH.

APPENDIX B – COST ESTIMATE

The original cost estimate provided by Service Delivery for the project was as follows. This is compared with the revised estimate with identified savings.

Primary Works

Price Summary Breakdown	Dollar Value
Plant+Labour+Material+Subcontract	$84,619
Risk controls	$3,385
Total Direct Cost	**$88,004**
Overhead and contingency	$37,554
Total Cost	**$125,558**

Pole Works

Price Summary Breakdown	Dollar Value
Plant+Labour+Material+Subcontract	$202,190
Risk controls	$8,088
Total Direct Cost	**$210,278**
Overhead and contingency	$89,732
Total Cost	**$300,010**

Secondary Works

Price Summary Breakdown	Dollar Value
Plant+Labour+Material+Subcontract	$ 121,366
Risk controls	$ 4,482
Total Direct Cost	**$ 125,848**
Overhead and contingency	$ 22,653
Total Cost	**$ 148,501**

TOTAL PROJECT VALUE	$ 574,059

APPENDIX C – FINANCIAL EVALUATION SUMMARY

Project Details

Project Name : HTS Redevelopment

Internal Reference UE-DOA-S-17-002

Year of construction 2016

Regulatory Category Reliability & Power Quality Maintained

Project Type [redacted]

Asset [redacted]

Budget Allocation $574

All costs to be entered in real ($2015)

Capital Costs

Capital Costs ($2015)		2016	2017	2018	2019	2020	2021	2022	2023	2024
		$000	$000	$000	$000	$000	$000	$000	$000	$000
	Technical Options									
Reference Case	Status Quo									
Option 1	HTS Redevelopment	574								
Option 2										
Option 3										
Option 4										
Option 5										

Operating Costs ($2015)

"Status Quo" Reference Case

	Unit	2017	2018	2019	2020	2021	2022	2023	2024	2025
Maintenance Costs	($000)									

Negative Impact on Revenue (STPIS)	[redacted]	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAIFI sustained	(no. of Interruption)	0.090	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
SAIDI accidental	(minutes)	21.49	21.5	21.5	21.5	21.5	21.5	21.5	21.5	21.5
MAIFI momentary	(no. of Interruption)		0.0	0.0	0.0	0.0	0.0		0.0	0.0
Call centre response	(percentage)		0%	0%	0%	0%	0%		0%	0%

Network Outage Costs		2017	2018	2019	2020	2021	2022	2023	2024	2025
Customer off supply	(minutes)									

Loss of F Factor Benefit		2017	2018	2019	2020	2021	2022	2023	2024	2025
	(No. of fire start NOT avoided)									

Costs		2017	2018	2019	2020	2021	2022	2023	2024	2025
Cost 1	($000)									
Cost 2	($000)									
Cost 3	($000)									
Cost 4	($000)									
Cost 5	($000)									
Risk 1	($000)									
Risk 2	($000)									
Risk 3	($000)									
Risk 4	($000)									
Risk 5	($000)									

Option 1: HTS Redevelopment

		2017	2018	2019	2020	2021	2022	2023	2024	2025
Maintenance Costs	($000)									

Negative Impact on Revenue (STPIS)	[redacted]	2017	2018	2019	2020	2021	2022	2023	2024	2025
SAIFI sustained	(no. of Interruption)	0.045	0.0	0.0	0.0	0.0	0.0	0.045	0.0	0.0
SAIDI accidental	(minutes)	3.58	3.6	3.6	3.6	3.6	3.6	3.58	3.6	3.6
MAIFI momentary	(no. of Interruption)		0.0	0.0	0.0	0.0	0.0		0.0	0.0
Call centre response	(percentage)		0%	0%	0%	0%	0%		0%	0%

Network Outage Costs		2017	2018	2019	2020	2021	2022	2023	2024	2025
Customer off supply	(minutes)									

Loss of F Factor Benefit		2017	2018	2019	2020	2021	2022	2023	2024	2025
	(No. of fire start NOT avoided)									

Costs		2017	2018	2019	2020	2021	2022	2023	2024	2025
Cost 1	($000)									
Cost 2	($000)									
Cost 3	($000)									
Cost 4	($000)									
Cost 5	($000)									
Risk 1	($000)									
Risk 2	($000)									
Risk 3	($000)									
Risk 4	($000)									
Risk 5	($000)									

Project Details

Project Name : HTS Redevelopment

Asset : United Energy

Year in which project will begin : 2016

Discount Rate : 8.67%

**Business WACC (Pre-tax Nominal WACC)*

Project Type : Discretionary (asset replacement or refurbushment)

Regulatory Asset Category Proportion (Percentage)

Customer Initiated	0%
Demand (Reinforcement)	0%
Reliability & Power Quality Maintained	100%
Reliability & Power Quality Improved	0%
SCADA & Network Control	0%
Environmental, Safety & Legal	0%
Non-Network IT	0%
Non-Network general other	0%
Non-Standard Control	0%

Gas reg categories - to be completed

	0%
	0%
	0%
	0%
	0%
	0%
	0%
	0%
	0%

Economic Assessment

Budget :

Is the project included in the budget?	Yes
If yes, how much is allocated?	$ 574.00

Results:

$000

Least Cost Option **Option 1: HTS Redevelopment**

Least Cost (Present Value) **17,723**

Options	"Status Quo" Reference Case	Option 1 HTS Redevelopment	Option 2	Option 3	Option 4	Option 5
Capital Costs	-	585.2	-	-	-	-
Maintenance Costs	-	-	-	-	-	-
Negative Impact on Revenue (STPIS)	191,349.9	46,241.2	-	-	-	-
Network Outage Costs	-	-	-	-	-	-
Loss of F Factor Benefit	-	-	-	-	-	-
Cost 1	-	-	-	-	-	-
Cost 2	-	-	-	-	-	-
Cost 3	-	-	-	-	-	-
Cost 4	-	-	-	-	-	-
Cost 5	-	-	-	-	-	-
Risks	-	-	-	-	-	-
Total Costs	**191,349.9**	**46,826.4**	**-**	**-**	**-**	**-**
Present Value of Total Costs	**71,110.2**	**17,722.8**				
Project Ranking	***2***	***1***				

Notes:	
Option 1: HTS Redevelopment	
Option 2:	
Option 3:	
Option 4:	
Option 5:	

Timing Analysis - HTS Redevelopment