Appendix 2
Energy Conservation Measures Whole Life Cost Tool User Guide

SCOTTISH FUTURES TRUST

Introduction

This 'Energy Conservation Measures (ECM) Whole Life Cost Tool' has been produced as part of a wider suite of guidance developed by Scottish Futures Trust for identifying carbon reduction opportunities in lifecycle planning and potential alterations on operational PFI, PPP, hub and NPD (collectively PPP) Projects.

This document seeks to offer a strategic best practice approach to embedding whole life energy conservation measures within operational PPP projects.

This ECM Whole Life Appraisal Tool is designed to assist public sector partners managing operational PPP projects to make informed decisions to optimise a built asset's Net Zero performance where formal Net Zero Carbon changes or variations are being considered. The appraisal tool provides a consistent method of comparing ECM outcomes where an Authority is considering Net Zero Carbon changes or variations in existing operational PPP projects. It is both a qualitative and quantitative process that looks at the energy conservation outcomes in costs and relative savings over the remaining period of the PPP concession. The appraisal tool promotes the analysis of whole life outcomes across three assessment criteria: commercial; environmental performance; and environmental savings against a business as usual baseline.

The ECM Whole Life Appraisal Tool consists of an online excel workbook that offers a clear and consistent method of reporting whole life ECM outcomes for operational PPP projects. The key output of the tool is a Whole Life Dashboard which summaries and compares whole life ECM outcomes for different options or for a preferred solution. The appraisal tool offers a flexible framework for whole life ECM appraisals and is designed to be adopted across sectors (health and education) and in a variety of scenarios including general comparison of options.

The appraisal tool can be used to determine the impact on the financial model of the ECMs across the remainder of the project's concession period. However, whilst not its primary function, the appraisal tool can also be used to model the expected carbon emissions savings associated with different ECMs on a whole life basis. The tool allows users to assess the differing impacts and outcomes associated with investing in ECMs including energy and emissions costs saving forecasts, alongside potential Lifecycle cost/benefits when investing in differing ECMs.

Prior to using the tool, it is the expectation that users will already have identified ECM opportunities and associated cost inputs (energy performance and cost data), ideally through Decarbonisation Options Assessments (or energy audits) as set out in the Guidance with subsequent ECM analysis by Project Co or an Authority's appointed specialists (please see Chapter 7 of the Guidance for information on how to complete a Decarbonisation Options Assessment).

This toolkit guidance sets out how this appraisal tool should be adopted and the flexibility in how the user can modify the tool to align to the needs of their project. Access to the appraisal tool can be requested by e-mailing mailbox@scottishfuturestrust.org.uk

When developing a whole life ECM appraisal of any Net Zero Carbon change/variation, consideration should be made to the following:

- The appraisal tool is to support the strategic aims and development/assessment of ECM opportunities and should not be relied on for investment solely. It is expected that Authorities using this appraisal tool would take appropriate advice from technical and other advisers as required in this regard;
- Any outcomes will need collaborative working between Project Co and the Authority;
- Lifecycle savings would need to be discussed/agreed with the Project Co and are not guaranteed;
- The appraisal tool does not calculate the impact on any project agreement "cap and collar" arrangements i.e. if an Authority invests in ECMs, consideration should be given to energy savings and the impact they may have on energy targets where included within the relevant project agreement;
- The appraisal tool does not assess maintenance costs as it is unlikely to achieve any significant maintenance savings in replacing assets as these costs are typically 'fixed';
- That embodied carbon is not currently involved in the function or option appraisal process of the appraisal tool; and

The appraisal tool should be used in conjunction with the principles set out in the Guidance developed by SFT.

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1.2 ECM Whole Life Cost Tool

The ECM WLC tool is a spreadsheet tool, consisting of the following tabs:

1. Summary – Information page
2. Project Data Input – Input tab
3. ECM Options Data – Input tab
4. ECM Options Lifecycle – Input tab
5. An options selector and outputs Dashboard – Options selection and presentation tab
6. Option A Outcomes – Presentation tab
7. Option B Outcomes – Presentation tab
8. Option C Outcomes – Presentation tab

The tool allows users to assess the predicted impact and outcomes of three differing investment options (Options A – C) through selection and de-selection of ECM 'opportunities' from the Dashboard tab.

A significant proportion of the tool's outputs are automated. Only cells highlighted in yellow throughout the tool require user input, with those in green allowing overwriting as and if required.

The following sections of this instructions document talk users through the inputs and outputs of each of the tool's tabs. Presentation tabs are for information only and are not described further in this User Guide.

1.3 Summary Tab

This tab provides a summary and disclaimer to the tool. Users should read this tab and appraise themselves of its notes. No input data is necessary.

Figure 1:
Summary Tab

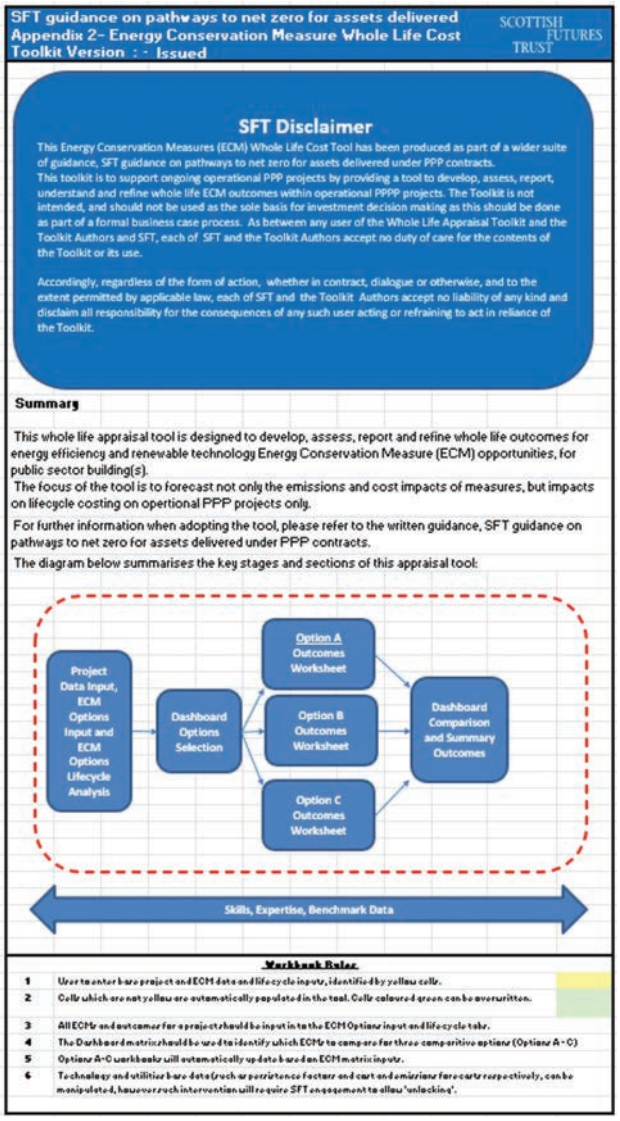

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Figure 2:
Project Data Input

PPP/PFI/hub DBFM/NPD

ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGY WHOLE LIFE OUTCOME TOOL

Project Input Sheet

Date	01/04/2022
Revision	P1

Year of Project's Operational Commencement	2018
Concession Period Length - Years	25
Current Year of Operation	2022
Remaing Concession Period - Years	21

Utility		Last Full Year Energy Consumption Data				Notes
		kWh	£	£/kWh	t.CO_2	
Electricity		856,371	140,638	0.145	172	Community Hospital - 7002 m2
Gas		7,118,810	177,970	0.030	1,309	
Other Fossil Fuel	Fuel oil	-	-	-	-	
Other Fossil Fuel	Burning oil	-	-	-	-	
Total		7,975,181	318,608		1,481	

1.4 Project Data Input Tab

This tab requires users to input base project, energy performance and cost data, as directed by the yellow cells. It provides the base consumption and costs performance for future forecast analytics of BAU.

The project's commencement date, concession length and current year of operation should be input within the cells bounded in green in Figure 2.

A user is expected to input 'baseline' energy consumption and costs covering a full 12 month period in the cells bounded in the red box in Figure 2; such data are expected to be provided through monthly or annual reports by the Project Company.

Unit rates (£/kWh) are calculated automatically through a simple division of costs by consumption. Where invoice costs are not available, a user may choose their own unit rates by overwriting inputs in the "£" and "£/kWh" columns.

Whilst predominantly focused on electricity and gas, 'other fossil fuel' types can be chosen from the drop downs in cells bounded in blue in Figure 2.

Annual emissions rates are automatically calculated relevant to the utility type and Current Year of Operation; emissions factors as taken by HM Treasury's Green Book[1] figures and forecasts.

It should be noted that the tool uses the HM Treasury Green Book 'carbon offset' forecast cost figures for the purposes of commercial evaluation of investment; using the 'central' range of costs for £/T.CO2 for 'non-traded' emissions. Where a user requires such cost offsets to be removed, or where the 'price of carbon' is determined separately for any given year by a user, SFT should be contacted to amend the tool accordingly.

1.5 ECM Options Data Tab

This tab requires users to input data relating to potential ECMs for the building/site.

The expectation is that users will have identified ECM opportunities prior to using this tool; ideally through energy audits and subsequent ECM analysis by Project Co or Authority appointed specialists. Simplistic desktop analysis of potential ECM savings may also be used as an initial appraisal; understanding that the accuracy of outcomes will be dependent on the accuracy of savings calculations.

Up to nine ECMs may be 'input' with the user completing all yellow cells associated with each ECM.

1 Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal - GOV.UK (www.gov.uk)

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Figure 3:
ECM Categorisation

PPP/PFI/hub DBFM/NPD

ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGY WHOLE LIFE OUTCOME TOOL

Energy Conservation Measure (ECM) Input Data

Energy Conservation Measure (ECM) Categorisation

Ref No.	Description	Category	ECM type
1	Replacement of lighting throughout with LED lighting	LED_lighting	Compact Fluorescent to LED including new fitting
2	Pipework insulation	Insulation_pipework	Heating pipework insulation (internal)
3	Replace pumps	Motor_controls	Variable speed drives
4	Solar PV Installation	Renewable_energy	Solar PV
5	BEMS Software Upgrades	Building_management_systems	BEMS - remotely managed
6	Boiler Upgrade	Boilers	Boilers - replacement modular
7	Elec supply optimisation	Voltage_management	Voltage management - variable ratio
8			
9			
TOTAL			

Figure 4:
Existing Assets Categorisation

Existing Assets

Replacement of asset?	Replaced Asset Category	Replaced Asset Sub-Category	Asset	Replaced Asset Reference Service Life
Yes	Elec_Plant	Lighting	Compact Fluorescent	20
Yes	Mech_plant	HW_Installation	Hot water pipework	20
Yes	Mech_plant	HW_Installation	Distribution Pumps	15
No				-
No	Mech_plant	Building_Controls	Building Management	-
Yes	USER ADDED			15
No				-
				-
				-

1.5.1 Energy Conservation Measure Categorisation

A written description of each ECM should be provided by the user under the cells bounded red in Figure 3.

As a general rule, where a yellow/input cell has a drop down list, and the user requires to reset that cell or cells back to a 'blank' cell, users are required to apply the keyboard 'Delete' key to reset the required cell back to "blank".

The 'ECM Category' and 'ECM type', under the cells bounded green in Figure 3 respectively use data lists for inputs. These columns utilise the Salix Finance[2] referencing of ECMs, which enables lookup functions for persistence factors of such technologies[3]. A user is expected to best match their ECM opportunity with these pre-selected categories and measure types.

2 Salix Finance
3 Tech List - Apr19 Client Version_0.pdf (salixfinance.co.uk)

Appendix 2 (continued)

Figure 5:
User Added

Existing Assets				
Replacement of asset?	Replaced Asset Category	Replaced Asset Sub-Category	Asset	Replaced Asset Reference Service Life
Yes	Elec_Plant	Lighting	Compact Fluorescent	20
Yes	Mech_plant	HW_Installation	Hot water pipework	20
Yes	Mech_plant	HW_Installation	Distribution Pumps	15
No				-
No	Mech_plant	Building_Controls	Building Management	-
Yes	USER ADDED			15
No				-
				-
				-

1.5.2 Existing Assets Categorisation

The input sheet asks users to identify where an ECM may replace an existing asset.

Where this is the case, the 'Replacement of Asset?' column should be identified to the affirmative. The relevant drop-down lists in the cells bounded in red in Figure 4 should be used to identify the replaced asset.

In choosing the replaced asset, the sheet will automatically look up the identified asset's Reference Service Life from the CIBSE Guide M (Maintenance Engineering and Management) for comparison.

Existing assets are split in to five main categories:

- 'Elec Plant' – Being electricity based building services assets such as lighting, power installations and electricity generating renewable technologies;
- 'Mech Plant' – Being mechanical based building services assets such as heating, ventilation and cooling (HVAC) plant and controls and domestic hot water systems;
- 'FF&E' – Being specialist equipment relevant to the building's operation and energy consumption (including catering);
- 'Building Fabric' – Being building fabric related assets such as windows, insulation and draught proofing; and
- 'USER ADDED'

It is noted that the last option is 'USER ADDED' and it is this drop down that should be used where an existing asset cannot be found from the database (for example specialist equipment such as swimming pool covers). In this scenario, a user should engage with the Project Co to identify the Reference Service Life of the asset, or otherwise consult CIBSE Guide M itself. Under 'USER ADDED' no 'Asset Sub-Category' or 'Asset' drop downs are required. A user is expected to simply input the Reference Service Life into the overwritable cells in green, an example is highlighted in Figure 5 below.

Where an ECM is the provision of a new asset(s) and is not replacing existing plant, fabric or equipment, no inputs are required under this section.

Appendix 2 (continued)

Figure 6:
ECM Costs

ECM Cost			
No. units	Unit Rate	Cost per unit	Total Project Cost
			£
4450	Unit Rate	£89	£396,050
500	Unit Rate	£14	£7,000
4	Unit Rate	£960	£3,840
1	Total	£20,000	£20,000
1	Total	£8,000	£8,000
1	Total	£15,000	£15,000
1	Total	£5,000	£5,000
			£0
			£0

1.5.3 ECM Costs

ECM capital costs should be input by the user in line with the direction of the yellow cells.

Where units and unit rates for ECMs are known, these should be individually input e.g. number of luminaires and luminaire costs for lighting replacements. Rates may include use of area weighted metrics i.e. £/m2 for Gross Internal Floor Area or extent of building fabric replacement such as glazing.

Where only a single 'lump sum' cost is known, this may be entered by a single unit and unit cost.

Ultimately a single capital cost under the 'Total Project Cost' should be achieved.

As a note, all costs (including use of unit and rates) should be inclusive of all fees, such as design works and management charges.

It is recommended that specialists should be involved in identifying, or at least 'sense checking', the expected costs for a given ECM.

1.5.4 ECM Savings

The ECM Savings are an important part of the tool, and rely on users identifying the utilities impact of implementing an ECM.

Figure 7:
ECM Savings

ECM Savings													
Electricity		Gas		Fuel oil		Burning oil							
Annual Savings		Annual Savings		Annual Savings		Annual Savings		Annual Saving		Simple Payback	SALIX PF	Total Lifetime CO2	£/Lifetime. Tonne of CO_2
%	kWh	%	kWh	%	kWh	%	kWh	£	T.CO2	Years	Years	T.CO2	
12.00 %	102764	-	0	-	0	-	0	£16,877	22	23.5	25.00	546	726
2.00 %	17127	-	0	-	0	-	0	£2,813	4	2.5	22.50	82	86
2.00 %	17127	-	0	-	0	-	0	£2,813	4	1.4	10.26	37	103
11.00 %	94201	-	0	-	0	-	0	£15,470	20	1.3	22.50	450	44
-	0	10.00 %	711881	-	0	-	0	£17,797	131	0.4	8.42	1102	7
	0	18.00 %	1281386	-	0	-	0	£32,035	236	0.5	10.83	2551	6
5.00 %	42819	-	0	-	0	-	0	£7,032	9	0.7	19.00	173	29
	0	-	0	-	0	-	0	£0	-	0.0	0.00	0	0
	0	-	0	-	0	-	0	£0	-	0.0	0.00	0	0
	274,039		1,993,267		-		-	94,836	425	5		4,941	92

Appendix 2 (continued)

Figure 8:
ECM Options Lifecycle Appraisal

PPP/PFI/hub DBFM/NPD
ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGY WHOLE LIFE OUTCOME TOOL
ECM Lifecycle Data

SCOTTISH FUTURES TRUST

Date 01/04/2022
Revision P1

	Category	Category	Category	System	Quantity	Unit	Unit Cost	Capex	Frequencies: Year Installed	Persistence Factor (Rounded)	Actual Quantity each event	Cost each event
46	1	ECM	LED_lighting	Compact Fluorescent to LED including new fitting	4,450	Unit Rate	£89.00	£396,050.00	18	25	100.0%	£396,050.00
47		Replacement	Lighting	Compact Fluorescent				£0.00	0	20	100.0%	£0.00
49	2	ECM	Insulation_pipework	Heating pipework insulation (internal)	500	Unit Rate	£14.00	£7,000.00	18	23	100.0%	£7,000.00
50		Replacement	HW_Installation	Hot water pipework insulation				£0.00	0	20	100.0%	£0.00
52	3	ECM	Motor_controls	Variable speed drives	4	Unit Rate	£960.00	£3,840.00	18	11	100.0%	£3,840.00
53		Replacement	HW_Installation	Distribution Pumps				£1,920.00	0	15	100.0%	£1,920.00
55	4	ECM	Renewable_energy	Solar PV	1	Total	£20,000.00	£20,000.00	18	23	100.0%	£20,000.00
56		Replacement	0	0				£0.00	0	0	100.0%	£0.00
58	5	ECM	Building_management_systems	BEMS - remotely managed	1	Total	£8,000.00	£8,000.00	18	9	100.0%	£8,000.00
59		Replacement	0	0				£0.00	0	0	100.0%	£0.00
61	6	ECM	Boilers	Boilers - replacement modular	1	Total	£15,000.00	£15,000.00	18	11	100.0%	£15,000.00
62		Replacement	0	0				£0.00	0	15	100.0%	£0.00
64	7	ECM	Voltage_management	Voltage management - variable ratio	1	Total	£5,000.00	£5,000.00	18	19	100.0%	£5,000.00
65		Replacement	0	0				£0.00	0	15	100.0%	£0.00
67	8	ECM	0	0	0	0	£0.00	£0.00		0	100.0%	£0.00
68		Replacement	0	0				£0.00		0	100.0%	£0.00
70	9	ECM	0	0	0	0	£0.00	£0.00		0	100.0%	£0.00
71		Replacement	0	0				£0.00		0	100.0%	£0.00
73				Total								£0.00
75												TOTAL

The input sheet allows the impact to be identified by predicted '%' change in affected utilities on implementing each ECM.

It is recommended that specialists should be involved in identifying, or at least 'sense checking' the impact of the savings for a given ECM, as it is these values which will forecast emissions and costs savings.

Savings %s may be input negatively where there is an anticipated increase in utilities consumption e.g. where a heat pump replaces a gas boiler, gas consumption will reduce, however, electrical consumption will rise.

kWh savings by fuel type are automatically calculated based on % savings. Where kWh savings have been identified in place of % savings, the kWh savings values may be hard input into these columns as the 'green' cells are overwritable.

The tab will automatically identify the energy costs and emissions savings of ECMs, based on the yellow cell input data.

1.5.6 Interaction Effects

It is expected that some ECMs will have an interactive effect on one another e.g. the benefits of Voltage Optimisation would be drastically reduced where a project also seeks to replace existing fluorescent lighting with LEDs. Similarly gas optimisers on boilers will not generate savings if gas boiler replacement through the introduction of heat pumps is proposed.

The tool does not automatically calculate interaction effects and will rely on sense checking of outcomes by the user and their specialists.

The tool does limit the total utilities saving to the extent of 'baseline' performance however e.g. five measures at 25% electrical saving will not create a negative electrical consumption forecast.

1.6 ECM Options Lifecycle Tab

This tab provides the necessary information to inform the Lifecycle impact of implementing each ECM, assessing the Lifecycle costs of replacing the ECM and any replacement assets for the remainder of the Concession Period.

1.6.1 New ECM Impact

The tab automates the expected future Lifecycle cost of replacing new ECMs based on their Persistence Factor and the remaining Concession Period of the project.

A user should identify the year that each ECM is planned to be installed under the 'Year Installed' column and may also identify the total percentage cost impact of future replacement under the 'Actual Quantity each event' column. A default Lifecycle cost

Appendix 2 (continued)

Figure 9:
New ECM Impact

Frequencies			
Year Installed	Persistence Factor (Rounded)	Actual Quantity each event	Cost each event
18	25	100.0%	£396,050.00
0	20	100.0%	£222,500.00
18	23	100.0%	£7,000.00
0	0	100.0%	£0.00
18	11	100.0%	£3,840.00
0	15	100.0%	£1,920.00

Figure 11:
Replacement Asset Impact

Quantity	Unit	Unit Cost
4,450	Unit Rate	£89.00
4,450	Unit Rate	£50.00
500	Unit Rate	£14.00
4	Unit Rate	£960.00
4	Unit Rate	£550.00
1	Total	£20,000.00

Figure 10:
Replacement Asset Impact

Category	Category	Category	System
1	ECM	LED_lighting	Compact Fluorescent to LED including new fitting
	Replacement	Lighting	Compact Fluorescent
2	ECM	Insulation_pipework	Heating pipework insulation (internal)
	Replacement	HW_Installation	Hot water pipework insulation
3	ECM	Motor_controls	Variable speed drives
	Replacement	HW_Installation	Distribution Pumps
4	ECM	Renewable_energy	Solar PV
	Replacement	0	0

replacement of 100% (the original capital cost of installing the asset) is otherwise used for each Lifecycle event.

1.6.2 Replacement Asset Impact

Where no replacement asset under an ECM is identified, the relevant 'Replacement' data for each ECM may be left blank.

Where an asset is to be removed/replaced it will be for a user to engage with the project's Lifecycle model to assess the age and Lifecycle plans for each replaced asset alongside any identified budget. This will require close working the Project Co to complete each yellow cell relevant to the project's progress to date under the Lifecycle operations.

Where access to Lifecycle plan information is not possible, the inputs will require a user to estimate the cost of replacing each replacement asset under the 'Quantity', 'Unit' and 'Unit Cost' columns.

The sheet will, however, default to a year 0 install (i.e. no replacement since Operational Commencement) under the 'Year Installed column', and will make an assumption on the required year of replacement based on the Reference Service Life of the asset which is automatically looked up from the ECM Options Data tab (carried through to the 'Persistence Factor (Rounded)' column.

For the avoidance of doubt, the inclusion of 'Replacement Asset' lifecycle costs in the model will assume that, in replacement with a new ECM, these costs will be given as a saving to the Authority. This assumption will need to be discussed/agreed with the Project Co as part of ECM appraisals.

1.7 Dashboard Tab

This tab enables a user to select the ECM opportunities identified in the ECM Options Data tab for inclusion in assessment of three options, A-C.

Appendix 2 (continued)

Figure 13:
Dashboard Options

PPP/PFI/hub DBFM/NPD

ENERGY EFFICIENCY AND RENEWABLE TECHNOLOGY WHOLE LIFE OUTCOME TOOL

Dashboard

Date Revision

	ECM	Option A	Option B	Option C
1	Replacement of lighting throughout with LED lighting	x	x	x
2	Pipework insulation	x	x	
3	Replace pumps	x	x	x
4	Solar PV Installation	x	x	x
5	BEMS Software Upgrades	x	x	x
6	Boiler Upgrade	x	x	
7	Elec supply optimisation	x	x	
8	-			
9	-			

Funding Options		Option A	Option B	Option C
Finance or Capital?		Capital	Finance	Capital
Finance Interest Rate (%)		-	4.50 %	-
Finance Term (years)		0.0	21.0	0.0

On selecting ECMs for each option, through use of an 'X' against each respective measure, commercial and emissions outcomes for each option for the remainder of the Concession Period will be automatically updated and presented under the Dashboard tables and graphics.

A user may choose to identify how the ECM investment may be financed, either through 'capital' or 'finance' as a drop down under row '20' for each Option.

Under 'Finance', a user can input variable finance interest rates and financing terms. This function allows a variable output for selected options based on the financing route, and can allow comparison of outputs for the same selections under differing finance arrangements.

It is re-iterated that the analysis is limited to present outcomes up to the end of the Concession Period and thus longer-term savings benefits are not forecast as part of the tool's outputs.

Detailed year by year forecasts of the impacts of the ECM option selections under the Dashboard tab can be found in the individual Options outcomes tabs, discussed below.

1.8 Options A – C Outcomes

The outcomes tabs for Options A – C are for user information only. No data inputs are required, noting that the source information for the forecasting is all automated from other tabs in the workbook.

The purpose of the outcomes tabs is to show the forecast cost and savings under each future year of the Concession Period for more elemental analytics of ECM investment outcomes.

Supporting graphs are also included to compare the various outcomes of each chosen option.

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Figure 14:
Options A - C Outcomes

Remainder of Concession Period Outcomes Analysis:				
Remaining Concession Commercial Appraisal	Business As Usual	Option A	Option B	Option C
Capital Costs (£)	-	454,890	-	427,890
Loan Repayment Costs (£)	-	-	703,976	-
Utilities Costs (£)	6,069,611	4,271,656	4,271,656	5,093,408
Lifecycle Cost Differential (£)	-	(224,700)	(224,700)	(224,700)
Carbon Offset Costs (£)	2,453,198	1,760,114	1,760,114	2,184,671
BAU Saving (£)	-	2,260,850	2,011,764	1,041,541
NPV		1,416,131	1,411,590	589,613
IRR		31 %	31 %	17 %
Lifetime Carbon Costs (£/LT.CO2)		67	67	162

Remaining Concession Emissions	Business As Usual	Option A	Option B	Option C
Emissions (t.CO2)	23,921	17,156	17,156	21,278
BAU Saving (t.CO2)	-	6,765	6,765	2,643

Figure 15:
Typical Output Dashboard