Design led Whole Life Costing Tool

User Manual

Created for: Resource Efficient Scotland

Prepared by: Emma Hutchinson of GEP Environmental Ltd

Growth that doesn't cost the earth

A programme from ZERO WASTE SCOTLAND

Contents

Disclaimer

IMPORTANT NOTICE IN RELATION TO THE LIABILITY OF ZWS IN RESPECT OF THIS TOOL

This Tool has been prepared by or on behalf of Zero Waste Scotland Limited ("Zero Waste Scotland") and is provided for general information purposes only by users ("Recipients").

Whilst reasonable steps have been taken by Zero Waste Scotland to procure that the content and information contained in this Tool is correct in all material respects, such content and information may be incomplete, inaccurate and/or out of date. Accordingly, reliance should not be placed on this Tool by the Recipient (or any other person) and the Recipient is recommended to seek its own advice in connection with the purposes for which it intends to use the Tool.

The entire liability of Zero Waste Scotland to the Recipient in respect of any loss or damage arising from or in connection with this Tool (including any negligence and any delictual act or omission in respect of it) shall in no event exceed the greater of (a) the amount paid (if any) by the Recipient to Zero Waste Scotland specifically for the preparation of this Tool and (b) £500. ZWS shall not be liable in respect of (a) any loss of profits, damage to goodwill, loss of business, loss of revenue, loss of contracts, loss of anticipated savings or increased costs or expenses or (b) any type of special, indirect or consequential loss or damage howsoever caused. No warranties, representations, guarantees or undertakings are given in respect of this Tool and all warranties, conditions or other terms implied by statute or common law are excluded to the fullest extent permitted by law.

Nothing presented within this Tool is intended to be or should be interpreted as an endorsement or recommendation of any supplier, service or product.

Notwithstanding any of the above, the liability of Zero Waste Scotland to the Recipient for any death or personal injury caused by negligence, for fraudulent misrepresentation or for any other matter for which liability cannot be limited or excluded by law shall not be limited or excluded in any way.

1 Introduction

1.1 The Resource Efficient Scotland Whole Life Costing Tool

To help organisations in Scotland create a more resource efficient and sustainable built environment, Zero Waste Scotland's Resource Efficient Scotland programme commissioned the development of a spreadsheet tool to assist in the evaluation of whole life costs (WLC) in response to stakeholder demand. The spreadsheet is provided unlocked and therefore fully adaptable and easily tailored for different projects and applications.

1.2 What is whole life costing?

It is an analysis method that allows the economic appraisal and comparison of alternative solutions to a particular requirement or problem, so that more informed and better decisions can be made. The analysis must be based upon the alternatives providing the same functionality i.e. levels of cooling to create the necessary internal environment.

Whole life costing refers to the total cost of ownership over the life of an asset. In the case of the built environment, it is normally used to refer to the total costs and benefits of ownership of a building over its design life. It is also adaptable enough to evaluate the total cost of ownership of a discrete element of a building such as the roof.

Whole life costing takes into consideration initial capital costs, finance costs as well as future costs including all operational costs, such as rent, rates, cleaning, inspection, maintenance, repair, replacements, renewals, energy and utilities, carbon, dismantling, disposal, security and management over the life of the built asset. The operation, maintenance and end of life costs will often exceed the initial capital costs by a factor of 5.

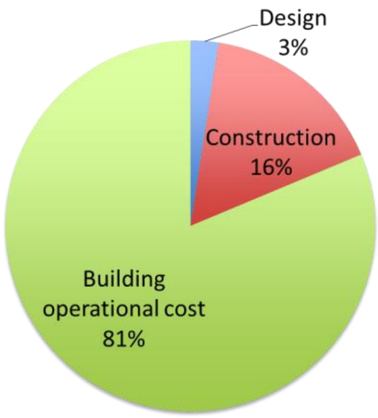


Figure 1: Relationship between initial capital costs and operational costs

The timing of future costs must be taken into account in the comparison of options. Future cost flows are discounted by a rate that relates present and future money values - which may include an allowance for inflationary changes.

Opportunity costs represent the cost of not having the money available for alternative investments (which would earn money) or the interest payable on loans to finance work.

These costs are totalled and discounted using discounted cashflow analysis. This uses the concept of present value that can be described as the current worth of a future sum of money or stream of cash flows given a specified rate of return.

Two financial measures are normally used to evaluate the whole life costs:

- Net Present Value (NPV): NPV is defined as the sum of the present values (PVs) of incoming and outgoing cash flows over a period of time.
- Internal Rate of Return (IRR): The discount rate that reduces to zero the net present value of a stream of incoming and outgoing cashflows over a period of time, usually the lifetime of the project.

1.3 Why carry out whole life costing?

Private and Public sector organisations are encouraged, and in some cases required, to improve their sustainability and carbon emission performance through a number of compliance measures such as CRC, carbon management plans, corporate social responsibility requirements, etc. Whole life costing is an ideal method of ensuring an improvement in sustainable building performance and resource efficiency.

Too many designs are influenced on the basis of short term capital financial outlays and do not consider the longer term operation of the building. Value for money can only be achieved if the costs associated with the life of the product are considered.

Undertaking a design led WLC exercise allows resource efficiency to be appropriately considered during the assessment of the true cost of designing, constructing and operating a building/works. WLC factors in the costs associated with running the building for its expected life time and enables designers to test different design choices to determine the impact on building construction and operating costs.

For example, a design team may be considering using either a steel structure with high levels of glazing or a timber frame structure with low levels of glazing for an office building. Whole life costing will allow the factoring of the different costs of these options to determine the most appropriate resource efficient investment option. In this scenario, the option with high levels of glazing is likely to have higher running costs due to the increased cooling requirements.

Another use of whole life costing is to help assess the value engineering decisions. Value engineering processes frequently involve the substitution of materials or equipment that are supposedly like for like and unfortunately reduce the sustainability of a construction project. Using whole life costing to evaluate the impact of such substitutions can reveal that whilst capital cost savings are made, the impact of the building's operating costs can be severe.

1.4 What information is needed to carry out whole life costing?

Whole life costing requires the input of good quality, precise and accurate data to obtain valuable numerical results. It needs data about the cost of individual activities and components plus data about the timing of future events e.g. capital equipment replacement costs and dates.

To carry out whole life costing on a new building, both the capital/revenue and operating costs of the building will be analysed. Income streams, such as grants or entrance fees, can also be considered. The operating costs need to cover all aspects of operating a building including:

- Design costs
- Utility costs
- Maintenance costs
- Labour costs
- Replacement costs and expected life of major items of plant or building fabric

Other aspects that can and should be included are:

- Rates
- Information technology costs
- Fixtures, fittings and furnishing replacement costs
- Manufacturing or process equipment costs
- Staff costs

The capital costs can include the cost of each of the main elements of the building, construction costs such as ground works and any associated professional fees.

The other factors that need to be considered before embarking on whole life costing are the financial assumptions that are going to be used for inflation rates, discount rates, utility prices, carbon costs and any renewable energy support mechanisms.

1.5 The Whole Life Costing Tool

1.5.1 Why it has been developed

Whilst there are a number of tools for carrying out whole life costing available, they often do not fully encompass resource use during operation. The ZWS Whole Life Costing Tool incorporates normal whole life costing functionality but also allows energy and water use to be incorporated into the analysis allowing design decisions to be tested and energy supply options to be evaluated.

1.5.2 Who should use it

Whole life costing is used by public sector and private organisations to analyse their investments and the tool is suitable for use by any organisation. Examples of its use are for the construction of a new office building and for an options appraisal for energy supply to a leisure centre.

Accountability and responsibility for completing the whole life costing

The project owner will normally specify the use of the whole life costing tool at the inception of every project and hand the responsibility for undertaking whole life costing to the technical delivery team.

Typically the project manager is accountable for completion of the whole life costing however, the tool will be compiled and used by a combination of the following design team members:

- The project manager (PM)
- The quantity surveyor (QS)
- The M&E engineer (M&E)

Cost data will normally be provided by the QS and performance data by the M&E. The PM should “own” the model and be responsible for ensuring that it is correctly used.

1.5.3 How it should be used

For new builds, the first financial decisions are made at RIBA stage 0, Strategic Definition and the initial whole life costing model should be produced at the outset. Only a high level assessment is required at this stage reflecting capital costs, approximate utility consumption and operating costs. This will ensure that the delivered building will be affordable to run and maybe used to justify the Business Case.

At stages 0 and 1, the model can be used to inform site selection with different sustainable aspects of the sites such as the potential for ground-works material re-use and the availability of renewable resources being evaluated.

Once a site is selected, options for different building orientations and forms can be modelled. At this stage of design an initial thermal model of the building is required to determine the optimal configuration. Where different options are explored, each of these can be evaluated using the whole life costing model using information from the thermal model combined with high level costing assumptions.

Once the project moves on through the project stages, the model is refined and more detail added such as detailed energy balances and the introduction of renewable technologies until the design is finalised.

At the value engineering stage, any substitutions can be evaluated to ensure that they do not have a detrimental impact on building operating costs or resource efficiency.

Finally, the model can be used as part of the post occupancy evaluation, in order to evaluate the financial impact of any differences between design performance and actual performance.

1.5.4 Excel Version

The tool is designed to work in Excel 2010 and 2013.

2 Preparing to use the Tool

2.1 Deciding on the approach

In order to use the tool, decisions will need to be made about the methodology used to evaluate the project. These decisions will cover the scope of the assessment and financial assumptions.

2.1.1 Scope

The model can be used in two ways, either the whole building can be modelled, or a single aspect can be assessed. The second of these options is more appropriate for refurbishments, for example boiler replacement options could be modelled.

In addition, it is possible to only model the costs of the building or to include any income such as grants, operating budgets or gate fees. Including income in the analysis can help evaluate whether the building is affordable.

2.1.2 Financial index rates and discount rates

To assess the impact of differing inflation rates for different elements of the model, you will need to enter in expected inflation rates for:

- Capital costs
- Income
- Operating and maintenance costs
- Staff costs
- Utilities
- Renewable energy tariffs
- CRC costs

These could all be set to a single inflation rate such as the retail price index (RPI) or each could be set individually. Setting them individually allows factors such as fuel costs increasing at a different rate from inflation to be reflected.

The discount rate used will be determined by your organisation's policy. It may be based on the organisation's cost of capital or may be set by management. The difference between the real discount rate and the nominal discount rate is often based on the retail price index (RPI).

Add in the typical public sector discount rate from the treasury book i.e. 3.5% (note correct in February 2015)

2.1.3 Opportunity costs- Real or Nominal

The model is set up to analyse projects on both a real and a nominal basis. The fundamental difference between these two options is that the real analysis ignores the effect of inflation whilst the nominal analysis factors in inflation rates for all costs and income. We would normally recommend that the nominal analysis is used as it allows the potential for utility costs to increase at a greater level than normal inflation to be included.

Consulting with your Finance Manager at an early stage will help to buy commitment to whole life costing and will also provide direction on main financial assumptions.

2.2 Data gathering

Once the scope and main financial assumptions have been made, detailed cost data is gathered for entry into the tool.

2.2.1 Capital costs

For each main element of the building, the capital costs of that element along with its expected life will be required. Consideration will also be required of how its replacement cost at the end of its life will relate to its initial cost. For example, the initial cost of a roof including its supporting structure could be £100,000 and it could have a thirty year life. When it needs replacing in thirty years, the replacement cost may only be 60% of the initial cost as the supporting structure will last for the life of the building and only the roof panels will need replacement.

Capital costs will normally be provided by the QS or public sector in-house design teams. Estimates for the expected life of main elements of the building can be obtained from manufacturers or typical values from CIBSE Guide M: Maintenance Engineering and Management can be used.

2.2.2 Operating costs

The following table shows the information required for the model for each separate major element of the building fabric, services and any renewables:

What you need	What units should it be in	Where will you find it
Annual Maintenance Costs	£/year	From manufacturers and facility managers
Periodic Equipment Replacement Costs and	£/year	From manufacturers and suppliers

Maintenance		
Utility Costs	£/year	Quotes from suppliers, corporate contracts
Staff Costs	£/year	Finance department
Other Costs e.g. rates, IT provision	£/year	From suppliers

2.2.3 Income

Where it is decided to include income streams within the model, up to ten different income streams can be included. It is not possible to vary the income year on year other than by increasing it by inflation.

2.2.4 Energy balance

The energy balance is a very important part of the model. It shows how energy is used in the building and its source. Many design decisions impact on energy use and may result in increased building operating costs.

This can be by increased heat losses through building fabric or increased electricity costs due to low levels of natural light.

In order to create the energy balance you will need to know where the energy will be used in your building. Almost all buildings that are undergoing renovation and all new builds have a statutory requirement to evaluate their energy consumption using either an SBEM model or a dynamic simulation model. These thermal models produce an energy performance certificate for the building that must be submitted as part of the building warrant process. They also produce a Brukl report which details u-values and the air permeability of the buildings. Working out what your net energy use by each element of the buildings can be achieved by one of two methods:

1. Interrogation of the thermal model to determine the required values. Most software packages will produce a report detailing the required information

2. Use the u-values and air permeability from the Brukl report to calculate the energy consumption attributable to those elements.

The data required for creating the energy balance for the model is:

What you need	What units should it be in	Where will you find it
The annual heat losses attributable to the: • Walls • Floor • Roof • Windows and doors	kWh/year	Can be found by: • Interrogating the thermal model • Manual calculation using u-values • Rules of thumb for early stage models
The annual ventilation losses for the building	kWh/year	Can be found by: • Interrogating the thermal model • Manual calculation using air permeability • Rules of thumb for early stage

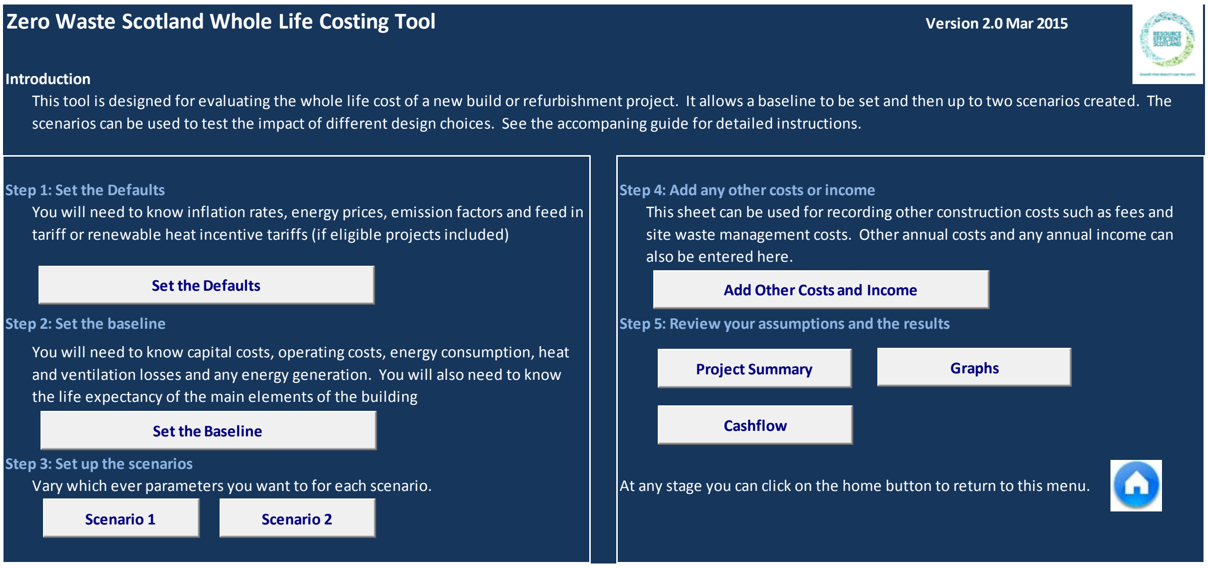
		models
The distribution losses from the heat distribution system	kWh/year	From the M&E engineers
Heat exported	kWh/year	From the M&E engineers
Electricity exported	kWh/year	From the M&E engineers
Solar gains	kWh/year	From the M&E engineers or from the thermal model
Internal gains	kWh/year	From the M&E engineers or from the thermal model
Total heat produced from conventional heat production	kWh/year	From the M&E engineers or from the thermal model
Total fuel required for conventional heat production	kWh/year	From the M&E engineers or from the thermal model
Electricity used for heat production	kWh/year	From the M&E engineers or from the thermal model
Electricity used for DHW production	kWh/year	From the M&E engineers or from the thermal model
Electricity used for cooling	kWh/year	From the M&E engineers or from the thermal model
Electricity used for lighting	kWh/year	From the M&E engineers
Other electricity usage	kWh/year	From the M&E engineers
Water usage	m^3/year	From the M&E engineers
Waste water to sewer	m^3/year	From the M&E engineers
Installed capacity of renewables	kW	From the M&E engineers
Electricity generated from each renewable/CHP	kWh/year	From the M&E engineers
Heat generated from each renewable/CHP	kWh/year	From the M&E engineers
DHW generated from each renewable	kWh/year	From the M&E engineers
Electricity consumed by each renewable/CHP	kWh/year	From the M&E engineers
Renewable fuel consumed	kWh/year	From the M&E engineers

2.2.5 Other Data

Emissions factors will be required in order to calculate the expected carbon emissions and any carbon related costs such as the CRC. These emission factors can be obtained from http://www.ukconversionfactorscarbonsmart.co.uk/ .

3 Using the tool

The home page of the tool allows simple navigation around each section of the tool. Each page of tool has a button to allow you to return back to the home page.



Data should only be entered into the cells shaded yellow [yellow cell].

3.1 Setting the defaults

On first use for a new project, basic information about the project should be added and the main default assumptions entered. The default assumptions include:

- Project dates
- Financial assumptions
- Utility costs
- Feed in tariffs and renewable heat incentive tariffs
- Emission factors

Select the **[Default Assumptions]** tab and enter the project name, version number and the date.

Project Name:	**Test Project**
Version:	**Business Plan Analysis**
Date:	**12/02/2015**

The main dates should then be entered. The **Project Start** is the year that the cashflows will be discounted to and will normally be the current year.

The **Construction Start** is the date that the construction will start. It is assumed that all the construction costs are incurred in the year that construction starts.

Operation Start is the date when the building is handed over and occupied.

Operation Life is the expected life time of the building. This can be up to 100 years.

Dates		
Project Start	01/01/2015	Project will discount to this year
Construction Start	25/04/2015	
Operation Start	01/08/2016	
Operation Life	59	Years

Next the inflation rates should be entered as the annual percentage increase. Different inflation rates can be used for the following costs and incomes:

- **Capital Costs**
- **Income**
- **Operating and Maintenance Costs**
- **Staff Costs**
- **Utilities**
- **Tariffs**
- **CRC Costs**

The **Real discount rate** and **Nominal discount rate** should also be entered.

Inflation Rates & Discount Rates		Notes
Base Inflation Rate	2.5%	
Capital Costs	2.5%	
Income	2.5%	
Operating & Maintenance Costs	2.5%	
Staff Costs	2.5%	
Utilities	6.0%	
RHI/FiT Tariffs	2.5%	
CRC Costs	2.5%	
Real discount rate	3.5%	
Nominal discount rate	6.0%	

Next the emission factors are entered. Energy emissions factors should be entered in $kgCO_2/kWh$ and water emissions factors should be entered in $kgCO_2/m^3$.

Emission Factors		Notes
Heating Fuel	0.1845574	$kgCO_{2e}/kWh$ Defra 2014
Electricity	0.5331000	$kgCO_{2e}/kWh$ Defra 2014
Biomass	0.0118383	$kgCO_{2e}/kWh$ Defra 2014
Water	0.3441000	$kgCO_2/m^3$ Defra 2014
Waste Water	0.7085000	$kgCO_2/m^3$ Defra 2014

If any renewables are used that may be eligible for the renewable heat incentive or the feed in tariff, the appropriate tariff should be used. These can be found on the Ofgem website https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/tariffs-apply-non-domestic-rhi-great-britain and https://www.ofgem.gov.uk/environmental-programmes/feed-tariff-fit-scheme/tariff-tables . It should be noted that these differ depending on the installed capacity and are revised regularly dependent on take up.

Tariffs can be entered for:

- **Biomass**
- **Solar Thermal**
- **Heat Pumps**
- **Wind or Hydro**
- **PhotoVoltaics (PV)**

RHI Tariffs	Tariff 1	Tariff 2	Notes
Biomass	£ 0.06800	£ 0.01800	
Solar Thermal	£ 0.10000	£ 0.10000	
Heat Pump	£ 0.08700	£ 0.02600	

FiT Tariffs	Tariff	Notes
Wind or Hydro	£ 0.16000	
PV	£ 0.11710	

Tariffs for each utility used or produced can be entered. This includes for any biomass fuel used. It is recommended that the notes field is used to record the fuel type where appropriate.

The following fuel types can be entered:

- **Electricity Import (£/kWh)**
- **Heating Fuel (£/kWh)**
- **Renewable Fuel (£/kWh)**
- **Heat Export (£/kWh)**
- **Electricity Export (£/kWh)**
- **Water Import (£/m^3)**
- **Waste Water (£/m^3)**

Utility Costs	Tariff	Notes
Electricity Import £/kWh	£ 0.10350	
Heating Fuel £/kWh	£ 0.04000	Natural Gas
Renewable Fuel £/kWh	£ 0.04375	Biomass Wood Chip
Heat Export £/kWh	£ 0.02000	
Electricity Export £/kWh	£ 0.08000	
Water Import £/m^3	£ 1.00000	
Waste Water £/m^3	£ 0.80000	

Finally a CRC cost should be entered. If your organisation is not a CRC participant, this should be set to zero. The cost will depend on whether your organisation chooses to buy its carbon allowances in the forecast sale or the buy to comply sale.

Other Costs	Tariff	Notes
CRC Cost	£ 15.60000	

3.2 Setting the baseline

The baseline represents the base case assumptions for the model at each stage of the project. It will change as the design of the project forms and as decisions are made.

3.2.1 Structure and Fabric

The Structure and Fabric data entry is divided into six sections:

- **Substructure, Flooring**
- **Roof**
- **External Walls**
- **Windows and External Doors**
- **Internal Walls, Partitions and Doors**
- **Frame**

For each section, the **Capital Cost**, **Life** expectancy, **Annual Maintenance** cost and a **Replacement Cost Multiplier** is required. For the first four of these, the **Heating Losses**

Attributable in kWh/year will also be required. Finally it is possible to assign a **Maintenance Schedule** (A to H) to each section (see section 3.4 below).

Assumptions						
Structure & Fabric	Substructure, Flooring	Roof	External Walls	Windows & External Doors	Internal Walls, Partitions and Doors	Frame
Capital Cost	£30,000	£75,000	£25,000	£15,000	£10,000	£60,000
Life (years)	60	25	60	15	30	60
Annual Maintenance	£0	£0	£0	£1,000	£0	£0
Maintenance Schedule	0	0	0	A	0	0
Heating Losses Attributable kWh	100,000	300,000	250,000	35,000		
Replacement Cost Multiplier	1	0.5	1	1	0.5	1

3.2.2 Building Services

The building services should then be inputted and these have been divided into six sections each of which will require a **Capital Cost**, **Life** expectancy, **Annual Maintenance** cost, a **Maintenance Schedule** (if required) and a **Replacement Cost Multiplier**. Each one also requires information on its impact on the energy balance as follows:

- Conventional Heat Production (e.g. boilers or storage heaters)
  - **Electricity Consumption** (kWh/year) and/or;
  - **Heating Fuel Consumption** (kWh/year)
    - For HVAC
    - For Domestic Hot Water (DHW)
  - **Heat supplied from electricity** (kWh/year)
  - **Heat supplied from heating fuel** (kWh/year)
- Ventilation and Distribution Losses (e.g. plant room losses, distribution pipework losses)
  - **Electricity consumption** (e.g. distribution pump electricity usage)
  - **Heating demand/losses** (kWh/year) (e.g. heat losses from distribution pipework and losses due to ventilation)
- Cooling (e.g. split unit energy consumption, cooling to AHU)
  - **Electricity consumption** (kWh/year)
    - Electricity consumption for cooling
    - Electricity for ventilation and air handling units
    - Electricity used by heat pumps not classified as renewable
  - **Cooling demand/losses (kWh/year)**
    - Cooling requirement
    - Losses from distribution pipework
  - **Free Cooling** (kWh/year)
- Lighting
  - **Electricity consumption** (kWh/year)
- DHW Production (kWh/year)
  - **Electricity consumption** (e.g. point of use water heating)
  - **Heating fuel consumption** (e.g. direct gas fired water heater)
  - **Heating demand/losses** (e.g. standing losses from calorifier)
  - Any heating fuel consumption can be included in the Conventional Heat Production Column if it is supplied from the boiler or can be entered in the heating fuel consumption cell in the DHW Production column
  - Heat supplied from electricity (kWh/year) (the demand for DHW from electrical sources)
  - Heat supplied from heating fuel (kWh/year) (the demand for DHW from heating fuel sources)
- Other

- This can be used to enter any energy demand or supply that is not included in the first five sections. It can include:
  - **Electricity consumption** (kWh/year)
  - **Heating fuel consumption** (kWh/year)
  - **Heating Demand Losses** (kWh/year)
  - **Solar Heat Gains** (kWh/year)
  - **Internal Heat Gains** (kWh/year)
  - **Heat Export** (kWh/year)
  - **Electricity Export** (kWh/year)

- **Water Usage** (m3) and **Waste Water to Sewer** (m3) can also be entered in this section

Services	Conventional Heat Production	Ventilation & Distribution Losses	Cooling	Lighting	DHW Production	Other
Capital Cost						
Life (years)						
Annual Maintenance						
Maintenance Schedule						
Electricity Consumption kWh						
Heating Fuel Consumption kWh						
Heating Demand/Losses kWh						
Cooling Demand/Losses kWh						
Solar Heat Gains/free cooling kWh						
Internal Heat Gains kWh						
Heat supplied from electricity kWh						
Heat supplied from heating fuel kWh						
Heat Export kWh						
Electricity Export kWh						
Water Usage m3						
Waste water to sewer m3						
Replacement Cost Multiplier						

3.2.3 Renewables

Renewable technologies can be entered and modelled:

- **Wind or Hydro (not both)**
- **Solar PV**
- **Biomass**
- **Heat Pump**
- **Solar Thermal**
- **CHP**

Each of these will require a **Capital Cost**, **Life** expectancy, **Annual Maintenance** cost, a **Maintenance Schedule** (if required) and a **Replacement Cost Multiplier.** They also require an **Installed Capacity** in kW. Wind & Hydro and Solar PV require **Electricity Consumed** (if any) and **Electricity Generated** to be entered in kWh/year.

Biomass, Heat Pumps and Solar Thermal require **Electricity Consumed** (if any), **Heat Generated** and **DHW Generated** to be entered in kWh/year. Biomass also needs **Renewable Fuel Consumed** to be added in kWh/year. **Fossil Fuel Consumed** can be added in kWh/year for the heat pump option (for gas fired heat pumps).

The CHP requires **Heating Fuel Consumed**, **Electricity Generated**, **Heat Generated** and **DHW Generated** to be entered. **Electricity Consumed** can also be used if required for any self-consumption by the CHP (referred to as parasitic losses, for a gas turbine this is the gas compressor).

Renewables	Wind & Hydro	Solar PV	Biomass	Heat Pump	Solar Thermal	CHP
Capital Cost						
Life (years)						
Annual Maintenance						
Maintenance Schedule						
Installed Capacity kW						
Electricity Consumed kWh						
Electricity Generated kWh						
Fossil Fuel Consumed kWh						
Heat Generated kWh						
DHW Generated kWh						
Renewable Fuel Consumed kWh						
Replacement Cost Multiplier						

3.3 Other Costs and Income

This page allows one off and recurring costs to be entered. Each section allows ten different categories to be added. The following sections are included:

- **One off Construction Costs:** for non-repeating costs such as ground-works and Site Waste Management plans

One off Construction Costs	Baseline	Scenario 1	Scenario 2
Groundworks	£50,000	£50,000	£50,000
Site Waste Management Plan	£5,000	£5,000	£5,000
Category 3	£0	£0	£0
Category 4	£0	£0	£0
Category 5	£0	£0	£0
Category 6	£0	£0	£0
Category 7	£0	£0	£0
Category 8	£0	£0	£0
Category 9	£0	£0	£0
Category 10	£0	£0	£0
Total	£55,000	£55,000	£55,000

- **Annual Operating Costs:** for annually repeating operating costs such as IT costs or security systems

Annual Operating Costs	Baseline	Scenario 1	Scenario 2
Catering Provision	£30,000	£30,000	£30,000
IT Provision	£7,000	£7,000	£7,000
Category 3	£0	£0	£0
Category 4	£0	£0	£0
Category 5	£0	£0	£0
Category 6	£0	£0	£0
Category 7	£0	£0	£0
Category 8	£0	£0	£0
Category 9	£0	£0	£0
Category 10	£0	£0	£0
Total	£37,000	£37,000	£37,000

- **Annual Staff Costs:** for annually repeating staff costs

Annual Staff Costs	Baseline	Scenario 1	Scenario 2
Operations Staff	£40,000	£40,000	£40,000
Maintenance Staff	£20,000	£20,000	£20,000
Category 3	£0	£0	£0
Category 4	£0	£0	£0
Category 5	£0	£0	£0
Category 6	£0	£0	£0
Category 7	£0	£0	£0
Category 8	£0	£0	£0
Category 9	£0	£0	£0
Category 10	£0	£0	£0
Total	£60,000	£60,000	£60,000

- **Annual Income Streams:** for annually repeating income such as gate fees or an operating budget.

Annual Income Streams	Baseline	Scenario 1	Scenario 2
Grant	£200,000	£200,000	£200,000
Gate Fee	£100,000	£100,000	£100,000
Category 3	£0	£0	£0
Category 4	£0	£0	£0
Category 5	£0	£0	£0
Category 6	£0	£0	£0
Category 7	£0	£0	£0
Category 8	£0	£0	£0
Category 9	£0	£0	£0
Category 10	£0	£0	£0
Total	£300,000	£300,000	£300,000

- **End of Life Costs/Income:** for any income or costs associated with disposal of building.

End of Life Costs/Income	Baseline	Scenario 1	Scenario 2
Disposal Value			
Deconstruction/Disposal Costs			
Total	£0	£0	£0

3.4 Setting up Maintenance Schedules

Maintenance schedules allow cost profiles to be set up for individual items that require periodic renovation or major parts replacing. Items such as windows requiring painting or part of a heat pump needing replacing should be included. Each maintenance profile (A, B, C, D, E, F, G and H) can then be assigned to a different element of the building, services or renewables. Enter the appropriate costs into the required year. For example, if the windows need painting every ten years at a cost of £10,000 per year, that amount should be entered into year 10, year 20, year 30 etc.

Additional Maintenance Schedules: Services								
Year	A	B	C	D	E	F	G	H
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

3.5 Setting up Scenarios

Once the baseline is set, the data from each table from the **[Baseline]** page can be copied into the scenario pages and varied as required. This can be done by simply clicking on the 'Copy from Baseline' button. For example, the roof construction could be varied resulting in an increased capital cost but decreased heat losses and maintenance costs.

Once the scenarios are set up the results can be compared on the **[Project Summary]** page. The type of NPV analysis (real or nominal) is selected from the yellow drop down box. The table and graphs then summarise the capital cost and NPV for the baseline and two scenarios and the change in capital cost and NPV relative to the baseline.

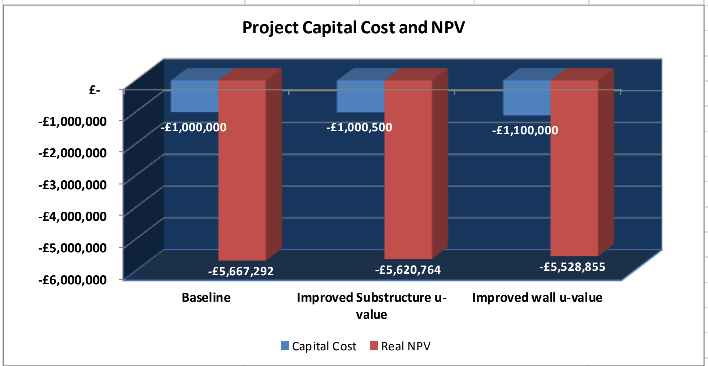
4 Reports

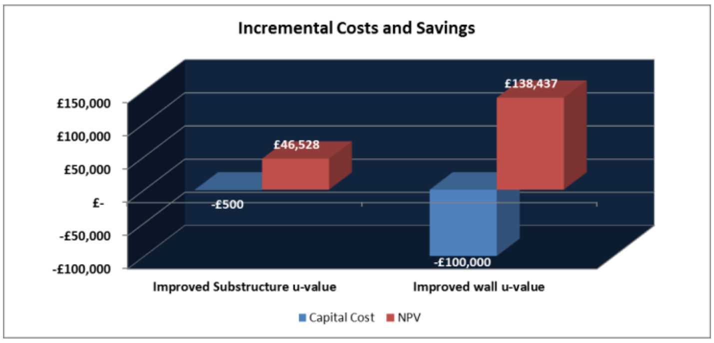
A summary of the project can be printed from the **[Project Summary]** page. This shows the results of the analysis and also shows a summary of the main assumptions for one of the three scenarios.

Project Summary: Test Building
Version: v1
Date: 16-Mar-2015

Results Analysis Type: Real

Scenario	Baseline	Improved Substructure u-value	Improved wall u-value
Capital Cost	-£ 1,000,000	-£ 1,000,500	-£ 1,100,000
Real NPV	-£ 5,667,292	-£ 5,620,764	-£ 5,528,855
Capital Cost Change		-£ 500	-£ 100,000
NPV saving (+ve = saving, -ve = increased cost)		£ 46,528	£ 138,437
Spend to save ratio: Every one pound spent saves		£ 93.06	£ 1.38





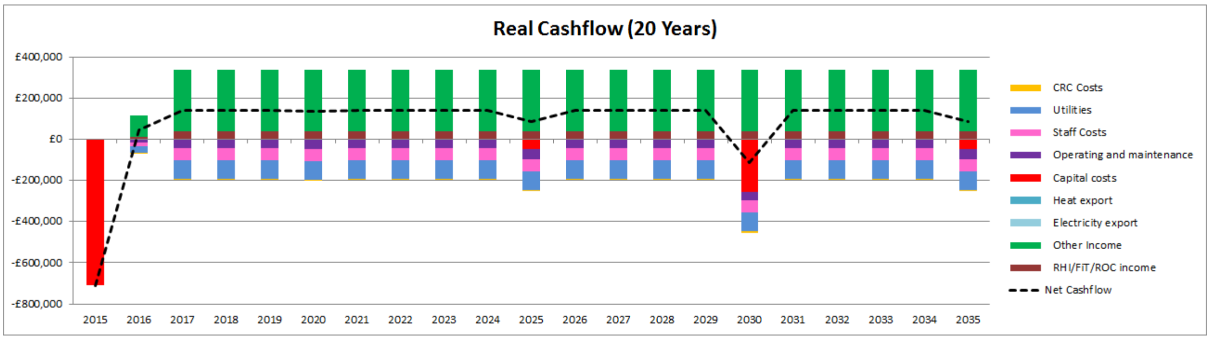
The scenario shown in the assumptions section can be selected using a drop down box coloured yellow.

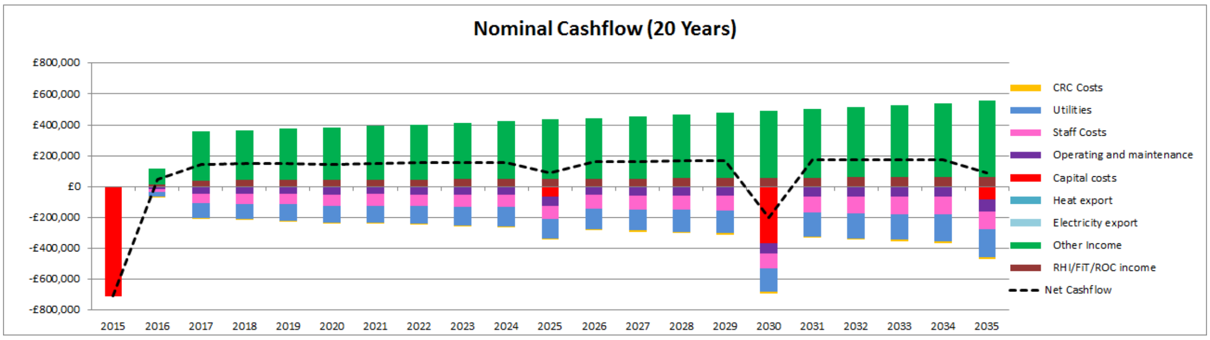
Assumptions (Annual costs and income based on first full year of operation)					
Selected Scenario	Baseline				
Costs and Lifespan					
Building Element	Capital Cost	Lifespan	Annual Income	Annual Maintenance	Maintenance Schedule Used?
Structure and Fabric					
Substructure	£60,000	60		£0	No
Roof	£150,000	25		£0	No
External Walls	£70,000	60		£0	No
Windows & External Doors	£50,000	15		£1,000	Yes
Internal Walls, Partitions and Doors	£30,000	30		£0	No
Frame	£125,000	60		£0	No
Total	£485,000			£1,000	
Services					
Heat Production	£500,000	15		£5,000	No
Distribution Losses	£300,000	15		£2,000	No
Ventilation & Cooling	£200,000	15		£3,000	No
Lighting	£100,000	20		£1,000	No
DHW Production	£50,000	15		£500	No
Other	£50,000	25		£750	No
Total	£1,200,000			£12,250	
Renewables					
Wind & Hydro	£50,000	25	£2,803	£1,000	No
Solar PV	£0	0	£0	£0	No
Biomass	£0	0	£0	£0	No
Heat Pump	£0	0	£0	£0	No
Solar Thermal	£100,000	15	£36,000	£0	No
CHP	£0	0		£0	No
Total	£150,000		£38,803	£1,000	
Other Costs and Income					
Other Capital Costs	£1,055,000				
Other Income & Costs			£830,000	£564,250	
Total	£1,055,000		£830,000	£564,250	
Grand Total	£2,890,000		£868,803	£578,500	

Finally the energy balance for the selected scenario is shown.

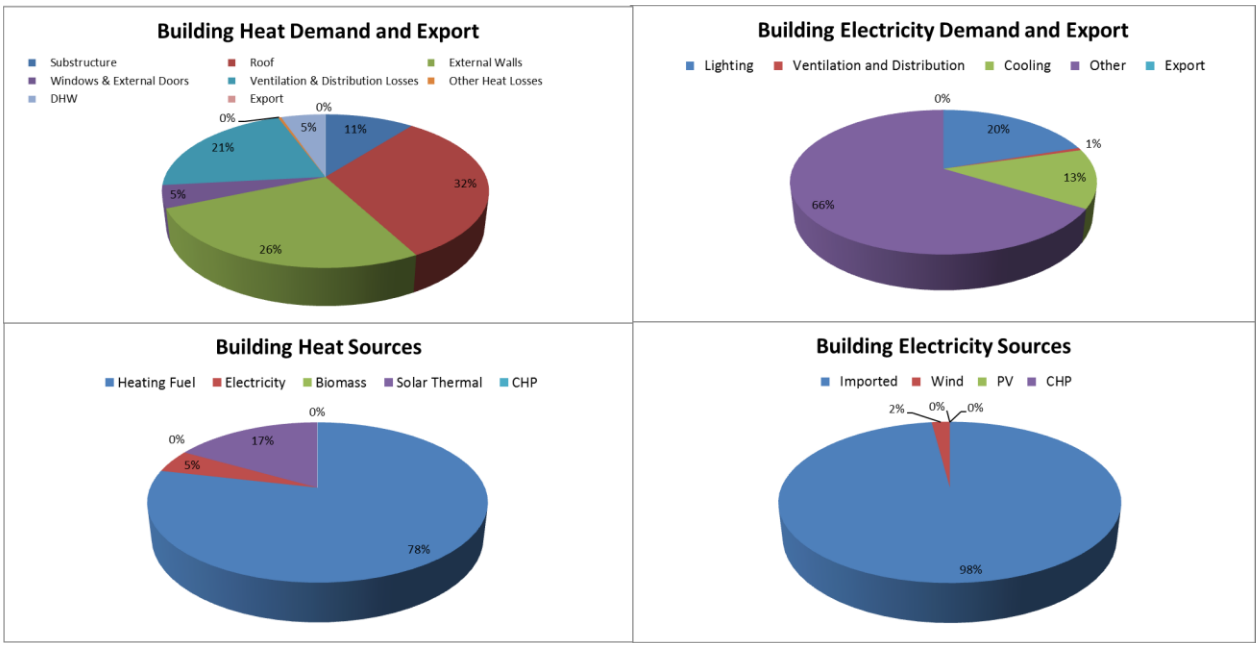
HEAT DEMAND		HEAT INPUT		
Heating & DHW	**kWh**	**Heating & DHW**	**Demand**	**Supply**
Heat Losses		Solar Gains	0	0
Substructure	200,000	Internal Gains	0	0
Roof	600,000	Heating Fuel	1,437,000	1,690,588
External Walls	500,000	Electricity	100,000	100,000
Windows & External Doors	90,000	Biomass	0	0
Ventilation & Distribution Losses	400,000	Solar Thermal	360,000	360,000
Other Heat Losses	7,000	CHP	0	0
Other Heat Use			**1,897,000**	**2,150,588**
DHW	100,000			
Export	0	Conventional Heating System Efficiency		85%
Total	**1,897,000**			
ELECTRICITY DEMAND		**ELECTRICITY INPUT ENERGY**		
Electricity (excl. heat)		**Electricity**		**kWh**
Lighting	150,000	Imported		836,860
Ventilation and Distribution	4,380	Wind		17,520
Cooling	100,000	PV		0
Other	500,000	CHP		0
Export	0			
		less heating/dhw		-100,000
Total	**754,380**	**Total**		**754,380**

More Report outputs are shown on the **[Graphs]** page. These include detailed graphs showing real and nominal cash-flow breakdowns. The following graph shows the first twenty years of positive and negative cashflows for a project. The dotted black line shows the net cashflow.





Graphs showing the energy balance for the building are also available. These demonstrate how energy is used in the building and where it is sourced from.



5 Adapting the Tool

The sheets within the tool have been locked but not password protected. They can therefore be easily unlocked making it possible to tailor them for use in any project. Care should be taken that the logic within the spreadsheet is understood before this takes place. The tool can be adapted to create exemplar templates such as Hotel refurbishment projects or new Health Centre designs.

www.resourceefficientscotland.com | 0808 808 2268 | @ResourceScot

Resource Efficient Scotland, Ground Floor, Moray House, Forthside Way, Stirling, FK8 1QZ

Growth that doesn't cost the earth

A programme from ZERO WASTE SCOTLAND

natural scotland
SCOTTISH GOVERNMENT