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**Programme Area:** Buildings

**Project:** Building Supply Chain for Mass Refurbishment of Houses

**Title:** Final costing methodology used in the ETI-TE model

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**Abstract:**

Please note this report was produced in 2011/2012 and its contents may be out of date. This deliverable is number 2c of 7 in Work Package 2. It presents the final approach to the costing methodology for thermal efficiency improvements to be employed by the project and incorporated into the computer model being developed. Accurate cost information for retrofit interventions is key to ensuring the identification and development of the optimum solutions for each housing archetype previously identified in deliverable D2.1. Intervention costs are estimated for simple / average / difficult properties of each type. This costing detail will be incorporated into the definition of retrofit interventions in Work Package 3.

**Context:**

This project looked at designing a supply chain solution to improve the energy efficiency of the vast majority of the 26 million UK homes which will still be in use by 2050. It looked to identify ways in which the refurbishment and retrofitting of existing residential properties can be accelerated by industrialising the processes of design, supply and implementation, while stimulating demand from householders by exploiting additional opportunities that come with extensive building refurbishment. The project developed a top-to-bottom process, using a method of analysing the most cost-effective package of measures suitable for a particular property, through to how these will be installed with the minimum disruption to the householder. This includes identifying the skills required of the people on the ground as well as the optimum material distribution networks to supply them with exactly what is required and when.

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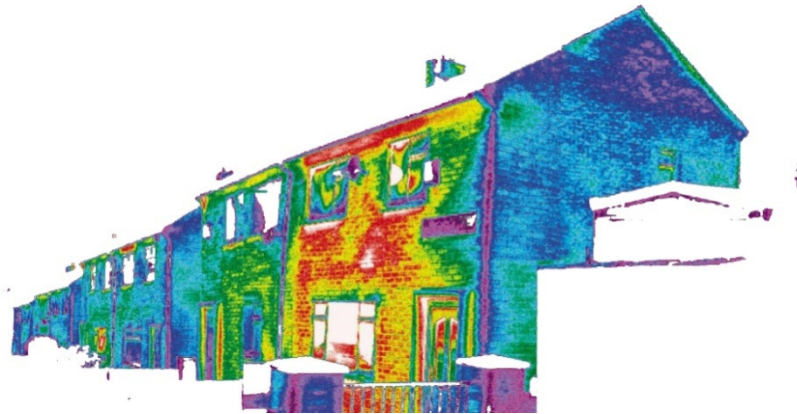
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The **ENERGY ZONE**  
CONSORTIUM:

**bre**



Optimising Thermal Efficiency  
of Existing Housing

# Final costing methodology used in the ETI-TE model (WP2.2c)

FINAL REPORT

Submitted by BRE on behalf of the  
**ENERGY ZONE CONSORTIUM**

*September 30, 2011*

## EXECUTIVE SUMMARY:

The objective of this workpackage item is to provide a structure for costs to be used within the ETI Thermal Efficiency computer model and provide some baseline prices. These costs are not necessarily intended to be used as direct inputs into the model, but represent current prices and practices, and are able to be adjusted in the course of the project to investigate alternative supply chain and design solutions. The costs should provide sufficient information and be presented in a structure which allows sufficient flexibility for alternative scenarios to be investigated.

This note presents the final results of a three-stage process in the development of costs which finalised the costs and model functionality. This was based on feedback from partners on the previous notes and existing model functionality. The model has also been populated with the examples of specific costed interventions at this stage.

### ***SUMMARY OF OUTPUTS***

To allow costs of improvements to be estimated within the modelling, and the TE project more widely, a set of detailed costs for energy efficiency improvements have been produced by Wates. These indicate the costs of installing the measures included in the energy improvements matrix (item 3.3a) and have been considered across the twelve most prevalent housing types described in item 2.1a of the programme. Costs are provided for 'simple', 'average' and 'difficult' properties of these types.

These have been produced by considering the work that is required to install these technologies, and providing prices for each element of work from Wates's experience in providing retrofit solutions. Each of the twelve principal dwelling types have been considered in turn, and the potential for the costs to vary from the base cost (i.e. that originally calculated) has been considered. If a significant variation is believed to be likely an adjusted cost has been produced.

The costs themselves have been split into 'fixed' and 'variable' elements, to reflect that some costs are related to, or dependent on, the area of elements being treated (e.g. wall area), but some are not. This differentiation also allows the user to account for overlapping savings when multiple improvements are applied at the same time. The user is able to adjust these costs in the most appropriate way, to account for savings from items such as access costs, or from installations on a 'whole street level' etc. This allows the user to estimate costs for the specific package or scenario of improvements which they are investigating.

The costs themselves are included in the Excel spreadsheet which accompanies this report (embedded in the word version as Appendix A), as well as being accessible directly from within the computer model itself.

# Refined costing methodology in the ETI-TE model

## INTRODUCTION

This note outlines the final approach to the costing methodology for thermal efficiency improvements which is incorporated as part of the gamma version of the ETI TE computer model (for a single dwelling).

The initial stage of the costing process (outlined in the note produced for WP2.2a) considered how costs should be dealt with by the model. At this stage the costs were defined as either 'fixed' or 'variable', to reflect that some costs are related to, or dependent on, the area of elements being treated (e.g. wall area), but some are not. This differentiation would also allow the user to account for overlapping savings when multiple improvements are applied at the same time and allowed for alternative scenarios to be adjusted. The second stage of the process (WP 2.2b) produced the initial costs themselves. At this stage a spreadsheet containing actual costs was produced, and integrated as part of the ETI computer model itself.

This document forms deliverable WP2.2c of the project in conjunction with both the functionality present within the model itself (which allows calculations of the cost of improvements using the costs contained in Appendix A) and the accompanying spreadsheet of costs.

## DEVELOPMENT OF THE COSTING METHODOLOGY

Estimates of costs for installing Thermal Efficiency measures are essential to be able to assess the feasibility of a large scale retrofit programme. Realistic costs are required to provide estimates of the resources required for such a programme at both the national level and for any particular sub-section of the stock and carry out the appropriate cost-benefit analysis for particular retrofit solutions. This workpackage item defines the baseline costs to be used in the modelling component of the project. The costs themselves are not necessarily intended to be used as direct inputs into the model, but represent current prices and practices, and which are in a format which is suitable to be adjusted in the course of the project to investigate alternative supply chain and design solutions.

Initial consideration of the costs of retrofit looked at those recorded for particular retrofit exemplars. However, it is considered that exemplars would not normally be subject to the same budgetary constraints which would be required by a mass retrofit programme, and indeed would often not have the same aims. Exemplars are typically produced to demonstrate a particular technology, to act as a mechanism of finding and highlighting problems for follow-on projects, and to attempt to achieve a particular target (e.g. zero carbon refurbishment). As a result they often have less regard to the cost of improvements than would be required for a mass retrofit programme. Furthermore, they would not be able

to benefit from the economies of scale that a mass retrofit would be able to achieve. Whilst the technical lessons from exemplar projects will be of great use to the project as a whole, our costing methodology uses an approach based on costing from first principles.

This approach uses the twelve dwelling types and characteristics as identified in the dwelling archetypes document (WP item 2.1a) combined with the improvement options outlined in the technical solutions matrix (WP item 3.3). A range of costs have been provided for each of these types by Wates's team of costing experts which include estimates for the major variables which can affect costs. Specific costs are provided for each dwelling archetype identified.

In accordance with the methodology outlined in item WP2.2a and WP2,2b, costs have been split into two broad types:

- a) Unit costs
- b) Other fixed costs

Unit costs are expressed as a cost per unit area (e.g. cost per square metre of loft insulation). Fixed costs include all other costs associated with installation of the item. By splitting up costs in this way, it allows the user to account for, for example, savings in fixed costs which occur when multiple measures are installed at the same time. This allows the user of the costs (and the model) to take account of items such as 'access cost' savings (scaffolding etc.) when installing new double glazing at the same time as solid wall insulation. This scenario can be simulated in the model by adjusting (or removing) fixed costs when particular measures are installed together.

Through a series of discussions, correspondence and meetings, the initial costs outlined in WP item 2.2b have been reconfirmed by Wates and other partners, and missing items have been completed. Furthermore, the ability to add user defined labels to each element of the costs (fixed and variable) has been added to the computer model itself, together with the incorporation of a variable percentage uplift factor. Finally, some examples of improvements as required for scenarios (such as those required for WP items 3.4 (single dwelling refurbishment plan) and 4.3 (supply chain solutions)) have been pre-loaded into the software. Specific scenarios in support of these WP items will be investigated in the next phase of the project under WP item 2.5 (running of scenarios).

The costs themselves (as well as being accessible from within the model) are included in the MS Word version of this note as an embedded file in Appendix A.

## **MODEL FUNCTIONALITY FOR COSTING**

The computer model which is being developed for the ETI includes functionality to allow the consideration of unit costs and fixed costs.

Costs are able to be input for:

- a) Loft insulation
- b) Cavity wall insulation

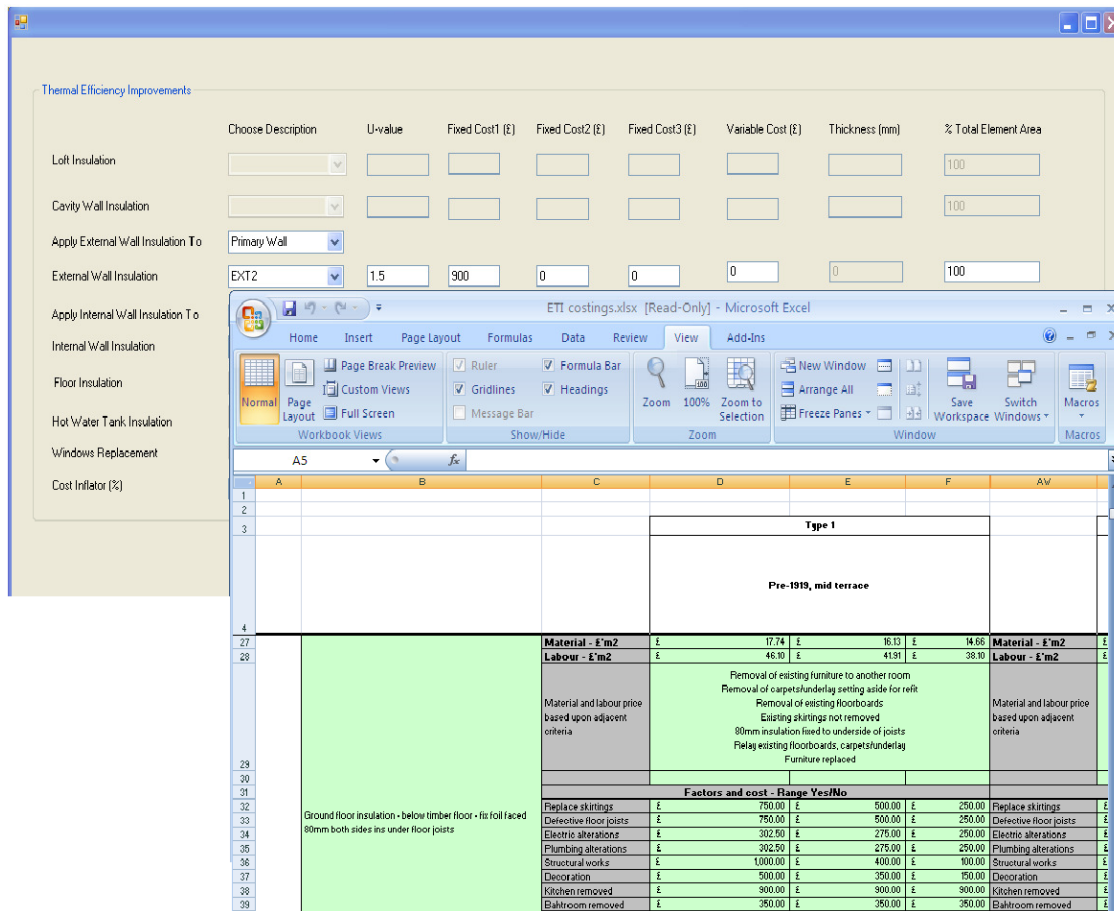
- c) External wall insulation
- d) Internal wall insulation
- e) Floor insulation
- f) Hot water tank insulation
- g) Replacement windows

These are input by the user directly into the model, with reference to the spreadsheet of costs (reproduced in Appendix A) which the user can access via a button on the form. Details of improvements specified by the user (including these costs) are saved to a database for future analysis or adjustment as required. This functionality is shown in Figure 1 to Figure 3 below.

	Choose Description	U-value	Fixed Cost1 (£)	Fixed Cost2 (£)	Fixed Cost3 (£)	Variable Cost (£)	Thickness (mm)	% Total Element Area
Loft Insulation	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="100"/>
Cavity Wall Insulation	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="100"/>
Apply External Wall Insulation To	<input type="text"/>							
External Wall Insulation	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="100"/>
Apply Internal Wall Insulation To	<input type="text"/>							
Internal Wall Insulation	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="100"/>
Floor Insulation	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="100"/>
Hot Water Tank Insulation	<input type="text"/>		<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
Windows Replacement	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	
Cost Inflator (%)	<input type="text" value="100"/>							

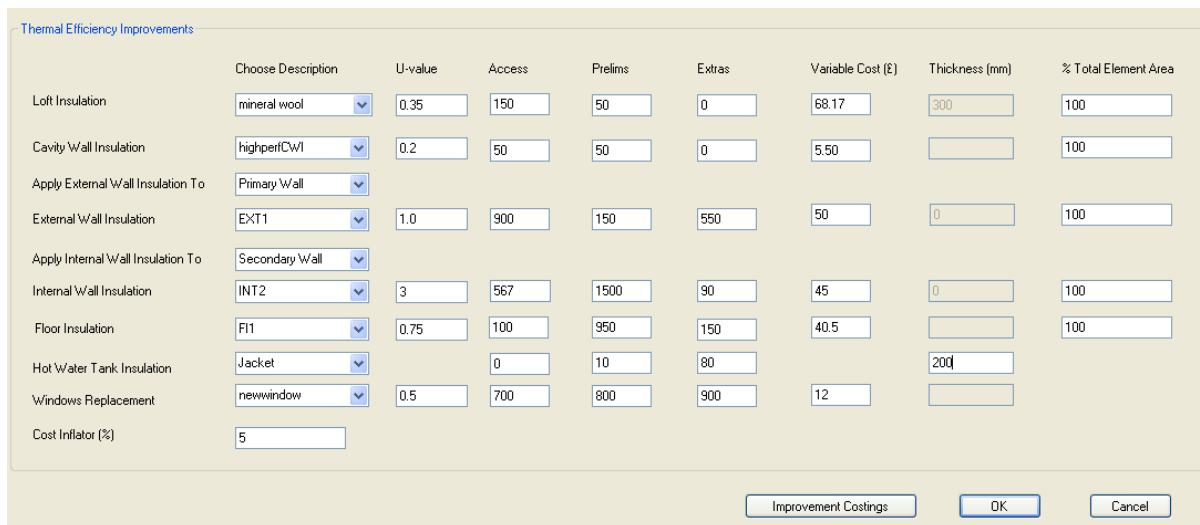
**FIGURE 1: THE BLANK COST SPECIFICATION SCREEN IN THE ETI-TE MODEL. ARROW INDICATES HOW TO ACCESS THE COSTINGS SPREADSHEET.**

Within the model, the user is able to specify the TE improvements they would like to investigate for their particular house type. This includes specifying the details of the costs being attached to each improvement. This should be done with reference to the detailed costing spreadsheet produced by Wates. Pressing the 'costings' button indicated in Figure 1 opens up the costs spreadsheet to allow the user to input costs for any particular dwelling (or set of dwellings). This is shown in Figure 2 below. Users are able to adjust for overlaps or simulate savings to particular measures (for example from an alternative supply chain).



**FIGURE 2: BY USING THE COST SPREADSHEETS (OPENED BY PRESSING THE COSTINGS BUTTON) THE USER IS ABLE TO INPUT DETAILS OF FIXED AND VARIABLE COSTS FOR EACH IMPROVEMENT.**

Full costs for each improvement can be specified. Once specified by the user these are saved for use in further scenario work, or for reference. The headings for each element of the costs (e.g. Access, Prelims etc) can be specified and adjusted by the user for each improvement scenario.



**FIGURE 3: DETAILS OF EACH IMPROVEMENT ARE SETUP BY THE USER AND CAN BE RECALLED FOR FUTURE SCENARIOS THAT ARE RUN.**

The model also includes the capacity to adjust fuel prices to allow lifetime savings in running costs to be compared to capital costs of measures. This is shown in Figure 4 below.

SingleDwelling

bre energy technologies institute UCL

Use UCL internal temperature algorithm  Record monthly energy use

Select Dwelling Stereotype: Semi & end terrace - Pre 1919

General Dimensions Space Heating Water Heating Occupants **Fuel Prices** Others

Mains Gas (p/kWh)	3.41
Bulk LPG (p/kWh)	6.77
Bottled LPG (p/kWh)	9.59
Oil (p/kWh)	4.69
Coal (p/kWh)	3.48
Standard Electricity (p/kWh)	12.46
7-Hour Tariff On Peak (p/kWh)	14.29
7-Hour Tariff Off Peak (p/kWh)	5.17
Biomass (p/kWh)	3.84

Exit Run Model

FIGURE 4: THE ETI-TE MODEL USER INPUT SCREEN ALLOWING FUEL PRICES TO BE SET BY THE USER

## SUMMARY

A set of costs has been produced in the format of 'variable' and 'fixed' costs. These have been developed and confirmed based on current prices of work undertaken by Wates. Specific functionality has been incorporated within the computer model to incorporate these costs which will allow alternative scenarios for design and supply chains to be investigated. The costs themselves can be accessed directly from within the computer model and can also be found in the spreadsheet which accompanies this note (embedded in the MS Word version of this note or as a separate Excel worksheet).



## **APPENDIX A: COSTS OF INTERVENTION FOR 12 PRIMARY DWELLING TYPES**

The following table of costs has been produced by Wates as indicative of the costs for intervention in the 12 most common dwelling types in England. Users of the ETI TE model are referred to these costs when specifying TE improvement scenarios.

There are 12 sets of tables which are best examined using the specific index worksheet:



BU1001\_PM05.2.2c\_  
CostSpreadsheet\_v1